FARM HOUSEHOLD DECISION-MAKING:

THEORY AND EVIDENCE FROM A RURAL ECONOMY

BY

© SHAHIDUR RAHMAN KHANDKER, B.Sc. (Honours), M.Sc. M.A.

A THESIS

Submitted to the School of Graduate Studies in Partial Fulfilment

of the Requirements for the Degree

DOCTOR OF PHILOSOPHY

McMaster University

(1982)

FARM HOUSEHOLD DECISION-MAKING:

THEORY AND EVIDENCE

DOCTOR OF PHILOSOPHY (1982)
(Economics)

McMaster University
Hamilton, Ontario

TITLE: Farm Household Decision-Making: Theory and Evidence from a Rural Economy.

AUTHOR: Shahidur Rahman Khandker

B.Sc. (Honours, Jahangirnagar University)

M.Sc. (Jahangirnagar University)

M.A. (McMaster University)

SUPERVISOR: Professor David W. Butterfield

Number of Pages: xvi, 343

DEDICATED TO MY

PARENTS

ABSTRACT

Policy interventions into the rural sectors of developing countries are urgently needed in order to alleviate poverty and foster economic growth. The applicability of a farm household model that combines the farm household's production and consumption decisions to the evaluation of policy measures has been explored in this study. A model incorporating the farm household's decisions regarding resource allocation, family size, schooling and participation in income earning activities is developed and its predictions are tested with farm household data from Bangladesh.

The data analysis reveals that in rural Bangladesh there exist close relationships between farm size, family size, child schooling and income. The size of the family labour force, which is determined by family size and child schooling rates, appears to be an important determinant of farm household participation in income earning activities. Farm households are found to maximize profit, to respond to price incentives and to be allocatively efficient, given the technology and resources available. On the consumption side, a linear expenditure system that contains a set of household demand functions for goods, including household produced goods, family size and child schooling, and labour supply functions has been estimated. Household response elasticities with respect to some selected variables are calculated first on the assumption that consumption is independent of production decisions. The results show that the household's

demand for farm goods is income inelastic while demand for non-farm goods is income elastic. It also suggests that the demand for child quantity and child quality are income inelastic but that a trade-off exists between quantity and quality of minor children.

To the extent that the farm household's consumption decisions depend on production decisions, an analysis of the interaction between production and consumption behaviour is undertaken. The major finding of this analysis is that farm households are responsive to prices, income and technical change, both in production and consumption. Any change that may occur in production, following exogeneous changes through some policy variables, also affects household consumption behaviour. This suggests that a model of farm household decision-making that incorporates the interaction of production and consumption behaviour can be of particular importance for policy evaluation.

ACKNOWLEDGEMENTS

A number of persons and agencies have contributed in various ways to the completion of this study. I would like to extend my sincere gratitude to all of them.

I express my deep gratitude to my supervisory committee for their keen interest and help in undertaking this project. I am deeply indebted to Professor David W. Butterfield for his constant help and encouragement at every stage of this research. His generous and constant guidance in shaping up my ideas in this study is gratefully acknowledged. I am also indebted to Professor Stuart Mestelman for his valuable guidance at different stages of this work. He had also helped me substantially in matters related to undertaking the sample survey project in Bangladesh. I express my deep gratitude to him. I also acknowledge my gratitude to Professor David Feeny for his constructive suggestions at different stages of this study and for referring me constantly to the vast field of the development literature. I also benefitted from a discussion with Professor Mark Rosenzweig of Minnesota University.

I was greatly encouraged by my discussions and correspondences with Professor Robert Evenson of Yale University. I wish to thank him for his help in constructing my sample questionnaire by allowing me to use materials at the Economic Growth Center and in arranging discussions with his colleagues at the center.

I am indebted to the Ford Foundation for their individual grant which supported my sample survey project in Bangladesh. I would like to thank Dr. Martin Hanratty, of the Ford Foundation, Dacca, for his help and interest in my project. Also I am thankful to the National Foundation for Research on Human Resource Development (NFRHRD), Dacca for accrediting me as a visiting scholar with the Foundation and providing me logistic support for carrying out the sample survey project. I am particularly thankful to Dr. S.A. Qadir and Dr. Sal Ahmed and their colleagues at NFRHRD for their friendly help at various stages of the data collection project. My sincere gratitude is also extended to my research enumerators and the farm households of Hamsadi and Khilgati for their cooperation.

I would like to acknowledge my gratitude to McMaster University for financial support throughout my graduate study. I am thankful to John Ellis for his computational assistance and Ms. Linda Palmer for her excellent job in typing of this thesis.

I am ever grateful to my parents and brothers and sisters for their moral support and encouragement in my study abroad and in the completion of the work. I am also thankful to my wife, Shirin, for her compassionate encouragement and support.

The responsibility for mistakes and deficiencies in the study rests, of course, with me.

TABLE OF CONTENTS

Page

Page

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

INTRODUCTION

In recent years, there is an increasing consensus among policy makers that the alleviation of poverty and the satisfaction of basic needs of the rural population should be a priority in the development plans of the developing nations. The emphasis on this objective is based on the realization that "urban-oriented" development models failed to promote growth in the rural sector and that the agrarian sectors of developing countries are lagging behind. Ironically, it is in the agricultural sector that the overwhelming majority of the population lives.

Not surprisingly the recent economic development literature has shifted its focus from urban development models to "rural-led" growth models. Increasing attention is now given to the understanding of rural institutions and the underlying decision-making of farm households. This understanding is needed if policy interventions into the agrarian economy are to successfully alleviate poverty and foster economic growth. This shift in policy emphasis has resulted in a number of rural development strategies being launched by the governments of LDCs. These policies include the provision of rural infrastructure, inputs, organizational services, rural schooling facilities, and the delivery of health and family planning services.

Unfortunately very little progress has been achieved for most of the developing nations. It is observed that for many of these countries, the sluggish performance of the rural sector is often characterized by insufficient food production, unemployment, rapidly growing population, low literacy rates and above all, mass poverty. Given these facts, the growing concern is that before any significant progress can be achieved the underlying decision-making process of farm households needs to be identified properly so that policy intervention can be directed accordingly. The reason for this is obvious. The effect of any policy intervention in the rural sector is ultimately determined by the responses of the economic agents in this sector. And in an agrarian society the relevant economic agents are the farm households who are producers as well as consumers in the household enterprise. Any policy intervention, therefore, must be evaluated in terms of farm household responses regarding both production and consumption behaviour. For instance, the provision of modern technology into the agrarian sector of irrigation facilities coupled with high yielding crops would certainly affect the production decisions of farm households. But simultaneously, as a spill-over effect, this also results in changing consumption behaviour. The consumption of goods and leisure is changed because of the induced income effects of this technical change.

Similarly, providing schooling facilities in the rural areas to improve literacy, or the delivery of health and family planning services to promote the small family size norm among peasant households must be evaluated in terms of the effects on both production and consumption decisions. If schooling facilities or family planning services are intended to lead to consumption of more child schooling or less child quantity, then these policies should also have effects on corresponding production decisions of farm households. More specifically, since the family labour force is one of the major determinants of household resource allocation and since family size and child schooling decisions affect this family labour endowment, the services provided by the government to improve the literacy rate or reduce family size must have effects on agricultural production decisions. Because family labour, including child labour, is valuable in the household enterprise, the objective of curbing the population explosion or increasing literacy rates by providing family planning and schooling services in the villages will be estimated inaccurately unless their simultaneous effects on household production decisions are considered. It follows, therefore, that a theory of the farm household that combines production and consumption decisions together is of particular importance for policy evaluation in the context of an agrarian economy.

A review of studies of the peasant economy in Chapter Two reinforces our argument that, in order to evaluate policies for the rural sectors of the developing countries, modelling farm household decision-making is important. The literature review is focussed on issues involved directly with the peasant household's decision-making regarding family size, child schooling, and agricultural production and input choice decisions. We find that resource allocation decisions as presented in the development literature are presumed to be independent of the farm household's resource position including the family labour endowment, while consumption decisions of the peasant households are guided by the income-leisure trade-off given the size of the family labour force. Thus, we discover that resource allocation decisions are particularly dependent on the family labour endowment, which in turn depends on family size and child schooling decisions. It follows that family size and child schooling decisions, which are part of consumption decisions, are very much related to the resource allocation decisions of the peasant households. This in turn suggests that a farm household model integrating both production and consumption decisions can be of particular importance for evaluating "strategies" for rural development.

The present study is directed towards formulating a model of the farm household that integrates all the relevant decision-making problems including family size, child schooling, consumption of all other goods and leisure, as well as agricultural production decisions. The study of the farm household model is not new, although data limitations have restricted it actual application.[1] The theory of the farm household has been applied to data from Taiwan and Malaysia in order to describe the income-leisure choice of rural households.[2] However, these models do not consider the endogeneous determination of the size of the family labour force. The farm household model developed in Chapter Three utilizes the work of Becker (1965), in which non-traditional goods, such as child quantity and child schooling can be regarded as household produced goods.[3] These are integrated with all other farm household consumption decisions into the resource allocation model in order to identify a systematic relationship between agricultural production decisions and family consumption decisions.

The application of this farm household model requires extensive and detailed farm household survey data. With support from the Ford Foundation, a detailed data set covering the major household characteristics, and the spectrum of major income earning activities and expenditures has been collected from two villages of rural Bangladesh. The period covered was from March, 1981 to April, 1982.

Chapter Four presents a discussion of the major socio-economic characteristics of the data set in terms of farm size, family size, schooling and income earning activities. The major observations are that there exist close relationships between farm size, landholding, income earned, family size and child schooling and that competitive forces in the labour market ensure that farm household production decisions can be regarded as independent of consumption decisions. However, consumption decisions depend on production decisions through farm income. Any changes in farm income will have an impact on consumption behaviour.

Accordingly, farm household production decisions regarding resource allocation in agriculture are explored in Chapter Five through a production function analysis. Production function estimates are made for a multi-crop farm economy, with special emphasis on heterogeneous labour services. The results of this analysis suggest that peasant households maximize profits, respond to price incentives and are allocatively efficient given the technology and resources available.

The sixth chapter considers household consumption decisions as if consumption is independent of production decisions. As part of the farm household model, a linear expenditure system is developed which incorporates the features of the Bangladesh data characteristics. A set of household demand functions, for different categories of leisure (and hence labour supply functions), farm and non-farm goods, child quantity and child quality (schooling) are derived. The system of linear expenditure equations has been estimated with farm household data and household response elasticities with respect to some selected variables are calculated and presented. These empirical results show the demand for farm goods to be income inelastic while the demand for non-farm goods is income elastic. One particular conclusion following from the estimated expenditure equations is that the demand for child quantity and child quality are income inelastic and that there exists a trade-off between child quantity and child quality.

The household response elasticities presented in Chapter Six are based on the assumption that household expenditure is held constant. This requires that farm profits are not allowed to vary. To the extent that farm profits are responsive to price incentives and technical change, it is imperative that interactions between production and consumption decisions are allowed to take place through changes in farm profits following exogeneous changes in output prices, wage rates or technology.

In Chapter Seven this interaction of production and consumption decisions of farm households is examined. The analysis in this chapter shows that the interaction of the farm household production and consumption decisions is important to the extent that the farm household's consumption response is changed dramatically when production decisions are allowed to exert their influence. This implies that a farm household model that combines production and consumption decisions together is extremely important for policy evaluations in the context of a peasant economy.

However, to derive the policy implications of this farm household model these micro-economic findings must be incorporated into a general equilibrium analysis of the village economy. This more comprehensive model can be used to analyze the impact of alternative policy instruments which may be introduced to stimulate economic activity in the rural sector of a developing country. Chapter Eight summarizes the results of the work in the previous chapters and presents a discussion regarding the possible ways of extending this research on the rural economy.

FOOTNOTES TO CHAPTER ONE

1. See, e.g., Chayanov (1966), Krishna (1969), Sen (1966).

2. Two empirical studies are known to the author; one is done for Taiwan by Lau et al (1978), and the other is for Malaysia by Barnum and Squire (1979).

3. For empirical results of a household production model that incorporates Becker's work, see, e.g., Rosenzweig and Evenson (1977).

CHAPTER TWO

DECISION-MAKING BY FARM HOUSEHOLDS IN A PEASANT ECONOMY

2.1 Introduction

The last decade has witnessed a major switch from the development model of rapid industrialization which assigns agriculture a secondary role to a "rural led" growth model with major emphasis on agricultural development and the rural population. This shift in emphasis has arisen mainly because of (i) a high population growth rate - a rate that cannot be absorbed in the modern sector of the developing countries and (ii) the chronic food deficit due to the slow growth of production in the rural sector. It is, therefore, necessary to expand agricultural production and other employment opportunities in the rural sector in order to permit the absorption of a growing work force in productive rural employment. Although accelerating the expansion of output and employment in the modern sector is of great importance, there exist highly significant linkages between agricultural development and an employment oriented growth strategy for industry. More importantly, for the agrarian developing economies the lead must come from the rural sector [John Mellor (1976)].

Mass poverty with malnutrition, disease and poor health reduce the productivity of human resources. To overcome such problems, the simultaneous expansion of food production and the increase of the effective demand of the lower income groups is necessary. This will enable a large proportion of the population to raise its consumption of necessities. This requires that a large and increasing percentage of farm households participate in the increased productivity and income associated with agricultural development. For this to occur a fundamental requirement is the encouragement of the adoption of labour-using technology and the (divisible) yield-increasing inputs which require greater participation of the farm population. This increased agricultural output and employment will foster the growth of rural based manufacturing firms which in turn will increase demand for urban based commodities. In other words, the most fundamental factor leading to larger returns to labour and hence to an increase in the consumption of necessities is a rate of growth in the demand for labour that exceeds the rate of increase in the supply of workers seeking jobs [Johnston & Meyer (1977)].

At the same time, it is also important to reduce the high rate of growth of population. With the continued growth of a country's farm population, it becomes increasingly difficult to raise per capita output in agriculture. Therefore it is suggested that many of the agrarian developing countries are not likely to succeed in their efforts to promote economic and social development unless strategies for rural development are designed to achieve the inter-related objectives of reducing the birth rate and increasing farm output. This has led policy makers to suggest strategies for achieving self-sustaining economic growth.

The complexities of the socio-economic factors responsible for the sluggish performance of the rural economy require "multimodal" strategies of rural development. They include (i) a strategy for agricultural development by providing rural infrastructure, inputs and organisational services; (ii) a rural education strategy; (iii) a strategy for fostering the growth of the rural based manufacturing firms; and finally (iv) a strategy for the delivery of health and family planning services.

Given this new emphasis, most developing countries are pursuing strategies for rural development, within their resource constraint. Unfortunately, very little progress has been achieved. On the contrary, the situation is often getting worse. Growing commercialization with government intervention in the rural economy has produced some perverse results. An increased intensity of landlessness and near-landlessness with mass poverty among rural peasants has been found in many of the developing countries [see I.L.O. Report for Asia (1977)]. This evidence indicates that the strategies launched so far are inadequate in coping with the problems of the rural sector as a whole. This raises doubts about the efficacy of such strategies in the context of the rural economy[1]. However, to evaluate such policies it is necessary to understand decision-making problems of the peasant economy and the constraints within which rural households make decisions about the allocation of their resources. Before making such an evaluation, it is also necessary to examine the literature dealing with the decision-making of farm households which will help us to carry out further research into the peasant economy.

2.2 Decision-Making by Farm households: A Review of Peasant Studies

Since strategies for rural development emphasize issues such as high population growth, low literacy rates, low agricultural production and low rural employment opportunities, a review of the literature on the peasant economy will be guided by the following questions which will help to identify the factors responsible for impoverishing the rural sector:

(a) why do peasants have large families relative to land and other productive resources?

(b) what influences child-education decisions of the farm households?

(c) what are the factors responsible for the low productivity in agriculture?

(d) how do peasants allocate their resources and what constraints do they perceive in the allocation of their resources?

(e) are peasant farmers efficient in resource allocation?

(f) does the family size or the decision about the family size and child-schooling affect the household's resources and their allocation? How does the resource position and its allocation affect family size and child-schooling decisions?

(g) is this causal effect a one way or a two-way interaction?

The literature on all these issues related to rural development strategies is fragmentary and the purpose of this review is to bring it together.

2.3 Decisions over Family Size and Child-Schooling

Our understanding of the determinants of human fertility is still inadequate for precisely identifying what determines high fertility in a peasant economy. While there is no over population problem in the developed countries, many developing countries, such as India and Bangladesh, are experiencing a population boom with a rate of growth of 2 to 3% annually. The optimistic view prevailing over the last two decades was that the launching of family planning programmes would cut down this high birth rate in the developing world in much the same way that death rates (infant) have been brought down by the transfer of modern health technology. But recent experience has belied this optimism and the increasing consensus is that various socio-economic and cultural variables which influence attitudes, motivation and ideas about optimal family size must change if family size is to be reduced. Policy makers still lack an understanding of the prime factors among these variables which could be manipulated to effectively reduce fertility rates.

There are various explanations given by social scientists for the differences in human fertility in a society. Following Easterlin's synthesis of the economics and sociology of fertility, three sets of variables influence family size in a society:

(i) demand, defined as the number of surviving children parents would want (for various reasons);

(ii) supply, defined by the "natural fertility" which is to some extent demand determined; and

(iii) the costs of fertility regulation which include both subjective and objective costs.

While sociologists emphasize the third factor, the economists' explanation is mainly based on the demand aspects. They attempt to identify the economic variables that determine the parents' desire to have children.

The potential supply of children usually depends on "natural fertility" which is influenced by cultural and physiological factors and the survival prospects of children. Easterlin's hypothesis is that in a society's pre-modern phase, the supply of children is influenced by low survival rates and typically falls short of the desired number of children. Hence there is no problem of excess supply. But in the early modern phase, improved child survival prospects and other changes lead to an increase in the potential supply, given the pre-modern behaviour, so that potential supply exceeds the desired number of children. This hypothesis thus suggests that in this early modern phase, it is demand side, which is influenced by taste and preferences, income and prices, that determines the ultimate family size in a society. This assumes that while technological change (regarding child survival) is not anticipated, economic factors will be incorporated into the households decision.

The economist's explanation of this demand side, usually based on a utility maximizing framework, focuses on income and the prices of children as major variables determining fertility. Becker's (1965) seminal work on the new consumer theory produces a demand theory of fertility where children are viewed as commodities produced in the home. In this approach, one can derive shadow prices of children which depend on prices and quantities of inputs used to produce them, and on the structure and technology of the household production process. Because both quantity and quality of children presumably yield positive utility and have positive costs, the income of the household and the shadow price or cost of children determine fertility [Willis (1973), Keeley (1975)].

This theoretical model has been tested with data from various sources [see e.g, Wilkinson (1978), Ben Porath (1973)]. Though the estimates of different studies do not always yield the same results, the most important variables appear to be the cost of mother's time (the opportunity cost) and income of the household. However, significant controversy arises over the effect of income. In some studies, increase in per capita income appears to be negatively related with fertility while others showed positive or no relationship [see Leibenstein (1974), Keeley (1975)]. However, in most developed countries, it has been observed that fertility has declined while there has been an increase in per capita income.[2] Since an increase in per capita income is a sine qua non of economic development, this finding suggests that modernization is the key factor in reducing fertility. On the other hand, urbanization is the defacto evidence of modernization in the history of development, this in turn implies that urbanization would coincide with a slowing down of the population growth rate.

Of course, none of these findings suggest the immediate reduction of population growth in most of the developing countries. Neither urbanization nor large increases in per capita income is achievable for these countries in the near future. Yet evidence from Taiwan, Korea and Sri Lanka suggests that fertility can be significantly reduced even without increases in income or the level of urbanization.[3] This suggests that the empirical evidence from the developed countries need not be interpreted as describing a necessary condition for population growth control.

One crucial assumption in the existing demand theory [e.g., Willis (1973)] is that children produce only non-pecuniary returns, an assumption which may be more relevant in the developed economies than in agrarian developing economies. In most rural societies, children play an important role in productive activities and thus yield pecuniary returns, as well as psychic returns to parents. This productive role of children should be incorporated into the theoretical model which attempts to explain the variation in fertility in the peasant economy. Leibenstein (1975, 1974) stresses this productive role of children and the form of old-age security which they provide while analysing the determinants of fertility.

Rosenzweig (1977), and Rosenzweig and Evenson (1977) include the productive activity of children in the demand theory of fertility. In the Rosenzweig and Evenson study, decisions which are jointly associated with child investment (family size, child schooling and child labour force participation) are examined in the household production model and tested with district level data from rural areas of India. In their study, it is found that variables positively related with the pecuniary returns to child labour (size of landholding, agricultural productivity and child-wage rates) are positively associated with fertility and child-labour force participation and negatively related to child schooling.

This finding suggests that one of the basic factors motivating rural families to bear relatively large numbers of children is the return to the use of child labour. Hence, the productive contribution of children appears to be an important factor in determining family size and child schooling. At the same time, the Rosenzweig and Evenson study suggests that a land distribution program aimed at promoting equality would both increase fertility and depress child schooling rates.

Starting with the hypothesis that fertility is inversely related to the distribution of income, Repetto (1979) explores redistribution policies in rural India, indicating that the distribution of landownership is the primary determinant of income distribution. Repetto's book presents a case study of economic development and fertility change in the Republic of Korea, providing a historical perspective on the consequences of income redistribution. He draws the conclusion that an equitable land distribution in rural India would reduce fertility. In a study of Bangladesh rural areas, no unambiguous relationship between landownership and fertility was found [Latif and Chowdhury (1977)]. However, Mead Cain's (1977) study on children's activity in rural Bangladesh shows that a major activity of children is their productive activity, which is found to be very important for generating family income in rural areas. In another study, following Leibenstein's suggestion of the productive role of children, it is shown that the effect of uncertain landrights has actually tended to increase family size in rural areas of Mexico [DeVany and Sanchez (1979)].

These studies, therefore, reveal two important facts about peasant society:

(a) children's productive contribution is a significant factor in household decision-making about family size and child schooling;

and (b) any uncertainty associated with the landholding right (the major item in the peasant's resource position) influences the fertility decision of the rural household.

While uncertainty may play an important role in a peasant economy, no study has yet explored the effect of the uncertainty of household income (as distinct from uncertainty of landholding) on the family size and child schooling decision. Because different studies recognize the productive contribution of children in generating household income, it can be reasonably expected that any uncertainty related to this income also may have an effect on decisions regarding family size and child schooling. More importantly, the productive role of children in the family enterprise recognises further that the resource position of the household not only influences family size and child schooling decisions, it is also influenced as well by these decision variables. That is to say, the resource position and its allocation is not independent of family size and child schooling decisions of the household. As Zvi Griliches (1973) observes, children differ from other consumer durables in that once born, they undoubtedly affect the family decision-making process itself.

But the analysis of resource allocation in the peasant economy has been approached as independent of the agricultural household's ability to affect its labour endowment. Keeping in mind the fact that family size can affect the household's resource position and its allocation, let us now explore the resource allocation problem and its efficiency and then try to link this issue with the issue of family size.

2.4 Resource Allocation and its Efficiency in the Peasant Economy

A large volume of theoretical and empirical literature has been devoted to the problem of household resource allocation in agricultural economics. Out of this vast literature it is very difficult to make a comprehensive survey regarding all relevant issues pertaining to the rural economy. Since agriculture itself is a complex set of activities which is highly variable within a peasant economy, any such attempt would be a heuristic exercise. But since we are interested in the individual household decision-making problems, those issues pertaining to the decision-making process will be covered in this survey. Before beginning a literature survey for analytical purposes it is better to identify the mutually inclusive issues that are closely related with such agricultural decision-making problems. These include:

i) postulates of economic behaviour of peasants;

ii) land tenancy and its effects on efficiency;

iii) farm size, tenancy conditions and productivity;

iv) peasants' attitudes toward the adoption of new technology;

v) the impact of uncertainty and risk aversion on resource allocation.

Since efficient decision-making is very much related to the household resource position, we must know the state of tenure arrangements in a peasant economy. Moreover, as efficiency is always characterized by the efficient use of inputs, it is also important to know the nature of the production functions of agricultural outputs.

For a peasant economy the most important variables are land and labour. While capital is also a necessary input of production, in a premodern agricultural setting, capital takes mainly the form of circulating capital - seed plus a "wage fund" to enable the family to subsist between harvests [Reynolds(1975)]. On the other hand, the nature of tenurial arrangements depends in part on the distribution of land. Given the distribution of land, family size and its structure determine the household endowment of labour which can affect the household resource (land) allocation and hence land tenancy. Moreover, because the family is considered as the productive unit within the family-based enterprise, its size can affect the farms' resource position, such as landholding. This effect is neglected in the modern literature.

The customary practice in the analysis of agricultural economics is to identify the nature of tenurial arrangements in the peasant economy and to study the efficiency of resource allocation of the household enterprise. In a peasant economy, one encounters several kinds of land tenure systems such as owner-operated farming, share-tenancy, fixed-rent tenancy, and wage-labour farming. Though any combination of these systems can exist together, one particular form often tends to be predominant in any particular peasant society. The pragmatic approach is to model the peasant economy on the basis of this dominant form. For most peasant economies, a model based on large landowners hiring wage labour is not appropriate, because while such landlords do exist, they rarely predominate in the rural economy. Similarly, the pure family farm or the "natural economy" which uses only family labour and does not hire in labour is also an inappropriate system for modelling the South Asian peasant economy, because even the small owners obtain a significant percentage of total labour input from the labour market. Therefore, a correct way to model the peasant economy is to assume a mixed family farming system which, depending on its land-labour endowment, allocates resources between agriculture and non-agriculture, between own farming and wage earning, and between own-land farming and rented-in land farming. The dominant form of peasant activity, described and analysed in the literature, is the allocation of resources among agricultural activities.

But even within agricultural activities, there are constraints on both inputs, land and labour, and a household enterprise can diversify its productive activity in different ways according to its perceived set of constraints. Not surprisingly, therefore, the bulk of the literature analyses the probable constraints and their effects on household decisions concerning resource allocation and, hence, on allocative efficiency and agricultural productivity.

There are quite a number of hypotheses offered in the literature to explain the economic behaviour of peasants. Some postulate "inert" peasants who are bound by custom and tradition and who are unresponsive to new production and consumption possibilities. Some view farmers as "satisfycing" peasants who put forth only the effort needed to achieve a certain target income. On the other hand some model the peasant economy on the basis of optimizing behaviour on the part of the peasants [T. W. Schultz (1964)]. In this view, the optimizing peasant is a shrewd fellow who has learned through experience to allocate resources efficiently and who is "responsive" to economic incentives within his perceived opportunity set [Reynolds (1975)]

Since the weight of available research evidence supports the optimizing peasant behaviour approach, the alternative characterizations of peasants have for the most part been discarded in the current literature. Therefore, it is now a customary practice to model the peasant in an optimizing fashion and subsequently to write the marginal equalities necessary to maximize the family's satisfaction and then test these against survey data.

Of course, the observed behaviour of peasants does not always coincide with the hypothetical optimizing behaviour. The apparent deviations are explained by appealing to alternative constraints on the behaviour of the peasants rather than by alternative motivations. Hence the bulk of the recent studies are devoted to theoretical and empirical attempts to explore alternative sets of constraints and their influences on peasant behaviour, and then to consider whether these explanations are reasonable approximations of the observed phenomenon. These studies, however, generally ignore the allocation of household resources between agricultural and non-agricultural activities which seems to be an important decision in the peasant economy.

2.4.1 Allocative Efficiency in Agriculture

Ever since T. W. Schultz (1964) suggested that peasant agriculture might indeed be efficient within the context of traditional technology and factor availability, a substantial amount of research has been done to test this hypothesis of efficient resource allocation in agriculture. Most of the literature tests agricultural efficiency by determining whether the ratio of the mean marginal product of any pair of inputs in agricultural production is equal to the ratio of input prices. And by such a measure most studies have found peasant farmers to be reasonably efficient [see Sahota (1968), Hopper (1965), Huang (1971), Yotopoulos and Lau (1973)].

Allocative efficiency poses another important question, namely, whether peasant producers respond to change in the direction predicted by maximizing models of farm management. There now is an overwhelming body of evidence that peasant producers respond to changes in relative prices (either inputs or outputs) in the "correct" direction (though not always) and that the magnitude of the response varies with the circumstances. This suggests that Schultz's optimizing peasants are rational within their own context. Now the question immediately arises - does it follow that growth in agricultural productivity can be achieved by increasing factor availability and the provision of new technologies? Of course, this is a dynamic issue, different from the static problem of allocative efficiency. Here the received economic analysis discusses two important aspects of this matter: (a) farm size and efficiency; and, (b) the tenancy system and efficiency.

2.4.2 Farm Size and Efficiency

The general conclusion of the existing literature is that an inverse relationship exists between farm size and land productivity (a partial measure of efficiency) [see Bardhan (1971), Berry and Cline (1979), M. Hossian (1977)]. The main reason for this observed inverse relationship lies in the factor endowment position of the farmers. The small farmer makes intensive use of his available land, largely through applying higher levels of family labour inputs per unit of land, thus leading to higher per acre yields than those obtained by the large farmer.

The labour to land ratio is greater for small farms than large farms because the small farm owner has family members who can be put to work on the land but who cannot be effectively hired out (primarily because of their age or because they are needed for other household chores). The large farm owner does not have as many family members per acre as does the small farm owner and must, therefore, hire in additional workers at the market wage rate. Because the large farm owner must pay to add more labour to his land, his labour to land ratio is not as large as that of the small land owner who puts his additional workers into the land, treating their opportunity cost as less than the market wage [see

S. S. Bhalla in Berry and Cline (1979)]. The yield per acre of the small landowner will be greater than of the large landowner. Small farms are universally characterized by higher land utilization either in the form of high multiple cropping ratios or in higher shares of total land cultivated. But, critics argue, this does not necessarily reflect a superiority of family based peasant production over wage labour based large farm production. A more important issue is the dynamic one, namely, which size farms are more prone to adopt new technology. In other words, the issue is to examine whether the provision of new technologies in agriculture shows any discrepancy between adoption rates among different size farmers and whether this phenomenon has any effect on the inverse relationship between farm size and land productivity.

It may be observed that large farm owners are more dynamic than small farm owners in the adoption of new technologies. Their higher education makes them more aware of technologies and their greater margin for risk taking and access to capital markets may enable them to shift to new techniques sooner.

The observation in some countries of higher yields per acre from the land put into cultivation on large farms is often cited as empirical evidence in support of this view. However, in some cases, this relationship is found to be reversed. For instance, in Ferozpur, India, it is found that as a result of the introduction of chemical fertilizers, labour saving machinery and modern irrigation equipment, the relationship between farm size and land productivity changed from negative to positive [A. K. Ghose (1978)]. The tendency on these farms, however, is to confine cultivation to a smaller, more fertile proportion of total area and this may contribute to such reversals in the relationship.

Therefore, this issue must be carefully explored at the empirical level with careful examination of the important factors which must be considered before reaching any conclusion on this issue. In their study, Berry and Cline (1979) observe these factors to be important:

i) The existence of an imperfect capital market confers an advantage to large farm owners in access to the credit needed for purchasing modern inputs. It has been observed, therefore, that precisely because of this disadvantage, the small farms will frequently have a higher rate of return resulting from the supply of additional units of credit-financed modern inputs;

ii) In labour-abundant economies, large farm adoption of mechanized techniques represents a distortion in the factor market;

iii) By referring to the well known logistic curve (S-shaped), relating the percentage of farmers adopting new technology to time, which suggests that ultimately small farmers will also adopt new techniques, but with a lag, it is argued that once adoption of new techniques and varieties take place, the earlier size-productivity relationship is likely to be re-established in relative terms, with higher output per farm area at all sizes.

Therefore, Berry and Cline suggest that programs must be expanded to make credit and modern inputs available to small farms where the return would be higher because of lower or nil current levels of utilization of modern inputs.[4]

Another hypothesis introduced in the recent literature is that small farms are lagging behind in adopting modern technologies because of their attitudes toward risk. Here the empirical issue is to identify to what extent risk plays a role in the discrepancy between observed behaviour of farms with the hypothetical optimizing behaviour. In a recent study, J. A. Roumasset (1976) questions the validity of the hypothesis that poverty causes risk aversion which inhibits innovation. This is often suggested to explain the apparent reluctance of small farmers to switch to modern production methods. The assumption usually advanced is that HYV's in combination with high levels of cash inputs will maximize expected profit but would also involve high risk which may inhibit farmers from accepting them. Roumasset argues that there is no valid evidence to support the assumption that the most profitable techniques of rice production are more risky than the traditional techniques. Similarly, he argues, it has not been established that even if an inverse relationship between profitability and security exists, that risk preferences are such so as to inhibit acceptance of the profitable techniques that maximize expected profit. Roumasset (1976) attempts to test this "poverty-inhibits-innovation" hypothesis with data from Filipino rice farmers and concludes that "the widespread belief that risk aversion explains farmers reluctance to adopt modern packages of inputs appears to be wrong, at least for the areas selected for the present study" (p.177). He suggests that it is the constraints and production that usually determine the farmer's position regarding his choice in adopting HYV's.

Binswanger (1980, 1981) reports the results of gambling experiments he conducted among rural workers and farmers in India as well as similar experiments conducted in El Salvador and the Philippines. He argues that nearly all participants display approximately the same degree of partial risk-aversion, regardless of farm size. Thus, the slower rate of adoption of modern technologies by small size farmers cannot primarily be explained by higher degrees of risk-aversion. On the basis of his research in India, he found that at high pay off levels, most individuals exhibited intermediate or moderate risk-aversion with little variation according to personal characteristics such as age, schooling and asset position. Thus, risk is important but should be carefully analyzed when explaining observed differences in behaviour among different size groups of farmers.

Feder (1980) shows that there is no universal one to one relationship between risk, risk-aversion and the adoption rates of modern technologies. That is to say, risk and risk-aversion have to be carefully considered in explaining differences in input use and the rate of adoption of modern techniques by farmers of different sizes. Feder (1980) has shown that different behaviours can follow under different conditions so that universal relationships cannot be established on the basis of results obtained in particular areas. He also points out that the impact of risk and risk-aversion does not depend only on the size of farmholding (wealth) but also on other factors and constraints that may characterize the farmers' environment.

However, a number of other recent studies have indicated that risk aversion plays an important role in farmers' decision-making [Dillon and Anderson (1971), Dillon and Scandizzo (1978), Wolgin (1975), Moscardi and de Janvry (1977)]. On the basis of an empirical study in North-east Brazil, Dillon and Scandizzo (1978) conclude that:

i) most but not all peasants are risk averse;

ii) risk aversion tends to be more common perhaps greater among small owners than among sharecroppers;

and iii) the level of income and other socioeconomic variables influence peasant attitude toward risk.

Wolgin (1975) has also shown that risk plays an important role in farmers' decision-making. If farms are making decisions under uncertainty, then the traditional tests of allocative efficiency are mis-specified. He, however, observes that farms are efficient in their allocation of resources and that lack of credit availability appears to be a major bottleneck in getting increased agricultural productivity.

If uncertainty plays an important role in decision-making, and farmers' attitudes toward risk are major determinants of the rate of diffusion of new technologies among peasants, research should be directed towards finding what characterizes farmers' attitudes toward risk. Moscardi and de Janvry (1977) examine the extent to which risk may be responsible for the discrepancy between peasants predicted demand for fertilizer, an important complement of the HYV's, without risk and their actual demand under risky conditions. They found that risk aversion is responsible for substantial differences between the predicted demand for fertilizer without risk and the actual demand and, hence, risk premiums are high, thereby discouraging the use of fertilizer for increased agricultural production. In this study, they have also established a systematic relationship between risk aversion and a number of socio-economic variables which characterize peasant households, such as, schooling, family size, households' access to income-generating opportunities and their relationship to public institutions. Therefore they suggest that knowledge of the attitudes toward risk of particular categories of peasants can be inferred from knowledge of the socio-economic variables which characterize the households. This can be used to determine a package of modern inputs and institutions, optimally tailored to peasants' economic situation which would encourage the farmers to adopt a set of modern techniques which will raise agricultural production.

2.4.3 Tenancy System and Allocative Efficiency

Another critical issue in the literature is the concern with the comparative efficiency of resource allocation under alternative forms of land tenure such as sharecropping, fixed rental, wage labour cultivation and owner cultivation. Three questions are raised in this issue.

i) How do tenancy contracts affect allocative efficiency or production behaviour?

ii) What determines the type of contract that is devised and agreed upon in given circumstances?

iii) What tenure system is most conducive to rapid adoption of new production technology?

There is an overwhelming body of literature dealing with the question of whether one tenure system is preferable to another on productivity grounds. Sharecropping is a geographically widespread and historically ubiquitous form of rental arrangement. It is often considered as the "villain", with the "hero" being owner-farming. There are two schools of thought. According to the first school (Marshall, Bardhan-Srinivasan), tenancy, especially sharecropping, results in an inefficient allocation of resources as well as a reduced incentive to improve agricultural land. It causes inefficient allocation of resources because, unless landowner and sharecropper share all input costs in the same proportion as output (unlikely for the labour input which is usually fully the sharecroppers'), the sharecropper will apply below-optimal levels of variable inputs since he will equate the full marginal cost of such inputs with his share of their marginal product, not with the full marginal product. Hence, this school maintains that owner farming leads necessarily to more efficient factor combination than does a tenancy system such as sharecropping.

On the other hand, the second school (Cheung-Newbery) argue that the form of land tenure has no bearing upon allocative efficiency since:

i) the traditional view fails to recognize that the shares of inputs and outputs are themselves endogeneous to the contractual process rather than being exogeneously given and, therefore,

ii) it is possible to specify tenancy arrangement so that it will produce the same factor combination and the same output as owner operation [see Newbery (1975)].

Cheung (1969), one leading proponent of the second school ("equal efficiency"), first proposed a maximization model in which the share that emerges is just that level at which sharecropper's share equals the wage and the share going to the landowner equals the rent per unit of land in the cash rental market. Hence, although the medium of sharecropping is used, the result is the same combination of factors and level of output as in the neo-classical land-rental market solution. Bardhan and Srinivasan (1971) have objected to this view. They have pointed out that Cheung's condition requires the extreme assumption that the landlord precisely stipulates all input levels (including labour) that the sharecropper must apply, which they consider to be unrealistic. Instead, Bardhan and Srinivasan offer an alternative model, involving maximization from the standpoint of the sharecropper, which rehabilitates the marginalist (Marshall) conclusion of inefficiency in sharecropping production.

As Newbery (1975) has shown, the fundamental difficulty with this formulation is the unrealistic assumption that the sharecropper can obtain land to the point where its marginal product falls to zero. Newbery extended and generalized Cheung's original formulation where both the rental share and the minimum labour input per unit of land are stipulated in all contracts and their values are jointly determined in a model where landlord maximizes his income subject to the condition that the tenant's income does not fall below his alternative wage earning in a perfectly competitive labour market. The equilibrium which obtains in this scheme happens to be identical with that prevailing in a competitive fixed rental system and is therefore Pareto efficient.

However, Bell and Zusman (1976) argue that there still remains the dubious enforceability of the minimum labour intensity provision of the contract which is completely determined by the landlord. Instead they take a game theoretic approach and suggest that a realistic solution involves neither complete domination by the landlord, nor maximization only from the standpoint of the sharecropper, but the outcome of bargaining between the two. Bell and Zusman, on the basis of their theoretical model, indicate that bargaining is not likely to generate a share precisely consistent with the rental market solution and thus, that the problem of incentive distortion under sharecropping still remains.

If sharecropping is less efficient than the fixed rental contract or owner operated farming, then two relevant issues immediately arise.

i) How severely does the existence of sharecropping lessen the productive potential of agriculture and how large are the output gains which might result by a shift away from sharecropping to small farm ownership, or cash rental of land?

ii) Why does sharecropping, as an inefficient contract system, dominate or co-exist with fixed-rent tenancy in most countries?

Both these issues are very much related to the existence of uncertainty in agriculture. For the first issue, complete conversion from sharecropping to ownership farming through land reform might be more efficient but this involves major legislation which is difficult to obtain in most LDCs. The more feasible objective may be the conversion from share contracts to cash rental contracts. It is argued that this conversion might increase efficiency under complete certainty,[5] but when risk is considered it is evident that the tenants might be unwilling to lease as much land under cash rental as under share contract. Fears of bad weather, hence poor yields, or low product prices and thus the resulting risk of being unable to cover both cash rents and subsistence costs would act against the renting of the optimal amount of land. "In other words, for any given expected income from cash rental the tenant would insist on a risk premium that leads to a lower expected rental rate than that which he would be prepared to accept under sharecropping" (Berry and Cline (1979), p. 26). A theoretical study by Stiglitz (1974) emphasizes the importance of risk in the evaluation of sharecropping and concludes that in the absence of alternative arrangements for risk sharing, the system is not inefficient as suggested by Marshall and Bardhan-Srinivasan.

Hence, one explanation of the widespread existence of sharecropping is the risk-sharing of the sharecropping system. It also appears that even some incentive effects, from the landlord's point of view, exist in sharecropping as compared to the alternative of wage-labour farming. If production is uncertain, it will be very difficult for the landlord to decide whether the worker was shirking or if the weather was to blame for poor harvests. Thus, it is difficult for him to enforce even a simple wage contract. On the other hand, a share contract reduces the worker's incentives to shirk by rewarding him with a share of the output he produces. Hence, the existence of uncertainty in production allows both the risk sharing and incentive aspects to be offered to explain the widespread existence of sharecropping.

However, Newbery (1977) argues that output uncertainty by itself is not sufficient to account for the existence of sharecropping, because if it is possible to costlessly enforce wage contracts the economy will achieve a Pareto efficient allocation with fixed rent and wage contracts alone. Hence, according to him, the usual risk-sharing explanation for the existence of sharecropping does not hold. Instead Newbery (1977, 1975) shows that if labour markets are risky, a reasonable assumption in the rural economy where the demand for agricultural labour is very much related to agricultural activity itself, then sharecropping offers additional risk-sharing advantages both to landlords as well as to share tenants. He shows that labour market uncertainty makes sharecropping more desirable than wage contracts and fixed rent contracts. He argues that if sharecropping is to be explained as an institutional device for sharing risk, then it must be because of other risks in addition to those affecting output. According to some authors, in addition to the risk-sharing advantage, share tenancy might provide a fuller utilization of non-marketable or not easily marketable resources (such as family labour - particularly female and child labour, draught animal labour, or managerial skill) which may contribute to the historical persistence of the institution of sharecropping [Bardhan(1980), Bell(1977)]

Like the issue of farm size and efficiency, the allocative efficiency of sharecropping versus owner-farming is very important with regard to policies designed to increase agricultural production in a rural economy. Although this issue has stimulated much theoretical research, this body of literature does not provide a conclusive answer. Furthermore, empirical evidence, thus far, does not conclusively support any view. A number of empirical studies appear to lend support to the equal efficiency view that there is little if any observable difference in output per acre between farms cultivated by the owner and the farms cultivated under share tenancy [Huang (1971), Ruttan (1966)]. However, some doubts have been raised to the appropriateness of the methodologies which have been used to resolve the debate on the efficiency of various land tenure systems [Bell (1977), Ip and Stahl (1978)]. In some studies, it is found that the "mixed" tenant cultivates sharecropped land less intensively than his own land, while there is no difference between the "pure" share tenant and the small farm owner, on land productivity grounds [Bell (1977), Hussian (1977)]. A recent attempt by Berry and Cline (1979) with cross-country data, fails to find significant effects of tenancy on productivity. They conclude that given "the fact that our understanding of the micro-economics of peasant agriculture in general and land rental markets in particular is not adequate to choose one theoretical specification over another, it would seem that the efficiency impact of sharecropping remains, to put it mildly, ambiguous". (P. 26). Instead, on the basis of their research, they observe, "it is clearly of much less importance as a determinant of agricultural output and employment than is the .... influence of farm size on the utilization of available resources" (P.27) They argue that since most tenants (sharecroppers) are small farmers, the prime issue is not the land tenancy-efficiency but size-efficiency and the study of the possible constraints in the way of adopting modern technology. We have already examined this issue.

2.4.4 The Role of Non-Agricultural Activities

Whatever conclusion one may draw, the controversies over land tenancy and efficiency and farm size and efficiency may be seriously limited because of the exclusion from the analysis of another important activity in a rural economy, namely non-agricultural activities or the so-called Z-goods activity. These non-agricultural activities may include construction, commerce, services, transport, very small scale processing and manufacturing, and handicrafts. It is by now fairly evident that a large fraction of the total income accuring to households comes from the Z-goods activities [see Berry and Cline (1979), Chinn (1979), Anderson and Leiserson (1980)]. But non-agricultural activities in rural areas have received little attention in the discussion of agricultural development. Instead the role of these important income generating activities in some theoretical literature has been misspecified. For instance, in an agrarian model with non-agricultural activity, Hymer and Rosnick (1969) predict a decline of such activity with the pace of agricultural development. In particular, their model shows that an improvement in agriculture's terms of trade will produce a reallocation of labour time from Z-goods toward crop production.

In a recent paper by Anderson and Leiserson (1980), it is shown that non-agricultural activities in rural areas expand quite rapidly in response to agricultural development. In particular, it is evident that non-farm activities in rural areas are a primary source of employment and earnings for approximately one quarter of the rural labour force and a significant source of secondary earnings in the slack season for small and landless farmers. The growing importance of this non-farm activity lies elsewhere, too. Because of the slow growth of labour absorption in agriculture it is argued that raising agricultural productivity is a necessary but not sufficient condition for significantly alleviating rural poverty in some LDCs. The Taiwan experience [Chinn (1979)], shows that for a major rice producing region of Taiwan, income from non-farm sources rather than increased income from farming (because of higher productivity) was responsible for rising recent income levels. In addition, the phenomenon played a role in reducing income inequality within the rural sector.

Hence, it is important to analyse allocative efficiency in agriculture with the non-agricultural activities included in the framework. This inclusion is important for various reasons. First, this may aid in understanding why the average product of land differs between large farmers and small farmers in agriculture. If it is evident that the larger the landholding of the family the greater is its accessibility to the non-agricultural activities, the large landowners may allocate more family labour (and other resources) to these activities and less resources to farming. Thus they might be efficient in family labour allocation but exhibit low land productivity. On the other hand, because of poorer access to off-farm jobs, the small farmers, given their available resources, would intensify agricultural cultivation by increasing cropping intensity and hence, in this sense, they generate greater productivity per acre than the large landowners. Second, any farmer wishing to increase agricultural production by investing resources in the adoption of new technologies (such as HYV seeds or chemical fertilizer) would consider the relative return on agricultural and non-agricultural activities.

Moreover, as risk plays an important role in agriculture, the presence of this risk factor may imply that fewer resources are devoted to agriculture and more to off-farm activities. These factors together may indicate one reason for low rate of agricultural productivity growth in many LDCs. Third, the increasing volume of these non-agricultural activities may justify land reform policy. We have noted that large landowners may have greater access to non-agricultural activities and their higher relative return may lead them to acquire expertise in entrepreneurship by acquiring modern education but may keep that experience under-utilized because of their affluence. These large owners may have some expertise in non-agricultural activities which, as Ip and Stahl (1978) suggest, could be effectively exploited for economic development through a land redistribution policy. As many observe, there exists some form of entrepreneurship in the choice of land tenancy and cropping pattern in agriculture [see, e.g., C.H.H. Rao (1971)]. This expertise is possessed by small landowners. The use of the scarce expertise of large landowners in the non-agriculture sectors could be induced by the introduction of land reform while this reform may also effectively use some of the entrepreneurial talent in agricultural production of small landowners and tenants, and thus, together result in material gains to the society as a whole. In Ip's and Stahl's view, the analysis of allocative efficiency in agriculture within the context of land tenancy is a misleading exercise unless it is done within the framework of intersectoral interactions and linkages. Though the focus of their analysis is the interaction between urban and rural sectors the same kind of argument may be put forward for the growth of rural based firms for self-sustaining economic growth. In our view, land reform would nourish the development of the non-agricultural activities in rural areas to complement growth in agriculture by releasing "an educated potential entrepreneurial class" from agricultural activity while effectively using the entrepreneurship of tenants in agricultural operation.

Of course, less access to off-farm jobs does not necessarily imply that small farmers do not actively participate in this activity. In fact, data show that small farmers effectively combine off-farm and farm income to meet the requirements of the family. As we have noted, small landowners are more risk averse than the large landowners. They may intensively exploit their limited non-agricultural opportunities, as they do their small plots of land, to generate family income. The intensity of use of the non-agricultural activity actually depends on the level of income earned for family needs from agricultural operations. If small farmers are too small to produce a living in agriculture, they will increasingly need to supplement their agricultural income with non-agricultural income. This is evident from some recent studies. In Sri Lanka, about 30% of the farm operators earned most of their income from non-argicultural activities, as did over half of those with less than one acre [Berry and Cline (1979)]. In a village study in Bangladesh, it is found that two-thirds of village income was generated from non-agricultural activities [Dacca University Village Study Group Working Paper (1973)]. Therefore, it is necessary to supplement farm income with income from non-agricultural activities in order for small farmers to generate sufficient income for sustaining needs.

2.5 Role of Family Size

The ability to diversify family labour into different productive activities (agricultural and non-agricultural) for generating income for family needs crucially depends on the availability of family labour. Thus, family size and its structure becomes very important for small farmers. The fact that small farmers can earn significant income from non-agricultural activity is because of their larger labour/land ratio. The reason that they have a large famile size relative to other productive resources (such as land) is because they can reduce risk and increase mean income through diversification of family labour. They produce more per acre than large landowners because they employ more family labour per acre. In some cases, the small farmers augment their land area under cultivation by obtaining working plots from large landowners as a part of an arrangement whereby they guarantee that they will provide labour to large farmers. Indeed, an empirical study of Bangladesh agriculture [M. Hussain (1977), (1978)] shows that tenancy as well as farm (land) productivity is largely determined by the labour/land ratios of farm operators and hence, their family size position relative to their landholding. Therefore, the family size decision affects the resource position of the household and its allocation, in turn, determines land productivity. Thus, there exists a close relationship between farm size, family size and land productivity. This relationship between family size and its effect on land productivity and farm size should be linked with the results cited earlier which identify the productive contribution of children as an important determinant of family size and child schooling in a peasant economy [Rosenzweig and Evenson (1977), Cain (1977)]. When trying to analyze the resource allocation of the farm household, family size must be treated as an endogeneous variable which is affected by and which affects the household's resources and income. In other words, the decisions by farm households over family size, child schooling, resource allocation between agricultural and non-agricultural activities are not independent of each other, rather they are interrelated decision variables in the overall decision-making of the farm households. These relationships, however, are not normally examined in this way in the development literature.[6]

The interdependencies of family size, and the allocation of family labour and income were examined more than fifty years ago by A.V. Chayanov[7], in what is now considered a classic study of the peasant economy. He provided insights into the efficiency of the peasant farmer which were supported by much more rigorous analysis forty years after his work was completed. Although Chayanov did not introduce risk or uncertainty into his analysis, he did consider interdependencies which have not yet been adequately treated within the current, more rigorous, analytical framework used by economists. To the extent that his conslusions regarding resource allocation of the peasant farmer have been supported by current researchers, Chayanov's insights regarding family size need to be incorporated into a more comprehensive and rigorous model of the peasant farmer. The major insights include, among other things:[8]

(a) The absolute number of household members (producers and consumers) their sex and age, together with the traditional standard of living of the community are the dominant determinants of the minimum total output that a household must produce.

(b) In any household, the ratio of producers to consumers is a dominant determinant of the minimum amount of labour devoted to produce the output.

(c) Given soil, climate and market conditions, per capita income will tend to be higher the higher the producer-consumer ratio of the household.

(d) Using total cultivated area per household as an index of total family economic activity, Chayanov predicts a relationship between household size and income. He showed that the direction of causality was generally from family size to farm size rather than vice versa. Of course, this prediction is based on the assumption that farm size can be varied through leasing or sale and purchase.

(e) Chayanov observed that peasant households usually engage in crafts and trades as well as farming. The average amount of time devoted to farm and off-farm activities may vary across households or regions. Chayanov claims that this variation is a function of variation in the relative return to labour engaged in the farm and off-farm activities.

(f) Another observation is that when access to land is limited, the peasant household adjusts to this constraint by, (i) varying the intensity of cultivation, (ii) by increasing the amount of family labour hired out, and (iii) by increased participation in crafts and trades.

Chayanov's resource allocation model of the peasant economy is overly simple but it provides a variety of insights for the study of a peasant economy [see Diana Hunt(1978)]. Indeed, one important insight which is neglected in the modern literature (after Schultz's pioneering work) is that the household resource position and its income are very much related to the family size and its structure. Decisions over family size can influence the household resource position and its allocation in generating household income through different productive activities.

2.6 Concluding Remarks and Objectives of the Present Study

Let us recapitulate the major findings of this survey in order to provide a background for further research on the decision-making problems of farm households.

(1) Decisions about family size and child schooling are affected by children's productive role in the household enterprise (Rosenzweig and Evenson);

(2) A household enterprise can, given its resource position and the economic and institutional constraints, diversify resource among agricultural and non-agricultural activities (Chayanov);

(3) Within agriculture, households may perceive a land constraint and hence the size and structure of the family can affect productivity and tenancy.

(i) Land tenancy and cultivated farm size under household enterprise can be affected by family size and its structure (Chayanov, Hussain);

(ii) Land productivity is determined by the endowment of family labour - the smaller the farm size and the larger the labour/land ratio, the larger is the yield per acre (Berry and Cline, Hussain);

(iii) Smaller farmers are equally efficient under various forms of tenancy (sharecropping versus owner-operated farming) arrangements (Ruttan, Huang, Berry and Cline).

(4) The smaller the landholding, the smaller the access to off-farm activity but the larger the necessity of supplementing farm income with non-farm income. The generation of sufficient income for family needs requires intensive exploitation of the available non-farm activities (as well as farm activity) and here, too, the family size and its structure is a significant determinant of participation.

(5) Risk or uncertainty may have an important role in each stage of decision-making of the farm household.

(i) More household resources may be devoted to non-agricultural than agricultural activities because agriculture is a riskier activity;

(ii) Within agriculture itself, risk aversion may lead to more resources being devoted to less risky crops than to more risky crops than would be the case if farmers were risk-neutral (Wolgin). This statement may apply to choice between HYVs and Traditional varieties of crops.

(iii) Risk aversion may lead to higher cropping intensity in order to minimize risk, depending on the land/labour ratio;

(iv) Risk in agricultural production, together with uncertainty in the labour market may imply the widespread existence of sharecropping (Newbery). This, in turn, may imply that more family labour is allocated to rented-in land than to wage-labour in agriculture, if the uncertainty in the labour market is generated from uncertainty in agricultural production;

(v) Since family size and child schooling affect the household's resource position, the allocation of which is influenced by the presence of uncertainty in agricultural production, we should expect family size and child schooling decisions of the farm household to be affected by this same uncertainty.

These points about the decision-making of farm households are summarized in the following flow chart (Fig. 2.1)

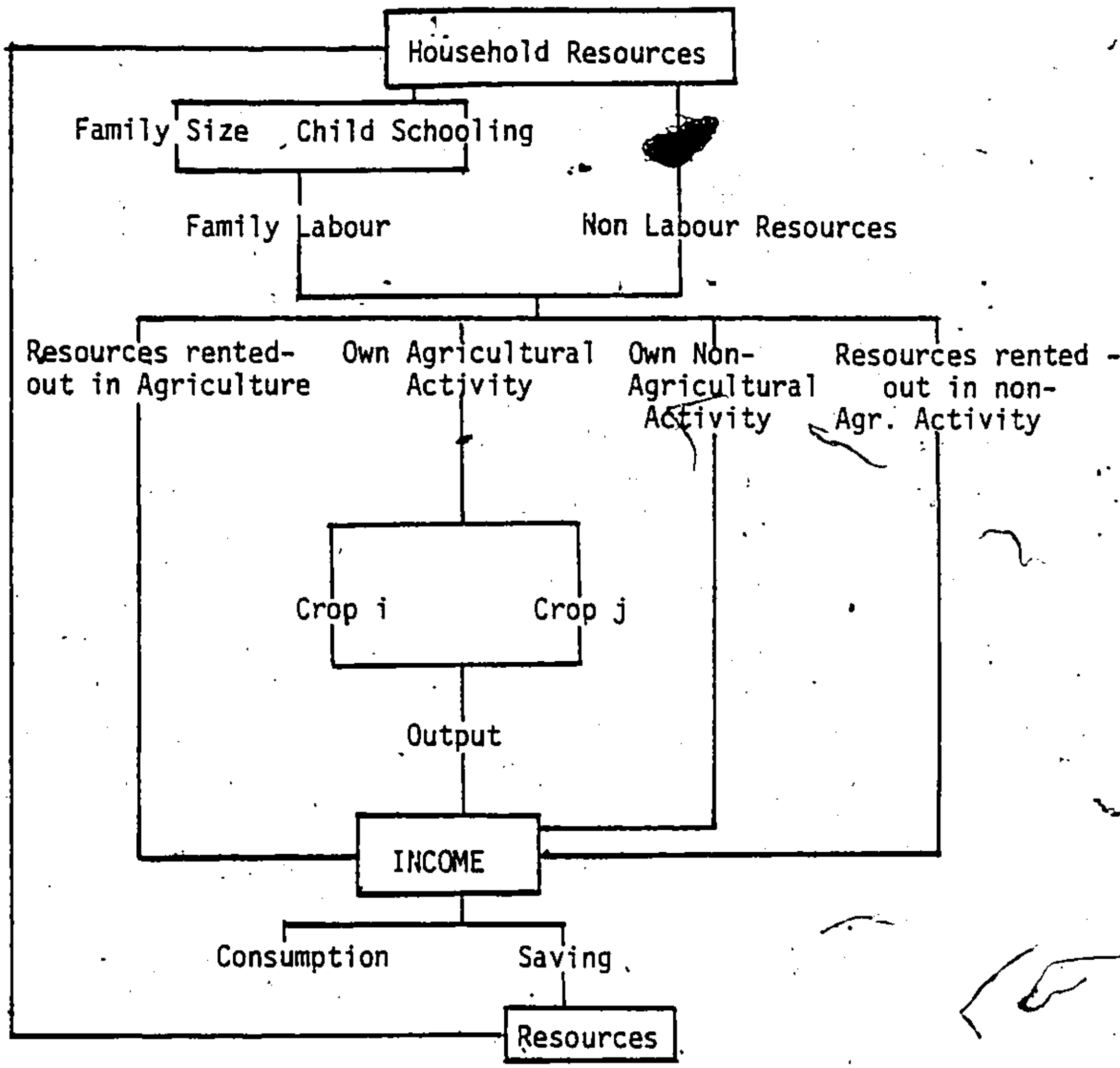


Figure 2.1

Flow Chart of Farm Household Decision-Making

This figure indicates that household resources affect family size and child schooling decisions, decisions which determine the family's labour constraint, which , in turn, in conjunction with the non-labour resources, affect the allocation of family resources to agricultural and non-agricultural activities . These generate various forms of income which are then allocated among consumption and savings. The savings activity may deplete or add to the household future resource base and the cycle continues. At each stage of decision-making, uncertainty may play an important role.

While a survey on various piecemeal studies of the peasant economy suggests the linkages among all relevant decision variables, such as family size, child schooling, resource allocation between agricultural and non-agricultural activities, farm size, and land tenancy and productivity, the next stage naturally is to link these issues together in a micro-economic model which, to our knowledge, has not been yet done in any study[9]. This is very important because such a model may help to explain the sluggish performance of the rural economy, in terms of high population growth and low land productivity. Indeed, this review of peasant studies substantiates the point that the basic requirement for rural development and hence for economic development of the agrarian LDCs is to meet the inter-related objectives of reducing farm population and increasing farm output. While the study of resource allocation in agriculture and its efficiency is important, it is not sufficient for generating policy recommendations for rural development. A bridge across interrelated decision variables, including family size, child schooling and non-agricultural activities, must be made so that the decision-making problems of rural households may be examined in the context of various rural development strategies. Building that bridge is the task of the present study.

FOOTNOTES:

1. It can be argued that the current rural development strategies are flawed in that they fail to take into account the process of household decision-making in a peasant economy.

2. Declining fertility, as income increases, is explained by three factors: (i) increasing substitution of consumption goods and services for children, (ii) the trade-off between the quantity and quality of children; and (iii) the increasing opportunity cost of parents' time.

3. An increase in the equality of income distribution resulting from mass participation in development activities is suggested as the reason for falling fertility rates [Repetto (1979), see also William Rich, "Smaller Families Through Social and Economic Progress", Overseas Development Council, Washington, D.C., January 1973]. In Sri Lanka, a demographic transition has occurred at low levels of income due to the public supply of risk reducing social services, including free education, health services and subsidized food. (See Roche, F.C., "The Demographic Transition in Sri Lanka: Is Development Really a Prerequisite?" Cornell Agricultural Economics Staff Paper, January 1976).

4. A recent paper by Barnum and Squire (1978) shows that both large and small farmers are efficient in that both small and large farmers do respond quickly by adopting modern technologies when they become available.

5. Efficiency under complete certainty is irrelevant in this context. From a social point of view, substantial risk pooling is possible so that rational individual behaviour may not be consistent with social efficiency. In measuring social efficiency under uncertainty, the social attitudes toward risk need to be characterized.

6. An additional reason for this inter-relationship of decision variables in farm household decision-making is due to the existence of the interlocking factor markets in the village economy. This latter interlocking system has been well recognized by the recent researchers of the peasant economy [see a good review of these issues in Bardhan (1980)]. It has been observed that participation in market activities in a village economy is personalized to the extent that any contract in the market often combines several markets as land, labour and credit. The best example of the interlinkage of factor markets is the sharecropping system where three markets, land, labour and credit are combined in one contract. However, although an interlocking market system is acknowledged in the literature, the participants' decision-making regarding family size, child schooling and participation in various market activities is not considered as part of the participants' comprehensive decision-making related to the interlocking factor markets.

7. A.V. Chayanov, a leading Russian agricultural economist, did his seminal work on the peasant economy during the period 1910-30. The major insights of his work are now being recognized by modern

economists beginning with the work of Schultz (1964). However, Chayanov and his work was unknown to modern economists until 1966, when some of his important works on the peasant economy were published in English under the leadership of D. Thorner [see Chayanov (1966), edited by Thorner, D. et al.].

8. The intent here is not to make a comprehensive listing of what Chayanov did but to highlight those aspects and issues most relevant in our context. For more details, see Chayanov (1966), D. Hunt (1978).

9. The literature dealing with the household decision-making problems in the peasant economy can be divided into three categories: the first category follows strict neo-classical production theory and examines the question of resource allocative efficiency in agriculture [e.g., Bardhan (1971), Yotopoulos and Lau (1973), Barnum and Squire (1978)]; the second category attempts to combine production and consumption aspects, taking family size and other resources as given in an optimizing framework, which again examines resource allocation issues in agriculture [e.g., see Barnum and Squire (1979)] and the third category deals with the family size and child schooling decisions, taking the household resource position as given [Rosenzweig and Evenson (1977)]. Thus far, no attempt has been made to unify all these aspects together in a more general theory of the decision-making process of farm household. This step seems to be essential for the evaluation of rural development strategies, particularly when it is recognized that all the decision variables are interrelated.

CHAPTER THREE

ALLOCATIVE EFFICIENCY, FAMILY SIZE AND CHILD SCHOOLING DECISIONS: A MODEL OF THE FARM HOUSEHOLD

3.1 Introduction

In the preceding chapter we examined the decision-making problems of farm households in a peasant economy. We discussed the different theoretical and empirical issues regarding income generating resource allocation decisions and the decisions over family size and child schooling. While the former decisions determine agricultural production and productivity, the latter decisions affect the literacy rates and rate of population growth. All three factors are of increasing concern for policy makers in formulating strategies for rural development. Our purpose is to link the production and consumption aspects of the farm household's decision-making in order to examine the factors associated with the sluggish performance of the rural economy. A theory of the farm household combines production and consumption aspects together in order to examine household behaviour in a peasant economy. For instance, Barnum and Squire (1979) apply the theory of the farm household to describe the income-leisure choice of rural households in Malaysia by deriving the labour supply function and the labour demand function from a model of household behaviour which incorporates both consumption objectives and production and resource constraints. This model, however, does not determine the size of the family labour force which seems to be very important for determining allocative decisions in resource allocation for an agricultural household. This aspect can be studied only through the study of family size and child schooling decisions that actually determine the size of the family labour force. On the other hand, Rosenzweig and Evenson (1977) apply the household production model to the consumption side to investigate family size and child schooling decisions. This is done by incorporating the productive role of children in income (wage) earning activities into their analysis. The primary focus of the Rosenzweig and Evenson study is to estimate the demand functions for children and child schooling in a rural economy where the economic contribution of children is significant. Child labour participation is estimated in this model which, however, ignores important aspects of the demand for family labour in the family farm. These can only be found by exploring the farm household's resource allocation decisions.

It is clear that agricultural production in a pre-modern densely settled peasant economy is generally characterized by the application of larger amounts of family labour to land [see Berry and Cline (1979)]. In turn, farm output and productivity are linked with the family size and child schooling decisions on the consumption side [Rosenzweig and Evenson (1977)]. Moreover, allocative decisions in agriculture have to be considered through the interaction of agricultural and non-agricultural (or farming and non-farming) income generating activities. Therefore, the issue of family size and child schooling decisions should be considered in this perspective as well.

Thus, in a model of the farm household, we attempt to integrate the issues of household resource allocation into the household production model (as developed and modified by Rosenzweig and Evenson) in order to determine the supply of family labour through family size and child schooling decisions on the consumption side and to measure the labour demand for family labour through the resource allocation decision between farming and non-farming activities. The relationship between the consumption side and the production side is developed here in an attempt to find if there is a systematic relationship between farm output and productivity, child schooling (literacy rate), and family size (population growth). The basis of this model of the farm household is that the allocation of resources to agriculture may not be independent of decisions with regard to family size and child schooling.

3.2 A Framework for the Model of the Farm Household

In a land-scarce and labour abundant agrarian economy, such as that of Bangladesh, the level of farm output and total factor productivity tends to be dominated by the level of land productivity, a partial measure of efficiency. Land productivity in a traditional agricultural economy is mainly affected by the application of more raw labour. On the other hand, demographic behaviour is usually characterized by low child schooling and large family size. It is predicted, a priori, that given the constraints that the rural households perceive, their decisions regarding resource allocation, family size, and child schooling may be efficient in the static sense. This prediction is consistent with results reported in the preceding chapter that indicate allocative efficiency in agriculture in LDGs.

T.W. Schultz (1964) observed that in a traditional agricultural economy such as India farmers are "poor but efficient". Farmers are poor because they have a low average income and low agricultural productivity. But nonetheless they are allocatively efficient in resource allocation in agriculture. This seemingly contrasting feature of the traditional peasant economy should not be misinterpreted. Allocative or price efficiency dictates that farmers tend to equate the value of marginal products of inputs with the respective input prices. In a land-scarce agrarian economy, labour is the dominant variable factor and hence in a labour abundant economy price efficiency requires that farmers tend to equate a low value of marginal product of labour with a low price of labour. This leads farmers to apply relatively large amounts of labour inputs to land in such an agrarian economy. But despite the heavy application of raw labour the yield per acre is fairly low and does not rise significantly with increases in labour input per acre, because the cash constraint restricts the purchases of complementary yield increasing inputs. This results in low income from their agricultural operations. The earnings from agriculture (family farming) may not furnish all of the household's subsistence needs, which in turn implies that the household may explore other means (particularly non-agricultural activity) to supplement its agricultural income. In doing so, households may need more family labour. This leads necessarily to low child schooling. Therefore, low agricultural productivity, low child schooling and high population growth may be interlinked in the village economy setting but also may be the result of efficient behaviour.[1]

Within a complete model of the farm household, given the household's resource position and technology and tastes, the conditions for efficient resource allocation in agriculture and the demand functions for children and child schooling can be derived.[2] Then the resource allocative decisions can be linked with the derived demand functions for family size and child schooling to discover whether a systematic relationship between farm output, agricultural productivity, large family size and low child schooling rate can be supported theoretically and statistically.

These hypotheses about allocative efficiency and family size and child schooling decisions should be equally applicable to small farmers and sharecropping tenants. In what follows, we shall try to illustrate these issues with the help of several simple diagrams, before formulating a formal theoretical model.

3.3 Farm Size, Productivity and Labour Supply Decisions

In the last chapter, we described the inverse relationship between farm size and land productivity which tends to be observed in land-scarce labour abundant agrarian economies. Small farmers tend to produce more per acre than do the large farmers. We also pointed out that this greater land productivity of small farmers relative to large farmers may be misleading unless it is analysed within a framework incorporating the interaction of agricultural and non-agricultural activities. Since generating income for family needs requires intensive exploitation of both farming and non-farming activities, allocative decisions in agriculture are essentially a part of family labour and other resource allocation and they are, therefore, to be evaluated with respect to family size and child schooling decisions, for these determine the stock of family labour.

Let us assume that for a given size of landholding, h, (with given technology and capital inputs), a farm household faces two decision-making problems: (i) how is family labour allocated between the family farm and other activities to generate income;[3] and (ii) how is income allocated to maximize utility by consuming child-quantity and child-quality expressed as schooling (we ignore for the moment other household consumption commodities)? We want to know if there is a linking factor between consumption and production in household decision-making. Let us also assume that the household faces a perfectly competitive market for its family labour in the other activities. Two types of other activities are available, non-agricultural activities and agricultural wage activities. We assume that the market wage for both of these activities will equal the certain wage rate WB_1.[4] Treating this wage rate WB_1 as a parameter for labour allocation, allocative efficiency is now entirely dependent on the condition of equality between the marginal product of labour in agriculture and the marginal return to the other activities. In the figure 3.1, a farm household allocates n_1 amount of family labour into land given the total product curve Tp_1, and correspondingly, produces average product (X_1) from agricultural operation. If hired and family labour are perfect substitutes, the farm household may hire in labour at the existing wage rate WB_1, if its family labour falls short of the required amount dictated by the marginal condition, and may hire out family labour if the total amount of family labour exceeds the required amount. Thus, if both the large- and small-owners face the same total product curve, Tp_1, and competitive market wage rate, WB_1, they would produce the same output per acre irrespective of their farm size and family size. However, if both size farmers face the same production functions and the same input prices yet the large farmer lags behind the small farmer in equating the marginal revenue product of factors to their respective prices, then it may be argued that the small farmer is more allocatively efficient than the large farmer [see e.g. Barnum and Squire (1978)].

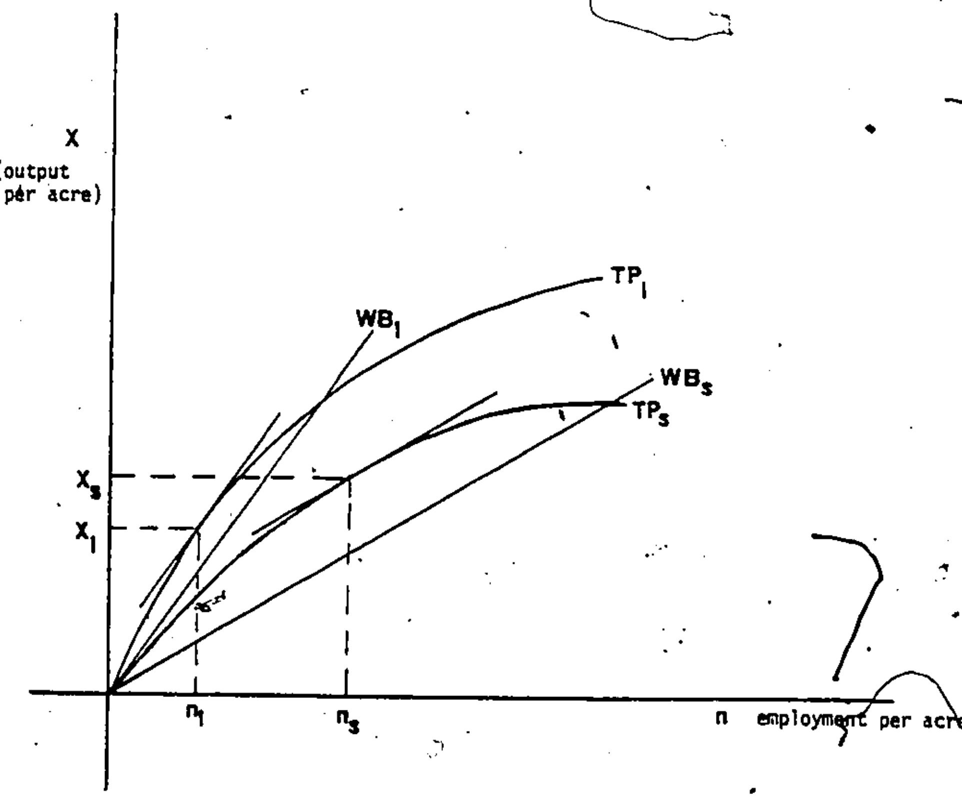


Fig. 3.1

Farm Size and Productivity

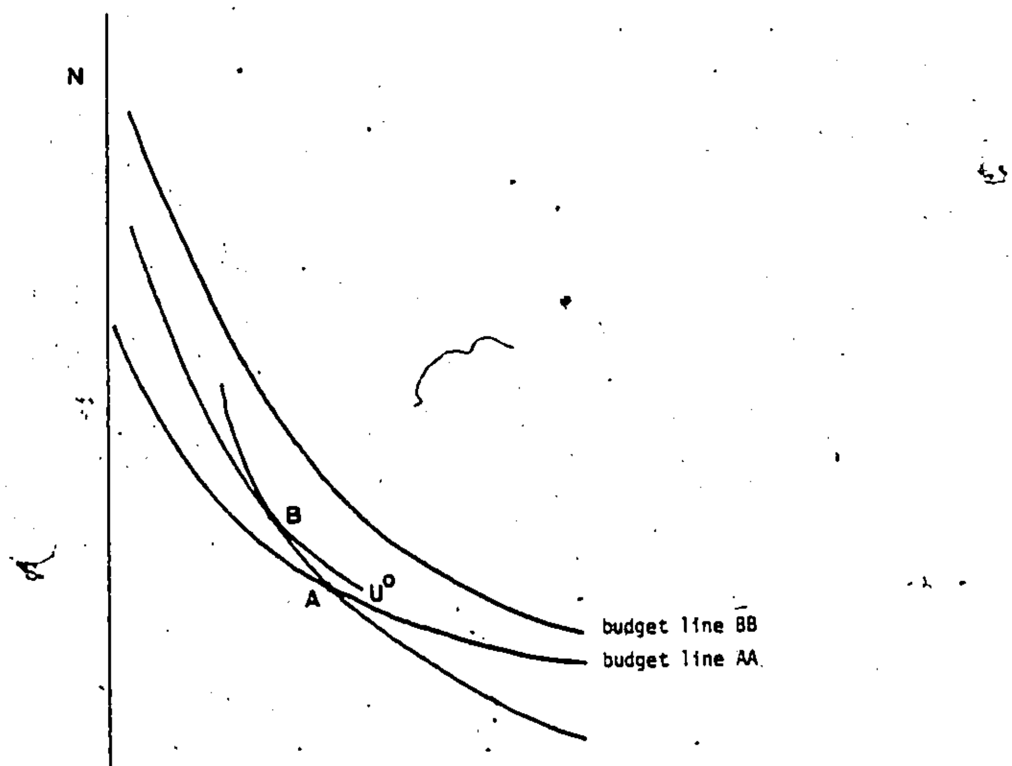


Fig. 3.2

An Interaction Between Quantity (N) and Quality (E) of Children

However, the above argument is not complete. It is argued in the literature that the opportunity cost of family labour for small farmers in the farming activity is less than that for large farmers [Berry and Cline (1979)]. Moreover, large land owners have larger working capital than does the small land-owner. If this is the case, we may say that the small farmers face WB_S instead of WB_l (figure 3.1) as the opportunity cost of its family labour and total product curve TP_S instead of TP_l . In this situation, the farm household would apply $n_S > n_l$ amount of labour into land and hence produces more output per acre $X_S > X_l$ than the large farmer who faces WB_l as the opportunity cost of its labour. Of course, the large farmer may apply hired labour to the land, but the wage for hired labour may be larger than the opportunity cost of the small farmer's family labour, some of which may not be marketable (young children or women). Thus, large farmers may not apply the same amount of labour per acre as the small farmers.

Since more family labour can be obtained from a larger family, the economic contribution of children to the farm household is potentially important. Whether the economic contribution of child labour is significant or not to the household depends upon the household's income generating activities. Because of the nature of agricultural and non-agricultural activities, family child labour may be a better substitute (though, perhaps, imperfect) for hired inputs in agricultural activities than in non-agricultural activities. Thus if the household income earning activity is largely non-agricultural, child labour is less valuable to the household. However, if the economic activity of the household is largely agricultural, child labour is more valuable to the household. The actual situation may be between two extreme cases: (i) the economic contribution of children is zero; and (ii) the economic contribution of children is positive and family child labour may be supplied at a fixed wage rate.

A household production model can be utilized to derive the demand functions for child-quantity (N) and child-quality (schooling,E) for these two cases. While Becker and Lewis (1973) and Willis (1973) treat the first case, Rosenzweig and Evenson (1977) analyze the second one. Since the interaction between child-quantity and child-quality is non-linear [see Becker and Lewis (1973)], the budget line is non-linear in N and E as shown in figure 3.2. When the economic contribution of a child rises (the wage to child labour goes from zero to a positive value), the household's budget frontier will rise from budget line AA to budget line BB. If point A represents the initial household choice of family size and child schooling, the introduction of an economic contribution from children will encourage increased family size and reduced levels of schooling (after accounting for real income effects). This phenomenon is illustrated in Figure 3.2, by the budget line through points A and B. Along this budget line income is adjusted so that the initial choice A can still be achieved. The movement from A to B thus represents a "Slutsky" substitution effect which leads to increased family size and reduced levels of child-schooling.

In the initial case the shadow price of quality is only the money cost involved in child schooling, while the shadow price of child-quantity (N) is the money cost plus the opportunity cost of the mother's time in raising children. In the second case, in addition to these costs, the price of quality involves an additional positive cost of forgone child earnings and the price of child-quantity (N) involves a negative cost of child earnings when we assume that children do have a productive role in the household enterprise [see Rosenzweig and Evenson (1977)]. Thus the budget line rotates because this makes the shadow price of E (quality) higher and the shadow price of N (quantity) lower than in the case where child labour makes no economic contribution. It is clear that at point B the demand for N is larger and the demand for E is smaller than when the child contributes nothing to income. Thus, there may be a tendency for households to demand more child-quantity and less child-quality when child labour has a productive role than when no such role exists.[5] Rosenzweig and Evenson (1977) in fact provide empirical evidence that conforms to this argument. It should also be noted that because of the income effect associated with the introduction of positive child productivity, total price effects are indeterminant.

However, since the basic model used above is static, those observed relationships are also static in nature. Therefore, this does not necessarily imply that increased income through improved technology such as high yielding varieties (HYVs) would lead to larger family size and lower rates of child schooling in a dynamic context. This point is examined in the following section.

3.3.1 Effects of Improved Technology

Let us suppose that an output augmenting technical change is made available by the Government to the farm household. As a result, the total product curve of labour is shifted out. If the new technology is equally available to small and large farmers, the marginal product of labour now increases for both size farmers. That means, given the differences in the opportunity costs of family labour that the farm households perceive, the observed inverse relationship between land productivity and farm size is likely to be re-established in the new equilibrium [Berry and Cline (1979)].

However, various studies show that the new technology is not equally available to all potential users. It is argued that the new technology is a heavily cash intensive technology and is therefore biased toward the large farmers who have better access to information as well as to the resources needed to purchase inputs used with the new technology. If this is the case, then the previous higher yields obtained by the small farmers may be in jeopardy and it is possible that the large farmers, by adopting the new technology, may have the same or even higher land productivity than the small farmers. Thus, the static inverse relationship between land productivity and farm size may not be maintained over time when there are imperfections in input and capital markets and access to technical change which requires capital investment.

In addition, technical changes have implications for the demand functions for child-quantity and child-quality. An increase in agricultural productivity, due to Hicks neutral technical change, has an income effect. Thus, the budget line (corresponding to equilibrium point B) in figure 3.2 shifts upward. Depending on the preference function, this may lead to more N and E or even more E but less N. In fact, evidence suggests that with the pace of agricultural development in some developing countries there is a growing shift of demand by farm households away from child quantity and to more child quality [T.W. Schultz (1980)]. This is happening for the relative returns to child quantity and child quality are changing. Because modern technology in agriculture requires educated farmers the LDCs farmers are finding it more profitable to substitute more child quality for child quantity.

3.4 Efficiency in Sharecropping and the Family Labour Supply Decision

Let us now turn to the case of allocative efficiency in sharecropping. For a given size of rented-in land (h), the tenant faces the problem of how to allocate labour into family farm and other income earning activities. Given a perfectly competitive family labour market, the household would allocate family labour into farming and other activities according to the marginal condition that its share of the value of marginal product in agriculture is equal to the off-farm wage rate. Thus, in figure 3.3, the tenant would apply t_1 amount of labour, which is less than the owner supplied amount t^* and hence accordingly the tenant is viewed as less productive than the owner ["inefficiency" schools' view (Marshall-Bardhan-Srinivasan)]. According to the "efficiency" school (Cheung-Newberry), this need not be the case since the optimum amount t^* is stipulated by the landlord which is endogenous to the contract and on principle the tenant would apply this amount. Hence both tenant and the owner would be equally productive.

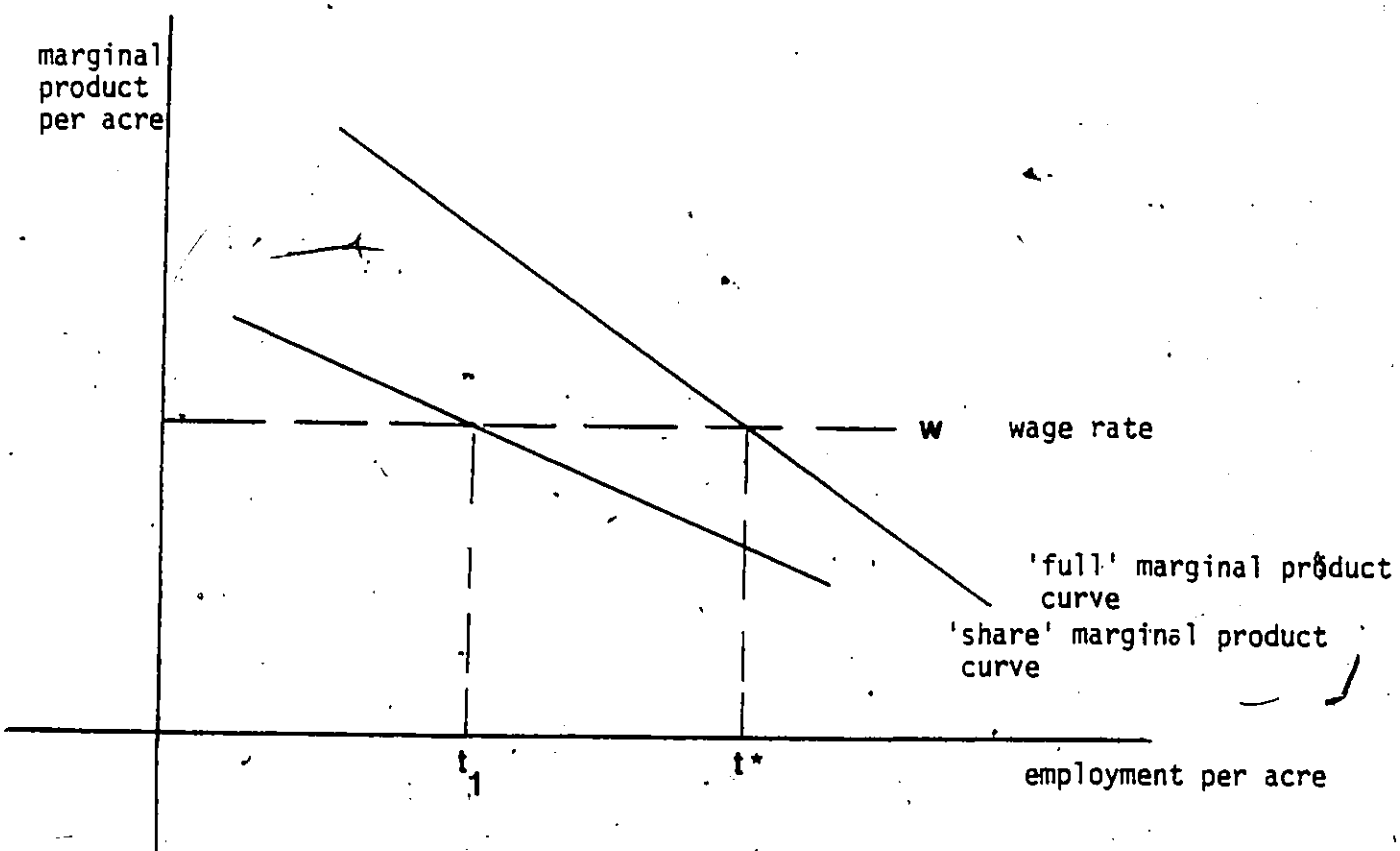


Fig. 3.3

Employment Under Sharecropper Versus Owner Operator

But how does the landlord make sure that the tenant is supplying t^*? The landlord would have to supervise the tenant's activity and this would involve some enforcement costs to the landlord. If the landlord's opportunity cost of supervising the tenant is zero then one can argue that the tenant might apply the stipulated t^* amount of labour to rented-in land. But this need not be the case. A landlord may have positive opportunity cost in the non-agricultural activity and the return there may be higher than what he would get by supervising the tenant. Therefore, it is possible that the tenant would apply a less than optimal amount of labour input and hence may exhibit lower land productivity than the owner-cultivator [Ip and Stahl (1978)].

Within our framework, allocative decisions in agriculture depend on the cultivator's perceived opportunity cost of using family labour on the land. Since the opportunity of earning alternative income other than from farming varies from household to household, depending on its resource position (family labour and land), it is quite likely that a pure tenant would face a different opportunity cost, than a "mixed" tenant or an owner-cultivator, for the use of family labour. Thus, it is possible that the differential opportunity cost of family labour would make the pure tenant appear to be more productive than an owner cutlivator.

Thus, we see that the differential opportunity cost of family labour as perceived by farm households would determine the decisions over family size and child schooling as well as the allocative decisions in agriculture. This is the underlying assumption of the decision-making models developed in the following section.

3.5 A Decision-Making Model of Farm Household Behaviour

The farm household model which we present here describes the decision-making behaviour of a semi-commercial farm household in a peasant economy. It has been argued in the literature that this kind of model is relevant to a major part of world agriculture which falls in between the polar cases of a complete commercial farm employing only hired labour and marketing all of its output and a pure subsistence farm using only family labour and producing no marketable surplus [Krishna (1969)]. Assuming that there is a competitive labour market in the economy there will be competitive wage rates for each type of family labour (W_m for adult male labour, W_W for adult female labour and W_C for child labour). If the farm household is a parental decision-making unit, a household production model may be used to derive the demand functions for child-quantity and child-quality by the household. The farm household decision-making problem is

$$(1) \quad \text{Max} \quad U = U(N, L_C, E, S)$$

subject to

(2) $F = F(D_M, D_W, D_C, d_j;\ LA, KA)$

(3) $N = N(X_N, T_{NW})$

$L_C = L_C(X_L, T_{LC})$

$E = E(X_E, T_{EC})$

$S = S(X_S, T_{SW})$

$\Omega_M = H_M + D_M$

(4) $\Omega_W = H_W + D_W + T_{NW} + T_{SW}$

$N\Omega_C = H_C + D_C + NT_{LC} + NT_{EC}$

(5) $P_L X_L + P_E X_E + P_N X_N + P_S X_S = W_M H_M + W_W H_W + W_C H_C + P_A F(..) - \Sigma P_j d_j$

where

N = child quantity

L_C = per child-leisure

E = per child schooling

S = aggregate composite commodity representing household standard of living index;

F = agricultural output

D_M = adult male labour

D_W = adult female labour

D_C = total quantity of family child labour used in family farm = NT_{FC}, where T_{FC} is time in farming per child;

d_j = other variable inputs used in F production

LA,KA = land and capital inputs (fixed)

P_A = the price of agricultural output

X_i = aggregate purchased goods from markets for production of household commodities N, L_C, E, S

T_{NW}, T_{SW} = wife's time involved in raising N and making S

T_{LC}, T_{EC} = per child time devoted to leisure and schooling

Ω_M, Ω_W, Ω_C are the total working hours available to each member of the household

P_j = the prices of purchased inputs for F production

P_i = prices of X_i, i = N, L_C, E, S

H_i = are net quantity of each type of labour time sold if H_M, H_W, H_C > 0 and net quantity of labour time of each type purchased if H_M, H_W, H_C < 0, where H_C is N times the hired labour time per child, T_{WC}, if H_C is positive.

This model treats hired labour and family labour as perfect substitutes in agricultural production and assumes perfectly competitive labour markets for family labour. It may not be realistic to assume perfectly competitive labour markets when there are imperfections in the other markets. Since the markets are linked in a village economy setting [see Bardhan (1980)] the imperfect land and capital markets can influence the labour market. The farm households may face different shadow wages , for their different types of labour, since there may be different opportunities in non-agricultural activities.

If it is assumed that hired and family labourers are not perfect substitutes in production then we would interpret the W's as the shadow wages for family labour in agricultural activity and the H's as the family time devoted to non-agricultural income earning activity. The W's may differ from the agricultural wage. In addition, the hired labour of any type would be a part of d_j. Thus, alternative assumptions about family labour may be represented by the above model.

The problem presented as equations (1) to (5) can be restated as

$$\text{Max } U = U(N, L_C, E, S)$$

subject to

(6) $I = N(\pi_N) + L_C(N\pi_L) + E(N\pi_E) + S(\pi_S)$

where I = agumented "full" family income = $\Pi + W_M\Omega_M + W_W\Omega_W$

Π = net income (profit) from agricultural production

$= P_A F(D_M, D_W, D_C, d_j; LA, KA) - W_M D_M - W_W D_W - W_C D_C - \Sigma P_j d_j$

π_N = unit price of child quantity = $(P_N x_N + t_{NW} W_W - W_C \Omega_C)$

π_E = unit price of child schooling = $(P_E x_E + t_{EC} W_C)$

π_L = unit price of child leisure = $(P_L x_L + t_{LC} W_C)$

π_S = unit price of commodity S = $(P_S x_S + t_{SW} W_W)$

Here the x_j's and the t_{ij}'s are the fixed input coefficients for the production of household commodities N, L_C, E, S. These coefficients are assumed to be independent of the levels of production, given prices, due to the assumption of linear homogeneity of the production functions for the household commodities. If, in addition, we assume that the household production functions are of the fixed-proportional type the input coefficients are also independent of prices. The first order conditions for the maximization problem (1) contain a subset which determine inputs used in agriculture and, thus, net agricultural income(π). This agricultural income is treated in the following problem as a function of the prices of agricultural output, the prices of agricultural inputs, land and capital.

The first-order conditions for the constrained maximization of (1) yield;

(7.i) $$\frac{\partial U}{\partial N} + \lambda\,(\pi_N + L_C\pi_L + E\pi_E) = 0$$

(7.ii) $$\frac{\partial U}{\partial L_C} + \lambda\,(N\pi_L) = 0$$

(7.iii) $$\frac{\partial U}{\partial E} + \lambda\,(N\pi_E) = 0$$

(7.iv) $$\frac{\partial U}{\partial S} + \lambda\,(\pi_S) = 0$$

(7.v) $$N(\pi_N + L_C\pi_L + E\pi_E) + S\pi_S = \Pi + W_M\Omega_M + W_W\Omega_W$$

where λ is the Lagrangian multiplier, $\lambda < 0$ and an interior solution is assumed.

The first-order conditions provide a set of shadow prices for the produced household commodities. Thus the shadow price of children (q_N) is

$$(\pi_N + L_C\pi_L + E\pi_E) = P_N x_N + t_{NW}W_W + EP_E x_E + L_C P_L x_L - T_{WC}W_C;$$

of child leisure (q_L) is

$$N\pi_L = N(P_L x_L + t_{LC}W_C);$$

and of child schooling (q_E) is

$$N\pi_E = N(P_E x_E + t_{EC}W_C).$$

Note that these shadow prices are variable. This is because of the non-linearity in the budget equation (6) due to the interaction between child quantity and child quality. Thus, the shadow price of children is positively related with the level of child schooling and child leisure chosen but is negatively related to the total child earnings. Similarly, the shadow prices of child schooling and child leisure are positive functions of child quantity.

Although this model is very similar to one derived by Rosenzweig and Evenson (1977), there is a significant difference. The difference is that the allocative efficiency conditions in agriculture have been integrated into consumption through the profit maximizing conditions. The essential difference between these two models can be seen directly from the budget constraint. The budget constraint [equation (7.v)] combines the income and time constraints as well as the technological constraints described by the production functions for both agricultural output and the household commodities. The right hand side of equation (7.v) is an augmented version of Becker's concept of "full income" which in this case includes the net profit Π from agricultural production (unlike the Rosenzweig and Evenson model).

The net profit from agricultural production is treated as a constant in the budget constraint to emphasize that the quantity of each type of labour demanded is determined solely by the profit maximizing condition in agricultural production. If there were an absence of labour market participation by the farm household, the quantity of each type of family labour used in production would be affected directly by the subjective evaluation of work to the household [see Chayanov (1966), Sen (1966)]. In other words, the level of labour supplied by each household member (including child labour) would be determined by the direct interaction of the quantity versus quality of children in the utility function. However, with an active labour market (including child labour) in some agrarian economies (including India and Bangladesh), the subjective evaluation of work for child labour on the basis of the interaction between child quantity and child quality only determines the level of wage labour (each type) supplied by the household but not the household's demand for labour (including child labour) in its own agricultural production. Instead, allocation of labour and hence child labour to the family's own farm is determined by the profit maximizing condition and hence in this way the production and consumption segments of the model can be examined separately.

Here lies the difference between this model and the model of Rosenzweig and Evenson (1977). Their model determines the supply of child labour on the basis of the subjective evaluation of the quantity versus quality of children in the utility function and a demand for child labour which is infinitely elastic at the market wage. In our model we incorporate agricultural profits into the budget constraint, thus providing a link between the allocative decisions in agriculture that determine farm income and the decisions regarding child schooling and family size which are determined by the interaction of child quantity and child quality in the utility function. This link does not run in the opposite direction since agricultural input choices are unaffected by the family size and child schooling decisions. The demand for child labour for agriculture does not necessarily equal the supply of child labour from the consumption side (derived by the income-leisure chioce). The discrepancy between these two can be attributed to the employment of hired child labour or hiring out of child labour.

Despite the incorporation of the allocative decisions in agriculture in the form of net profit, Π, the model gives comparative static results similar to the results derived by Rosenzweig and Evenson. After totally differentiating the first-order conditions (7.i) - (7.v) the compensated substitution elasticities of the three child investment commodities with respect to the child wage rate, W_C, can be written as (see appendix III.A for the derivation).

$$(8.\text{i}) \quad \eta^*_{NW_C} = \eta^*_{NN}\left(\frac{-T_{WC}W_C}{q_N}\right) + \eta^*_{NL}W_C\left(\frac{Nt_{LC}}{q_L}\right) + \eta^*_{NE}W_C\left(\frac{Nt_{EC}}{q_E}\right)$$

$$(8.\text{ii}) \quad \eta^*_{LW_C} = \eta^*_{LN}\left(\frac{-T_{WC}W_C}{q_N}\right) + \eta^*_{LL}W_C\left(\frac{Nt_{LC}}{q_L}\right) + \eta^*_{LE}W_C\left(\frac{Nt_{EC}}{q_E}\right)$$

$$(8.\text{iii}) \quad \eta^*_{EW_C} = \eta^*_{EN}\left(\frac{-T_{WC}W_C}{q_N}\right) + \eta^*_{EL}W_C\left(\frac{Nt_{LC}}{q_L}\right) + \eta^*_{EE}W_C\left(\frac{Nt_{EC}}{q_E}\right)$$

where η_{ii} are own price elasticities and η_{ij} are the cross price elasticities. Note that changes in W_C change the shadow prices q_j, j=N, L_C,E which in turn change quantities demanded of each commodity by the household. Therefore, changes in certain parameters associated with the shadow prices will influence the quantities demanded through the effects of shadow prices on these endogenous variables. Following Rosenzweig and Evenson, if we assume that L_C and E are net complements with each other but are net substitutes with N, we get

$$\eta^*_{NL},\ \eta^*_{NE},\ \eta^*_{LN},\ \eta^*_{EN} > 0 \text{ and } \eta^*_{LE},\ \eta^*_{EL} < 0.$$

Since second-order conditions restrict the own price elasticities η^*_{NN}, η^*_{LL}, $\eta^*_{EE} < 0$, we get unambiguous signs for all these three compensated elasticities. An increase in the child wage rate, W_C, if compensation were carried out, would lead to an increase in the family size ($\eta^*_{NW_C} > 0$), and a decrease in child quality ($\eta^*_{LW_C} < 0$, $\eta^*_{EW_C} < 0$). As a result, if the opprotunity cost of child labour in farming is positively related to the size of landholding, then child quantity is positively related with landholding and the child quality is negatively related to the farm size after compensating for the income effect. On the other hand, the uncompensated substitution elasticities with respect to W_C are

$$(9) \qquad \eta_{jW_C} = \eta_{jN}\left(\frac{-T_{WC}W_C}{q_N}\right) + \eta^*_{jL}\left(\frac{Nt_{LC}}{q_L}\right) + \eta^*_{jE}\left(\frac{Nt_{EC}}{q_E}\right) + \eta_{jI}\eta_{IW_C}, \quad j=N,L_C,E$$

Since $\eta_{IW_C} = \frac{-D_C W_C}{I} < 0$, the income effect only reinforces the substitution effects for the child quality elasticities and both η_{LW_C} and η_{EW_C} are negative. The sign of the child quantity elasticity is ambiguous (unlike the result of Rosenzweig and Evenson) because the substitution and income effects are opposite in sign. However, equation (9) for j=N suggests that the greater the share of child earning in the shadow prices, q_j, $j = N,L_C,E$, and the smaller the contribution of child earning to total family income (I), the more likely the compensated and uncompensated child wage effects on child quantity will be alike in sign. That is, an increase in W_C may lead to large family size when the economic contribution of children to total family income is smaller. However, even though we allow the same preference structure to hold, we obtain an ambiguous sign of the uncompensated child quantity elasticity (with inferiority ruled out). This is different from the result reported by Rosenzweig and Evenson (1977).

The effect of the wife's wage rate on the child investment commodities is similar to the results derived by Rosenzweig and Evenson. The compensated substitution elasticities with respect W_W are

$$(10)\qquad \eta^*_{jW_W} = \eta^*_{jN}\left(\frac{W_W t_{NW}}{q_N} - \frac{W_W t_{SW}}{q_S}\right) - (\eta^*_{jE} + \eta^*_{jL})\,\frac{W_W t_{SW}}{q_S}\,;\quad j = N, L_C, E$$

Thus if L_C and E are complements to each other but are substitutes for N, the sign of these elasticities now depend on the relative cost intensity of the goods N and S which consume the wife's time. Hence following Rosenzweig and Evenson if

$$\alpha_N = \frac{W_W t_{NW}}{q_N} > \alpha_S = \frac{W_W t_{SW}}{q_S} \quad \text{then}$$

$$\eta^*_{NW_W} < 0 \text{ and } \eta^*_{EW_W},\ \eta^*_{LW_W} > 0.$$

That is to say, a compensated increase in the wife's wage rate would lead to a substitution of child quality and S for child quantity. On the other hand, the uncompensated elasticities are given by the equation (11),

$$(11)\quad \eta_{jW_W} = \eta_{jN}(\alpha_N - \alpha_S) - \alpha_S(\eta_{jE} + \eta_{jL}) + \eta_{jI}\,\eta_{IW_W},\ j=N,L_C,E;$$

where $\alpha_N = \dfrac{W_W t_{NW}}{q_N}$ and $\alpha_S = \dfrac{W_W t_{SW}}{q_S}$.

since $\eta_{IW_W} = \dfrac{(\Omega_W - D_W)W_W}{I} > 0$,

the uncompensated wage elasticity of child quality must exceed zero because of reinforcing substitution and income effects. Therefore, η_{EW_W} and η_{LW_W} are positive when inferiority is ruled out. But the opposite substitution and income effects make the uncompensated child quantity elasticity, η_{NW_W}, ambiguous even if $\alpha_N > \alpha_S$. However, the negative substitution effect is likely to dominate the positive income effect, the lower is the wife's contribution to full family income (I), η_{IW_W}. That is to say, an increase in mother's income earning opportunity which would allow her to have a significant contribution to total family income is expected to lead reduced family size where no such opportunity exists.

The first-order conditions for household utility maximisation lead to a set of demand functions that depend on the exogenous parameters in the system. Moreover, changes in some parameters related to income earning activities have predictable effects on some of the endogenous variables. Although the consumption side is very similar to Rosenzweig and Evenson's model, the integration of the allocative decisions in agriculture with the consumption side differentiates this model from theirs. The allocative decisions reflected in Π imply that the total demand for labour (including child labour) in the family farm can be determined independently from the profit maximizing conditions. However, the family size and child schooling decisions are also affected by the farm households production decisions, for these will affect household income. This integration of production and consumption decisions shows that agricultural productivity does help determine family size and child schooling but that the reverse is not the case. However, the separation of agricultural production decisions and household time allocations is dependent on the assumption of competitive markets for family labour. Interesting special cases of the model occur if there is some limit on the amount of child labour which can be hired out, H_C, or if the child wage rate, W_C, is a decreasing function of the amount hired out. In these cases, the valuation of the child's time in consumption affects the agricultural input decisions, so that the decisions are completely interdependent.

3.6 Estimating the Model

Estimation of the above system requires estimation of the farm profit function. There are two ways one can estimate the profit function. Given an independent estimate of the agricultural production function, the profit maximizing conditions can be used to determine the variable inputs into agricultural production and hence the total agricultural output. These would then be used to derive Π [see Barnum and Squire (1978)]. Another alternative is a direct estimation of Π by utilizing the restricted profit function criteria [see Lau and Yotopoulos (1973)]. Both these approaches can be used to determine the demand for family labour, including child labour on the family farm. Moreover, we can incorporate the question of the relative efficiency of both types of farmers, large versus small, and owner versus the tenant farmers in these two approaches if we find differences in input demands by these respective types of farm households. However, once the profit function is estimated the impact of resource allocation decisions on the consumption side is transmitted through the value of Π in the budget constraint. Turning to the consumption side, the first-order conditions (7.i) - (7.v) can be solved to determine the demand functions for N, L_C, E, S in terms of all prices and augmented "full income" I, assuming that second-order conditions for maximization are satisfied. Therefore, the interlinked production and consumption decisions could make it possible to determine the relationship between allocation decisions and land or agricultural productivity on the one hand and family size and child schooling on the other hand. This relationship can be examined to determine whether the resource allocation decisions of the farm households are consistent with large family size and low child schooling rates.

The results of the theoretical model can be tested econometrically by specifying the form of the agricultural production function and using a linear expenditure system to represent the consumption expenditure. As an illustration, following Barnum and Squire (1979), we can use a Cobb-Douglas production function for agricultural output and derive demand functions for child-quantity and child-quality by specifying the utility function as

$$(12) \qquad U = \beta_{LC}\ln(L_C-\bar{L}_C) + \beta_E\ln(E-\bar{E}) + \beta_N\ln(N-\bar{N}) + \beta_S\ln(S-\bar{S})$$

where $\bar{L}_C$, $\bar{E}$, $\bar{N}$, and $\bar{S}$ are minimum amounts of child leisure, child schooling, child quantity and aggregate commodity (S) respectively. The farm household's problem is now to maximize (12) subject to the budget constraint (6). The first-order conditions yield the following equations:

$$(13.i) \qquad \frac{\beta_{LC}}{(L_C-\bar{L}C)} + \lambda\,(-N\pi_L) = 0$$

$$(13.ii) \qquad \frac{\beta_E}{(E-\bar{E})} + \lambda\,(-N\pi_E) = 0$$

$$(13.iii) \qquad \frac{\beta_N}{(N-\bar{N})} + \lambda\,(-\pi_N-L_C\pi_L-E\pi_E) = 0$$

$$(13.iv) \qquad \frac{\beta_S}{(S-\bar{S})} + \lambda\,(-\pi_S) = 0$$

$$(13.v) \qquad I-N(\pi_N + L_C\pi_L + E\pi_E)-S\pi_S = 0$$

where λ is the Lagrangian multiplier, and $\lambda > 0$.

The second-order conditions for maximization requires that the value of the bordered Hessian determinant of the first-order conditions (13.i) - (13.v) must be positive. This requires that

$$H = \frac{\pi_S}{(S-\bar{S})} \left(\pi_N + L_C\pi_L + E\pi_E\right) \frac{\beta_E}{(E-\bar{E})^2} \frac{\beta_{LC}}{(L_C-\bar{L}_C)^2} \frac{1}{N(N-\bar{N})} \{N(\beta_N-\beta_E-\beta_{LC}) + 2\bar{N}(\beta_E + \beta_{LC})\} > 0$$

where H is the value of the determinant. If $(S-\bar{S}) > 0$ and $(N-\bar{N}) > 0$, a sufficient condition for H to be positive is that $(\beta_N-\beta_E-\beta_{LC})>0$, which implies that the utility weight on child quantity must exceed the utility weight on child quality (schooling and leisure). Note that this condition for H to be positive holds whether or not $\bar{N}$ is equal to zero.

The equations (13.i) - (13.v) generate a set of linear expenditure equations for household commodities [see appendix III.B for the derivation]. Note also that the following expenditure equations e.g, (14.i) - (14.iv) are linear in variables despite the fact that this system has been derived using a non-linear budget constraint.

The comparative statics results of this model of the peasant household differ depending on whether family size is treated as being unconstrained by social pressure ($\bar{N}$=0) or being constrained by a social norm that implies a minimum family size for every peasant household ($\bar{N}$>0).

This particular modelling procedure of the linear expenditure system presumes that utility is realized only from the consumption of commodities beyond that prescribed by subsistence or institutional convention.

When $\bar{N}$=0, the resulting linear expenditure system is given by equations (14.i) through (14.iv).

(14.i) $\pi_S(S-\bar{S}) = K_1 \dfrac{\beta_S}{(\beta_S+\beta_N)}$

(14.ii) $N = \dfrac{K_1}{B} \dfrac{(\beta_N-\beta_E-\beta_{LC})}{(\beta_S+\beta_N)}$

(14.iii) $\pi_E(E-\bar{E}) = \dfrac{\beta_E}{(\beta_N-\beta_E-\beta_{LC})} B$

(14.iv) $\pi_L(L_C-\bar{L}_C) = \dfrac{\beta_{LC}}{(\beta_N-\beta_E-\beta_{LC})} B$.

where $K_1 = (I-\bar{S}\pi_S)$ is the maximum discretionary income available to the household for its decision variables, and $B = (\pi_N + \pi_L\bar{L}_C + \pi_E\bar{E})$ is the fixed cost associated with the minimum amount of child quality for the farm household. Notice that the second order condition, $(\beta_N-\beta_E-\beta_{LC}) > 0$, is necessary for N, $E-\bar{E}$, and $L_C-\bar{L}_C$ to have positive values. Assuming that the second-order conditions for maximization are satisfied, we can examine the comparative static results of this linear expenditure system.

The effect of changes of the agricultural product prices, P_A, on the quality and quantity of children and on the household's standard of living are given by equations (15.i), (15.ii) and (15.iii).

(15.i) $$\frac{dN}{dP_A} = \frac{dK_1}{dP_A} \frac{(\beta_N-\beta_E-\beta_{LC})}{\beta_S+\beta_N} \frac{1}{B}$$

(15.ii) $$\frac{dE}{dP_A} = \frac{dL_C}{dP_A} = 0$$

(15.iii) $$\frac{d_S}{dP_A} = \frac{dK_1}{dP_A} \frac{\beta_S}{\pi_S(\beta_S+\beta_N)}$$

Since $\frac{dK_1}{dP_A} = \frac{dI}{dP_A} = F(..) > 0$ and since the second-order conditions restrict $(\beta_N-\beta_E-\beta_{LC}) > 0$, we get $\frac{dN}{dP_A} > 0$, $\frac{dS}{dP_A} > 0$ and $\frac{dE}{dP_A} = 0$. There is no effect on child quality.

Although the household's expenditure on education rises, it remains at the same level per child. A similar result would hold for a Hicks-neutral technological change, provided that the implicit assumption of the negligible contribution of child schooling to productivity holds true. Of course, this assumption may not be tenable in the dynamic sense where the adoption of new technology is affected by the schooling of the farmers and may encourage farm households to have fewer children and to give their children more education. This assertion is made by Schultz (1980) and could be studied by modifying the original problem.

The effects of changes of the child wage, W_C, on education, family size, children's leisure and the family's standard of living are shown by equations (16.i) through (16.iv).

(16.i) $$\frac{dN}{dW_C} = \frac{(\beta_N-\beta_E-\beta_{LC})}{\beta_S+\beta_N} \left[\frac{dK_1}{dW_C} \frac{1}{B} - \frac{K_1(\bar{T}_{EC} + \bar{T}_{LC} - \Omega_C)}{B^2} \right]$$

$$(16.ii) \quad \frac{dE}{dW_C} = \left[\frac{\beta_E}{(\beta_N-\beta_E-\beta_{LC})}\right] \left[\frac{\pi_E(\bar{T}_{EC} + \bar{T}_{LC} - \Omega_C) - Bt_{EC}}{\pi_E^2}\right]$$

$$(16.iii) \quad \frac{dL_C}{dW_C} = \left[\frac{\beta_{LC}}{(\beta_N-\beta_E-\beta_{LC})}\right] \left[\frac{\pi_L(\bar{T}_{EC}+\bar{T}_{LC}-\Omega_C)-Bt_{LC}}{\pi_L^2}\right]$$

$$(16.iv) \quad \frac{dS}{dW_C} = \left[\frac{dK_1}{dW_C}\right] \left[\frac{\beta_S}{\pi_S} (\beta_S + \beta_N)\right]$$

An increase in the child wage rate reduces agricultural income, so that $\frac{dK_1}{dW_C} = \frac{dI}{dW_C} = -H_C < 0$ and since $(\bar{T}_{EC}+\bar{T}_{LC}-\Omega_C) < 0$, and $B=(\pi_N+\pi_L\bar{L}_C+\pi_E\bar{E}) > 0$, we get a negative sign for the changes of child quality [equations (16.ii), (16.iii)]and for the quantity of commodities(S) consumed by the household [equation (16.iv)]. Therefore, an increase in the child wage rate unambiguously would decrease child quality and household purchases of commodities, S, given the second-order condition for maximization that the utility weight on quantity exceeds the weight on quality. But the sign for the child quantity derivative [equation (16.i)] is ambiguous despite $(\beta_N-\beta_E-\beta_{LC}) > 0$. Since an increase in the child wage rate decreases agricultural income and the opportunity cost of child quantity, but increases the opportunity cost of child quality, the sign hence depends on the relative strength of these two factors. Thus $(\beta_N-\beta_E-\beta_{LC}) > 0$ is not sufficient to determine the impact of an increase of the child wage rate on the demand for child quantity.

The effect of changes of the wife's wage rate W_W, on the four endogeneous variables is given in equations (17.i) through (17.iv).

(17.i) $$\frac{dN}{dW_W} = \frac{(\beta_N-\beta_E-\beta_{LC})}{(\beta_S+\beta_N)}\left[\frac{1}{B}\frac{dK_1}{dW_W} - \frac{K_1 t_{NW}}{(B)^2}\right]$$

(17.ii) $$\frac{dE}{dW_W} = \frac{\beta_E}{(\beta_N-\beta_E-\beta_{LC})} \frac{t_{NW}}{\pi_E}$$

(17.iii) $$\frac{dL_C}{dW_W} = \frac{\beta_{LC}}{(\beta_N-\beta_E-\beta_{LC})} \frac{t_{NW}}{\pi_L}$$

(17.iv) $$\frac{dS}{dW_W} = \frac{dK_1}{dW_W} \frac{\beta_S}{\pi_S(\beta_S+\beta_N)} - K_1 \left(\frac{\beta_S}{\beta_S+\beta_N}\right)\left(\frac{t_{SW}}{\pi_S^2}\right)$$

Since $\frac{dK_1}{dW_W} = (\Omega_W-D_W) > 0$, we get $\frac{dE}{dW_W}$, $\frac{dL_C}{dW_W} > 0$ as $(\beta_N-\beta_E-\beta_{LC}) > 0$. But the signs of $\frac{dN}{dW_W}$ and $\frac{dS}{dW_W}$ are ambiguous where $(\beta_N-\beta_E-\beta_{LC}) > 0$ is not sufficient to determine their sign.

If the case is considered in which family size is constrained to be greater than two ($\bar{N}$>0), the resulting linear expenditure system is given by equations (18.i) through (18.iv), whose derivatives can be found in appendix III.B.

(18.i) $\pi_S(S-\bar{S}) = K.\ \beta_S/(A)$

(18.ii) $N\pi_L(L_C-\bar{L}_C) = K.\beta_{LC}/(A)$

(18.iii) $N.\pi_E(E-\bar{E}) = K.\beta_E/(A)$

(18.iv) $(N-\bar{N})\ (\pi_N+L_C\pi_L+E\pi_E) = K.\beta_N/(A)$

The variable $K=[I-\bar{S}\pi_S-\bar{N}(\pi_N+L_C\pi_L+\bar{E}\pi_E]$ is the discretionary income of the household, and

$$A = (\beta_N + \beta_S + \beta_E + \beta_{LC}) - (\frac{N-\bar{N}}{\bar{N}}) \; (\beta_{LC} + \beta_E)$$

Solving the equations (18.i) - (18.iv) we get the solution for (N-$\bar{N}$) as the following quadratic equation

$$(19) \qquad (N-\bar{N}) = \frac{-\bar{N}B\sum_{j=1}^{4}\beta_j + (\beta_{LC} + \beta_E - \beta_N)K \pm \sqrt{b^2 + 4\bar{N}KB \cdot \beta_N(\beta_S+\beta_N)}}{2B(\beta_N + \beta_S)}$$

where $\quad b = \bar{N}B\sum_{j=1}^{4} \beta_j + (\beta_{LC} + \beta_E - \beta_N)K$

The only relevant solutions are those for which (N-$\bar{N}$) > 0 if and only if

i) there is positive root

ii) $(\beta_{LC} + \beta_E - \beta_N) < 0$, and

iii) $(\beta_{LC} + \beta_E - \beta_N)K > \bar{N}B \sum_{j=1}^{4} \beta_j$

Though the second-order conditions for maximization restrict $(\beta_{LC}+\beta_E-\beta_N) < 0$ it is clear from above that for (N-$\bar{N}$) to be positive, the above condition (ii) is neither necessary nor sufficient.

If we specify the utility function to generate the linear expenditure system, the resulting demand equations are consistent with respect to the parameters related to income earning activities. Though the linear expenditure system restricts the preference structure [note that all goods are substitutes in the Hicksian sense, unlike the unrestricted utility function (1)] it is clear that the model is consistent with the results derived earlier in the case of a general utility function. Moreover, the allocative decisions in agriculture can be incorporated into the estimate of Π by independently estimating a specific production function which would determine the demand for all types of family labour in agriculture. Thus the interaction between production and consumption decisions can determine whether there is a systematic relationship between agricultural productivity, family size and child schooling in a peasant economy.

In order to identify any systematic relationship between resources allocated, family size and child schooling decisions it is necessary to obtain detailed farm household socio-economic data. A description of a survey undertaken to obtain such data is presented in the next chapter, along with summaries of the characteristics of the surveyed households.

FOOTNOTES:

1. This corresponds to the general statement that farmers are poor not because they have large families, but they have large families because they are poor [Mamdani (1972)].

2. The demand functions for other consumption goods, such as farm and non-farm goods, and leisure, can also be derived in the usual utility maximizing framework. However, to highlight the issues regarding the demand for children and child schooling, only these specific demand relationships are considered here. We shall consider a detailed set of demand functions for all consumption goods by a farm household later in the analysis.

3. Note that family labour need not to be a homogeneous units of labour. To the extent that minor (aged under 15) as well as female labour participate in farm activities along with adult male labour, there exist wage differentials for such heterogeneous rural labour market [K. Bardhan (1977), Binswanger and Rosenzweig (1981)]. It is this heterogeneity in the labour market that is crucial for deriving different opportunity costs for different categories of family labour.

4. The earnings between non-farm activities and wage-earning in agriculture need not be the same. To the extent that family labour is a collection of heterogeneous units of labour and since categories of labour primarily employed in farm and non-farm activities are different, there is high possibility that the earnings differential between farm and non-farm activities are substantial. If we assume that the category of labour employed primarily in non-farm activity is different from the type engaged in agriculture, it may not be unwarranted to assume that there is a competitive labour market for agricultural labour. After all, the allocation of family labour primarily engaged in agriculture is determined by the market wage rate for agricultural workers.

5. Child schooling is lower because in a traditional rural environment child schooling has a limited immediate pecuniary returns [T.W. Schultz (1964)].

CHAPTER FOUR

FARM SIZE, FAMILY SIZE, SCHOOLING AND INCOME EARNING ACTIVITY: AN ANALYSIS OF HOUSEHOLD SURVEY DATA IN RURAL BANGLADESH

4.1 Introduction

In the preceding chapter, a theoretical approach has been undertaken to explore the interrelationships between family size and child schooling decisions and agricultural inputs choice decision within the context of the farm household. To test the hypotheses incorporated into the theoretical work, it is necessary to obtain detailed microeconomic data including information on family size and its composition, child schooling, the allocation of family labour to land and other non-farm activities, land owned, land used, the choice of crops, hired labour and other purchased inputs, household consumption expenditure, and income from all other non-crop sources. With support from the Ford Foundation and the National Foundation for Research on Human Resource Development (NFRHRD) (both in Dacca, Bangladesh), these data were collected between June, 1981 and April, 1982.

The data set contains a sample of 200 households from two (2) areas in Bangladesh. Interviews were conducted three (3) times, corresponding to the three (3) cropping seasons, during the crop cycle year beginning in March 1981.

This chapter is divided into three major parts. Part one describes the data collection and sampling methods, quality and nature of data, and the questionnaire. Part two specifically deals with data set, evaluating it in terms of major household characteristics and income earning activities in rural Bangladesh. Part three concludes with implications of these results for the more rigorous analysis in the following chapters. Thus, this chapter is an analysis of the farm level survey data as a prelude to econometric work that will be presented in the following chapters.

4.2 The Data and Some General Sample Characteristics

4.2.1 Plan of the Study

Bangladesh[1] agriculture is a multicrop culture. Throughout the crop year, as many as three paddy crops are grown. Accordingly, there are three crop seasons - "Aus" (spring), "Aman" (summer), and "Boro" (winter) - in the crop cycle of a year. These three seasons, however, contain overlapping months of a year - the "Aus" season consists of months, March-April to July-August, the "Aman" season begins from July-August and ends at November-December while the third season, "Boro", lasts from November-December to March-April. Any choice - theoretic study in such a culture must accommodate the seasonal variations in the crop cycle while studying farm household decisions regarding crop production and allocation of its resources. Thus, the present study contains information on different flow variables (in addition to stock variables) such as application of inputs for different operations on crops grown during the course of a year, consumption expenditures, and allocation of family resources (including their time) among different activities.

4.2.2 Research Methodology

One critical decision in this kind of study is the choice between single and multiple interview techniques. Even assuming that farmers are willing to supply accurate information of the type requested, the single interview approach may be inaccurate and hence undesirable because the recall period required is extremely long and thus it involves taxing respondents' memories too much. Although more reliable information of the kind desired can be collected by visiting samples frequently during the reference period multiple surveys are expensive. However, given the type and quality of data required for the study, the multiple rather than the single interview approach was desirable. Therefore, given the resource constraint, a three(3) period multiple interview approach, each period corresponding to a crop season, was chosen.

4.2.3 Questionnaire and Data Collection Methods

The questionnaire was designed to cover both the stock and flow variables relating to the farm household decision making process. The questionnaire is divided into three broad categories.

a) General household characteristics: These include household composition, age structure, schooling level and occupation.

b) Stock variables: These include,

i) farm size, land use and land tenure;

ii) farm implements and their value;

iii) household non-land assets and their value.

c) Flow variables: These contain,

i) weekly time allocation of household members for income earning and other household activities;

ii) weekly consumption expenditures;

iii) cropping pattern and input allocation by land tenure and for different crops during the course of the year 1981-1982;

iv) crop production and its uses;

v) income from other non-crop and non-agricultural sources;

vi) borrowing and lending position of the household during the reference year.

In the first interview, during the months of July-August, information was collected on family size, schooling level, schooling information of school-age children, household composition, farm size and land tenure, the stock of farm implements, and non-land assets. Weekly data on consumption, time allocation, employment of family labour, and input-output type information on the "Aus" (spring) crop season were also collected. After scrutinizing these data, a second interview was carried out during the months of October-December to get information on the "Aman" season.

Finally, the third interview was conducted in March and April to cover the third, "Boro", season. During the second and third interviews, information on flow variables only was collected. A detailed discussion of the data set is found in Appendix IV.A.

4.2.4 Quality of the Data

The data has been collected for one year of a crop cycle in Bangladesh agriculture. A multiple interview approach was used in order to avoid over-taxing the respondents' memories. The weekly data are based on actual events for the week prior to the interview. However, the data on the past crop season regarding crop production and input allocation mostly relied on farmer's recall on past events of the last crop season. As records on farm business are not kept, some answers on crop production and input allocation may appear somewhat arbitrary since the recall period is larger (about 3-4 months) in this case. However, since this recall period is smaller than for a year, one would expect better response than could be obtained from a one-shot survey method. Moreover, observations from different studies suggest that farmers remember quite accurately such broad magnitudes as those relating to land tenure, land utilization, output produced, the amount of total inputs alloted and their sources, and so on. But they are not confident in telling exactly what amounts of variable inputs were actually allocated to different operations on different crops grown during the season. More reliable information of this kind could have been collected by visiting samples more frequently during the period of reference, but the limitation of resources restricted such attempts. However, if such errors are normally distributed over all samples, the results in our data analysis may not be affected.

Another error seems to be common for this type of data collection and arises from the "wilful" hiding of facts by respondents. Information on landholding, income and expenditure are items commonly vulnerable to this kind of error. In peasant societies, with low education background and unfamiliarity with researchers, cultivators may tend to be less "honest" on income and landholding or may "fear" tax collectors and thus have an incentive to under-report income or misreport landholding. Conversely, on the expectation that they might benefit by showing that their expenditures exceed their income, they may over-report expenditures. However, to minimize such errors, the questionnaire was designed as to contain some similar questions in different parts and for different interview periods, on the basis of which cross-checks were made.

With these shortcomings in mind, the data set collected from Bangladesh seem to be more reliable than those data already available to the author collected by one shot method. Moreover, with this quality of the data, it is hoped that the analysis carried in this study may well represent the rural population of Bangladesh.

4.2.5 Selection of Sample Area

Two rural areas were selected in this project from two districts of Bangladesh. These are Baidyerbazar Thana in Dacca district and Ghatail Thana in Tangail district.[2] One Union was selected from each Thana and a sample of 100 households were chosen from one village in each Thana. The two criteria employed in selecting the one hundred households in each area were i) households whose head is or has ever been married and ii) households have some cultivable land of their own.[3] The information was collected by three university graduate enumerators (with constant supervision by the author) through interviewing the head of each sample household.

One special feature of the sample areas deserves attention. The village in Ghatail Thana is irrigated while the village in Baidyerbazar Thana is not. The latter village is a low land rainfed area where no high yielding varieties of paddy are being planted. The only modern variety used is high yielding sugarcane. On the otherhand, the village in Ghatail has adopted high yielding "boro" paddy (the local name for "Chinese Irri)" which is made possible during the winter season through the use of irrigation water. The area in Baidyerbazar has more access to non-farm activities than the village in Ghatail. The two areas also vary to a certain extent with respect to landholding, tenure, literacy rate and demographic characteristics. These general household characteristics will be discussed later in this chapter. The sample households in each village have large-, medium-, and small-size landholdings, and are of different social background. No landless farmer has been included in this survey, though they represent more than one third of total population in rural Bangladesh.

4.2.6 Background of the Study Areas

The village Hamsadi belongs to the Baidyerbazar Thana of the Narayanganj sub-division in the Dacca district. It is located about 30 miles south-east of Dacca City. The village occupies an area of 2.2 square miles with a population of 2248 persons of which 1180 are males and 1068 are females. The total number of households is 321.[4] The mean family size in the village is 4.04 adults and 2.96 minors (under the age of 15) and mean farm size per household is 1.25 acres. The overall sex ratio in the village is 1.10 which is higher than the national average 1.06. Of 321 households, we have chosen 100 in our survey. The mean family size in our sample is 3.82 adults and 3.39 minors (under the age of 15). The overall literacy rate in our sample is 75%. There is one primary school and one "maqtab" (religious school) in the village. One high school and one college are about 1 1/2 miles and 3 3/4 miles respectively away from the village.

The village Khilgati, the other study area, belongs to Ghatail Thana of district T angail, and is situated about 95 miles north of Dacca City. Part of the village lies on the Dacca-Mymensingh highway which provides the major means of entry into and exit from the village. The area of the village is about 2.9 square miles with a population of 2635 of which 1397 are males and 1238 are females (the male-female ratio is 1.13). The total number of households in the village is 410 with mean family size 3.58 adults and 2.85 minors. Our samples constitute 100 households and the mean family size in our sample is 4.32 adults and 3.57 minors [see Appendix Table IV.C-1]. The overall literacy rate in the village is about 54%. There are two primary schools and two "maqtabs" (religious school) in the village. One high school is situated only 1 3/4 miles away from the village. One close similarity we find in these two villages i.e., the literacy is higher than the national average (according to 1974 census, male literacy rate was 27.67 and female literacy rate was only 12.2%) and hence are atypical in respect to literacy rate compared to most areas in rural Bangladesh.

4.3 Evaluation of Data

4.3.1 Family Type and Size

Bangladesh village life is in the mainstream of traditional society. The family is the basis of Bangladesh social life. The different kinsmen, along with their spouses and children, occupy the same homestead, eat together and enjoy property in common. They cooperate in economic activity and form the household. This household acts as an economic unit and is both a producing and consuming unit. Either the nuclear family or the patrilineally extended family is the basic social and economic unit of Bangladesh village. Cohesion among household members is very strong. Kinship and patronage ties stand out as the most powerful organizing forces in the village that jointly characterize the village structure. In fact, Kinship bonds at different levels tie individuals in a range of obligations. For instance, beyond his immediate household a person has a well defined duties to his bari[5], and somewhat weaker ties to the larger kin-based groups. The bari often operates as a corporate entity with land held in the name of its head, who excercises patriarchal control over all members.[6] In such a case, the bari itself is the basis of the lineal or extended family system. However, as we shall see later, these extended family and lineage groups have more significance among the bigger landowners, "for families with no land or only a house compound there is no economic rationale for emphasizing relations with close but equally impoverished Kin" [Arthur and McNicoll (1978)].

In an environment with few other physical assets land bestows one with social status, power and above all security. Some decades ago when villages were relatively self-sufficient with good harvests, lower population and less crop damage, a landless family in the village could satisfy its normal daily requirements on the basis of its wage income. But with a saturated labour market as a consequence of high population growth, it is now increasingly difficult to be guaranteed the same.

This can be evident from one study that shows that there has been a decline in the real wage in Bangladesh (See table 4.1).

In such a situation, only ownership of land or usage rights to it can provide a fair degree of certainty about future needs. Hence, wealth and poverty of different families are measured in terms of landholding. In turn, as we shall see shortly, the family size and its other characteristics can also be directly related to landholding. Our village study data shows that there is a tendency for extended family households to be concentrated in the large landholding group relative to the share of nuclear households in this same category.

Table 4.2 shows the distribution of various types of families/households together with respective landholding. For simplicity, we have categorized the households into two broad categories - "nuclear" and "joint". Of course, under each category, several sub-categories can be traced.

In a strict sense, the "nuclear" type family is one where the couple along with their unmarried children live together. This type has two sub-categories - "sub-nuclear" and"supplementary" nuclear families. In a "sub-nuclear" family, a widow/divorced head of the family lives with his/her unmarried children. A "supplementary" nuclear family is one where a married couple, their unmarried children, father/mother and unmarried brothers and sisters live together. However, these sub-categories are both classified as "nuclear" families in our table 4.2.On the other hand, a "joint" family is defined as one where two or more married couples (brothers only) and their unmarried children live together while the "lineal joint" is the type where a married couple with at least one married son live together with other unmarried lineal dependents of either spouse.

Table 4.2 shows that the "nuclear" type is dominant in both villages (67% in Hamsadi and 58% in Khilgati). The "joint" and "lineal joint" together constitute 33% of the total families in Hamsadi and 42% in Khilgati respectively. The predominance of "nuclear" type families in both villages is contrary to the usual belief that the majority of Bangladesh's rural families belongs to "joint" family system. Our finding, however, is not unusual and has support in other studies [Zaman (1977). S. Ahmed (1981)]. The pressure of population growth on land accompanied by natural disasters has made peasant households shake free from their former kin and patronage bonds and has tended to erode the kinship binding of the extended family system. In fact, one study observes that although Bangladesh village life is still dominated by patronage and kinship types of attachment, under the twin pressure of population growth and increasing commercialization, there are growing signs that both kinship and patronage bonds are weakening in villages [Abdullah et al (1974)].

Table 4.1 Index of the Real Wage of Agricultural Labour
(deflated by cost of living index)
(1965=100)

Year:	1967	1968	1969	1970	1971	1972	1973	1974
Index:	86	92	100	101	X	72	71	64

Source: Clay (1976)

Table 4.2: Family Types and Landholdings

Family Type	Landholdings (acres)					
	0.1-1.0	1.01-2.0	2.01-3.0	3.01-4.0	Greater than 4.0	Total
Hamsadi						
Nuclear	8(7.16)[a]	35(51.79)	16(39.19)	8(25.83)	X	67(135.69)
Joint or linealjoint	1(.90)	10(15.59)	11(28.75	2(7.43)	9(58.17)	33(99.12)
Khilgati						
Nuclear	6(5.56)	28(42.45)	16(38.49)	5(17.15)	3(14.48)	58(118.13)
Joint or lineal joint	3(2.91)	5(7.02)	11(27.49)	5(16.43)	18(107.2)	42(160.85)

[a] numbers in parantheses are sizes of landholdings in acres.

Table 4.3: Land Tenure Pattern

Type of Tenure	% of Cultivators		% of Land Cultivated	
	Hamsadi	Khilgati	Hamsadi	Khilgati
Owner-cultivator	77	52	80.26	70.64
Owner-manager	X	X	X	X
Owner-cum-tenant	23	48	19.74	29.36
Pure Tenant	X	X	X	X

The kinship attachment appears to only hold when the households own a larger landholding. Looking at the distribution of land in both villages among families, it is evident from table 4.2 that extended families are still prevalent mostly in larger landholding groups.

4.3.2 Distribution of Land-ownership and Operation Holding

As we have observed, land is the principal source of livelihood for the village population in Bangladesh. Thus, the distribution of land has an important effect upon production, employment and the distribution of income in the village economy. While one may not encounter any very large farm in absolute terms, in a land scarce village economy with so many fragmented landholdings, small variations in these holdings will imply differences in social status. The pattern of distribution of landownership in our survey areas can be seen from Table IV C-2 in Appendix IV.C.

Since the survey does not include any landless household, it is impossible to see the extent of landlessness in the study area. However, the distribution of landownership in both villages is skewed. In Hamsadi those households owning lands up to 3 acres constitute 85% of the total households and they occupy about 66% of the total land while the top 15% of the households(those owning land more than 3 acres) own 34% of the total land area. The distribution of landownership is also skewed in village Khilgati. Here 70% of total households own only 45% of the total land while the remaining 30% occupy 55% of the total land area. Thus, on average, those households owning up to 3 acres constitute 78% of total households and own only 55% of total land while the remaining 22% of total households own about 45% of the total land area. This pattern may be comparable with the recent Land Occupancy Survey (LOS), 1979, data which shows that about 72% of total households in Bangladesh, those who own up to 3 acres of land, occupy only about 37% of total land while the remaining 28% of total households who own land of size greater than 3 acres own about 68% of total land.

However, for the study of production and income in the village economy, it is not the landownership distribution, but the pattern of distribution of operational holding[7] (i,e, net cultivatable area) that is important. This pattern of distribution can be seen from Table IV.C-3 in Appendix IV.C It can be noted that about two thirds of total farms in Hamsadi and about a half of total farms in Khilgati are only 2 acres or less in size. Thus, on average, three fourths of total cultivators, cultivate nearly 55% of the total land in holdings of up to 3 acres while the remaining one quarter of households cultivate nearly 45% of total land in holdings of up to 7 acres. This again can be compared with LOS report (1977) which found that about 82% of total farm households held only 37% of total operational holdings up to of size 3 acres in size while the top 8.4% hold about 43% of land up to a size of greater than 5 acres. Thus it is clear that in our study area the distribution of operational holding is as skewed as the distribution of landownership. Both of the distributions, however, may be a little less skewed than the national averages.

The total land owned by the 100 sample households is 236.67 acres in Hamsadi and 278.92 acres in Khilgati respectively while the total operational holdings held by the same households are 224.64 acres in Hamsadi and 272.44 acres in Khilgati. Hence, the average farmsize per household is 2.24 acres in Hamsadi and 2.72 acres in Khilgati respectively while the per household land owned is 2.37 in Hamsadi and 2.79 acres in Khilgati. The average landholding and operational holding seem to be a little larger in size in both areas than is the national average size.[8]

Land Tenureship: Table 4.3 shows that tenancy is not that important in one study area while it is of considerable importance in the other area.[9] In Hamsadi, the owner cultivators (77%) seem to outnumber the number of owner-cum-tenant cultivators (23%) by a substantial percentage. The overwhelming proportion of farms under owner-operated tenure system is, of course, not a surprising one. In one study, it was found that about 75% of total households were owner-operators in a study area in Bangladesh [Khuda (1980)]. Note that in both areas, among our sample households, we do not encounter any landlord cultivator (ie, manager operator) nor any pure tenant. However, when we see the total percentage of land under each type of land tenure system, we find that it is only 20% of total land in Hamsadi and 29% in Khilgati under operational holdings that belong to the owner-cum-tenant group.

Again, out of 39.77 acres that actually was put under land rental market in Hamsadi, only 10.95 acres (28%) was put under share tenancy and the remaining 28.82 (72%) was under fixed rent (cash) tenancy while in Khilgati, out of 57.22 acres put under rental market, 48% land was put under share tenancy. This lower percentage of operational holdings under share tenancy arrangement is in sharp contrast with other studies which found that sharecropping dominates the land rental market in Bangladesh.[10]

4.3.3 Family Size, Fertility and Child Schooling: Some Observations

As we indicated earlier, the mean family size in both study areas (7.21 in Hamsadi and 7.89 in Khilgati, with overall average of 7.55) is quite high and even higher than the national average of 6.7. The dependency ratio which is .97 in Hamsadi and .92 in Khilgati with an average of .94, is also high compared to other developed countries.[11] This high dependency ratio indeed has a considerable impact on income, employment, and child schooling levels in our study areas. Moreover, these two observations, high mean family size and high dependency ratio, may correspond to high fertility rates and low child schooling rates in the study areas. As many have observed, high fertility rates are the single most important determinant of the population growth rate while the schooling rate in the village may indicate the diffusion rate of high yielding technology and the overall rate of rural advancement in the village economy [eg, World Bank (1974)].[12] Therefore, before analyzing the data in terms of income earning activity, it is important to examine the economic factors that may be associated with the determinants of fertility and childschooling levels in the sample areas.

Fertility and Desired Fertility: The population policy of Bangladesh is based on the concept of popularizing family planning, mainly through the delivery of family planning services. It is primarily a service-oriented approach. The basic assumptions underlying such a policy are (i) that couples can be persuaded to accept the small-family size norm, and (ii) that there exists a latent demand for the services provided by the government agencies. However, despite the national efforts, very little progress in reducing the birth rate has been achieved. The 1968 national impact survey together with a recent finding provide the evidence of low acceptance and hence insufficient demand of these services.[13] This suggests that the supply factor does not seem to be the major obstacle to the acceptance of the small family

Table 4.4: Mean Number of Children Born Per Ever Married Woman by Their Current Age

Current Age	Mean number of children ever born		Mean number of children born and living		Total number of ever married women	
	Hamsadi	Khilgati	Hamsadi	Khilgati	Hamsadi	Khilgati
15-19	nil	1.5	nil	1.5	nil	2
20-24	nil	2.20	nil	1.8	nil	5
25-29	4.06	4.19	3.82	3.4	17	16
30-34	4.39	4.93	3.61	4.0	18	14
35-39	4.57	7.50	4.36	6.25	14	12
40-44	5.36	7.56	5.18	6.13	11	16
45-49	5.24	6.83	5.0	6.0	17	12

norm. As one study observes, the real bottleneck is the generation of demand for these services and hence efforts must go beyond to family planning to offset factors which determine family size and fertility behaviour [Sirageldin et al, (1978)]. This, in turn, suggests that factors underlying the demand aspects should get priority as well in motivating households to accept the small family size norm. We shall now examine the factors which may be associated with fertility levels in what follows. The measure of fertility employed here is the mean number of children born per ever-married women in the study areas.

Table 4.4 suggests that the fertility rate is high at all ages in both Hamsadi and Khilgati. By the time a woman in sample area reaches the end of her reproductive life span, she has had six or seven live births. On the other hand, the child mortality rate is also high. Out of the six or seven live births the women has ended up with five or six surviving children.

The factors associated with high fertility, however, cannot be attributed only to high death rates among infants. There is enough evidence to support the hypothesis that economic factors are also related to high fertility. Of course, it is the net fertility (ie, crude fertility minus the crude mortality = mean number of surviving children) which should actually be associated with economic factors if these factors have any discernible effects on fertility.

Table 4.5: Mean Number of Children Born by Farm Size of Households to Which Women in Sample Areas Belong.

Farm Size(acre)	Mean number of children ever born		Mean number of children born & living		Mean no. of children desired by HH head		Total number of ever-married (includes 50 years & above)women.	
	Hamsadi	Khilgati	Hamsadi	Khilgati	Hamsadi	Khilgati	Hamsadi	Khilgati
.01-1.0	4.11	4.80	3.74	3.60	3.84	3.20	19	10
1.01-2.0	4.53	5.68	4.25	4.38	3.37	3.74	43	34
2.01-3.0	5.12	5.96	4.84	4.69	3.40	3.54	25	26
3.01-4.0	5.33	6.54	5.17	5.31	3.67	3.92	6	13
Greater than 4.0 acres	6.57	6.53	6.14	5.47	4.29	4.47	7	17

Table 4.6: Mean Number of Children Born by Education of the Respondent and Spouse.

Educational level	Males				Females			
	Hamsadi		Khilgati		Hamsadi		Khilgati	
	ever born	born & living	ever born	born & living	ever born	born & living	ever born	born & living
Illiterate	3.71	3.43	6.05	4.63	4.69	4.43	5.96	4.84
Primary (I-V)	4.71	4.55	5.38	4.37	5.15	5.01	5.62	4.93
Secondary (VI-X)	5.90	5.65	5.96	5.81	3.0	2.80	3.56	3.0
Post-Secondary (XI & above)	3.33	3.17	3.58	3.0	nil	nil	nil	nil
All educational level	4.85	4.59	5.72	4.86	4.79	4.56	5.49	4.67

As we noted earlier, the operational holding or farm size which a household possesses can be taken as a Proxy variable characterizing the economic conditions for most households in rural societies. Moreover, the pattern of income distribution in villages can be represented by the distribution of landholding.[14] Table 4.5 depicts the relationship between farm size and fertility and also between farm size and the desired fertility level which has been calculated on the basis of the desired number of children the sample household head wished to have.

From Table 4.5, we find a definite positive relationship between the mean number of children born (both everborn and born and living) and farm size in both study areas.[15] This finding is also evident in other studies [Khuda (1978); Rosenzweig and Evenson (1977)]. There are, however, other studies done for different areas in Bangladesh which do not find any conclusive relationship between economic factors such as farm size and fertility [Latif and Chaudhury (1977); Khuda (1980)].

Another important demographic aspect is also revealed from Table 4.5. If the difference between the mean number of children ever born and children born and living corresponds to mortality, the data shows that on average the lower income groups (since farm size holding is a good indicator of income of the households) have higher child mortality rates than those of high income groups. This is consistent with Bangladesh's higher mortality rates within low income groups than in high income groups.

Table 4.5 provides another insight into the relationship between fertility levels and fertility ideals. It is generally believed that high fertility levels prevail in societies which have favourable attitudes towards large family size. Here we find that in both areas, the number of children desired tends to be positively related to the size of the operational holding of the households. However, it is generally true that household heads reported that they have already given birth to more children than they actually desired to have and this difference also increases as the size of operational holding increases.

Another factor generally believed to have effects on fertility levels is the educational level of the couples. Table 4.6 shows that there is a sharp decline in fertility levels for male's educational level as one moves from the secondary to post-secondary categories while such a sharp decline in fertility occurs from a lower educational level for women when their educational level moves from the primary to secondary categories.[16]

Schooling Level of Farm Children: Despite government efforts in recent years to spread free primary education in the country, Table 4.7 provides the evidence that little was achieved during the 1960's and early 1970's. Though overall there is a significant increase in the female literacy rate (about 56%) over the period 1961-1974, there had

Table 4.7: Literacy Rates in Bangladesh 1961 and 1974

Area and Sex	Literacy rate (%) with respect to total population	
	1961	1974
Bangladesh all areas:		
Male	24.2	27.6
Female	7.8	12.2
Both Sexes	16.3	20.2
Bangladesh rural area:		
Male	22.8	25.7
Female	7.0	10.9
Both Sexes	15.1	18.5

Source: B.B.S. (1979)

been little increase in the overall literacy rate in Bangladesh. This may suggest that schooling opportunities provided by the Government have not been fully utilized by the people and in particular by the rural masses. One study reports that "of the present school-age population of 22 million children, only 9.3 million are currently enrolled in primary and secondary schools" [Stepanek (1979)]. The main reason for this enormous non-enrollment is that most poor people simply cannot afford the costs of the nominally free (primary) education such as books and materials, and the opportunity costs of child labour in terms of income foregone [World Bank (1974).T. Islam (1974)]. Thus, the world Bank study suggests:

> "In terms of policy implications, if the burden of costs effectively stands in the way of enrolling primary age group children, the traditional thinking of promoting [school] expansion by improving school environment and training of teachers etc., is probably not relevant" [World Bank, (1974)]

This in effect suggests that there are constraints on the demand side for schooling rather than on the supply side which may impede increasing the rate of literacy in the country. Serious consideration should be given to the farm household's demand for schooling. It is these households who constitute the overwhelming majority (80%) of the country's population. Our village study data for schooling [17] has been examined in terms of some major determinants, such as landownership, farm size and education level of the household head and these results are reported in tables 4.8, 4.9 and 4.10.

Table 4.8: Landownership and Schooling Level of Children

Landownership (acre)	Mean number of children ever gone to school		Mean number of children presently enrolled in primary school		Mean number presently enrolled in Secon. School		Mean number enrolled in Post-Second. School		Mean number of children presently enrolled in all school institutions	
	Hamsadi	Khilgati	Hamsadi	Khilgati	Hamsadi	Khilgati	Hamsadi	Khilgati	Hamsadi	Khilgati
0.1-1.0	2.56	1.89	1.89	1.78	.11	.44	nil	nil	2.0	2.22
1.01-2.0	2.91	2.39	1.58	1.36	.38	.33	.02	.12	1.98	1.81
2.01-3.0	3.71	2.68	1.71	1.21	.61	.57	.23	.11	2.55	1.89
3.01-4.0	3.83	2.89	1.83	1.22	.33	.56	.17	.33	2.33	2.11
Greater than 4 acres	4.67	4.10	2.0	2.19	.33	.67	.33	.43	2.66	3.29
All groups	3.33	2.83	1.84	1.49	.39	.50	.20	.22	2.30	2.27

Table 4.9: Farm Size and Schooling Level of Children

Farm Size (area)	Mean number of children ever-gone to school		Mean number of children enrolled in Secondary School		Mean number of children presently enrolled in Second. School		Mean number of children enrolled in Post-Second. School		Mean number of children enrolled in all school institutions	
	Hamsadi	Khilgati	Hamsadi	Khilgati	Hamsadi	Khilgati	Hamsadi	Khilgati	Hamsadi	Khilgati
0.1-1.0	2.37	2.0	1.47	1.3	.14	.10	nil	.10	1.61	1.50
1.01-2.0	3.23	2.32	1.51	1.35	.40	.53	.07	.09	1.98	1.97
2.01-3.0	3.48	2.73	1.96	1.35	.72	.38	.16	.08	2.84	1.81
3.01-4.0	4.67	3.46	1.50	1.23	.33	.54	.50	.15	2.33	1.92
Greater than 4.0 acres	4.29	4.18	2.14	1.47	.29	.35	.14	.47	2.57	2.29
All groups	3.29	3.12	1.78	1.48	.49	.43	.36	.23	2.28	1.92

Table 4.10: Respondent's Education Level and Children Schooling

Educational level of household head	Mean number of children evergone to School		Mean number of children presently enrolled in primary School		Mean number of children in sec. School		Mean number of children enrolled in Post-Second. School		Mean number of children presently enrolled in all educational Inst.	
	Hamsadi	Khilgati	Hamsadi	Khilgati	Hamsadi	Khilgati	Hamsadi	Khilgati	Hamsadi	Khilgati
"O" Level	2.14 (58%)[a]	2.67 (58%)	1.23	1.19	.08	.33	nil	.04	1.31 (61%)	1.56 (58%)
Primary level	3.32 (70%)	2.77 (69%)	1.78	1.27	.41	.33	.11	.43	2.30 (69%)	2.03 (73%)
Secondary Level	4.05 (78%)	3.81 (76%)	2.05	2.19	.75	.63	.20	.19	3.0 (74%)	3.01 (79%)
Post-Secondary Level	2.67 (90%)	1.0 (100%)	.97	.50	.67	.50	.33	nil	1.97 (74%)	1.0 (100%)
All educational Level	3.29 (68%)	2.59 (71%)	1.73	1.27	.44	.42	.11	.15	2.28 (66%)	1.84 (73%)

[a] numbers in parantheses indicate percentage of school going children to the total number of school-age children;

In both areas, mean number of children ever gone to school increases as the size of landholding increases. However, for the presently enrolled children at all levels of schooling, we do not get any definite relationship between mean number of children enrolled and the size of landholding (see Table 4.8). Similarly, we find a positive relationship between farm size and mean number of children ever gone to school in one area (Khilgati), but not so in Hamsadi. However, for the presently enrolled children at different levels of school, we do not find any definite relationship between their mean number and farm size in either area. Here the mean number of presently enrolled children at all levels increases, decreases and then increases as farm size increases [see Table 4.9].

From Table 4.10, we find that as the respondent's level of education increases, so does the childrens' level of schooling. Thus, on average, the respondents with the post-secondary school level education send 90% of their school-age children to school while the illiterate group with no schooling only send 58% of their children to school. Similarly, the percentage of mean number of children ever gone to school who are presently enrolled in all levels of schooling increases as the respondents' level of education increases.

4.3.4 Occupational Pattern

Before discussing income-generating activities of rural households, it is useful to know the occupational pattern in the study areas. Table 4.11 depicts the occupational pattern of various households of both villages. Both Hamsadi and Khilgati are predominantly areas of agriculturist households. Table 4.11 shows that 81% of total households in Hamsadi and 88% in Khilgati are mainly engaged in agriculture. The percentage of households engaged in non-agricultural activities as a primary occupation is also significant. It is also notable that rural households are increasingly involved in more than one occupation. This occurs mainly through the participation of working members of the household other than the household head. Since agriculture may not provide sufficient income for family needs, families mainly engaged in agriculture more often have some secondary occupations. These secondary occupations are presented in Table 4.12.

It is evident from Table 4.12 that among households engaged in agriculture, 65 households (80.25%) in Hamsadi and 50 households (60.23%) in Khilgati respectively have reported to have some secondary occupations. One especial feature of the occupational pattern is worth noting. With cultivation as the major occupation, 25 households in Hamsadi and 26 households in Khilgati are also engaged in business and trade, which requires a large amount of working capital while 19 house-

Table 4.11: Occupational Pattern in Sample Villages

Primary Occupation of Principal household head	Number of Households	
	Hamsadi	Khilgati
Agriculture		
i) cultivation	76	85
ii) agric. wage labour	5	3
Non-agricultural employment	19	12
Total	100	100

Table 4.12: Secondary Occupation of Some Households in Agricultural Subsector

Secondary Occupation	Number of households	
	Hamsadi	Khilgati
A. Cultivation		
Cultivation and Business/ trade	25	26
Cultivation and Service (Salaried)	13	14
Cultivation and agrl. wage labour	19	8
Cultivation and selling lab. to non-agrl. activity	2	1
B. Agricultural labour		
Agricultural labour and cultivation	5	3
Agricultural labour and trade	1	1
Total	65	53

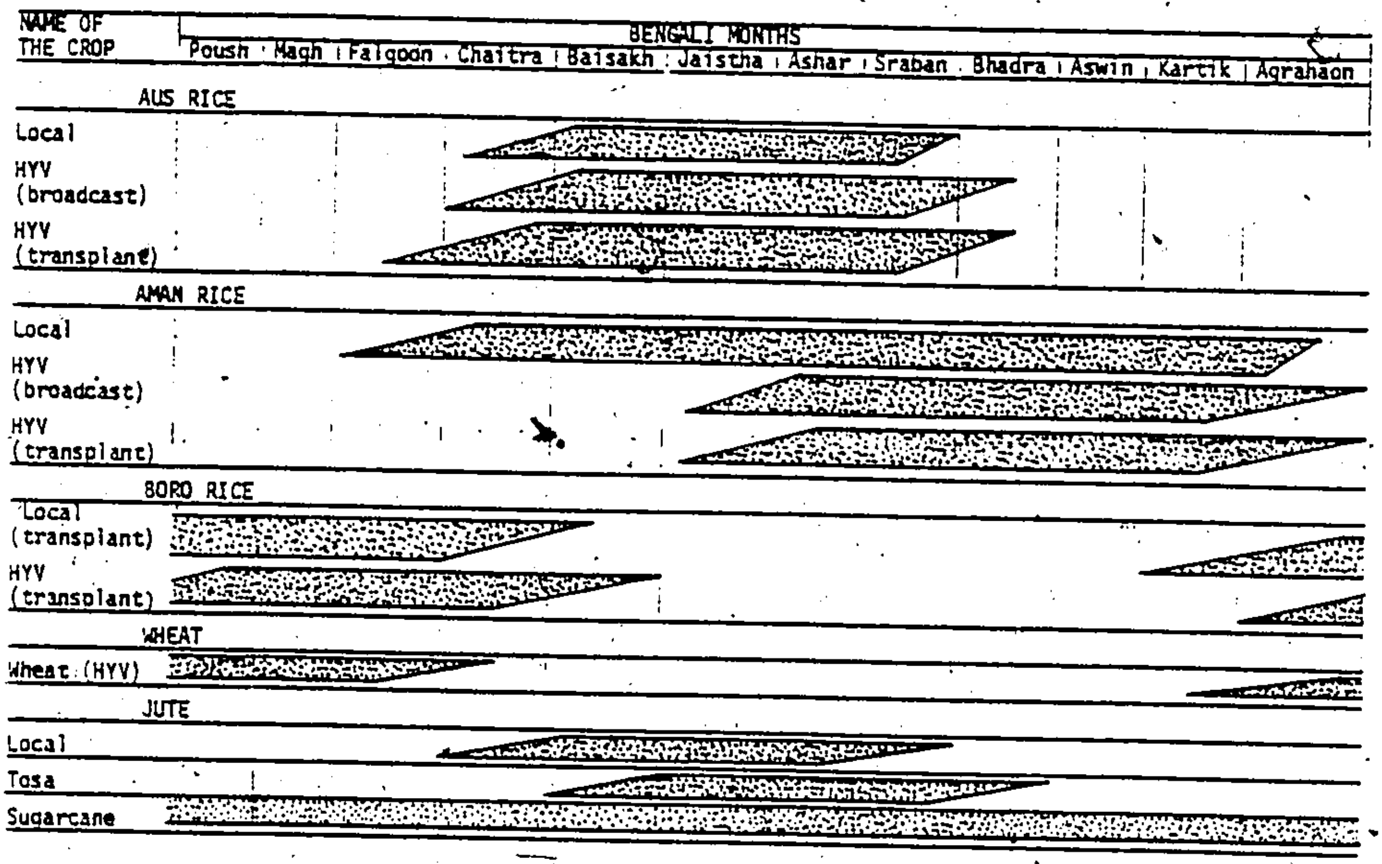
holds in Hamsadi and 8 households in Khilgati are engaged in agricultural wage employment. On the other hand, 5 households in Hamsadi and 3 households in Khilgati whose primary occupation is agricultural wage labour are also engaged in cultivation. Thus, these households, 24 in Hamsadi and 11 in Khilgati, may represent the marginal farmers who are compelled to do manual work as hired labourer on other farms in order to supplement their income from land cultivation. The group of households with agriculture as major occupation and who have business and trade as their secondary occupation (25 households in Hamsadi and 26 households in Khilgati) may represent wealthier farm households who invest their agricultural surplus in business.

4.3.5 The Crop Cycle and the Pattern of Agricultural Employment

Agricultural activity in Bangladesh is very much tied to the monsoon. The cultivation of various crops in a crop year follows a particular pattern that depends upon weather conditions. For a specific area, in addition to these exogeneous factors, the cropping pattern depends also on the nature of soil, irrigation facilities, availability of modern inputs, and economic status of farm households. Thus, given these economic and non-economic factors that characterize a particular area, the crop cycle and its pattern affects very much the utilization of land and labour force at different times of the year.[18] We present an idealized crop cycle pattern for Bangladesh in Figure 4.1 which may be compared with the cropping pattern in study areas.

FIGURE 4.1

AN IDEAL CROP CYCLE FOR BANGLADESH



BENGALI MONTHS	CORRESPONDING ENGLISH MONTHS	BENGALI MONTHS	CORRESPONDING ENGLISH MONTHS
Pousn - Magh	January	Ashar - Srabon	July
Magh - Falgoon	February	Srabon - Bhadra	August
Falgoon - Chaitra	March	Bhadra - Aswin	September
Chaitra - Baisakh	April	Aswin - Kartik	October
Baisakh - Jaistna	May	Kartik - Agranaon	November
Jaistna - Ashar	June	Agranaon - Pousn	December

SOURCE: Krishi Diary (Ministry of Agriculture, Government of Bangladesh, 1981).

According to Government documents, both of our sample areas have non-calcareous dark grey flood-plain soils which are mainly seasonally and deeply flooded soils of the old "Brahmaputra-Karatoya" flood plains and these are mostly suitable for the production of broadcast "Aman", deepwater transplanted "Aman" and "Boro" paddy.[19] Yet we find some differences in cropping pattern in the sampling areas. In Hamsadi, farmers cultivate broadcast "Aus" paddy and broadcast seed for "Aman" during the Bengali months of Chaitra and Baisakh (ie., March-April). During the months of Ashar-Sraban (July-August) harvesting of "Aus" paddy takes place with broadcast "Aman" continuing to be grown on the fields which will be harvested in the months of Kartik-Agrahaon (ie., October-November). After this, the same piece of land can be used to grow "Rabi" (winter) crops, such as pulses, wheat, oilseeds, and other major vegetables. However, some land in this area has been devoted to the cash crops, jute and sugarcane. Jute and Aus paddy are competing crops and as such, if Jute is cultivated, the land cannot be used for Aus cultivation in the same year (and vice versa).[20] Sugarcane, which is a high yielding crop, on the other hand, requires a 12-month period from sowing to harvesting time.[21]

In Khilgati, irrigation facilities during the winter period have permitted cultivators to grow HYV "Boro" paddy (locally called "Chinese Irri") during the months of Agrahaon-Poush when the harvesting of transplanted "Aman" is completed. The harvesting period of this "Boro" paddy is during Chaitra-Baisakh when farmers can sow "Aus" paddy. The land where Aus/Jute is grown, becomes ready for Aman transplantation, when the rice or jute crop is harvested during the months of Ashar-Sraban. Table 4.13 shows the amount of operational land put under different crops by farmers in the sampling areas.

The rice crops in Hamsadi and Khilgati occupy 46.45% and 89.87% of the total operational land respectively. It seems that Khilgati village is overwhelmingly a paddy growing area while Hamsadi is not. In both areas, the percentage of land devoted to jute is low, 6.47% in Hamsadi and 7.5% in Khilgati, which is roughly comparable to the national average which was 5.53 for the year 1976-1977. The percentage of land devoted to pulses (13.29%) and wheat (14.7%) in Hamsadi is quite high compared to the national figures which were 2.84% for pulses and 1.36% for wheat in 1976-1977 in Bangladesh. Because of this diversification among crops, rice was relatively under-represented in this area (Hamsadi) compared to the national figure which was 78.43% in 1976-1977.

Wheat is becoming a substitute for rice as a staple food in rural areas and is very important during its harvest period (during the months of Baisakh and Jaistha) when the poor landless and marginal farmers have negligible quantity of rice in their stocks. On the other hand, Khilgati is specializing in rice cultivation for which very negligible amounts of land can be alloted to other crops.

Table 4.13: Percentage of Total Operational Land Under Different Crops

Crops	Percentage of Land		Productivity (Kg. per hectare)[a]	
	Hamsadi	Khilgati	Hamsadi	Khilgati
Broadcast Aus Paddy	22.73	16.97	231.72	217.34
Transplant Aman Paddy	1.01	45.92	251.31	296.77
Broadcast Aman Paddy	22.72	X	238.76	X
Boro HYV Paddy	X	26.98	X	590.17
Jute	6.47	7.50	310.70	245.65
Pulses	13.29	X	111.39	X
Wheat	14.70	2.03	297.0	135.60
Oilseeds	3.48	.60	131.10	59.54
Sugarcane	7.28	X	8067.76	X
Vegetables (major)	8.33	X	na	X

[a] 1 maund = 82.29 lbs. = 37.33 kg.
1 hectare = 2.47 acre.

Table 4.14: Crop Intensity, Land Productivity and Farm Size

Farm Size (acre)	Index of Cropping Intensity		Index of Land Productivity (TK. Per acre)	
	Hamsadi	Khilgati	Hamsadi	Khilgati
.01-1.0	2.14	1.97	5943	5292
1.01-2.0	1.98	1.84	4817	4603
2.01-3.0	1.97	1.55	4778	4077
3.01-4.0	1.83	1.76	4588	5053
Greater than 4.0 acres	1.59	1.52	4276	3895
All groups	1.90	1.64	4759	4292

However, the percentage of land devoted to cash crops is fairly high in Hamsadi (13.75%) where jute and sugarcane are the cash crops, while it is low in Khilgati (only 7.5%) where jute is the only cash crop.[22] Thus, on average, both villages devote more land to food crops than to cash crops. This is not surprising.

4.3.6 Cropping Intensity and Land Productivity

Cropping intensity is a measure of the intensity of land use during the course of a year and hence gives the extent to which the operational land is used for cultivation in a year. Land productivity, a partial measure of agricultural productivity, is defined as the ratio of output to the associated land input under operation. In a land-scarce country like Bangladesh, both these concepts have a great appeal, since the effective supply of land can be increased by increasing the cropping intensity while total agricultural production can also be increased by increasing land productivity. Table 4.14 gives the measure of cropping intensity and land productivity in our study areas[23]; each is also related to farm size.[24]

The average crop intensity is higher in Hamsadi than in Khilgati. Both the averages, however, are higher than the national average crop intensity which was 1.49 in 1976-1977. The Second Five Year Plan (SFYP 1980-1985) of Bangladesh envisaged an increase in this crop intensity from 1.49 to 1.60 at the terminal period which suggests that both of our areas seem to have achieved the crop intensity well above the target intensity that has been planned for Bangladesh at the end of 1985. It is also evident that small- and medium-size farmers use their land more intensively than do their counterpart large farm households. For the holdings above 4 acres, the intensity of land use is relatively lower in both areas than those who cultivate land of holdings less than 4 acres. Of course, it is a matter for investigation to determine whether the existence of high crop intensity has resulted in substantial increases in production, employment and income in these villages.

From Table 4.14, we also see that on average there exists an inverse relationship between farm size and land productivity which is monotonically decreasing as farm size increases in Hamsadi but that is not so in Khilgati. From Table 4.14, we can conclude that land productivity on average is higher in Hamsadi than in Khilgati which may be due to the higher cropping intensity in Hamsadi. It is also true that higher land productivity in both areas for small- and medium-size farms is to a large extent due to the more intensive use of land as is reflected by the corresponding intensity index. However, cropping intensity cannot alone explain the differences in productivity among groups as well as over regions.[25] Two factors which can effectively contribute to variation in output per acre among the same size farms as well as over regions are (i) crop mix (cropping pattern) and (ii) productivity in individual crops.

As we have observed in Table 4.13, the crop mix as well as the average yield for each crop varies significantly over the two regions, which we expect may also explain the differences in land productivity across the regions.[26]

4.3.7 Production and Income

The households in both sample areas derive income by participating in different income earning activity. These activities include crop cultivation, agricultural wage employment, non-crop employment and non-agricultural employment.[27] Income received by households from various sources varies significantly over regions as well as over samples. To see the pattern of income distribution by sources and groups of households, income generated from all activities for each household has been calculated and presented in Table IV C.-4 in Appendix IV.C.[28] The distribution of income is skewed as was the distribution of landholding. In Hamsadi, about 15% of lowest income households, comprising 12% of the population, have only 7.3% of total monthly income of the village. The top 24% of the households (by income), having 31% of the population, enjoy 42% of total monthly income. On the other hand, in Khilgati about 45% of bottom households, having 36% of population, earn only 24% of total monthly income, while the wealthiest 33% of households, with 43% of the population, have 56% of the villages' total monthly income. The Gini coefficient for Hamsadi is .25 while it is .29 for Khilgati.

Similarly, the pattern of income distribution by sources also varies over regions and households. The lower income groups in both villages derive most of their income (over 98%) from agricultural sources and these groups apparently have very limited access to non-agricultural sources. On the other hand, as monthly income rises, the households belonging to upper income groups derive increasing amounts of income from non-agricultural sources. Hence, in both villages, the top income group derives about 21% of their total income from non-agricultural sources. However, on average, most of the income generated in both villages is overwhelmingly from agricultural sources (about 73% in Hamsadi and 83% in Khilgati). Among agricultural activities; the major income source is, of course, crop cultivation. The percentage contribution of wage (agricultural) income to total income in both villages of our sample areas is only 2.7% in Hamsadi and 1.37% in Khilgati. But the percentage contribution of agricultural wage income to total income is higher for the lower income groups than the higher income groups which is not surprising. In both villages, it is the lower income groups who do not have good access to non-agricultural employment and mostly rely on agricultural wage employment for their "excess" family labour.

Another important feature is that the higher income groups appear to support a large percentage of population in both villages than do ~~their~~ counterpart lower income groups. We suspect, therefore, that the

Table 4.15: Relationship Among Income, Familysize and Landholding

Monthly income group (TK.)	Mean Family Size		Average landholding(acre)	
	Hamsadi	Khilgati	Hamsadi	Khilgati
100-749	5.5	5.6	1.30	1.61
750-999	5.91	7.1	1.52	1.85
1000-1499	6.40	7.73	1.64	2.57
1500-1999	7.19	9.82	2.34	3.10
2000 + above	9.42	10.63	3.83	5.78

larger is the income earning from all possible sources, the larger is the size of the family and vice versa. In fact, we see in Table 4.15 that there is a positive relationship between income earned and the size of the family. That is to say, the larger income groups do really have a large family size.[29] More interestingly, it also appears from Table 4.15 that the higher income households in both villages have larger landholdings than do the lower income group households. We, therefore, can conclude that there is a positive relationship between landholding and income in our sample area.

4.3.8 Employment and Income

Income distribution, however, does not tell us the pattern of employment of the members of the rural households. One might expect that larger is the income earned from a particular economic activity, the more will be the employment of family labour in such an activity. However, this need not necessarily be the case. In order to see the pattern of employment and income, we have to look into employment data that describes the family labour supply for each type of economic activity. Therefore, a breakdown of the man-days devoted to various income earning activities in both the villages and the net returns for each activity is presented in Table 4.16.[30]

Table 4.16: Net Returns to Family Labour by Activity

Activity	Labour Input				Net Return				Labour Productivity TK. per manday	
	Mandays		Per cent		Taka (TK.)		Per cent			
	Hamsadi	Khilgati	Hamsadi	Khilgati	Hamsadi	Khilgati	Hamsadi	Khilgati	Hamsadi	Khilgati
Crop cultivation	142	207	30	42	11,128	10,584	62	73	78.37	51.13
Wage employment	49	23	11	4	553	220	3	2	11.29	9.57
Non-crop employment	95	117	20	24	1,299	1,020	7	7	13.67	8.72
Non-agrl. employment	185	147	39	30	4,950	2,646	28	18	26.76	18.0
Total	471	494	100	100	17,932	14,458	100	100	38.07	29.27

Table 4.16 shows that crop cultivation is both the major source of income as well as the most rewarding in both villages. However, cultivation is not the most important labour activity in Hamsadi as a percentage of total man-days. In Hamsadi, it is the non-agricultural activity that appears to be the main labour activity for the farm households. This suggests that farm households in this area must have better access to non-agricultural activities throughout the year than the households in Khilgati. Nonetheless, farm households in this latter village must have certain degree of access to these off-farm opportunities, since this activity turns out to be the second major labour activity in the village. Wage employment as another activity for utilizing family labour, seems not to be as important. Households devote only 4% and 11% of total labour activity to wage employment in Khilgati and Hamsadi, respectively. Thus, it also produces a relatively insignificant percentage contribution to household earned income (about 2.7% in Hamsadi and 1.37% in Khilgati). Of course, it does not mean that labour market participation by households is low in the villages, but only that very few households appear to be net suppliers of labour services in the labour market. This actually was confirmed by the data on occupational pattern in the villages (see section 4.3.4). However, for households in both areas, non-crop activity appears to be another important labour activity which employs about 20-24% of total family labour and yields about 15% of the total earned income.

For the average household, each economically active member works about 140.18 man-days (or 1262 hours) in Hamsadi and about 138.76 man-days (or 1249 hours) in a year in Khilgati.[31] Of these total man-days worked, each working member devotes 42.26 man-days and 58.15 man-days in Hamsadi and Khilgati respectively to crop production.

The next issue to be examined is the labour market participation i.e., the extent to which farm households both buy and sell labour services in the market. Since evidence from the survey on labour utilization and hence on labour market participation can not be shown in a seasonal context, we have presented the total labour utilization by farm households in different activities throughout 1981-1982 crop year in Table 4.17. This table can be used to establish the quantitative significance of labour market participation by the households in the study areas. Thus, throughout the year, hired labour in crop production represents about 51% (in Hamsadi) and 42% (in Khilgati) of the total labour input utilized for cultivation. On the other hand, off-farm wage employment of farm household members involved about 10% (in Hamsadi) and 5% (in Khilgati) of total man-days worked by all members during the crop cycle year 1981-1982. Both of these observations suggest that labour market participation in both villages is an important activity for almost all households in the study areas.

Table 4.17: Labour Utilization and Labour Market Participation

Employment Indicators Labour Utilization per Household (mandays)	Hamsadi (Mandays yearly)	Khilgati (Mandays yearly)
1. Total labour input for crop cultivation	289.34	355.29
2. Hired labour input for crop cultivation	147.24	148.22
3. Family labour input for crop cultivation	142.10	207.07
4. Family labour for wage employment	48.72	23.0
5. Family labour for non-crop production	95.48	117.25
6. Family labour for non-agrl. employment	185.06	146.49
7. Total family labour use	471.36	493.81

4.3.9 Product and Factor Markets

We shall now examine the nature of product and factor markets which are important for the analysis of agricultural production. Since crop cultivation is the major income earning activity in both villages, attention is given to markets that are closely linked with crop production. The most important feature of cultivation in both areas, as we have seen, is the utilization of most cultivated land for food production, especially for paddy production. Hence, the price of paddy (rice) is the single most important product price that determines crop cultivation in village Bangladesh [see, eg, Stepanek (1979)].

In Bangladesh, the price of paddy is largely determined in the paddy market. Although the government subsidizes and rations imported rice for use in some major cities to a certain extent, its impact on the equilibrium paddy price is minimal [see Stepanek (1979)]. In recent years, however, government has tried to stabilize the paddy price by its pricing and procurement policy and it usually operates after paddy harvesting of each season. It is generally true that the price of paddy is not largely influenced by the local production in both areas. Depending on the price of rice and the amount of local production coming to the market, there are flows of rice into the local market through petty traders. Hence, the paddy market is largely influenced by factors outside the realm of the farm households. We can assume, therefore, a perfectly competitive market for paddy in our study of production behaviour of farm households. That is to say, we assume that any major changes in paddy production by any group of individuals in these villages at any time would have little influence on the market price of paddy. In fact, to a large extent, the price of every major crop is determined in the market outside the realm of the farm households.

On the other hand, the agricultural operation in our study areas largely relies on four inputs, namely, land, labour, fertilizer and bullock power. Since the labour controversial input market, we shall treat this input market separately in the section 4.3.10. Meanwhile, we shall focus our analysis of factor markets on the behaviour of the remaining three inputs.

To the extent that the fertilizer price is determined by the government and there may not be sharp price differences between the price on the input supplying agency and the price at the receiving stations where the farm households actually buy fertilizer, the same price of fertilizer may be faced by all individuals. On the other hand, most of the bullock days are supplied by the owners of bullocks on their own farm. There is not infact a large well developed market for the rental of bullock power. However, it is observed that for those who bought bullock power from the market, the price of bullock day (one pair) reported by these households is more or less the same over the sample. We may assume that the market price of these bullock power actually transacted in the market reflects the "true" opportunity cost of bullock power for those households who use their own bullock power. On the other hand, it is believed that since kinship and patronage bonds still are prevalent in village society where land is the only major income earning asset, the land market is dominated by patron-client and kinship relationships. As we have seen earlier, renting land is not important in Hamsadi while it is to a certain extent in the other village, Khilgati. In Khilgati, most of the land under share arrangement has actually been transacted among relatives. However, the crucial question is - what should be the "true" indicator of the price of land. This is a real problem in a country like Bangladesh where land is the most scarce factor in agricultural production. However, two prices measures may be relevant in our context: one is the fixed cash rental price of land and the other is the share value of crop produced by sharecroppers per acre. Both of these measures may have some limitations. First of all, since share rental arrangements may be dominated by kinship and patron attachment, the pricing of land measured in such a way may not necessarily reflect the interaction between supply of and demand for land services but may reflect the influence of some non-economic factors such as intra-family transactions. On the other hand, population pressure on land with commercialization may indeed reflect some "extreme" scarcity of land in a land scarce economy which in recent years is buttressed by the inflow of cash capital from wage earnings of Bangladesh (skilled and unskilled) labourers abroad, particularly in oil rich middle east countries who invest their income on land. This has raised the price of land enormously even at the village level and may also be reflected in the (fixed) rental price of land. Therefore, such a measure of the land pricing may appear to be 'over priced' to a certain degree in the present context. However, both of these measures for pricing land will be considered in the next chapter in the context of an allocative efficiency test for farm households.

4.3.10 Labour Market and the Opportunity Cost of Family Labour

Evidence indicates that the rural labour market in Bangladesh is perfectly competitive to the extent that the wage is determined by the supply of and demand for labourers in the rural market [see Iqbal Ahmed (1981)]. In a Bangladesh village, the labour market is not a homogeneous market. There is ample evidence that the rural labour market is heterogeneous to the extent that wage differentials exists for different types of labour, such as male and female, adult and minor labourers [Cain (1977); K. Bardhan (1977); P.K. Bardhan (1979)]. Despite this, the general practice is to ignore the heterogeneity of labour and some empirical studies, for instance, average male and female wage rates in order to create one wage with which to study the behaviour of such markets [eg, Bardhan (1979); Barnum and Squire (1979)].

However, as Binswanger and Rosenzweig (1981) argue, there appear to be at least four categories of labour that may be present concurrently which can effectively yield heterogeneity in the rural labour market. They are, (i) hired versus family field workers; (ii) manager-entrepreneur versus field workers or permanent (attached) versus casual field workers; (iii) adult versus minor (those under age 15) workers; and (iv) male versus female workers.

Indeed, all categories of labour heterogeneity may exist in the rural labour market of Bangladesh. In our study areas, we have found the existence of both permanent and casual types of hired labourers. The percentage of households who are found to have attached workers is low: in Hamsadi 6, and in Khilgati 28; otherwise all of the households mostly rely on casual workers. However, it is also found that quite a significant proportion of attached workers (about 45%) were infact child or minor workers (below age 15). Thus, within this category itself, another sub-category in terms of ages emerges. But since we have labelled these permanent labourers, whether adult or minor, as family labour of the households, their presence in the labour market is considered not as a separate category but in the category of family versus hired casual workers. This latter type of heterogeneity in the rural labour market may appear to be the most controversial issue in estimating the total labour demand in agriculture. This is a controversial issue because there may exist a sharp difference between family labour and hired labour to the extent that family labourers and hired labourers are not perfect substitutes in production.

First of all, family members should have fewer incentives to shirk in production work than hired labourers - because of their participation in farm profits. This is one reason why small farms that employ mainly their family labour in cultivation can be more productive than the large farms who hire and supervise non-family labourers. Apart from this reason there is another worrisome point that may effectively differentiate a family labourer from a hired labourer. That is, the opportunity cost of using family labour may be different from the market wage rate for casual hired workers and also may vary from household to household. As one researcher argues, the opportunity cost of family labour in Bangladesh agriculture depends on the extent of (i) the amount of excess family labour, (ii) the social and psychological norms towards hiring out family labour and (iii) the alternatives available to them for using the "excess" labour in non-agricultural off-farm employment [Hossain, M (1977)]. Hossain further argued that the opportunity cost of family labour would not differ from the market wage rate if all the "excess" family labour after self-cultivation could be sold out in the market at this market wage. Two questions, however, arise in relating to this assertion. (a) Does the opportunity cost of family labour imply the opportunity cost of all family labour or that part of family labour which is actually primarily engaged in cultivation? (b) How large is the amount of "excess" family labour that is actually put forward to the market for agricultural wage employment which may not be sold out at the market wage rate?

The optimizing peasant farmer, given the choice between cultivation and non-agricultural employment, will allocate his family labour to these alternatives first.[32] Next he will allocate that part of family labour which was directed to cultivation to self-cultivation (for both crop and non-crop activity) and wage employment. It is this part of family labour that is actually allocated to cultivation whose opportunity cost has to be equated with the market wage rate. Now we have to explain why this type of family labour may be in excess after self-cultivation. Hossain (1977) observes that:

> "In conditions where cultivation depends on nature, permanent workers (family plus attached) cannot have enough work to keep themselves busy on the farm throughout the year, whatever the amount of land the family operates. For some days, they may not have any work to do while at others the labour requirements may be so high that casual labour has to be hired. Thus, the number of days in a year for which a family worker could remain employed on farm would always lie below the full-employment level" [Hossain, (1977); p. 305].

Hossain, however, did not specify what is the number of man-days required to reach to this "full-employment" level. However, as we have observed, farm households are also engaged in non-crop production in addition to cultivation. It is generally assumed in Bangladesh that about one third of total labour required in crop production is actually required in this non-crop production activities [Tims, W., (1965)]. Even after considering this fact, it is observed that there exists a significant level of "general" unemployment in Bangladesh villages [Hossain (1977); Iqbal Ahmed (1981)].[33] In our study areas, we find that the level of labour utilization by farm households in agricultural activity is low, and lower than what should be the "full-employment" level [see Table 4.17, items (3) & (5)]. Therefore, it is generally true that Bangladesh agriculture may exhibit significant amount of surplus labour. Now the question immediately arises - does this mean that all these surplus labourers are readily available for wage employment in agriculture at the market wage rate? It is observed that the marginal disutility of manual work in other's field is quite high because of higher psychic cost associated with it, and that the reservation price for hiring out family labour is also high, which together imply that a very low percentage of family labour is actually supplied at the going market wage rate [see Iqbal Ahmed (1981) for empirical evidence]. Iqbal Ahmed (1981) suggests that given this low supply, the wage rate is infact determined by the supply of and demand for casual agricultural labour. It is evident, therefore, that what ever amount of "excess" family labour is offered in the market, after self-cultivation, the market wage rate will adjust to absorb this supply.

In Bangladesh, the female workers are differentiated from adult male workers to the extent that women cannot participate in major field operation of agricultural activity because of the nature of jobs and due to social customs and restrictions that prohibit them from doing so. In our study areas, female participation in agricultural activity is very low. Their wage rates fluctuate from one third to one half of an adult male wage rate. In fact, their main activity is household chores, other non-crop activity and seasonal participation in threshing and other work associated with harvesting.

On the other hand, the role of minors (under age 15) as a worker in the rural labour market is found to be quantitatively significant for Bangladesh [Cain (1977)]. In Bangladesh, children older than ten (10) are considered to be part of the economically active population [see B.B.S. (1979)]. However, their renumeration rates vary according to their ages and the work they do. In our study areas, we found that the wage rates of minor workers also varied from one third to one half of an adult male wage rate.

However, it is generally recognized that in Bangladesh, the effective supply of both minor and female labour in the market is limited and is conditioned by the family preference that female and child labour should work on the family farm instead of working outside the farm. But for landless or marginal peasants (those having very small operational holding) the overriding concern for family consumption needs may relax these social conventions. While the market for young farm workers may not be well developed in many areas, competitive forces seem to determine a market wage. However, it seems that wage rates for both minor and female workers are very much influenced by the adult male wage rate, which is being determined by competitive forces.

We can conclude, therefore, that the wage for casual labour in agriculture is determined by market forces, and the opportunity cost of family labour that is supplied for agricultural operations is not different from the market wage rate.[34] In response to our question of the opportunity cost of using family labour in farm activity, most respondents in our sample areas reported some remuneration rates that were more or less the market wage rates (without food) for hired casual labour. This suggests that the market wage rate is the opportunity cost of labour in allcoation decisions for both family and hired labour in agricultural production.

4.3.11 Utilization of Family Labour in Income Earning Activity

Despite the contention made here that the opportunity cost of family labour is equal to the market wage rate, how can one rationalize the observation that the average level of utilization of family labour by farm households as is revealed from Table 4.17 is "low", lower than the so-

Table 4.18: Family Labour Utilization by Group of Farm

4.18A: Hamsadi:

Landholding (acre)	No. of households	Average No. of family-worker per household	Employment in crop production (mandays)	Wage employment (mandays)	Non-crop activity (mandays)	Non-agrl. employment (mandays)	Total man-days worked	Mandays Per worker Per household
.01-2.0	54	2.70	5452	4360	3431	9953	23196	159.09
2.01-4.0	37	3.22	5859	512	4031	6484	16886	141.73
Greater than 4.0 acres	9	4.78	2899	0	2086	2069	7054	163.97

4.18B: Khilgati:

Landholding (acre)	No. of households	Average No. of family-worker per household	Employment in crop production (mandays)	Wage employment (mandays)	Non-crop activity (mandays)	Non-agrl. employment (mandays)	Total man-days worked	Mandays Per worker Per household
.01-2.0	42	2.45	5907	1920	2863	5470	16160	157.09
2.01-4.0	37	3.38	7632	380	3997	4571	16580	132.58
Greater than 4.0 acres	21	4.81	7168	0	4685	4608	16641	164.75

called "full-employment" level. It is our contention here that it may not be unreasonable to argue that the level of utilization of family labour by farm households is low because of their strong preference for leisure. The argument is as follows. If we can show that income earning employment per an active member of family labour force is constrained by area owned (or operated), then it may imply that there is excess family labour that is involuntary unemployed because of a lack of employment opportunities. But if we can not, then the lower utilization of family labour for income earning activity by households may reflect their strong preference for leisure. We can see from Table 4.18 that for households with a family labour force of between 2 and 5 active working members, man-days worked per worker in income earning activities do not vary considerably as land ownership varies across farm households of different groups. That is to say, man-days worked per household worker vary little as landownership increases substantially the relevant figures are 159.09 man-days for Hamsadi and 157.09 man-days for Khilgati per worker for households owning an average of 1.43 acres (size group 1.01-2.0 acres); 141.75 man-days for Hamsadi and 132.58 for Khilgati per worker for households owning an average of 3.29 acres (belonging to 2.01-4.0 acres size group); and 163.97 man-days for Hamsadi and 164.75 man-days for Khilgati per worker for households owning an average of 6.0 acres (belonging to the top size group greater than 4.0 acres). This suggests that in both villages, while the percentage change in average landholding is quite high, the percentage change in man-days worked per worker is not.

In fact, our data shows that wage employment per worker decreases rapidly as landholding increases: for the same group of households, wage employment per worker is 29.9 (18.66), 4.3 (3.04) and 0 (0) man-days for Hamsadi (Khilgati), respectively. On the other hand, non-agricultural employment per worker also decreases as landholding increases: 68.26 (53.16) man-days for households of size landholding 0.1-2.0 acres, 54.42 (36.55) man-days for households belonging to size holding of 2.01-4.0 acres and 48.09 (45.62) man-days for households owning more than 4.0 acres in Hamsadi (Khilgati), respectively. Contrary to the belief that larger landholding groups have better access to non-agricultural employment, there is evidence to suggest that the utilization of labour in non-agricultural employment per worker of the large landholding group is lower than that of the small landholding group. This may reflect that the consumption of leisure is higher for larger landholding groups than the smaller landholding ones. To the extent that larger landholding groups in general operate larger farms (see Tables IV.C-2 and IV C-3 in Appendix IV.C), this may suggest that size of operation is not the constraint on utilizing family labour for income earning activities. The ability of households owning or operating relatively smaller areas of land to obtain as much income earning employment as households with larger areas of land by increasing off-farm employment is an indication that the total man-days worked per household worker is not constrained by landholding or farmsize but rather may be determined by the household's income-leisure trade off.

We can conclude, therefore, that the low utilization of family labour in income earning activity indicates the strong preference for leisure by farm households.[35] Active labour market participation with participation in non-agricultural employment ensures that labour utilization by farm households is not constrained by a lack of income-earning opportunities in our study areas.

4.4 Conclusions

In this chapter, we have discussed aspects of the major socio-economic indicators of the rural household survey data collected from two villages in Bangladesh. Both of the villages have many common characteristics regarding major socio-economic variables. Among the most important of them are the following. First, rural households participate in different income earning activities, such as crop cultivation, wage employment, non-crop activity and non-agricultural activity. The percentage contribution of crop cultivation is most important in both villages while non-agricultural activity appears to be the second-major income earning activity. Second, as far as land tenancy is concerned, the land rental market is not that important in Hamsadi, where most of the land is operated by own cultivators, while it is important to a certain extent in the other village. However, the sharecropping form of tenancy was not the dominant form of tenancy. Third, there is an interrelationship between income, landownership, family size and child schooling. Family size and child schooling are positively related with landownership while income is found to be positively related to landownership. Thus, in these villages, owned land is a good measure of the wealth of the rural household. Fourth, we found that all households participate actively in the labour market, either as buyers or as sellers. This suggests that there exists an active labour market for agricultural labour in the study areas. This last observation has a profound implication for the household model that interlinks both production and consumption aspects of household behaviour together. Recall that the only interlinkage between production (agricultural) and consumption is via the labour supply of households which is determined by income-leisure choice. The existence of an active labour market together with the observation that the opportunity cost of family labour supplied to agricultural operation is not different from the market wage rate for casual hired labour, thus, ensures that production and consumption decisions can be separable. That is, production decisions can be taken independently of consumption decisions. But, nonetheless, the income derived under production decisions will affect consumption decision via the budget constraint. Finally, the labour market is heterogeneous, but the existence of perfect competition in these markets may ensure that the opportunity cost of these labour services may be equated across all farms.

We shall present the analysis of production decisions in the following chapter (Chapter Five) while the next chapter (Chapter Six) will focus on consumption decisions of farm households.

FOOTNOTES TO CHAPTER 4.

1. Bangladesh is predominantly an agrarian economy. Agriculture accounts for about 55% of GDP, 90% of the merchandise exports and employs about 75% of the labour force. The country is small in size of 142 thousand square kilometers with a population of 90 million. Out of the 35 million acres gross area, 22.5 million acres are under cultivation at an intensity of 149%. Rice, the main crop, covers 25 million acres (90% of total cropped area). Agricultural productivity is very low with a paddy yield of only 1.2 tons per hectare. The population growth rate (2.8%) has surpassed the country's rate of growth of food production (2.3%) in recent years.

2. Thana or Police Station is the lowest rank in the hierarchy of the administrative system of the Bangladesh Government. It consists of several unions, which are in turn a collection of villages and administered by the local representatives of the people who carry out most of the developmental projects in villages with supervision from the Thana Government Officers.

3. To study the decisions involving family size and child schooling, sample household heads required to have ever been or be married. On the other hand, it is observed by many studies that access to income earning activity including crop cultivation in a poor agrarian economy is very much dependent on the resource position of the house-

hold [see, eg., Hossain (1977)]. The resource in an agrarian economy is mainly land which is, as we shall see later, also the index of wealth or poverty of rural households. Therefore, households were chosen who have some cultivatable land of their own.

4. A household is defined as a group of people sharing a common Kitchen or "Chula" (Bengali word for Kitchen). It is an economic unit, the members of which contribute to the fund from which they all eat.

5. A bari is a settlement with a rectangular pattern of huts facing a central compound which is usually surrounded by trees and shrubs [Khuda, (1980)].

6. Normally, a bari is comprised of a man (household head), his wife and sons, the wives of married sons, grand children, unmarried daughters and sometimes widowed sisters.

7. Operational holding is the total amount of land a household cultivates. It is the household's own land plus land rented in (both share-cropped and leased) and mortgaged in, minus land rented (both share cropped or leased) and mortgaged out.

8. Jannuzi and Peach (1979) reported that the average sizes of land owned and operational holding per household in Bangladesh were 1.78 and 1.65 acres respectively.

9. Note that LOS report (1977) in Bangladesh found that 32% of total farm households were owner-cum-tenant, 24% owner-cultivator, 38% were owner-manager and the remaining 6% were pure tenant [see Rabbani et al (1977)].

10. In one study area, it was found that 93% of the total land in the rental market was under share tenancy [Hossain (1977)] while in another area, it was found about 78% of land rented was under share arrangements [S. Ahmed (1981)]

11. The dependency ratio is calculated as the number of dependents (those under age 15 and above age 65) divided by the number of active numbers in the household. The dependency ratio in Bangladesh was 1.06 in 1974 while the dependency ratio for the developed countries was only .42 in the same year.

12. In fact, one recent study shows that the schooling level of the household head is an important indicator for the adoption of HYV of Paddy crops in Bangladesh [Hossain, M. (1980)],

13. A recent survey of 641 women in Mymensingh found that about 14% of the respondents claimed to have ever used any contraceptive method and only 7.3% were currently using the contraceptives [Govt. of Bangladesh, Planning Commission, (1980)].

14. In fact, we shall see later that there is a positive relationship between landholding and income of the households.

15. The relationship between landholding and fertility is actually indirect. To the extent that children, particularly sons, are productive in the household rendering labour in farm operations, they are sources of pecuniary returns.

16. A similar finding was reported in the study conducted in 1975 by the Govt. of Bangladesh (see Bangladesh Fertility Survey 1975).

17. Schooling data is only reported here for the children of the respondents. To the extent that families which are not nuclear and include other non-children school-age members would have larger number of school-age members enrolled in the schools in different levels, this analysis has to be qualified.

18. Note that the seasonal fluctuations of agricultural employment in Bangladesh is not a completely transitory phenomenon, since a large number of marginal and landless cultivators may remain unemployed most of the time in a crop season irrespective of the pattern of cultivation in a particular area simply because of the lack of working opportunities.

19. See, e.g., B.B.S. (1979).

20. Generally, however, in order to preserve the soil fertility, the practice of the farmers is that Jute and Aus paddy are cultivated on the same land in alternating years.

21. Hence, the cultivators who grow sugarcane on a particular piece of land could have grown, instead, two rice crops, broadcast Aus and Aman, on the same land.

22. In another study area, it was found that the percentage of total cropped land under cash crops (like Jute and Sugarcane) was 14.73 [Ahmed, S.(1981)].

23. See Appendix IV.B for a discussion of the measures of cropping intensity and land productivity.

24. Since we have observed that sharetenancy is not significant in the area, the relationship between farmsize and productivity becomes more relevant in our study areas. However, the tenancy-efficiency issue will be addressed later in the production analysis in Chapter Five.

25. Though there exists a close relationship between crop intensity and land productivity, the variation in land productivity among farmers may be attributed to another factor, output per acre, in addition to cropping intensity. That is to say, land productivity measure can be broken down into two multiplicative components, (i) cropping intensity and output per acre. Define O/A ≡ land productivity = $\frac{O}{\Sigma a_i} \cdot \frac{\Sigma a_i}{A}$, where O is the total value of crop production produced

25. (cont.) during the year on a farm, A is the total land allocated to the crop grown during the year. The term on the L.H.S is land productivity, while the first term on R.H.S. is output per acre and the second term is the cropping intensity.

26. In fact, one study found that the choice of crop-mix influenced the productivity differences among farm households of different sizes and over regions [Hossain, M (1977)]

27. Non-crop activity involves fishing, feeding cattle, dairy farming, raising poultry and fruit production while non-agricultural activity includes self-operated businesses, shop-keeping, teaching, civil service and employment in business.

28. Note that income from non-crop activity has been derived from the reported disposable income on such activities as raising poultry, fishing, fruit production and dairy products, while income from crop cultivation has been calculated by deducting the total expenditure on purchased inputs from the gross income of all crops grown during the course of year 1981-1982. All crops have been valued at the market prices prevailing in the area at the time of the interview while input costs were valued at the prices the farmers reported to have actually paid for their purchases.

29. Our finding is consistent with the findings for U.S. data [see Simon Kuznets (1982)]. However, there is a sharp difference between this two findings. Kuznets observed that there is a positive association between the size of family and income per family, but a negative association between size of family and family income per person, while in our finding, we do find that both size of family and income per family as well as size of family and family income per person are positively correlated.

30. Direct data on employment or man-days was collected on all activities except the non-crop activity. However, man-days calculated for such activity are based on one finding that shows that about one third of total man-days required for crop production is usually required for doing this non-crop activity in Bangladesh [see, Tims , W. (1965)]. Of course, this does not mean that one third of the man-days required for one taka of crop will yield 1 Taka of non-crop income.

Moreover, to the extent that various types of family labour, such as male and female, adult and minor, are involved in income earning activities, and that wage differentials exist for such types of labour, the labour inputs reported in Table 4.16 are the aggregate labour indices that have been calculated on the basis of the wage differentials that may reflect the efficiency of the particular kinds of labour input. Hence, adult male labour was weighted as one while female labour was weighted at .45 and minor labour (under

30. (cont.) age 15) at .40 in order to obtain indices for "effective" labour in adult male man-days. These weights are based on the average wages of these three types of labour actually paid in the survey areas. The heterogeneity in the labour market will be discussed in section 4.3.10 in detail.

31. The indices for the economically active members of households are calculated not only on the basis of differentiation between adult males and females but also considers minors aged above 10 but under 15 as a part of the economically active labour force. Again, the weights are: 1 for adult male, .45 for adult female, .40 for minor. Thus, for Hamsadi, the economically active labour force index per household is 3.36 and in Khilgati, it is about 3.56. Dividing the total number of man-day supplied by households in the reference year by the corresponding family labour index, man-days worked per household worker is obtained. However, one should recognize that the minor members (under age 15) or even members aged between 15-20 may not be full-time household worker to the extent that most of this population may also be engaged in schooling as a primary occupation, so that the family labour index may be less than we have reported here.

32. To the extent that non-farm activities require labour skills different from those of cultivation and that these employments may be full-time jobs rather than seasonal jobs (such as crop cultivation),

32. (cont.) the household will employ the suitable type of family workers for these activities according to its perceived constraint and then the rest of the family labour pool may be allocated to agricultural activities.

33. Ahmed, Iqbal (1981) assumed 275 man-days as the level of "full-employment" man-days for Bangladesh agriculture. However, he called the extent of unemployment as "general unemployment" just to differentiate it from "voluntary" and "involuntary" unemployment. Because of psychic cost associated with hiring out labour on others' field, there is a large amount of "involuntary" unemployment in agriculture. Thus, he suggests that the "surplus" is not the "surplus" in effective sense, because these "surplus" labours are not readily available for wage employment at the market wage rate.

34 Considering the non-agricultural off-farm employments that part of its family labour pool may undertake, the opportunity cost of (all) family labour may be different from the market wage rates for casual (agrl.) workers but the opportunity cost of family labour assigned for self-cultivation may not be different from the wage rates for agricultural (hired) labours.

35 Barnum and Squire (1979) also reported for Malaysia that farm households had a strong preference for leisure. To the extent that farm households of Malaysia enjoying a larger income levels than their counterparts in Bangladesh, the analogy in this results should be carefully qualified.

CHAPTER FIVE

TECHNOLOGY AND ALLOCATIVE EFFICIENCY: A PRODUCTION FUNCTION ANALYSIS IN A MULTICROP ECONOMY

5.1 Introduction

This chapter focusses on the estimation of an aggregate production function for a multicrop economy, with special emphasis on the heterogeneous labour inputs.[1] Aggregate data on outputs and inputs from two surveyed villages in Bangladesh are employed. Because of the multicrop output, aggregation across the output of individual crops cannot be made to obtain aggregate output in physical units. Thus, "net revenue" (ie., total value of crop production less expenditure on material inputs, such as seeds, manure, and irrigation, which are treated as used in fixed proportions by any particular farm household) is used instead.[2] Tests are eventually conducted to examine the extent to which the farm households in the sampled villages maximize profits. In order to do that, several preliminary tests are carried out. First, tests are conducted on the basis of production function estimates done for each village to see the extent to which aggregation of labour inputs with respect to either age-specific or sex-specific heterogeneous labour (such as adult male, adult female, and minor children) or family versus hired labour can be statistically supported.

Second, to allow for the possibility that two villages may have different production technologies, alternative production functions are estimated to test whether or not the two villages face the same production technology. Third, within each village, similar tests are conducted to examine whether or not the aggregate production technology differs across farm households with respect to farm size or tenancy status.

Tests of relative economic efficiency are finally conducted for farms in each village on the basis of (i) farm size (i,e, area operated), and (ii) tenancy status (i,e, pure owner-operator versus owner-cum-share tenant). The results of this work suggests that agricultural production in the villages surveyed is efficient; that given the existing technology producers respond to price incentives and appear to maximize profits.

5.2 Grouping of Farms: Farm Size and Tenancy

In the preceding chapter we presented data on major indicators of socio-economic factors that are related to farm household decision-making. These include land productivity and family labour utilization in income earning activities. We now turn to the analysis of crop cultivation by farm households. Generally speaking the production function identifies the maximum output associated with a given mix of inputs (such as land, labour, fertilizer, pesticides and animal power). However, as we discussed in chapter two, the analysis of production in developing agriculture often emphasizes farm size and economic efficiency, and tenancy and economic efficiency. These two aspects of production analysis have significant policy implications regarding land reform and increasing agricultural productivity [see, e,g, Berry and Cline (1979)]

It has been observed in many countries, that per acre yield and labour intensity are inversely related to the area operated. The interpretations usually forwarded for the differences between farms of different sizes are that either small and large farms face different configurations of output and input prices or that small and large farms differ with respect to economic efficiency. By economic efficiency, we mean technical and allocative efficiency: a group of farms may be considered technically more efficient than another group if it can produce a given output with less of some or all inputs, while a group of farms may be regarded as allocatively more efficient than another group if the former group is more successful than the latter group in equating marginal revenue product and factor price for each of the variable inputs. However, as researchers argue, testing the issues of relative economic efficiencies among group of farms should be preceded by another two tests-namely, a test of the nature of production function (i,e, whether the production function under consideration exhibits increasing, decreasing or constant returns to scale) and a test of the hypothesis that the different groups of farms under consideration face the same technology [see, Bardhan (1973), Barnum and Squire (1978)]

The bulk of the empirical literature regarding studies of farm size and economic efficiency rely on the Indian data and use the value of total crop production in a multicrop farm as the dependent variable. This approach has been criticized on the grounds that it is subject to a "crop composition effect" that may bias results. Thus in order to avoid or reduce in some way, this crop composition bias off the estimated results, one may use "net revenue" instead of total revenue as the dependent variable. The present study uses this concept of "net revenue" for sample data of a multicrop agrarian economy: Bangladesh. This concept, can be defined as the total value of crop production less expenditure on inputs such as seeds, manure, and irrigation which vary from crop to crop, purely due to the underlying technology.[3] This procedure attempts to reduce the crop composition bias from the total value of crop production by removing the part which may vary across farms or regions for some strictly technical reasons.

The issue regarding economic efficiency and tenancy essentially is whether or not tenancy [fixed (cash) rental or share cropping] results in allocative inefficiency as compared to the allocative behaviour of the owner-operator. Theoretically allocative inefficiency can not arise from the fixed rental contract while it does with sharecropping. The latter form of tenancy changes the marginal profit-maximizing conditions, while the former does not. Yet in some of the empirical literature both forms of tenancy are found to involve allocative inefficiency [see chapter two]. However, there are other studies which suggest that both types of tenancy are found to be allocatively efficient. Our survey does not include data on inputs and outputs for cash (fixed) rental contract tenant farms. We do have data for share-tenant operations for both villages, but the number of observations on share tenant operators in one village (Hamsadi) is too few to test the hypothesis of allocative efficiency for share tenants for this village. However, for the remaining village, Khilgati, the existence of differences in economic efficiency can be tested for farms grouped by tenancy status - with those renting in at least some of their land on a crop share basis consisting one group; and pure owner-operators consisting of other.

Another additional feature of our surveyed data is that Hamsadi is a rainfed low land area while Khilgati is an irrigated area (irrigation is only needed during the dry winter season). Therefore, the farms in Khilgati may differ from the farms in Hamsadi with regard to their production technologies. Tests are carried out to determine whether or not farms of each of the two villages face the same technology.

Table 5.1 presents the basic information on mean input and net value of output levels for two groups (farm size, and tenancy) in Khilgati and one group (farm size only) for Hamsadi. We can see from this table that there are differences regarding output and input use between farms of the two villages but not any significant differences between groups within each village.

Table 5.1: Arithmetic Means of Inputs and Net Revenue (crop)

Farm classification	Number of farms	Area operated (acres)	Yield[a] (net revenue) Per acre	Labour[b] input (mandays per acre)	Chemical inputs[c] (fertilizer + pesticides) TK. per acre	Bullock days per acre	Labour productivity (TK. per man-days)
small (≤ 2.5 acres)							
Hamsadi	72	1.60	5185.80	133.48	339.53	47.98	38.85
Khilgati	62	1.64	4720.27	139.49	322.24	57.19	33.84
large farm (>2.5 acres)							
Hamsadi	28	3.92	4749.80	123.53	290.83	44.70	38.45
Khilgati	38	4.43	4659.93	126.74	359.66	51.06	36.77
Owner-operator							
Hamsadi	na						
Khilgati	68	2.78	4700.97	133.38	352.25	53.66	35.25
Owner-cum-tenant							
Hamsadi	na						
Khilgati	32	2.52	4659.44	127.80	331.36	52.91	36.46
All farms							
Hamsadi	100	2.24	4994.38	129.18	317.12	46.58	38.66
Khilgati	100	2.72	4665.72	131.07	344.32	53.18	35.60

[a] Yield is basically net revenue per acre. Net revenue is calculated by subtracting cost on inputs that are applied in fixed proportions with the area operated, such as seeds, manure, and irrigation, from the total revenue. Total revenue is the summation over all crop revenues that are essentially price of crop times its production. The price of every crop is a standardized price based on the price prevailing in the area at the time of interview.

[b] Labour is the total labour input used by the farm. It is obtained by summing over family and hired labour of each category (adult male, adult female and minor aged under 15) with weights 1 for adult male, .45 for adult female and .40 for minor. The weights are based on the observed average wage rates of each category of labour.

[c] Chemical inputs include fertilizer and pesticides. Of course, very insignificant amount of pesticides were used by farms in both areas. This is in value terms (TK. per acre).

5.3 Methodology: A Production Function Approach

The methodology adopted here to examine the issues outlined above may be called the production function approach, as compared to the profit function approach.[4] Altogether six tests have been conducted here to address the issues regarding farm size-efficiency and tenancy efficiency. Tests are conducted, first, for each village to determine whether or not aggregation of all types of heterogeneous labour inputs can be made. This aggregation was carried out using weights based on the observed average wage rates of the three types of labour. Second, tests are done for each village to identify any differences in the aggregation of total labour inputs (summing over family and hired labour with equal weights) as opposed to separate entries for family labour and hired labour in the production function estimates. Depending on the results of these two tests, a third test is conducted to examine any intra-village differences in production technology by pooling data over samples of two villages. Then a fourth test is done to examine the differences in the intercept coefficients and the slope coefficients of the production function estimates for large farms, small farms and share-cropped farms. A fifth test is conducted to examine the scale properties of the production functions obtained following tests one to four. Finally marginal revenue products and factor prices are compared in an analysis of absolute and relative allocative efficiency for each group of farms in the study.

Since aggregation over crops is done in such a way as to reduce the crop composition bias which results from the use of total revenue product, the underlying nature of the profit function is different from the usual profit function. Our ultimate objective in this chapter is to obtain an estimate of the profit function which is to be linked with the consumption estimates later in chapter seven. Thus, it is imperative that we should discuss the specification of this profit function.

First of all, the requirement of material inputs (M), such as seeds, manure and irrigation, differs among crops but will maintain a fixed relation with output, Q_i, ie.,

$$(5.1) \qquad M_{ji} = \alpha_{ji} Q_i$$

Also for each crop i, we assume that

$$(5.2) \qquad Q_i = F_i(V_{Ri})$$

Equation (5.1) specifies a fixed relationship of material inputs, j, with each crop i through some weight α_{ji} which varies from crop to crop. Equation (5.2) indicates that crops output, Q_i, is a function of variable inputs (V_{Ri}) which include land, labour of different categories, chemical inputs (fertilizer and pesticides) and bullock power.[5] Assuming that P_i, P_M, and P_R are the vector price of crop i, vector price of material inputs and vector price of variable inputs respectively (the latter two being same across outputs). The objective of a farm household on a multicrop (i^{th} crop) farm is to maximize the following aggregated "net" profit function.

$$(5.3) \qquad \sum_i (P_i Q_i - \sum_j P_{Mj} \alpha_{ji} Q_i - \sum_R P_R V_{Ri}) = \Pi$$

$$\text{or} \quad (5.3)' \qquad \sum_i [(P_i - \sum_j P_{Mj} \alpha_{ji}) Q_i - \sum_R P_R V_{Ri}] = \Pi$$

Substituting (5.2) into (5.3)', we get

$$(5.3)'' \qquad \sum_i [(P_i - \sum_j P_{Mj} \alpha_{ji}) F_i(V_{Ri}) - \sum_R P_R V_{Ri}] = \Pi$$

Maximization of (5.3)'' yield variable input demand functions as

$$(5.4) \qquad V_{Ri} = G_{Ri}(P_i - P_M \alpha_i, P_R)$$

The profit-maximizing marginal conditions require that for each crop i,

$$(5.5) \qquad \frac{\delta F_i}{\delta V_{Ri}} = \frac{P_R}{(P_i - \sum_j P_{Mj} \alpha_{ji})}$$

Therefore, if (i) $P_i - \sum_j P_{Mj} \alpha_{ji} > 0$, $V_{Ri} \geqq 0$

if (ii) $P_i - \sum_j P_{Mj} \alpha_{ji} \leq 0$, $V_{Ri} = 0$

(i) also implies that $(P_i - \sum_j P_{Mj}\alpha_{ji}) \dfrac{\delta F_i}{\delta V_{Ri}} = P_R$

i,e,for each crop, the "net" marginal product is equal to the price of (variable) input.

On the other hand, summing over I crops, we get the following condition

$$\sum_{i=j}^{I} [(P_i - \sum_j P_{Mj}\alpha_{ji}) \frac{\delta F_i}{\delta V_{Ri}} = P_R . I$$

i,e, average "net" marginal revenue product from gross output should also be equal to the price of the variable factor.

Thus, the optimal condition for profit-maximizing multicrop farm is

$$(P_i - \Sigma P_{Mj}\alpha_{ji}) \frac{\delta F_i}{\delta V_{Ri}} = \frac{1}{I} \sum_i^I [(P_i - \sum_j P_{Mj}\alpha_{ji}) \frac{\delta F_i}{\delta V_{Ri}}]$$

(I is being the number of crops) .

which implies that farmers in a multicrop farm should equate the average "net" marginal product from gross output with the "net" marginal revenue product from each crop output.

Noting this condition, we can now define,

$$(5.6) \qquad NR(V_{Ri}) = \Sigma NR_i = \sum_i (P_i - \sum_i P_{Mj}\alpha_{ji})F_i(V_{Ri})$$

as a weighted sum of the production function for each crop, where the weight is "net" revenue (NR) per unit of output for each crop. This is the dependent variable in the estimating equations for the production function which follows.

Since we have a heterogeneous labour inputs - in terms of adult males, adult females, and minor labour, as well as family and hired labour, we need a detailed formulation of the underlying production relations. We would also like to see whether or not there are significant differences in technology between the two villages. We assume that the underlying production relation is of the Cobb-Douglas form, and consider four alternative specifications of the production function.

The alternative specifications are given by equation (5.7) through (5.10), where F is "net" revenue from all crop production as was defined in (5.6); X_1 is area operated; X_2 is total labour (mandays) with weights 1 for adult males, .45 for adult females, .40 for minors aged under 15, and also equal weight (1) for both hired and family labour of each category; X_{2A}, X_{2F}, X_{2M} are total man-days for adult males, adult females and minors respectively while X_{2HL} and X_{2FL} are man-days for hired labour (total) and family labour (total); X_3 is value (Taka) of chemical inputs (fertilizer and pesticides); X_4 is bullock labour (animal days); ℓ represents for village, 1 for Hamsadi, 2 for Khilgati; ν stands for pairing of farms, 1 for small farm, 2 for large farm, 3 for owner-operated farm, and 4 for tenant operated farm.

$$(5.7) \quad F_\ell = e^{\alpha_0} X_{1\ell}^{\alpha_1} X_{2A\ell}^{\alpha_{2A}} X_{2F\ell}^{\alpha_{2F}} X_{2M\ell}^{\alpha_{2M}} X_{3\ell}^{\alpha_3} X_{4\ell}^{\alpha_4} e^{\varepsilon_\ell}$$

$$(5.8) \quad F_\ell = e^{\alpha_0} X_{1\ell}^{\alpha_1} X_{2FL\ell}^{\alpha_{2FL}} X_{2HL\ell}^{\alpha_{2HL}} X_{3\ell}^{\alpha_3} X_{4\ell}^{\alpha_4} e^{\varepsilon_\ell}$$

$$(5.9) \quad F_\ell = e^{\alpha_0} X_{1\ell}^{\alpha_1} X_{2\ell}^{\alpha_2} X_{3\ell}^{\alpha_3} X_{4\ell}^{\alpha_4} e^{\varepsilon_\ell}$$

$$(5.10) \quad F_{\ell\nu} = e^{\alpha_0} X_{1\ell\nu}^{\alpha_1} X_{2\ell\nu}^{\alpha_2} X_{3\ell\nu}^{\alpha_3} X_{4\ell\nu}^{\alpha_4} e^{\varepsilon_\ell}$$

In equation (5.7), it is assumed that heterogeneity exists in the labour market with respect to age and sex, and thus three types of labour, adult males, adult females, and minor children are considered but without any difference between family labour and hired labour of each category. In equation (5.8), it is assumed that the aggregation of each category of labour in (5.7) can be done on the basis of observed wage differences for each category but a distinction is made now between family labour of each category and hired labour of each category. With equation (5.9) it is assumed that each category of labour can be aggregated into adult-male man-days indices on the basis of weights provided by the wage rates. Finally, equation (5.10) is simply an extension of equation (5.9) for each region to consider different sizes of farms, with respect to area operated, and tenancy status of the farms. The error term ϵ_{ℓ}, is assumed to have a zero mean and a uniform variance and to be distributed independently of the X's.

Tests of hypotheses regarding farm technology, as well as aggregation over different categories of human labour are conducted using a test that involves comparing the residual sum of squares from the unrestricted regressions with the residual sum of squares from the restricted regressions.[6] The F test conducted for such tests is defined as

$$(5.11) \qquad F = \frac{(RRSS-URSS)}{(\ell-1)K} \Big/ \frac{(URSS)}{(n-\ell K)}$$

where RRSS = the restricted residual sum of squares from the restricted (pooled) regression

URSS = the unrestricted residual sum of squares from the unrestricted (unpooled) regression

K = the number of parameters (including the constant) to be estimated

ℓ = the number of sampling regions

n = the number of observations (pooled)

We calculate F and compare it with the F-table at the given degrees of freedom. On the basis of this, the rejection or the failure to reject the hypothesis under consideration, will result if calculated F is greater than or less than the tabulated F, respectively.

In choosing from the four alternative production function specifications, six different cases are considered.

Case (A): To test whether or not aggregate data on labour inputs based on some known weights, instead of separate measures of each category of labour (adult male, adult female and minor children) should enter into the production function, we follow a three step procedure. Step (i): enter each category of labour without making a distinction between hired and family labour of each type into the production function (summing family and hired labour of each category giving them equal weight). The production function is estimated separately for each village. Step (ii): aggregate data on various categories of labour inputs into a single index - adult male man-days using weights 1 for adult male labour, .45 for adult female labour, and .40 for minor labour and again estimate the production function for each village. The first step essentially involves estimating equation (5.7) which can be treated as an unrestricted regression for this case. The second step involves estimating equation (5.9) assuming that

$$\alpha_2 = \alpha_{2A} + \alpha_{2F} + \alpha_{2M},$$

$$\text{and } X_2 = X_{2A} + \frac{W_W}{W_M} X_{2F} + \frac{W_C}{W_M} X_{2M}$$

where $\frac{W_W}{W_M} = .45$, $\frac{W_C}{W_M} = .40$, and W_M, W_W and W_C are the wage rates of adult male labour, adult female labour, and minor children labour, respectively.[7]

The final step in this case is to compare the residual sum of squares of the estimates of equations (5.7) and (5.9) with the help of an F-test.[8]

Case (B): Depending on the results of the above exercise, the analysis is now continued to see whether or not the adding up of family labour and hired labour with equal weight for each category of labour as was done in equation (5.7) is justified. This is done in one of two possible ways.

If the estimated coefficients of regression (5.7) for each category of labour are statistically different so that we cannot pool them together, then each category is split by family and hired labour units and a new production function is estimated for each village. In the second step, the data is pooled for the different categories of labour incorporating the weights introduced in case (A) when estimating equation (5.9). Again a production function is estimated for each village. The residual sum of squares of first step estimate (unrestricted one) are compared with the sum of squares of second step estimate (restricted one).

If the estimated coefficients of each category of labour in regression (5.7) are not statistically different from those of (5.9) so that the adding up of each category (adult male, adult female and minor labour) into a homogeneous units of labour input (adult-male man-days) is possible, then the next stage requires the comparison of the residual sum of squares obtained in regression (5.9) (restricted one) with the residual sum of squares obtained in regression estimate (5.8).

Case (C): Depending on the outcome of the above exercise, the analysis is now continued to examine whether or not there exists any significant differences in the production technology of the two villages. This test is conducted in the following way.

Step one involves estimating a production function of the specified form (based on the results of the above two cases) for each village separately and step two involves estimating the same form of production function with data pooled over two villages. The results of these two regressions will be used to examine whether or not a difference in production technology exists between the two villages with respect to either intercept coefficients or slope coefficients or both. However, the above two regression estimates only represent one possible case of the three kinds of F-tests required to examine the three types of differences in production technology just mentioned. The estimate with pooled data restricts both slope and intercept coefficients to be equal across villages while the estimate with unpooled data assumes that each village is different in terms of both intercept and slope coefficients. Thus, these two estimates provide two polar cases. Hence, one additional regression estimate is required that would serve as the intermediate case. This latter estimate can be obtained by introducing intercept shift dummy in the pooled regression which requires the slope coefficients to be equal between villages while the intercept coefficients are not. Thus, these three estimates together can determine whether or not the aggregate production behaviour of the two villages can be represented by the same production function. The three tests used for this case are as follows:

Test I: Test of equality of slope and intercept coefficients across villages (or across non-homogeneous groups).

$$F = \frac{\{\Sigma e^2_P - (\Sigma e_1^2 + \Sigma e_2^2)\}/(\ell-1)\ K}{(\Sigma e_1^2 + \Sigma e_2^2)/(n-\ell K)}$$

Test II: Test of restriction of equality of intercept coefficients (assuming common slope coefficients) across two villages.

$$F = \frac{(\Sigma e_P^2 - \Sigma e_D^2)/(\ell-1)}{(\Sigma e_D^2)/(n-(\ell+K-1))}$$

Test III: Test of restriction of common slope coefficients over two regions(assuming that intercept coefficients are different).

$$F = \frac{[\Sigma e_D^2 - (\Sigma e_1^2 + \Sigma e_2^2)]/(\ell-1)(K-1)}{(\Sigma e_1^2 + \Sigma e_2^2)/(n-\ell K)}$$

where Σe_p^2 = residual sum of squares (RSS) for the pooled regression (restricted one)

Σe_1^2 = R.S.S. for the first village (sub-sample)

Σe_2^2 = R.S.S. for the second village (sub-sample)

Σe_D^2 = R.S.S. for the pooled samples with intercept dummy

K = number of parameters (including constant) to be estimated

n = total number of observations (pooled)

ℓ = number of sampling regions.

Case (D): Based on the above exercise, the same kind of analysis as is canried out in case (C) is conducted next for different groups of farms (i,e, small farms and large farms, owner-operated and owner-cum-share tenant operated farms) to test the hypothesis that the two groups of farms face the same production technology.

Case (E): The test case (D) together with cases (A)-(C) will provide the functional form of the production function that is actually used to perform allocative efficiency tests for different groups of farms. However, the nature of the producton functions obtained through (A)-(D) has to be examined to see whether or not the production functions exhibit constant returns to scale. This is done in the following way:

i) Obtain the residual sum of squares from the production function estimate, specified as the final one obtained from cases (A)-(D).

ii) Obtain residual sum of squares from the estimate of a regression that is expressed in per acre form for the production function used in step (i). This imposes a constant returns to scale constraint on the estimated parameters.

iii) Compare the residual sum of squares between the two estimates.

Case (F): A final step of the methodology carried out here is to conduct tests that are concerned with the allocative efficiencies of small versus large farms and owner-operated farms versus tenant-operated farms. This is conducted by using the t-statistic calculated with respect to the ratio (ω) of marginal productivity and factor price. The equation used for calculating ω may be written as

(5.12) $$\omega = \frac{\alpha_R}{P_R} \left(\frac{F}{X_R}\right),$$ R = 1,2,3,4 identify different factors of production.

where α_R = exponent of the R^{th} factor in the estimated production function

P_R = money price of R^{th} factor

$\frac{F}{X_R}$ = average net revenue of the factor concerned.

α_R, the exponent of the R^{th} factor, is directly obtainable from the estimated production function. For instance, if both groups of farms face the same production technology, the same coefficient will be applicable for each group to calculate ω. On the contrary, $\frac{F}{X_R}$, which is the average "net" revenue of factor, X_R, will be specific to each group of farms. Thus, all we need now is to examine whether or not each group of farms face the same configuration of input prices (P_R). Thus, tests are conducted first for differences in the configuration of input prices on the basis of two pairings, farmsize and tenancy status. Then, on the basis of t-tests (tests that reflect whether or not the value of ω is significantly different from 1), absolute allocative efficiency is confirmed for either group if $\omega = 1$, and the two groups are considered to have equal allocative efficiency if their respective ω values are the same.

5.4 Estimated Production Function with Heterogeneous Labour Inputs

We present the results of the Ordinary Least Squires (OLS) estimates of the regression equation (5.7), (5.8) and (5.9) under cases (A) and (B) in Tables 5.2 and 5.3. In particular, Table 5.2 reports results for Hamsadi and Khilgati, respectively, of estimates based on whether each category of heterogeneous labour inputs in terms of age and sex or total labour input calculated on the basis of some known weights should enter into the estimation of the production function. Similarly, Table 5.3 reports results of estimates for both villages based on whether total labour input based on given weights or further categorizing total labour input between hired and family labour is desirable. The conclusion of these results is that the separate entry of labour inputs by adult male, adult female, and minor labour, or by family and hired labour does not yield significantly different results from those obtained from the entry of total labour inputs aggregated as described earlier.

Table 5.2: Results of Estimates of Regressions (5.7) and (5.9) under case (A)

Explanatory Variables	For Hamsadi: Estimated Coefficients, Equation (5.7)	For Hamsadi: Estimated Coefficients, Equation (5.9)	For Hamsadi: T-Statistic, Equation (5.7)	For Hamsadi: T-Statistic, Equation (5.9)	For Khilgati: Estimated Coefficients, Equation (5.7)	For Khilgati: Estimated Coefficients, Equation (5.9)	For Khilgati: T-Statistic, Equation (5.7)	For Khilgati: T-Statistic, Equation (5.9)
Constant ($\ell n\ \alpha_0$)	4.72(.46)*	4.37(.47)	10.24	9.29	3.75(.53)	3.68(.55)	7.08	6.75
Land (X_1)	.17(.97)	.14(.09)	1.70	1.50	.08(.11)	.07(.09)	.74	.53
Labour (X_2)[a]		.58(.12)		5.03		.29(.15)		1.92
Adult male labour (X_{2A})	.46(.11)		4.15		.23(.13)		1.87	
Adult female labour (X_{2F})	.07(.06)		1.24		-.06(.08)		-.73	
Minor labour (X_{2M})	.04(.04)		.09		.11(.04)		2.93	
Chemical inputs (X_3)	.26(.07)	.24(.06)	3.92	3.79	.50(.64)	.48(.06)	7.86	7.81
Bullock days (X_4)	-.02(.07)	.01(.06)	-.30	.15	.13(.08)	.12(.07)	1.63	1.54
$\bar{R}^2$	.94	.94			.91	.91		
Sum of Squared Residuals	1.26	1.27			3.07	3.26		
Returns to Scale	.98	.97			.99	.96		
Number of observations	100	100			100	100		
F-statistic[b]			.37				2.88	

[a] X_2 = Total labour = $X_{2A} + .45\ X_{2F} + .40\ X_{2M}$

[b] $F = \frac{(RRSS-URSS)/2}{URSS/(n-K-2)}$

* Numbers in parentheses are standard errors of the estimates.

Table 5.3 Results of Estimates of Regression (5.8) and (5.9)* under Case (B)

Explanatory variables	For Hamsadi				For Khilgati			
	Estimated Coefficients		T-Statistic		Estimated Coefficients		T-Statistic	
	Equation (5.8)	Equation (5.9)*	Equation (5.8)	Equation (5.9)*	Equation (5.8)	Equation (5.9)*	Equation (5.8)	Equation (5.9)*
Constant ($\ell n \alpha_0$)	5.28(.42)	5.30 (.42)	12.59	12.74	4.32(.48)	4.34(.36)	8.92	11.96
Land (X_1)	.28(.09)	.28 (.09)	3.08	3.10	.13(.09)	.13(.08)	1.33	1.58
Labour (X_2)[a]		.17 (05)		3.47		.06(.04)		1.45
Family labour (X_{2FL})	.18(.05)		3.47		.06(.09)		.72	
Hired labour (X_{2HL})	.16(.06)		2.70		.06(.04)		1.44	
Chemical inputs (X_3)	.34(.06)	.33(.10)	5.51	5.57	.53(.06)	.53(.06)	8.68	8.73
Bullock days (X_4)	-.01(.07)	-.01(.07)	-.14	-.19	.16(.08)	.15(.07)	1.94	2.01
$\bar{R}^2$	.93	.93			.90	.91		
Sum of Squared Residuals.	1.42	1.43			3.31	3.32		
Number of observations	100	100			100	100		
F-Statistic[b]			.66				.28	

* Because of the log linear function, total labour input in equation (5.9) is

$$LX_2 = LX_{2FL} + LX_{2HL}, \text{ not } X_2 = X_{2FL} + X_{2HL}$$

[a] X_2 = total labour=$(LX_{2FL} + LX_{2HL})$

[b] $F = \frac{(RRSS-URSS)/(n-K-n-K+1)}{(URSS)/(n-K-1)} = \frac{(RRSS-URSS)/1}{(URSS)/(n-K-1)}$

First, it appears from Tables 5.2 and 5.3 that in both villages, the regression with pooled data on labour inputs reveals that all coefficients are significant at a 90 per cent confidence level except for land in Khilgati and bullock power in Hamsadi. In both villages, however, labour and chemical inputs appear to be the most statistically significant factors of production. On the other hand, the separate entry of adult male, adult female and minor labour inputs does not make much difference to these results. In Hamsadi, both adult male and female labour coefficients are statistically significant (at 10 percent significance level) but the coefficient on minor labour is not. In contrast, for Khilgati it is adult male and minor labour, the coefficients of which are statistically significant (at 5 percent significance level) but the coefficient on adult female labour is not. However, from the value of F-test, F which compares the overall fit of the two equations (5.7) and (5.9), it follows that the overall difference between these two estimates is not significantly different so that the hypothesis of estimating the regression with total labour input based on some known weights instead of estimating the regression with separate entries of all categories of labour can not be rejected at a 1 percent significance level. This implies that no substantial loss of generality in terms of statistical precision would occur if we estimate a production function with aggregated labour inputs when aggregation is done with weights based on the observed wage differences of each category of labour in the heterogeneous labour market. This is also supported by the other F-test conducted for estimates of equations (5.8) and (5.9) that compares the residual sum of squares of a regression with total labour input with one with separate entry of family labour and hired labour as in equation (5.8) [see Table 5.3]. In both villages we find that there are no significant differences between family labour and hired labour in estimating a production function.[9]

Therefore, from this point on, we shall use only the form of production function given by equation (5.9), which contains a single weighted and aggregated labour input.

5.5 Production Technology Between Two Villages

Both Hamsadi and Khilgati, the two sample villages in our study, differ to some extent in terms of cropping patterns and also the extent to which farmers cultivate irrigated land. In Khilgati, irrigation facilities provided by the government made it possible, in recent years, for farmers to adopt a high yielding variety of winter "Boro" paddy. This uses extensive amounts of fertilizer. On the other hand, Hamsadi is a rainfed low land area where no high yielding variety of paddy is grown. However, they do produce a cash

Table 5.4: Results of Estimates of Regression (5.9) with pooled data across two villages.

Explanatory Variables	Estimated Coefficients[a]		T-Statistic	
	Pooled data with no dummy	Pooled data with intercept dummies	Pooled data with no dummy	Pooled data with intercept dummies
constant ($\ell n \alpha_0$)	4.13(.38)		10.81	
Constant ($\ell n \alpha'_0$)		3.85(.37)		10.52
Constant ($\ell n \alpha''_0$)		3.73(.37)		10.08
Land (X_1)	.13(.07)	.07(.07)	1.80	.99
Labour (X_2)[b]	.36(.09)	.40(.09)	3.63	4.18
Chemical inputs (X_3)	.44(.05)	.42(.04)	9.61	9.63
Bullock days(X_4)	.01(.06)	.08(.05)	.26	1.53
$\bar{R}^2$	.91	.69		
Sum of Squared Residuals	5.34	4.76		
Number of observations	200	200		
F[c] 6.79				
F[d] 23.64				
F[e] 2.41				

[a] Regression (5.9) is run by pooling data across two villages, (i) with no dummy whatsoever and (ii) with intercept dummies D_1, D_2, where D_1=1, for Hamsadi; 0, for Khilgati while D_2=1, for Khilgati; 0, for Hamsadi. Thus constant ($\ell n \alpha_0'$) corresponds to intercept dummy D_1 while constant ($\ell n \alpha_0''$) corresponds to intercept dummy D_2 in regression equation.

[b] X_2 is total labour input as in equation (5.9)

[c] F tests the hypothesis of equality of intercept and slope coefficients in both villages by comparing the sum of squared residuals for pooled data with the sum of squared residuals for unpooled data for each village, the latter found in Table 5.2.

[d] F tests the hypothesis of equality between intercept coefficients (assuming common slope coefficients) for the two villages. This involves comparing the sum of squared residuals for pooled data with no dummy and that for pooled data with intercept dummies D_1, and D_2.

[e] F tests the hypothesis of equality of slope coefficients (assuming different intercept coefficients) across villages. This involves comparing sum of squared residuals for separate equations for two villages with the pooled regression with intercept dummies.

crop of high yielding sugarcane. Moreover, Khilgati produces transplanted "Aman" paddy while Hamsadi cultivates mostly broadcast "Aman" paddy. Thus, a priori there is some reason to expect that the two villages may differ in terms of production technology. Thus, it is necessary to determine whether or not the two sample data sets can be pooled in order to fit a single production function for both villages. In Table 5.2, we report the results of estimates of regression (5.9) for each village. As we outlined in case (C), we need two more estimates based on pooled data, one with no dummy variables whatsoever, the second with intercept shift dummies to identify the two villages.

Table 5.4 presents the results of the estimates of regression (5.9) on pooled data with no dummy and with intercept dummies D_1 for Hamsadi and D_2 for Khilgati. The residual sum of squares of these two estimates (pooled) have to be compared with the residual sum of squares of separate regression (5.9) for each village data set which are given in Table 5.2.

Now, on the basis of three F-tests as outlined in case (C) in section 5.3, we want to explore whether or not two villages differ from each other in terms of the technology reflected by the production function estimates. All the three F-tests are calculated and presented in Table 5.4. The first test F^c, whose value is 6.79 as against tabulated F.01=3.12, clearly shows that the hypothesis of equality of both intercept coefficients and slope coefficients between two villages can be rejected at 1 percent level of significance. The question is now - do the two villages differ in terms of both of these technical coefficients or only with respect to one of these? This can be found in the values of F^d and F^e in Table 5.4. F^d, whose value is 23.64 as against tabulated F.01=6.84, tests the hypothesis of equality of intercept coefficients between two villages and shows that this hypothesis can be rejected at 1 percent level of significance. On the other hand, the value of F^e (2.41 as against tabulated F.01=3.32, F.05=2.37) which tests the hypothesis of equality of slope coefficients indicates that this hypothesis of equality of slope coefficients between two villages can be rejected at the 5 percent but not at the 1 percent level of significance. These three tests together suggest that both Hamsadi and Khilgati differ with respect to their production technologies. This in turn suggests that the estimated production function as in equation (5.9) in Table 5.2 is different for each village and should be used separately for further analyses.

5.6 Production Technologies Among Pairing of Farms

Following the results in section 5.5, we now have a different estimated production function for each of the two villages. We would like to see whether or not different groups of farms by farmsize or

Table 5.5: Results of Estimates of Equation (5.10) and (5.9) under Case (D) Hamsadi

Table 5.5(i) Equation (5.10) for large versus small farmers

Explanatory Variables	Estimated Coefficients		T-Statistic	
	Large farm	Small farm	Large farm	Small farm
Constant ($\ell n\alpha_0$)	5.56(.85)	3.41(.59)	6.56	5.79
Land (X_1)	.29(.17)	-.06(.12)	1.69	-.59
Labour (X_2)	.46(.29)	.67(.12)	1.60	5.45
Chemical inputs (X_3)	.22(.14)	.31(.07)	1.56	4.51
Bullock days (X_4)	-.09(.18)	.01(.07)	-.54	.08
$\bar{R}^2$	.87	.89		
Sum of Squared Residuals	.37	.76		
Number of Samples	28	72		

Table 5.5(ii) Results of Estimates of (5.9) with shift dummy for pooled data

Explanatory Variables	Estimated Coefficients	T-Statistic
Constant ($\ell n\alpha_0$)	4.38(.46)	9.48
Dummy for intercept[a]	.09(.03)	2.26
Land (X_1)	.10(.09)	1.04
Labour (X_2)	.57(.11)	5.02
Chemical inputs(X_3)	.26(.06)	4.25
Bullock days (X_4)	-.02(.06)	-.31
$\bar{R}^2$	.94	
Sum of Squared Residuals	1.20	
Number of observations	100	
F^b 1.89		
F^c 4.70		
F^d 1.18		

[a] A shift dummy D is used to differentiate intercept coefficients for large and small farms, with D=1, for large farm: 0 for small farm: Thus, the constant term for small farm is 4.47.

[b] F calculates for the test of hypothesis of equality of intercept and slope coefficients between two group of farms;

[c] F tests the hypothesis of equality of intercept coefficients between two group of farms (assuming common slope coefficients).

[d] F tests the hypothesis of equality of slope coefficients between two group of farms (assuming different intercept coefficients.)

tenancy status face different production technologies within each village. It requires that we construct F-tests on estimates of production functions (5.9) and (5.10). First we discuss tests concerning technological differences between small and large farms for Hamsadi, and second, we discuss similar analyses for Khilgati in terms of farm-size and tenancy status.

The results of estimates of regressions (5.10) on the two group of farms, small and large, and of (5.9) for pooled data over these two groups with intercept dummy are presented in Tables 5.5 (i) and 5.5 (ii) respectively. Again, three tests similar to the ones in section 5.5 are conducted to examine whether or not small and large farms in Hamsadi face the same production technology. Thus, examining the values of F^b, F^c, and F^d against tabulated F.01=3.22, 6.85, 3.48 we can conclude that the hypothesis of equality of both intercept and slope coefficients between two groups of farms in Hamsadi can not be rejected at the 1 per cent level of significance, since F^b, F^c, $F^d < F_{.01}$. This follows that small and large farms face the same production technology and that a single equation (5.9) run over the entire sample for large- and small- farms as in Table 5.2 will suffice to represent both groups in our sample village, Hamsadi.

Table 5.6: Results of Estimates of Regression (5.10) and (5.9) under Case (D) Khilgati

Table 5.6(i) Equation (5.10) for large versus small farms.

Explanatory Variables	Estimated Coefficients		T-Statistic	
	Large farm	Small farm	Large farm	Small farm
Constant ($\ell n\alpha_0$)	3.24(.72)	4.02(.83)	4.49	4.84
Land (X_1)	-.16(.16)	.07(.14)	-.92	.46
Labour (X_2)	.38(.27)	.21(.19)	1.42	1.09
Chemical inputs (X_3)	.39(.10)	.54(.08)	3.75	6.14
Bullock days (X_4)	.29(.14)	.07(.11)	1.96	.69
$\bar{R}^2$	.89	.73		
Sum of Squared Residuals	.74	2.39		
Number of Samples	38	62		

Table 5.6(ii) Equation (5.9) for Pooled data with intercept dummy

Explanatory Variables	Estimated Coefficients	T-Statistic
Constant ($\ell n\alpha_0$)	3.61(.57)	6.56
Intercept dummy D^a	.12(.11)	1.14
Land (X_1)	-.01(.11)	-.09
Labour (X_2)	.31(.16)	1.96
Chemical inputs(X_3)	.49(.06)	7.34
Bullock days (X_4)	.14(.08)	1.63
$\bar{R}^2$	.91	
Sum of Squared Residuals	3.20	
Number of Observations	100	
F^b .75		
F^c 1.76		
F^d .50		

[a] A shift dummy D is used to differentiate intercept coefficients for large and small farms, with D=1 for large farm; 0 for small farm.

[b] F tests the hypothesis of equality of intercept and slope coefficients between two groups of farms.

[c] F tests the hypothesis of equality of intercept coefficients between two groups of farms (assuming common slope coefficients).

[d] F tests the hypothesis of equality of slope coefficients between two groups of farms (assuming different intercept coefficients).

Table 5.7: Results of Estimates of Regression (5.10) and (5.9) under Case (D) Khilgati

Table 5.7(i): Equation (5.10) for pure owner-operator-cum-share operator

Explanatory Variables	Estimated Coefficients		T-Statistic	
	Owner Op.	Owner-cum-share operator	Owner operator	Owner-cum-share operator
Constant ($\ln\alpha_0$)	3.78(.70)	3.99(1.12)	5.34	3.56
Land (X_1)	.04(.13)	.20(.21)	.28	.95
Labour(X_2)	.26(.21)	.32(.23)	1.20	1.34
Chemical Inputs(X_3)	.45(.86)	.54(.12)	5.21	4.53
Bullock days(X_4)	.21(.10)	-.06(.17)	2.03	-.36
$\bar{R}^2$	.89	.91		
Sum of Squared Residuals	2.29	.85		
Number of Observations	68	32		

Table 5.7(ii): Equation (5.9) with intercept dummy for pooled data.

Explanatory Variables	Estimated Coefficients	T-Statistic
Constant ($\ln\alpha_0$)	3.82(.60)	6.29
Intercept dummy, D[a]	.12(.06)	.26
Land (X_1)	.07(.10)	.63
Labour (X_2)	.23(.16)	1.46
Chemical inputs(X_3)	.49(.06)	7.35
Bullock days (X_4)	.16(.08)	1.89
$\bar{R}^2$	.90	
Sum of Squared Residuals	3.24	
Number of observations	100	
F[b] .69		
F[c] 1.58		
F[d] .72		

[a] A shift dummy D is used to differentiate intercept coefficient for owner and share-tenants, with D=1 for owner; 0 for share tenant.

[b] F-tests the hypothesis of equality of intercept and slope coefficients between two groups of farms.

[c] F-tests the hypothesis of equality of intercept coefficients between two groups of farms.

[d] F tests the hypothesis of equality of slope coefficients between two groups of farms.

Since in Khilgati, two pairings of farms in terms of farm size and tenancy status are possible the results of estimates of regression (5.9) and (5.10) are presented in Tables 5.6 and 5.7 respectively. Equation (5.10) is based on large and small farms, and owner and share-tenants and equation (5.9) is based separately with shift dummy on the pooled data on the basis of two pairings. Three tests similar to the previous ones for the case of Hamsadi are conducted to examine whether these two pairings of farms face the same production technology. If we examine the values of F^b, F^c and F^d for both group of farms against the tabulated values of $F_{.01}$=3.17, 6.85, 3.48, we see that the hypothesis that the factor coefficients are the same for each pairing of farms in Khilgati cannot be rejected at a 1 percent level of significance for both grouping of farms. This suggests that small and large farms as well as owners and share tenants face the same production technology.[10] Therefore, a single production function fitted for the entire sample in Khilgati would be justified on the basis of statistical criteria.

According to our results on pairing of farms for both villages, we now can present the estimated production function for each village, Hamsadi and Khilgati respectively, as follows:

$$(5.13) \quad \log F_{Hamsadi} = \underset{(9.29)}{4.37^{*}} + \underset{(1.50)}{.14^{***}} \log X_1 + \underset{(5.03)}{.58^{*}} \log X_2$$

$$+ \underset{(3.79)}{.24^{*}} \log X_3 + \underset{(.15)}{.01} \log X_4$$

$$\bar{R}^2 = .94, \text{ Returns to scale: } .97$$

$$(5.14) \quad \log F_{Khilgati} = \underset{(6.75)}{3.68^{*}} + \underset{(.53)}{.07} \log X_1 + \underset{(1.92)}{.29^{**}} \log X_2$$

$$+ \underset{(7.81)}{.48^{*}} \log X_3 + \underset{(1.54)}{.12^{***}} \log X_4$$

$$\bar{R}^2 = .91, \text{ Returns to scale: } .96$$

* significant at 1 percent level, ** significant at 5 percent level.

*** significant at 10 percent level.

As we see from equations (5.13) and (5.14), all coefficients are statistically significant except the one for bullock power for Hamsadi and the one for land for Khilgati.[11] Labour and chemical inputs have highly significant coefficients in the agricultural production functions of both villages. The coefficient on chemical inputs is especially high in Khilgati. On the other hand, the coefficient on land for this village is low and insignificant largely because there is not much variation in its value over the sample farms. Moreover, the effect of irrigation which effectively increases the supply of land is removed by deducting the value of irrigation costs from total value of crop production in this village. But the intensive use of fertilizer in this village may reflect the importance of the irrigation scheme and therefore, might capture part of the contribution of land.

It is evident, however, that in both villages returns to scale are not significantly different from one using a 1 percent significance level.[12] This confirms that returns to scale are constant in both villages.[13]

5.7 Allocative Efficiency Between Pairs of Farms

We now return to the question of the allocative efficiency of different groups of farms after observing that both groups of farms face the same production technology and that constant returns to scale holds for each village production function. As we said earlier, allocative efficiency tests should be preceeded by another test concerning whether or not different group of farms face the same configuration of input prices.[14] Accordingly, in Tables 5.8 and 5.9, a break down of mean input prices for pairing of farms is presented for each village. These tables confirm that all groups of farms face the same configuration of input prices with differences in means which are not statistically significant at the 1 percent level of significance. These prices are used for allocative efficiency tests.

Table 5.8: Mean* Input Prices in Taka in Hamsadi

Farm Classification	Wage per adult male man-day	Price of fertilizer (TK/maund)	Rental price of land per acre	Rental price of bullock per bullock day
Small farm ≤2.5 acres	2.73(.09)	4.86(.04)	7.84(.15)	2.30(.01)
Large farm >2.5 acres	2.72(.14)	4.88(.03)	7.76(.14)	2.31(.02)
All farms	2.72(.10)	4.86(.03)	7.82(.15)	2.30(.01)

Table 5.9: Mean* Input Prices in Taka in Khilgati

Farm Classification	Wage per adult male man-day	Price of fertilizer (TK/maund)	Rental price of land per acre	Rental price of bullock per bullock day
Small farm ≤2.5 acres	2.70(.09)	4.69(.04)	8.04(.16)	2.33(.07)
Large farm >2.5 acres	2.68(.10)	4.66(.03)	7.99(.12)	2.38(.09)
Owner-operator	2.69(.11)	4.68(.40)	7.99(.17)	2.35(.08)
Owner-cum-share operator	2.67(.06)	4.67(.04)	8.08(.15)	2.31(.06)
All Farms	2.68(.09)	4.68(.04)	8.02(.17)	2.34(.08)

Note: Numbers in parantheses are standard errors.

* Geometric mean of the prices are quoted here. Rental price of land is calculated on the basis of the fixed-rental price of land.

Table 5.10: Marginal Productivity and Allocative Efficiency for Hamsadi

Farm classification	Land	Labour	Chemical input	Bullock Power
Marginal products[a]				
Small	6.60(.18)	3.12(.12)	1.31(.16)	.78(.23)
Large	6.50(.19)	3.11(.13)	1.41(.23)	.73(.21)
Allocative efficiency: Value of ω[b]				
Small	.84(.06)	1.14(.05)	1.31(.16)	.34(.10)
Large	.84(.07)	1.14(.06)	1.41(.23)	.32(.09)

Table 5.11 Marginal Productivity and Allocative Efficiency for Khilgati.

Farm Classification	Land	Labour	Chemical input	Bullock Power
Marginal products[a]				
Small	5.79(.31)	2.26(.26)	1.97(.35)	2.29(.32)
Large	5.77(.54)	2.36(.57)	1.86(.63)	2.40(.62)
Owner	5.78(.33)	2.30(.24)	1.92(.27)	2.33(.29)
Tenant	5.77(.24)	2.29(.25)	1.95(.31)	2.33(.30)
Allocative efficiency: value of ω[b]				
Small	.72(.04)	.84(.10)	1.97(.35)	.98(.14)
Large	.72(.07)	.88(.21)	1.86(.63)	1.01(.26)
Owner	.72(.04)	.86(.09)	1.92(.37)	.99(.12)
Tenant	.71(.03)	.86(.09)	1.95(.31)	1.01(.13)

Note: Standard errors are presented in parentheses

[a] Marginal products are computed at the geometric means and expressed in Taka. Marginal products are 'net' marginal products in value terms.

[b] The estimate of ω is obtained by dividing 'net' marginal products by the corresponding factor price except for chemical inputs. The net value of marginal products of chemical inputs is equal to 1 Taka because this inputs are in value terms.

Using equation (5.12) we calculated the mean marginal productivities for each factor for each village and then calculated the value of ω by dividing mean marginal productivity by the corresponding mean input prices.[15] Tables 5.10 and 5.11 represent the results of the tests of allocative efficiency for the two villages, Hamsadi and Khilgati, respectively. Examining the values of ω for different groups of farms in Hamsadi, we find that at a 1 percent level of significance both small and large farms are allocatively efficient (i.e., ω is not significantly different from one) with respect to labour and chemical inputs but not in terms of land and bullock power. On the other hand, all groups of farms in Khilgati are allocatively efficient with respect to labour and bullock power at a 1 percent significance level and also allocatively efficient at a 5 percent significance level with respect to chemical inputs. However, in this latter village too, all groups of farms are not allocatively efficient (i.e., the value of ω is significantly different from one) with respect to land. Thus, in both villages, for all groups of farms, the value of marginal products of land is consistently less than the price of land. The rental price of land as calculated in Tables 5.8 and 5.9 is based on the (fixed) cash rental price of land. We tried another measure - which is based on the share value of crop produced on share tenant's rented-in land and calculated its price per acre. We found that for all farms, this mean (geometric) price is 7.29 Takas per acre for Hamsadi and 7.42

Takas per acre for Khilgati. Using these prices, we still find that net value of marginal product of land is consistently less than the market price of land. This implies that for all groups of farms in both villages, ω is consistently less than unity indicating over-utilization of the land input. This is rather a surprising result.[16] This result in fact holds for all group of farms and for both villages.

If we examine the question of relative allocative efficiency, we find that at a 1 percent level of significance, all groups of farms in both villages are equally allocatively efficient regarding land, labour, chemical inputs and bullock power (i,e,they have the same value of ω). But for land in both villages, ω < 1 indicating over-utilization of land input regardless of farm size and tenancy status and for bullock power in Hamsadi, ω is also less than unity implying rental price of bullock power exceeds the value of net marginal product.

5.8 Conclusions

This chapter examined the effects of farm size and tenancy status on economic efficiency in the context of production function analysis. While doing this, we have also examined the issues of the heterogeneity of labour inputs in terms of age and sex, something which has not been incorporated in any study to date. The conclusion regarding labour heterogeneity in terms of adult male, adult female and minor children labour, for both villages, is that no substantial loss of statistical precision occurs if aggregation over these various categories of labour inputs is done with the weights based on the observed differences in their market wages. In line with other studies, we confirm statistically the homogeneity of family labour and hired labour in our study areas. We have also found that both types of farms, small and large as well as owner and owner-cum- share tenants are equally efficient in the economic sense in both of our study areas. However, some technological differences exist between the two villages to the extent that separate production functions best fit the data of the two villages.

The final conclusion is that all of these results hold subject to the use of "net revenue" as a dependent variable, a measure based on the idea of removing or reducing the "crop composition effect" from the value of total crop production (i,e, total revenue) in a multicrop farm economy.

FOOTNOTES TO CHAPTER FIVE

1. Heterogeneity in the rural labour market in an agrarian economy arises due to difference in terms of age, sex and family versus hired labour [for further discussions, see Binswanger and Rosenzweig (1980)]. While the latter aspect of labour heterogeneity (heterogeneity in terms of family versus hired labour) is well addressed in the literature [see, eg, Bardhan (1973), Nath (1974)], the former aspect of heterogeneity in terms of age and sex (such as adult male, adult female and minor children) is often ignored in production function estimates.

2. Using the value of total crop production in a multicrop farm implicitly assumes that the crop composition of total production is similar for different farms. Although the effect of output price differentials on this value can be removed by using standardized prices of different outputs for different farms, the influence of crop composition bias on this value term is a serious error that may lead to misleading results [Bardhan (1973)]. This bias arises mainly because of different cropping patterns for different farms as well as for different regions. This problem has not been sufficiently examined in the literature.

3. The requirement of these material inputs actually vary widely depending on the crop. For instance, extensive irrigation water is necessary for "boro" (winter), HYV paddy production whose yield is also the highest among different types of paddy grown in Bangladesh. Similarly, for another high yielding crop, sugarcane, the seed cost requirement is enormously high compared to any other crop produced in this region.

4. Both production and profit function approaches are used for production analysis. The profit function seems to work best if there are significant differences in output and input prices. But for cross-section data where such variation is minimal, the production function seems to be the appropriate method. For the production function approach, see Bardhan (1973) and Barnum & Squire (1978), and for the Profit function approach, see Sidhu (1974), Yotopolous and Lau(1973).

5. Area operated is treated here as a variable input on the assumption that the farm household, to some extent, can vary the size of its operational holdings by renting in or out land. Bardhan (1973) does not include bullock labour as separate input because of its strong complementarity with human labour. But to the extent that variation in cropping pattern over the two village under consideration involves a variation in labour use, as well as bullock labour use, throughout the year, there is some justification for incorporating bullock labour as a separate variable input in the production

function. For instance, crop production activity are such in the two villages that per acre use of bullock labour by all farms is much lower in Hamsadi than in Khilgati, although average cropping intensity is higher in Hamsadi than in Khilgati (see Table 5.1). Also, we include various categories of human labour as separate inputs in the production function to determine the extent of their heterogeneous effects on production.

6. Yet another procedure which assumes that error term has a uniform variance over the entire sample involves using the dummy shift parameter with a dummy variable (equal to zero for one group and 1 for the other group) in an additive form for the intercept coefficient and multiplicative form for the slope coefficients. However, both approaches will yield the same results.

7. It should be mentioned that aggregation over all three categories of labour inputs as in equation (5.7) is not strictly followed while aggregating total labour inputs in adult male mandays in equation (5.9). However, it is not difficult to show that aggregation in (5.9) as $(X_{2A} + \frac{W_W}{W_M} X_{2F} + \frac{W_C}{W_M} X_{2M})^{\alpha 2}$ can be viewed as an approximation to $X_{2A}^{\alpha_{2A}} X_{2F}^{\alpha_{2F}} X_{2M}^{\alpha_{2M}}$. Profit maximization with respect to each category of labour leads to the following conditions in terms of total labour (X_2);

$$X_{2A} = \frac{\alpha_{2A}}{(\alpha_{2A} + \alpha_{2F} + \alpha_{2M})} X_2$$

$$X_{2F} = \frac{\alpha_{2F}}{(\alpha_{2A} + \alpha_{2F} + \alpha_{2M})} \frac{W_M}{W_W} X_2$$

$$X_{2M} = \frac{\alpha_{2M}}{(\alpha_{2A} + \alpha_{2F} + \alpha_{2M})} \frac{W_M}{W_C} X_2$$

where W's are the wage rates of different categories of labour.

8. Note that the F-test on (5.7) and (5.9) is not strictly correct since the hypotheses are not nested. Really one should use a non-nested test. However, it can be argued that because total female labour and minor labour man days are small relative to adult male mandays that it would not make much difference. The average numbers of mandays for adult males, adult females and minor children for all farms in Hamsadi and Khilgati, respectively, are: 254.08, 47.3, and 35.02, in Hamsadi, 313.2, 38.2 and 62.01 for Khilgati.

9. The assumption of homogeneity of family labour and hired labour can not be statistically rejected. Similar results were found by Bardhan (1973) for some of the district-level data in India while Nath (1974) reported for one region in India that significant differences exist between hired and family labour. To the extent that family labour works both in slack and busy seasons while hired labour is mostly

employed in busy periods, there should be some differences, as some researchers argue, in the coefficients as well as marginal products for these types of labour. However, we do not have disaggregated data on labour on a seasonal basis for each crop. Because of this we are unable to separate the labour between slack and busy periods. Neither do we observe any significant differences between the market wage rates of hired labour and the opportunity cost of using family labour on the farm, as reported by farm households.

10. The results in other countries are mixed. Bardhan (1973) for India and Barnum and Squire (1978) for Malaysia report that both small and large farms face the same technology. These results were obtained using the production function approach. On the other hand, using the profit function approach, Sidhu (1974) found that small and large farms were equally efficient while Yotopoulos and Lau (1973) concluded that small farms were technically more efficient than large farms.

11. The lesser use of bullock labour in Hamsadi as compared to Khilgati may lead to the conclusion that the coefficient on bullock labour for this village is insignificant to the extent that bullock labour and human labour are complementary inputs, the contribution of bullock power, thus, may be captured in part by the coefficient on human labour. However, the greater use of bullock labour for land preparation and associated activity for each crop throughout the year

may lower to some extent, the role of human labour in agricultural production for Khilgati. In both villages, land coefficients are low. For the case of India with the value of total crop production as the dependent variable Bardhan's (1973) results also show low coefficients on land input using different district level data.

12. This is obtained by comparing residual sum of squares for estimates of production function 5.9 and that of the restricted one where (5.9) is expressed in per acre form. An alternate way of testing constant returns to scale is the one used by Bardhan (1973) where the value of total crop production is the dependent variable and area operated with other inputs in per acre form are the independent variables. The coefficient of land (which is basically the sum of all coefficients of inputs including land) is compared to unity. We used this latter technique and found the same result.

13. Bardhan (1973) reports constant returns to scale for wheat-producing districts and decreasing returns to scale for predominantly paddy-growing regions for India. Barnum and Squire (1978) report constant returns to scale for a paddy producing area in Malaysia.

14. Since outputs in both villages have been multiplied by the prevailing market prices in the area, and that these prices did not show any significant differences over two regions, the question as to whether or not all households face the same output prices does not arise.

15. Note that since chemical inputs entered into production functions estimation in value terms, its price should be taken as unity in calculating the value of ω.

16. In an uncertainty context, however, this may happen. When farmers perceive risk associated with agricultural production, they may allocate more land to producing different food crops throughout the year which may in turn imply overutilization of land input.

CHAPTER SIX

A LINEAR EXPENDITURE SYSTEM FOR BANGLADESHI FARM HOUSEHOLDS

6.1 Introduction

The theoretical model developed in Chapter Three contains the interdependent production and consumption components of farm household decision-making. In the preceding chapter, we presented results from the production side of the model. We shall now present empirical results for the consumption part of the farm household model. Household demand functions for the consumption of farm goods, market purchased non-farm goods, child investment goods and supply functions for family labour of different categories (adult male, adult female and children under the age of 15) are estimated and presented in this chapter. The model employed here to provide a basis for the demand equations is a modified version of the model presented in Chapter Three.

The model has been extended to include both nuclear and extended families, where the number of adult males and females who participate in household decision making is greater than two. A second modification is made to link the consumption model primarily with income earning activities in agriculture, although in Chapter Four we found that non-agricultural activities are important as well in both of the villages which were surveyed. However, the opportunity cost of the two types of activities is different to the extent that employment in non-agricultural activities requires very specific types of labour, which may be different from those used in agriculture. Thus, the exclusion of non-agricultural activities from the labour supply consideration will probably not seriously affect our conclusions. The effect of such activity as an income earning activity is captured through the inclusion of non-agricultural income as an exogeneous variable in the model. Finally, the model contains demand functions for agricultural and non-agricultural consumption bundles.

We first present the modified model, with the features just discussed, and the estimation procedures regarding the linear expenditure system derived within this framework. Next, we present the results of estimates of demand functions for commodities as well as labour supply functions for different categories of agricultural labour. Third, in order to highlight the significance of the model and its estimated parameters, we also present some of the elasticities calculated for the household commodities demand and labour supply functions with respect to some selected variables.

6.2 The Linear Expenditure System

The model corresponding to the linear expenditure system that is employed to estimate demand functions is a modified version of the model in Chapter Three. Households are assumed to maximize the objective function given by 6.1(i) subjects to the constraints 6.1(ii) through 6.1(viii), where

C = consumption of farm goods, and p is its price

Q = consumption of non-farm goods, and r is its price

N_1 = number of adult males in the household

N_2 = number of adult females in the household

ℓ_3 = leisure per minor child

N = number of minor children under the age of 15 in the family

$L_1 = N_1\ell_1$ = total leisure consumed by adult males

$L_2 = N_2\ell_2$ = total leisure consumed by adult females

G = non-farm income

D_1 = total man-days of adult males employed in crop production

D_2 = total adult female man-days in crop production

D_3 = total minor labour (man-days) in crop production

H_1 = total adult male man-days hired out ($H_1>0$) or hired in ($H_1<0$)

H_2 = total adult female man-days hired out ($H_2>0$) or hired in ($H_2<0$)

H_3= total minor child man-days hired out (H_3>0) or hired in (H_3<0)

W_C= wage rate of minor children under the age of 15

and all other notation corresponds to notation used in Chapter Three.

6.1(i) $U = U(C,Q,N,E,\ell_3, L_1,L_2)$

6.1(ii) $F = F(D_1,D_2,D_3, d_j; \bar{K}A)$

6.1(iii) $N = N(X_N,T_{NW})$

6.1(iv) $E = E(X_E,T_{EC})$

6.1(v) $N_1\Omega_M = H_1 + D_1 + L_1$

6.1(vi) $N_2\Omega_W = H_2 + D_2 + L_2 + T_{NW}$

6.1(vii) $N\Omega_C = H_3 + D_3 + T_{EC} + N\ell_3$

6.1(viii) $P_NX_N + P_EX_E + rQ = W_MH_1 + W_WH_2 + W_CH_3 + G + p(F-C)-\Sigma P_jd_j$

Assuming that the production functions for N and E in equation 6.1(iii) and (iv) are subject to constant returns to scale and fixed proportion production relations, we can substitute 6.1(ii)-6.1(vii) into 6.1(viii) to get the new budget constraint as

6.1(ix) $N(\pi_N+E\pi_E+W_C\ell_3)+ rQ + pC + W_ML_1 + W_WL_2$

$= \Pi + G + W_MN_1\Omega_M + W_WN_2\Omega_W = I$

where $\Pi = pF(\ldots) - W_MD_1-W_WD_2-W_CD_3-\Sigma P_jd_j$

is income from agricultural activity

$\pi_N= (P_Nx_N + t_{NW}W_W-W_C\Omega_C)$

is price per minor child per year

$\pi_E= (P_Ex_E + t_{EC}W_C)$

is cost of schooling per schooling year per child

The symbol I in the budget 6.1(ix) represents an augmented "full income" constraint according to Becker's (1965) terminology.

To derive a set of demand functions corresponding to the arguments in the utility function 6.1(i) for estimating purposes, we have chosen to represent the household's preferences by an "augmented" Stone-Geary utility function.[1]

$$(6.2) \quad U = \beta_C \ell n(C-\bar{C}) + \beta_Q \ell n(Q-\bar{Q}) + \beta_N \ell n(N-\bar{N}) + \beta_E \ell n(E-\bar{E}) + \beta_{L1} \ell n(L_1-\bar{L}_1) + \beta_{L2} \ell n(L_2-\bar{L}_2) + \beta_{\ell 3} \ell n(\ell_3-\bar{\ell}_3)$$

Maximization of (6.2) subject to 6.1(ix) leads to the following first-order conditions

$$(6.3)\ (i) \quad \frac{\beta_C}{(C-\bar{C})} + \lambda[-p] = 0$$

$$(ii) \quad \frac{\beta_Q}{(Q-\bar{Q})} + \lambda[-r] = 0$$

$$(iii) \quad \frac{\beta_N}{(N-\bar{N})} + \lambda[-(\pi_N + E\pi_E + W_C\ell_3)] = 0$$

$$(iv) \quad \frac{\beta_E}{(E-\bar{E})} + \lambda[-N\pi_E] = 0$$

$$(v) \quad \frac{\beta_{\ell 3}}{(\ell_3-\bar{\ell}_3)} + \lambda[-NW_C] = 0$$

$$(vi) \quad \frac{\beta_{L1}}{(L_1-\bar{L}_1)} + \lambda[-W_M] = 0$$

(vii) $\frac{\beta_{L2}}{(L_2-\bar{L}_2)} + \lambda[-W_W] = 0$

(viii) $I - N(\pi_N+E\pi_E+W_C\ell_3) - rQ-pC-W_ML_1-W_WL_2 = 0$

where λ=Lagrangian multiplier > 0.

Let us assume that $\bar{N} = 0$ (i.e., there is no social norm regarding the minimum number of children the family should have)[2]. As we have done in Chapter Three, some manipulation of the above system (6.3) would lead to the following set of demand equations for household commodities:

(6.4) (i) $P(C-\bar{C}) = \frac{\beta_C}{A}[I-p\bar{C}-r\bar{Q}-W_M\bar{L}_1-W_W\bar{L}2]$

(ii) $r(Q-\bar{Q}) = \frac{\beta_Q}{A}[I-p\bar{C}-r\bar{Q}-W_M\bar{L}_1-W_W\bar{L}_2]$

(iii) $N(\pi_N + \bar{E}\pi_E + \ell_3W_C) = \frac{(\beta_N-\beta_E\beta_{\ell 3})}{A}[I-p\bar{C}-r\bar{Q}-W_M\bar{L}_1-W_W\bar{L}_2]$

(iv) $N\pi_E(E-\bar{E}) = \frac{\beta_E}{A}[I-p\bar{C}-r\bar{Q}-W_M\bar{L}_1-W_W\bar{L}_2]$

(v) $NW_C(\ell_3-\bar{\ell}_3) = \frac{\beta_{\ell 3}}{A}[I-p\bar{C}-r\bar{Q}-W_M\bar{L}_1-W_W\bar{L}_2]$

(vi) $W_M(L_1-\bar{L}_1) = \frac{\beta_{L1}}{(L_1-\bar{L}_1)}[I-p\bar{C}-r\bar{Q}-W_M\bar{L}_1-W_W\bar{L}_2]$

(vii) $W_W(L_2-\bar{L}_2) = \frac{\beta_{L2}}{(L_2-\bar{L}_2)}[I-p\bar{C}-r\bar{Q}-W_M\bar{L}_1-W_W\bar{L}_2]$

where $A = (\beta_N + \beta_Q + \beta_C + \beta_{L1} + \beta_{L2})$

Define $Z = I-p\bar{C}-r\bar{Q}-W_M\bar{L}_1-W_W\bar{L}_2$ as the "discretionary" income available to the household for the consumption of household commodities. Note also that in equations 6.4(iv) and 6.4(v) we have taken total expenditure on child schooling and child leisure as the dependent variable.

For purposes of estimation, the demand equations in (6.4) seem to require explicit measures of leisure of different categories and that can only be obtained by making an arbitrary assumption about the value of Ω, the total time available to each group of household members. Thus, the measurement of leisure can be obtained as a residual after deducting time required for income earning and other time-consuming activities from total available time, Ω, which involves a potential specification error. As Barnum and Squire (1979) observed, in deriving the supply curve of labour from the demand curve for leisure in this way, the results necessarily are sensitive to the assumption of the length of working day, i.e, Ω.

Since from a policy point of view, it is the supply curve of labour rather than the demand curve for leisure that is important, it is desirable to obtain direct estimates of the labour supply functions. Fortunately following Abbott and Ashenfelter (1976), the linear expenditure system (LES) does allow us to obtain a direct estimate of the labour supply function for each category of labour once we recognize that it is the maximum "feasible" hours out of total available hours that is crucial for deriving the labour supply function. We define

$$\bar{\gamma}_1 \equiv N_1\Omega_M-\bar{L}_1$$
$$\bar{\gamma}_2 \equiv N_2\Omega_W-\bar{L}_2$$
$$\bar{\gamma}_3 \equiv N\Omega_C-\bar{L}_3,\ \bar{L}_3 = N\bar{\ell}_3$$

as the maximum "feasible" working man-days in a year available for allocating to different activities by adult males, adult females, and minor members of the households, respectively.

We can therefore, substitute $N_1\Omega_M-\bar{\gamma}_1$ for $\bar{L}_1$, $N_2\Omega_W-\bar{\gamma}_2$ for $\bar{L}_2$, $N\Omega_C-\bar{\gamma}_3$ for $\bar{L}_3$ as well as $N_1\Omega_M-L_1 = H_1 + D_1 = S_1$, $N_2\Omega_W-L_2 = H_2 + D_2 + Nt_{NW} = S_2 + Nt_{NW}$, $N\Omega_C-L_3 = H_3 + D_3 + NEt_{EC} = S_3 + NEt_{EC}$ [from the time constraints (6.1(v)-6.1(vii)] into the demand system (6.4). Here S_1 is the labour supply of adult males, S_2 is the labour supply of adult females, S_3 is the labour supply of minor members of the household, t_{NW}, t_{EC} are the marginal (=average) fixed coefficients associated with the production functions of N and E respectively. Let us also define NE=e as the total schooling of minor children in the household.

These substitutions yield:

(6.5) (i) $$pC = p\bar{C} + \frac{\beta_C}{A}[Y + W_M\bar{\gamma}_1 + W_W\bar{\gamma}_2-p\bar{C}-r\bar{Q}]$$

(ii) $$rQ = r\bar{Q} + \frac{\beta_Q}{A}[Y + W_M\bar{\gamma}_1 + W_W\bar{\gamma}_2-p\bar{C}-r\bar{Q}]$$

$$\text{(iii)} \quad N(P_N x_N + W_W t_{NW}) = -\pi_E \bar{e} + W_C \bar{\gamma}_3 + \frac{(\beta_N - \beta_E - \beta_{\ell 3})}{A} [Y + W_M \bar{\gamma}_1 + W_W \bar{\gamma}_2 - p\bar{C} - r\bar{Q}]$$

$$\text{(iv)} \quad \pi_E e = \pi_E \bar{e} + \frac{\beta_E}{A} [Y + W_M \bar{\gamma}_1 + W_W \bar{\gamma}_2 - p\bar{C} - r\bar{Q}]$$

$$\text{(v)} \quad W_C(S_3 + et_{EC}) = W_C \bar{\gamma}_3 - \frac{\beta_{\ell 3}}{A} [Y + W_M \bar{\gamma}_1 + W_W \bar{\gamma}_2 - p\bar{C} - r\bar{Q}]$$

$$\text{(vi)} \quad W_M S_1 = W_M \bar{\gamma}_1 - \frac{\beta_{L1}}{A} [Y + W_M \bar{\gamma}_1 + W_W \bar{\gamma}_2 - p\bar{C} - r\bar{Q}]$$

$$\text{(vii)} \quad W_W(S_2 + Nt_{NW}) = W_W \bar{\gamma}_2 - \frac{\beta_{L2}}{A} [Y + W_M \bar{\gamma}_1 + W_W \bar{\gamma}_2 - p\bar{C} - r\bar{Q}]$$

where $Y = N(P_N x_N) + NEP_E x_E + pC + rQ - W_M S_1 - W_W S_2 - W_C S_3$ is total expenditure less labour (farm) earnings.

The above equations, after the addition of error terms, can be directly estimated with the available data. Following Abbott and Ashenfelter (1976), if we consider $Y + W_M \bar{\gamma}_1 + W_W \bar{\gamma}_2$ as the "feasible" full income, then in effect equations 6.5(i) - 6.5(iv) turn full income into an estimatable quantity while 6.5(v) - 6.5(vii) requires that the household as a group set aside the fraction $\frac{\beta_{L3}}{A}$, $\frac{\beta_{L1}}{A}$, and $\frac{\beta_{L2}}{A}$ of its "discretionary" income for leisure time. As we see the system, (6.5), parameters $\bar{\gamma}_1$, $\bar{\gamma}_2$, $\bar{C}$, $\bar{Q}$ appear in each equation while parameters $\bar{e}$, $\bar{\gamma}_3$ only appear in equations [6.5(iii), 6.5(iv) and 6.5(v)] that are associated with quantity and quality of minor children. Moreover, the distribution of β parameters are constrained by the relations:

$$\frac{\beta_C}{A} + \frac{\beta_Q}{A} + \frac{\beta_N}{A} + \frac{\beta_{L1}}{A} + \frac{\beta_{L2}}{A} = 1$$

and $\frac{\beta_N}{A} > (\frac{\beta_E}{A} + \frac{\beta_{\ell 3}}{A})$ for N to be positive. That is to say, an estimate of $\frac{\beta_{L2}}{A}$ can be obtained from the estimates of $\frac{\beta_C}{A}$, $\frac{\beta_Q}{A}$, $\frac{\beta_N}{A}$ and $\frac{\beta_{L1}}{A}$.

We can represent the system (6.5) in matrix form as follows:

(6.6) $\theta = \beta B + \psi P$,

where

$$\theta = \begin{bmatrix} pC \\ rQ \\ N(P_N x_N + W_W t_{NW}) \\ e\pi_E \\ W_C(S_3 + et_{EC}) \\ W_M S_1 \\ W_W(S_2 + Nt_{NW}) \end{bmatrix} \quad \beta = \begin{bmatrix} \frac{\beta_C}{A} \\ \frac{\beta_Q}{A} \\ (\frac{\beta_N - \beta_E - \beta_{\ell 3}}{A}) \\ \frac{\beta_E}{A} \\ \frac{-\beta_{\ell 3}}{A} \\ \frac{-\beta_{L1}}{A} \\ \frac{-\beta_{L2}}{A} \end{bmatrix}$$

$$B = \begin{bmatrix} Y & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & Y & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & Y & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & Y & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & Y & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & Y & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & Y \end{bmatrix}$$

$$\Psi = \begin{bmatrix} p(1-\frac{\beta_C}{A}) & -r\frac{\beta_C}{A} & 0 & 0 & W_M\frac{\beta_C}{A} & W_W\frac{\beta_C}{A} \\ -p\frac{\beta_Q}{A} & r(1-\frac{\beta_Q}{A}) & 0 & 0 & W_M\frac{\beta_Q}{A} & W_W\frac{\beta_Q}{A} \\ -p\frac{(\beta_N-\beta_E-\beta_{\ell 3})}{A} & -r\frac{(\beta_N-\beta_E-\beta_{\ell 3})}{A} & -\pi_E & W_C & W_M\frac{(\beta_N-\beta_E\beta_{\ell 3})}{A} & W_W\frac{(\beta_N-\beta_E-\beta_{\ell 3})}{A} \\ -p\frac{\beta_E}{A} & -r\frac{\beta_E}{A} & \pi_E & 0 & W_M\frac{\beta_E}{A} & W_W\frac{\beta_E}{A} \\ p\frac{\beta_{\ell 3}}{A} & r\frac{\beta_{\ell 3}}{A} & 0 & W_C & -W_M\frac{\beta_{\ell 3}}{A} & -W_W\frac{\beta_{\ell 3}}{A} \\ p\frac{\beta_{L1}}{A} & r\frac{\beta_{L1}}{A} & 0 & 0 & W_M(1-\frac{\beta_{L1}}{A}) & -W_W\frac{\beta_{L1}}{A} \\ p\frac{\beta_{L2}}{A} & r\frac{\beta_{L2}}{A} & 0 & 0 & -W_M\frac{\beta_{L2}}{A} & W_W(1-\frac{\beta_{L2}}{A}) \end{bmatrix}$$

$$\text{and } P = \begin{bmatrix} \bar{C} \\ \bar{Q} \\ \bar{e} \\ \bar{\gamma}_3 \\ \bar{\gamma}_1 \\ \bar{\gamma}_2 \end{bmatrix}$$

Since observations on $\bar{C}$, $\bar{Q}$, $\bar{e}$ and γ's are not directly obtainable, we can express these parameters as functions of household characteristics, such as the number of adult males (N_1), number of adult females (N_2), years of schooling of the household head (s), and age of the household head (a). In particular, the matrix P can be rewritten as a function of household characteristics, i.e,

$$P = \alpha H',$$

where

$$\alpha = \begin{bmatrix} \delta_1 & \alpha_{11} & \alpha_{12} & \alpha_{13} & \alpha_{14} \\ \delta_2 & \alpha_{21} & \alpha_{22} & \alpha_{23} & \alpha_{24} \\ \delta_3 & \alpha_{31} & \alpha_{32} & \alpha_{33} & \alpha_{34} \\ \delta_4 & \alpha_{41} & \alpha_{42} & \alpha_{43} & \alpha_{44} \\ \delta_5 & \alpha_{51} & \alpha_{52} & \alpha_{53} & \alpha_{54} \\ \delta_6 & \alpha_{61} & \alpha_{62} & \alpha_{63} & \alpha_{64} \end{bmatrix}$$

$$H' = \begin{bmatrix} 1 \\ N_1 \\ N_2 \\ s \\ a \end{bmatrix}$$

Thus, the final estimating equations are;

$$(6.7) \quad \theta = \beta B + \psi \alpha H'$$

The estimation of (6.7) proceeds using the Full-information Maximum Likelihood (FIML) method under the assumption that the error terms of the equations in 6.7 are from a multivariate normal distribution with mean zero.[3] The data for these equations are described in detail in Appendix VI.A.

Based on the results of the production relations in Chapter Five, which showed that production technologies were different for each village in our study, we have estimated separate demand equations for each of the villages. This allows us to integrate resource allocation and consumption behaviour together so as to derive some policy implications of the farm household model (see Chapter Seven). Our interest in this chapter is to estimate the linear demand functions as contained in 6.7. However, computation of the maximum likelihood estimates of the structural parameters in system (6.7) requires initial values of those parameters. To this end, our estimation strategy proceeds as follows.

Recognizing that $\psi\alpha$ is the matrix of the reduced-form parameters of the demand system (6.7), Ordinary Least Squares (OLS) is applied separately to each equation of (6.7) to obtain initial values of the $\psi\alpha$ matrix under the assumption that the disturbance terms in each equation are independent and have zero means and uniform variances. Then the system (6.7) is estimated by the FIML method with the restriction that $\frac{\beta_C}{A} + \frac{\beta_Q}{A} + \frac{\beta_N}{A} + \frac{\beta_{L1}}{A} + \frac{\beta_{L2}}{A} = 1$ and with the initial values of those parameters and coefficients obtained by OLS in order to get the maximum likelihood estimates of the reduced-form parameters. The FIML estimates of these parameters are presented in Appendix VI.B. These will be of particular interest when calculating the effects of household characteristics, such as the number of adult males (N_1), number of adult females (N_2), education (s) and age (a) of the household head on the commodity demand and labour supply functions. Also from the estimates of reduced-form parameters, we can obtain the initial values of the structural parameters, such as the δ's and the α's in (6.7). With these initial values, we form β and $\psi\alpha$ matrices and run the system (6.7) by FIML method in order to obtain estimates of the structural parameters.

Table 6.1 presents maximum likelihood estimates of the structural parameters of the system (6.7). As one can see from this table, a large number of parameters (about 50%) are estimated with tolerable statistical precision, some of which are significantly different from zero at a 90 percent confidence level. To a certain extent, however, there is some variation in coefficient signs as well as in the significance levels of structural parameters for the two villages of our study. All but a few marginal budget shares ($\frac{\beta_i}{A}$) of commodities and of labour supply in both villages have significant coefficients. Some of the signs of the α coefficients which measure the effects of household characteristics on minimum consumption needs for commodities and maximum "feasible" working days for different categories of labour may have some plausible interpretations. For instance, in both villages

Table 6.1: Maximum Likelihood Estimates of Linear Expenditure System (6.7)

Coefficients	Estimates		T-Statistic	
	Hamsadi	Khilgati	Hamsadi	Khilgati
δ_1	-4392.63	15028.6	-.98	1.56*
δ_2	-18906.0	-10935.5	-1.19	-1.31*
δ_3	-458.37	-339.49	-1.28*	-.77
δ_4	249.58	1779.03	.28	1.29*
δ_5	2926.96	107.4	2.03*	.17
δ_6	-2926.96	-107.4	-2.03*	-.17
α_{11}	752.51	1662.57	.48	1.23*
α_{12}	-678.85	-2305.52	-.39	-1.33*
α_{13}	367.44	845.10	2.56*	1.70*
α_{14}	91.95	-1.64	1.04	-.02
α_{21}	-8305.92	1006.64	-1.58*	.72
α_{22}	-8634.37	-3023.23	-1.54*	-1.75*
α_{23}	573.09	557.24	.68	1.21*
α_{24}	186.15	-57.02	.49	-.42
α_{31}	50.19	263.19	.57	3.27*
α_{32}	-273.84	-27.88	-1.99*	-.27
α_{33}	43.72	21.86	3.02*	.77
α_{34}	8.19	.05	1.17	.006
α_{41}	302.4	57.44	1.04	.22
α_{42}	-950.99	-423.72	-2.55*	-1.15
α_{43}	95.27	207.9	2.36*	2.62*
α_{44}	13.97	-1.68	.93	-.063

Table 6.1 Cont..

Coefficients	Estimates		T-Statistic	
	Hamsadi	Khilgati	Hamsadi	Khilgati
α_{51}	84.67	-65.49	.14	.76
α_{52}	-678.01	-343.53	-.90	-2.53*
α_{53}	-195.52	4.01	-4.66*	.14
α_{54}	-18.10	.78	-1.31*	.09
α_{61}	-84.67	65.49	-.14	.76
α_{62}	678.0	343.53	.91	2.53*
α_{63}	195.52	-4.01	4.66*	-.14
α_{64}	18.10	-.78	1.31*	-.09
$\beta_{\frac{C}{A}}$	.25	.57	53.24*	80.54*
$\beta_{\frac{q}{A}}$	.75	.43	156.11*	59.87*
$\beta_{\frac{N}{A}}$	.11	.11	2.28*	3.69*
$\beta_{\frac{E}{A}}$	.01	.004	1.28*	.44
$\beta_{\frac{\ell 3}{A}}$	-.04	-.07	-2.53*	-4.21*
$\beta_{\frac{L1}{A}}$	-.03	-.07	-.43	-3.72*
$\beta_{\frac{L2}{A}}$	-.06	-.01	-2.11	-.72

*Asterisk refers to estimates that are significantly different from zero at a 90 per cent confidence level.

it appears that an increase in the number of adult males in the household may lead to an increase in the minimum consumption needs of farm goods, schooling and/or maximum feasible working days of adult and minor workers in the household. On the contrary, it seems to be true for both villages that an increase in the number of adult females increases the maximum feasible working days with depressing effects on minimum consumption needs for child schooling. Thus, any plausible interpretation may be given depending on the signs of the coefficients. However, the over all effects of these household characteristics on commodity demand and labour supply functions which are of particular interest for policy implications are more important than their individual effects on the minimum consumption needs of goods. Therefore, to show the importance of those estimates of table 6.1 on commodity demand and labour supply functions, we calculate the elasticity of the endogeneous variables with respect to some selected variables and present them with plausible interpretations, in the next section.

6.3 Household Response Elasticities with Total Expenditure Net of Labour Earnings Treated as An Exogeneous Variable

The response elasticities of all seven endogeneous variables, C, Q, N, e, S_3, S_1 and S_2 with respect to the price of farm goods (p), the price of non-farm goods (r), wage rates W_M, W_W, W_C, the number of adult males (N_1), the number of adult females (N_2), the education (s) and age (a)

Table 6.2: Elasticities of Household Response with Respect to Exogeneous Variables with Total Expenditure Less Labour Earnings Assumed Constant

Variables	Village	Elasticities						
		Consumption of farm products	Consumption of non-farm products	Number of minor children	Level of child schooling	Minor Labour Supply	Adult Male Labour supply	Adult female labour supply
Price of agricultural products (p)	Hamsadi	-.88	-.27	-.04	-.06	-.10	-.03	-.36
	Khilgati	-.57	-1.04	-.44	-.13	-2.58	-.43	2.64
Price of non-farm goods (r)	Hamsadi	.65	-2.43	.68	.91	1.60	.49	5.37
	Khilgati	.51	-2.22	.39	.12	2.28	.38	-2.33
Adult Male wage rate (W_M)	Hamsadi	.01	.04	.01	.01	.002	-.86	.02
	Khilgati	-.02	-.04	-.02	-.005	-.09	-1.25	.13
Adult female wage rate (W_W)	Hamsadi	-.01	-.04	-.28	-.01	-.002	-.004	-6.47
	Khilgati	.02	.04	.02	.005	.09	.02	-5.20
Minor labour wage rate (W_C)	Hamsadi	-	-	.09	-.44	-1.30	-	-
	Khilgati	-	-	.22	-.11	.16	-	-
Number of adult males (N_1)	Hamsadi	.18	-.39	.20	.75	-2.85	.30	2.24
	Khilgati	.0004	-.01	-.19	1.27	-5.06	-.12	2.02
Number of adult females (N_2)	Hamsadi	.21	-.46	.21	-.74	.93	-.09	6.80
	Khilgati	.08	-.19	.11	-.08	.02	.06	4.08

Table 6.2 Cont.

Variables	Village	Elasticities						
		Consumption of farm products	Consumption of non-farm products	Number of minor children	Level of child schooling	Minor Labour Supply	Adult Male Labour Supply	Adult female labour supply
Education of the household head (s)	Hamsadi	.01	-.03	-.04	.36	-.65	-.31	1.09
	Khilgati	.01	-.02	-.01	.11	.39	-.11	-.24
Age of the household head (a)	Hamsadi	.05	-.11	-.22	.67	-2.70	-.58	.93
	Khilgati	.11	-.27	.09	-.03	.47	.08	1.26
Total Expenditure (Y)	Hamsadi	.36	2.40	.38	.51	.89	.28	3.01
	Khilgati	.81	1.46	.62	.18	3.66	.60	-3.70

Note: Using the formulas in Table 6.3 and parameter values from Table 6.1, all elasticities are computed at the arithmetic mean of variables and under the assumption that Y is independent of all prices and wages.

Table 6.3: Elasticity Formulas for all Seven Endogeneous Variables with Respect to Prices, Wages, Expenditure and Household Characteristics

a) With Respect to Price of farm goods (p)

$$\varepsilon_{Cp} = -1\left(1-\frac{\beta_C}{A}\right)\frac{\bar{C}}{C}$$

$$\varepsilon_{Qp} = -\frac{\beta_Q}{A}\;\frac{p\bar{C}}{rQ}$$

$$\varepsilon_{Np} = -\left(\frac{\beta_N-\beta_E-\beta_{\ell 3}}{A}\right)\left(\frac{p\bar{C}}{N\pi_N}\right)$$

$$\varepsilon_{ep} = -\frac{\beta_E}{A}\left(\frac{p\bar{C}}{\pi_E e}\right)$$

$$\varepsilon_{S3p} = \frac{\beta_{\ell 3}}{A}\left(\frac{p\bar{C}}{W_C S_3}\right)-\left(\frac{W_C t_{EC} e}{W_C S_3}\right)\varepsilon_{ep}$$

$$\varepsilon_{S1p} = \frac{\beta_{L1}}{A}\left(\frac{p\bar{C}}{W_M S_1}\right)$$

$$\varepsilon_{S2p} = \frac{\beta_{L2}}{A}\left(\frac{p\bar{C}}{W_W S_2}\right)-\left(\frac{W_W N t_{NW}}{W_W S_2}\right)\varepsilon_{Np}$$

b) With Respect to Price of non-farm goods (r)

$$\varepsilon_{Cr} = -\frac{\beta_C}{A}\;\frac{r\bar{Q}}{pC}$$

$$\varepsilon_{Qr} = -1+\left(1-\frac{\beta_Q}{A}\right)\frac{\bar{Q}}{Q}$$

$$\varepsilon_{Nr} = -\left(\frac{\beta_N-\beta_E-\beta_{\ell 3}}{A}\right)\left(\frac{r\bar{Q}}{N\pi'_N}\right)$$

$$\varepsilon_{er} = -\frac{\beta_E}{A}\left(\frac{r\bar{Q}}{\pi_E e}\right)$$

$$\varepsilon_{S3r} = \frac{\beta_{\ell 3}}{A}\left(\frac{r\bar{Q}}{W_C S_3}\right)-\left(\frac{W_C t_{EC} e}{W_C S_3}\right)\varepsilon_{er}$$

$$\varepsilon_{S1r} = \frac{\beta_{L1}}{A}\left(\frac{r\bar{Q}}{W_M S_1}\right)$$

$$\varepsilon_{S2r} = \frac{\beta_{L2}}{A}\left(\frac{r\bar{Q}}{W_W S_2}\right)-\left(\frac{W_W N t_{NW}}{W_W S_2}\right)\varepsilon_{Nr}$$

c) With Respect to Adult Male Wage (W_M)

$$\varepsilon_{CW_M} = \frac{\beta_C}{A}\;\frac{W_M\bar{Y}_1}{pC}$$

$$\varepsilon_{QW_M} = \frac{\beta_Q}{A}\;\frac{W_M\bar{Y}_1}{rQ}$$

$$\varepsilon_{NW_M} = \left(\frac{\beta_N-\beta_E-\beta_{\ell 3}}{A}\right)\frac{W_M\bar{Y}_1}{N\pi'_N}$$

d) With Respect to Adult Female wage (W_W)

$$\varepsilon_{CW_W} = \frac{\beta_C}{A}\;\frac{W_W\bar{Y}_2}{pC}$$

$$\varepsilon_{QW_W} = \frac{\beta_Q}{A}\;\frac{W_W Y_2}{rQ}$$

$$\varepsilon_{NW_W} = \left(\frac{\beta_N-\beta_E-\beta_{\ell 3}}{A}\right)\frac{W_W\bar{Y}_2}{N\pi'_N}-\left(\frac{W_W t_{NW}}{\pi'_N}\right)$$

Table 6.3 Cont.

c) With Respect to Adult Male Wage (W_M)

$$\varepsilon_{eW_M} = \frac{\beta_E}{A}\frac{W_M\bar{\gamma}_1}{\pi_E e}$$

$$\varepsilon_{S3W_M} = -\frac{\beta_{\ell 3}}{A}\frac{W_M\bar{\gamma}_1}{W_C S_3} - \left(\frac{W_C e t_{EC}}{W_C S_3}\right)\varepsilon_{eW_M}$$

$$\varepsilon_{S1W_M} = \left(\frac{1-\beta_{L1}}{A}\right)\frac{\bar{\gamma}_1}{S_1} - 1$$

$$\varepsilon_{S2W_M} = \frac{-\beta_{L2}}{A}\frac{W_M\bar{\gamma}_1}{W_W S_2} - \left(\frac{W_W N t_{NW}}{W_W S_2}\right)\varepsilon_{NW_M}$$

d) With Respect to Adult Female Wage (W_W)

$$\varepsilon_{eW_W} = \frac{\beta_E}{A}\frac{W_W\bar{\gamma}_2}{\pi_E e}$$

$$\varepsilon_{S3W_W} = \frac{-\beta_{\ell 3}}{A}\frac{W_W\bar{\gamma}_2}{W_C S_3} - \left(\frac{W_C e t_{EC}}{W_C S_3}\right)\varepsilon_{eW_W}$$

$$\varepsilon_{S1W_W} = \frac{\beta_{L1}}{A}\frac{W_W\bar{\gamma}_2}{W_M S_1}$$

$$\varepsilon_{S2W_W} = \left(\frac{1-\beta_{L2}}{A}\right)\frac{\bar{\gamma}_2}{S_2} - 1 - \left(\frac{W_W N t_{NW}}{W_W S_2}\right)(1 + \varepsilon_{NW_W})$$

e) With Respect to Minor Wage (W_C)

$$\varepsilon_{NW_C} = \frac{W_C\bar{\gamma}_3}{N\pi_N'} - \frac{\pi_E\bar{e}}{N\pi_N'}\left(\frac{W_C t_{EC}}{\pi_E}\right)$$

$$\varepsilon_{eW_C} = \left(\frac{\pi_E\bar{e}}{\pi_E e} - 1\right)\left(\frac{W_C t_{EC}}{\pi_E}\right)$$

$$\varepsilon_{S3W_C} = -1 + \frac{W_C\bar{\gamma}_3}{W_C S_3} - \left(\frac{W_C e t_{EC}}{W_C S_3}\right)(1+\varepsilon_{eW_C})$$

f) With Respect to Total (exog.) Expenditure (Y)

$$\varepsilon_{CY} = \frac{\beta_C}{A}\frac{Y}{\bar{p}C}$$

$$\varepsilon_{QY} = \frac{\beta_Q}{A}\frac{Y}{rQ}$$

$$\varepsilon_{NY} = \left(\frac{\beta_N - \beta_E - \beta_{\ell 3}}{A}\right)\frac{Y}{N\pi_N'}$$

$$\varepsilon_{eY} = \frac{\beta_E}{A}\frac{Y}{\pi_E e}$$

$$\varepsilon_{S3Y} = \frac{-\beta_{\ell 3}}{A}\frac{Y}{W_C S_3} - \frac{(W_C e t_{EC})}{W_C S_3}\varepsilon_{eY}$$

$$\varepsilon_{S1Y} = \frac{-\beta_{L1}}{A}\frac{Y}{W_M S_1}$$

Table 6.3 Cont.

f) With Respect to Total (exog.) Expenditure (Y)

$$\varepsilon_{S2Y} = \frac{-\beta_{L2}}{A}\frac{Y}{W_W S_2} - \left(\frac{W_W N t_{NW}}{W_W S_2}\right)\varepsilon_{NY}$$

g) With Respect to Household Characteristics, $i=N_1, N_2$, s, a

$$\varepsilon_{Ci} = \{\alpha_{1j} + \frac{\beta_C}{A}(\alpha_{5j} + \alpha_{6j} - \alpha_{1j} - \alpha_{2j}\}\frac{i}{pC}$$

$$\varepsilon_{Qi} = \{\alpha_{2j} + \frac{\beta_Q}{A}(\alpha_{5j} + \alpha_{6j} - \alpha_{1j} - \alpha_{2j})\}\frac{i}{rQ}$$

$$\varepsilon_{Ni} = \{\alpha_{4j} - \alpha_{3j} + \frac{(\beta_N - \beta_E - \beta_{\ell 3})}{A}(\alpha_{5j} + \alpha_{6j} - \alpha_{1j} - \alpha_{2j})\}\frac{i}{N\pi_N'}$$

$$\varepsilon_{ei} = \{\alpha_{3j} + \frac{\beta_E}{A}(\alpha_{5j} + \alpha_{6j} - \alpha_{1j} - \alpha_{2j})\}\frac{1}{e\pi_E}$$

$$\varepsilon_{S3i} = \{\alpha_{4j} - \frac{\beta_{\ell 3}}{A}(\alpha_{5j} + \alpha_{6j} - \alpha_{1j} - \alpha_{2j})\}\frac{i}{W_C S_3} - \left(\frac{W_C e t_{EC}}{W_C S_3}\right)\varepsilon_{ei}$$

$$\varepsilon_{S1j} = \{\alpha_{5j} - \frac{\beta_{L1}}{A}(\alpha_{5j} + \alpha_{6j} - \alpha_{1j} - \alpha_{2j})\}\frac{i}{W_M S_1}$$

$$\varepsilon_{S2i} = \{\alpha_{6j} - \frac{\beta_{L2}}{A}(\alpha_{5j} + \alpha_{6j} - \alpha_{1j} - \alpha_{2j})\}\frac{i}{W_W S_2} - \left(\frac{W_W N t_{NW}}{W_W S_2}\right)\varepsilon_{Ni}$$

where $i = N_1, N_2$, s, a

$j = 1, 2, 3, 4, 5, 6$

$\pi_N' = (P_N x_N + t_{NW} W_W)$

Note: All elasticities are calculated on the assumption that total "net" expenditure (Y) is independent of all prices and wages as well as N_1 and N_2.

of the household head are presented in Table 6.2. All elasticities are computed at the arithmetic mean of variables under the assumption that total expenditure on all consumption items less implicit and explicit labour earnings, Y, remains constant. That is to say, the augmented concept of full income, $I = \Pi + W_M N_1 \Omega_M + W_W N_2 \Omega_W + G$, is held constant. In other words, here we are presenting elasticities which include the conventional substitution and income effects and also the "endowment" effects in a labour supply problem. Our analysis of these household response elasticities will follow next with occasional reference to some similar analyses done for other countries.[4]

We shall consider first the expenditure elasticities of different consumption commodities. For both villages, the expenditure elasticity for consumption farm goods (.36 in Hamsadi and .81 in Khilgati) is positive but less than one indicating that the demand for agricultural products for consumption with respect to income is inelastic, whereas, the elasticity for non-farm goods with respect to income (2.40 in Hamsadi and 1.46 in Khilgati) is greater than one, indicating that the income elasticity of demand for non-farm goods is high. These results correspond to the results obtained by Barnum and Squire (1979) for Malaysia. The expenditure elasticity for the number of minor children and that for the level of child schooling in both villages are positive but less than one (.38 and .51 respectively for Hamsadi, .62 and .18 respectively for Khilgati) indicating that expenditure for child investment goods is income inelastic. However, one interesting relationship between these two elasticities for each village is worth notable: where the expenditure elasticity of minor children is high, the corresponding expenditure elasticity of child schooling is low and vice versa. This suggests that there is a trade-off between quantity and quality of minor children conformable to the expectation that quantity and quality of minor children may be inversely related.

The expenditure elasticity of the adult male labour supply to agricultural activities in both villages is positive but less than one (.28 in Hamsadi and .60 in Khilgati) which may indicate that the implied income elasticity of leisure is negative and hence that adult male leisure is an inferior good.

As we can see from the formula for expenditure elasticity of minor labour supply (ε_{S3Y}) in table 6.3, this elasticity is adjusted by the expenditure elasticity of child schooling, because apart from leisure and income earning activity, the minor children may also pursue schooling which might compete with income earning activities. Therefore, it follows that the larger is the expenditure elasticity of child schooling and hence the larger is the total expenditure on schooling, the lower is the expenditure elasticity of minor labour supply. The reason is that the larger expenditure elasticity of child schooling implies a lower minor labour supply to farm activity, so that income earned is lower and income foregone will be higher which together depresses the expenditure elasticity of minor labour supply. Thus, the fact that the expenditure elasticity of child schooling is higher in

Hamsadi (.51) than in Khilgati (.18) which implies lower expenditure elasticity of minor labour supply in Hamsadi (.89) but larger elasticity for Khilgati (3.66). It follows, therefore, that the higher is the productive role of minor children in income earning activity, the lower is the child schooling rate.

Similarly, for the reason that female members of the household bear the major burden for raising minor children, the expenditure elasticity of the female labour supply is related to the expenditure elasticity of minor children (see ε_{S2Y} in table 6.4). Thus, it follows that the higher is the expenditure elasticity of minor children, the lower will be the expenditure elasticity of female labour supply. Even in the case where the productive role of female members in income earning activity is minimal and the child raising role is the primary one, there is good chance that the cost of raising children may outweigh the positive contribution of female labour in income earning activities and hence the expenditure elasticity of female labour supply may become negative. Actually, that has happened in one village, Khilgati, where the negative expenditure elasticity of female labour supply (-3.70) implies that the productive role of women in income earning activities in this village is minimal and that their primary role lies in raising minors. On the contrary, the productive role of female workers in Hamsadi (expenditure elasticity of female labour supply is 3.01) is higher than their counterparts in Khilgati.

Now we turn to the own-price elasticities of different goods. The own-price elasticities of farm goods in both villages (-.88 in Hamsadi and -.57 in Khilgati) appear to be low compared to the own-price elasticities of non-farm goods (-2.43 in Hamsadi, -2.22 in Khilgati) which are considerably higher indicating that farm goods are necessary items of consumption while non-farm goods are not. This sounds quite plausible. In fact, evidence from Malaysia reinforces this pattern [Barnum and Squire (1979)]. The own-price elasticity of labour supply of different categories of labour appear to be quite different for the two villages. For instance, the own-price elasticity of adult male labour supply which is -.86 in Hamsadi and -1·25 in Khilgati indicates that for both villages adult male labour supply responds negatively to the wage rate but inelastically in Hamsadi and elastically in Khilgati. This implies further that even taking into account the "endowment" effects the supply curve for adult male labour is backward bending.[5] On the other hand, the own-price elasticity of minor labour supply is -1.30 in Hamsadi and .16 in Khilgati. Finally, the own-price elasticity of female labour supply is -6.47 in Hamsadi and -5.20 in Khilgati respectively, implying that female labour supply responds negatively and elastically to changes in the female wage rate.

The linear expenditure system imposes the restriction that all own-price elasticities bear an approximate linear relationship to expenditure elasticities [see, Deaton (1974)]. To test this alleged proportionality rule, we calculate this proportional ratios for C, Q, S_3, S_1 and S_2, we find that the ratios of the own-price to the expenditure elasticities which are -2.44, -1.01, -1.46, -3.07, -2.15 for Hamsadi and -.70, -1.52, .04, -2.08, 1.41 for Khilgati respectively, indicate that the own-price and expenditure elasticities are not related by a constant proportion. A similar finding is reported by Barnum and Squire (1979) for Malaysian farm household data. In line with the arguments put forwarded in the literature for this results, it is argued here that this alleged proportionality factor is not important, probably because of the fact that the budget share of each commodity is large but the level of disaggregation is correspondingly low [Deaton (1974), Barnum and Squire (1979)].

Our next concern is about the cross-price elasticities and the elasticities with respect to household characteristics. Since we do not have any a priori information about the sign or magnitude of these elasticities, it is difficult to make any conjectures about their effects. In fact, more than one plausible explanation may be attached to any particular elasticity. For example, an increase in the adult male wage rate may cause a positive or negative response in the consumption of farm goods. As we can see from table 6.2, an increase in the adult male wage rate has a mild positive effect on the consumption of all goods including farm goods (for Khilgati) while it reduces the consumption of all goods (for Hamsadi). Hence, the cross-price elasticity of consumption goods with respect to the price of leisure (i.e, wage rate of adult male) may be positively or negatively inelastic and both conclusions are plausible. Similarly, the cross-price elasticities of female or minor labour supply with respect to the price of adult male's leisure (i,e, W_M) may be positively or negatively elastic or inelastic.

However, one result of particular interest lies in the cross-price elasticities of child quantity (N) and child schooling (e) with respect to the minor labour wage rate (W_C) and female labour wage rate (W_W). For both villages, it follows from table 6.2 that an increase in the minor wage rate (W_C) can lead to an increase in the quantity (N) but decrease in quality (e) of minor children. This conforms to our theoretical conjecture in Chapter Three. That is to say, the cross-price elasticities of child investment goods with respect to W_C are positive for quantity but negative for quality [see, Rosenzweig and Evenson (1977) for India]. On the other hand, the cross-price elasticities of child investment goods with respect to the female wage rate (W_W) are mixed: in Hamsadi, an increase in W_W reduces both quantity and quality while in Khilgati, it increases both or has very negligible effects.

Similarly, the effects of an increased number of adult males/females can have an impact in either direction. For example, due to an increased number of adult males in the household which can be viewed as an increase in the family labour force, the family possibly can restructure its consumption pattern away from non-farm goods (-.39 in Hamsadi and -.01 in Khilgati) to farm goods (.18 in Hamsadi, .0004 in Khilgati), and can increase the adult male labour supply (2.24 in Hamsadi, 2.02 in Khilgati thereby reducing the minor labour supply to farm activity (-2.85 in Hamsadi, -5.06 in Khilgati) and increasing child schooling level (.75 in Hamsadi and 1.27 in Khilgati) by increasing child school attendance. On the other hand, an increase in the number of adult males may be viewed as increasing married couples (and hence an increase in the number of females) in the household which in turn, may increase fertility and increase the consumption allocation to minor children. By similar reasoning, an increase in the number of adult females increases the number of minor children and may increase minor labour supply by decreasing child schooling level and possibly increase female labour supply [see the relevant elasticities in Table 6.2].

As for the effects of the household head's education level on consumption goods, the results for the two villages are very similar. An increase in the level of education of the household head decreases the number of minor children possibly by decreasing fertility while increasing child schooling level by increasing consumption on child schooling and reducing minor labour supply. But simultaneously, for an increase in the level of education of the household head, the farm household may restructure its resource allocation and hence thereby reduce the adult male labour supply to agricultural activities while increasing female labour supply to such activities.

The age of the household head appears to have some predicable impacts on household consumption goods as compared to the findings of no effect for Malaysia and Taiwan [Barnum and Squire (1979), Lau, Lin and Yotopoulos (1978)]. In Khilgati, an increase in the age of the household head (which may be interpreted in terms of the demographic transition of the household structure producing larger household size over time) appears to increase the consumption of farm goods and reduce the consumption of non-farm goods, increase the number of minor children in the family, and may increase the minor labour supply to farm activities by reducing consumption on child schooling and hence schooling attendance. Also as a result of a larger family base, it may also increase both adult male and female labour supply. On the contrary, for Hamsadi, an increase in the age of the household head appears to imply a reduction in family size possibly through demographic transition (i.e, adult male sons may leave the old parental house and form a new family base) and this may be viewed as a reduction in the number of minor children and hence on their consumption. This may also mean a reduction in the minor labour supply, an increase in child schooling and increased female labour supply. But conversely, adult male labour supply is reduced which may come primarily from the household head who, because of older age, may enjoy more leisure.

6.4 Conclusions

A linear expenditure system (LES) that contains seven endogeneous variables representing demand functions for farm and non-farm goods, child investment goods, and labour supply functions has been estimated by Full-information Maximum Likelihood (FIML) method with data from two surveyed villages in Bangladesh. Since production relations were found to differ between two villages, LES's has been fitted separately for each village. However, except for some differences, the household response elasticities with respect to some selected exogeneous variables in the system among the two villages were remarkably similar. Since there is no empirical evidence from other countries for models similar to our model, the Bangladesh results cannot be compared with other findings. However, to some extent, Barnum's and Squire's (1979) reported LES elasticities with respect to some variables can be compared with our findings. We find that to a certain extent Bangladeshi farm households show responses that are similar to those of Malaysian farm households with respect to some selected variables.

However, the results reported here are primarily based on the assumption that total "net" expenditure (Y) is exogeneous to the system.

As Y can be defined as $\Pi + G$, which varies as farm profit varies, which in turn varies with wages, prices and technology, the total "net" expenditure Y is thus endogeneous to the decision process. Therefore, production conditions influence consumption decisions through farm profit Π and hence an attempt to show an interaction between production and consumption decision is valuable. An analysis of this interaction between production and consumption decisions is presented in the next chapter.

FOOTNOTES TO CHAPTER SIX

1. This choice is not entirely arbitrary. Given the choice between a direct utility function (such as Stone-Geary one that yields the linear expenditure system, LES) and the indirect utility function (that generates logarithmic linear expenditure system, LLES) one will choose the Stone-Geary utility function on practical considerations in that it is the only utility function consistent with linear expenditure and labour earnings functions [see, Abbott and Ashenfelter (1976)]. Moreover, on an empirical basis with farm household data, Barnum and Squire (1979) found LES to perform better than its counterpart LLES.

2. We can derive similar demand equations assuming $\bar{N} > 0$. This involves, however, more complicated non-linearity both in the parameters and in the variables. This, in turn, involves substantial computational problems. To the extent that $\bar{N} > 0$ may be important for policy implications, the estimation of the demand system with $\bar{N} > 0$ remains as an exercise for future research.

3. Since equation system (6.7) is a simultaneous equations system and is non-linear in parameters, FIML is chosen to estimate the model. It is the only known asymptotically efficient estimator method for models that are non-linear in their parameters. How-

ever, the FIML estimator has small sample bias [see,e,g, Maddala (1979)]. In our equation system we have 36 parameters and use 100 observations for each village. This clearly is a small sample situation.

4. Application of the linear expenditure system (LES) to farm-level data is rare. The only LES application known to the author is the Barnum and Squire (1979) study of Malyasia. Another study of farm-level consumption data is the logarithmic linear expenditure system (LLES) used by Lau et al (1978) and applied to Taiwan. To the extent that our model introduces different categories of labour supply functions and demand functions for child investment goods in the linear expenditure system, it is difficult to compare our results with the findings, of Barnum and Squire (1979) for Malaysia. However, whenever it is relevant, we shall try to refer to similar findings.

5. This result appears inconsistent with the negative income elasticity of leisure reported earlier. This apparent inconsistency is resolved if we examine the formula for the elasticity of adult male labour supply with respect to the male wage rate. This formula can produce a negative value if the maximum labour supply, $\bar{\gamma}_1$, is sufficiently smaller than the actual labour supply, S_1. Since $\bar{\gamma}_1$, is estimated indirectly [illegible] a function of household characteristics its estimated value [illegible]not exceed that of S_1. When $\bar{\gamma}_1$ is less than S_1 the "endowment" effect is smaller than the "income" effect and a backward bending supply curve of labour is possible when leisure is an inferior good.

CHAPTER SEVEN

THE INTERACTION OF PRODUCTION AND CONSUMPTION DECISIONS: IMPORTANCE FOR THE THEORY OF THE FARM HOUSEHOLD

7.1 Introduction

The theory of the farm household combines production and consumption analyses together in the context of farm household decision-making. We presented the results of production function estimates in Chapter Five. Chapter Six contained the empirical results for the linear expenditure system fitted to the farm household data of two surveyed villages in Bangladesh. In this chapter we shall present an analysis of results based on the interaction of production and consumption decisions of farm households. Given the observation that there are competitive labour markets and active labour market participation by farm households, either as net buyers or sellers of labour services, production decisions were viewed as independent of consumption decisions, where production decisions are governed by profit maximizing behaviour. Based on our empirical results in Chapter Five, it appears that farmers in both villages maximize profits and respond to price incentives.[1] This observation implies that "net" farm profit can be expressed as a function of factor prices and technology. On the other hand, the consumption responses with respect to some selected parameters, such as the prices of consumption goods, wages and expenditure, as presented in

Chapter Six, are calculated by assuming that farm profit is exogeneous. However, to the extent that, "net" farm profit is influenced by labour market conditions, output prices, and technology, it follows, therefore, that exogeneous changes in variables underlying the "net" profit function will influence household expenditure, which will in turn influence household consumption patterns.

The household demand functions as derived under the linear expenditure system can be expressed as

$$(7.1) \quad Z = Z(p,r,w,Y;\ a_i),\ Z=C,Q,N,e,S_3,S_1,\ S_2$$

where Z is a vector of the consumption of goods of different categories, p is the price of agricultural products, r is the price of non-farm goods, w is the adult male wage rate, Y is the total expenditure net of labour earnings, and a_i is a vector of household characteristics. On the other hand, "net" expenditure, Y, can be expressed as

$$(7.2) \quad Y = I-W_M N_1 \Omega_M - W_W N_2 \Omega_W = \pi(p,w,\alpha_0) + G$$

where G is non-farm income, and α_0 indicates the technological parameters of the production function, p is the output price (aggregate) and w is the wage rate of labour. Thus, the household reaction to changes in, for example, w or p consists of both a consumption response, and a production response. For example, for a change in the wage rate, w, the effect on Z is

$$(7.3)\quad \frac{dZ}{dw} = \frac{\partial Z}{\partial w} + \frac{\partial Z}{\partial Y} \cdot \frac{\partial \Pi}{\partial w}$$

Hence, the production response to a wage change is transmitted to consumption through the term $\frac{\partial \Pi}{\partial w}$. In order to comprehend the full impact of a change in the wage rate, w, we can rewrite the equation (7.3) in elasticity terms as follows:

$$(7.4)\quad \eta_Z = \varepsilon_Z + \varepsilon_{ZY}\ \varepsilon_{\Pi w} \frac{\Pi}{Y}$$

here $\eta_Z = \frac{w}{Z}\ \frac{dZ}{dw}$, $\varepsilon_Z = \frac{w}{Z}\ \frac{\partial Z}{\partial w}$, $\varepsilon_{ZY} = \frac{Y}{Z}\ \frac{\partial Z}{\partial Y}$

$\varepsilon_{\Pi w} = \frac{w}{\Pi}\ \frac{\partial \Pi}{\partial w}$.

We can interpret these elasticities in the following ways. ε_Z is the elasticity of consumption goods, Z, with respect to the wage rate, w, given that the level of farm profits is held constant. These elasticities are infact the consumption elasticities with respect to the adult male wage rate, W_M, presented in the preceding chapter. These have been calculated on the assumption that "net" expenditure (Y) is held constant. On the other hand, η_Z can be regarded as the elasticity of consumption goods, Z, with respect to w, given that farm profits are allowed to vary according to profit maximizing behaviour. The weighted production response ($\frac{\Pi}{Y}\ \varepsilon_{\Pi w}$), however, is converted to a consumption response, η_Z, via the expenditure elasticity, ε_{ZY}. It follows therefore, that a simple way of determining the significance of production decisions in the theory of the farm household lies essentially in comparing the two elasticities, η_Z, and ε_Z. In order to compare these two elasticities, we need to calculate the profit elasticity, $\varepsilon_{\Pi \bar{w}}$. The exercise can be repeated to examine other elasticity measures.

7.2 Production Function Estimates and Profit Elasticities

The results presented in Chapter Five indicate that to a large extent farm households in both villages maximize "net" profit. Accordingly, we can express "net" profit as a function of factor prices and technology. The profit equation we are interested in is an aggregate function based on aggregate output. The aggregation over individual crops is done using "net" revenue per unit of output for each crop. We further assume that the same form of profit equation as expressed in (5.3) in Chapter Five exists for aggregate outputs of the farm. That is to say, we assume that the aggregate profit equation is

$$(7.5) \qquad \Pi = (p-\sum_j P_{M_j}\alpha_j)Q-\sum_R p_R x_R$$

where Π is the aggregate "net" profit, p is the aggregate agricultural price index, Q is the total output of the multicrop farm, x_R is the total amount of variable input, R, (R=1,2,3,4).

Given the specification of the Cobb-Douglas production function as in (5.9) in Chapter Five, the "net" profit equation (7.5) can be maximized with respect to variable inputs, land, labour, chemical inputs, and bullock power. These yield the demand functions for the variable inputs as

$$(7.6) \quad x_R = \frac{\alpha_R}{p_R} (p - \sum_j P_{M_j} \alpha_j) Q, \; R = 1,2,3,4$$

where α_R is the exponent of the Rth factor in the production function.

Substituting the demand functions into the profit equation and the production function we get

$$(7.7) \quad \Pi = (1-\Sigma\alpha_R)(p-\Sigma P_{M_j}\alpha_j)Q$$

and

$$(7.8) \quad Q = [\alpha_o\{\frac{\alpha_1}{p_1} (p-\sum_j P_{M_j}\alpha_j)\}^{\alpha_1}\{\frac{\alpha_2}{p_2} (p-\sum_j P_{M_j}\alpha_j)\}^{\alpha_2}\{\frac{\alpha_3}{p_3} (p-\sum_j P_{M_j}\alpha_j)\}^{\alpha_3} \{\frac{\alpha_4}{p_4} (p-\Sigma P_{M_j}\alpha_j)\}^{\alpha_4}]^{\frac{1}{(1-\Sigma\alpha_R)}}$$

Also by substituting (7.8) into (7.7) and (7.6), we can express profit factor demands as functions of the technological parameters, α_o and α_R and the relative factor prices of all variable inputs.

We want to present some of the elasticities of profit, output and labour demand in terms of some selected variables of particular interest. These include output price, p, wage rate, w, and the parameter, α_0. However, two relevant issues are worth noting. First, as we see above, the derivations of profit, output and factor demand functions are based on the premise that farmers are successful in equating the value of marginal product of each factor to its respective price. However, we have observed in Chapter Five that while farm households in both villages do equate the value of marginal products of labour and chemical inputs to their respective prices, this is not the case for the land input. In addition, farm households in Khilgati were successful in equating the value of marginal product of bullock power with its price while their counterparts in Hamsadi were not. Therefore, the derived profit functions or factor demand functions should be adjusted for these differences from allocative efficiency. It is, of course, not difficult to introduce this adjustment factor into the analysis. We can adjust the estimated exponents (α_i) of production function by dividing each by its corresponding ω value, where ω represents the ratio of the value of marginal product to the corresponding input price. Depending on the results of tests of the allocative efficiency conditions, ω can be greater than, equal to, or less than one. Since for some of the inputs, the villages did not achieve absolute allocative efficiency for each variable factor, the profit, output or factor demand equations are expressed in terms of the adjusted exponents of the estimated production functions.[2]

Second, from the aggregate production function estimation as reported in (5.13) and (5.14) in Chapter Five, we can get only the total labour demand, but not the demand function for each category of labour. On the supply side in the linear expenditure system, we actually obtained labour supply functions for adult male, adult female, and minor child labour. Therefore, in order to compare elasticities of similar types, we need to derive demand functions for each category of labour from the total labour demand. According to the assumption of Chapter Five, the total labour X_2 is equal to the weighted average of each category of labour, such that

$$X_2 = X_{2A} + \frac{W_W}{W_M} X_{2F} + \frac{W_C}{W_M} X_{2M},$$

where X_{2A} is adult male man-days, X_{2F} is adult female man-days, X_{2M} is minor labour man-days and W_M, W_W and W_C are the prices of these three categories of labour. Since X_2 is expressed in total adult male man-days, the wage index is the wage rate of adult male workers. However, given the specification of a Cobb-Douglas production function, both in aggregate labour units and individual labour units [see (5.9) and (5.7) of Chapter Five], it is easy to express the demand for each category of labour in terms of total labour demand, i.e,

$$X_{2A} = \frac{\alpha_{2A}}{(\alpha_{2A} + \alpha_{2F} + \alpha_{2M})} X_2$$

$$X_{2F} = \frac{\alpha_{2F}}{(\alpha_{2A} + \alpha_{2F} + \alpha_{2M})} \frac{W_M}{W_W} X_2$$

$$X_{2M} = \frac{\alpha_{2M}}{(\alpha_{2A} + \alpha_{2F} + \alpha_{2M})} \frac{W_M}{W_C} X_2$$

where α_{2A}, α_{2F}, α_{2M} are the exponents of individual categories of labour as contained in equation (5.7) in Chapter Five [see Table 5.2]. Note that the production coefficients of each category of labour are positive except for female labour in Khilgati. Since a negative coefficient for any particular input into production is difficult to interpret we do not present elasticities for this category of labour in this village.[3]

Based on equations (7.6), (7.7) and (7.8) and the discussion followed therein, we derive some of the elasticities of profit, output and labour demand with respect to the output price (p), the wage rate ($w=W_M$), and the technological change parameter (α_o) and present their formulas in what follows.

(a) Elasticity of output (Q), labour demand (X_2) and profit (Π) with respect to the price of agricultural output (p):

$$\varepsilon_{Qp} = \frac{(\alpha_1 + \alpha_2 + \alpha_3 + \alpha_4)}{(1-\Sigma\alpha_R)} \frac{p}{(p-\Sigma R_{M_j}\alpha_j)}$$

$$\varepsilon_{X_{2p}} = \frac{1}{(1-\Sigma\alpha_R)} \frac{p}{(p-\Sigma P_{M_j}\alpha_j)}$$

$$\varepsilon_{X_{2A,p}} = \frac{\alpha_{2A}}{(\alpha_{2A}+\alpha_{2F}+\alpha_{2M})} \varepsilon_{X_{2p}} \left(\frac{X_2}{X_{2A}}\right)$$

$$\varepsilon_{X_{2F,p}} = \frac{\alpha_{2F}}{(\alpha_{2A}+\alpha_{2F}+\alpha_{2M})} \varepsilon_{X_{2p}} \left(\frac{X_2}{X_{2F}} \frac{W_M}{W_W}\right)$$

$$\varepsilon_{X_{2M,p}} = \frac{\alpha_{2M}}{(\alpha_{2A}+\alpha_{2F}+\alpha_{2M})} \varepsilon_{X_{2p}} \left(\frac{X_2}{X_{2M}} \frac{W_M}{W_C}\right)$$

$$\varepsilon_{\Pi p} = \frac{1}{(1-\Sigma\alpha_R)} \quad \frac{p}{(p-\Sigma P_{M_j}\alpha_j)}$$

(b) Elasticities of output (Q), labour demand (X_2), and profit (Π) with respect to the wage rate $w(=W_M)$

$$\varepsilon_{Qw} = -\frac{\alpha_2}{(1-\Sigma\alpha_R)}$$

$$\varepsilon_{X_{2w}} = \left[\frac{-\alpha_2-(1-\Sigma\alpha_R)}{(1-\Sigma\alpha_R)}\right]$$

$$\varepsilon_{X_{2A},w} = \left(\frac{\alpha_{2A}}{\alpha_{2A}+\alpha_{2F}+\alpha_{2M}}\right)(\varepsilon_{X_{2w}})\frac{X_2}{X_{2A}}$$

$$\varepsilon_{X_{2F},w} = \left(\frac{\alpha_{2F}}{\alpha_{2A}+\alpha_{2F}+\alpha_{2M}}\right)(\varepsilon_{X_{2w}}+1)\left(\frac{X_2}{X_{2F}}\frac{W_M}{W_W}\right)$$

$$\varepsilon_{X_{2M},w} = \left(\frac{\alpha_{2M}}{\alpha_{2A}+\alpha_{2F}+\alpha_{2M}}\right)(\varepsilon_{X_{2w}}+1)\left(\frac{X_2}{X_{2M}}\frac{W_M}{W_C}\right)$$

$$\varepsilon_{\Pi w} = \frac{-\alpha_2}{(1-\Sigma\alpha_R)}$$

(c) Elasticities of output (Q), labour demand (X_2) and profit (Π) with respect to the technical change parameter (α_o)

$$\varepsilon_{Q\alpha_o} = \frac{1}{(1-\Sigma\alpha_R)}$$

$$\varepsilon_{X_2\alpha_o} = \frac{1}{(1-\Sigma\alpha_R)}$$

$$\varepsilon_{X_{2A},\alpha_o} = \frac{\alpha_{2A}}{(\alpha_{2A}+\alpha_{2F}+\alpha_{2M})}\varepsilon_{X_2\alpha_o}\left(\frac{X_2}{X_{2A}}\right)$$

$$\varepsilon_{X_{2F},\alpha_o} = \left(\frac{\alpha_{2F}}{\alpha_{2A}+\alpha_{2F}+\alpha_{2M}}\right)\left(\varepsilon_{X_2\alpha_o}\right)\frac{X_2}{X_{2F}}\,\frac{W_M}{W_W}$$

$$\varepsilon_{X_{2M},\alpha_o} = \left(\frac{\alpha_{2M}}{\alpha_{2A}+\alpha_{2F}+\alpha_{2M}}\right)\left(\varepsilon_{X_2\alpha_o}\right)\frac{X_2 W_M}{X_{2M}W_C}$$

$$\varepsilon_{\Pi\alpha_o} = \frac{1}{(1-\Sigma\alpha_R)}$$

Based on the above formulas and the corresponding estimated coefficients of aggregate production function (5.9) and those of the disaggregated (in terms of labour) production function (5.7) in table 5.2 of Chapter Five, the elasticities of output, labour demand and profit with respect to the output price (p), the wage (w) and the technological parameter (α_0) are calculated and presented in Table 7.1. Note that these elasticities are based on the production coefficients of equation (5.9) of Chapter Five adjusted by the corresponding allocative efficiency parameter, ω. It is also notable from table 7.1 that the magnitudes of all elasticities are quite high, and their signs do not contradict _a priori_ expectation. For instance, an increase in the wage rate reduces profit, total labour demand, and hence output. On the other hand, _ceteris paribus_ an increase in output price (p) or in the technical change parameter (α_0) increases output, labour demand and profits. However, because the production functions in both villages exhibit almost constant returns to scale to all variable factors, the highly elastic nature of these elasticities reported in Table 7.1 is not surprising.[4] The particular

Table 7.1: Elasticities of Output, Labour Demand, and Profit with Respect to Some Selected Variables (adjusted by the allocative efficiency parameter, ω)

Variables	Output (Q)		Total labour demand (X_2)		Adult male labour demand (X_{2A})		Adult female labour demand (X_{2F})		Minor labour demand (X_{2M})		Profit (Π)	
	Hamsadi	Khilgati	Hamsadi	Khilgati	Hamsadi	Khilgati	Hamsadi	Khilgati	Hamsadi	Khilgati	Hamsadi	Khilgati
Output price (p)	8.41	4.44	9.45	5.55	8.73	5.19	15.42	-	13.66	31.13	9.45	5.55
Wage rate (w)	-4.55	-1.65	-5.55	-2.65	-5.12	-2.48	-7.43	-	-6.58	-9.25	-4.55	-1.65
Neutral technical change Parameter (α_0)	9.09	5.0	9.09	5.0	8.39	4.67	14.83	-	13.14	28.04	9.09	5.0

elasticity which we need for computing the interaction between production and consumption decisions as reflected in (7.4) is the profit elasticity.[5]

7.3 Integrating Production Responses into Consumption Elasticities

After presenting the profit elasticities in the preceding section, we are now in a position to integrate the production response with the consumption responses of Chapter Six. As one can see in equation (7.4), the importance of this interaction for the theory of the farm household is characterized by the difference between the elasticities, η_Z and ε_Z. If the computed values of η_Z and ε_Z are not significantly different from each other, either in sign or in absolute magnitude, then there is little to be gained by integrating the effects of production decisions and the consumption decisions. Examining the equation (7.4), we see that the difference between η_Z and ε_Z entirely depends on three specific elements, (i) the expenditure elasticity (ε_{ZY}), (ii) the profit elasticity and (iii) the importance of profit income in expenditure ($\frac{\Pi}{Y}$). We shall discuss the significance of these three elements later in the section.

We present in Table 7.2 consumption elasticities with respect to some variables common to the production and consumption decisions such as the price of farm products (p), the wage rate (w), and the technical change parameter (α_0)[6]. The elasticities corresponding to the row ε in table 7.2 are the relevant elasticities of table 6.2 of Chapter Six which are calculated on the assumption that farm profits, Π, are held constant.

Table 7.2: Comparison of Selected Household Response Elasticities (η and ε)

Variables	Consumption of farm-products		Consumption of non-farm products		Number of minor children		Level of child-schooling		Minor child labour supply		Adult male labour supply		Adult female labour supply	
	Hamsadi	Khilgati	Hamsadi	Khilgati	Hamsadi	Khilgati	Hamsadi	Khilgati	Hamsadi	Khilgati	Hamsadi	Khilgati	Hamsadi	Khilgati
Price of farm products (p)														
η	-.68	-.03	1.09	-.07	.18	-.03	.23	-.01	.40	-.14	.13	-.03	1.35	.18
ε	-.88	-.57	-.27	-1.04	-.04	-.44	-.06	-.13	-.10	-2.58	-.03	-.43	-.36	2.64
Wage rate (w)														
η	-.09	-.18	-.62	-.33	-.09	-.14	-.13	-.02	-.24	-.81	-.94	-1,37	-.80	.86
ε	.01	-.02	.04	-.04	.01	-.02	.01	-.005	.002	-.09	-.86	-1.25	.02	.13
Neutral technical change parameter (α_0)														
η	.20	.49	1.31	.88	.21	.37	.28	.11	.49	2.20	.15	.36	1.64	-2.22
ε	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 7.3: Consumption Elasticities (η) with Unadjusted Production Coefficients

	Consumption of farm goods	Consumption of non-farm goods	Number of minor children	Level of child schooling	Minor labour supply	Adult male labour supply	Adult female labour supply
Price of agricultural products (p)							
Hamsadi	-.63	1.39	.22	.29	.52	.16	1.73
Khilgati	.10	.18	.08	.02	.47	.07	-.44
Wage rate (w)							
Hamsadi	-.13	-.89	-.14	-.19	-.34	-.97	-1.44
Khilgati	-.20	-.36	-.15	-.04	-.89	-1.38	.93
Technical change Parameter (α_0)							
Hamsadi	.24	1.60	.25	.34	.59	.19	2.01
Khilgati	.61	1.10	.47	.14	2.75	.45	-2.78

On the other hand, the elasticities corresponding to the row η in table 7.2 represent the elasticities for situations in which farm profits are allowed to vary and exert an influence on consumption. Hence, these η elasticities are calculated by taking into account the profit elasticities of table 7.1.[7]

The elasticities η and ε shown in table 7.2 differ significantly for both villages. For Hamsadi, out of 14 pairs (η and ε) of elasticities, twelve elasticities differ with respect to sign, while the remaining two pairs of elasticities differ neither with respect to sign nor magnitude. On the other hand, for Khilgati, out of fourteen pairs of elasticities, all elasticity pairs have the same sign but each pair differs with respect to absolute magnitude. Thus, out of fourteen elasticity pairs in this latter village, six differ with respect to absolute magnitude by at least $\pm$ .40, and all except one differ by at least $\pm$ .11. It is obvious that the more dramatic the changes which occur in these elasticities with respect to signs and magnitudes, the more significant is the interaction of production and consumption decisions. Thus, from the elasticities presented in table 7.2 it appears that a theory of the farm household that attempts to integrate production and consumption decisions is appropriate for both villages.

In both villages an increase in the price of agricultural products (p), when farm profits are not allowed to vary, <u>ceteris paribus</u>, decreases consumption of virtually every good including the level of child schooling and the number of minor children, and also decreases all categories of labour supply in both villages except for female labour supply in Khilgati. But when farm profits are allowed to vary as p changes, a dramatic change occurs for one village. In Hamsadi, an increase in the price of agricultural output increases profit income which allows households to restructure their consumption behaviour by increasing consumption of non-farm goods, the level of child schooling and the number of minor children in the family and also by increasing the supply of all three categories of labour to agricultural activities. However, for the consumption of farm goods the income effect of this price change is not enough to offset the negative own-price effect, which leaves the elasticity of the consumption of farm goods still negative. On the other hand, for the village Khilgati, the positive income effect for increased profit income resulting from an output price increase is not sufficient to outweigh negative own- and cross-price effects for all consumption goods so that negative cross-price or own-price effects of the agricultural output price dominate. However, these negative effects are dampened by the positive income effect of profit income for all elasticities. Thus, when profits are allowed to exert their influence on consumption, the previous significantly negative response elasticities for the village Khilgati become mildly negative elasticities, suggesting a smaller impact of a price change of agricultural output on demand for consumption goods and on labour supply.

We observe similar effects for both villages following a wage rate increase. When farm profits are not allowed to vary with respect to changes in the wage rate, w, the value of the household's stock of labour increases which in Hamsadi allowed farm households to increase consumption of virtually every consumption good while reducing the labour supply of adult males and increasing the labour supply of adult females and minor children. But when farm profits are allowed to vary with respect to the wage rate, an increase in the wage rate reduces profit income because of increased labour costs and forces farm households of the village Hamsadi to decrease consumption of all goods and supplies of all types of labour.

On the other hand, for Khilgati a change in the wage rate, w, has mild negative effects on consumption goods and child labour supply. These magnitudes become larger (and still negative) for the case where farm profits are allowed to vary with the wage change than the case where they are not. One notable difference is that female labour responds more positively (and hence more dramatically) to changes in the adult male wage rate when Π is allowed to vary than in the case where Π is held constant.

Another interesting case is the change in consumption elasticities with respect to a change in the technical change parameter (α_0). It is obvious that a change in the technology parameter (α_0) can affect consumption only if expenditure is allowed to vary for induced change in profit income for an outward (neutral) shift of production technology. The effect of such an induced change in profits is positive for farm income which induces farm households to increase expenditure on all goods. Although households in both villages increase consumption of all goods as a result of the induced change in income, the most dramatic change occurs for the case of non-farm goods, where the positive effect is very high. To the extent that the induced effect of technology on consumption behaviour is mainly determined by the expenditure elasticity, the ultimate results of these elasticities depend on the sign and magnitude of the expenditure elasticity. As we have observed in the preceding chapter, the demand for non-farm consumption goods is highly income-elastic. Thus the observation here that, for a neutral technical change, the larger response of non-farm consumption goods is not surprising. The trade-off between quantity and quality of minor children as described in Chapter Six also prevails here following the induced income effect due to an increase in the neutral technical change parameter (α_0). Thus, it appears that when consumption decisions are made and farm profits are allowed to vary, in both villages the change in the neutral technical change parameter has more dramatic effects (higher elasticities) on consumption decisions than changes in the output price (p) or the wage rate (w).

The effect of integrating production and consumption decisions depends on the product of three terms; (i) the sign and magnitude of the expenditure elasticity (ε_{ZY}), (ii) the sign and magnitude of the elasticity of profit; and (iii) the importance of the farm profits in expenditure ($\frac{\Pi}{Y}$) [see equation (7.4)].

First, consider the term $\frac{\Pi}{Y}$ which acts as a weight in profit elasticity. We calculate $\frac{\Pi}{Y}$ as .06 for Hamsadi and .12 for Khilgati. The very low values of $\frac{\Pi}{Y}$ reflects the small contribution of farm profit to total household expenditure. We must notice that Π is "net" profit which is equivalent to "pure" profit in our analysis. Since it uses "net" revenue per crop as a measure when aggregating across crops, this procedure essentially measures only the return on fixed inputs. Moreover, since we did not consider land as a fixed input Π does not include the returns to owner-farmed land and to household labour. Thus, the low values of $\frac{\Pi}{Y}$ in both villages are not surprising. As we see in table 7.1 all of the elasticities of profit are high implying that these should have a large impact on the consumption elasticities, provided that the expenditure elasticity is not very low. In fact, given the value of $\frac{\Pi}{Y}$ and the profit elasticity, the elasticity η can be significantly different from ε (i.e, when farm profits are held constant) if the expenditure elasticity is high. Thus, for instance, we obtained higher values of η for both villages for non-farm goods, with respect to a change in the technical parameter (α_0) when expenditure elasticities of non-farm goods (2.40 in Hamsadi, and 1.46 in Khilgati) are high and the profit elasticities with respect to α_0 are also high (9.09 for Hamsadi, and 5.0 for Khilgati).

We can conclude that given the mean values of the ratio of "net" farm profits to "net" expenditure ($\frac{\Pi}{Y}$) for both villages, the integration of farm household behaviour appears to be quantitatively important if either the expenditure elasticity is large and/or the impact of a change in an exogeneous variable on farm profits is large. The converse is true if either the expenditure elasticity or the profit elasticity is low.

Taking these considerations into account, we see that the integration of production and consumption decisions produces some dramatic changes in household response elasticities, which otherwise will be ignored if analysis is mainly based on consumption decisions without taking into account the production responses of farm households. This is particularly relevant for policy implications with regard to farm household decision-making in the context of an agrarian economy. That is to say, the theory of the farm household is of particular importance for assessing the microeconomic effects of exogeneous variables, such as agricultural output price, wage rate, and technical change on farm household decision-making.

Thus, the empirical findings in this study suggest that the farm households are responsive to changes in prices and technology both in production and consumption and that this response can be explained in terms of profit maximizing behaviour in production and utility maximizing behaviour in consumption. Now the question may be raised, if farm households are efficient both in production and consumption, then why is there a need for policy intervention into the rural economy. However, one should remember that individual rationality may not always be consistent with collective rationality so that policy interventions may be desirable from a social point of view. Moreover, the analysis carried out here is purely a partial equilibrium analysis where price incentives are exogeneous at the farm household level. But at the macro level most prices are endogeneously determined so that one should consider the implications and consequences of policy intervention in a model which allows prices to be endogeneous. This requires that the micro-findings of this study must be embedded into a general equilibrium analysis where some of the price variables currently being treated as exogeneous should be allowed to be endogeneous. For instance, individual farm households may consider the wage rate as given and take decisions accordingly. But at the aggregate level when all households respond to this wage rate, their aggregate decisions influence the wage rate itself.

This implies that for deriving the full policy implications of the farm household model, one needs to incorporate our findings into a general equilibrium framework where some of the price variables are considered as endogeneously determined. This exercise, however, remains as an important task for future research.

The major conclusion of this study is that farm households are responsive to price incentives and technology both in production and consumption which suggests that the government policy interventions into a rural economy may take the form of manoeuvring these price incentives and in the provision of new technology. As we mentioned earlier, the effectiveness of any policy measure ultimately depends on the responses of the economic agents. In an agrarian economy, whether or not the policy measures of the government to promote growth in the rural sector yield positive results depends on how the farm households respond. Fortunately, our analysis suggests that the response elasticities as calculated and presented for different price variables and technology are large so that the pay-off to correctly designed policy measures may be high. Obviously, policy interventions would make no difference if the response elasticities were small.

To this extent, the analysis of Bangladesh data suggests that policy measures by the government may yield significant progress in the rural areas of Bangladesh. For instance, the response elasticity of the demand for non-farm goods to an induced income effect due to improvements in technology is found to be quite high in both study villages. This suggests that a technical improvement in agriculture, perhaps in the form of irrigation facilities combined with high yielding crop varieties, would result in increased farm income that could greatly increase the demand for non-farm goods and thus help foster economic growth in the urban sector. This finding suggests that a "rural-led" growth strategy for a country such as Bangladesh may have a large potential impact on the overall growth of the economy.

FOOTNOTES TO CHAPTER SEVEN

1. However the marginal conditions for some inputs suggest systematically under-or over-utilization. These results could be due to errors in measuring the production coefficients, misspecification of the production function, errors in the input price data, misspecification of the decision rule or violation of the competitive market assumptions.

2. Later we shall present results with unadjusted production coefficients in order to compare them with the results cited here with the adjusted production coefficients. However, as we shall see, the latter approach using unadjusted coefficients does not make any significant differences to our conclusions.

3. Theoretically the negative production coefficient for female labour suggests negative marginal productivity of women's labour. This is not a realistic result. This may imply that female labour is acting as a proxy for some unspecified variable in the production estimation, which is negatively correlated with female labour. Since this negative production relationship accounts for something other than female labour, computing elasticities from this variable is not going to be meaningful.

4. The production coefficients add to less than one which indicates that the supply curve for farm will be slightly rising. The conclusion that constant returns to scale exists follows from the sum of production coefficients being not statistically significantly different from 1.

5. Since ultimately, we shall use profit elasticities for integrating production and consumption decisions, we would like to present here the profit elasticities with respect to price (p), wage (w) and the technical change parameter (α_0) for the unadjusted production coefficients. Note here that these elasticities are biased upwards to the extent that for inputs, especially land for both villages, the value of marginal product of land is consistently less than its price.

Profit Elasticity

	Hamsadi	Khilgati
with respect to the price (p)	34.66	27.75
with respect to the wage rate (w)	-19.33	-7.25
with respect to the technical change parameter (α_0)	33.33	25.0

6. To the extent that variables such as the price of agricultural products (p), the wage rate (w) and the neutral technical change parameter (α_0) can represent the results of policy interventions by the government, these variables are considered here. The

objective here is to show what extent farm households respond to these policy interventions. This response is one of the elements necessary to predict the full general equilibrium results of policy measures.

7. One can also compute consumption elasticity (η) with unadjusted production coefficients. Thus, using the mean values of $\frac{\Pi}{Y}$, which are .02 for Hamsadi and .03 for Khilgati, and the profit elasticity of footnote 3, we present the corresponding η values for consumption elasticities as reported in table 7.3. Note that comparing these elasticities, and ε elasticities of table 7.2, our conclusions regarding the importance of production-consumption interactions in the theory of the farm household is unaffected.

CHAPTER EIGHT

SUMMARY AND CONCLUSIONS

8.1 Introduction

This chapter summarizes the results of the research on farm household decision-making in a developing economy. This research has been motivated by the potential applicability of the farm household model to the evaluation of policy interventions into the rural sector of the economy. The empirical results, obtained from data collected in two Bangladeshi villages, suggest that a farm household model that integrates the farm household's resource allocation and consumption decisions may be indeed valuable for evaluating policy measures designed to foster economic growth in an agrarian economy.

8.2 Summary of Results of the Study

In Chapter Two, we presented a critical review of the literature dealing with farm household decision-making problems in a peasant economy. The review brought out an important consideration: household resource allocation depends on the household resource position, which in part depends on the family's labour endowment. The family's labour endowment in turn depends on family size and child schooling decisions, which are a part of the family's consumption decisions. The analyses of farm household production which have been carried out within the framework of resource allocation models tend to be incomplete, to the extent that they fail to incorporate consumption decisions of farm households. Similarly, the consumption analyses, focussing only on consumption decisions, are also incomplete for they do not include the household's resource allocation decisions. These production decisions clearly will affect farm household consumption decisions. Because farm households are producers as well as consumers, it follows that a farm household model that incorporates both production and consumption decisions, in a framework where the family labour force is endogeneously determined, can provide better insights into farm household decision-making.

With this objective in mind, a model of the farm household was constructed and presented in Chapter Three. The objective of this modelling is to identify a systematic relationship between agricultural production and family consumption decisions. The major prediction of the model is that given the constraints that the rural households perceive, their decisions regarding agricultural production, lower child schooling rates and large family size are interlinked in the village economy setting but also are the results of efficient behaviour both in production and consumption. Given the productive role of minor children in the household enterprise, the model predicts that the larger is the pecuniary return to child labour, the lower is the child schooling rate and the larger is family size in the rural economy. That is to say, there exists a trade-off between the quantity and quality of minor children.

Chapter Four focussed on identifying the major socio-economic characteristics of the data set which was collected through a sample survey of two villages in Bangladesh. The data were used to test the behavioural hypotheses underlying the farm household model developed in Chapter Three. The data analysis reveals that for these Bangladeshi villages, there exist substantial interrelationships between income, landownership, family size, and child schooling rates. In both villages, family size and child schooling rates were found to be positively related to landholding while income was positively correlated with landownership. Rural households in both areas are found to participate in different income earning activities, such as crop cultivation, wage employment, non-crop activity and non-agricultural activity. The percentage contribution of crop cultivation to income was largest in both villages while non-agricultural activity appeared to be the second-major income earning activity. Heterogeneity in terms of age and sex exists in the labour market in the form of differential wages. However, it was found in both villages that there exists an active labour market for agricultural labour.

Chapter Five analysed household resource allocation in agriculture in a multicrop farm economy context with heterogeneous labour services. Production function analysis was utilized to study farm household production behaviour. The conclusion regarding labour heterogeneity in terms of adult male, female and minor children labour, for both villages, was that no substantial loss of statistical precision occurred when aggregation over these various categories of labour inputs was done with the weights based on the observed differences in their market wages. Similarly, for both villages, the homogeneity of family labour (aggregate) and hired labour (aggregate) was statistically confirmed. Also both types of farms, small and large as well as owner and owner-cum-share tenants were found to be equally efficient in the economic sense in both of our study areas. However, technological differences in terms of both slope and intercept coefficients exist between the two villages to the extent that separate production functions best fitted the data of the two villages. Thus, within each village, farm households were found to maximize profit, to be responsive to price incentives and to be allocatively efficient with respect to the major inputs, labour and chemical inputs. However, for both villages, land was found to be systematically over utilized.

In Chapter Six, a linear expenditure system was developed and a set of household demand functions for different consumption goods were derived. The expenditure system, which contained seven endogeneous variables representing the household demand functions for goods (farm and non-farm goods, children and child schooling) and labour supply functions for adult male, female and minor labour, was estimated by the Full-information Maximum Likelihood method separately for each village. The estimated results were used to calculate household response elasticities with respect to expenditure (assuming that expenditure was exogeneous), prices of agricultural products and non-agricultural products, wages, and some household characteristics. Generally the household response elasticities in the two villages were similar.

The empirical results show that the demand for farm goods was income inelastic while the demand for non-farm consumption goods was income elastic. This finding is consistent with findings for other countries (e.g., for Malaysia). The demands for child quantity and child quality (schooling) were found to be income inelastic but a trade-off exists between child quantity and child quality. That is to say, if the number of children in the family is large, the corresponding child schooling rate is lower for those families, a finding consistent with the prediction statement of the theoretical model of Chapter Three.

An increase in the level of education of the household head is found to be negatively correlated to the number of minor children and minor labour supply while it was positively correlated to child schooling levels. This also tended to be positively correlated with the female labour supply to agricultural activity. The policy implication of this result may be that the spread of education in the rural areas of Bangladesh will restructure household resource allocation as well as consumption decisions by increasing child schooling attendance, reducing minor labour supply, and reducing fertility as well as increasing female labour participation in income earning activities.

The household response elasticities presented in Chapter Six were computed as if consumption was independent of production. To the extent that production decisions varied with changes in prices and technology, the consumption analysis must be allowed to include the effects of changes in farm income in order to determine the effects of exogeneous changes in prices and technology. In Chapter Seven, the interaction of production and consumption decisions was discussed. This analysis suggests that the farm household's consumption response changes dramatically when production decisions are allowed to exert their influence. We find that, in both villages, consumption response elasticities with respect to changes in some policy variables, such as agricultural product prices, the wage rate and the technical change parameter, are changed either in sign or in absolute magnitude when production effects are included. It also appears in both villages that a change in the neutral technical change parameter has more dramatic effects (higher elasticities) on consumption decisions than changes in the output price or the wage rate. It should be mentioned however, that the resource cost incurred by the government to achieve the results indicated for technical change may be much higher than those required for policy interventions associated with the output price or the wage rate.

One example of the policy implication of this interaction analysis is that a technical improvement in agriculture, perhaps in the form of irrigation facilities combined with high yielding crop varieties, results in increased farm income and can produce a large increase in the demand for non-farm goods by farm households. In a country such as Bangladesh, where the overwhelming majority of population lives in villages, this effect has a large potential impact. The provision of new technology in the rural areas can greatly increase the demand for non-farm goods and help foster economic growth by increasing the demand for urban-based commodities. This finding increases the potential importance of a "rural-led" growth strategy.

8.3 Future Research Directions

A micro-economic model that incorporates farm household production and consumption decisions was developed and tested with Bangladesh data. It was observed that farm household decision-making regarding resource allocation in agriculture, family size, schooling, and participation in income earning activities is interlinked. Thus, such a comprehensive decision-making model can be useful in predicting the responses of the farm households to any policy intervention into the rural economy.

However, the micro-economic findings of this research must be incorporated into a general equilibrium model of the village economy in order to predict the quantitative significance of alternate policy measures that may be introduced in order to stimulate economic activity in the rural areas. Thus, one obvious future direction of research is to embed these micro results into a general equilibrium framework in order to derive policy implications of the model.

Second, this micro-economic model can be extended to incorporate those variables currently treated as exogeneous, such as risk, land owned, and savings, so that they become endogeneous. As was recognized elsewhere, uncertainty in agricultural production is an important aspect of peasant agriculture which should be explicitly incorporated into the farm household decision-making model.

On the other hand, the farm household's resource position includes not only the family labour endowment, but also physical assets, such as land and capital. These asset positions must also be considered in the decision making model. Ideally they should be endogeneously determined together with the family labour endowment. This requires that savings activity of the farm households must be incorporated explicitly as an endogeneous variable, which in turn implies an inter-temporal model of the farm household, perhaps of the sequential type. In fact, we need to incorporate explicitly the capital and land markets as well as the labour market in order to formulate a dynamic model of the village economy. Such work may represent an important extension of the model of the village economy.

Apart from these broader aspects, there are two specific ways in which the existing study can be improved. One is allowing $\bar{N} \neq 0$ in the linear expenditure system. The other is to drop the assumptions of competitive labour markets and perfect substitutability of family and hired labour at least for female and perhaps child labour.

APPENDIX III.A

Derivation of Comparative-Static Results for the General Model

The optimization problem for the farm household is

A.1 Max $\alpha = U(N, L_C, E, S) + \lambda\,[N(\pi_N + E\pi_E + L_C\pi_L) + S\pi_S - I]$

where λ is the Lagrangian multiplier < 0.

The first-order conditions imply:

A.2(i) $\dfrac{\partial U}{\partial N} + \lambda\,[\pi_N + E\pi_E + L_C\pi_L] = 0$

A.2(ii) $\dfrac{\partial U}{\partial L_C} + \lambda\,[N\pi_L] = 0$

A.2(iii) $\dfrac{\partial U}{\partial E} + \lambda\,[N\pi_E] = 0$

A.2(iv) $\partial U/\partial S + \lambda\,[\pi_S] = 0$

A.2(v) $N(\pi_N + E\pi_E + L_C\pi_L) + S\pi_S - I = 0$

Here, shadow prices of

Children, $q_N = \pi_N + E\pi_E + L_C\pi_L$

$= P_N x_N + t_{NW} W_W + EP_E x_E + L_C P_L x_L - (\Omega_C - L_C t_{LC} - E\,t_{EC}) W_C$

$= P_N x_N + t_{NW} W_W + E\,P_E x_E + L_C P_L x_L - T_{WC} W_C$;

Child leisure, q_L

$= N\pi_L = N(P_L x_L + t_{LC} W_C)$;

Child Schooling, q_E

$= N\pi_E = N(P_E x_E + t_{EC} W_C)$;

commodity, S, q_S

$$= \pi_S = (P_S x_S + t_{SW} W_W),$$

Totally differentiating the first-order conditions A.2(i) - A.2(v) treating π's as constant, and arranging results in matrix form, we get the system as follows:

$$\begin{bmatrix} U_{NN} & U_{NL} + \lambda\pi_L & U_{NE} + \lambda\pi_E & U_{NS} & (\pi_N + E\pi_E + L_C\pi_L) \\ U_{LN} + \lambda\pi_L & U_{LL} & U_{LE} & U_{LS} & N\pi_L \\ U_{EN} + \lambda\pi_E & U_{EL} & U_{EE} & U_{ES} & N\pi_E \\ U_{SN} & U_{SL} & U_{SE} & U_{SS} & \pi_S \\ (\pi_N + E\pi_E + L_C\pi_L) & N\pi_L & N\pi_E & \pi_S & 0 \end{bmatrix} \begin{bmatrix} dN \\ dL_C \\ dE \\ dS \\ d\lambda \end{bmatrix}$$

$$= \begin{bmatrix} -\lambda & -\lambda L_C & -\lambda E & 0 & 0 \\ 0 & -\lambda N & 0 & 0 & 0 \\ 0 & 0 & -\lambda N & 0 & 0 \\ 0 & 0 & 0 & -\lambda & 0 \\ -N & -NL_C & -NE & -S & 1 \end{bmatrix} \begin{bmatrix} d\pi_N \\ d\pi_L \\ d\pi_E \\ d\pi_S \\ dI \end{bmatrix}$$

Assuming $d\pi_S = 0$, and solving for dN, dL_C, and dE by Cramer's rule, we get;

A.4(i) $$dN = \frac{1}{\Delta}[-\lambda\Delta_{11}\, d\pi_N + \lambda(N\Delta_{21} - L\Delta_{11})d\pi_L - \lambda(E\Delta_{11} + N\Delta_{31})d\pi_E + \Delta_{51}(dI - Nd\pi_N - NL_C\, d\pi_L - NE\, d\pi_E)]$$

A.4(ii) $$dL_C = \frac{1}{\Delta}[\lambda\Delta_{12}\, d\pi_N + \lambda(L_C\Delta_{12} - N\Delta_{22})d\pi_L + \lambda(N\Delta_{32} + E\Delta_{12})d\pi_E - \Delta_{52}(dI - Nd\pi_N - NL_C\, d\pi_L - NE\, d\pi_E)]$$

$$\text{A.4(iii)} \quad dE = \frac{1}{\Delta}[-\lambda\Delta_{13}\, d\pi_N + \lambda(N\Delta_{23} - L\Delta_{13})d\pi_L - \lambda(N\Delta_{33} + E\Delta_{13})d\pi_E + \Delta_{53}(dI - Nd\pi_N - NL_C\, d\pi_L - NE\, d\pi_E)]$$

where Δ is the determinant of the matrix A in the left-hand side of A.3 and Δ_{ij} are the cofactors of matrix A.

Compensated substitution effects with respect to W_C can be obtained for each equation of A.4 by setting;

$$dI - N\, d\pi_N - NL_C\, d\pi_L - NE\, d\pi_E = 0$$

and thus we obtain;

$$\text{A.5(i)} \quad \frac{\partial N}{\partial W_C} = \frac{1}{\Delta}[-\lambda\Delta_{11}\frac{\partial \pi_N}{\partial W_C} + \lambda(N\Delta_{21} - L_C\Delta_{11})\frac{\partial \pi_L}{\partial W_C} - \lambda(E\Delta_{11} + N\Delta_{31})\frac{\partial \pi_E}{\partial W_C}]$$

$$\text{A.5(ii)} \quad \frac{\partial E}{\partial W_C} = \frac{1}{\Delta}[-\lambda\Delta_{13}\frac{\partial \pi_N}{\partial W_C} + \lambda(N\Delta_{23} - L_C\Delta_{13})\frac{\partial \pi L}{\partial W_C} - \lambda(N\Delta_{33} + E\Delta_{13})\frac{\partial \pi E}{\partial W_C}]$$

$$\text{A.5(iii)} \quad \frac{\partial L_C}{\partial W_C} = \frac{1}{\Delta}[\lambda\Delta_{12}\frac{\partial \pi_N}{\partial W_C} + \lambda(L_C\Delta_{12} - N\Delta_{22})\frac{\partial \pi_L}{\partial W_C} + \lambda(N\Delta_{32} + E\Delta_{12})\frac{\partial \pi_E}{\partial W_C}]$$

If the budget constraint is linear and it touches the original non-linear budget line at the equilibrium point, then;

$$I - N(L_C\pi_L + E\pi_E) = R = q_N N + q_L L_C + q_E E + q_S S$$

where the q's are the shadow prices. Treating this new budget line as linear in shadow prices which are assumed to be constant we totally differentiate the system A.2 and get a matrix as in A.3 except that the right-hand side of A.3 is replaced by;

$$\text{R.H.S} = \begin{bmatrix} -dq_N \\ -dq_L \\ -dq_E \\ -dq_S \\ dI-Ndq_N-L_G dq_L-Edq_E-Sdq_S \end{bmatrix}$$

Solving this system, we get the conventional substitution effects;

A.6
$$\frac{\partial N}{\partial q_N} = -\frac{\lambda\Delta_{11}}{\Delta}\ ; \quad \frac{\partial N}{\partial q_L} = \frac{\lambda\Delta_{21}}{\Delta}\ ; \quad \frac{\partial N}{\partial q_E} = -\frac{\lambda\Delta_{31}}{\Delta}\ ;$$

$$\frac{\partial L_C}{\partial q_N} = \frac{\lambda\Delta_{12}}{\Delta}\ ; \quad \frac{\partial L_C}{\partial q_L} = -\frac{\lambda\Delta_{22}}{\Delta}\ ;$$

$$\frac{\partial L_C}{\partial q_E} = \frac{\lambda\Delta_{32}}{\Delta}\ ;$$

$$\frac{\partial E}{\partial q_N} = -\frac{\lambda\Delta_{13}}{\Delta}\ ; \quad \frac{\partial E}{\partial q_L} = \frac{\lambda\Delta_{23}}{\Delta};$$

$$\frac{\partial E}{\partial q_E} = -\frac{\lambda\Delta_{33}}{\Delta}.$$

Second-order conditions restrict $\frac{\Delta ii}{\Delta} < 0$, so that

$$\frac{\partial N}{\partial q_N} < 0, \quad \frac{\partial L_C}{\partial q_L} < 0 \text{ and } \frac{\partial E}{\partial q_E} < 0.$$

Evaluating A.5 with the help of A.6, we obtain A.5 in elasticity form. The compensated child investment elasticity with respect to W_C are represented as;

A.7 $$\eta^{*}_{jW_C} = \eta^{*}_{jN} \frac{(-T_{WC}W_C)}{q_N} + \eta^{*}_{jL} \frac{W_C N t_{LC}}{q_L} + \eta^{*}_{jE} \frac{W_C N t_{EC}}{q_E} \; ; \; j = N, L_C, E.$$

The uncompensated child investment elasticities are

A.8 $$\eta_{jW_C} = \eta_{jN} \frac{(-T_{WC}W_C)}{q_N} + \eta^{*}_{jL} \frac{(N\, t_{LC})}{q_L} + \eta^{*}_{jE} \frac{(W_C N t_{EC}}{q_E} + \eta_{NI}\, \eta_{IW_C} ;$$

$j = N, L_C, E.$

The compensated effect of W_W is obtained by solving A.4 with the help of A.5. The resulting child investment elasticities are

$$\eta^{*}_{jW_W} = \eta^{*}_{jN} \frac{W_W t_{NW}}{q_N} + \eta^{*}_{jS} \frac{W_W t_{SW}}{q_S} \; ; \; j = N, L_C, E.$$

Using the homogeneity property of the demand functions

$$q_N \frac{\partial N}{\partial q_N} + q_E \frac{\partial N}{\partial q_E} + q_S \frac{\partial N}{\partial q_S} + q_L \frac{\partial N}{\partial q_L} + I \frac{\partial N}{\partial I} = 0$$

In compensated terms,

$$-[q_N \frac{\partial j^{*}}{\partial q_N} + q_E \frac{\partial j^{*}}{\partial q_E} + q_L \frac{\partial j^{*}}{\partial q_L}] = q_S \frac{\partial j^{*}}{\partial q_S}$$

Using these terms for substituting η^{*}_{LS}, η^{*}_{NS}, η^{*}_{ES}, we obtain

A.9 $$\eta^{*}_{jW_W} = \eta^{*}_{jN} \left(\frac{W_W t_{NW}}{q_N} - \frac{W_W t_{SW}}{q_S}\right) - (\eta^{*}_{jE} + \eta_{jL}) \left(\frac{W_W t_{SW}}{q_S}\right) \; ; \; j = N, L_C, E.$$

On the other hand, the uncompensated elasticities with respect to W_w are;

A.10 $\eta_{jW_W} = \eta_{j_N} \left(\frac{W_W t_{NW}}{q_N} - \frac{W_W t_{SW}}{q_S}\right) - (\eta_{jE} + \eta_{jL}) \frac{W_W t_{SW}}{q_S} + \eta_{jL}\, \eta_{IW_W}$; $j = N, L_C, E$.

APPENDIX III.B

Derivation of Comparative-Static Results for the Linear Expenditure System

The optimization problem in this case is:

B.1 $$\text{Max } U = \beta_{LC}\ell n(L_c-\bar{L}_c) + \beta_E \ell n(E-\bar{E}) + \beta_N \ell n(N-\bar{N}) + \beta_S \ell n\,(S-\bar{S})$$

Subject to

$$I = \pi + W_M\Omega_M + W_M\Omega_M$$
$$= N(\pi_N + L_C\pi_L + E\pi_E) + S\pi_S$$

Maximization leads to the following first-order conditions:

B.2(i) $$\frac{\beta_{LC}}{(L_C-\bar{L}_C)} + \lambda\,(-N\pi_L) = 0$$

(ii) $$\frac{\beta_E}{(E-\bar{E})} + \lambda\,(-N\pi_E) = 0$$

(iii) $$\frac{\beta_S}{(S-\bar{S})} + \lambda\,(-\pi_S) = 0$$

(iv) $$\frac{\beta_N}{(N-\bar{N})} + \lambda\,(-\pi_N-L_C\pi_L-E\pi_E) = 0$$

(v) $$I - N\,(\pi_N + L_C\pi_L + E\pi_E) - S\pi_S = 0$$

where λ = Lagrangian multiplier > 0.

The second-order conditions for maximization requires that the bordered Hessian determinant of the above first-order conditions must be positive. After expanding and arranging the determinant, we get the following expression;

$$H = [\frac{\pi_S}{(S-\bar{S})} \quad (\pi_N + L_C\pi_L + E\pi_E) \frac{1}{N(N-\bar{N})} \frac{\beta_{LC}}{(L_C-\bar{L}_C)} \frac{\beta_E}{(E-\bar{E})2}$$

$$\{N(\beta_N-\beta_E-\beta_{LC}) + 2\bar{N}\ (\beta_E+\beta_{LC})\}]$$

Thus, we have two cases where $\bar{N} = 0$ or $\bar{N} > 0$. Under any case the condition required for H to be positive is $\beta_N > (\beta_E+\beta_{LC})$ given that $(S-\bar{S}) > 0$, $(N-\bar{N}) > 0$.

Noting this condition for the satisfaction of the second-order conditions, we can now see how the demand functions can be derived from the first-order conditions. B.2(i) and B.2(iii), B.2(ii) and B.2(iii), and B.2(iv) and B.2(iii) respectively yield:

B.2(vi) $\quad \pi_L(L_C-\bar{L}_C) = \frac{\pi_S}{N} (S-\bar{S}) \frac{\beta_{LC}}{\beta_S}$

B.2(vii) $\quad \pi_E(E-\bar{E}) = \frac{\pi_S}{N} (S-\bar{S}) \frac{\beta_E}{\beta_S}$

B.2(viii) $\quad (N-\bar{N})(\pi_N+L_C\pi_L+E\pi_E) = \pi_S(S-\bar{S}) \frac{\beta_N}{\beta_S}$

B.2(viii) Can be rewritten as

B.2(ix) $\quad (N-\bar{N})(\pi_N+\bar{L}_C\pi_L + \bar{E}\pi_E) + (N-\bar{N})\{\pi_L(L_C-\bar{L}_C) + \pi_E(E-\bar{E})\} = \pi_S(S-\bar{S})\frac{\beta_N}{\beta_S}$

and B.2(v) can be rewritten as

B.2(x) $\quad I-\pi_S\bar{S}-\bar{N}(\pi_N+\bar{L}_C\pi_L + \bar{E}\pi_E) = K$

$$= (N-\bar{N})(\pi_N + \bar{L}_C\pi_L + \bar{E}\pi_E) + (N-\bar{N})\ \{\pi_L(L_C-\bar{L}_C)$$

$$+ \pi_E\ (E-\bar{E})\} + \bar{N}\pi_L\ (L_C-\bar{L}_C) + \bar{N}\pi_E(E-\bar{E}) + \pi_S(S-\bar{S})$$

where K is the maximum discretionary income available to the household for the consumption of the decision variables. Substituting B.2(vi), B.2(vii) and B.2(ix) in B.2(x), we obtain;

B.3 $$K = (S-\bar{S})\ \pi_S\left[\frac{\beta_N + \beta_S + \beta_{LC} + \beta_E}{\beta_S} - \frac{(N-\bar{N})}{N}\left(\frac{\beta_{LC} + \beta_E}{\beta_S}\right)\right]$$

The expenditure functions for this system are case 1: when $\bar{N} = 0$,

$$K_1 = I - \pi_S\bar{S} \text{ and}$$

B.4 (a) $$\pi_S(S-\bar{S}) = K_1\ \frac{\beta_S}{(\beta_S+\beta_N)}$$

(b) $$N\pi_E(E-\bar{E}) = K_1\ \frac{\beta_E}{(\beta_S+\beta_N)}$$

(c) $$N\pi_L(L_C-\bar{L}_C) = K_1\ \frac{\beta_{LC}}{(\beta_S+\beta_N)}$$

(d) $$N(\pi_N + L_C\pi_L + E\pi_E) = K_1\ \frac{\beta_N}{(\beta_S+\beta_N)}$$

Substituting (b) and (c) into (d), we get the following demand functions for the three child investment commodities;

B.5 (a) $$N = \frac{K_1}{B}\ \left(\frac{\beta_N - \beta_{LC} - \beta_E}{\beta_S + \beta_N}\right)$$

(b) $$\pi_E(E-\bar{E}) = \frac{\beta_E}{(\beta_N-\beta_{LC}-\beta_E)}\quad B$$

(c) $$\pi_L(L_C-\bar{L}_C) = \frac{\beta_{LC}}{(\beta_N-\beta_{LC}-\beta_E)}\quad B$$

where: $B = (\pi_N + \pi_L \cdot L_C + \pi_E \bar{E})$.

The peculiarities in the above demand functions arise because of the existence of non-linearity in the budget constraint. However, it can be proved easily that when these demand functions are substituted back to the budget constraint, the constraint is satisfied.

Case II. when $\bar{N} > 0$,

B.6 (a) $\pi_S(S-\bar{S}) = K \dfrac{\beta_S}{A}$; and by substituting B.6 (a) into B.2 (vi), we obtain;

(b) $N\pi_L(L_C-\bar{L}_C)=K \dfrac{\beta_{LC}}{A}$. By substituting B.6 (a) into B.2 (vii) we get;

(c) $N\pi_E(E-\bar{E}) = K \dfrac{\beta_E}{A}$, and by substituting B.6 (a) into B.2(viii),

(d) $(N-\bar{N})\ (B + \pi_L(L_C-\bar{L}_C) + \pi_E(E-\bar{E}) = K \dfrac{\beta_N}{A}$,

where, $A = (\beta_N + \beta_S + \beta_{LC} + \beta_E)-\dfrac{(N-\bar{N})}{N}\ (\beta_{LC} + \beta_E)$.

Combining B.6 (b), B.6 (c) and B.6 (d) , we get

$$(N-\bar{N})\ [B + \frac{K}{NA}\ (\beta_{LC} + \beta_E)]=K \frac{\beta_N}{A}$$

$$\text{or } (N-\bar{N})\ [\ NAB + K\ (\beta_{LC} + \beta_E)] = KN\beta_N$$

As we know, $A = (\beta_N + \beta_S + \beta_{LC} + \beta_E) - (\dfrac{N-\bar{N}}{N})(\beta_{LC} + \beta_E)$

$$\text{or } A = \beta_N + \beta_S + \frac{\bar{N}}{N}\ (\beta_{LC} + \beta_E)$$

$$\text{or } NA = N(\beta_N + \beta_S) + \bar{N}\ (\beta_{LC} + \beta_E)$$

$$= (N-\bar{N})\ (\beta_N + \beta_S) + \bar{N}\ (\beta_{LC} + \beta_E + \beta_N + \beta_S)$$

$$\therefore \quad (N-\bar{N})\ [\{(N-\bar{N})\ (\beta_N + \beta_S) + \bar{N}\ \Sigma_{j=1}^{4}\beta_j\}B + K(\beta_{LC} + \beta_E)]$$

$$= NK\beta_N;\ j = L_C, E, N, S.$$

This can be expressed as

$$(N-\bar{N})^2(\beta_N+\beta_S)B+(N-\bar{N})[B\bar{N}\{\Sigma_{j=1}^{4}\beta_j+(\beta_{LC}+\beta_E-\beta_N)K]-\bar{N}K\beta_N = 0,$$ which is a quadratic equation. Thus, the solution for $(N-\bar{N})$ is;

B.7 $$(N-\bar{N}) = -\frac{\{\bar{N}B\Sigma_{j=1}^{4}\beta_j + (\beta_{LC} + \beta_E - \beta_N)K\} \pm \sqrt{b^2 + 4\bar{N}BK\ \beta_N(\beta_S+\beta_N)}}{2(\beta_N + \beta_S)B}$$

where $b = \{\bar{N}B\Sigma\beta_j + (\beta_{LC} + \beta_E - \beta_N)K\}$.

APPENDIX IV.A

Rural Household Survey Data: Bangladesh[1]

This data set was collected by drawing a sample of households from three areas in Bangladesh and carrying out interviews three times during the period July 1981 through March 1982, corresponding to the three cropping seasons from April 1981 through March 1982. The data fit into twelve categories which broadly describe the economic activities, schooling decisions and general characteristics of the rural households surveyed.

Data on 101 stock variables were collected at one point in time from 300 households. These variables were identified as "general household variables", "schooling", "consumer durables", "agricultural capital", "borrowing and lending during the past year" and "land tenure and land value". These data were collected during the first set of interviews, in July and August of 1981.

In addition to these stock variables, observations were collected on the weekly values of variables identified as "employment and wages", "time allocated to household activities" and "consumption expenditures". Each household reported values for these variables at three different times (each during a different cropping season and for the week prior to the interview). There are 73 variables collected in this format.

Income from non-farming sources was collected from the 300 household corresponding to the three cropping seasons. This was recorded for ten different items, representing another 10 variables, with observations associated with each of the three different seasons.

The final two categories represent data on "crop production and disposal" and "input utilization by crop". All of these data are reported both with respect to crop and with respect to the tenure of the land on which the crop was grown. In these two categories, there are 1254 variables possible for each household. Since there are three cropping seasons, and as many as eleven major crops which may be produced over these three seasons, each general variable, such as "operator's share in production", could apply to eleven different crops. Furthermore, two different tenure classes are considered regarding the land used for agricultural production. Either the operator owns and/or rents in land at a fixed rent or the operator rents in land on a share basis. Depending on the area and land tenure circumstances, a farmer could, potentially, provide 22 different items for each of the general variables in these last two categories. This would represent 22 different variables.

The data set contains 1439 variables for each household, and three different observations for 84 of these variables. This provides more than 1600 pieces of information for each of 300 households (of course, for many households, many of the observations are zero).

The twelve categories and the variable definitions and codes are presented on the following pages. The codes should be easily related to the definitions, with perhaps one exception. The first variable, IVUTR, identifies the household providing data and contains very specific locational information. The first letter simply identifies the household and takes a value from 001 to 300. The second letter, V, identifies the village in which the household is located. V takes the number which represents the position in the English alphabet of the first letter in the name of the village. Therefore, if the village is Hamsadi, V will take the value 08, for H is the eighth letter in the alphabet. The same rule is used to identify the Union, Thana and Region (or District) in which the respondent's village is located. If respondent 37 is from the village of Hamsadi, in the Union of Baidyerbazar, Thana of Baidyerbazar, in the Dacca Region, his (or her) responses would be identified as 03708020204. All of the respondents' locations have been carefully checked to be certain that village, union, thana and region designations used in this data set uniquely identify a respondent's residence.

I. General Household Data

Variable Number	Variable Code	Definition of Variable
1	IVUTR	Identification and location of respondent (see text for explanation of entry)
2	AGR	Age of the respondent
3	NM	Not a member of an agricultural cooperative organization (records 1 if non-member, 0 otherwise)
4	YM	Years of membership in an agricultural co-op
5	RF	Respondent is father (records 1, 0 otherwise)
6	RM	Respondent is mother (records 1, 0 otherwise)
7	YER	Years of schooling completed by the respondent
8	FS	Family size of the household (all members)
9	NAM	Number of adult males in the household
10	NAF	Number of adult females in the household
11	NMM	Number of males who are minors (of age below 15 years) in the household
12	NMF	Number of females who are minors in the household
13	NAS	Number of adult sons of the respondent
14	NAD	Number of adult daughters of the respondent
15	NDM	Number of adult daughters of the respondent who are married and living elsewhere
16	NMC	Number of respondent's minor children in the household
17	AGS	Age of respondent's spouse
18	YES	Years of schooling completed by the spouse
19	SD	Spouse is dead (records 1, 0 if still living)

Variable Number	Variable Code	Definition of Variable
20	SDA	Spouse's age at death
21	NASM	Number of adult male servants[2]
22	NSF	Number of female servants[3]
23	NMSM	Number of male servants who are minors
24	ASASM	Annual salary of adult male servants
25	ASMSM	Annual salary of male servants who are minors
26	ASFS	Annual salary of female servants
27	NCEB	Number of children born to respondent (or respondent's wife)
28	NLC	Number of children born (and still living) to respondent (or respondent's wife)
29	NDC	Number of children desired by the respondent
30	NPOA	Number of household members having their primary occupation on the respondent's farm
31	NPOOA	Number of household members having their primary occupation on a different household's farm
32	NPONA	Number of household members having their primary occupation in non-agricultural activities
33	NSOA	Number of household members having their secondary occupation in agriculture
34	NSOOA	Number of household members having their secondary occupation as a wage-earner on another farm
35	NSOB	Number of household members having their secondary occupation in business[4]
36	NSOSS	Number of household members having their secondary occupation as a salaried service worker[5]
37	NSOSW	Number of household members having their secondary occupation as a wage-earning service worker
38	NSOH	Number of household members having their secondary occupation in handicrafts[6]

II. Schooling

Variable Number	Variable Code	Definition of Variable
39	OSC	Number of the respondent's children with no schooling
40	OSNC	Number of household members, who are not in the respondent's nuclear family, with no schooling
41	PSCC	Number of the respondent's children who have completed primary school
42	PSNCC	Number of household members, who are not in the respondent's nuclear family, who have completed primary school
43	SSCC	Number of the respondent's children who have completed secondary school
44	SSNCC	Number of household members, who are not in the respondent's nuclear family, who have completed secondary school
45	PSSCC	Number of the respondent's children who have completed post-secondary school
46	PSSNCC	Number of household members, who are not in the respondent's nuclear family, who have completed post-secondary school
47	PSC	Number of the respondent's children who are enrolled in primary school
48	PSNC	Number of household members, who are not in the respondent's nuclear family, who are enrolled in primary school
49	SSC	Number of the respondent's children who are enrolled in secondary school
50	SSNC	Number of household members, who are not in the respondent's nuclear family, who are enrolled in secondary school
51	PSSC	Number of the respondent's children who are enrolled in post-secondary school
52	PSSNC	Number of householdmembers, who are not in the respondent's nuclear family, who are enrolled in post-secondary school

Variable Number	Variable Code	Definition of Variable
53	CPS	Total household expenditures on primary school education
54	CSS	Total household expenditures on secondary school education
55	CPSS	Total household expenditures on post-secondary school education
56	YSPSC	Total years of schooling which will be given to the primary school students of the respondent
57	YSPSNC	Total years of schooling which will be given to the primary school students in the household, other than the respondent's
58	YSSSC	Total years of schooling which will be given to the secondary school students of the respondent
59	YSSSNC	Total years of schooling which will be given to the secondary school students, other than the respondent's, in the household
60	YPSSC	Total years of schooling which will be given to the post-secondary school students of the respondent
61	YPSSNC	Total years of schooling which will be given to the post-secondary school students, other than the respondent's, in the household
62	NSD	Total number of school age children in the household who dropped out, or were not going to school during the past year.[7]
63	NSD1	...because the school is far away
64	NSD2	...because the school is not conveniently located
65	NSD3	...because it is too expensive
66	NSD4	...because help was needed on the family farm
67	NSD5	...because the children had to work off of the farm
68	NSD6	...because the children did not want to go

III. Consumer Durables

Variable Number	Variable Code	Definition of Variable
69	VHB	Value of dwellings and related buildings
70	VHF	Value of the household's furniture
71	VHA	Value of the household's appliances
72	VOA	Value of the household's vehicles and other assets
73	TVCD	Total value of consumer durables (the sum of the values of 69 through 72)

IV. Agricultural Capital

Variable Number	Variable Code	Definition of Variable
74	VL	Value of livestock owned by the household
75	VFK	Value of the household's fixed agricultural capital
76	VAI	Value of other agricultural implements
77	TVAK	Total value of agricultural capital (the sum of the values of 74 through 76)

V. Borrowing and Lending

Variable Number	Variable Code	Definition of Variable
78	HBI	Household borrowing from institutional sources during the past year
79	HBNI	Household borrowing from non-institutional sources during the past year
80	THB	Total outstanding loan of the household at the end of the past year
81	RHBI	Interest rate paid on insitutional loans made during the past year
82	RHBNI	Interest rate paid on non-institutional loans made during the past year
83	HUD	Household's urgent debt[8]
84	PDR	Probable date of repayment of urgent debt
85	HL	Amount lent to others by household members
86	RHL	Interest rate received by household on loans
87	RDLIH	Reported disaster level income of the household
88	RMCH	Reported minimum consumption needs of the household, in maunds of food grains[9]

VI. Land Tenure and the Value of Land

Variable Number	Variable Code	Definition of Variable
89	HNAL	Size of household's homestead land, in acres
90	HAL	Size of household's agricultural land, in acres
91	HTL	Total land owned by the household, in acres (the sum of variables 89 and 90)
92	VHNAL	Value of household's homestead land
93	VHTL	Value of all land owned by the household
94	HRILC	Acres of land rented-in by the household on a cash basis
95	HRILS	Acres of land rented-in by the household on a share basis
96	HROLC	Acres of land rented-out by the household on a cash basis
97	HROLS	Acres of land rented-out by the household on a share basis
98	HLM	Acres of household land carrying a mortgage-in trust[10]
99	HTFS	Total size of household's agricultural holdings, in acres (the sum of variables 90, 94 and 95 less the sum of variables 96, 97 and 98)
100	VRPLT	Total payment for land rented-in on a cash basis
101	MVLM	Value of land mortgaged-in-trust

VII. Employment and Wages[11]

Variable Number	Variable Code	Definition of Variable
102i	HWHFi	Total hours worked by household members on their own farm
103i	MDFi	Total man-days worked by household members on their own farm
104i	RCHFi	Cost of replacing household members involved in working on their own farm
105i	AHFi	Number of adult household members working on the household's farm
106i	MHFi	Number of minor household members working on the household farm
107i	RCAFi	Cost of replacing an adult household member who works on the household's farm
108i	RCMFi	Cost of replacing a minor household member who works on the household's farm
109i	HWHOi	Total hours worked by household members on a farm not belonging to the household
110i	MDOi	Total man-days worked by household members on a farm not belonging to the household
111i	WHOi	Total wage income earned by all household members working on a farm not belonging to the household
112i	AHOi	Number of adult household members working on a farm not belonging to the household
113i	MHOi	Number of minor household members working on a farm not belonging to the household
114i	WAHOi	Daily wage of an adult household member working on a farm not belonging to the household
115i	WMHOi	Daily wage of a minor household member working on a farm not belonging to the household
116i	HWHSi	Total hours worked by all household members in off-farm self-employment

Variable Number	Variable Code	Definition of Variable
117i	MDSi	Total man-days worked by household members in off-farm self-employment
118i	IHSi	Total income earned by all household members in off-farm self-employment
119i	AHSi	Total number of adult household members in off-farm self-employment
120i	MHSi	Total number of household members who are minors and in off-farm self-employment
121i	RCASi	Daily replacement cost of an adult household member in off-farm self-employment
122i	RCMSi	Daily replacement cost of a household member who is a minor and in off-farm self-employment
123i	HWHNAi	Total hours worked by household member, employed by others, in non-agricultural activities
124i	MDNAi	Man-days worked by household members, employed by others, in non-agricultural activities
125i	IHNAi	Total income earned by household members, employed by others, in non-agricultural activities
126i	AHNAi	Number of adult household members, employed by others, in non-agricultural activities
127i	MHNAi	Number of minor household members, employed by others, in non-agricultural activities
128i	WANAi	Daily wage of an adult household member, employed by others, in non-agricultural activities
129i	WMNAi	Daily wage of a minor household member, employed by others, in non-agricultural activities

VIII. Time Allocated to Household Activities[11]

Variable Number	Variable Code	Definition of Variable
130i	TMAi	Time spent marketing by adult household members[12]
131i	TMMi	Time spent marketing by household members who are minors
132i	TWCAi	Time spent washing and cleaning by adult household members
133i	TWCMi	Time spent washing and cleaning by household members who are minors
134i	TCFAi	Time spent cooking and serving food by adult household members
135i	TCFMi	Time spent cooking and serving food by household members who are minors
136i	TWFAi	Time spent getting water and firewood by adult household members
137i	TWFMi	Time spent getting water and firewood by household member who are minors
138i	TRSAi	Time spent on schooling and reading by adult household members
139i	TRSMi	Time spent on schooling and reading by household members who are minors
140i	TBCAi	Time spent on baby care by adult household members
141i	TBCMi	Time spent on baby care by household members who are minors
142i	TOAi	Time spent on other household activities by adult household members
143i	TOMi	Time spent on other household activities by household members who are minors
144i	LAi	Leisure time of all adult household members
145i	LMi	Leisure time of all household members who are minors

IX. Consumption Expenditures[11]

Variable Number	Variable Code	Definition of Variable
146i	TCRi	Total consumption of rice by the household, in seers[13]
147i	CROPi	Consumption of rice by the household from its own production, in seers
148i	CRPMi	Consumption of rice, purchased from the market, by the household, in seers
149i	CROSi	Consumption of rice by the household, from other sources, in seers
150i	PRi	Price of rice, per seer
151i	TVRCi	Total value of rice consumed by the household
152i	TCWi	Total consumption of wheat by the household, in seers
153i	CWOPi	Consumption of wheat by the household from its own production, in seers
154i	CWPMi	Consumption of wheat, purchased from the market, by the household, in seers
155i	CWOSi	Consumption of wheat by the household from other sources, in seers
156i	PWi	Price of wheat, per seer
157i	TVWCi	Total value of wheat consumed by the household
158i	TCPi	Total consumption of pulses by the household, in seers
159i	CPOPi	Consumption of pulses by the household from its own production, in seers
160i	CPPMi	Consumption of pulses, purchased from the market, by the household,in seers
161i	CPOSi	Consumption of pulses by the household, from other sources, in seers
162i	PPi	Prices of pulses, per seer

Variable Number	Variable Code	Definition of Variable
163i	TVPCi	Total value of pulses consumed by the household
164i	TCOFi	Total value of all other food items consumed by the household
165i	COFFPi	Value of all other food items consumed by the household from its own production
166i	COFPMi	Value of all other food items consumed by the household and purchased from the market
167i	COFOSi	Value of all other food items consumed by the household, from other sources
168i	TVCFi	Total value of all food items consumed by the household (the sum of the values of variables 151i, 157i, 163i and 164i)
169i	CECi	Consumption expenditures by the household on clothing
170i	CEEi	Consumption expenditures by the household on education
171i	CEMi	Consumption expenditures by the household on medicine
172i	CETi	Consumption expenditures by the household on transport
173i	CEONFi	Consumption expenditures by the household on other non-food items
174i	TVCNFi	Total value of consumption expenditures on all non-food items (the sum of the values of variables 169i through 173i)

X. Household Income from Non-Crop Sources[14]

Variable Number	Variable Code	Definition of Variable
175i	INCi	Total value of production from non-crop agricultural sources
176i	VCNCi	Total value of non-crop agricultural production consumed by the household
177i	VSNCi	Total value of non-crop agricultural production sold by the household
178i	IWEAi	Income received by all household members from wages earned working on another farm
179i	IWENAi	Income received by all household members from wages earned working at non-agricultural activities
180i	IBi	Income received by all self-employed household members from business activities
181i	IHi	Income received by all self-employed household members from handicraft activities
182i	ISi	Income received by all salaried household members from service activities
183i	IOSi	Income received by all household members from all other non-agricultural activities, including remittance income
184i	INASi	Total income received by all household members from all non-agricultural sources (the sum of the values of variables 179i through 183i)

XI. Crop Production and Disposal[15]

Variable Number	Variable Code	Definition of Variable
185jk	QPCjk	Quantity of crop j produced on the household's land of tenure class k
186jk	OSPCjk	Operator's share of production of crop j produced on land of tenure class k
187jk	QSRCjk	Quantity of crop j produced on land of tenure class k that was used for seed requirements
188jk	QSCCjk	Quantity of crop j produced on land of tenure class k that was used for household consumption
189jk	QSCjk	Quantity of crop j produced on land of tenure class k that was sold on the market
190jk	VQSCjk	Value of the quantity of crop j produced on land of tenure class k that was sold on the market
191jk	PCjk	Per unit price received for the sale of crop j produced on land of tenure class k
192jk	TVPCjk	Total value of the production of crop j produced on land of tenure class k
193jk	NCYBjk	Yield of crop j produced on land of tenure class k relative to the previous year's yield: record (1) if better, zero (0) otherwise
194jk	NCYAjk	Yield of crop j produced on land of tenure class k relative to the previous year's yield: record (1) if about the same, (0) otherwise
195jk	NCYWjk	Yield of crop j produced on land of tenure class k relative to the previous year's yield: record (1) if worse, (0) otherwise
196jk	PCDjk	Percentage of crop j harvested from land of tenure class k that was damaged
197jk	RFCDjk	Flood or excess rainfall as a reason for damage to crop j on land of tenure class k: records (1) if a reason, (0) otherwise
198jk	RDCDjk	Drought as a reason for damage to crop j on land of tenure class k: records (1) if a reason, (0) otherwise

Variable Number	Variable Code	Definition of Variable
199jk	RICDjk	Insects as a reason for damage to crop j on land of tenure class k: records (1) if a reason, (0) otherwise
200jk	RLCDjk	Absence of complementary input at the appropriate time as a reason for damage to crop j on land of tenure class k: records (1) if a reason, (0) otherwise
201i	NIROi	Net income received by the household from the production and sale of crops other than rice, jute, oil seed, pulses, sugarcane and wheat, in season i [16]

XII. Input Utilization[17]

Variable Number	Variable Code	Definition of Variable
202jk	QHPCjk	Quantity of crop j produced by the household on land of tenure class k
203jk	TLAjk	Total amount of land devoted to the production of crop j on land of tenure class k
204jk	QSDjk	Quantity of seed used for crop j on land of tenure class k[18]
205jk	ESDjk	Total cost of seed used for crop j on land of tenure class k
206jk	PSDjk	Unit price of seed used for crop j on land of tenure class k
207jk	QFZjk	Quantity of fertilizer used for crop j on land of tenure class k, in maunds[19]
208jk	EFZjk	Total cost of fertilizer used for crop j on land of tenure class k
209jk	PFZjk	Unit price of fertilizer used for crop j on land of tenure class k
210jk	QMNjk	Quantity of manure used for crop j on land of tenure class k, in maunds
211jk	EMNjk	Total cost of manure used for crop j on land of tenure class k
212jk	PMNjk	Unit price of manure used for crop j on land of tenure class k
213jk	QPDjk	Quantity of pesticides used for crop j on land of tenure class k, in seers
214jk	EPDjk	Total cost of pesticides used for crop j on land of tenure class k
215jk	PPDjk	Unit price of pesticides used for crop j on land of tenure class k

Variable Number	Variable Code	Definition of Variable
216jk	EIRjk	Total cost of irrigation for crop j on land of tenure class k
217jk	PIRjk	Daily charge for irrigation for crop j on land of tenure class k, per acre[20]
218jk	OALjk	Bullock labour provided by household's bullocks for crop j on land of tenure class k, in bullock-days
219jk	HALjk	Hired bullock labour for crop j on land of tenure class k, in bullock-days
220jk	TALjk	Total bullock labour for crop j on land of tenure class k, in bullock-days
221jk	EHAPjk	Expenditure on hired bullock power for crop j on land of tenure class k[21]
222jk	PHAPjk	Daily price of hired bullock power for crop j on land of tenure class k
223jk	FLMjk	Number of adult male household members working with crop j on land of tenure class k
224jk	HLMjk	Number of hired adult males working with crop j on land of tenure class k
225jk	FLFjk	Number of adult female household members working with crop j on land of tenure class k
226jk	HLFjk	Number of hired adult females working with crop j on land of tenure class k
227jk	FLCjk	Number of household members who are minors and are working with crop j on land of tenure class k
228jk	HLCjk	Number of hired minors working with crop j on land of tenure class k
229jk	MFLMjk	Man-days of adult male household members working with crop j on land of tenure class k
230jk	MHLMjk	Man-days of hired adult males working with crop j on land of tenure class k

Variable Number	Variable Code	Definition of Variable
231jk	MFLFjk	Man-days of adult female household members working with crop j on land of tenure class k
232jk	MHLFjk	Man-days of hired adult females working with crop j on land of tenure class k
233jk	MFLCjk	Man-days of household members who are minors and are working with crop j on land of tenure class k
234jk	MHLCjk	Man-days of hired minors working with crop j on land of tenure class k
235jk	WAFMjk	Wage-bill for adult male household member working with crop j on land of tenure class k[22]
236jk	WAHMjk	Wage-bill for hired adult male working with crop j on land of tenure class k
237jk	WAFFjk	Wage-bill for adult female household member working with crop j on land of tenure class k[22]
238jk	WAHFjk	Wage-bill for hired adult female working with crop j on land of tenure class k
239jk	WAFCjk k	Wage-bill for household member who is a minor and is working with crop j on land of tenure class k[22]
240jk	WAHCjk	Wage-bill for hired minor working with crop j on land of tenure class k
241jk	EHLjk	Total expenditure on hired labour used for crop j on land of tenure class k
242jk	TEPIjk	Total expenditure on purchased inputs used for crop j on land of tenure class k

Notes

[1]This data was collected by Shahidur Rahman Khandker with support from the Ford Foundation and the National Foundation for Research on Human Resource Development, Dacca, Bangladesh.

[2]Servants are all full-time employees who live in the household and are included as household members.

[3]There is no price distinction between minor and adult female servants. The tendency is for minor females to remain in the parent's household, and to perform chores for the household. Other social customs tend to restrict the supply of minor female servants. In general, then, the tendency is for this category to contain only adult females.

[4]If he or she would be a self-employed merchant or shop keeper or village doctor (Kabiraz).

[5]Service workers can be salaried or wage-earners. Service workers include teachers, civil servants and employees of businesses.

[6]Major handicraft activities are basketmaking, woodcarving, pottery and leathercraft.

[7]The past year, or the previous year, refers to the year ending in April 1981.

[8]The household's urgent debt is the total of outstanding loans taken by the household which it must pay back during the year ending April 1982.

[9]One maund is equal to 82 pounds. It is a measure of weight.

[10]Under the mortgage-in-trust transaction, the landowner, in return for a sum of money, transfers his/her land to the mortgagor as collateral on the loan. Until the debt is repaid, the mortgagor has the rights to the use of the services of the land.

[11]All of these variables are for week i. They were collected three times during the year April 1981 to April 1982, therefore i takes the values 1, 2 and 3. These three observations correspond to each of three cropping seasons and were generated during the week prior to the interview of the respondent.

[12] Marketing by household members includes both purchasing household items and selling household production.

[13] One seer is equal to 2.05 pounds. It is a measure of weight.

[14] All of these variables are for season i. The year is defined by the crop cycle and begins in April. The first season applies to the crop planted in early spring.

Non-crop agricultural income is generated primarily from fishing, dairy farming, raising poultry and fruit production.

[15] Crop production is disaggregated into eleven different crops and by two different land tenure classes. The different crops are identified as j=1 (local Aus rice), 2 (high yielding variety, HYV, Aus rice), 3 (jute), 4 (sugarcane), [redacted] (local Aman rice), 6 (HYV Aman rice), 7 (local Boro rice), 8 (HYV Boro rice), 9 (oil seed), 10 (pulses) and 11 (wheat). The different land tenure classes are identified as k=1 (owned land plus land rented-in on a cash basis) and 2 (land rented-in on a share basis).

[16] This refers to the income generated by the production of major vegetable crops, such as cauliflower, beans, potatoes, tomatoes and eggplant.

[17] Input utilization is recorded for the same eleven different crops and according to the same two land tenure classes as were described in footnote 15.

[18] All seed quantities are recorded in seers, with the exception of sugarcane, which is recorded in maunds (equal to 40 seers).

[19] Three fertilizers are commonly used: nitrogen phosphate, sodium phosphate and potassium phosphate. The data for the different fertilizers were not reported separately, and so the differential impact of the different fertilizers can not be identified.

[20] The daily irrigation charge per acre is determined by the government and represents payment for a standard quantity of water applied to an acre of land each day that water is supplied.

[21] Bullock power is different from bullock labour. Bullock power refers to the unit of two bullocks and one operator (usually the owner of the animals). Because of this, the value of the animal can not be directly obtained by considering the price of bullock power as representing a flow of income to the bullock.

[22] This is the respondent's estimate of replacement cost. In all cases the wage-bill refers to the daily cost of a worker or the daily wage of a hired worker.

APPENDIX IV.B.

IV.B.1 Measurement of Cropping Intensity: Methodology

Cropping intensity is a measure of the intensity of land use during the course of a year and it is usually measured by total cropped acreage as a ratio of total cultivated acreage. That is to say, we calculate the total cropped acreage for a particular group of farmers by taking the sum of amounts of land put under different crops during the reference year 1981-1982 and divide it by the total amount of operational holdings of this particular group of size farms in order to obtain their cropping intensity index.

Thus, cropping intensity (CI) is calculated as:

$$CI = \frac{\Sigma_{i=1}^{n} \Sigma_{j=1}^{m} L_{ij}}{\Sigma_{i=1}^{n} L_i}$$

where L_{ij} = amount of land under crop j, cultivated by i^{th} farmer

L_i = land operated by the i^{th} farmer;

m = number of crops grown in a year;

n = number of farmers in the particular group of size farms.

IV.B.2 Measurement of land productivity: Methodology

Unlike cropping intensity, the measurement of land productivity is not so simple. Land productivity is defined as the ratio of output to the associated land input. It is difficult to construct an index particularly in a multi-crop situation like that of Bangladesh where the general practice is to produce more than one crop on a given piece of land in a given year.

First of all, different kinds of crops produced on a given piece of land require different amouts of material inputs for their production. Second, outputs of different crops cannot be aggregated together in physical units to obtain an index of output produced on the given piece of land. Third, the same piece of land can be devoted either to mono crop or multi crop cultivation in which case it is difficult to determine the amount of land to be taken as the correct measure of the land input, especially when the crop-mix choice varies across farms of a particular size. To construct a productivity index, the following conventions were used.

For the measure of output, the value of total crop production is used, following Bardhan (1973). However, using the value of total crop production in a multicrop farms would imply that the results are subject to a "crop composition effect" that may bias the results in an indeterminant direction. There is a "crop composition effect" because the requirement of material inputs per unit of output widely differs among crops. Therefore, one should not use gross value of production on the farm as a measure of total output. One possible way to reduce the "crop composition effect" on the value of crop production is to use "net revenue" which can be obtained by deducting the total expenses on material inputs of crop production, such as seeds, fertilizer, manure and irrigation from the gross value of total crop production. The requirement of these material inputs per unit of crop production varies among crops. Therefore, deducting these material expenses is essentially a method of removing the influences on the value of output that arise due to technical production requirements of different crops. Thus, this "net revenue" can vary across farms not for technical reasons but for the economic reasons that are associated with the economic status of cultivators.

However, outputs and inputs have been valued by the market prices prevailing in the area. Although an insignificant proportion of output may be marketed by many households, all outputs whether self-consumed or marketed, have been valued by the market prices prevailing in the area at the time of interview. For information, it is better to indicate here that the prices of common kinds of crops, such as paddy, jute, wheat, grown in both sampling areas reported do not vary widely across these two regions.

Both the purchased and household own-supplied seeds have been valued by their retail prices at the time of sowing. Fertilizer and irrigation have been valued at the prices the households are reported to have actually paid for them.

For the measure of land input, the amount of net cultivated land (or operational holding) has been used, following Hossain (1977). Hence, the portion of land used for growing a second or third crop during the course of a year has not been added twice or thrice to get the total land input. This is not done because of the discrepancy between yields of long-maturity crop versus the short-maturity crops. For instance, if a cultivator decides to cultivate two short-maturity crops like broadcast "Aus" and "Aman" on a piece of land instead of producing a long-maturity high yielding crop, such as sugarcane, counting the land twice for this cultivator would certainly show a lower land productivity for this farmer than that for the one who grows one long-maturity crop like sugarcane.

APPENDIX IV.C

Table IV.C-1 Sex and Age Distribution of Population in Survey Areas

	Hamsadi (Dacca)			Khilgati (Tangail)		
Age Group	Males	Females	Total	Males	Females	Total
Under 5	31 (8.24%)[a]	49 (14.2%)	80 (11.1%)	61 (13.77%)	43 (12.43%)	104 (13.18%)
5-9	59 (15.69%)	84 (24.35%)	143 (19.83%)	58 (13.09%)	68 (19.65%)	126 (15.97%)
10-14	61 (16.22%)	55 (15.94%)	116 (16.09%)	74 (16.7%)	53 (15.32%)	127 (16.1%)
15-19	40 (10.64%)	22 (6.38%)	62 (8.6%)	76 (17.16%)	33 (9.54%)	109 (13.8%)
20-24	41 (10.9%)	13 (3.77%)	54 (7.49%)	30 (6.77%)	22 (6.36%)	52 (6.59%)
25-29	30 (7.98%)	25 (7.25%)	55 (7.63%)	28 (6.32%)	28 (8.09%)	56 (7.10%)
30-34	9 (2.39%)	22 (6.38%)	31 (4.3%)	24 (5.42%)	17 (4.91%)	41 (5.2%)
35-39	21 (5.59%)	16 (4.64%)	37 (5.13%)	16 (3.61%)	16 (4.62%)	32 (4.06%)
40-44	17 (4.52%)	14 (4.06%)	31 (4.3%)	16 (3.61%)	13 (3.76%)	29 (3.68%)
45-49	20 (5.32%)	19 (5.51%)	39 (5.41%)	13 (2.93%)	12 (3.47%)	25 (3.17%)
50-54	14 (3.72%)	12 (3.48%)	26 (3.61%)	11 (2.48%)	14 (4.05%)	25 (3.17%)
55-59	8 (2.13%)	6 (1.74%)	14 (1.94%)	12 (2.7%)	11 (3.18%)	23 (2.92%)
60-64	13 (3.46%)	4 (1.16%)	17 (2.36%)	13 (2.93%)	7 (2.02%)	20 (2.53%)
65 + over	12 (3.19%)	4 (1.16%)	16 (2.22%)	11 (2.48%)	9 (2.6%)	20 (2.53%)
Total	376 (100%)	345 (100%)	721 (100%)	443 (100%)	346 (100%)	789 (100%)

[a] numbers in parentheses are in percentage.

Table IV.C-2

Distribution of Households by Landownership

Ownership groups (acres)		% of households	Cumulative (%)	Total Population	Average Household members	Total Area (in acre)	% of land owned	Cumulative (%)	Average land owned per household	Average landownership per person
0.1-1.0	Hamsadi	9	9	55	6.11	8.06	3.41	3.41	.90	.15
	Khilgati	9	9	57	6.83	8.27	2.97	2.97	.92	.15
1.01-2.0	Hamsadi	45	54	299	6.64	69.24	29.26	32.67	1.54	.23
	Khilgati	33	42	212	6.42	49.46	17.73	20.70	1.50	.23
2.01-3.0	Hamsadi	31	85	228	7.35	79.94	33.78	66.45	2.58	.35
	Khilgati	28	70	222	7.93	68.93	24.71	45.41	2.46	.31
3.01-4.0	Hamsadi	6	91	47	7.83	21.26	8.98	75.43	3.54	.45
	Khilgati	9	79	74	8.22	30.58	10.96	56.37	3.40	.41
Greater than 4 acres	Hamsadi	9	100	92	10.22	58.17	24.57	100.00	6.46	.63
	Khilgati	21	100	224	10.67	121.68	43.63	100.00	5.79	.54
All Farms	Hamsadi	100		721	7.21	236.67	100		2.37	0.33
	Khilgati	100		789	7.89	278.92	100		2.79	0.35

Table IV.C-3

Distribution of Operational Holding By Size

Size of Landholding (acre)	Hamsadi			Khilgati		
	% of farms	% of land cultivated	Average Size	% of farms	% of land cultivated	Average farm size
0.1-1.0	19	7.50	.88	10	2.98	.81
1.01-2.0	43	32.99	1.70	34	19.22	1.54
2.01-3.0	25	29.37	2.60	26	22.41	2.35
3.01-4.0	6	10.19	3.76	13	15.10	3.17
Greater than 4 acres	7	19.95	6.32	17	40.28	6.46
all farms	100	100	2.22	100		2.72

Table IV.C-4

Distribution of Personal Income By Groups and Sources

Monthly income group		Percentage of		Average monthly income per household	Percentage of Total Monthly Income by Source				
		Households	Population		Crop Income (CI)	Non crop Income (NCI)[a]	Agricultural wage Income (AWI)	Total Agrl. Income (AGI)	Non-Agrl. Income (NAGI)[b]
100-749	Hamsadi	4	3	684	16.34	19.48	19.18	100.00	0
	Khilgati	25	18	608	69.48	18.56	6.62	94.66	5.34
750-999	Hamsadi	11	9	884	66.10	19.34	12.16	97.59	2.41
	Khilgati	20	18	871	72.98	17.83	2.68	93.49	6.51
1000-1499	Hamsadi	35	31	1216	57.19	17.57	4.83	79.59	20.41
	Khilgati	22	22	1195	63.53	16.78	1.35	81.66	18.34
1500-1999	Hamsadi	26	26	1681	57.06	17.99	1.92	76.97	23.03
	Khilgati	17	21	1781	59.12	14.39	0	73.51	26.49
2000 + above	Hamsadi	24	31	2997	49.12	12.96	0	62.08	37.92
	Khilgati	16	21	2752	68.65	14.89	0	83.54	16.46
All income group	Hamsadi	100	100	1707	54.33	15.87	2.70	72.90	27.10
	Khilgati	100	100	1332	66.14	15.95	1.37	83.46	16.54

Note: Samples is 100 in each village: [a]NCI-see definition in Appendix IV.A
[b]NAGI-see definition in Appendix IV.A.

APPENDIX VI.A. Definition of Variables and Data

The data used for commodity demand functions and labour earnings functions is taken from 100 households in each village. The data as described in appendix IV.A has generated the variables needed to estimate the linear expenditure system. This is especially relevant for data on child investment goods. The data generated for the variables of expenditure system (6.7), as well as the definition of those variables are described below. Unless indicated otherwise, all data is available from the survey.

C = consumption of agricultural produce.

Q = consumption of non-farm goods.

p = price of agricultural output. Given the heterogeneity of consumption goods, rice, wheat, vegetables so on, the estimation is done in terms of the value of farm goods in a year (i.e, pC).

r = price of non-farm goods. Similarly for the heterogeneity of non-farm goods, estimation is undertaken in terms of the value of non-farm goods in a year (i.e, rQ).

$P_N x_N = \frac{(P_N X_N)}{N}$ = total monetary cost per minor child (aged under 15) which necessarily includes cost of raising children per year in terms of fixed cost associated with birth, annual cost of food, medicine, footwear, clothing etc. No direct data was available on this cost. However, based on a study by Khuda (1980) in another village, this cost has been calculated as TK. 1640.0 per year per child under age 15 for our sample households. To the extent that food cost actually dominates these cost, and the daily requirements per child does not vary significantly across households, this annual cost of TK. 1640 per each minor taken for all farm households may not be misleading.

$t_{NW} = \frac{T_{NW}}{N}$ = average time involved in raising minor children. Based on the weekly data on baby care for all minors in the household by female members, we calculate the yearly time spent by all females in terms of man-days (7 hours per day).

N = number of minors under age 15.

W_W = wage rate of female workers (TK. per man-day).

$N(P_N x_N + W_W t_{NW})$ = total expenditure both in terms of monetary cost (direct) and indirect cost for minor children per year in Taka, which is the dependent variable in the equation for consumption on child quantity.

$\pi_N' = (P_N x_N + W_W t_{NW})$ = average expenditure per minor child calculated as described above.

$P_E x_E = (\frac{P_E X_E}{E})$ = average monetary expenditure the household actually spent for schooling minor children up to class X per year.

e = maximum total schooling level of all minor children under age 15 (in years). This is calculated as [e = 5 x number of children enrolled in primary schools + 10 x number of children enrolled in Secondary school].

E = maximum per child schooling. It is defined as $\frac{e}{N}$ = [5 x $\frac{\text{primary school children}}{\text{total number of children}}$ + 10 x $\frac{\text{Sec. School children}}{\text{total number of children}}$]

T_{EC} = Total time spent by minor children in schooling in a year. Based on weekly data on time spent on schooling by minors, we calculate yearly time spent in man days by multiplying the weekly hours by 32 weeks (the maximum number of weeks the school may open in a year) and dividing it by 7 hours to reach total man days.

$t_{EC} = \frac{T_{EC}}{E}$ = average yearly time spent by minor children per schooling year.

W_C = wage rate of minor labour (Taka per day).

$\pi_E = (P_E x_E + W_C t_{EC})$ = average cost (both monetary and opportunity cost) per schooling year for a minor (calculated on the basis of the discussion above).

$e\pi_E$ = total cost of educating minor children in a year in terms of monetary cost and income forgone of their pursuing an education (Taka per year)

S_3 = total man days worked by minors in farm activity.

$W_C(S_3+et_{EC})$ = total "possible" earnings by minor children in a year in terms of actual earnings W_CS_3, and forgone earnings, W_Cet_{EC} that could be accured had these minors not attended school last year.

S_1 = total labour supply to farm activity by all adult males in the household in a year.

W_M = adult male wage rate (TK. per day).

S_2 = total labour supply to farm activities by all adult females in the household in a year.

$W_W(S_2+Nt_{NW})$ = total "possible" earnings by all females in the household in a year. This includes actual earnings, W_WS_2, and the potential earnings, W_WNt_{NW}, forgone by raising the N number of minors in the household.

N_1 = number of adult males in the household over 15 years of age.

N_2 = number of adult females in the household over 15 years of age.

s = educational attainment of the household head. It is measured by the number of years of formal education received by the household head.

a = age of the household head. It is directly obtained from data on the age of the household head who was also the respondent of the questionnaire in our sample survey.

Y = total expenditure of the household in a year (Taka per year) less of labour (farm) earnings.

Appendix VI.B

Maximum Likelihood Estimates of Reduced-form Parameters of 6.7

Coefficients	Estimates		T-Statistic	
	Hamsadi	Khilgati	Hamsadi	Khilgati
C_{10}	2269.25	-546.48	2.34*	-.20
B_1	.25	.57	9.66*	7.88*
C_{11}	1158.31	21.82	3.27*	.03
C_{12}	2072.12	738.05	3.79*	5.84*
C_{13}	41.58	44.98	.41	.29
C_{14}	15.84	40.96	1.95*	.94
C_{20}	-2269.25	546.48	-2.34*	.20
B_2	.75	.43	28.57*	5.86*
C_{21}	-1158.31	-21.82	-3.27*	-.03
C_{22}	-2072.12	-738.05	-3.79*	-5.84*
C_{23}	-41.58	-44.98	-.41	-.29
C_{24}	-15.84	-40.96	-1.95*	-.94
C_{30}	4040.76	2288.71	2.21*	1.27*
B_3	.13	.15	2.41*	3.53*
C_{31}	706.37	-529.43	1.43*	-1.16*
C_{32}	1105.81	413.31	1.54*	1.36*
C_{33}	-72.61	-35.89	-.50	-.24
C_{34}	-35.96	14.06	-.83	.45
C_{40}	-258.43	-370.68	-1.08	-.75
B_4	.011	.005	1.45*	.051
C_{41}	140.01	267.68	3.87*	2.94*
C_{42}	-210.27	-22.67	-3.26*	-.24

Appendix VI.B Cont..

Coefficients	Estimates		T-Statistic	
	Hamsadi	Khilgati	Hamsadi	Khilgati
C_{43}	34.73	20.68	3.31*	.67
C_{44}	5.76	-.34	1.18	-.05
C_{50}	899.04	-.04	1.62*	-.009
B_5	.05	.07	2.98*	4.53*
C_{51}	82.83	-146.17	.67	-.59
C_{52}	-453.68	-52.3	-1.93*	-.21
C_{53}	63.37	110.69	1.56*	2.16*
C_{54}	2.57	3.15	.21	.18
C_{60}	3724.61	2084.51	3.13*	1.86*
B_6	.03	.07	.81	2.21*
C_{61}	316.96	-134.94	1.01	-.49
C_{62}	-141.52	84.99	-.36	.37
C_{63}	-167.25	-111.89	-1.85*	-1.25*
C_{64}	-28.07	4.92	-.93	.24

* Asterisk refers to that estimates are significantly different from zero at 90 percent confidence level.

where:

$$C_{10} = \delta_1 + \frac{\beta_C}{A}\ (\delta_5 + \delta_6 - \delta_1 - \delta_2)$$

$$C_{20} = \delta_2 - \frac{\beta_Q}{A}\ (\delta_5 + \delta_6 - \delta_1 - \delta_2)$$

$$C_{30} = \delta_4 - \delta_3 + \left(\frac{\beta_N - \beta_E - \beta_{\ell 3}}{A}\right) (\delta_5 + \delta_6 - \delta_1 - \delta_2)$$

$$C_{40} = \delta_3 + \frac{\beta_E}{A}\ (\delta_5 + \delta_6 - \delta_1 - \delta_2)$$

$$C_{50} = \delta_4 - \frac{\beta_{\ell 3}}{A}\ (\delta_5 + \delta_6 - \delta_1 - \delta_2)$$

$$C_{60} = \delta_5 - \frac{\beta_{L1}}{A}\ (\delta_5 + \delta_6 - \delta_1 - \delta_2)$$

$$B_1 = \frac{\beta_C}{A},\ B_2 = \frac{\beta_Q}{A},\ B_3 = \left(\frac{\beta_N - \beta_E - \beta_{\ell 3}}{A}\right),$$

$$B_4 = \frac{\beta_E}{A},\ B_5 = \frac{-\beta_{\ell 3}}{A},\ B_6 = \frac{-\beta_{L1}}{A},$$

$$C_{11} = \alpha_{11} + \frac{\beta_C}{A}\ (\alpha_{51} + \alpha_{61} - \alpha_{11} - \alpha_{21})$$

$$C_{21} = \alpha_{21} + \frac{\beta_Q}{A}\ (\alpha_{51} + \alpha_{61} - \alpha_{11} - \alpha_{21})$$

$$C_{31} = \alpha_{41} - \alpha_{31} + \left(\frac{\beta_N - \beta_E - \beta_{\ell 3}}{A}\right)(\alpha_{51} + \alpha_{61} - \alpha_{11} - \alpha_{21})$$

$$C_{41} = \alpha_{31} + \frac{\beta_E}{A}\ (\alpha_{51} + \alpha_{61} - \alpha_{11} - \alpha_{21})$$

$$C_{51} = \alpha_{41} - \frac{\beta_{\ell 3}}{A}\ (\alpha_{51} + \alpha_{61} - \alpha_{11} - \alpha_{21})$$

$$C_{61} = \alpha_{51} - \frac{\beta_{L1}}{A}\ (\alpha_{51} + \alpha_{61} - \alpha_{11} - \alpha_{21})$$

$$C_{12} = \alpha_{12} + \frac{\beta_C}{A}\ (\alpha_{52} + \alpha_{62} - \alpha_{12} - \alpha_{22})$$

$$C_{22} = \alpha_{22} + \frac{\beta_Q}{A} (\alpha_{52} + \alpha_{62} - \alpha_{12} - \alpha_{22})$$

$$C_{32} = \alpha_{42} - \alpha_{32} + \frac{(\beta_N - \beta_E - \beta_{\ell 3})}{A} (\alpha_{52} + \alpha_{61} - \alpha_{12} - \alpha_{22})$$

$$C_{42} = \alpha_{32} + \frac{\beta_E}{A} (\alpha_{52} + \alpha_{62} - \alpha_{12} - \alpha_{22})$$

$$C_{52} = \alpha_{42} - \frac{\beta_{\ell 3}}{A} (\alpha_{52} + \alpha_{62} - \alpha_{12} - \alpha_{22})$$

$$C_{62} = \alpha_{52} - \frac{\beta_{L1}}{A} (\alpha_{52} + \alpha_{62} - \alpha_{12} - \alpha_{22})$$

$$C_{13} = \alpha_{13} + \frac{\beta_C}{A} (\alpha_{53} + \alpha_{63} - \alpha_{13} - \alpha_{23})$$

$$C_{23} = \alpha_{23} + \frac{\beta_Q}{A} (\alpha_{53} + \alpha_{63} - \alpha_{13} - \alpha_{23})$$

$$C_{33} = \alpha_{43} + \alpha_{33} + \frac{(\beta_N - \beta_E - \beta_{\ell 3})}{A} (\alpha_{53} + \alpha_{63} - \alpha_{13} - \alpha_{23})$$

$$C_{43} = \alpha_{33} + \frac{\beta_E}{A} (\alpha_{53} + \alpha_{63} - \alpha_{13} - \alpha_{23})$$

$$C_{53} = \alpha_{43} - \frac{\beta_{\ell 3}}{A} (\alpha_{53} + \alpha_{63} - \alpha_{13} - \alpha_{23})$$

$$C_{63} = \alpha_{53} - \frac{\beta_{L1}}{A} (\alpha_{53} + \alpha_{63} - \alpha_{13} - \alpha_{23})$$

$$C_{14} = \alpha_{14} + \frac{\beta_C}{A} (\alpha_{54} + \alpha_{64} - \alpha_{14} - \alpha_{24})$$

$$C_{24} = \alpha_{24} + \frac{\beta_Q}{A} (\alpha_{54} + \alpha_{64} - \alpha_{14} - \alpha_{24})$$

$$C_{34} = \alpha_{44} - \alpha_{34} \frac{(\beta_N - \beta_E - \beta_{\ell 3}}{A} (\alpha_{54} + \alpha_{64} - \alpha_{14} - \alpha_{24})$$

$$C_{44} = \alpha_{34} + \frac{\beta_E}{A} (\alpha_{54} + \alpha_{64} - \alpha_{14} - \alpha_{24})$$

$$C_{54} = \alpha_{44} - \frac{\beta_{\ell 3}}{A} (\alpha_{54} + \alpha_{64} - \alpha_{14} - \alpha_{24})$$

$$C_{64} = \alpha_{54} - \frac{\beta_{L1}}{A} (\alpha_{54} + \alpha_{64} - \alpha_{14} - \alpha_{24})$$

BIBLIOGRAPHY

Abbott, M., and O. Ashenfelter, "Labour Supply, Commodity Demand and The Allocation of Time", Review of Economic Studies, vol. 63, October 1976, pp. 389-412.

Abdullah, A., M. Hossain, and R. Nations, Report on Integrated Rural Development Programme, Dacca: SIDA/ILO, 1974.

Ahmed, Iftekhar "Technical Change and Labour Utilization in Rice Cultivation: Bangladesh", The Bangladesh Development Studies, July 1977, pp. 359-366.

Ahmed, Iqbal, "Wage Determination in Bangladesh Agriculture", Oxford Economic Papers, Vol. 33, July 1981, pp. 298-322.

Ahmed, N., Development Agriculture of Bangladesh, Dacca: Bangladesh Books International, 1976.

Ahmed, S., Rural Development and Employment Expansion in Bangladesh: Experiences from Ulashi, Research Report, National Foundation for Research on Human Resource Development, Dacca, 1981.

Alamgir, M., "Some Analysis of Distribution of Income, Consumption, Saving and Poverty in Bangladesh", The Bangladesh Development Studies, October 1974, pp. 737-818.

Anderson, D., and M.W. Leiserson, "Rural Non-farm Employment in Developing Countries", Economic Development and Cultural Change, January 1980. pp. 227-248.

Arthur, W.B., and G. McNicoll, "An Analytical Survey of Population and Development in Bangladesh", Population and Development Review, March 1978, pp. 23-30.

Bangladesh Bureau of Statistics (B.B.S.), Statistical Yearbook of Bangladesh, Ministry of Planning, Dacca, 1979.

Bangladesh Bureau of Statistics (B.B.S.), Bangladesh Population Census 1974, Ministry of Planning, Dacca, 1978.

Bangladesh Bureau of Statistics (B.B.S), The Year Book of Agricultural Statistics of Bangladesh 1976/1977, Ministry of Planning, Dacca, 1978.

Bardhan, K., "Rural Employment, Wages and Labour Markets in India - A Survey of Research", Parts I, II, and III, Economic and Political Weekly, June-July, 1977, Nos. 26, 27, 28, pp. 34-48, 1062-1074, 1101-1118.

Bardhan, P.K., "Size, Productivity and Returns to Scale: An Analysis of Farm Level Data in Indian Agriculture", Journal of Political Economy, Vol. 81, 1971, pp. 1370-1386.

Bardhan, P.K., "Agricultural Development and Land Tenancy in A Peasant Economy: A Theoretical and Empirical Analysis". American Journal of Agricultural Economics, February, 1979, pp. 48-57.(a).

Bardhan, P.K., "Labour Supply Functions in a Poor Agrarian Economy", American Economic Review, Vol. 69, 1979, pp. 73-83 (b).

Bardhan, P.K., "Wages and Unemployment in a Poor Agrarian Economy: A Theoretical and Empirical Analysis", Journal of Political Economy, Vol. 87, 1979, pp. 479-500. (c).

Bardhan, P.K., "Interlocking Factor Markets and Agrarian Development: A Review of Issues", Oxford Economic Papers, Vol. 32, March 1980, pp. 82-98.

Bardhan, P.K., and Srinivasan, T.N.,"Crop-Sharing Tenancy in Agriculture: A Theoretical and Empirical Analysis", American Economic Review Vol. 61, 1971, pp. 48-64.

Barnum, H.N., and Lyn Squire, "Technology and Relative Economic Efficiency", Oxford Economic Papers, Vol. 30, July 1978, pp. 181-198.

Barnum, H.N., and Lyn Squire, "An Econometric Application of the Theory of the Farm-Household", Journal of Development Economics, Vol. 6 1979, pp. 79-102 (a).

Barnum, H.N., and Lyn Squire, A Model of an Agricultural Household: Theory and Evidence, Baltimore and London: The Johns Hopkins University Press, 1979 (b).

Becker, G.S., "A Theory of the Allocation of Time", Economic Journal, September, 1965, pp. 493-517.

Becker, G.S., and R.T. Michael, "On the New Theory of Consumer Behaviour", Swedish Journal of Economics, December, 197[illegible] pp. 378-396.

Bell, C., "Alternative Theories of Sharecropping: Some Tests Using Evidence from Northeast India", Journal of Development Studies, Vol. 13, July 1977, pp. 317-346.

Bell, C., and P. Zusman, "A Bargaining Theoretic Approach to Crop-Sharing Contracts", American Economic Review, Vol. 66, September 1976, pp. 578-588.

Ben-Porath, Y., "Economic Analysis of Fertility in Israel: Point and Counterpoint", Journal of Political Economy, Vol. 81, 1973, pp. S 202-233.

Berry, R.A., and W.R. Cline, Agrarian Structure and Productivity in Developing Countries, Baltimore and London: Johns Hopkins University Press, 1979.

Binswanger, H.P., "Attitudes Toward Risk: Experimental Measurement in Rural India", American Journal of Agricultural Economics, Vol. 62, August 1980, pp. 395-409.

Binswanger, H.P., "Attitudes Toward Risk: Theoretical Implications of an Experiment in Rural India", Economic Journal, Vol. 91, December 1981, pp. 867-890.

Binswanger, H.P., and M.R. Rosenzweig, Contractual Arrangements, Employment and Wages in Rural Labour Markets: A Critical Review, New York: Agricultural Development Council, 1981.

Blair, H.W., "Rural Development, Class Structure and Bureaucracy in Bangladesh", World Development, January 1978, pp. 65-82.

Cain, M.T., "The Economic Activity of Children in A Village in Bangladesh", Population and Development Review, September 1977, pp. 201-227.

Chayanov, A.V., The Theory of Peasant Economy (eds.) Daniel Thorner et al., Illinois: The American Economic Association, 1966.

Cheung, S.N.S., "Private Property Rights and Sharecropping", Journal of Political Economy, Vol. 76, 1968, pp. 1107-1122.

Cheung, S.N.S., The Theory of Share Tenancy, Chicago: University of Chicago Press, 1969.

Chinn, D.L., "Rural Poverty and the Structure of Farm Household Income in Developing Countries: Evidence From Taiwan", Economic Development and Cultural Change, January 1979, pp. 283-301.

Chowdhury, R.H., "Education and Fertility in Bangladesh", The Bangladesh Development Studies, Vol. 5, January 1979, pp. 81-110.

Clay, E.C., "Institutional Change and Agricultural Wages in Bangladesh", The Bangladesh Development Studies, Vol. 4, 1976, pp. 423-440.

Dacca University: Village Study Group, Working Paper, 1973.

Deaton, A., "A Reconsideration of the Empirical Implications of Additive Preferences", Economic Journal, Vol. 84, June 1974, pp. 338-348.

DeJanvry, Allain and Carlos Garramon, "The Dynamics of Rural Poverty in Latin America", Journal of Peasant Studies, No. 4, April 1977, pp. 206-216.

DeVany, A., "Land Reform and Agricultural Efficiency in Mexico: A General Equilibrium Analysis", Journal of Monetary Economics Suppl. Series, 1977, pp. 123-147.

DeVany, A., and N. Sanchez, "Land Tenure Structures and Fertility in Mexico", Review of Economics and Statistics, February, 1979, pp. 67-72.

DeVany, A., "Property Rights, Uncertainty and Fertility: An Analysis of the Effect of Land Reform on Fertility in Rural Mexico", Weltwintsch. Arch. 1977, pp. 741-764.

Dillon, J.L. and J.R. Anderson, "Allocative Efficiency, Traditional Agriculture and Risk", American Journal of Agricultural Economics Vol. 53, 1971, pp. 26-32.

Dillon, J.L. and P.L. Scandizzo, "Risk Attitudes of Subsistence Farmers in North-east Brazil: A Sampling Approach", American Journal of Agricultural Economics, August, 1978, pp. 425-435.

Easterlin, R.A., The Economics and Sociology of Fertility: A Synthesis, Unpublished report, University of Pennsylvania, Department of Economics, July 1973.

Easterlin, R.A., "An Economic Framework for Fertility Analysis", Studies in Family Planning, Vol. 6, March 1975, pp. 54-63.

Feder, G., "Farm size, Risk-aversion and the Adoption of New Technology under uncertainty", Oxford Economic Papers, vol. 32, July 1980. pp. 263-283.

Government of Bangladesh, Ministry of Agriculture, Krishi Diary, Dacca, 1981.

Government of Bangladesh, Ministry of Health and Population Control, Bangladesh Retrospective Survey 1975, Dacca, 1978.

Government of Bangladesh, Planning Commission, External Evaluation Unit, Retrospective Study of Fertility and Contraceptive Behaviour in Mymensingh District, Dacca, 1980.

Griffin, K.B., "Growth and Impoverishment in the Rural Areas of Asia", World Development, April/May, 1979, pp. 361-383.

Griliches, Z., "Comment", Journal of Political Economy, Part II, March/April 1973, pp. 219-221.

Hayami, Y., and V.W. Rutton, Agricultural Development: An International Perspective, Baltimore: Johns Hopkins University Press, 1971.

Heibert, L.D., "Uncertainty and Incentive Effects in Share Contracts", American Journal of Agricultural Economics, August 1978, pp. 536-539.

Hopper, David, "Allocative Efficiency in Traditional Indian Agriculture", Journal of Farm Economics, Vol. 47, 1965, pp. 611-624.

Hossain, M., "Farm Size, Tenancy and Land Productivity: An Analysis of Farm Level Data in Bangladesh Agriculture", The Bangladesh Development Studies, July 1977, pp. 285-348.

Hossain, M., "Factors Affecting Tenancy: The Case of Bangladesh Agriculture", The Bangladesh Development Studies, Summer 1978, pp. 139-162.

Hossain, M., "Foodgrain Production in Bangladesh: Performance, Potential and Constraints", The Bangladesh Development Studies, (Special issue on Food Policy and Development Strategy in Bangladesh), Vol. 8, 1980, pp. 39-70.

Hsiao, J.E., "The Theory of Share Tenancy Revisited", Journal of Political Economy, Vol. 83, Oct. 1975, pp. 1023-1032.

Huang, Y., "Allocative Efficiency in a Developing Agricultural Economy in Malaya", American Journal of Agricultural Economics, Vol. 53 1971, pp. 514-516.

Huffman, W.E., "Interactions Between Farm and Non-Farm Labour Markets", American Journal of Agricultural Economics, December 1977, pp. 1054-1061.

Hunt, D., "Chayanov's Model of Peasant Household Resource Allocation and its Relevance to Mbre Division, Eastern Kenya", Journal of Development Studies, October 1978, pp. 59-86.

Hymer, S., and S. Resnick, "A Model of an Agrarian Economy with Non-agricultural Activities", American Economic Review, September 1969, pp. 493-506.

I.L.O., Poverty and Landlessness in Rural Asia, Geneva, 1977.

Ip, P.C., and C.W. Stahl, "Systems of Land Tenure, Allocation Efficiency and Economic Development", American Journal of Agricultural Economics, February 1978, pp. 19-28.

Islam, Nurul, Development Planning in Bangladesh: A Study in Political Economy, New York: St. Martin's Press, 1977.

Islam, Nurul, Development Strategy of Bangladesh, Oxford: Pergamon Press, 1978.

Islam, R., "Foodgrain Procurement, Input Subsidy and the Public Food Distribution System", The Bangladesh Development Studies (Special issue on Food Policy and Development Strategy in Bangladesh), Vol. 8, 1980, pp. 89-120.

Islam, T., Social Justice and the Education System of Bangladesh, mimeo, Bureau of Economic Research, University of Dacca, 1973.

Jannuzi, F.T., and J.T. Peach, Report on the Hierachy of interests in Land in Bangladesh, Dacca, USAID, 1977.

Johnson, D.G., "Resource Allocation Under Share contracts", Journal of Political Economy, Vol. 58, 1959, pp. 111-123.

Johnston, B.F. and J. Cownie, "The Seed-Fertilizer Revolution and Labour Force Absorption", American Economic Review, September 1969, pp. 569-582.

Johnston, B.F., and A.J. Meyer, "Nutrition, Health and Population in Strategies for Rural Development", Economic Development and Cultural Change, October 1977, pp. 1-23.

Junanker, P., "A Test of Profit Maximization Hypotheses: A Study of Indian Agriculture", Journal of Development Studies, Vol. 16 1980, pp. 186-203.

Keeley, M.C., "A Comment on 'An Interpretation of the Economic Theory of Fertility'", Journal of Economic Literature, Vol. 18, 1975, pp. 461-468.

Khan, A.R., "The Commilla Model and the Integrated Rural Development Programme of Bangladesh: An Experiment in Co-operative Capitalism", World Development, April/May, 1979, pp. 397-422.

Khuda, B., Labour Utilization in a Village Economy of Bangladesh, Unpublished Ph.D. Dissertation, A.N.U., Canberra, 1978.

Khuda, B., Fertility Level and Attitudes and the Value of Children in Sreebollobpur: A Relatively Developed Bangladesh Village, Research Report New Series, 22, The Bangladesh Institute of Development Studies, Dacca, 1980.

Krishna, R., "Comment: Models of the Family Farm" in Subsistence Agriculture and Economic Development, (ed.) C.R. Wharton, Jr., Chicago: Aldine, 1969.

Kuznets, S., "Children and Adults in the Income Distribution", Economic Development and Cultural Change, Vol. 30, July 1982, pp. 697-738.

Latif, A. and N. Chowdhury, "Land ownership and Fertility in Two Areas of Bangladesh", The Bangladesh Development Studies, April 1977, pp. 239-246.

Lau, L.J., W. Lin and P.A. Yotopoulos, "The Linear Logarithmic Expenditure System: An Application to Consumption-Leisure Choice", Econometrica, Vol. 46, July 1978, pp. 843-868.

Leibenstein, H., "An interpretation of the Economic Theory of Fertility: Promising Path or Blind Alley?" Journal of Economic Literature, Vol. 12, June 1974, pp. 457-479.

Leibenstein, H., Economic Backwardness and Economic Growth, New York: John Wiley and Sons, 1957.

Mamdani, M., The Myth of Population Control, New York: Monthly Review Press, 1972.

Marshall, A., Principles of Economics, London: MacMillan and Co., 1952.

Mellor, J., The New Economics of Growth: A Strategy for India and the Developing World, Ithaca, New York: Cornell University Press, 1976.

Moscardi, E. and A. deJanvry, "Attitudes Toward Risk Among Peasants: An Econometric Approach", American Journal of Agricultural Economics, November 1977, pp. 710 -716.

Muqtada, M., "The Seed-Fertilizer Technology and Surplus Labour in Bangladesh Agriculture", The Bangladesh Development Studies October 1975, pp. 403-428.

Newbery, D.M.G., "The Choice of Rental Contract in Peasant Agriculture" in *Agriculture in Development Theory*, (ed.) L.G. Reynolds, New Haven: Yale University Press, 1975.

Newbery, D.M.G., "Crop Sharing Tenancy in Agriculture: Comment", *American Economic Review*, Vol. 64, December 1974, pp. 1060-1066.

Newbery, D.M.G., "Risk Sharing, Sharecropping and Uncertain Labour Markets", *Review of Economic Studies*, Octover, 1977, pp. 585-594.

Philips, L. *Applied Consumption Analysis*, Amsterdam: North-Holland, 1974.

Rabbani, G., J.T. Peach, and F.T. Jannuzi, *Land Occupancy Survey of Rural Bangladesh*, Dacca: Bangladesh Bureau of Statistics, 1977.

Rahman, M.A. "Farm Size, Efficiency and the Socio-economics of Land Distribution", *The Bangladesh Development Studies*, July 1975, pp. 301-318.

Rao, C.H.H., "Uncertainty, Entrepreneurship and Sharecropping in India", *Journal of Political Economy*, Vol. 79, May/June 1971, pp. 578-595.

Rao, P.M., and R.L. Miller, *Applied Econometrics*, Belmont, Calf.; Wadsworth Publishing Co., 1971.

Repetto, R., *Economic Equality and Fertility in Developing Countries*, Baltimore and London: Johns Hopkins University Press, 1979.

Reynolds, L.G., "Agriculture in Development Theory: An Overview," in *Agriculture in Development Theory*, (ed.) L.G. Reynolds, New Haven: Yale University Press, 1975.

Rosenzweig, M.R., "The Demand for Children in Farm Households", Journal of Political Economy, Vol. 85, 1977, pp. 123-146.

Rosenzweig, M.R., "Neoclassical Theory and the Optimizing Peasant: An Econometric Analysis of Market Family Labour Supply in a Developing Country", Quarterly Journal of Economics, Vol. 95, 1980, pp. 31-55.

Rosenzweig, M.R., and R. Evenson, "Fertility, Schooling and the Economic Contribution of Children in Rural India: An Econometric Analysis", Econometrica, July 1977, pp. 1065-1079.

Roumasset, J.A., Rice and Risk: Decision Making Among Low-income Farmers New York: North-Holland Publishing Company, 1976.

Ruttan, V.W., "Tenure and Productivity of Philipine Rice Producing Farms", Philipine Economic Journal, Vol. 5, 1966, pp. 42-63.

Sahota, G.S., "Efficiency in Resource Allocation in Indian Agriculture", American Journal of Agricultural Economics, Vol. 50, 1968, pp. 589-605.

Schultz, T.W., Transforming Traditional Agriculture, New Haven: Yale University Press, 1964.

Schultz, T.W., "Nobel Lecture: The Economics of Being Poor", Journal of Political Economy, vol. 88, August 1980, pp. 639-651.

Schultz, T.W., (eds.) "New Economic Approaches to Fertility". Proceedings of a Conference, Journal of Political Economy Part II, Vol. 81(2), March/April, 1973.

Sen, A.K., "Peasants and Dualism with or without Surplus Labour". Journal of Political Economy, Vol. 74, 1966, pp. 425-450.

Sidhu, S.S., "Economics of Technical change in Wheat Production in the Indian Punjab", American Journal of Agricultural Economics, May 1974, pp. 217-226.

Sidhu, S.S., "Relative Efficiency in Wheat Production in the Indian-Punjab", American Economic Review, Vol. 64, September 1974, pp. 742-751 .

Sirageldin, I., et al., "Family Planning in Bangladesh: An Empirical Investigation, The Bangladesh Development Studies, January 1975, pp. 1-26.

Stiglitz, J.E., "Incentives and Risk Sharing in Sharecropping", Review of Economic Studies, Vol. 41, 1974, pp. 219-256.

Stepanek, J.F., Bangladesh - Equitable Growth? New York: Pergamon Press, 1979.

Stone, J.R.N., "Linear Expenditure Systems and Demand Analysis: An Application to the Pattern of British Demand", Economic Journal Vol. 64, 1954, pp. 511-527.

Tims, W., Employment by Regions and Sectors: 1950-1985 (Memorandum to Planning Commission), Govt. of Pakistan, 1965.

Theil, H., Theory and Measure of Consumer Demand, Amsterdam: North-Holland, 1976.

United Nations, Demographic Yearbook, New York, 1974.

Willis, R.J., "A New Approach to the Economic Theory of Fertility Behaviour", Journal of Political Economy, Vol.81, 1973, pp. 14-64.

Wilkinson, M., "An Econometric Analysis of Fertility in Sweden, 1870-1965", Econometrica. July 1973, pp. 633-642.

Wolgin, J.M., "Resource Allocation and Risk: A Case Study of Small Holder Agriculture in Kenya", American Journal of Agricultural Economics Vol. 57, 1975, pp. 622-630.

World Bank, Bangladesh - Development in a Rural Economy, 1974 (three volumes).

Yotopoulos, P.A. and L.J. Lau, "A Test for Relative Economic Efficiency: Some Further Results", American Economic Review, Vol. 63, 1973, pp. 214-223.

Yotopoulos, P.A., Allocative Efficiency in Economic Development, Athens: Center for Planning and Economic Research, 1967.

Zaman, M.Q., Social Conflict and Political Process in rural Bangladesh: A Case Study, Unpublished M. Phil. Thesis, Rajshahi: Institute of Bangladesh Studies, 1977.

Zellner, A., J. Kmenta and J. Dreze, "Specification and Estimation of Cobb-Douglas Production Function Models," Econometrica, Vol. 34, 1966, pp. 784-795.