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# ***Modernising Floodplain Agriculture***

*A Study of the Green Revolution in Bangladesh*

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*Geography after all is as concerned with concrete realities as anything can be: open your eyes, start from what you see, from what is visible to everyone. In theory at any rate, there is nothing very difficult about that.*

Fernand Braudel: The Anatomy of France

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## ***Glossary of Non-English words***

<i>Aman</i>	Late summer rice	<i>Gur</i>	Molasses made from date palm or sugarcane
<i>Arodtar</i>	Intermediate agent linking selling and buying traders	<i>Gusthi</i>	Patrilineage
<i>Aus</i>	Spring rice	<i>Hat</i>	Bi-weekly market
<i>Bari</i>	Homestead	<i>Khal</i>	Small river, channel
<i>Bazaar</i>	Daily market	<i>Mahajan</i>	Moneylender
<i>Beel</i>	Low lying area, depression	<i>Matabar</i>	Village leader
<i>Bepari</i>	Trader	<i>Maund</i>	Unit of weight measurement (37.3 kg)
<i>Boar</i>	Oxbow lake	<i>Mouza</i>	Revenue village
<i>Boro</i>	Winter rice	<i>Mullah</i>	Religious leader
<i>Char</i>	Land formed through silt deposits along rivers	<i>Paiker</i>	Agent operating on behalf of a trader
<i>Chula</i>	Oven, hearth, also household	<i>Para</i>	Neighbourhood, part of village
<i>Dadan</i>	Production loan conditional on selling produce to loan giver	<i>Purdah</i>	The seclusion of Muslim women from outsiders
<i>Dheki</i>	Rice husking machine operated by women	<i>Robi</i>	later summer/winter non-rice crop
<i>Feriwalla</i>	Small trader, peddler	<i>Samaj</i>	Village association
<i>Ghata</i>	Set of two pair of oxen used for preparing land	<i>Sardar</i>	Leader
<i>Ghor</i>	Hut	<i>Shalish</i>	Village court
<i>Gram</i>	Village (perceived)	<i>Union</i>	Sub- <i>upazila</i> unit of administration
		<i>Upazila</i>	Sub-district unit of administration (also Thana)

## ***Acronyms***

BADC	Bangladesh Agricultural Development Corporation	IRWP	Intensive Rural Works Programme
BARD	Bangladesh Academy For Rural Development	KSS	Krishi Samobai Samity (village farmers' co-operative)
BKB	Bangladesh Krishi (Farmers) Bank	LIG	Landless Irrigation Group
BRAC	Bangladesh Rural Advancement Committee	LLP	Low Lift Pump
BRDB	Bangladesh Rural Development Board	MP	Muriate of potash
BRDW	Bangladesh Water Development Board	MSS	Mihila Samobai Samity (village women's co-operative)
CIMMYT	IARC for maize (Mexico)	MVs	Modern Varieties
DTW	Deep Tubewell	NGO	Non-governmental Organisation
IARC	International Agricultural Research Centre	RESP	Rural Employment Sector Programme
IBRD	International Bank for Reconstruction and Development	STW	Shallow Tubewell
IRRI	IARC for rice (Philliphines)	TSP	Triple Superphosphate
		TVs	Traditional Varieties
		UNDP	United Nations Development Programme

## ***Units***

1 Maund	37.3 kg
1 Acre	0.4047 ha
1 Cusec	28.32 litres per second
1 US\$	33.3 taka (1988)

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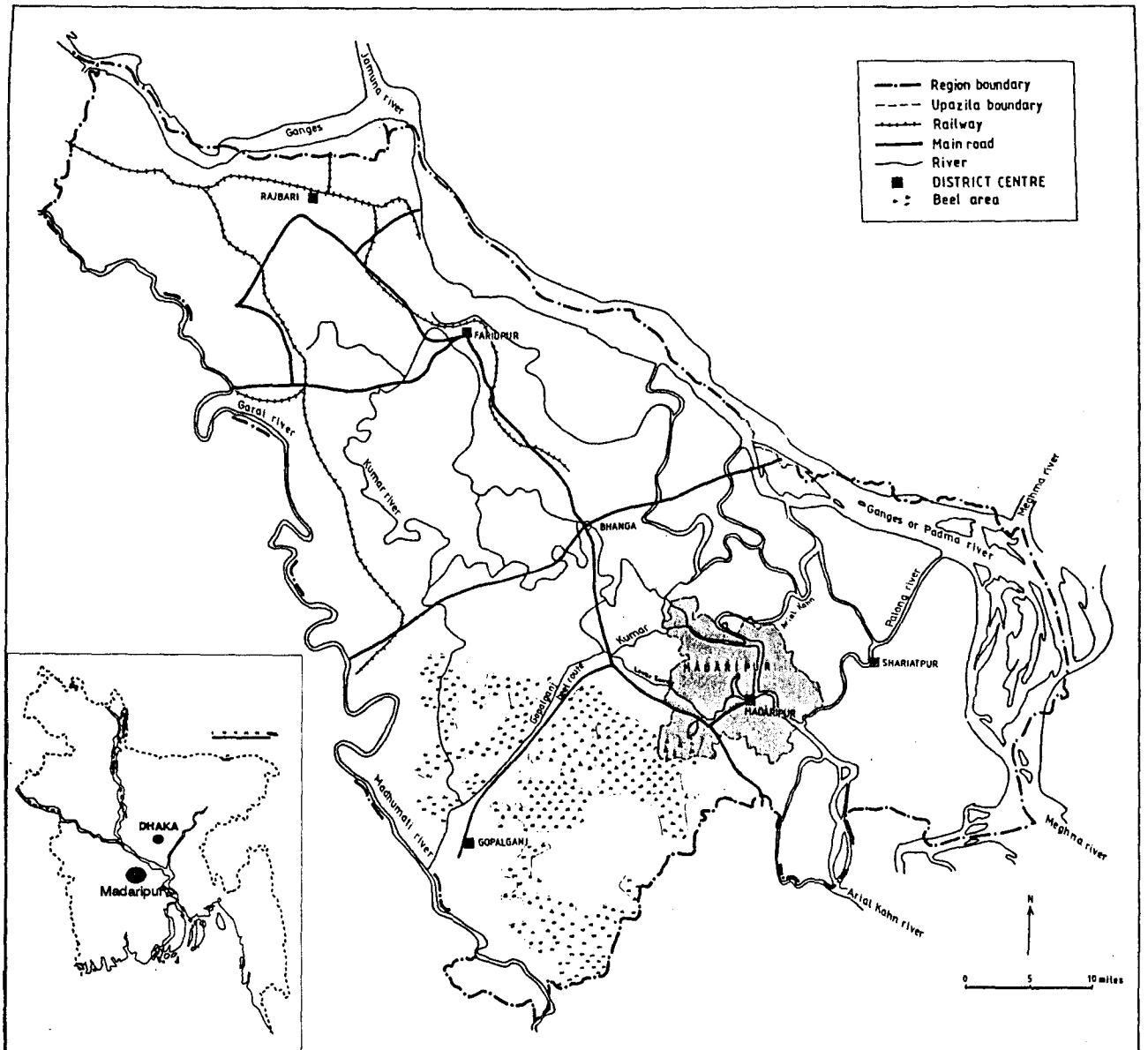
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*Map showing Faridpur Region and location of Madaripur upazila*



## CHAPTER ONE

*INTRODUCTION**The problem*

“*A land made for natural disasters*” is one of the many descriptions of Bangladesh (Bingham 1989). Others have characterised Bangladesh as, “...*the largest and most densely populated pocket of deep poverty in the world*” (Miranda 1990, 198). The reasons for such claims are well known. International news agencies regularly report stories of human suffering caused by floods, cyclones and storm surges. Apparently overpopulated, economically backward, and with widespread poverty, Bangladesh for many represents the prime example of third world misery. Behind such a simplified and stereotypic perception of a stagnant society trapped in deep poverty lies a different and more dynamic Bangladesh. In many arenas Bangladesh is a society undergoing change.

Bangladesh has during recent years gradually obtained a new role in the international division of labour, first of all through rapid growth in the ready-made garment industry. Politically the country is striving towards democracy, after the downfall of the Ershad Regime. In agriculture a process of substantial modernisation has been under way for more than two decades — since the introduction of the green revolution technology in the late 1960s.

The present study is a study of agricultural change in Madaripur Upazila, a small community located in the south-western part of Bangladesh. In many ways the study starts in a small upazila a few miles north of Madaripur, in Bhanga upazila. The upazila is located at the junction between the Faridpur-Barisal Road and a small section of the ‘South-Asian Highway’, a road which once in the future is supposed to provide a link between Calcutta and Dhaka. The upazila centre is dominated by the a large market and a modern upazila administration complex. This centre is surrounded by open paddy fields, rimmed with clusters of green and densely forested homesteads. Anyone passing through Bhanga on the road to Barisal will see an upazila apparently just like any other upazila in this part of Bangladesh.

But Bhanga is different. I first became interested in Bhanga when sitting in my office in Bergen, glancing through one of the many publications from the Bangladesh Bureau of Statistics. In the section on agriculture, this small and apparently insignificant upazila gradually emerged as something of a 'special case'. The statistics showed that in comparison to other upazilas in Faridpur region, a much larger share of the land in Bhanga was irrigated and that the percentage of land cropped with high yielding modern varieties (MVs) was also well above the average. In short, the figures showed that this particular upazila was, in some ways, the centre of the green revolution in the region.

At that time, a question which has continued to draw my attention came to mind; why should this particular upazila lie there like an island in a district where the "green revolution" had, in general made so little progress. Why should Bhanga be so much different from its neighbouring upazilas? I have visited Bhanga Upazila several times, but not done any real fieldwork in order to try to find an answer to this question. Personally, I think it has much to do with umbrellas; that the key to understanding the situation in Bhanga is to be found in the non-agricultural part of the economy. Bhanga is the centre of the umbrella production and repair business in Bangladesh, and it is quite likely that in any market in Bangladesh you will find a man from Bhanga repairing umbrellas. The umbrella business in Bhanga employs several thousand people, both in Bhanga and throughout the country. The majority of those involved are farmers and landless labourers who for part of the year travel from place to place throughout Bangladesh. It is possible that these travelling farmers cum peddlers have brought back both ideas and capital which have been invested in agriculture.

When, in March 1988, I came to Bangladesh in order to plan fieldwork for a study I then thought would focus on agricultural growth linkages, I re-visited *Char Bhamondi*, the small village where I had done fieldwork for my Masters Thesis in 1985/86 (Lein 1987). When I arrived, I saw a village in change. Much of the land which during the winter of 1986 had lain brown and barren, was, in 1988, filled with green rice plants. When I returned again, in spring 1990, even more land had become green, so that almost all of the agricultural land in the village was utilised for irrigated, winter rice production. A small, local, green revolution had taken place during these few years.

Several questions emerged out of these visits to Madaripur. Maybe the most intriguing was related to the question of timing; why did this development take place in this particular period. The changes was obviously not based on the introduction of any new innovations,

the main elements of the green revolution technology had been known, and used, in this particular village, at least since the beginning of the 1970s. These changes had also taken place in a period where farmers had experienced heavy crop losses due to the floods. From this point of view, the late 1980s was hardly as period which invited to investments in agriculture.

The two cases briefly discussed above deal with two key issues. In the case of Bhanga, the problem is how to explain the uneven spread of innovations in space. In the case of Madaripur the main problem is to explain uneven spread of innovations in time. These two issues are central to any study of agricultural change. On a general level the study should be read as a contribution to an on-going discussion on what causes agricultural change, and in particular why such changes, as pointed out by Brookfield (1984), so often tend to take the form of *spatial clusters and temporal bursts*.

The most concrete and main objective of this study is to document *what* happened in Madaripur and *Char Bhramondi* in the late 1980s, to try to find out *why* these events took place and to identify some of the *effects* these changes had on both individual farmers and the local society. As such, the study can be read as a case study, contributing to the growing literature on agricultural change in Bangladesh.

There exists a wide range of theories which seek to explain both causes and patterns of spread of new agricultural innovations. Beside presenting and analysing an interesting case study, a second main objective of the study is to provide a contribution to an on-going discussion on how this type of agricultural change in general best could be analysed and explained. What are the most appropriate theoretical approaches? To what extent can agricultural change be described and analysed with the help of general theories or models? Must such changes rather be perceived as being basically historically and geographically unique processes?

## *Some conclusions*

Although the full answer to the questions presented above are discussed throughout the various chapters, here I briefly present *some* of the most important conclusions of the study.

The changes observed in *Char Bhramondi* took place in a period when the farmers experienced two major natural disasters, two massive floods. I will hereby argue that the floods of 1987 and 1988 and the substantial crop damages caused by these two floods on the rain-fed monsoon crops, have acted as a main driving force behind the spread of the green revolution in Char Bhramondi. *Contrary to what seems to be a widely held opinion, the adoption of green revolution technology in Bangladesh must be seen as a means by which farmers can reduce risks linked to agricultural production.*

The farmers in Madaripur have in the late 1980s adopted technologies which, with some modifications, had been well known in the area for more than 20 years. This sudden adoption happened during the 1980s simply because the farmers gained improved access to existing technology. This improved access is related to policy reforms in the agricultural sector. Reforms that have been much debated in Bangladesh. The experiences from Madaripur, *Char Bhramondi* and elsewhere show *that recent policy reforms in the agricultural sector of Bangladesh have been successful in the sense that they have improved farmer's access to vital inputs such as irrigation equipment and fertiliser.*

Boyce (1986) among others, have forcefully argued that the problems of setting up efficient collective institutions for utilising the available water resources have been, and will be a major constraint to agricultural development in Bangladesh. *The findings from this study show that Boyce may have been too pessimistic in regard to the possibilities to develop local institutional solutions to utilise the key water resource.* The experience from *Char Bhramondi* shows that it is possible to develop informal organisational solutions which make it possible both to raise local capital, as well as to organise a considerable number of reasonably well functioning irrigation schemes.

The spread of irrigation in the late 1980s has mainly been based on a market system, where pumps are privately owned and water is sold as a commodity. I found a market which was not (as sometimes argued) a market controlled by a few powerful 'water lords' enjoying monopolistic control over the vital water resources. But on the contrary, *this study presents*

*a fairly dynamic and competitive water market, involving varying and numerous water-sellers.*

The agricultural innovations discussed here require capital. In our case, adoption of new technology has taken place in a period of excessive and repeated crop damages due on the whole to floods, though also to hailstorms. This implies that there must have been little room for surplus generation within the agricultural sector itself in this period. I will here argue that *one important key to understanding the spread of the green revolution, is to be found outside the agricultural sector.* Conditions and growth in other sectors of the local economy have most likely been instrumental in setting off changes within the agriculture sector, as in the brief discussion of the Bhanga case. *One important effect of the policy reforms within the minor irrigation sector in particular, seems to have been that the reform has stimulated an inflow of capital generated from outside the agriculture sector, to the agricultural sector.* This flow may be very temporal and is no doubt motivated by a hope of extracting profits from the agricultural sector. Nevertheless this flow may have been crucial in setting off a process of agricultural modernisation.

Concerning the effect of the new technology on the rural society, there exists ample empirical evidence from Bangladesh which stands in stark contrast to claims that the spread of the new technology has been limited only to the more resourceful farmers. The findings from *Char Bhramondi* clearly support the broader view. Following on from this it is therefore difficult to argue that the spread of these innovations can be regarded as the main driving force behind a process of differentiation and polarisation in rural Bangladesh, as for instance claimed by Rahman (1989). *Several studies, including the present one, show that the use of irrigation, MV and fertiliser are common among all groups of farmers. Further it will be argued that the new technology will improve the production capacity and increase economic returns on all types of farms, including the smallest farms.* The new technology does thereby contribute to the consolidation of the small farm.

At the same time it seems clear that the introduction of the new technology also will increase the absolute economic gap between different groups of rural people. The already relatively land rich farmers will gain most in absolute terms because they have more land on which they can utilise the new and more profitable technology. Further, many relatively wealthy farmers, are able to capture a substantial share of other farmers production gains, both through the interest paid on the informal loans and through profits made on land rent from sharecropped land. *The present study shows that a substantial share of the production gains are siphoned off through the water market, as the owners of the irrigation*

*equipment acquire a substantial part of the economics benefits from the use of the new technology.*

Bhauri et al (1986) have in more general terms argued that there are processes in contemporary Bangladesh, such as increased tenancy and use of hired labour, which contains features leading to the persistence of the small farm. They have used the expression "persistence and polarisation" when describing social and economic changes taking place in rural Bangladesh. Although perceived from a quite different perspective, *I think the expression 'persistence and polarisation' to a considerable extent also summarises the impact of the green revolution in Bangladesh agriculture.*

With respect to the question of how to explain agricultural change on a more general level, I will from study discuss four fundamentally different types of theoretical explanations or models which seek to explain agricultural change. *I will on the basis of the empirical evidence presented in this study argue that these more conventional theoretical contributions, do, at best, provide partial explanations.* The changes in Char Bhamondi and Madaripur must to a large extent be understood as the outcome of specific geographical and historical circumstances.

I will further argue that *in order to understand agricultural change, one should look for geographical and historical 'pockets of opportunities'* . This basically implies that one has to look for three basic features. Firstly, one should look for *pressure for change*. This can be the pressure to produce enough food to feed the family, or a strongly felt need to avoid the impact of natural hazards Secondly, one should search for *opportunities for change*. These can be agro-ecological or economic opportunities. Thirdly, examine for *constraints to change*, these being physical, social or economic. Farmers and societies have to find ways of dealing with these constraints, if any actual change is going to take place.

## ***Outline of the study***

Chapter two starts with a presentation of various assessments of the impact of the green revolution. After this general discussion, the more concrete elements of what I will term the 'green revolution technology' in Bangladesh is identified. In the latter part of the chapter I set out to describe the basic features of the approach chosen for the present study. I will take a very brief look at an ongoing discussion within geography, on the relevance of what now commonly is termed the 'new regional geography'. This is done in order to provide a

background for the approach chosen in the present study. In the last part of the chapter, the data on which this study is based, is presented.

The main purposes of chapter three is to present and discuss some of the theories which seek to explain why agricultural change takes place. The review does not attempt to cover all theories or models, but rather to present some models which will be used to interpret some of the observations presented in the empirical part of the study. I have limited the discussion to four fundamentally different types of models and effort has been put into identifying what I see as the main line of reasoning underlying these various models, and to identify the main (causal) explanations they are based on.

Chapter four starts with a description of some general aspects of rural life in Bangladesh. Both some basic physical issues as well as basic social organisation are briefly described. In the following section, aggregate agricultural performance is discussed. Both growth in production of food grains, spread of modern inputs and recent policy reforms in agriculture are discussed. The last part of the chapter is devoted to a review of some empirical, micro-level studies which, in one way or another, set out to explain patterns and causes of agricultural change.

In chapter five, I present the region in which the empirical parts of the study has been carried out. The first part of the chapter gives a description of some key features of the region. The latter part of the chapter is devoted to a more detailed presentation of the agricultural sector and the important changes which have taken place within the sector especially during the 1980s. Most significant among these changes has been the spread of small scale irrigation. The chapter is mainly based on data referring to Madaripur upazila and the Faridpur region.

Chapter six focuses on the spread of irrigation in *Char Bhramondi*. I describe how irrigation schemes are organised, and I identify the owners of pumps, as well as those controlling the different irrigation schemes in the village. A part of the chapter is devoted to a description of some selected schemes, primarily in order to capture the more relational and dynamic aspects of the situation. Two other issues will also be discussed in the closing sections of the chapter, namely; the cost and return to the owners of the irrigation pumps, and the issue pertaining to the access to water in the irrigation schemes.

In chapter seven the consequences of the spread of irrigation in *Char Bhramondi* is are described in more detail. Changes in land use caused by the introduction of a new irrigated

crop are presented. Following on from this I discuss the impact these changes have on labour use and use of other inputs. In the last section I address the impact of land use changes on production, costs and returns

In the concluding chapter, chapter eight, I start by discussing to what extent I think the various model of agricultural development presented in chapter three can be used to explain what has happened in Madaripur and *Char Bhramondi* over the last few years. The concluding part of this chapter includes a brief discussion on the importance and effects of the green revolution on rural societies in Bangladesh.



## CHAPTER TWO

***ON THE STUDY OF AGRICULTURAL  
CHANGE******Introduction***

This study is about a type of agricultural change commonly summarised in the expression, “the Green Revolution”. This term, which came into use in the late 1960s, originally referred to the then predicted consequences of the introduction of new high yielding crop varieties in Third World agriculture, a green revolution would make a red revolution redundant. Over time the expression has gained a slightly different meaning, and is now commonly used as a reference to the introduction of a particular set of innovations in Third World agriculture.

The present chapter starts with a discussion on some aspects of this green revolution. First some general features, as well as various assessments of the impact of the green revolution are presented. After this general discussion, the more concrete elements of what I will term ‘the green revolution technology’ are discussed. In the last part of the chapter I set out to describe the basic features of the approach chosen for the present study. Before doing so, however, I will take a very brief look at an ongoing discussion within geography, on the relevance of what now commonly is termed the ‘new regional geography’. This is done in order to provide a background for the approach chosen in the present study.

***On the nature of the green revolution***

On a very general level the green revolution can be regarded as an attempt to utilise modern science to solve one of mankind's oldest problem: how to feed a growing population. Besides aiming at increasing food production and thereby improving the well-being of the Third World population, it was, as the initial use of the expression itself suggest, regarded by some as a means of maintaining political stability in Third World societies. The green revolution is the result of systematic and world-wide research efforts , with the explicit goal of developing modern, more productive crop varieties.

The development of the first modern varieties (MVs) began in the 1940s, but it was in the 1960s, with the emergence of the first international agricultural research centres, The International Rice Research Institute (IRRI) in the Philippines, and the Centro Internacional de Mejoramiento de Maiz y Trigo (CYMMYT) in Mexico, that the development took off. Since then other similar research institutes, or International Agricultural Research Centres (IARCs), have been established, and at present form an international network of 13 research centres around the world.

These research efforts have been coupled with the development of both national and international industrial capacity for production of the modern inputs (fertiliser, pesticides, pumps etc.) needed to realise the full potential of these modern varieties. International aid agencies along with governments in Third World countries have put great effort into distributing MVs and the other modern inputs to the farmer, through both various macro-economic policies, and specific rural development programmes. In sum, the green revolution must be viewed as the outcome of a large scale international, goal-directed effort to modernise traditional Third World agriculture through a combination of scientific research, the development of industrial capacity and public policies.

#### *The green revolution as a social revolution*

In the 1960s the expectation of what could be achieved through such an effort was as at it highest, perhaps culminating in 1970, when the Nobel's Peace Price was awarded to Norman Borlaug, the 'father' of the green revolution. At that time, many saw the green revolution as the means to solving the problem of producing enough food to a rapidly growing population, thereby eradicating mass-hunger in the Third World. The optimism of that time is captured in Lester Browns often cited assessment of the future impact of the new seeds:

*"...the new seeds promise to improve the well being of more people in a shorter time than any other single technological advance in history. They are replacing disappointment and despair with hope. For literally hundreds of millions they can be the key to the door opening into the twentieth century"* (Brown 1970, 196)

Although in retrospect this claim seems somewhat overly optimistic, the impact on food grain production has been dramatic. To a considerable extent this large scale attempt to modernise Third World agriculture must be termed a success, at least when it comes to increasing production. It has set off a growth in agricultural production, which, according to Lipton and Longhurst (1989), neither in scale, speed, duration nor extent has precedence

in history . Even those questioning the future potential of of the green revolution, acknowledge the importance of what has been achieved so far:

*"After twenty years, the green revolution stands as a touchstone in international agricultural development. At a time when famine seemed imminent, new varieties of wheat and rice introduced to Asia and Latin America along with fertiliser, pesticides and mechanised farm equipment dramatically increased harvests. This agricultural strategy, which transformed lives and prospects of hundreds of millions of people, is considered the most successful achievement in international development since the Marshall plan and the reconstruction of Europe following World War II. India, whose food prospects once seemed bleak, today holds grain reserves that provide insurance against famine. Indonesia, once the worlds largest rice importer, is now self- sufficient and exports rice"(Wolf 1986, 5)*

The impact has, however, been unevenly spread. In large parts of Asia, where the green revolution has made most progress, growth in output of major food grains has more than kept pace with population growth. On the other hand, food grain production per capita in large parts of Africa has declined over the last 20 years. Although this decline may have many causes, it is clear that the African continent has to a considerably degree, been left out of the green revolution. One major reason has been that so far there has been relatively limited progress in developing MVs of some important crops grown in Africa.

Although the green revolution has been rather successful in some respects it has also been heavily criticised for several decades. This critique has been wide sweeping, covering many issues. In 1974, at an early stage of the green revolution, Keith Griffin opened his well known book *'The Political economy of Agrarian Change'* by claiming that *"The story of the green revolution is a story of a revolution that failed"*(Griffin 1974, xi).

One point which has attracted much attention, especially in the 1970s, was the assumed uneven spread of the green revolution technology among different groups of farmers. It has often been claimed that the green revolution is a revolution for the rich, and that only the already wealthy farmers can afford to use the various inputs needed in order to realise the potential of the new seeds.<sup>1</sup> Although there are, as discussed in chapters three and four, both theoretical arguments and ample empirical evidence, contradicting such a simplified view, this view still survives, not least in many textbooks.

One argument following from this view of the green revolution, is the belief that the new technology will wipe out the small subsistence farmer. Some, such as Byres (1981) see the green revolution as a means by which capitalism and capitalist forms of production are brought into Third World agriculture, ultimately leading to the proletarianization of the poor peasantry, and the emergence of a group of capitalist farmers:

*“That the ‘new technology’ has hastened the process of differentiation seems beyond doubt...It has served to consolidate the rich peasantry as a powerful, dominant class: the rich peasantry has become stronger economically and has taken on more of the characteristics of a class of capitalist farmers” (Byres 1981, 427).*

However, this view has also been disputed, and the question of to what extent the green revolution will bring about such a rural transformation has been a major issue in a long-standing debate on the direction of rural change on the Indian subcontinent.<sup>2</sup>

In the 1980s, one saw the re-emergence of a somewhat more positive assessment of the green revolution. Several writers emphasised the positive impact of the new technology on the rural labour market, on food prices, as well as on small farmers’ capacity to produce enough food. In a review of some of the lessons to be learned from experiences with the green revolution in Asia, John Harriss, previously a self acclaimed sceptic regarding the extent to which the small cultivator could benefit from the new technology, concludes as follows:

*... contrary to some pessimistic assessments which continue to influence the thinking of a surprising number of people, the “green revolution” has not impoverished rural people in Asia but rather made a positive contribution to livelihoods. The problem of impoverishment is not due to the “green revolution” but rather, in significant measure, to the lack of an effective “green revolution” in so many regions (Hariss 1989, 142)*

Still, in 1991, nearly twenty years after Keith Griffin wrote his well known book, Vivanda Shiva opens her critique of the green revolution in Punjab in a fairly similar way to the way Griffin started his book:

*“The green revolution has been a failure. It has led to reduced genetic diversity, increased vulnerability to pests, soil erosion, water shortages, reduced soil fertility, micronutrient deficiencies, soil contamination, reduced availability of nutritious food crops for the local population, the displacement of vast numbers of small farmers from their land, rural impoverishment and increased tensions and conflicts. The beneficiaries have been the agrochemical industry, large petrochemical companies, manufacturers of agricultural machinery, dam builders and large landowners” (Shiva 1991a,57)*

As the citation above indicates the present critique of the green revolution has a slightly different focus than in the 1970s. Now, the sustainability and ecological viability of the green revolution is increasingly questioned. Shiva (1991a, 1991b) claims that because the green revolution is ultimately based on what she sees as the modern, western science’s belief that nature must and can be conquered, the green revolution strategy is not sustainable and will ultimately lead to an ecological breakdown. She, and others argue that the strategy

is non-sustainable as it leads to increased monoculture, reduced genetic diversity, increased pollution from fertiliser and pesticides, as well as increased energy use.

Although this brief review only raises some of the main issues discussed in the comprehensive literature dealing with the green revolution, it does show that the history of research on the green revolution is filled with general wide sweeping observations, explanations and statements. It also shows that there is substantial disagreement as to how the green revolution should be perceived and as to how its effect should be interpreted. That there should be differences in point of view is hardly surprising, MVs and their accompanying inputs have been taken into use in a number of different settings: places with different ecological basis, as well as different economic, institutional and political systems. Some authors, such as B. H. Farmer, have, however, also suggested that some of the differences in points of view, can be traced back to the ideological basis of those studying the green revolution:

*"If the labellers of the Left are prone to see the classical Marxist scenario (itself based on what was thought to be happening in eighteenth- and nineteenth-century England and Russia) being played in front of their eyes, and to find a pauperized peasant behind every clump of jowar, those at the other end of the international research agenda may take a panglossian view of the beneficent effects of the international research agencies and for that matter of international and local capital, and seeing a smiling and grateful peasantry amid fields of waving corn (Farmer 1986, 191).*

Chambers (1984) explain some of the discrepancies by pointing at differences in professional background. He talks of two groups of people with different views, 'the positive optimist', including biological scientists involved in creating the new technologies, and the 'negative pessimists', including many social scientists.

What both critics and advocates of the green revolution seem to agree upon, however, is that the green revolution, for better or worse, effects third world farmers and societies in a fundamental way, the impact on both individuals as well as societies will be profound and lasting.

## ***The elements of the green revolution technology***

So far, only the more general aspects of have been discussed. As stated above, the use of the expression the 'green revolution', has changed over the years so that it is now commonly used as a term embracing a set of innovations brought into traditional

agriculture. I will in this section discuss in greater detail the nature of this set of innovations, here also termed the green revolution technology, with special reference to wet-land rice (paddy) production. As underlined by Chambers (1984), many have tended to perceive the new seeds as the main, and most important element of the green revolution technology. However, both the spread of irrigation and increased use of chemical fertiliser may, in practice, have been more important factors behind the increase in food grain production experienced in many parts of the world.<sup>3</sup>

### *The new seeds*

Cultivated rice is commonly classified into two species, *Oryza glaberrima*, grown in limited areas of West Africa, and *Oryza sativa*. The latter is, on the basis of geographical distribution, separated into three major groups; *Indica*, *Japonica* and *Javanica* (Tivy 1990). The first two groups, which each have quite distinct characteristics (table 2.1), were used for the development of the first modern rice varieties (MVs). In short, this involved breeding some of the characteristics of the *japonica* varieties, such as better fertiliser responsiveness, non-photo period sensitivity, etc., into *indica* varieties.

*Table 2.1 Characteristics of indica and japonica varieties of rice*

<i>Characteristics</i>	<i>Variety</i>	
	<i>Indica</i>	<i>Japonica</i>
Climatic zone	tropical monsoon	temperate
Day length	sensitive	not sensitive
Tolerance to unfavourable conditions	high	moderate
Response to fertiliser	poor	good
Lodging	susceptible to	resistant to
Height	tall	short
Yield potential	medium	high

Source: Tivy 1990.

The main purpose of this breeding was to increase agricultural production. One way to achieve this was to develop varieties more responsive to fertilisation than traditional varieties (TVs). Whereas TVs tend to become leafy and to lodge when heavily fertilised, the shorter MVs can absorb heavy fertilisation without this happening. It is often claimed that the new varieties are dependent upon heavy use of chemical fertiliser in order to yield more than TVs, and that the new varieties should therefore be termed, 'highly fertiliser responsive varieties', rather than the more commonly used term, 'high yielding varieties' (HYVs). However, according to Lipton and Longhurst (1989), MVs are bred to make better use of nutrients irrespective of source, and a number of studies have shown that

MVs out-yields TVs with little or no use of inorganic fertiliser, even under relatively marginal environmental conditions. In the long run, this may not be a sustainable practice, as it may lead to substantial fall in soil fertility over some time.

Apart from being bred to be able to absorb more chemical fertiliser, the new varieties are also developed with the purpose of increasing single crop yields by developing varieties that use available nutrients more efficiently, allocate more biomass to grain, at the expense of roots and leaves, and have smaller roots and leaves than TVs, allowing denser planting.

In addition to higher output per crop, higher total output per unit of land can be achieved in other ways. One such way is to develop varieties which allow growth of more crops per year. This can be done by breeding varieties which have a short maturing period and low photo-period sensitivity. Such varieties may be adopted in various seasons and do therefore allow double cropping. Apart from increasing overall output from land, such double cropping may enable seasonal smoothing of food output, work opportunities and food prices (Lipton and Longhurst 1989, 52-3). Another way by which to secure higher output from the land in the long run, is to reduce the risk of crop failure caused by moisture stress (drought and floods) or "pests" (insects, fungi etc.).

The first modern rice variety, IR 8, had, apart from having better fertiliser responsiveness and a higher yielding capacity than the "indica" varieties usually grown in South Asia, a number of other distinct characteristics. The variety was relatively short stemmed, it was non-photo sensitive and had a shorter maturing period than the traditional "Indica" varieties (130 to 150 days vs. 180 days). The variety was however, also highly susceptible to pest and diseases. MVs developed more recently have overcome many of these problems, and many MVs are less vulnerable to damage caused by insects and pests than TVs.

The varieties developed so far have, however, proven to be less suited to the flood prone areas of South Asia. The short maturing period as well as the shortness of the new varieties have proved to be major hindrances for adoption in the deepwater rice areas of South Asia. A short maturing period may cause the rice to mature before the monsoon is finished. The shortness of the new varieties represents a serious problem in heavily flooded areas, as the plants are neither able to grow fast enough nor high enough to survive rapid and/or high flooding. Nor do they withstand periods of submersion as some traditional varieties do. According to Farmer (1979), some of the problems faced with the new varieties in the monsoon areas of South Asia can be linked to choice of breeding strategy. Both IR 8 and other early MVs were bred to be adaptable to a wide range of environmental settings.

Recently, greater emphasis has been put on breeding more location specific, modern varieties. To a great extent new varieties are now developed at national research stations.

*The role of irrigation and other inputs*

The spread of modern varieties has often been closely associated with the spread of irrigation, and in many cases the effect of irrigation has been systematically underestimated compared with the effect of new seeds (Chambers 1984). A distinction between the green revolution technology and irrigation must, however, be made. Irrigation has been in use for thousands of years, and still is used in combination with TVs and traditional manuring practices. At the same time, MVs can be, and are, grown, without irrigation. However, irrigation in combination with MVs, chemical fertiliser and other modern inputs, clearly represents a more optimal solution, as the fertiliser- responsive capacity of the MVs are only fully realised when accompanied by adequate water control, as well as weed and insect control (Hayami and Ruttan 1984).

On a general level, irrigation can be described as a technique for human interception in the hydrological cycle. Irrigation is, in principle, a means to release some of the constraints on human behaviour set by nature. At the same time irrigation also implies the introduction of new constraints, which are technical and social of nature, and which are linked to the appropriation and distribution of water (Carlstein 1982).

Rutenberg (1971) define irrigation as:

*"those practices that are adopted to supply water to an area where crops are grown so as to reduce the length and frequency of the period in which a lack of soil moisture is the limiting factor for plant growth."*(ibid., 132).

Whereas this definition describes irrigation as a means of allowing crop production in dry seasons, irrigation is, in fact, a means of allowing expansion of crop production in both time and space, i.e. into new land which has not been utilised previously, due to lack of sufficient moisture, as well as into new seasons with insufficient rainfall.

Apart from allowing expansion of crop production in time and space, irrigated agriculture has a number of specific agro-economic and ecological advantages compared with rain-fed agriculture, Ruthenberg (1971) lists :



- Higher gross yields per unit of land, either through higher yields per crop, by more crops per year, through growth of heavier yielding crops or by increased (and more profitable) use of major inputs such as manure and labour.
- Reduced yield fluctuations, more continuous and adaptable production.
- Increased production capacity of the farm, reducing the minimum farm size necessary for supplying the household.

The introduction of irrigated agriculture also implies the introduction of a new and more fertile environment compared to rain-fed agriculture. Natural fertilisation of the soil takes place through siltation, through various types of nitrogen fixing blue algaes in the water standing on the fields, and through the mineral content of the applied water (Ruthenberg 1971).

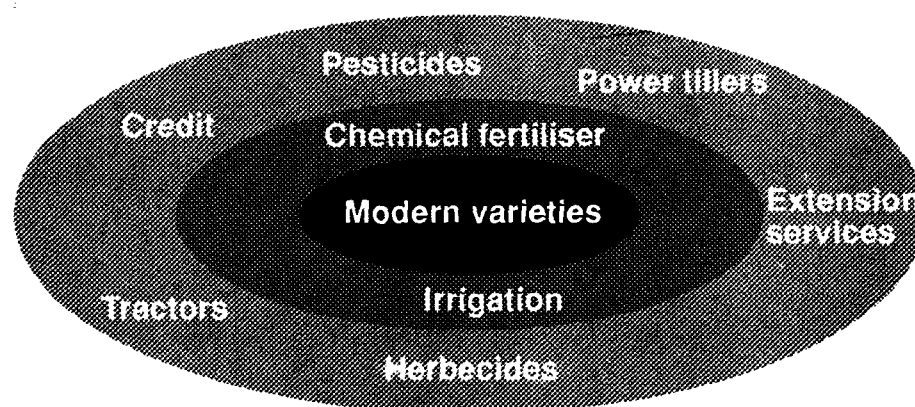
Beside MVs, fertiliser and irrigation, pesticides and fungicides are commonly regarded as the most complementary elements. Weed control is probably of greater importance for the successful growth of MVs than TVs, both because the increased use of fertiliser encourages weed growth, and because the short-stemmed MVs face stiffer competition for sunlight. Herbicides are becoming cheaper and increasingly more common in use in Asia and are rapidly substituting manual weeding (Jayasurunga and Shand 1986). Mechanisation, in the form of power tillers, rice mills etc., is, by some, defined as an integrated element of the green revolution technology (Byres 1981). Others dispute this, and claim that there is good empirical evidence in support of the view that the spread of such labour displacing innovations has taken place quite independently of the spread of other elements of the new agricultural technology (Hayami and Ruttan 1984).

### ***Defining the green revolution technology in Bangladesh agriculture***

The green revolution technology is commonly described as a package of closely related innovations. As can be seen from the short descriptions given above, this package eventually consists of several separate elements which have a number of characteristics which are either overlapping, reinforcing or supplementary to each other. This poses an analytical problem, if, as discussed above, irrigation is treated as a part of the green revolution package. It is reasonable to assume that much of the gain in production attributed to the new varieties, should more rightly be attributed to the introduction of irrigation.

Further, if the new technology is perceived as a package consisting of several innovations which have to be utilized in combination, the definition of this package will be significant as it will have a influence on assessments of both possible adoption patterns as well as on the economic and social impact of the new technology (see figure 2.1). If one assumes that only the core of the innovation - the new seeds - is a necessary element, the new technology is clearly highly divisible and easily adoptable, even for poor farmers. If on the other hand, one assumes that all the elements listed above are necessary and closely linked elements, the use of the new technology will be costly and available only to the more resourceful farmers.

The latter view seems to have formed the basis for some of the more pessimistic assessments of the social effects of the green revolution. Many researchers have claimed that the new technology consists of so many and so expensive elements, that only the most resource-rich farmers can afford to adopt it. Other writers have on the other hand, claimed that the new technology does not necessarily consist of so many new and expensive elements and that in practice various elements, for instance chemical fertiliser, can be, and are, adopted gradually (Rigg 1989). They therefore claim that, in practice, the green revolution technology may be quite accessible, even for resource-poor farmers.



*Figure 2.1 Various elements of the green revolution "package"*

When discussing the case of Bangladesh, I will use the term green revolution technology as a term encompassing three core elements; new seed, chemical fertiliser and irrigation. The other elements are clearly more peripheral. Feder et al (1985) claim that adoption of such new technology should be perceived as a process of adjustment along a continuum, rather than as a dichotomous variable in the meaning use – non-use. In many cases this

may be a sensible view, but cannot be applied without problems in the Bangladeshi context. There is clear evidence of certain complementarity between the use of various inputs, especially between irrigation and other inputs. As will be discussed in greater detail in chapter four, irrigation has been identified as the 'leading input' (Boyce 1987), or in other terminology, the main 'supply side constraint' (Rahman 1984), in the process of modernising Bangladeshi agriculture. Many studies show that the adoption of MVs and other elements of the green revolution technology is dependent upon access to irrigation, and that this constitutes a threshold for adoption which makes it meaningful to use the terms adoption and non-adoption. However, once this threshold is overcome, i.e. a farmer has access to irrigation, adoption of the other elements, especially fertiliser, should be seen as a more continuous process, with numerous individual, farm-level adjustments.

### ***The new regional geography and third world studies***

The problem of explaining what has happened in Bhanga and *Char Bhramondi* is linked to a more fundamental question which commonly arises when one wants to study this kind of social phenomena. The question is simply of to what extent an observed relationship, situation or process of change can and should be described and explained by referring to general processes and relationships, or whether they should be perceived and explained as ultimately unique events in time and space. In human geography, this basic question is partly reflected in the discussion of the role of regional and systematic studies.

#### *The new regional geography*

Regional geography is, by both laymen and some professional geographers, seen as the core of geography, or as Hart see it; "*The highest form of the geographers art*" (Hart 1982). The role of regional studies in geography has, however, varied over time and. During the quantitative revolution, regional studies were to some extent written off as unimportant, compared to more 'scientific' systematic studies. Likewise, the radical geography that emerged during the 1970s, with its focus on general, structural explanations, left little room for the study of particular regions. There has, during the last decade or, so been voiced calls for a revitalisation of regional studies in geography. As pointed out by Pundrup (1988), this call has come from two quite different milieus and has, in fact, been a call for two different types of regional geography. Some, such as Hart, have argued for the revitalisation of the traditional type of regional geography. Others have during the last years

argued for the development of a quite different type of regional approach, and it is this which has been summarised under the heading 'the new regional geography'.

The origins of this new regional geography can, according to Pundrup (1988), be traced back to a growing dissatisfaction with how space increasingly became neglected in explanations of social and spatial processes – in many cases space became a mere container for social processes. In his book *"Ideology, science and human geography"*, Derek Gregory concluded by a statement who have been interpreted as a one of the earliest call for a renewed interest in regional geography:

*"What does make geography so difficult, it seems to me, is not these definitional problems at all, but rather its attempt to operate within specifically regional contexts. Even since regional geography was declared to be dead – most fervently by those who had never been any good at it anyway – geographers, to their credit, have kept trying to revivify it in one form or another. .... This is a vital task: objections to the uncomfortable pinhead perch of neo-classical economics are familiar enough, but they also apply to the rest of political economy and social sciences. We need to know about the constitution of regional social formations, of regional articulations and regional transformations. (Gregory 1978, 171).*

Later Thrift (1983) made a call for what he termed a "reconstructed" regional geography. This should be a regional geography building upon traditional regional geography but with "emancipatory aims" Later Doreen Massey in a short article, *Geography matters!*, came with a well known and influential call for an approach focusing on the interaction between general processes and localities (Massey 1984).

In a recent review Johnston (1991) argues that the new regional geography emerged from the recognition that spatial variations are fundamental to the organisation of society, and that, in fact, the world consists of specific places:

*"...within which general processes are enacted but whose features cannot be accounted for by those processes alone. Thus the nomothetic analysis of spatial structure which characterized much of the 1960s and 1970s are criticized for their emphasis on general laws which determine spatial patterns; so are the ideographic alternatives proposed by some, which focus entirely on the specific characteristics of places and fail to acknowledge the existence of any general processes" (Johnston 1991,49)*

It is difficult to precisely define the new regional geography, as the term embraces elements associated with empirical studies such as locality studies, aspects of more abstract social theory, such as structuration theory, as well as the philosophy of critical realism. Sayer (1989) claims that the new regional geography represents only a loose coalition of interest, which can best be identified through its opposition to traditional regional geography, spatial analysis and theoretic tendencies within radical geography. The term 'new' regional geography may, as Sayer (1989) points out, be highly misleading because the new regional

geography, both philosophically and methodologically, has little in common with the 'old'. Despite this, the term is widely used and accepted, and will be used here.

As emphasised by both Gilbert (1988) and Bradshaw (1990), the concept of a new regional geography has been embraced by researchers working from different theoretical perspectives. Bradshaw therefore finds it relevant to speak of several new regional geographies. On the basis of the various theoretical perspectives underlying the interest in the region, Gilbert (1988) classifies the new regional geography into three categories, while Bradshaw has added a fourth:

i) In the structuralist approach, regional change is seen as a the local response to capitalist processes. This is an approach which, according to Gilbert (1988), is based on a political economy approach grounded on Marxist theory. It is assumed that regions and regional change must be analysed with the social relations of production as the basic point of departure. However, these relations are not regarded as spatial, but rather as being constructed over space. Regions are defined as “... *the concrete articulation of relations of production in a given place and time* (ibid, 208). A prime purpose of this approach is to understand how processes of capital circulation operate in places with distinct social characteristics. The traditional people-environment concern of geography is widened to include society, so that the substance of the new regional geography becomes the triangular relations between people, society and nature (ibid, 210).

ii) In the humanistic approach, the region is seen as a source of identification and meaning. Regions are seen as cultural relationships between people and place, or the symbolic appropriation of space by a group of people. The region is a creation of peoples minds, with the objective of creating order. The region is thus basically a collective physiological phenomena .

iii) In the structuration approach the region is seen as an arena which enables and constrains social interaction. Regions “ *are the physical setting for social interaction, whose properties are employed in a chronic way by agents in the physical and meaningful continuation of encounters across space and time*” (ibid, 212). Regions are reproduced and transformed through practices, through the interaction between institutions and individuals. Social and spatial relations are interdependent and, “...*regional differentiation cannot be grasped without an understanding of the concrete historically situated and politically charged material settings or locale.* (ibid, 213). Bradshaw (1990), also include a fourth category,

the realist approach, in which the region is seen as a provider of contextual conditions, and which determines how and to what extent causal powers act.

As this brief review indicates, the new regional geography is, in fact, a manifold phenomena. As I see it, a main and very central issue in the new regional geography, is a discussion of the role of general versus particular or contextual explanations. As Sayer (1989) put it, a key question in the new regional geography is: “...*how far, or at what depth are social structures and processes context dependent?*.” (Sayer 1989, 255). In her article, “*Geography matters*”, Doreen Massey summarised this basic problem as follows:

*“The fundamental methodological question is how to keep a grip on the generality of events, the wider processes lying behind them, without losing the generality of events, the wider processes lying behind them, without losing sight of the individuality of the form of their occurrence. Pointing to general processes does not adequately explain what is happening at particular moments or in particular places. .... ‘general processes’ never work themselves out in pure form. There are always specific circumstances, a particular history, a particular place or location. What is at issue — and to put it in geographical terms—is the articulation of the general with the local (the particular) to produce qualitatively different outcomes in different localities”* (Massey 1984, 9).

The new regional geography has been criticised from various angles. Bradshaw maintains that Pundrup, in her description of traditional regional geography has created and attacked a ‘straw regional geography’, the distinction between the new and traditional regional geography may not be as clear as she claims (Bradshaw 1990, 317). Others see this new regional geography as being basically a return to empiricism, others again suggest that it may be seen as a more human variant of structural Marxism.<sup>4</sup>

#### *The new regional geography and third world studies*

One of the problems with many recent theoretical discussions in human geography is that they are based on experiences from Western Europe and North America. This is also the case for the new regional geography. Calls for a widening of this basis have been voiced by several writers, for instance Bradshaw (1988) calls for inclusion of non-western experiences:

*“Social theory in human geography is almost entirely concerned with Western capitalism. This is the social theory which informs the new regionalism. If we, as geographers are ‘to take the rest of the world seriously’, we must develop frameworks for examining regional change under different political economic and social systems”* (Bradshaw 1990, 218).

One call for a new regional approach in third world studies comes from Blaikie and Brookfield (1987) who introduce what they call an 'regional political ecology' approach. They see this approach as especially suitable in studies of land management and land degradation. The term 'political ecology' is according to Emel and Peet (1989) increasingly used as a label on resource management studies where resource problems are approached by studying the social system in a dynamic relationship with the environment. The 'regional political ecology' approach may be seen as an extension of the political economy approach and is an approach where: "... *'political ecology' combines the concerns of ecology and broadly defined political . Together this encompasses the constantly shifting dialectic between society and land bases resources, and also within classes and groups within society itself*" (Blaikie and Brookfield 1987, 17) and where the regional aspect is important; "... *because it is necessary to take account of the environmental variability and the spatial variations in resilience and sensitivity*" (ibid, 17).

Brown (1988, 1991) have attempted to outline another framework. In a critique of conventional development studies, he argues for what he terms a 'ground level reality approach' in Third World studies. He claims that the simple conceptual models (centre-periphery models, class analysis etc.) commonly used in traditional development research give only limited insight, and should be replaced by more open research protocols which transcend paradigmatic thinking and, which allow the use of different perspectives. The emphasis should, according to Brown, be laid on inductive, substantiated and informed local level investigations. This is an approach where 'place knowledge' is vital in order understand and explain social processes:

*"In arguing that research on Third World settings should be grounded in and guided by the specifics of place, place knowledge becomes an essential ingredients. This emphasis has an association with traditional regional geography and its descriptive orientation towards informing on areal characteristics for their own sake. But qualification, spatial modelling, neoclassical reasoning, and political economy perspectives of the 1960s, 70s and 80s (which may be seen as a reaction to traditional geography) also are represented. Advocated here then and earlier by Taaffe....., is a return to the geography of place, not as an end in itself, but as a means for understanding societal processes, human behaviour, and the role of place therein."* (Brown 1988, 272).

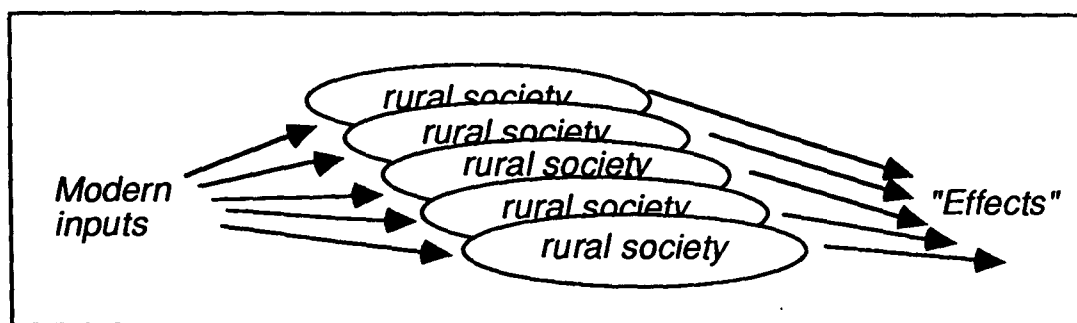
This is an approach which focuses on local level change, but which should not be seen as a call for the study of places in isolation. In general, change is the result of the intermix of external forces, with the individual characteristics of a place. A core element in Browns argument is that studies should emphasise how external forces, such as international political and economic change, international development aid as well as national policies, are articulated in a local context.<sup>5</sup> Place knowledge must not be perceived simply as

knowledge about the local society itself, rather it should involve local knowledge as well as thorough knowledge about the external forces at work in these places. The research strategy must be based on a combination of nomothetic and ideographic perspectives:

*"In a broader frame of reference, focusing on Third World localities as totalities and reviving thereby a long-standing geographical tradition, should increase our knowledge and lead to generalisations that build on, argument, and integrate those already available. The mechanism for accomplishing this is a research strategy that focusses on the intersection of external forces and local characteristics, draws on detailed knowledge of both, and seeks to provide generalizations in the presence of specific conditions. Such a tactic implements a fusion of approaches, blending the nomothetic perspective of development paradigms and the ideographic perspective identified with traditional regional geography." (Ibid, 273)*

## ***The present approach***

The present study is influenced in many ways by the 'new regional geography' and perhaps especially Browns claim for a 'ground level reality approach'. As discussed in the introduction, the present study is based on an underlying view that the green revolution can be seen as a large scale, global process of modernisation of Third World agriculture. This means that it will be possible to identify some general features of the green revolution, that there are certain similarities as regards pattern of spread of the new technology, and consequently, that a substantial part of this modernisation process can best understood by focusing on certain general, social and economic processes working themselves out in more or less similar ways in different localities.



*Figure 2.2 The green revolution perceived as a process*

At the same time it is clear that the green revolution is not something which is simply brought to rural societies and to which they passively respond. It is too simple to interpret the different experiences reported in so many studies of the green revolution as simply being a kind of minor deviations from some general patterns. Rather it is necessary to see



the green revolution as a process which is the outcome of an interplay between general, non-local processes, local societies and individual farmers. The green revolution is created by Third World farmers in local societies, rather than being something that simply happens to them (figure 2.2).

This study deals with a well researched topic. A large number of researchers have dealt with a number of aspects of the green revolution in general, as well as in a specific Bangladeshi context. During the last few years several comprehensive and important studies covering various aspects of the green revolution in Bangladesh has been published. Boyce (1987) present a detailed analysis of long term agricultural changes based on regional statistics. Glaeser (1989) focused on the role of water and water management in a number of shallow tubewell irrigation schemes in several villages. In a recently published study, Lewis (1991) focused on the role of the new, rural entrepreneurs, responsible for delivering modern inputs and services to farmers. In their studies Hossain (1989b,1989c), and Alauddin and Tisdell (1991) present data from comprehensive sample surveys, which cover various aspects of the green revolution. In addition to these studies a large number of other studies have carried out during recent years, some of which will be presented in greater detail in chapter four.

The present study has much in common with the studies mentioned above, as regards both topics covered, and methods of data collection and analysis. There are, however, certain differences. The approach chosen as basis for this study can be summarised in a few points— basic assumptions that have guided my work with the present study.

Firstly, although have chosen what I would call a regional approach as the basis for my study, it is not a study of a single particular region. This study differs from other types of regional studies in the sense that it focuses on a set of regions, rather than on one in particular. The regions focused on here range from the country Bangladesh, to the region Faridpur, the upazila Madaripur, to the village *Char Bhramondi*. Secondly, efforts have been made in order to see recent changes in connection with more long term, historical changes. This is because past experiences unavoidably influence present changes.

Thirdly, agricultural changes are seen in relation to other aspects of economic life. Agricultural change, even in traditional rural societies, is influenced by changes in other sectors of the economy. Fourthly, local changes are seen in relation to non-local changes. This is based on the assumption that all local societies are influenced by processes initiated, and driven, by forces external to the locality. Fifthly, an understanding of the fundamental

aspects of the physical environment has been considered important, simply because these set limits as to what type of agricultural changes that can take place.

Although the approach chosen, as the points above indicate, can be characterised as rather comprehensive and wide reaching, the focus is, in some respects, rather narrow. The study mainly deals with aspects of the material world. The focus is on concrete issues, such as population growth, land use changes, economic changes etc. Considerably less attention has been paid to other aspects of rural life, such as local culture and local politics. Some will undoubtedly also find my treatment of a number social relations rather simplified and shallow. Such biases in focus must partly be seen as the outcome of a conscious choice, and partly as a reflection of my academic background and interests.

As Brown (1988), I think it is both possible and necessary to combine the use of general, abstract theories, with a more ideographic regional approach. The argument is, simply, that theories must be interpreted in a particular context in order to give meaning. If one wants to understand important aspects of contemporary agricultural change in Bangladesh, one needs knowledge both of more general theories of agricultural change, as well as of the localities this agricultural change takes place within.

Theories are, as I see it, means which help us perceive and make sense of the world. The theories and models of agricultural change that are presented in chapter three have directed the empirical focus of the study. Not primarily in the more traditional hypothetical-deductive meaning, in the sense that I have gone in the field in order to test these theories. Rather this theoretical knowledge have guided my more inductive investigations in the field. It has guided me in certain directions, towards an interest in some types of issues, some types of variables and some types of interpretations. This is, as I see it, unavoidable, the empirical must necessarily be grounded in theory.

Apart from providing such a 'hidden' guidance for the empirical part of the study, the various theoretical explanations are also used in a more direct, analytical way. Throughout the text, I will, in a rather pragmatic way, draw upon various theoretical contributions whenever this seems suitable. In some cases, observations can only be understood by drawing on the specific theories presented, while in other cases the theories do provide limited guidance for interpretation.

The present study is a study which has a very limited empirical basis. It is confined to basically a small geographical area and it covers a tiny fraction of the 10 millions farm

households in Bangladesh. There is therefore every reason to underline the danger of looking upon the finding presented here as being 'representative' for rural Bangladesh in general. Having said so, I do think that some of the findings and the interpretations have certain relevance also beyond my study area, simply because many of the issues I have focused on in my study area, are issues common to many villages and farmers in Bangladesh.

In their well known study of the village Palanpur in India, Bliss and Stern (1982) have addressed the problem of using a single village as a basis for such an empirical study:

*People have sometimes remarked to us: 'How can a study based on one village teach us anything?' The remark is pertinent only if it were supposed that we are proposing generalisations for village India. We do not presume to do that. If what we have done seems interesting, then it will have to be tested out elsewhere; alone it could only be suggestive. Nevertheless, we think that it is usefully suggestive. The intensive study of one village is an important testing ground for theories of rural development (Bliss and Stern 1982, 325).*

I agree with Bliss and Stern that such case studies as the present can be used to assess the usefulness of different theoretical contributions. I have, however, in my study not set out to test different theoretical contributions in the same systematic manner they have done in their study. My approach has been more inductive as I have tried to apply different theoretical contributions in order to explain a process of change which I have observed during my visits to the area.

## **Data**

The study is mainly based on data collected during fieldwork periods in Bangladesh in 1986, 1988 and 1990. Data was collected through the use of a set of structured questionnaires, as well as through a number of more open interviews of both farmers and others. In addition to the primary data collected during these fieldwork periods, parts of the study are based on secondary sources, some of which are also presented in more detail in this section.

Some basic features of the structured interviews carried out in 1986 and 1990, are shown in figure 2.3. The material from 1986 has been presented earlier (Lein 1987). Parts of the material collected in 1986, especially from the household interviews, are, however, also presented here. Other findings from 1986 are used indirectly as background references.

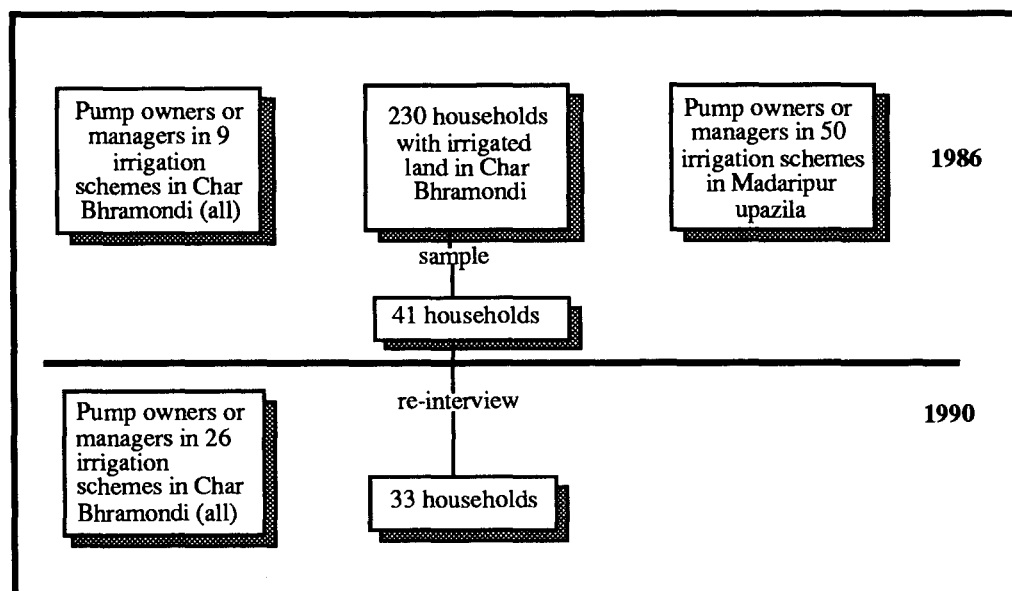


Figure 2.3 Overview of samples

In 1986 information on irrigation schemes in both in the village Char Bhramondi, as well as in other parts of Madaripur, were collected<sup>6</sup>. In 1990, only information on the 26 irrigation schemes in Char Bhramondi was collected. The information on the schemes was mainly obtained through questionnaire aided interviews of pump owners and/or scheme managers. The main objectives of these interviews were to obtain information on the utilisation of pumps, the cost and return for the operation of the pumps as well as some background information on the owner/manager. These interviews were, especially in 1990, supplemented with a number of more informal interviews.

In 1986, a complete land holding census covering all land in the nine irrigation schemes in operation in *Char Bhramondi* was undertaken. In this, farmers owning and operating land in the nine schemes were briefly interviewed on details such as land holding, sharecropping and the land under irrigation. The purpose of this land holding census was primarily to find out which farmers have access to water. In addition to this, the land holding census was supposed to provide a sample frame for the selection of households for more in-depth interviews. However it proved to be rather difficult and time consuming to obtain an complete overview over all farmers involved in the nine irrigation projects. In order to be able to start the household interviews, a non-random sampling procedure was chosen as this allowed us to begin with the household interviews, before having a complete overview of the land holding pattern. From a total of 230 farmers, a small sample of 41 households was selected for interviews.<sup>7</sup>

These household interviews covered basic aspects of the household and sources of income and credit, as well as a rather detailed section on crops and cropping practices. In 1990, we were able to locate and re-interview 33 of these 41 households. These interviews basically dealt with the same issues as in 1986, but were based on a slightly revised questionnaire. All interviews were carried out with the help of an interpreter/assistant.

The 41 households interviewed were initially selected through quota sampling, on the basis of farm size. Quota sampling is a purposive sampling technique which implies: "*...the selection of a number of elements of the population in such a way that a given number of them fall within each of a defined set of subgroups of the population, but where the choice of the actual elements included in the sample for each subgroup is left to the discretion of the enumerator*" (Casley and Lury 1982,72). Although such a purposive procedure does not allow any statistical inference about the population as a whole, the aim of this procedure is still to collect data which gives insight on a larger population. The use of such a non-random sampling procedure does not imply that the findings obtained cannot be seen as relevant for others households than those included in the sample, rather it implies: "*...the selection of a number of elements of the population by a person exercising deliberate choice in an attempt to achieve a sample that represents the population*" (ibid.). A high degree of uncertainty on the representativeness has to be accepted, as one can only hope: "*...that the sample is representative enough for the purpose in hand, but this will not be known with any degree of precision: the probability of bias is there, but its size is unknown*" (ibid.).

As can be seen from table 2.2 below, the 1986 sample reflects the composition of the sample frame (all farmers) in a reasonably good manner in respect to the number of households in different farm size classes. Of the 41 households interviewed in 1986 we were able to find and re-interview 33 households in 1990. Except where otherwise stated, all figures in this chapter are based on the responses from the households included in both the rounds of interviews. Among the households interviewed in 1990, marginal farmers are somewhat over represented, whereas large farmers on the other hand are underrepresented. This was to some extent unavoidable, as we were not able to find and arrange for re-interviews of all those included in the original sample from 1986. The interviews in 1990 covered basically the same issues raised in the 1986 survey, but some new issues, mainly related to flood damages were also included.

Table 2.2 Household interviewed in 1986 and 1990. Percent of total households

	<i>All farmers*</i> 1986	<i>sample</i> 1986	<i>re-interviewed</i> 1990
Marginal farmers(up to 1 acre)	21	24	36
Medium farmers (1 to 5 acres)	53	54	49
Large farmers (more than 5 acres)	27	22	15
<i>Total</i>	<i>100</i>	<i>100</i>	<i>100</i>
	(N=230)	(N=41)	(N=33)

Note: \*Landowners and tenants (sharecroppers).

In addition to these structured interviews, a number of more unstructured interviews were carried out in 1986, 1988 and 1990. These were individual interviews with local farmers and pump owners, as well as with key officials in BADC, Proshika and the upazila administration. Group interviews were also carried out on some occasions. This was mainly to obtain information on specific issues such as labour use patterns, labour migration patterns, the paddy trade system etc. In addition to the interviews carried out in Madaripur, information on the paddy trade system, as well as on other issues such as the Barisal Irrigation Project, was collected during a visit to Barisal town and some of the nearby paddy trading centres in April 1990.

Although a large number of secondary sources has been utilised, a few sources have been more important than others, and deserve some comments. In 1916, a small book with the title: *The economic life of a Bengal district*, was published. The book, written by J. C. Jack gives a unique account of rural life in Faridpur at the beginning of this century. The book contains chapters on physical aspects, agriculture, rural indebtedness and settlement patterns. The book is based on information collected at the beginning of this century, while Jack served as a colonial officer in the district. In his work in the land settlement process, Jack used his junior officers to collect information from the farmers on a number of different issues. The officers were equipped with questionnaires and a fieldwork guide which, with some minor modifications, could have been used as a guideline for fieldwork today. The result of this work was a rather enormous amount of data, of which only a small part is presented in Jack's book. That the book exists at all must be seen as a one of the more fortunate incidents of history. During World War I, Jack served as an officer in the British Army. He wrote his book during a eight day long leave in 1916, after which he returned to the front and was killed. I have used the book as a background, against which I have assessed more long-term historical changes.

As regards information on the situation in Madaripur in the 1980s, data from my own fieldwork have been supplemented with information from two other important sources. At the beginning of the 1980s, a study team prepared a report on Madaripur Thana in connection with the planning and implementation of the so-called Intensive Rural Works Programme (Gallagher et al 1982). In 1986, a new team prepared a Upazila Plan Book, this time in connection with the implementation of the NORAD/SIDA funded Rural Employment Sector Programme (RESP) (LGEB 1986). The first report in particular has proved to be valuable source, as it is a fairly comprehensive, well written, and, on many aspects a well researched report which gives good insight into the situation in Madaripur at the beginning of the 1980s.

### **NOTES**

- 1 For a discussion on the relevance of this claim, see Rigg (1989).
- 2 For a review of this debate, see i.a Thorner (1982). The debate is still on-going, for a recent contribution see Harriss (1992).
- 3 Pinstrup-Andersen and Hazell (1988) cites estimates done which shows that for eight of the major rice producers in Asia, MVs added an estimated 27 million tons to the production in 1980, whereas fertiliser and irrigation added 29 and 34 million tons respectively.
- 4 See Johnston (1991) for a review of some of the critique.
- 5 The reasoning is very similar to much of the reasoning found within the NRG, however Brown argue that he has developed his perspective rather independently of this.
- 6 For a more comprehensive presentation of these findings, see Lein (1987).
- 7 The identification of the household is based on the commonly used 'chula definition' presented in chapter four

## CHAPTER THREE

*EXPLAINING AGRICULTURAL CHANGE**Introduction*

The introduction and spread of agricultural innovations is an issue which has been of concern to geographers and other social scientists for a long time. The topic has been approached from a variety of standpoints and there exists a wide range of theories, or models, which seek to explain the spread and adoption of new innovations into agriculture. Hyami and Ruttan (1985) have identified six main models of agricultural change; the resource exploitation model, the conservation model, the location model, the diffusion model, the high pay-off model and the induced innovation model. A different classification has been presented by Bush and Turner (1987), who group various theoretical contributions into three classes, grouped according to the basic, underlying perspectives. These three main groups of theoretical contributions, (or 'themes') are 'technology themes', 'demand themes' and 'political economy themes'.

A main purpose of this chapter is to present and discuss some of these theoretical contributions. This review is not an attempt to cover all theories or models, but rather to present some models which will be used to interpret some of the observations presented in the empirical part of the study. Effort has been put into identifying what I see as the main line of reasoning underlying these various models, and to identify the main (causal) explanations they are based on, rather than to presenting each theoretical contribution in any great detail.

I will limit my discussion to four fundamentally different types of explanations. I will start by describing what I see as the core elements of diffusion studies. Here, agricultural change is explained as being the result of spatial and social diffusion of agricultural innovations. This presentation is followed by a discussion of some of the criticisms which have been raised against this view. This discussion leads up to a presentation of what I have termed economic explanations of agricultural change. Here agricultural change is seen as the result of rational economic calculations among farmers — farmers undertake changes because it is profitable for them to do so. The presentation of this argument leads up to a



more general discussion about peasant rationality and in particular the importance of risk and risk minimising behaviour.

The third section presents what can be called structural explanations of change. The underlying argument here is that various aspects of the rural society — how it in a broad sense is organised — will decide whether, and to what extent agricultural change will take place. Here two contrasting views on the role of tenancy is presented. The final type of explanation presented here, by some seen as being especially relevant for Bangladesh, deals with the relationship between population growth and agricultural change. A number population based theories exists which seek to explain both the rate and the nature of agricultural change, the most well know among geographers possibly being Ester Boserups' theory on agricultural intensification.

## ***The diffusion of agricultural innovations.***

### *Models of diffusion*

Diffusion of knowledge about new crops, modern inputs and new cropping practices are undoubtedly important factors behind agricultural growth and agricultural change. The study of innovation diffusion is a long and well established tradition within geography and broadly speaking one can distinguish between two major approaches to the study of innovation diffusion within geography.

One approach is linked to Carl Sauer and the 'Berkeley school of geography'. Here, the spread of innovations has been studied in a historical- geographical perspective. The method has been characterised as empiristic-inductive. On the basis of an observed or reconstructed historical pattern of diffusion, one tries to identify possible factors which might explain the diffusion process (Jones 1978).

A second approach, which will be discussed in greater detail here, is linked to Torstein Hägerstrand work on the spatial diffusion of innovations. In 1953, Torstein Hägerstrand published his well known study "*Innovationsförloppet ur korologisk synpunkt*" in which he developed a more formalised approach to studying the spatial spread of innovations. The core elements in Hägerstrands spatial diffusion theory can be summarized in a few main points. Firstly, the spread of an innovation is basically seen as the spread of information. Secondly, the spread of this information is primarily based on direct face-to-face contact between individuals. This again leads to the third main point, — the key to understanding the spread of an innovation in space are the individual 'information fields'.

These information fields tend to be of local nature, people tend to gain most of their information from their immediate neighbourhood. Although the actual information fields of individuals vary, it is possible to identify 'mean information fields' which summarise the potential probability of contact between an adopter and a non-adopter.

On the basis of these simple assumptions, Hägerstrand built a model which could simulate the spread of an innovation in space, with the use of a stochastic 'Monte Carlo' simulation of a diffusion process. Hägerstrand tried to simulate the diffusion of agricultural innovations, among them, pasture improvement subsidies, in Skåne in southern Sweden, and to compare these result with historical information on the actual diffusion pattern.

This initial model has over the years, been extended and elaborated upon, regarding issues such as the structure of "mean information fields", the role of barriers, resistance to accepting an innovation, and so on. And while Hägerstrand initially presented a model of contagious, spatial diffusion, in which geographical distance was the key variable, other types of diffusion, such as hierarchic diffusion, have later been modelled along basically the same way of thinking.

Hägerstrand's work is seen as a major contribution to geographical theory. Morill, Gail and Thrall (1988) have summarized the most important aspects of Hägerstrand's work in four points:

*"The significance of Hägerstrand's work to the specific contribution of diffusion lies, first, in his recognition that diffusion is a pervasive spatial process; second, in his demonstration that spatial diffusion exhibits a degree of regularity or predictability; third, that the actual process of diffusion in space and time critically depends on the pattern of contact among individuals, and on other sources of information available to individuals; and fourth, that it is possible to model the microgeography of diffusion as person to person spread"* (Morill, Gail and Thrall (1988, 34)

Hägerstrand's work on spatial diffusion, as well as later studies within this tradition, is clearly linked to studies of what can be called social diffusion of innovations. This is a topic which, for a long time, has been studied by rural sociologists. The first substantial studies within this tradition arose from the US Department of Agriculture's desire to support small farmers in the Great Plains during the depression in the 1920s and 1930s (Blaikie 1978).

Central to this tradition is a strong focus on the relationship between diffusion and the acceptance of innovations, and the personal characteristics of the farmer. As in the case of studies of spatial diffusion, much effort has been put into identifying patterns and stages of diffusion, mainly in a non-spatial context. Various categories of adopters such as early

adopters, laggards, etc., have been identified. Important, personal characteristics of adopters, such as education, personality type, socio-economic status etc., have been compared to those of non-adopters.

### *Critique of diffusion theories*

Diffusion theories see information as a key variable when explaining innovation diffusion. Blaikie (1978) contests this view and claims that lack of information may not necessarily be the cause of non-adoption, and that limited access to resources and innovations tend to be of much more importance. Both Blaikie (1978) and Gregory (1985) claim that most of the criticism of diffusion theory stems from its failure to locate itself in a theory of social change. Blaike summarises the critique of this tradition as follows:

*“In summary, the major problems of diffusion research derive from its own history and that parts of the bourgeois social science as a whole: namely, an emphasis upon the implicitly ideological concept of the individual adopter, who makes decisions about single technical innovations as the universal and desired model; the treatment of communication as an exogenous, independent variable inducing change; the enlargement of the role of communication at the expense of resource inequalities in explaining innovation adoption: the diversion of syntactics, semantics and pragmatics in the treatment of the communication process; an obsession with quantitative model-building which at present ill founded in the socio economic branch of spatial diffusion theory; and the failure of the theory to be of use in developing countries in the light of current theories of development and underdevelopment” (Blaikie 1978, 278)*

Blaike maintains that structural rather than informational variables is determine innovation diffusion. He suggests what he calls a ‘resource theory of innovation diffusion’, where individual access to resources, markets and information are included. Further he suggest that the two sets of variables — informational and structural — can be joined into a single concept: class. This is so because class is associated with both resource endowments and, as a consequence, the quality of information available to the individual.

A somewhat different critique of the diffusion paradigm has come from Blaut (1977). He criticises what he terms ‘Hägerstrandian’ diffusion theory for being ethnocentric as it is based on a platonic theory of knowledge that assumes that knowledge can be separated form the material world, and because it is based on a specific model of the world, where knowledge (cognitive learning) is privileged over other cultural elements such as values, social structure and economic conditions. He underlines the importance of cultural variations, and suggests that diffusion studies should be more closely linked to the cultural ecology tradition within geography. He advocates what he calls ‘conceptual diffusion theory’, a more broadly based theoretical approach where diffusion is seen as only one aspect of cultural change in general, and where diffusion can only be explained and

predicted on the basis of a broad based theory of culture. Whereas Blaike underlines the importance of access to resources in the diffusion process, Blaut is more concerned with the limited cultural basis for the theory.

According to Hyami and Ruttan (1985), the diffusionist perspective formed the basis for what they call the 'extension bias' in choice of agricultural development strategy in Third World countries in the 1950s. One assumption underlying this strategy is that farmers lacked information and/or knowledge and that they were therefore not utilising available resources efficiently. Linked to this was the argument that small farmers were inefficient producers, and the development of extension services which could diffuse knowledge about new practices, crops and inputs, were essential in order to modernise agriculture. Agricultural extension programs were also supposed to transform the tradition-bound peasant into a more economic rational farmer who would respond to available technical opportunities and allocate resources more efficiently in response to economic incentives (Hyami and Ruttan 1985).

Although formal diffusion theory, as well as the diffusionist model of agricultural development have been heavily criticised, this does not mean that this line of reasoning and the policies based upon it, have been abandoned. Agricultural extension services are still perceived as a key instrument in promoting agricultural development in the Third World, and basic diffusionist thinking still forms a major theoretical foundation for this.<sup>1</sup>

## ***Economic explanations of change***

### *The theory of the optimising peasant*

A highly influential critique of the diffusion paradigm originates in T. Schultz's book "*Transforming traditional agriculture*". The problem of traditional agriculture was not according to Schultz, that farmers lacked knowledge or acted as irrational, non-optimising producers. Rather, he argued, Third World farmers are in general "efficient but poor". Their main problem was that there were few technical and economic opportunities to which they could respond. The way to develop Third World agriculture was, therefore, to transform traditional agricultural systems into modern, more productive ones, by making high pay-off inputs, mainly in the form of non-renewable inputs, available to farmers in the Third World (Hayami and Ruttan 1985).

Schultz claimed that most types of agricultural technology is location specific, and that there are relatively few innovations which can directly be transferred from one setting to another.

The development of location specific solutions is needed, and this can only be achieved through private and public investments in order to:

- 1) develop the capacity of agricultural experiment stations so that they can produce new technical knowledge
- 2) develop capacity in the industrial sector to develop, produce and market new technological inputs and,
- 3) develop the capacity of farmers, through training and education, so that they become familiar with the efficient use of modern agricultural inputs efficiently (Hayami and Ruttan 1985).

The high-payoff output model of agricultural development did provide a significant and highly influential theoretical basis for the formulation of an agricultural strategy, based on the development and spread of the green revolution technology. As underlined by Hyami and Ruttan, *“The significance of the high-payoff input model is that policies based on the model appear capable of generating a sufficiently high rate of agricultural growth to provide a basis for overall economic development consistent with modern population and growth requirements”* (Hyami and Ruttan 1985, 61). In short, one can say that Schultz delivered a strong economic argument for putting resources into the type of research carried out at the international research centres.

According to Ellis (1988), another major contribution of Schultz’s book was that through his argument in favour of the ‘efficient’ peasant, he placed the discussion on peasant rationality firmly on the agenda:

*“...the Schultzian hypothesis derives its importance not from its accuracy as a description of resource allocation in peasant agriculture, but from its success in placing peasant economic rationality firmly on the agenda. Prior to Schultz the literature on ‘traditional’ agriculture was permeated by stereotypes of laziness, perversity, lack of motivation, and, in short irrationality on the part of peasants as economic agents. His hypothesis was the point of departure for taking much more seriously the logic of peasant farm systems, and, from there, for seeking to discover the underlying logic of peasant farm practices instead of dismissing them out of hand as ‘backward’”* (Ellis 1988, 74).

A core element of Schultz’s theory was that farmers were efficient producers and profit maximisers<sup>2</sup> This means that the peasant is also a rational adopter of innovations. He accept new innovations as long as they increase his profit:

*In both the traditional and modern static states he is a rational allocator of resources. He is also a rational innovator as he contrasts his traditional state with the modern state and moves to the latter when profit commands. He then continues to innovate in response to price signals as new technological options continue to emerge (Adams 1986, 275).*

Schultz's main arguments are still accepted by many as being equally valid today and they are used as a guide to academic training as well as basis for policy decisions (Adams 1986). The view of the profit maximising peasant has, however, been much criticised, and is, at least in its pure form, not perceived as a suitable model for farmer's behaviour. Ellis (1988) claims that:

*"In summary, the proposition that peasant farmers are efficient in a pure neoclassical profit maximising sense is neither proven as a general hypothesis, nor is it insightful of variations and its causes in the peasant economy. It requires such strict assumptions about the homogeneity of production and resource conditions confronting all farmers in a sample, as well as about the competitiveness of the markets in which peasant farms operate, that these are rarely likely to pertain in the peasant populations" (Ellis 1988, 73).*

He maintains that a concept of partial or 'constrained' profit maximisation may be a suitable point of departure, given the widespread empirical evidence of economic calculations on behalf of the peasant (ibid, 78). And as Feder et al (1985) show, the assumption that farmer's decisions are derived from a desire to maximise profit or utility, form a basis for most studies on the spread and adoption of innovations. However, the profit maximisation assumption has been modified, as it is acknowledged that farmers operate under certain constraints and uncertainty, and that this may have a profound effect on farmers behaviour in general, as well as on their inclination to adopt innovations.

#### *The risk-minimising peasant*

The view that Third World peasants are profit maximising producers, has been heavily criticised, and some have even argued that Third World farmers rather should be described as risk minimisers. There are two principal approaches to the analysis of risk and risk averse behaviour.<sup>3</sup> One approach links risk to variations in income, and the probability that a specific event will result in income above or below average. The second approach links risk to the probability of disaster. Here, avoidance of disaster is looked upon as the central goal of peasants. A poor peasant simply cannot take any chances which may result in production falling below a certain minimum level, as this would mean outright starvation. He will therefore try to organise his production in a way that secures a minimum production even in bad years. It is this reasoning which underlies Lipton's (1968) 'survival algorithm.'

If a peasant tries to minimise such risk, this will have consequences both for his choice of cropping pattern, and for the adoption of innovations. Cropping patterns will be designed to ensure a minimum level of food security, rather than to maximise output. Innovation spread and adoption may be inhibited, as the introduction of new crops or practices may increase the possibility of failure,. This may be due to lack of knowledge regarding factors such as input and output prices, yield, and the choice of appropriate agronomic practices (Feder et al 1985).

A strong argument in favour of perceiving peasants as risk minimisers, rather than profit maximisers has been put forwarded by Scott in his book on of the moral economy of peasants (Scott 1976).<sup>4</sup> According to Scott :

*“Living close to the subsistence margin and subject to the vagaries of weather and the claims of outsiders, the peasant household has little scope for the profit maximisation calculus of traditional neoclassic economics. Typically, the peasant cultivator seeks to avoid the failure that will ruin him rather than attempting a big, but risky killing. In decision making parlance his behaviour is risk averse; he minimizes the subjective probability of the maximum loss (Scott 1976, 4)*

The conclusion is that the closer a household is to the minimum subsistence level, the less willing it will be to take risk, as: *...the closer to the line a family is - provided that it is still above it - the less its tolerance for risk and the more rational and binding the “safety-first” formula becomes (Scott 1976, 22).*

This safety-first principle does not, however, completely rule out the possibility of risk taking and innovation adoption. Scott identifies two conditions under which this may take place. Firstly, farmers innovate when its safe to do so, that is to say when an innovation offers clear advantage at little risk to subsistence security. A second, and quite different situation occurs when innovation and risk-taking emerge as the last possible solution to a immediately felt subsistence problem:

*“A critical assumption of the safety-first rule is that subsistence routines are producing satisfactory results. What if they are not? Here the rationale of the safety-first principle breaks down. To continue the same routines means to go under in any case and it once again makes sense to take risks; such risks are in the interest of subsistence. ... Much of peasant innovation has this last-grasp quality to it” (Scott 1976, 26).*

Scotts book lead to a renewed discussion on peasant rationality.<sup>5</sup>In a review of this debate, Little (1991) argues for the use of a modified rational choice model. Instead of simple rational choice models, such as the profit maximisation model which he described as a ‘thin’ theory of human action, he argues for a rational choice approach which incorporate

some of the elements of the critique raised against the use of rational choice models in Third World societies. He ends up with what he terms, 'broadened practical rationality', a concept especially suitable for use in area studies:

*"This conception assumes, first that agents are goal-directed and calculating. It loosens the requirement that agents can make precise utility comparisons across options, assuming instead only that they are capable of making approximate and sometimes qualitative comparisons. This conception dispenses with the egoistic premise, allowing that agents may adopt goals that are both self-regarding and other-regarding. It requires that an adequate analysis of choice situations must be based on a relatively specific description of the social and natural environment of choice. And it requires that the model of calculating rationality should incorporate the workings of normative constraints as well as goal-directedness"*  
(Little 1991, 49).

This concept, claims Little, preserves the structure of goal directed rationality, but underlines that for use in concrete cases, it is necessary to have specific information about both local institutions and the normative system the individuals operate within: *"Area studies from a rational choice perspective thus continue to demand detailed investigation of local particulars; there is no basis for supposing that it is possible to derive "theorems" of social action from highly schematic assumptions about utilities and hypothesized market arrangements"* (Little 1991, 49)

## ***Agrarian structure and agricultural change***

### *The relationship between farm size and innovation adoption*

Whereas the previous two sections presented approaches focusing on the individual farmer, the last two sections of the present chapter deal with explanations which focus on how various aspects of the rural society at large will influence on to what extent a agricultural change will take place.

Farm size is often used as an explanatory variable in many theoretical and empirical studies of innovation adoption . Farm size can be treated in principally different ways. Firstly, it can be used directly, in the meaning the amount of land on a given farm. Secondly, farm size can be used as a representation of a type of farm enterprise operating on a certain scale of capital intensity. Thirdly, and maybe most common, farm size can be it can be seen a representation or indicator of wealth and/or class. It is the latter use which will be discussed here.



The use of farm size as an indicator of wealth is not without problems. Wealth can of course be acquired from other sources than farming, and it may likewise be invested outside agriculture. There may therefore be little correspondence between land ownership and wealth in general. There is however, as underlined by Lipton and Longhurst (1989), reason to believe that there is a correlation. In the present study, as in many others, farm size will be interpreted as reasonable good indicator of wealth. Many writers have used farms size as a representation of a Marxist based class concept. This is, however a use that has been criticised for being a to simplistic and one-dimensional measure which fails to capture the relational aspect of the class concept. Several researches have therefore tried to develop more complex, operational definitions of class.<sup>6</sup>

The discussion regarding the relationship between farm size and innovation adoption is directly linked to a discussion of the relationship between farm size and productivity in general. It is something of a conventional wisdom that in traditional agriculture one will very often find an inverse (or negative) relationship between farm size and land productivity (see i.a Berry and Cline 1983). Land productivity is higher on small farms than on large farms due to factors such as: i) a higher percentage of land being under cultivation, ii) higher cropping intensity, iii) higher yield, and iv) higher value mix in cropping pattern. From these, Boyce (1986) identifies points ii) and iv) as being especially relevant for Bengali agriculture.

There may be many causes for these commonly observed patterns. Firstly, it can be argued that the observed inverse relationship between farm size and output only reflects an inverse relationship between farm size and labour use. Small farms will, given the higher on-farm labour-land ratio, have lower labour costs than large farms, who have to depend more on hired labour. A second explanation may be that small farmers have better land than large farmers. A third explanation may be the problems of supervising hired labour, which allow small farmers relying on family labour an advantage over large farmers, who are more dependent on the use of hired labour.

Given the nature of the new technology, and the fact that it is dependent upon the use of certain modern inputs, it is commonly assumed that rich farmers would have clear advantage over poor farmers when it comes to adopting the new agricultural technology. There are several issues which may support such a view. Firstly, there is reason to assume that there may be certain advantages of scale linked to the use of the new technology, as there will always be a certain fixed cost of adoption. This is especially relevant when it comes to the adoption of more expensive technical innovations, such as tractors and tubewells. It can also be argued that this is also the case when it comes to more divisible

modern, variable inputs such as seeds and fertiliser, as there are certain set-up cost, linked to learning about the use of technology, acquiring information about markets and so on (Feder et al 1982).

A somewhat different, but related, argument in favour of claiming that rich farmers will have an advantage over poorer farmers, has been presented by Keith Griffin in his book, *'The Political Economy of Agrarian Change'* (Griffin 1974). Here, Griffin provides an analysis of the interplay between the nature of the green revolution technology, factor endowments on the individual farm, and the nature of rural markets. As a general rule, Griffin argues, rich farmers have more capital per unit of land, whereas the land poor farmer may have more labour available per unit of land. The introduction of capital intensive technology will therefore be more of an advantage to rich farmers than to poor farmers. Rich farmers would adopt such innovations more rapidly and enjoy greater gains from them, than would poor farmers. A labour using innovation, on the other hand, would be more small farmer friendly. In Griffin's terminology, the first type of innovation is 'landlord friendly' while the second is 'peasant friendly'. A key characteristic of the green revolution technology is that it may be looked upon as both labour and capital intensive technology. How capital intensive it is in practice depends, as noted above, on which elements are included in the green revolution 'package'.

Because of the duality of the new technology, it is not a straightforward issue to evaluate to what extent wealth alone will influence the adoption of this innovation. However, Griffin emphasised the complementarity between access to irrigation and the adoption of modern varieties, and argued that since irrigation represented a lumpy capital intensive innovation, the green revolution technology is, in sum, a capital intensive and landlord friendly innovation. In addition there is reason to assume that different classes of farmers face different prices on rural factor markets. In comparison with rich farmers, poor farmers tend to pay higher interest on credit, pay higher wages to hired labour, and face higher prices on inputs such as fertiliser. This may lead to an inefficient use of resources: large farmers choose a more capital intensive technique of production than the social optimum, while the small farmer chooses a more labour intensive technique.

Griffin mainly attributes the malfunctions of rural markets to unfortunate governmental sector policies. In sum, differences in factor endowments, the nature of the green revolution technology, as well as the bias of public policy will result in large farmers being more inclined to adopt the new technology than small farmers. Also among those who have adopted the new technology, rich farmers will enjoy greater gains from the innovation compared to the poorer farmers, as they will have to pay less for the inputs needed.

Another reason for assuming a higher adoption rate by rich farmers is based on the risk aversion hypothesis discussed above. It is reasonable to assume that rich farmers can better afford to take risks than poor farmers (Lipton and Longhurst 1989). Large farmers may therefore be more inclined to adopt the new technology at an early stage, while smallholders may hold back until the advantage and viability of the innovation is proven. That may mean that the more well off farmers may earn an innovators rent. As early adopters, they will enjoy the advantage of having lower costs of production (per produced unit) without experiencing a corresponding fall in prices received for their products. When smaller farmers catch up at a later stage, the cost-price margin may be narrower, as the increased overall production may have driven product prices down.

Although there are good theoretical arguments for assuming a positive relationship between innovation adoption and farm size/wealth, there are also arguments for an inverse relationship, i.e. that small farmers will be more inclined to adopt the new technology than large farmers. One such reason can be termed the subsistence pressure hypothesis. The basic underlying assumption here is that small farmers do face the immediately felt problem of producing enough food, and of obtaining the income required to feed the household members. Small farmers have a very strong need to adopt of the green revolution technology, simply because it may help them grow enough food and make enough money to survive. The small farmers thus adopts out of necessity, as Mahmud and Muqtada (1988), in their analysis of the validity of this hypothesis for Bangladeshi agriculture, conclude: *“Seeking the possibilities in the new technology thus appears almost like the last straw in the small farmers’ bid to survive as a family farm rather than sell their land (and other agricultural assets) and join the rank of landless labourers”* (Ibid, 214).

A second, closely related reason for an inverse relationship between farm size and adoption, is what can be termed the ‘labour scarcity hypothesis’. Here, the basic argument is that as the green revolution technology is relatively labour intensive, the small farms will, due to the relative high (family)worker- land ratio, have an advantage compared to the larger farms. The new technology offers scope for more efficient utilization of available family labour in order to meet the subsistence and income requirements of the family. The land rich farmer will be more dependent upon use of hired labour, and may face considerable supervision cost linked to the utilisation of the new technology. This, together with a broader range of investment opportunities outside agriculture, may explain their relatively limited interest in adoption.

Rigg (1989) argues that it may not only be easier for the small farmer to apply more labour, it may also be easier for him to apply large quantities of purchased inputs. This is because costs escalate in direct proportion to the area of land that is cultivated. A farmer may be land rich, but this does not mean he necessarily has a correspondingly large working capital at hand. Rigg also points to the fact that studies show that small farmers, out of pure necessity, are often more involved in activities outside agriculture, and this may mean that they will have better access to cash per unit of land, than the more land rich farmers (Rigg 1989).

### *Tenancy and adoption*

There exists a large amount of literature on sharecropping in Third World agriculture. Many writers have been particularly interested in whether or not sharecropping is an efficient way of organising production, and how contractual conditions are set. Sharecropping has also been a central issue in some studies on the green revolution. Here an important question has been whether or not tenancy prohibits or promotes the spread of agricultural innovations, and it is this question which will be briefly discussed here. The presentation is mainly based on Ellis (1988), and to some extent on Quibra and Rashid (1984).

Ellis (1988) presents two basic models of sharecropping: the 'tenant, or Marshallian, model' and the 'landlord model', developed by Cheung. According to Ellis, these two theories diverge on to what extent the tenant or the landowner is the principal decision maker as regards resource use. In the tenant model, it is assumed that the tenant controls resource use, and that he is only obliged to pay a certain crop share to the landowner. As the tenant will receive only a portion of the marginal output, he will only apply labour to the level where the marginal product accruing to him is equal to the fixed wage level. This again implies that sharecropping is an inefficient way of organising production, compared to direct, landowner production, as the tenant will apply less than optimal amount of inputs. In the landlord model, it is assumed that the landowner will much more actively set the conditions for the sharecropping contract, in a way which minimises land rent and maximises his profit. He will only have to ensure that the contract allows the tenant an income equal to the going wage, otherwise he will not be able to find tenants.

According to Ellis, none of these theories are good at explaining why sharecropping exists in the first place. In the tenant model, sharecropping is, from the landowner's point of view, an inefficient way of organising production. He would be better off if he organised

his production with the use of hired labour. In Cheungs 'landowner' model, the outcome for the landlord would not be different from direct, owner cultivation (Ellis 1988).

Other explanations of sharecropping which may give more insight into why sharecropping exists at all, have been put forward. Sharecropping can fulfil several functions: it can be perceived as a means of risk sharing, as a way of compensating for imperfect labour markets, a way of compensating for incomplete or non-existent markets (e.g. bullocks) or, as a way of solving the monitoring and incentive problem of the landowner.

Sharecropping can also be analysed as one element in a more complex system of linked or interlocked markets. The term 'interlocked markets' is commonly used to describe situations where terms of exchange in one market, are linked to terms of exchange in other markets. If a landowner sharecrops out land to a tenant, and at the same time provides credit to this tenant on the agreement that the loan will be repaid in kind after harvest, it may be seen as a set of interlinked transactions involving land, capital and labour, as well as the final product.

One view on such interlocked transactions is that they are a means of increasing efficiency and of promoting rapid adoption of innovations. For a profit maximising landowner, interlocking of markets is a means by which he can overcome the inefficiencies of incomplete and fragmentary markets. A landlord can, for instance under the threat of eviction, force the tenant to work harder. The system can also ensure that tenants innovate and make the investments which the landlord finds profitable, either by use of negative means such as threat of eviction, or by positive means, such as giving the tenant credit or some other compensation for the higher costs and risks associated with the innovation.'

A completely different view on sharecropping and rural interlocked markets has been provided by Bhaudri (1986). He sees tenancy as a part of a pre-capitalist, semi-feudal system of surplus extraction and capital accumulation. In this system, surplus is siphoned off from poor peasants both through interest paid on consumption loans, and through crop share (land rent). This system will be so advantageous for the landlord that he will resist attempts to change this relationship, for instance through the adoption of more productive techniques.

*"When the lender of consumption credit is also the landlord, he derives his income both from forced commerce and from rent. Assuming that the share of rent is customarily given, the moneylending landlord has economic interest in ensuring that his borrowing tenant is regularly in need of consumption loans so as his income from forced commerce does not dry up. In addition, the landlord would have diminished control over a tenant who is not constantly in need of consumption loans from him.*

*This requires that the tenant's income must be kept at a sufficiently low level in relation to his indebtedness in order to keep the basis for forced commerce secure. Thus if the tenant's income raises due to agricultural improvement, such moneylending landlords would not be particularly inclined to introduce improvements in agriculture. In such situations the existence of forced commerce would act as a barrier to productive investments in agriculture and technological backwardness may be used as a "control variable" to reinforce the existing asymmetry of economic power relations." (Bhauri 1986, 269-70).*

The model has been criticised both on theoretical and empirical grounds. One argument against the model is linked to the assumption that rent is customarily given, i.e. that it is fixed. If one does not accept this assumption one can, on basis of Cheung's landlord model, simply assume that the landlord can secure, or even increase his income from the sharecropper, by changing the rental conditions for rent (increase share of crop) along with the introduction of the new technology. Although Bhauri's model can be criticised for being unrealistic on this point, it may be argued that the model points to a more general feature, the fact that a landlord may resist change. This resistance may not necessarily be linked only to the economic side. As Boyce (1987) points out, traditional social relations may be altered along with the introduction of more productive production. A landlord may therefore try to resist such changes, for fear of losing social and political power, rather than for fear of incurring a direct economic loss.

## ***Population and agricultural change***

### *Two views on population and agricultural change*

In this last section I will present some theoretical models on the relationship between population and agricultural change. The most well known theory in this field may be Boserup's theory on agricultural intensification. A related, and perhaps more well known theory among economists, is the theory of induced innovations.

In general, there are two opposing views on the relationship between population and agricultural change. One line of reasoning is based on the Malthusian pessimistic view on the relationship between population growth and agricultural growth. Malthus claimed that growth in agricultural production could never keep pace with population growth. The current neo-malthusian view is perhaps less dramatic, but maintains a negative view on the effect of population growth. The main argument is that for several reasons population growth leads to stagnation or decline in agricultural output. Firstly, population growth generally reduces the overall growth rate, as resources are diverted from productive investments to consumption and non-productive investments. Secondly, population growth

may lead to various types of environmental degradation such as overgrazing, soil erosion and deforestation, again reducing agricultural production capacity of the land. Thirdly, population growth may lead to an less efficient agrarian structure, characterised by small and highly fragmented land holdings.

A second line of reasoning maintains a much more positive view on the relationship between population and agricultural growth: many researchers have emphasised that population growth may induce production increasing technological and institutional changes. Gigg (1976, 1979), has on basis of a general, historical discussions on the relationship between population pressure and agricultural change, identified several responses to population pressure. All of these responses have in common that they set out to increase food availability in a society.

The historically most significant response to population growth has been to expand cultivated area. In traditional societies this is the easiest and quickest way of increasing output. A second solution is to crop land more frequently — this response is the core element in Ester Boserup's theory of agricultural intensification. A third solution is to increase labour input. More frequent cropping will normally imply increased labour-use, but increased labour-use can also be implemented on land already intensively cultivated. More extreme cases of the latter may be found in rice growing societies, and has been described by Geertz (1964) as a process of agricultural involution. A fourth solution is to change to higher-yielding crops, a prime historical example being the introduction and spread of potatoes in Northern Europe during the nineteenth century. Finally, adoption of a completely new production system may serve to increase agricultural output. This may be achieved through the use of crops and techniques already known in the society but which are not widely practised, or through the adoption of crops and techniques new to the society.

Perhaps the most well known theory on population growth and agricultural change has been presented by Ester Boserup in her study *"The conditions of agricultural growth"* (Boserup 1965), in which she explores the relationship between population growth and agricultural intensification. Boserup sees population pressure as a major cause of change in land use, agricultural technology, tenure systems and settlement forms (Gigg 1979). A central concern is that choice of agricultural technology and technological change cannot be treated separately from population changes and corresponding population induced changes in land use. The principal means of increasing output is more frequent use of cultivated areas. This is a measure of intensification which differs from others, more conventional measures of intensity, such as capital or labour-use per unit of land.

*The theory of induced innovations*

Many of the arguments presented by Boserup are also present in another theory which focusses on the relationship between population and agricultural change. The theory of induced innovations, or more specifically, the theory of induced technical and institutional change, has attracted a good deal of attention among economists in particular.<sup>7</sup> The theory of induced technological change is based on the view that the nature of technological change in agriculture will be dependent upon societies factor endowments. Some societies are rich in land and capital, others in labour. This will, if the market is allowed to operate freely, be reflected in relative factor-prices. Labour would be relatively cheap compared to land and capital in densely populated societies and relatively expensive in more land-and capital-abundant societies. Hayami and Ruttan (1985) argue that this relationship between factor-endowments and factor-prices will determine the direction of technical change. In a labour-rich country farmers will seek to economise on the more expensive factors (land and capital) favouring use of labour which is relatively cheaper. In land-rich societies, farmers will seek to economise on labour-use, by introducing labour-saving machines.

The assumption of induced technical change is supplemented by a theory of induced institutional change. This is a theory of institutional innovation in which shifts in the demand for institutional innovations are induced by changes both in relative resource endowments and by technical change. Technical change may imply that traditional local institutions are put under pressure and have to be changed. The introduction of new types of labour payment systems, and lease arrangements observed in a village in the Philippines after the introduction of the green revolution, has been interpreted as examples of such induced institutional changes at local level (Hayami and Kikuchi 1987). Induced technical change may also induce other types of institutional change. Differences and changes in factor-prices will create a demand for certain innovations. In a society with limited land resources there would be a demand for land-saving innovations (e.g. fertiliser), and this would induce both private and public agencies to search for, and produce inputs needed to meet this demand.



The core elements of the theory of induced agricultural change has, by Hyami and Ruttans, been summarised as follows:

*“We hypothesize that technical change is guided along an efficient path by price signals in the market, provided that the prices efficiently reflect changes in the demand and supply of products and factors and that there exists effective interaction among farmers, public research institutions, and private agricultural supply firms. Farmers are induced, by shift in relative prices, to search for technical alternatives that save the increasingly scarce factors of production. They press the public research institutions to develop the new technology and also demand that agricultural supply firms supply modern technical inputs that substitute for more scarce factors. Perspective scientists and science administrators respond by making available new technical possibilities and new inputs that enable farmers profitably to substitute the increasingly abundant factors for increasing scarce factors, thereby guiding the demand of farmers for unit cost reduction in socially optimal direction” (Hyami and Ruttan 1985, 88).*

As the citation shows, the model is based on two important assumptions: firstly that factor endowment is reflected in relative factor-prices, and secondly that there is an operational linkage between farmers, researchers and business which relates farm-level demand to the research and business community.

The theory of induced innovations, as outlined above, is termed by Boyce (1987) as the ‘pure’ theory of induced innovations. This ‘pure’ theory will, according to Boyce, run into two sets of problems. Firstly, as initially pointed out by Griffin (1974), it is reasonable to assume that different groups of farmers may face different factor-prices, and that this may lead to a more inefficient path of technical change than if factor endowments alone were allowed to determine the path. Secondly, it is clear that factor ratios and product demand are not the only determinants of technical change. Such change may require certain institutional arrangements both in the national education and research system, as well as at local level. For instance, collective action among farmers may be needed in order allow technical change to take place.

In both the approaches discussed above population and population change are central to the analysis and explanation of agricultural change. Boserup is more concerned with the effect of population change upon land-use intensity, and assumes that changes in land use intensity must be accompanied by technical change. The induced innovation model set out to explain choice and changes in of technology as a result of variations and changes in societies’ factor endowments. Since labour is a key input in agricultural production, population growth is assumed to influence relative factor-prices, and hence choice of technology. Population growth can be assumed to induce land-saving labour-using innovations.

Although there are reasons to assume that population growth in many cases may induce such changes, population pressure cannot in itself, as underlined by Boyce, automatically 'explain' agricultural growth:

*"The problem of course is that the inducement effects are neither automatic nor universal, but on the contrary have been historically very uneven. Population growth cannot 'explain' at the same time prosperity in the Western world and poverty in South Asia. At most it serves to define along with the natural environment, the context within which technological and institutional changes are induced"* (Boyce 1987, 33).

#### *Brookfield on agricultural intensification*

Harold Brookfield has, in two of his articles provided a broader based framework for understanding agricultural change, in which the role of population pressure is seen in relation to a number of other issues (Brookfield 1972, 1984). His article from 1972 is in many ways a discussion and elaboration on Boserups theory on the relationship between population and agricultural change. Here it is suggested that agricultural production should be disaggregated into three types of production: production to meet subsistence needs, production based on social/cultural needs, and production for trade/ cash. Of these three types, only subsistence production is directly related to population pressure. The fact that agricultural production normally takes place for other purposes than simply meeting subsistence needs, makes it difficult to identify a simple population to agricultural-system relationship. Population pressure alone cannot explain agricultural change. In order to incorporate the other types of production, he suggests that one should speak of pressure of needs rather than population pressure.

In his article of 1984 Brookfield states that he finds his 1972 publication to be rather unconvincing on many aspects. In his earlier article he had failed to take adequate account of all the social variables he himself had raised, his theoretical formulations are being too dependent upon the population variable. He found it necessary to draw a clearer distinction between the concepts of intensification and innovation. Intensification is defined as a term referring to the intensified application of labour and others inputs within a system, whereas innovation is a term referring to qualitative changes which are new to the system of production. Innovations may not only be agro-technical, they may also take the form of new factor combinations within the social system, changes in land tenure, pattern of settlement and so on. The increased application of inputs is not an innovation, but if applied in a new way, it also incorporates innovation.

Whereas Boserup emphasises the need for intensification due to subsistence pressure, Brookfield argues that in order to understand agricultural change, the focus should be directed to a greater degree towards the possibilities for change. Conditions for agricultural change vary. In some cases strong forces will be working against change. For instance, a landlord taking advantage of abundant cheap labour in a crowded-low productive system may prefer to maintain a stable situation rather than taking the risks involved with productivity improvements arising from innovation adoption. At the same time, many traditional rural societies have various levelling mechanisms which may be a disincentive to innovation. A farmer will be far more willing to innovate in situations where surplus is neither dispersed through such levelling mechanisms nor concentrated into the hands of a small minority. In sum:

*“..innovation arising from within a society is far more likely to occur, therefore, in a fluid situation in which there is hope of gain than under conditions of mass poverty. In so far as pressure of population on resources is a trigger for innovation, the mediating context must be a social situation in which individuals can hope to gain by innovating, whether, these individuals seek to gain advantage by the exercise of power in society, or are farmers who expect to be able to retain the advantages accruing from the enterprise. For neither of these situations is population pressure a necessary condition, although the perceived possibility that individuals might suffer a decline in their welfare by not innovating may provide a spur to action (Brookfield 1984, 35).*

The main advantage of innovation adoption is the prospect of material gain and central to achieving such gains is a reduction of risk. Unlike many other writers on agricultural change and especially on the green revolution, Brookfield sees innovations as means to reduce risk. Innovation must according to Brookfield, be seen as a risk-reducing strategy.

*All agriculture is subject to risk from climatic hazard and many other forms of risk also intervene. The environment of agriculture is one of constant uncertainty and a high proportion of innovations are designed to reduce that uncertainty, by water control, slope control to minimize the risk of soil loss, and concentration of production for better protection against predators (ibid, 37).*

Unlike Boserup, Brookfield does not see duress as the most likely context for innovation. Innovation, unlike intensification, takes place as the result of perceived advantage, not necessity and in order to be able to innovate, it is necessary to have a surplus. Innovation is, in fact, the productive use of a surplus:

*In order to concentrate and sustain production it is necessary to control the effect of natural processes under interference, and since control is not a directly productive activity its innovation generally requires the existence of a surplus and the means to allocate that surplus. (ibid, 38)*

The main conclusion is that in order to understand why and when innovations occur, one has to search for both opportunities and pressure:

*In seeking a trigger for innovation, therefore we need to look for opportunities as well as for pressures. We have suggested that reduction of risk, especially but not only the risk of a deteriorating environment under pressure, is a major reason for innovation adoption. However, it is necessary to have a surplus to risk in order to reduce risk (ibid, 38)*

This view of innovation may, claims Brookfield, provide a plausible framework for understanding why innovations so often tend to take place in spatial clusters and bursts, followed by long time periods without major change.

Rigg (1985, 1986) has used Brookfield's broad pragmatic approach as a basis for studying agricultural change in Northern Thailand. He finds that population pressure is a factor which forces farmers to change not only their agricultural production system, but also to get more involved in various types of non-agricultural production. Of vital importance for change was the widened pattern of needs over subsistence level. Along with Brookfield's line of reasoning, Rigg finds that agricultural change takes place not only as a result of subsistence needs, but also as the result of the households need for cash. He also underlines that it is important to see agricultural production and non-agricultural activities together, as income from non-agricultural activities is necessary in order to be able to adopt the new technology.

## ***Concluding remarks***

As this short review shows, there exists a wide range of models explaining agricultural change. These tend to differ both as regards mode of explanation, as well as in their main focus. In diffusion studies, the main focus is on the social and spatial spread of information, regarding new practices and new inputs, as a catalyst to agricultural change. This is based on a view of Third World peasants as being basically traditional non-efficient producers, who can gain advantages by combining and using available resources in new and more productive ways. The practical implication of this point of view is that emphasis should be given to training, education and agricultural extension service as means of instigating agricultural change.

This latter view has been contested by a number of writers who have argued that although Third World peasants may be poor, they are efficient producers. They argue that peasants

basically are rational profit-maximisers, which also means that they are economically rational adopters of innovations. If the peasant sees an economic advantage to adopting a new innovation, he will do so. What first of all is needed are more economically viable innovations which farmers can take into use, not more information or training. Such innovations can only be identified through increased research, as well as increased efforts to make high pay-off inputs available to the farmers.

The differences between these theoretical models outlined above is still reflected in discussions over the future prospects for agricultural growth. In a recent review article, Ali and Byerlee (1991) argue that although much effort so far has been put into developing and expanding the use of MV, irrigation and chemical inputs, the potential for future expansion of food production along in way may be reaching a limit. Most likely there will be no new major technological breakthroughs in agriculture before the next century. There exist evidence, however, which suggest that the full potential of existing technologies is still not fully explored. In other words there exist sizeable inefficiencies in the use of the existing green revolution technology. They therefore argue that in order to increase foodgrain production during the next 10 -20 years priority, should be given to the generation of location-specific information, to the upgrading of extension services and to improving basic education.

The assumption that the Third World peasant is a profit-maximising producer, has been contested by a number of writers, who have argued that peasants are risk-minimisers rather than profit-maximisers. This implies that poor peasant in particular will be reluctant to accept innovations as doing so may introduce new uncertainties and increased objective or perceived risk. Opposing this view, some have argued that although a poor farmer may avoid taking risks, he will do so only up to a certain point, beyond which farmers may be willing (or forced) to take such risks. This is because the 'survival algorithm' may work in two ways: taking too much risk may jeopardise the chance of survival, taking no risk may equally do so.

The relationship between access to resources, especially land, and the spread of agricultural innovation is an issue which has been much debated in the literature on the green revolution. As regards the relationship between wealth (or farm size class) and adoption, there is no straightforward conclusion to be drawn on the basis of theoretical arguments alone. It is reasonable to assume that rich farmers will have initial advantages when adopting new innovations, as they enjoy superior access to the capital needed in order to purchase the necessary inputs. In addition, rich farmers may also enjoy greater access to other rural factor markets.

However, there are also some arguments in favour of seeing the small farmer as the most likely adopter of the green revolution technology. Poor farmers may feel a much stronger need to adopt than rich farmers, simply because they need to produce more food to feed the family. In addition, it has been argued that small farmers will have better access to labour, a vital input in the new technology. As regards sharecropping, one can also see two different views. Some argue that sharecropping leads to inefficient use of resources, and that it may inhibit adoption of new innovations. Others argue that sharecropping can be seen as an institution which may promote the rapid spread of innovations.

Several writers have analysed the relationship between population growth and agricultural change. Both Boserup's theory of agricultural intensification, and the theory of induced agricultural innovations, describe a positive relationship between population growth and agricultural change, in the sense that population pressure sets off changes which bring about the establishment of more intense and productive cropping systems. It also seems clear, however, that population pressure alone cannot explain agricultural development.

Initially on the basis of Boserup's theory, H. Brookfield formulated what can be seen as a general framework for how agricultural change best can be understood. In short, his argument is that in order to understand agricultural change, one need to look not only for pressure, as in Boserup's theory, but also for opportunities to undertake change. Innovations take place in order to reduce risk, but for an innovation to be adopted, surplus is also needed. In short, one can say that the core of Brookfield's argument is that in order to explain agricultural change, one should look for pockets of both opportunities and pressure, certain constellations in time and space which allow innovations to take place.

In this chapter I have presented a brief review of a number of models of agricultural change. A key question which arises is to what extent these models and theories discussed here are appropriate means for explaining agricultural change of the type that has taken place in Madaripur and Char Bhramondi. This is an issue to which I will return in the concluding chapter eight. But it should be clear that I have chosen to present only models and theories which I think are relevant, in the sense that they at least potentially can help me interpret the changes I saw in Madaripur and Char Bhramondi. This does not mean that they necessarily will be equally useful, but before assessing which ones which are more useful, I necessarily will have to present more of the 'real' world as I have seen it.

## NOTES

- <sup>1</sup> See van den Ban and Hawkins (1988) chapter 5, for a good example.
- <sup>2</sup> The proposition that peasants are efficient also assume that the household or farmer seeks profit maximisation, as Ellis (1988 ) points out: "*efficiency and profit maximisation are two sides of the same coin, at the level of the individual production unit you cannot have one without the other*" (Ellis 1988, 63).
- <sup>3</sup> It has been common to separate the concepts of risk and uncertainty on the basis of to what extent it is possible to attach probabilities to the occurrence of an event. Risk has been used to refer to situations where it is possible to attach such probabilities, whereas uncertainty has been used referring to situations where it has not been possible to do so, as the likelihood of an event is not known. According to Ellis (1988), the concept has gradually changed content, so that risk is now commonly used as a reference to the farmer's or decisionmaker's subjective assessment of the likelihood of an event, whereas uncertainty is used to describe more general aspects of the economic environment confronting peasant farm households.
- <sup>4</sup> For a critique of the whole concept of 'moral economy', see Popkin (1979)
- <sup>5</sup> For some recent reviews see Adams (1986), Feeny (1983), Little (1991).
- <sup>6</sup> See i.a Athreya et al (1987), Patnaik (1986].
- <sup>7</sup> Koppel and Oasa (1987) argue that the theory of induced innovations in some sense have acquired an ideological role in the sense that has been interpreted as an argument against politically interference in agricultural research priorities.

## CHAPTER FOUR

***PATTERNS OF AGRICULTURAL CHANGE IN BANGLADESH******Introduction***

With a population of 108 million in 1991 (BSS 1991), Bangladesh is the eighth most populous country in the world. This large population compared to the small physical size of the country (144,000 km<sup>2</sup>), makes it one of the most densely populated countries of the world (750 persons per km<sup>2</sup>), only surpassed by the city states of Singapore and Hong Kong.<sup>1</sup>

This large population is growing. In the period 1965-80 population growth rate was on average 2.7 percent per year. Figures from the latest population census indicate that this may have fallen to 2.17 percent per year in the period 1981-1991 (BSS 1991). The total fertility rate has gone down from 6.8 in 1965 to 5.5 in 1988 (World Bank 1991). Infant mortality is still as high as 118 per thousand, life expectancy at birth was in 1987 as low as 52 years (UNDP 1990). Like many other developing countries the population is young, about 45 percent of the total population was in 1988 below 15 years of age. This means that population growth will continue in the coming decades, even with drastic reductions in fertility. Projections of future population growth rates vary, by the year 2025 there will be somewhere between 199 and 239 million people in Bangladesh. The highest figure is perhaps the more realistic (Miranda 1990).

Besides being numerous, the people of Bangladesh is also poor. With a GNP per capita of 160 USD in 1987 Bangladesh ranks among the poorest countries of the world.

Figures from the 1985-86 Household Expenditure Survey indicates that more than half of the population had an income allowing an estimated daily calorie intake of less than 2122 kilo cal. per day set as the official poverty line (BSS 1988). Of these, 21 million could be defined as "ultra poor" as they had an estimated daily calorie intake of less than 1805 kilo cal. per day. Direct comparisons with earlier expenditure surveys are not possible due to methodological differences, but both Hossain et al (1991) and Ahmed et



al (1991) found evidence of a slight decline in the extent of rural poverty during the first half of the 1980s. This improvement may, however, have been confined to the more moderately poor, according to Rahman (1992) there are indications that the extent of extreme poverty in rural areas increased in this period.

Bangladesh is a country dominated by agriculture. Slightly less than 90 million people live in rural areas. Forty percent of the gross domestic product (GDP) is generated in the agricultural sector while manufacturing industries contribute only about 15 percent of the GDP (World Bank 1990). Over the last years the economy has witnessed a moderate growth, GDP rose by approximately 3.5 per cent per year between 1980-88. One of the fastest growing sectors of the economy over the last years have been the ready-made garment industry.

Despite growth in other sectors, the agricultural sector will continue to be a leading sector in the Bangladesh economy for many years to come. And the challenge is formidable. Not only must production increase so as to keep pace with a growing population, in addition the living conditions for those living in deep poverty must also be improved. In the present chapter I will start by describing some general aspects of rural life in Bangladesh. Both some basic physical issues as well as basic social organisation will be briefly described. In the following section aggregate agricultural performance will be discussed. Both growth in production of food grains as well as spread of modern inputs will be described. In connection with this the recent policy reforms in agriculture will be discussed. The last part of the chapter is devoted to a review of various empirical micro-level studies which, one way or another, set out to explain patterns and causes of agricultural change.

## ***The rural setting***

### *Seasons and crops*

Bangladesh is a low lying delta formed by three main rivers. These rivers, Bhramaputra, (also called Jamuna), Ganges (or Padma) and Meghna have a total catchment area of about 1.5 million km<sup>2</sup>. Of this only 7.5 percent lies within Bangladesh itself (Brammer 1990a). Most of the country is classified as 'floodplain area', more hilly areas are found only along parts of the North-eastern border, and in the Chittagong Hill tracts in the south-eastern part of the country.

Annual rainfall varies from 1250 mm / year in the west, to more than 5000 mm / year in the north east. Rainfall is chiefly concentrated to the monsoon season, lasting from late May to mid October. Winter rainfall is negligible. Average winter temperatures vary from 16°C in the north to 20°C on the coast, but may fall below 10 °C in the hilly northern regions. Temperatures rise to a maximum in March -April with a maximum average in the north of up to of 35-36°C.

Traditionally the year is divided into three main agricultural seasons: The *robi* season, often referred to as the dry or winter season, lasts from October/November to March/April. The main crops grown in this season are wheat, pulses, mustard, vegetables and *boro* rice. *Boro* rice can either be of traditional, rain-fed or irrigated modern varieties (MVs). Production of MV-*boro* tends to overlap with the next season, the *Bhadoi* season, the period between March/April and July/August, i.e, from the premonsoon *Choitra Basar* ("little rains") to the height of the monsoon. The main crops in this season are jute and *aus* rice. The *Aghani*, or *aman* season, lasts from June/August to November. The main crop grown in this season is *aman* rice, either broadcast, transplanted local varieties or transplanted MVs.

### *Floods*

Flooding is a normal phenomena in Bangladesh, large parts of the country are to some extent flooded during the monsoon. One source of flooding is overspill from the main rivers caused both by snow melting in the Himalayas, combined with heavy rainfall over the Himalayas, Assam and Tripura hills areas to the north of Bangladesh. Floods caused by local rainfall, however, are the most common type of flooding in many areas.

An important feature of Bangladeshi agriculture is the relationship between land level, inundation regime and the cropping pattern. In practice the depth and nature of flooding does to a large extent determine the crops that can be grown during the monsoon and this will again influence the choice of crops in other seasons. It is common to classify land according to normal depth of flooding, as in table 4.1. There is a strong association between the extent of flooding and the type of rice crop a farmer can choose to grow under rain-fed conditions.

Traditional agriculture is well adjusted to normal flood situations. Broadcast, deep-water *aman*, which traditionally has been the main crop in many areas, is a crop well suited to heavy flooding. It can grow up to 5 metres long, at a rate of up to 15 centimetres per day, and it can be submerged under water for 2-3 days. Intermixed cultivation of crops,

especially broadcast *aus* and *aman*, is used as a means to reduce risk, most common in many heavily flooded areas. In addition farmers divide their holdings into several plots with different elevations and then grow different rice crops on these. This is a means to spread risk, as well as to ease seasonal labour and capital requirements.

Table 4.1. Land types in Bangladesh according to depth-of-flooding.

Land type	Flood depth	% of cult. area	Suitable rice crops	
			Wet season	Dry season
High land	0-30 cm	37	MV- <i>aus/aman</i> <i>Aus</i>	
Medium high	30-90 cm	34	Broadcast <i>aus</i> Transplanted <i>aman</i>	
Medium low	90-180 cm	16	Broadcast <i>aman</i>	
Low land	180-300 cm	12	Broadcast <i>aman</i>	Traditional <i>boro</i>
Very lowland	>300 cm	1		Traditional <i>boro</i>

Note: The assessment of suitability is based on rain-fed conditions.

Source: Adapted from MPO 1986.

Although traditional agriculture is flood tolerant, damaging floods also occur quite regularly. Damaging floods are by Brammer defined as floods where: “..*water rises earlier, higher, more rapidly or later than farmers expect when they decide which crops to grow on their different kinds of land*” (Brammer 1990a, 14). Here damaging floods are linked not only to the water level, but also to the timing of inundation, as well as crop choice.

Major, damaging floods have according to Brammer (1990a) occurred 11 times since 1954. During the 1980s the country was hit by major damaging floods in 1980, 1984, 1987 and 1988, the last two were at the time both claimed to be among the worst in history. In 1987 about 57 000 and in 1988 about 82 000 km<sup>2</sup> of land were flooded, well above the approximately 26 000 km<sup>2</sup> flooded in more normal years. In 1988 the flood reached normally flood-free urban areas, killing more than 2000 people and damaging seven million houses (Brammer 1990a). When it comes to the principal causes behind the two last floods Brammer claims that the 1987 flood mainly was caused by abnormal high local rainfall, especially in the northern part of the country. The 1988 flood on the other hand, was to a large extent "imported" through the river system as a result of excessive rainfall in the areas north-east of Bangladesh.

### *Social organisation*<sup>2</sup>

Rural life in Bangladesh is organised around a number of basic social, and to a considerable extent, also spatially defined units. Each elementary family unit sleeps and keeps their belongings in a separate hut called a *Ghor*. One or more families, living in different *ghors*, will again form a household, or *chula*, literally the fireplace where food is prepared. A household in Bangladesh is usually defined according to who eats together (obtain food from the same *chula*). In most cases they will also constitute a joint economic unit.<sup>3</sup> The household is commonly referred to as the *chula*. In general the *ghors* of one or several households are set up around a yard where the domestic activities are carried out. This homestead area is called a *bari*. The *bari* will in many cases be fenced in order to maintain the privacy (*purda*) of the female family members. Several *baris* form a neighbourhood or *para* and several *paras* again constitute a village.

In official statistics and for administrative purposes the term 'village' is commonly synonymous to the lowest administrative unit in rural Bangladesh, the *mouza*. The *mouza*, often termed 'a revenue village', is a geographical cadastre initially prepared for identifying land holdings for tax purposes. On the other hand, the term village in the meaning *gram*, as used by most people in common language, refers to a perceived geographical and social unit. The term can refer to locality with people belonging to the same mosque (or *jamat*), or simply to a geographical area with a group of homesteads socially identified as a village (Nathan 1988). This village can be identical with the *mouza*, but in many cases this will not be so.<sup>4</sup>

In addition to these basic social and spatially defined units, there are at least two other important social institutions at village level. All household belongs to a *gusti*. Although the actual meaning of *gusti* may vary, the term is used for groups of households or families whom are agnatically related and, more precisely persons who can identify a common deceased male ancestor.<sup>5</sup> The members of a *gusti* will have certain obligations towards each other. For instance will, well-to-do households have a certain obligation towards poorer households belonging to the same *gusti*. And as shown by Jansen (1986), belonging to a common *gusti* may play an important role in a number of transactions such as sale of land, access to non-institutional credit as well as sharecropping contracts.

The *samaj* also constitute a group of households with reciprocal obligations to each others. The *samaj*, headed by one or more a village elders called *matbars*, is an

institution which should ensure that people conform to a proper moral conduct. It is engaged in solving local conflicts through the *shalish* (village court) system and in religious purposes such as the Eid celebrations. As the *gusti*, the *samaj* is not a clearly defined geographical entity, it may indeed cover households from different villages and in some cases many people in a single village may belong to different *samajs*.

It is common to use the village as an analytical unit in rural studies in Bangladesh. It is however not unproblematic, not only because the definitions may differ, but also because it may be difficult to grasp what a village actually is, and what it means to people.<sup>6</sup> The village undoubtedly has very profound meaning for most Bangladeshis, but at the same time it is also clear that a village, or *gram*, can be quite an elusive entity. Bertocci (1976) underlined the dual character of a Bangladeshi village, it contains both an intensive and extensive dimension. On the one hand the village is a territory characterised by intense daily interaction. This intense character of the village is countered by the fact that people in a village will have many, and often important ties outside their village. Farmers may have much of their land in other villages. The landless may seek employment in other villages. At the same time there are few, if any social institutions that are organised solely around the village. Basic social institutions, such as the *samaj* and the *gusthi* are institutions extending outside the village borders.<sup>7</sup>

The dominant form of social formation in rural areas has by Jansen (1986) been described as a network of patron-client relationships. A patron-client relationship may be seen as a multi-level, many stranded vertical relationship between a powerful patron and the poorer clients. This relationship may involve employment, land transfer, sharecropping, credit as well as political and economic protection. Rich people try to maintain and increase both land owned, wealth and social status by appending a number of poorer clients. This can be done through mechanisms such as lease of land (sharecropping), by providing credit, or economic and physical protection in difficult situations. It is however a reciprocal relationship. Poorer peasants will seek to establish and maintain such a relationship preferably with rich and powerful patrons as means to get access to land as well as more general economic and social protection. The price they pay for such a relationship may not only be in the form of interest rates or crop share, but is also paid for in the form of loyalty in village affairs in general as well as in the often violent, factional disputes so common in many villages in rural Bangladesh.

The future of this patron client relationship system has been questioned. Jansen (1990), asks whether this system will be eroded in the future, as a growing number of landless and poor rural households in the future may fall outside this network:

*“As clients they have nothing to offer the well-to-do patrons. These people will be without any influence in the ‘political sphere’ of village life and nothing can be extracted from them since they are without possessions. The only asset with which they can enter into an exchange relations is the provision of their labour. On the labour market, however, others who are more attractive as clients because they possess some land receive priority. Thus they are both totally landless and unemployed. It would appear that in the future, because of continued population growth and increased landlessness, many more deprived households will belong to a section of the community which has no important vertical relationships with the more well-to-do households of the community.” (Jansen 1990, 29).*

This, argues Jansen, will put traditional support mechanisms for the poor at village level under stress. It also means that a number of poor and landless will have, at best, a single stranded relationship with more wealthy landowners—as employed agricultural labourers. This may again form a basis for the establishment of horizontal, more class based relationships in the future.

### *Land ownership*

Economic wealth in rural Bangladesh has traditionally been, and still is, closely associated with land ownership. Purchase of land is given high priority when surplus capital is to be invested and ownership of land must still be seen as a key indicator of wealth. Land is perceived as a liquid and secure form of saving, as land is least likely to lose value in this land scarce society. Access to land is also an important means to establish and maintain patron-client relationships, for instance through the sharecropping system. Besides the more direct economic calculations, land ownership must also be seen as a deeply rooted cultural phenomena. It has traditionally been very important for a farmer's social status to have enough land to feed his family without having to work for others as hired labour. Many small farmers will try to stay ‘pure farmers’ as long as possible, even when they could have improved their economic situation, by taking work as hired labour either in or outside agriculture.

Land in Bangladesh is normally divided into two main categories; homestead land mainly comprising land around the *bari*, and agricultural land which is land used for the main crops. According to the 1983-84 agricultural census the 9.2 million hectare of net cropped area were operated by about 10 million farm households, giving an average size of slightly more than 0.9 hectares per household.<sup>8</sup>

Land is unevenly distributed. Nine percent of all households had no land at all, though more than half of the rural households could be classified as functionally landless as they possessed less than 0.2 hectares of agricultural land. Farms with more than 3 hectares of land, in Bangladesh classified as large farms, comprised 5 percent of farm households, but owned 26 percent of land. To give any precise estimates on changes in land distribution is difficult as figures from different sources tend to be incompatible. In a review of changes from 1960 to 1983-84, Rahman (1989) concluded that there has been a marked increase in number as well as land owned by small and marginal farmers. At the same time there was a relative stable situation as regards medium sized farms, as well as a decline in the number of large holdings and land area under the control of large farms.

Besides being in general very small, farms are also highly fragmented. According to the 1977 agricultural census each holding was divided into approximately 10 different plots on average. Lease of land is common. The 1983-84 agricultural census does not provide any information on tenancy, however the 1977 agricultural census found that 17 percent of land was leased. And as much as 42 percent of all rural household were involved in various lease arrangements (Rahman 1989).

Most rural households are in some way or another engaged in agricultural production and gain their principal income from agriculture, most of this again comes from crop production. However, some studies have shown that non-crop and non-agricultural activities may be of vital importance for a large share of the rural population. The rearing of animals is an activity that most rural households are involved in. Fishing, either in rivers, ponds or on flooded land, is an important additional source of food for many households, especially the land-poor. In addition to these activities rural people are engaged in a number of varying activities, first of all different types of rural industries, as well as trade and other types of services.

Beside more traditional ways of maintaining and strengthening their situation, such as sharecropping, crop diversification etc., a number of other strategies reaching out over agriculture and the village is pursued. Diversification of the economic basis of the household, seems to be a strategy pursued by all groups of rural people, including farm households. More wealthy farmers may choose to invest in various small scale industries and trade business. They commonly also try to give at least some of their children (sons) a higher education, hoping that this will lead to employment in private or

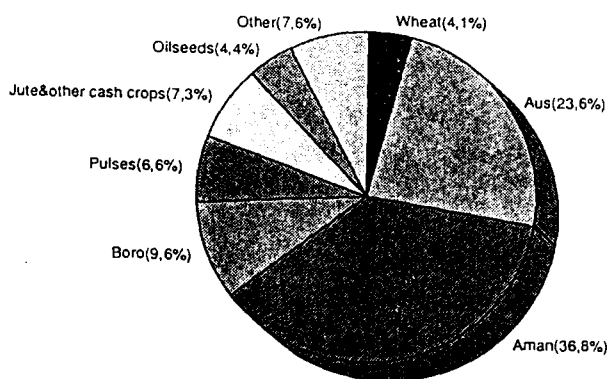
public agencies. They may also get involved in local politics, hoping that this, some way or another, will give access to governmental funds.

Land-poor farmers may have to rely on income derived from more traditional rural activities such as fishing, agricultural employment or seasonal migration during the harvest. They may also engage themselves in various forms of (seasonal) petty trading at local rural markets. Some also may seek temporarily or permanent employment outside agriculture. They may become part time rickshaw drivers in Dhaka or the small rural towns. During the dry winter season there will also be job opportunities in various types of construction work, brick-fields as well as public works programmes. In short the 'normal' rural Bangladeshi household is a multi-activity household. Most probably a relatively small share of Bangladeshi households are 'pure' farming households, this may in fact be a rapidly disappearing category in rural Bangladesh.

## *Agricultural performance*

### *Growth in agricultural production*

According to the latest agricultural census gross cropped area was in 1983-84 13.5 million hectares (BSS 1986a). Out of this, about 75 percent was devoted to production of cereals, mainly rice. In addition to rice and wheat, other main crops were pulses, oilseeds and jute (figure 4.1).



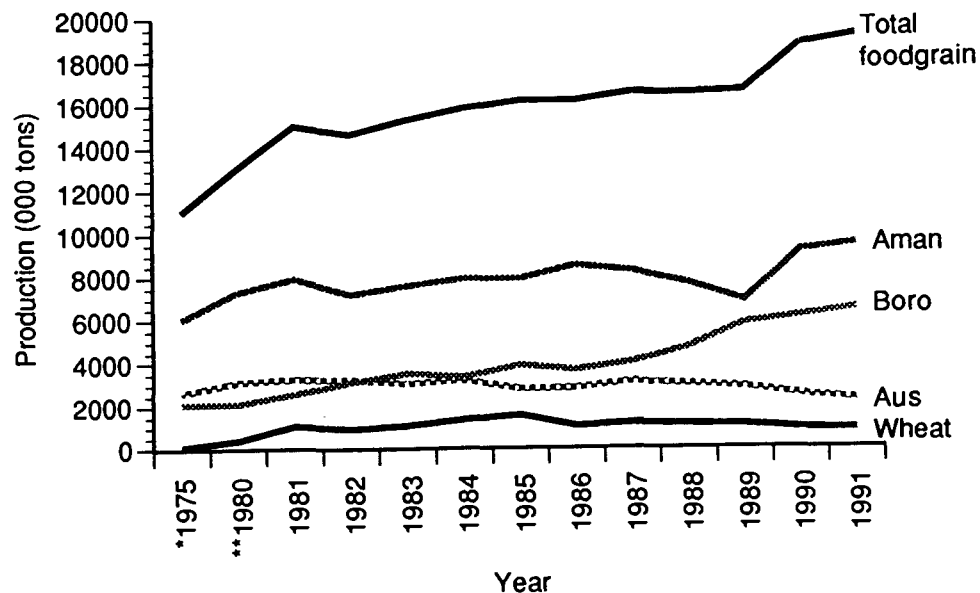
*Figure 4.1. Main crops grown in Bangladesh*

Long term growth in agricultural output, from 1949 to 1980, was about two per cent per year. Production of food grain did increase, from on average 11 million tons per year in 1970-75, to almost 21 million tons in 1990-91 (figure 4.2). In the period 1973-87 rice production increased by about 2.2 percent per year. Most of this growth (1.7%) can be



attributed to increase in yield, the remaining (0.5%) to increase in area under rice cultivation (Hossain 1989a). Most of the growth in rice production is due to growth in *boro* production, which grew by 5.7 percent per year in the same period. This growth was caused both by a marked increase in area under *boro* production (3.7 %), and a somewhat smaller increase in yield (2 %). *Aman* production grew at a much more moderate rate, although there are some evidence that production of this rice crop increased substantially during the last part of the 1980s. The most dramatic change have taken place in wheat production. From a initially very low coverage and small production, wheat production grew by almost 20 percent per year in the period, first of all due to expansion of area under wheat production.

Despite a substantial growth in agricultural production, and especially in cereal production, this has barely kept pace with population growth. There has been only a slight improvement in per capita cereal production since independence. A key question is whether it in the future will be possible to sustain a growth in production which will keep pace with population growth in the coming decades. If one assumes a annual average population growth of 2.1 percent in the period 1985-2010, this will, varying with different assumptions about future income and expenditure patterns, imply a growth in demand for food grain in the range 2.3 to 2.9 percent per year (Hossain 1989a). For other agricultural products, such as meat milk vegetables etc., it will imply a growth up to 4-5 percent per year.



Notes: \* average 1970-75, \*\* average 1975-80.

Sources: World Bank 1991, 208, figures for 1991; EIU 1991.

Figure 4.2 Food grain production in Bangladesh 1970 - 1991.

### *Use of modern varieties*

As discussed above the main factor behind the growth in agricultural production and especially cereal production has been increased output per unit of land. This increase in yield is again the result of increased use of modern inputs, first of all modern varieties (MVs), fertiliser and irrigation.

Modern rice varieties were first introduced in Bangladesh in the late 1960s. At that time seeds were imported from the International Rice Research Institute in the Philippines, and from India. In the 1970s Bangladesh Rice Research Institute was set up, and following this, a number of MVs have been developed and produced locally. The spread of MVs have in Bangladesh mainly been limited to dry season crops, use of MV is much more common in wheat and *boro* production than in other rice crops. In 1985 MVs were grown on 84 percent of *boro* area, accordingly the figures for *aus* and *aman* were 21 and 18 percent respectively (Hossain 1989b). In regard to wheat, MVs are grown on nearly 100 percent of the cultivated wheat area. Among the most important long term changes that have taken place in Bangladeshi agriculture during the last decades is the increased importance of *boro* rice in overall food grain production. This crop stood for only five percent of total rice production in 1960-65, in 1990 this had risen to more than 30 percent.

The growth in production of wheat and *boro* has come at the expense of other crops, especially *aus* and winter crops, such as pulses and oilseed. To some extent the decline in area and production of *aus* in the last years, can be explained by expansion of area under wheat and MV-*boro*. The most dramatic effect of this expansion may however have been in the production of other dry season crops, first of all pulses and oilseeds. A comparison between the 1977 and 1983-84 agricultural census shows a 32 percent decline in the area under pulse-cultivation in that period. Hossain (1989a) reports on a 1.5 percent decline in production in the period 1973 to 1987, caused by reduction in area. In the same period, production of mustard oilseeds increased, yet this was solely due to increase in yield.

This low coverage of MV-*aus* and *aman* indicates that there may be considerable scope for expansion of MV coverage. However, some assessments also indicate that there might be serious ecological constraints to their future spread. Figures prepared in connection with a recent agroecological mapping of Bangladesh indicate that only about

20 percent of agricultural land may be suited for MV-*aman* under rain-fed conditions and 26 percent under irrigated conditions( FAO 1988a).

*The spread of irrigation and use of fertiliser*

There exists strong empirical evidence, both from farm-level studies (see next section) and macro level studies (Boyce 1987, Hossain 1986), that the spread of MVs in Bangladesh is closely linked to the spread of irrigation. MV-*boro*, grown in the dry winter season is totally dependent upon irrigation. MV-wheat can be, and is to a considerable extent, grown without irrigation. Modern *aus* and *aman* varieties, which also in principle can be grown under rain-fed conditions on relatively high land, will in most cases need supplemental irrigation before (*aus*) or after (*aman*) the monsoon. The close relationship between irrigation and adoption of MVs observed in Bangladeshi agriculture has lead some to identify irrigation as the main 'supply side constraint' (Rahman 1984) or- in another terminology - 'the leading input' in the green revolution technology in Bangladesh (Boyce 1987).

The rapid spread of MV-*boro* in Bangladeshi agriculture can to a large extent be explained by what Farmer (1979) has termed the 'deepwater rice problem'; the fact that most of the new rice varieties developed so far are relatively short stemmed and thus less suited to the heavily flooded monsoonal areas of Southern-Asia. He has on more general terms identified three basic strategies for dealing with this problem:

- 1) Prevention of flood through investments in flood control measures.
- 2) Development of modern, deepwater rice varieties.
- 3) Avoidance of the monsoon season, by emphasising crops in other seasons.

A considerable amount of money has been put into building various flood control structures in Bangladesh over the last decades, but both the effectiveness and suitability of such investments have been seriously questioned (Islam 1990, BARC 1989).

Regarding development of deepwater varieties, there have been some progress, but there is at present no modern, deepwater rice variety available for the Bangladeshi farmer.<sup>9</sup>

Whereas the first two strategies outlined by Farmer (1979) are based on intervention by public institutions, and thus beyond direct control of the individual farmer, the third option is not. And one can say that due to lack of modern deepwater rice varieties and effective flood control measures, many farmers in Bangladesh have gone for a *strategy of avoidance*, by changing their cropping pattern from being organised around a rain-fed monsoonal rice crop, to a pattern based on a modern, irrigated winter rice crop.

Table 4.2. Characteristic, different types of minor irrigation equipment

Type of equipment	Water source	Price (taka)	Capacity (Litres per sec.)	Potential command area (acres)
Low lift pump (LLP)	Surface water	20-30 000	28-56	60
Shallow tubewell (STW)	ground water	30-40 000	14	5
Deep tubewell (DTW)	ground water	120 000	56	60

Source: MPO 1986.

Much effort has been put into expanding irrigation throughout the country during the last three decades.<sup>10</sup> The earliest post-partition plans of the 1950s envisaged expansion of irrigation through large scale gravity systems as parts of more comprehensive plans for flood protection and drainage. But from the 1960s and onwards small scale irrigation has been the major source of irrigation expansion. Low lift pumps, also called power pumps, used for pumping water from surface water sources, were introduced in 1956 through the Mechanised Cultivation and Power Pump Irrigation Programme, active until 1968, when it was replaced by the Thana Irrigation Programme. This latter programme fielded approximately 4000 pumps.

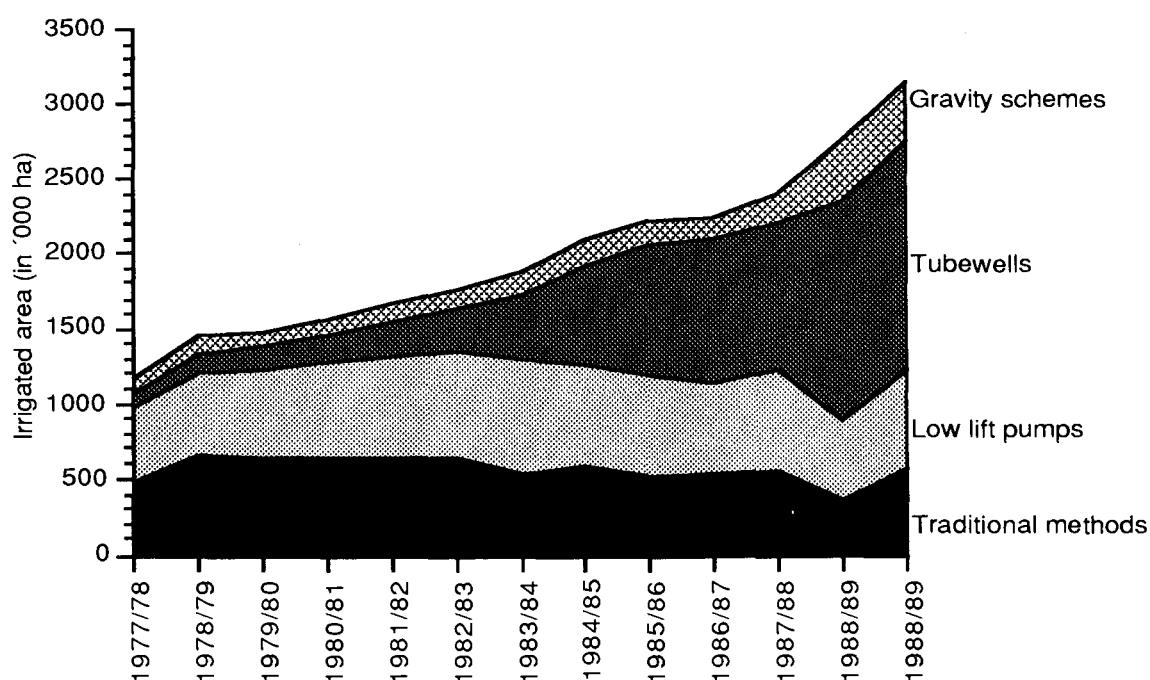
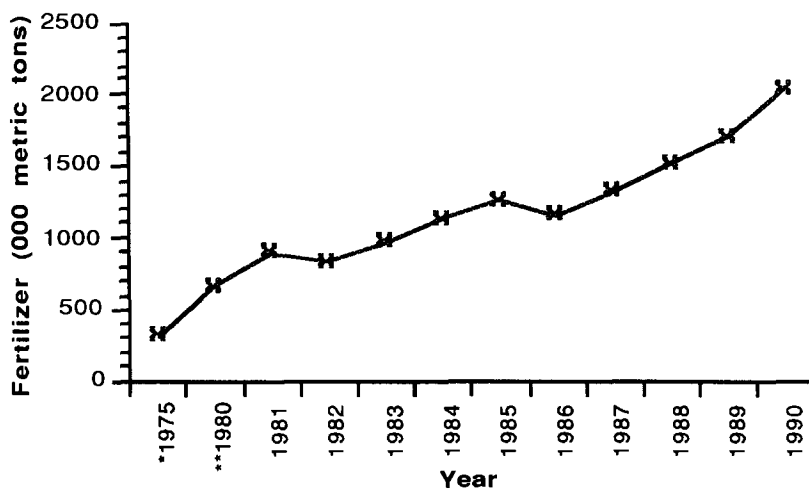


Figure 4.3 Expansion of irrigation in Bangladesh 1976 - 1988

More advanced and expensive Deep tubewells (DTW) were first introduced in 1961, through a German funded project in Thakurgaon. From 1974 and onwards shallow tubewells (STWs) rapidly became popular and were the main driving force behind the rapid expansion of irrigation coverage during the 1970s and early 1980s. Area under irrigation has increased steadily over the last decades. During the period 1980-1989 area under irrigation nearly doubled, from 1.7 million hectares to 3.1 million hectares.

In general, expansion of irrigation in the 1960s and 1970s was based on surface water utilisation by low lift pumps, whereas during the 1980s expansion has been based on utilisation of ground water, primarily by the use of shallow tubewells. In regards to equipment, one can say that public and private priorities have changed from an emphasis on large scale, capital intensive methods (dependent upon foreign import and technical support) to more small scale, less capital intensive devices. In the utilisation of surface water sources this has implied a change from canal irrigation to LLP irrigation. For utilisation of ground water resources, a change from DTW to STW.

There seems to be room for future expansion of irrigation coverage. According to the National Water Plan it *could* be possible to increase the area under irrigation up to 5.5 million hectares by the year 2005 (MPO 1986). In order to achieve this, the plan proposes a strategy based on giving top priority to expansion of surface water irrigation, first of all based on LLPs. With regard to ground water irrigation, priorities should be given to shallow tubewells and so-called deep-set shallow tubewells, installation of deep tubewells should be confined to special zones.



Notes: \* average 1970-75, \*\* average 1975-80.  
Sources: World Bank 1987, tab 1.13, 1991, tab 7.6

Figure 4.4 Year wise distribution of chemical fertiliser in Bangladesh 1970-1990

Chemical fertiliser came into use in crop production in the beginning of the 1960s. Their utilisation has grown steadily since. In the period 1970-85 fertiliser consumption grew by approximately 10 percent per year (Hossain 1989a). Fertiliser is used on a wide variety of crops, but studies show that it mainly is used on dry season crops such as wheat and *MV-boro*. Most of the consumption is confined to three types of fertiliser; Urea, MP and TSP. Despite a substantial growth in consumption, average fertiliser use is still quite low by international standards.

## ***The effect of natural calamities on production***

### *MVs and stability in production*

It is sometimes claimed that although the introduction of MVs will lead to a higher total production, this will come at the expense of increased instability in production. There is however little evidence in support of this view in Bangladesh. In a study based on regional data covering the period 1969/70 to 1979/80, Mushid (1987) found that although the introduction of MVs so far has not brought about an increase in instability, but claims that this *may* be the result of future spread of MVs. On the other hand, Muijeri (1991) in a study covering a longer period (1949-84) found less variation in aggregate production and yield in the post-adoption period compared to the pre-adoption period. Alauddin and Tisdell (1991) in their analysis of various sets of inter-regional data made similar conclusions.<sup>11</sup>

In a more general analysis of the relationship between calamities and food production in the period 1973 to 1990 Hossain (1990), found that although there have been substantial shortfalls in production in one season, especially in the wet season, the overall effect on annual production has been more limited. This due to compensatory crop production in the following season, or in other, less affected regions. In 1988/89 wet season production (*aman*), was 22 percent lower than normal, but due to compensatory dry season production annual food grain production fell by only 9 percent. The conclusion of the analysis being that viewed on national level, the effects of natural calamities on overall cereal production have seldom been severe. In fact there is some evidence that suggest that economic factors, such as falling crop prices, may have as severe effect on production as natural calamities (Hossain 1990).

As discussed above both the 1987 and 1988 floods caused substantial damages. With regard to crop damages, the 1987 flood mainly caused damages to the transplanted *aman*

crop in the north-western parts of the country. The 1988 floods caused damage both to transplanted and deepwater (broadcast) *aman*, most seriously in the central flood-plain areas adjacent to the main rivers. Despite widespread damages the effects on overall agricultural production seem to have been limited. In 1986/87, a year with normal inundation, annual cereal production was estimated to be 16.5 million tons. In 1987/88 and 1988/89 the production was estimated to be 16.46 and 16.54 million tons respectively. In 1989/90 total food grain production has been estimated to have been about 19.5 million tons. Some sources even suggest that production may have been as high as 21.5 million tons. The high production in 1989/90 was mainly due to a remarkably good *aman* harvest, the 1990 MV-*boro* crop was not particularly successful, due to a long winter season combined with heavy rain from February onwards.

Brammer (1990a) suggests four explanations for such a high level of overall production despite substantial flood losses. First, average *aman* yields in non-flooded areas might have been higher than normal due to high rainfall. Second, the extra moisture could have benefited wheat production. Third, farmers might have been able to recoup some of their losses through compensatory *aman* production, by transplanting *aman* after the water receded. A fourth explanation may be; that the floods have provided farmers with strong incentives to expand dry season irrigation in order to grow high yielding *boro* rice.

The findings discussed above suggest that farmers may apply two sets of strategies for dealing with flood and flood related crop damages. The short term response is to try to recoup some of the losses incurred by compensatory production in the following season. A second response, which implies a more fundamental reorganisation of crop production is to try to reduce the exposure to hazards. In heavily flood prone areas, this can be done by shifting to an irrigated winter crop such as MV-*boro*, a crop less exposed to this type of natural hazard.

#### *Future agricultural development; irrigation versus flood control?*

In Bangladesh there has for a long time been a widespread opinion that the national flood problem only can be solved through an international agreement over the management of the Ganges-Bhramaputra river basins. Such a regional solution would among other things involve construction of a number of large water reservoirs in Nepal. However the realism of such a stand-point has been seriously questioned (Crow and Lindquist 1989). The construction of several large dams in Nepal would most likely cause substantial environmental damage and may involve resettling of a large number of people in an

already land-scarce country. Further the time span for implementing such options would be very long, up to 50 years. Finally, such a solution involving at least three countries would have been criticised for being too demanding politically, as it would require stable international relations for the foreseeable future.

After the 1988 flood, four major donors - USAID, UNDP, and the French and Japanese governments, commissioned separate studies on how the flood problem issue should be approached. Three of these studies suggested further investment in embankments and other types of flood protections. The fourth, the USAID funded study, supported a fundamentally different approach, putting more emphasis on regional co-operation and other means for adjusting to flood

The main "solution" to the flood problem at present being implemented in Bangladesh is to build embankments along the major rivers to protect land from river overflow. The assumed need for such embankments varies. The French report prepared after the 1988 flood, suggested construction of more than 4000 km of embankments to make the country more or less "flood proof." A UNDP study aimed at "controlled flooding" by a combination of embankments, river training and various other measures. This latter model has again formed the basis of the IBDR headed "Flood Action Plan" at present being supported by most international donors to Bangladesh.<sup>12</sup>

The technical viability of the embankment strategy has however been questioned by many who both claim that large scale construction of embankments may not only be costly and technically unfeasible in Bangladesh, flood protection of this type may not even be desirable (Islam 1990, BARC 1990). A main argument against embanking is that flooding must be seen as a basic feature of the whole agro-ecosystem of the delta. Flooding has a number of positive effects such as maintaining the fertility of the soil and thus on overall food production. Among the most serious negative effects of a successfully implemented flood protection strategy may be the impact on inland capture fisheries; it is commonly assumed that improved flood protection would lead to substantially smaller catches during the monsoon. Further, as surface water bodies during the monsoon has many characteristics of a common property resource to which also landless people have access, a transformation of flood plain to dry land would have direct negative effects for the poor landless people who then would loose access to important fish resources (Sadeque 1990).

A basic justification for building embankments in rural areas is that flood protection will transform deeply flooded areas into less flooded areas. This will allow adoption of MVs



during the monsoon. So, whereas irrigation is a means to allow growth of modern varieties in the dry season, flood protection is a means for modifying the physical conditions to allow growth of modern varieties in the monsoon season. Flood protection thus has in common with irrigation that it allows the growth of MV-rice on heavily flooded land, though in a different season.

The National Water Plan (MPO1986) suggests that in order to enhance agricultural production in a rapid and cost effective way, development of minor irrigation should be preferred over investments in flood protection. This view was supported by a recent UNDP funded Agricultural Sector Review, which suggested that scarce public and private resources should be used for developing minor irrigation (Norbye 1990). Brammer (1990b) claims that these two strategies, based either on expansion of irrigation or flood protection are not mutually incompatible, but rather supplementary strategies. The minor irrigation option envisaged by the National Water Plan is a strategy for developing available water resources up to the year 2005, other types of interventions are needed to support a continuing growth in food grain production after this time.

## *The policy reforms of the 1980s*

### *The privatisation of the distribution system*

The growth in agricultural production and increased use of inputs have taken place in a changing institutional and political framework. A major feature of rural development policies in Bangladesh both during the Pakistani period and after independence in 1972 was promotion of co-operatives as a vehicle for rural development. Shortly after independence from Britain in 1947 the Government of Pakistan started organising multi-purpose co-operative societies at Union level. But the main breakthrough came in the 1960s with the establishment of the Pakistan Academy for Rural Development, later Bangladesh Academy for Rural Development (BARD). Since 1961 this institution has been promoting the so-called Comilla model for rural development.

This model, which was first developed in Kotwali Thana in the Comilla district, had five major components. Among them was a programme for expansion of irrigation, and a two-tier co-operative system with village based farmer-associations, so-called *Krishi Samabuy Samities* (KSS).<sup>13</sup> The main purposes of these co-operatives were to mobilise local resources through group savings, and to act as a channel for dispersion of credit, subsidised fertiliser and minor irrigation equipment. After liberation the programme was implemented in other parts of the country under the Integrated Rural Development

Programme (IRDP), later to become the Bangladesh Rural Development Board (BRDB). BRDB together with Bangladesh Agricultural Development Council (BADC) came to form the institutional basis for government rural development efforts up to today. While BRDB was mainly engaged in setting up co-operatives and disbursing government credit to the co-operatives, BADC obtained a monopoly on supply of fertiliser and irrigation equipment to the co-operatives.

During the late 1970s and at the early part of the 1980s, a number of far reaching reforms in the agricultural sector of Bangladesh were initiated and gradually implemented. These reforms were to a large extent formulated under the influence of some of the major donors organisations to Bangladesh. The main objective of these reforms was to improve farmers' access to agricultural inputs, by establishing a private distribution system for agricultural inputs. In 1978 a new marketing system for fertiliser was introduced and following this the BADC withdrew from retail sale and instead concentrated their activities to the distribution up to so-called primary distribution points. From there private wholesale dealers and retailers would be responsible for sale of fertiliser to the farmers. At the same time subsidies were removed and from 1983 price regulations were abolished. Later the BADC was to also lose its monopoly on the wholesale of fertiliser.

Reforms in the minor irrigation sector were also a central element of the new agricultural policy implemented during the 1980s.<sup>14</sup> The core elements of the Thana Irrigation Programme, sometimes called the rental programme, was public ownership of irrigation equipment through BADC, and rental of the pumps/tubewells by co-operatives or water-users groups. The new policy implied that pumps and tubewells were to be put out for sale either to groups/co-operatives or private farmers and the old rental system was to be gradually phased out during the first part of the 1980s. Old, previously rented equipment were to be sold, all new pumps fielded should be owned by co-operatives or individual farmers. The new policy also implied a reduction of subsidies to the sector. The monopoly of the BADC was during the first part of the 1980s phased out. Both spare parts and pumps were to be sold through private dealers. These reforms in fertiliser distribution and irrigation expansion were combined with a new price support policy for rice and wheat, as well as a rapid expansion in the supply of agricultural credit through both private and public credit institutions.

The effect of these policy reforms has been much debated subject in Bangladesh. Some critics have claimed that these reforms was the underlying cause of a period of low agricultural growth experienced in the mid 1980s. Whereas annual growth in food grain

production was about 3.5 percent during the second five year plan (1980-85), this fell to about 1.5 percent per year during the first years of the third five year plan (1985-90). Others, as some major donors, seem to assess the effect of the policy reforms in a much more positive way claiming the rapid dispersion of fertiliser, irrigation pumps and tubewells in the late 1990 as being the ultimate evidence of the success of the reforms (see EIU 1990).

A few studies have tried to appraise the effect of the policy reforms in more detail. Regarding the effect of the new fertiliser distribution system, it was clear that access to fertiliser under the old distribution system in many cases was confined to the more powerful farmers, and that the less resource rich farmers faced difficulties in obtaining fertiliser. One study of the new fertiliser distribution system, Quasem (1986) found that the number of retailers had increased after the reform, although wholesaling had become more concentrated and in fewer hands. He also suggested that fertiliser trade improved, primarily in more easily accessible locations, with access becoming more difficult in remote areas. However the empirical evidence on which he based this conclusion seems to be very weak. In a study focusing on the role of rural entrepreneurs in a village in Comilla, Lewis (1991) concludes that the reforms have improved the distribution system and improved farmers access to fertiliser. At the same time he found that following the reform some private fertiliser dealers had been able to interlock sale of fertiliser with supply of credit and sale of products.

The question of fertiliser subsidies has raised more discussion than the re-organising of the fertiliser trade system. Studies have shown that fertiliser use is highly sensitive to price. One normally assumes that increased fertiliser prices would have a negative effect on consumption. In practice the effect on total consumption seems to have been quite limited, as sales have continued to increase during the 1980s, with a small setback in 1985-86. In late 1980 the growth seems to have accelerated. During the first five and a half months of 1989/90 the Ministry of Agriculture reported a 32 percent increase in fertiliser distribution (EIU1990).

In 1988 a comprehensive review of the agricultural sector was carried out (Abdullah et al 1989). Among a long list of issues covered by the review was the question of fertiliser subsidies. Although the review mission defended the principle of fertiliser subsidies as a suitable means in certain situations, it did not support the re-introduction of subsidies. Mainly because the price/fertiliser ratio was at reasonable level, despite fertiliser price rises. In a later report, commissioned by the interim government set up after the downfall of the Ershad regime in 1990, the conclusion was that the reforms had *"at least had done*

*no harm and possibly done some good*" (Abdulla et al 1991,123).<sup>15</sup> The commission found that the price level for fertiliser were reasonable and claimed there had been no reports on shortages of fertiliser following the reform.

When it comes to the policy changes within the minor irrigation sector, there are relatively few studies which have sought to analyse the effect of the policy reforms on aspects such as irrigation coverage and economic efficiency. In one study of 379 pumps of both private and rental pumps in South East Bangladesh, it was concluded that:

*"No programme has absolute advantage over the other. Their relative merits become discernible when the national objectives are given. The study therefore, recommends the RP [rental programme] if the national objectives are to achieve food self-sufficiency and to ensure utilization of pumps by smaller farmer groups; and the SP [sales programme] , if the national objectives are to derive maximum economic and financial benefits per unit of pump and to create non-farm employment opportunities." (Hamid 1984, xx)*

This conclusion was based on data showing larger command areas in rental schemes than in private schemes. This again gave greater total production in the rental schemes, even though the yield per acre was better in the private schemes. Since the rental schemes comprised larger command areas than the private schemes it also involved more farmers and, notably, more small farmers. On average each irrigator in the private schemes owned 57 per cent more land than the irrigators in the rental schemes. The major advantage of private ownership was that this made it possible to use the pumps also for other purposes than irrigation (rice mills, boats etc.). The income from such non-agricultural use gave a higher total net return per pump. An additional advantage was that the pumps used for these kinds of activities, would generate additional non-farm employment.

In another study of the new distribution system, covering both STWs', DTWs' and LLPs', it was concluded that: "*...the new system particularly the policy of sale of machines to individuals/groups, is not an improvement over the BADC rental arrangement, at least with respect to capacity utilization, irrigation costs to irrigators and cost of operation*"(Quasem 1985, 138).The command areas of LLPs were larger in schemes operated under the rental programme than in schemes based on privately owned pumps. Water charges were also higher in private schemes than in rental schemes, so was also cost of operation. But under the new system, access to water seemed to be biased in favour of medium size farmers.

Some critics, such as Quasem (1990) have claimed that the removal of subsidies on irrigation equipment made it unprofitable for private owners to enter into this type of "water business". He suggest that this was a major reason for the observed slow-down in irrigation expansion in the mid 1980s. The view that privatisation may have hampered the pace of irrigation development seems also to be shared by Hossain (1989c) who claims that:

*The government's policy on distribution of irrigation equipment through the private sector may have constrained expansion of irrigation at the socially desirable pace, as the private sector may have better investment opportunities outside agriculture. The government should thus consider reversing this policy and should plan development of irrigation facilities on the same line as the development of other infrastructural facilities such as roads and markets (Hossain 1989, 26).*

The new government's task force on agriculture the other hand reached a completely different conclusion. They admit that a definitive study on this issue is missing but concludes that indications are that "*deregulation has made it easier, quicker and cheaper for farmers to adopt irrigation*" (Abdulla et al 1991, 120)

#### *The socialisation of minor irrigation*

In the light of the new policy in the minor irrigation sector, the idea about an alternative approach to ownership and management of pumps and tubewells was put forward. As early as 1976 some groups of landless and small farmers operating irrigation equipment had been established within the Small Farmers and Landless Labourers Development Project, (Bottrall 1983). In the beginning of the 1980s a plan for a landless irrigation programme for implementation through IRDP was formulated. It was however a national NGO, Proshika, which first was able put the idea into practical action in 1980-81. Later on, other NGOs, such as BRAC and Grameen Bank as well as BRDB have started their own landless irrigation programmes. At present at least two public agencies, BRDB and Grameen Bank, and major NGOs, Proshika and Bangladesh Rural Advancement Committee (BRAC) have included some kind of Landless Irrigation Programme in their activities. However Proshika has at present the largest and best documented programme.<sup>16</sup>

Proshikas irrigation programme is based on groups of landless and near to landless rural people owning minor irrigation equipment. In return for providing water to farmers, the group is paid, either in cash or crop share. According to one of its initiators the programme should not be looked upon solely as an income generating programme. Rather it should be regarded as a contribution to agrarian reform in the broad sense

(Wood 1982). The program is based on the view that there are resources in rural Bangladesh which are less institutionalised than land. Water is one such resource and the irrigation programme is an attempt by the landless to help capture water rights in a period where water becomes more scarce, but at the same time more important in agricultural production.

Proshika started their programme in 1980. The objectives at the programme were:

- "1. To facilitate the acquisition and use by landless group of LLPs and STWs to enable them to sell water to owners and cultivators of land.*
- 2. To develop a source of income and therefore purchasing power among those groups under conditions where the rates of reward are partially determined by their control of productive assets.*
- 3. To ensure that landless groups share in the benefits from the enhanced productivity of land to which they contribute through providing the source of irrigation.*
- 4. To achieve a more efficient use of water through its wider distribution to smaller farmers (including tenants) by challenging the monopoly of larger farmers/landlords usually achieved through their superior access to the market and government.*
- 5. To add to the basis for landless groups to participate in a wider programme of nondependent economic activity and to the material security required for any individual to act freely in the democratic institutions of the country.*

*And the term 'landless group' was defined for these purposes as:*

*- a group with no control over the means of production or distribution; landless or marginal farmers with no assets; fishermen with no implements; rural artisans who lack working capital or raw materials; families who sell their manual labour; women of the above groups." (Wood 1982, 5-6)*

Proshikas irrigation programme is based on groups of landless and near to landless rural people owning minor irrigation equipment. In return for providing water to farmers, the group is paid, either in cash or crop share. Groups wanting to undertake an irrigation project must fulfil certain requirements. The group should be at least two years old and have carried out other less demanding economic projects before they are allowed to start a irrigation project. If the group decides to try to establish an irrigation project, the first step will be to approach the farmers in the projected command area and negotiate an agreement with the farmers. According to some groups the key problem is to persuade the first farmers to join the scheme. Once some have agreed others will follow and when the scheme has grown to a certain size and the command area becomes a more continuous area, it will be increasingly more difficult not to participate. As it create a number of practical problems for a single farmer to operate land independent of the surrounding plots as this in many cases will imply following a completely different annual cropping pattern .

Before the project is finally approved by Proshika, a written, legally binding agreement must be presented by the group. The main elements in such an agreement will usually be :

- The group will undertake the responsibility to deliver water to the farmers in the command area for a period of 3-5 years. The farmers will in this period renounce the right to field any other pump or tubewell within the scheme area.
- The group will be responsible for constructing and maintaining the main drains in the scheme. The farmers themselves are responsible for the smaller, secondary channels.
- The farmers agree to apply the necessary amount of other inputs (except water), labour, fertiliser, pesticides needed to secure a good crop.
- Water is to be paid for at a fixed price, usually 1/3 or 1/4 of standing crop.
- The group is responsible for water delivery, but is however not legally liable in cases of failure of supply water due to mechanical problems.

If the group is able to reach an agreement with the farmers, the proposal is reviewed by the Proshika staff to investigate the feasibility of the proposed scheme. If the scheme is approved, the group will be able to raise loans to finance both the initial capital costs and operating costs. Up to the 1985/86 season groups obtained loans from the Bangladesh Krishi Bank at an interest rate of 16 percent per annum. Under a general agreement Proshika would guarantee the loans taken by the group. This agreement was however tormented by well known problems of the bank sector in Bangladesh, namely; demands for bribes, delays in disbursement of loans and harassment of group members approaching the bank. From 1985 Proshika finances both short term loans (6 months) for operating costs, and long term loans (3-5 years) for capital costs (machine, drain), directly through their own revolving fund.

The groups are supposed to finance a part of the investment from their own savings. In general female groups are supposed to cover 20 percent of the investment from their own savings, male groups 25 percent. All loans are supposed to be repaid as soon as possible, until they are repaid no part of the earnings are to be withheld in the group or distributed to members except in the form of wages considered part of the operating costs.

Certain points in these general guidelines outlined above are modified when put into practice. In some cases the groups will agree to provide inputs other than water, for instance pesticides. The price of water will to some extent also be determined through negotiations between the farmers and the group, reflecting the bargaining strength of the group vis-a-vis the farmers. In other cases the formal requirements of the groups, such

as minimum age, experience and minimum contribution to investments will be modified. Likewise the request for immediate repayment of loans, i.e no dispersion of profit among the group members before all loans are repaid, will not be pursued too rigidly.

Since Proshika started its programme a total of 204 LIG has been established. The experience during these initial years seems to be mixed. Although a number of viable groups have been established, the rate of failure has been high, nearly 50 percent of all groups had been discontinued less than five years after upstart. Due to a lack of directly comparative data, it is difficult to judge whether such a high rate of discontinuity is the norm. Wood and Palmer -Jones (1991) however assume that the discontinuity rate is even higher in the private sector. They attribute many of the economic and financial problems faced by many groups in the mid 1980s, to general macro-economic factors beyond the direct control of Proshika or the individual groups, primarily linked to deteriorating agricultural input -output price ratios in this period.

### ***Agricultural change, some farm level evidence***

#### *An overview of studies*

So far agricultural performance has been discussed on a general level, on the basis of aggregate statistics. In the present section I review some farm-level studies, which deal with various aspects of agricultural change in Bangladesh. These are studies that both describe patterns of adoption as well as attempting to explain adoption and the different patterns of adoption. Most of the studies are confined to one or two villages, only two studies (Hossain 1989a, 1989b) covers a large number of villages from various parts of the country. There is also a certain bias in favour of the regional coverage. Except for the nation wide studies, only one study used data from the Northern parts of the country, none is based on data from the South -western part of the country.<sup>17</sup>

In general most farm level studies reviewed here apply a limited set of explanatory variables. Much of the discussion of adoption patterns is centred around the relationship between adoption and farm size. Farm size seems to be used as a fairly loose representation of class or wealth, without very much discussion of the problems with such a use. Only in a few studies is the analysis centred around other types of variables, such as education and other personal characteristics of the farmers.



### *Patterns of adoption*

In Bangladesh as in many other third world countries, it has been claimed that only the most resourceful farmers have been able to take advantage of the green revolution. One proponent of this view is Rahman (1986a, 1986b) who claims that :

*A number of studies on Bangladesh have concluded that due to better access to capital and input markets, the rich farmers adopted the new technology more frequently than the smaller ones and the proportion of their land under HYVs was greater. As a result, the richer peasantry have been able to command greater surplus generated in the rural economy in cumulative terms, thus pushing the less fortunate ones to the ranks of the impoverished peasantry. (Rahman 1986a, 89).<sup>18</sup>*

This statement in essence says that the rich farmers have adopted the new technology more frequently than the small farmers and that they (the rich) have a larger share of land under MVs than small farmers. In a study from the beginning of the 1980s a completely different picture was presented. Here the conclusion was that:

*"...the two smallest [farm]size groups show a higher rate of adoption than do the rest. These results are reassuringly surprising in view of the much lower ability of the small farmers to finance the working capital needs of HYV and, presumably, a more restricted access on their part to the publicly provided subsidised inputs for HYV" (Khan et al. 1981, 78).*

A brief review of a number of studies dealing with adoption reveal a more complex picture than the one presented by both Rahman (1986a) and Khan, et al. (1981). As regards *rate of adoption* (the share of farmers adopting MVs) some studies have found that large farmers adopted the new technology more frequently than the smaller ones (Rahman 1981, Rahman 1983, Asaduzzaman 1979). Others report as what can be seen as an inverse U-shaped relationship as the medium sized farmers had the highest adoption rate (Mugtada 1975 Ahmed 1984, Alauddin and Tisdell 1991). Other studies find no systematic relationship (BUP 1982, Hossain 1989b). As regards changes over time Alauddin and Tisdell (1991) found that large farmers were the earliest adopters, with small farmers catching up at a later stage.

In regard to *intensity of adoption* (measured as share of land under MVs) most studies reported a negative relationship between intensity of adoption. Small farmers tend to have a higher proportion of their land under MVs compared to more land-rich farmers. (Asaduzzaman 1979, Rahman 1984, Hossain 1989a, 1989b). Jones (1984) found a Ushaped adoption rate, where medium farmers adopted less than both small and large farmers. Ahmed (1984) report no systematic relationship. Alauddin and Tisdell (1991) found a negative relationship for MV-*boro* but no systematic relationship for MV-*aman*.

Concerning the relationship between *tenancy and adoption*, there too findings also tend to differ. Jones (1984) and Alauddin and Tisdell (1991) seem to assume that there is a negative effect of tenancy on adoption. Hossain (1989b) found a positive association; tenants tend to have a higher share of land under MV compared to 'pure' land owners.<sup>19</sup> Others again report that tenancy seems to have no clear effect on adoption rates (Hossain 1989a, Azadussaman 1979, BUP 1982 ).

With regard to the relationship between farm size and *use of fertiliser* Hossain (1991b) found that large farmers are more likely to use fertiliser. But when it came to the intensity of use, he as well as Jones (1984) and Mugtada (1975) found an inverse relationship. Small-farmers apply a higher dose of fertiliser per unit of land than large-farmers.

On basis of the studies reviewed here it is difficult to reach any firm conclusion concerning the relationship between farm size and adoption. In general most of the available evidence suggests that there may be a positive relationship between farm size and rate of adoption. What seems clear from most studies is that there is a negative relationship between farm size and intensity of adoption. The lack of any firm conclusion on the effect of tenancy is maybe somewhat surprising, there is however no clear evidence indicating that sharecropping inhibits adoption, rather on the contrary. When looking at fertiliser use, the two studies reviewed here covering this aspect suggest that large-farmers are more inclined to use fertiliser, though when a small-farmer uses fertiliser, he will use it more intensively.

#### *Explaining adoption and patterns of adoption*

As discussed in chapter three one commonly used and very plausible way of explaining adoption is simply that farmers adopt MV because it is profitable for them to do so. That MVs, despite the higher cost of production give higher net returns per acre. This has been confirmed by several studies (Assaduzzaman 1979, Rahman 1981, Jones 1984). For instance Jones (1984) reported a 57.5 percent increase in farmers net return, when comparing return from non-irrigated cropping to irrigated cropping patterns.

One possible explanation of the different adoption rates among different farm size groups may be that profitability of MV production for some reason or another differ among various groups of farmers. This may be because some groups are able to obtain higher yields than others, or it may be that rural markets in general operate such that different

groups of farmers face different prices for their inputs. This may effect the use of inputs and consequently one may assume yield. This will, possibly combined with differences in price received for final products, lead to differences in net return which may explain different adoption rates.

Regarding profitability Hossain (1989b) found that the large farms had the highest profit from MVs. But at the same time he found substantial relative gains, measured as percentage increase in profits/return to family labour of MVs compared to TVs among all farm size groups. Ahmed (1984) concluded that all factors of production gained from the new technology, but that the large-farmers were gaining more, measured by the acre.

One issue which has attracted some attention is whether the inverse relationship between farm size and productivity per unit of land commonly observed in traditional third world agriculture, will disappear after the introduction of MVs. The higher yields and more intense land use often found on small farms, has been attributed to a higher labour input, again due to better access to family labour. But as the new varieties are more dependent and responsive to non-labour inputs such as fertiliser, which one may assume that richer farmers better can afford, the above relationship might change.

The inverse relationship between farm size and productivity seems to be generally accepted as valid as regards to traditional agricultural production in Bangladesh (Hossain 1977, Khan et al 1981). Hossain (1989b) found that yield is inversely related to farm size both for TVs and MVs. But when comparing traditional and modern villages he saw some indications of a diminishing difference in yield. Jones (1984) on the other hand found that the small-farmers were not significantly more productive than large farmers when cultivating 'traditional' cropping patterns, but that they were so when growing irrigated MV based cropping patterns.

As the citations from both Rahman (1986a) and Khan et al. (1981) indicate, capital is often assumed to be a key determinant of adoption. It is commonly argued that small-farmers have less working capital and less access to cheap institutional credit and this will prevent the small and marginal farmers from adopting MVs and the other elements of the green revolution 'package'. In both his studies Hossain (1989a, 1989b) found that adoption was positively related to the access to both institutional and non institutional credit. None of these studies does however give detailed information on which different groups have access to agricultural credit.

Several studies deal with the relationship between family size and adoption. Since a main objective of a family farm is to provide food for the family, a high consumption demand compared to available land may be a strong incentive to adoption of more productive MVs. An argument closely related to this is the labour scarcity argument. This is based on the assumption that farmers with little land in general will have more family labour per unit of land than land rich farmers. And since the cropping practices accompanying MVs are more labour demanding than the traditional cropping practices, the small farmer may have an advantage compared to the land rich farmer, who will have less family labour per unit land available. The land rich farmers have to therefore rely on use of hired labour, thereby incurring supervising costs.

Viewing the relationship between subsistence pressure and adoption, Alauddin and Tisdell (1991) reached no clear conclusion. They found a positive relation regarding MV-*boro*, but negative regarding MV-*aman*. Hossain (1989a, 1989b), found a positive relationship between subsistence pressure and adoption of MVs in the dry season (*aus/boro*), but not for adoption of MVs in the monsoon season (*aman*).

Within the labour scarcity argument it is worth noticing that studies clearly show that MVs are more labour demanding than traditional varieties. In one study (Ahmed 1977), a 28 percent higher labour input for MV-*aman* was reported than traditional *aman*, and a 50 percent higher labour use for MV-*boro* compared to traditional-*boro*. Mugtada and Alam (1983) in a study of labour use in three villages found that a change to MVs brought about an increase in labour demand varying from 9 to 33.6 percent. Studies show that small-farmers apply more labour per unit of land than large farmers when producing TVs (Mugtada and Alam 1983). With regard to the relationship between availability of family labour and adoption (the labour-scarcity argument), both Hossain (1989b) and Alauddin and Tisdell (1991) found a positive relationship between adoption of MVs and family labour available. Hossain (1989a) on the other hand reports no clear relationship.

As regards use of hired labour versus family labour, it sometimes claimed that MVs tend to require more use of hired labour as a number of operations will have to be conducted within a shorter time span (Mugtada 1975, Ahmed 1977). Mugtada and Alam (1983) found that the production of MVs brought about an increase in use of hired labour among all farm size groups but mostly on large farms.

As discussed in chapter three Griffin (1974) argued that rural factor markets in general tend to operate in such a way that small farmers have to pay a higher price for both

modern and traditional inputs needed in order to utilise the new technology. With regard to differences in price paid on different inputs, Hossain (1989b) found that small farmers paid a higher wage rate than large farmers and that pure tenants paid a substantial higher wage rate, this giving support to Griffins assumptions about the working of rural markets. But with regards price paid for fertiliser, Hossain (1989b) found no differences among farms of different size.

The role of education is covered by some studies. Kashem (1987) argues that education has a positive effect on adoption as it reduces obstacles to adoption, such as risk aversion and fatalism. Alauddin and Tisdell (1991) found a positive relationship between level of education and adoption. Hossain (1989a) on the other hand found that education had a negative impact on adoption. He explains this by arguing that farmers who are educated tend to loose interest in agriculture, and thus seek opportunities outside agriculture.

## ***Access to irrigation***

### *The role of irrigation*

As discussed above, there are good agro-ecological reasons for viewing irrigation as a key to the modernisation of Bangladeshi agriculture. Although the various empirical studies discussed here, tend to focus and to a varying extent, explain adoption by referring to a number of different variables, all studies underline the importance of irrigation. All studies find that adoption of the new cropping practices is decisively dependent upon irrigation. The various studies cover different seasons, so this applies not only for adoption of MV-*boro* but also MV *aus* and *aman*. Due to this close relationship between irrigation and MVs one can argue that the decision on whether to adopt the new varieties or not, as well as the extent of adoption, will not primarily be the decision taken by the individual farmer, but rather decisions taken by the pump or tubewell owner. The pump owner could be another farmer, a group of farmers, or a businessman involved in selling water. The strong focus in many farm level studies on the relationship between certain characteristics of the individual farmers and adoption may therefor partly be regarded as somewhat misdirected. If one assumes that access to irrigation equipment is beyond the direct control of most Bangladeshi farmers, more attention should be devoted to the factors underlying the spread of the key input; irrigation.

Access to irrigation can be divided into two main issues. Firstly, access to irrigation equipment, in Bangladesh this means pumps and tube-wells. Secondly, it involves access to water. These two issues are to a considerable extent linked to each other, control over a pump will normally also secure access to water. But at the same time it is clear that most farmers in Bangladesh obtain water without owning or in other ways controlling a pump or tubewell. Even an owner of a pump or tubewell will in many cases also have to purchase water from other pump owners. This arising because most land holdings will be so highly fragmented and such it will not be possible to service all land solely with a single pump or tubewell. Access to water must therefore be treated separately from the question of ownership of irrigation equipment.

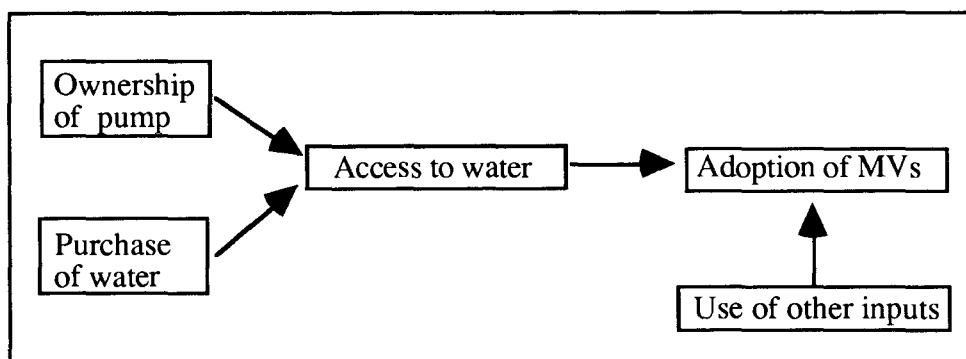


Figure 4.5 The relationship between ownership of equipment, access to water and adoption of MVs

#### *Control over irrigation schemes*

The initial idea behind the Comilla co-operatives and later TIP, was to encourage farmers to organise themselves into co-operatives in order to secure water for their own agricultural land. Farmers should themselves have control over the irrigation scheme through democratically run co-operatives. In practice it proved to be quite difficult to achieve this goal. Studies have shown that the process of allocating heavily subsidised equipment through BADC, with scant attention to the process of group formation, encouraged the establishment of many fake groups/co-operatives, either existing only on paper and in practice owned by one or a few wealthy and influential farmers.<sup>20</sup>

There exists some recent studies which provide information on the new owners of irrigation equipment. In a study covering the background of rural entrepreneurs, Quasem (1986) concluded that the purchasers of the machines (LLPs and STWs) were better educated and had more land than the average farmer. In 1986 I did as discussed in chapter one, carry out a study covering all low lift pumps sold from BADC in Madaripur

during the 1984/85 season, as part of the policy reform (Lein 1987). Of the 39 pumps sold, 27 pumps were used by the owner, for irrigation purposes<sup>21</sup>. The survey showed that pumps were purchased by persons with a land holding varying from nothing more than homestead land to well above 33 acres. The majority (16) of the pump owners could however be classified as relatively land rich farmers, as they owned more than 5 acres of land. Six pumps were owned by small farmers with less than 2,5 acres of land, but five of these six had other important sources of income beside agriculture. Most of the pump owners owned and operate some land in the scheme, this however varied widely, from 0 to 98 percent of the land within the command areas.

A study from Comilla Lewis (1991) divided the owners of shallow tube-wells into two categories. One category, by Lewis termed 'STW farmers', had mainly obtained a tube-well in order to irrigate their own land. The other category, the 'STW businessmen' on the other hand, saw the tubewell mainly as a source of income and were therefore interested in selling as much water as possible. According to Lewis the last group of owners provided better services to farmers in terms of providing the required water.

#### *Access to water*

Although many studies have underlined the importance of water, there exist few studies which have addressed the issue of access to water in any great detail. Many studies have concluded that in general, utilisation of various types of equipment, measured in area irrigated, have been well below the potential capacity of the equipment. This may have many causes. Firstly, it may in many cases be due to physical constraints, such as an undulating topography, small rivers or sections of sandy soil. Secondly, it may be due to managerial problems; even small schemes may be very complex when it comes to distributing water timely and in adequate amounts. Thirdly there may be simple economic reasons behind the limited capacity utilisation. Under the old rental system the high level of subsidy gave few economic incentives to efficient utilisation, as capital costs could be met even in very small schemes.

This low capacity of utilisation has also often been attributed to large farmer dominance of irrigation schemes. Such dominance in irrigation schemes may have unfortunate effects with regards to both efficiency in the utilisation of equipment as well as access to water.<sup>22</sup> It may follow that the equipment may be installed at a non-optimal location, either in order to maximise the pump owners own land under irrigation or to secure physical control over the tubewell/pump. Some have experienced that many pump owners often will tend to give priority to land belonging to their own kin, as well as rich

farmers. It has also been claimed that in some cases the manager may deny a farmer water, with the ultimate objective of gaining control over the farmer's land.

Large farmer dominance in a scheme need not necessarily result in low command areas. A pump or tubewell can be perceived purely as an income generating asset, this providing an incentive to maximise income and scheme coverage. But the value of having control over a pump or tubewell cannot be assessed in purely economic terms, but must be considered in a more broad-based analysis of the dominating pattern of social relationship in rural Bangladesh. A pump or tubewell can be a means to strengthen the patron-client relationship. Water is not only paid for in cash or crop share but also through loyalty in other matters, such as village or union affairs (Jansen 1979). Control over an irrigation scheme can also be used as an instrument in conflicts and then the fractional structure of the rural society may become quite visible, as revealed by this description from a village with a DTW:

*"When walking on the narrow paths and trails between the plots we could clearly distinguish the land belonging to some of the enemies of Shamsul Huq [the pump owner and wealthy, absent landowner]; their land was brown and barren, next to plots filled with bulging, green rice plants. From the top of the engine-house of the deep tubewell the command area of the well resembled a chessboard, where the plots were spread about in green and brown squares" (Jansen 1986, 254).*

But even in cases where control over irrigation schemes are used as an instrument in a more overriding struggle of social control the actual choice of strategy may vary. In a detailed study of four deep tube-well users groups in Bogra, Chisholm (1986) found that two DTWs controlled by two different large farmer dominated 'co-operatives' were operated on quite different terms. In one case the potential positive effects of irrigation on farmers income, was seen as a possible threat to the traditional power system. The tubewell was therefore sparsely utilised and water was not supplied to potential rivals of the family controlling the tubewell. In another scheme, also tightly controlled by a influential family, the tubewell was much more efficiently utilised. Here the family saw the possibility of delivering water to a large number of farmers as a way of strengthening their ties to the farmers, thereby consolidating their already influential position in the locality.

There exist few studies which in some detail have tried to find out what kind of farmers actually have access to water and especially to what extent small farmers actively are discriminated against. Those studies that exist have, however, found no clear evidence in support of a claims that small farmers in general actively are discriminated against with regard to the access to water. Khan (1989) presenting results from both a larger nation-



wide study of DTW schemes, and his own study of three villages in Comilla, concludes that these studies show that all groups of farmers had access to water. Although larger farmers had, in an absolute sense more land under irrigation, small farmers had a larger share of their land under irrigation.

An explanation of this relationship between farm size and irrigated land, has been provided by Rahman (1984).<sup>23</sup> This explanation focuses on the interplay between the agrarian structure and the nature of irrigation techniques in use. Rahman argues that the highly fragmented land holding pattern in Bangladesh, in combination with relatively large scale irrigation equipment, will lead to a high degree of arbitrariness as regards to who will obtain access to water, and hence who will be able to grow MVs. He, as many others, found a positive relationship between farm size, access to irrigation and consequently the rate of adoption of *MV-boro*. He explain this by the nature of the land holding pattern in Bangladesh; large farmers will have more plots distributed over a larger area than a small farmer with few plots. Hence the chance for having one or more plots within a irrigation scheme will be higher for large than small-farmers. As regards to the extent of adoption the picture will be different. Once a small-farmer gets a plot or two under irrigation, this area inevitably tends to comprise a larger share of his total land holding than a large-farmers total holding. Thus one can argue that the present land holding pattern in Bangladesh is in itself an important explanatory variable behind the pattern of adoption of *MV-boro*. The spatial proximity of land to a pump/irrigation scheme making it possible to purchase water, will be the most important factor in determining access to the water needed to grow MVs.

### ***Concluding remarks***

There has, since independence been a substantial increase in food grain production in Bangladesh. But due to a fairly high rate of population growth, production per capita has barely increased. This growth in food grain production must be seen as a result of a substantial increase in the use of modern inputs. Of special importance has been the spread of small scale irrigation. Several studies have underlined the importance of irrigation as a key input in the green revolution's technology. Once a Bangladeshi farmer gets access to water for his land, all experiences indicate that he will use this opportunity to grow MVs.

What seems clear is that even the small farmers are able to take advantage of the new innovations. The empirical studies cited here do not support the claims that the spread of the green revolution technology is limited only to the most resourceful farmers, rather in many situations the small farmers have been more inclined to take up the new practices. It is therefore difficult to argue that the spread of these innovations can be regarded as the main driving force behind a process of differentiation and polarisation in rural Bangladesh as for instance claimed by Rahman (1986a). The evidence available does in fact point in a different direction:

*The positive relationship of the adoption of MVs with the size of landownership which is alleged to have contributed to accentuating income inequality across socio-economic groups in other South-Asian countries is not found valid for Bangladesh. In fact a strong inverse relationship is found, which suggest that the diffusion of modern varieties benefits more the lower income groups (Hossain 1989b, 25).*

Although water is a key input, direct ownership of mechanised minor irrigation equipment and thus direct control over water, is beyond the reach of most Bangladeshi farmers. Most farmers have to buy water from a pump owner. This means farmers having land close to where a pump/tubewell owner is located will have access to water and thereby the opportunity to adopt the new crop types. This infers that one can argue that; the decision on whether to adopt the MVs or not, and also the extent of adoption, will not primarily be the outcome of decisions taken by the individual farmer, but rather dependent upon a locational decision taken by the pump or tube-well owner. This means that the strong focus on relationship between adoption and a number of characteristics of the individual farmers (land ownership, education, family size etc.) in some respect misses a main point. The real decision on whether or not to adopt MVs, is a decision in practice not taken by the farmers themselves.

Some critics have claimed that by allowing to private ownership, a new group of local 'water lords' would take control of local water resources, thereby reaping a substantial share of the benefits accruing from the use of MVs. In practice the impact of the policy reforms as regard to the ownership issue may have been more limited than both the advocates and critics of the reform claimed. In many cases irrigation schemes were virtually 'owned' by relatively rich powerful families also under the old rental system.

Lewis (1991) has argued that owners of irrigation equipment can be divided into two main categories; those who had obtained a tubewells primarily to irrigate their own land, and those who see a tubewell primarily as a income generating asset. One could add a third category, wealthy and powerful farmers using a pump or tubewell as a means to

maintain social and economic control of a locality - either by denying some groups of farmers water, or by using the pump to strengthen patron-client relationships. In fact the term 'water lords' may fit this third category better than the new water entrepreneurs that have invested in irrigation devices in order to earn money. One may assume these water lords enjoyed much better conditions some years back, when irrigation equipment was much more scarce and when those who obtained access to a pump or tubewell, in practice had more or less monopoly on irrigation in a village.

## NOTES

- <sup>1</sup> In regard to the ratio of people to cultivated land Bangladesh is less exceptional. For instance Japan in 1982 had more than twice as many people per unit of agricultural land compared to Bangladesh (2418 vs. 1014 per km<sup>2</sup>) (Norbye 1986).
- <sup>2</sup> The following description is mainly based on Jansen (1986) and Adnan (1990).
- <sup>3</sup> For a discussion of the problems of defining households see Jansen et al (1983).
- <sup>4</sup> The 1989 "Mouza based study of rural facilities" distinguish between these two terms as follows: *Generally the concepts of mouza and village are used interchangeably, but do not denote necessarily the same land area. A village is defined as the name of a place assigned by its inhabitants and commonly known as such. Thus, the concept of village can be differentiated from the mouza from the fact that while a mouza has a fixed boundary and a map, a village has no formal boundary nor map and not (sic!) constituted by government.* (BBS 1990, 1)
- <sup>5</sup> As regard to married women, they will, according to Jansen (1986) maintain a kind of dual *gusti* membership - both the one they were born into and the one they have married into.
- <sup>6</sup> The fact that most low level statistics are collected according to *mouza*, means that it is difficult to utilise this information in village studies organised around a socially perceived village (*gram*).
- <sup>7</sup> With regards administrative divisions above the village level; the 60315 *muzas* are organized into 4 401 unions. These unions were until 1990 gathered in 490 *Upazilas*. These were formerly named thanas, but were renamed as part of a more large scale administrative reform in 1982. The 490 upazilas were again gathered in 64 *Zila* - or Districts (former sub-divisions), these are again gathered in 21 regions (former districts). After the downfall of the Ershad regime the upazilas have been renamed thanas. I have in the present study chosen the term in use in the period covered by the study.
- <sup>8</sup> A farm household is defined as a household with more than 0.05 acres of cultivated area
- <sup>9</sup> According to Rahman (1989) there are MVs suitable for deep water areas in the process of being approved for seed production.
- <sup>10</sup> For a review of irrigation policies see Lein (1987,1990c).
- <sup>11</sup> *"The evidence indicates that the Green Revolution has not in practice been a source of increased relative variability of foodgrain yield and production in Bangladesh. Bangladeshi experience indicates to the contrary ; that the Green revolution may have reduces such a variability"* (Alauddin and Tisdell 1991, 225)
- <sup>12</sup> For a description of the plan and its background, see Brammer and Jones (1990), Boyce (1991)

- <sup>13</sup> The other elements were, according to Hossain and Jones (1983):
- \* A Rural Works Programme (RWP) aimed at improving the physical infrastructure in the rural areas through construction and rehabilitation of roads, channels for drainage and irrigation etc., as well as creation of employment for landless and small farmers in the slack winter season.
  - \* A Thana Training and Development Centre (TTDC) for training and education of model farmers and cooperative leaders.
  - \* Non-agricultural co-operatives for the landless.
- <sup>14</sup> Some main premises for the reform is presented by a report from a joint Government of Bangladesh/World Bank mission (GOB 1982).
- <sup>15</sup> In 1990 the new interim government set up 29 commissions or so-called "task forces" These commissions should identify important development issues as well as possible policy options to be discussed by the new government and the parliament. The reports have been published in 4 volumes.
- <sup>16</sup> Various aspects of the programme are presented in Wood and Palmer -Jones (1991).
- <sup>17</sup> This bias in regional coverage seems to reflect a more general regional pattern. In a review of village studies carried out between 1942-88. Adnan (1990) found that very few studies had been carried out in the South-western parts of the country, whereas a large number of studies had been carried out in Pabna, Bogra Dhaka and especially, Comilla and Nohakali.
- <sup>18</sup> In order to substantiate this statement, Rahman cites Asaduzzaman (1980) and Jones (1984), but in fact Jones specifically states that his findings are not consistent with the findings from Asaduzzaman (see Jones 1984, 209).
- <sup>19</sup> In their analysis of adoption based on regional statistics, Mahmud and Mugtada (1988) also conclude that there is a positive relationship between tenancy and adoption.
- <sup>20</sup> For a review of studies see Botrall (1983).
- <sup>21</sup> Of the 39 pumps sold, the owners of 4 pumps could not be identified. In the remaining 35 cases, 5 pumps (or more rightly engines) were used exclusively in ricemills. In addition, three pumps were rented out for unknown purposes.
- <sup>22</sup> For a more comprehensive discussion of this see Boyce (1987).
- <sup>23</sup> A similar argument is also presented in Khan (1989).

## CHAPTER FIVE

***AGRICULTURAL CHANGE IN MADARIPUR  
UPAZILA******Introduction***

In this chapter, I will present the region in which the empirical parts of the study have been carried out. Madaripur upazila is located in the south-western part of Bangladesh (Figure 5.1). It covers an area of 285 km<sup>2</sup>, and had, in 1986, an estimated population of about 319,000 (LGEB1986). Madaripur town is the administrative centre of both Madaripur upazila and Madaripur district (previously Madaripur Sub-division). Administratively, the upazila is divided into 15 unions and 1 *pourashava* (municipality), and 158 *mouzas* (revenue villages).

In addition to presenting the study area, the present chapter sets out to meet two other objectives. Firstly, I will try to describe some important changes which have taken place in the agricultural sector during the 1980s. Most significant among these changes has been the spread of minor irrigation. Secondly, I will try to put these contemporary changes into a more long term, historical perspective. This is mainly done by using J.C. Jacks book "*The economic life of a Bengal district*" as a basis for comparison (Jack 1975). This unique study does, as discussed in chapter two, give a comprehensive and detailed description of various aspects of life in Faridpur at the beginning of this century.

The first part of the chapter gives a description of some key features of the region, such as the physical environment, population and land ownership, as well as some aspects of the local economy. The latter part of the chapter is devoted to a presentation of the agricultural sector. Besides describing crops and cropping patterns, I have tried to identify and describe some important aspects of the changes which have taken place during the 1980, especially the spread of minor irrigation. This presentation is mainly based on data referring directly to Madaripur upazila. Due to a lack of suitable, disaggregated data, I will, in some cases also use information referring to other geographical levels.

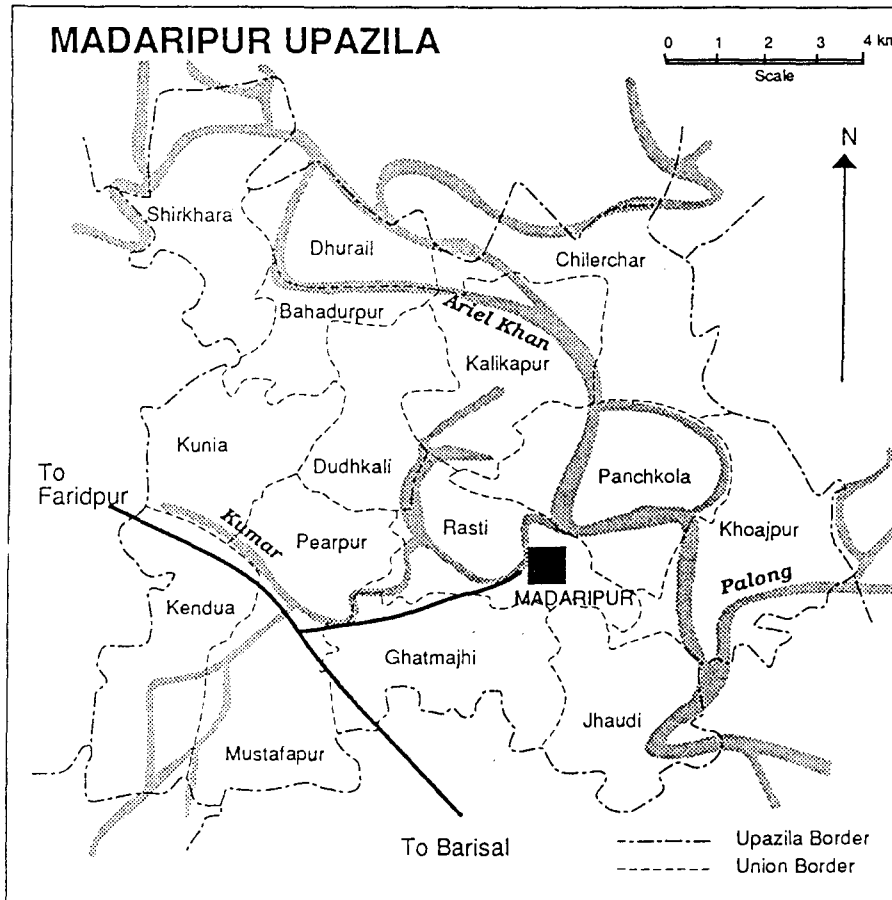


Figure 5.1 Map of Madaripur upazila .

## ***The environment***

### *The physical landscape*

Madaripur upazila lies in the southern part of Faridpur region. At the beginning of the century, J. C. Jack described the South-eastern part of Faridpur as a landscape in rapid change:

*“It is still in the process of formation and is full of rivers which are broad and deep, heavy in the flood season with constructive silt, ...Here the banks are of mud so that the rivers can swing about at will; but although at any one spot there may be land to-day, a river next year and new land a few years later, yet in the total land is always slowly increasing at the expense of the rivers and the level of the whole tract is always slowly rising. The soil in this portion of the district is very fertile and the population very dense; but the homesteads are new and orchards of well-grown trees are rarely to be seen.”* (Jack 1975, 16-7)

The main landforming elements in Madaripur were then, as they are today, the rivers. Four tributaries of the Padma (lower Ganges) river meet in Madaripur upazila. The River

Kumar, which is a dying river comes from the north. The Kumar branches off from the River Chadna near Faridpur town, and zig-zagg southwards, across Faridpur (old) district, until one of its many branches joins Ariel Khan in Madaripur. The Ariel Khan River has two offtakes from Padma. One branches off about 10 nautical miles north of the upazila, and enters Madaripur at the northwestern corner. The second branches off further south, and enters into Madaripur east of the first tributary. The two tributaries then meet in Madaripur upazila and flow south towards Barisal. The fourth river, the Palong branches off from the Padma south of the two the two tributaries of the Ariel Khan, joining the Ariel Khan in the southeastern corner of the upazila.

During recent decades the Ariel Khan River has changed its course significantly. At the end of the 18th century, the main channel of the Padma (lower Ganges) followed what is today called the Bhubaneswar River. This river also ran into the Ariel Khan River passing through Madaripur. Later, due to a number of complex changes in the main river system, the water course of the Padma gradually shifted eastward, and the Ariel Khan became merely a tributary to the Padma.

In the 1920s and 30s the Padma began to move eastward, causing massive siltation at the mouths of its tributaries to the southwest, including the Ariel Khan and the Palong river. At present both Ariel Khan and Palong becomes dry at the offtakes of during the winter season. The Kumar River, which formed the connection between Char Muguria and the Madaripur-Gopalganj *Beel* route described in more detail below, also gradually dried up, and became completely dry for the first time in 1979<sup>1</sup>. These processes, together with more normal river meandering processes, have resulted in massive changes in the local river system in the upazila during the last century (figure 5.2).

These changes have resulted in a relatively undulating landscape with substantial variations in the characteristics of top soils, and with numerous, small, local drainage problems. Here, as in many other areas of Bangladesh, the land slopes away from relatively high lying sandy river banks, into low lying saucer-like depressions (*beels*), or oxbow lakes (*boars*), with heavy, clayey soils.

Except for a small section of the southwestern part of the upazila belonging to the Gopalganj *beel*, the upazila falls within the “eastern, lower Ganges River floodplain” agroecological region (region 12b) (FAO 1988a). Soils in this region is mainly calcareous grey and dark grey floodplain soils, with moderate agricultural potential. The southwest corner of the upazila differs however, as this area, being a part of the large Gopalganj*beel*, consists of low lying marsh.

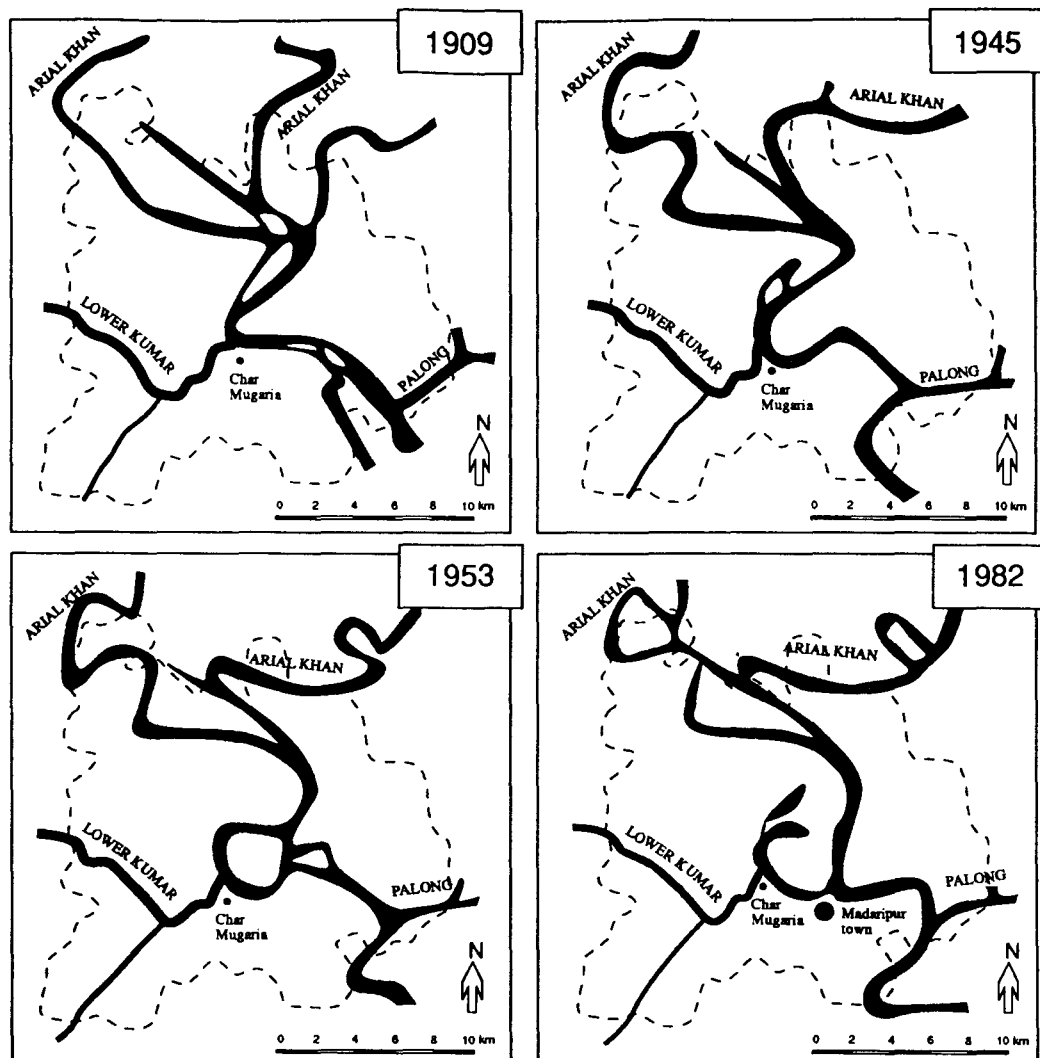


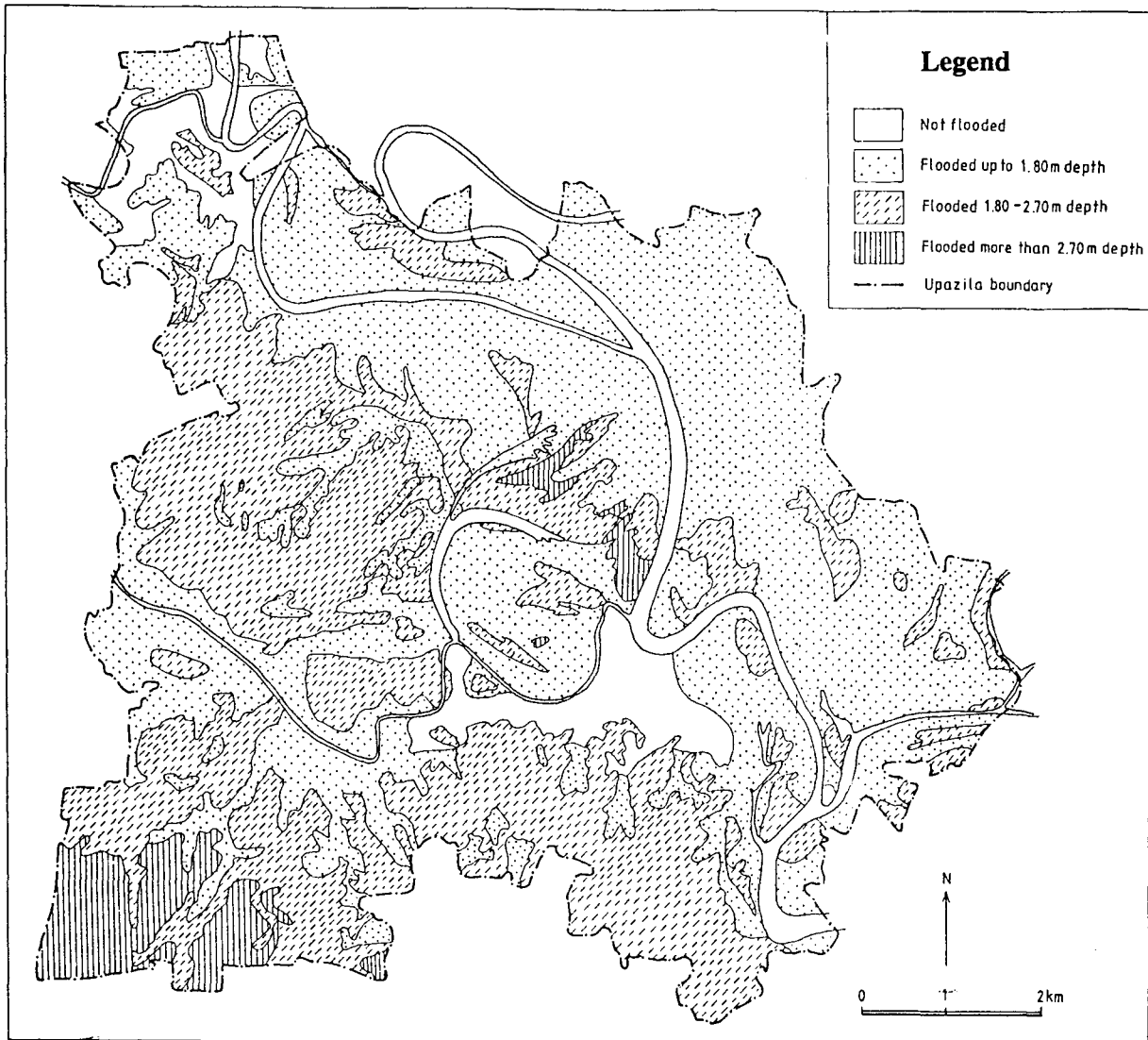
Figure 5.2. Maps showing changes in major river system in Madaripur upazila 1909 to 1982.

Annual rainfall in Madaripur has been calculated to an average of 1952 mm, with a standard deviation of 448 mm (FAO 1988b). This rainfall is highly concentrated to the summer months, with approximately three fourths of the total rainfall occurring between June and October. Temperatures normally vary between a minimum of 12-13 °C in January, and a maximum of 35-36 °C in May.

### Floods

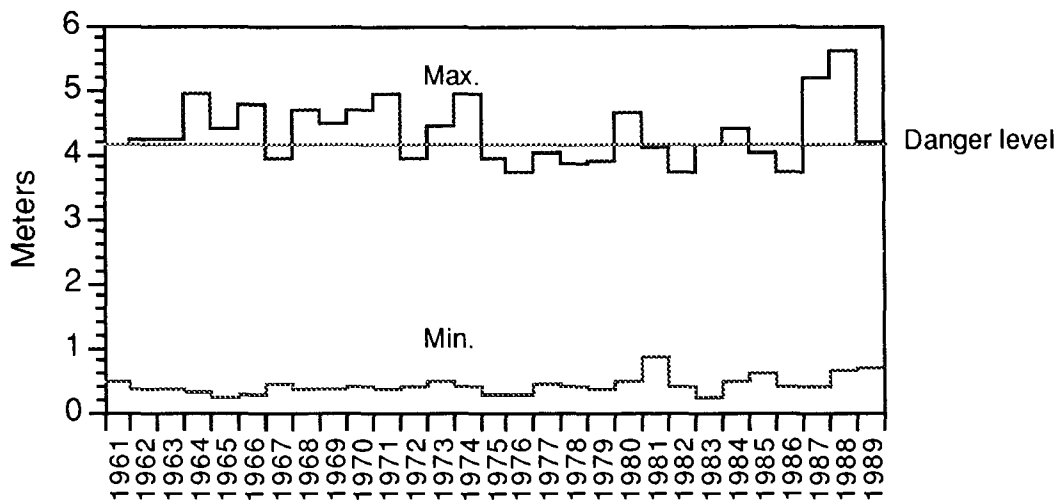
Madaripur upazila is comprised of a low lying area, with land elevation varying between 6 meters in the northeast, to 1.2 meters in the southwest. The upazila is therefore, even under normal circumstances, heavily inundated during the monsoon. About 70 percent of the land is classified as low and medium low land, i.e land which is normally flooded by more than 90 centimetres. Only about 4 percent of the land is classified as totally flood-free land (high land). The flooding pattern in the upazila is shown in figure 5.3.





*Figure 5.3. Map showing depth of flooding in Madaripur upazila.*

According to the latest Faridpur District Gazetteer, abnormally high flood levels have occurred several times in Madaripur since the last World War. During the 1954 flood, waist-deep water in Madaripur town was reported, in 1958 the whole town was said to be “under water”. In 1968 all thanas of Madaripur sub-division was inundated, and in 1970 Madaripur was claimed to be the worst affected sub-division in Faridpur (GOB 1977). Data on the maximum water level of the Ariel Khan River is presented in figure 5.4. They show that excessive inundation has been quite a regular phenomena during the last 30 years. These data do not support claims that damaging flooding has become a more frequent problem during recent decades. On the contrary they in fact indicate that excessive flooding was a more frequent phenomena in the 1960s than in the 1970s.



Source: BWDB records for station nr 5, Madaripur town

Figure 5.4 Maximum and minimum water level of the Ariel Khan River 1960-1990

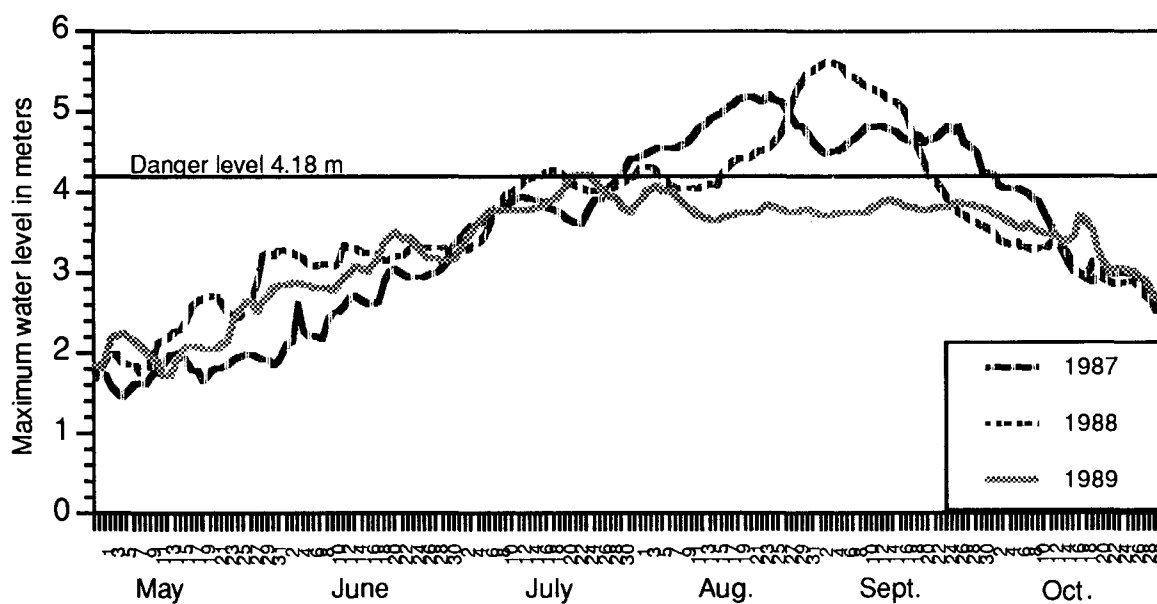
Although flooding is a normal phenomena to which the annual cropping pattern is well adjusted, flooding may still cause damage. But, just as floods may have different causes, they also have different effects. The most important causes of flooding, and flood-related damage in Madaripur are, according to Gallagher et al (1982):

- Flooding caused by heavy local rainfall. This can damage the paddy at early stages of growth. It is a small scale village level problem, varying both with soil structure as well as local topography.
- Flooding caused by a sudden rise of the rivers in the pre-monsoon period. This can also damage paddy at early stages of growth. This is a type of flood which mainly affects low lying areas close to the rivers. It is not caused by local rainfall, but rather a combination of the early swelling of the Brahmaputra (Jamuna) river, and high tides.
- High monsoon floods in August-September. These may damage the mature crops because of either i) strong currents, ii) rapid rise in water level or iii) to high water level.
- Slow post monsoon drainage may prohibit or delay planting of robi crops.

It is worth pointing out that a too high absolute water level, is only one cause of crop damage. What may be of greater importance is the timing of the flood in relation to plant growth.

Madaripur upazila was seriously affected by monsoon floods both in 1987 and 1988. Data on maximum water level in the Ariel Khan River at Madaripur town, presented in figure 5.5 gives an indication of the extent and duration of the flooding. In 1987 the water reached its

maximum height on 28 August (5.17 m), and in 1988 on 4 September (5.60 m). While the absolute water level was higher in 1988 than in 1987, the 1987 flooding lasted longer. In 1987 the river rose above danger level (D.L.) on 31 July, and remained above until 3 October. In total the river was above D.L. for 65 days consecutively.



Source: BWDB records for station no 5, Madaripur town.

Figure 5.5 Maximum daily water level in the Ariel Khan River 1987, 1988 and 1989

In 1988 the river rose above D.L. for two short periods; 18-21 July and 2-6 August. On 17 August, the river again rose above D.L. and remained so for 37 days, until September 22. The rise in water level was very rapid in some periods—in less than 10 days the river rose more from an already high level of 4.59 m to a record level of 5.60 m (from 26 August to 4 September).

The main crop damages due to the last three floods are summarized in table 5.1. The reported crop damages were higher in 1987 than in the all-time record flood of 1988, mainly because of the extensive damages to the *aus* crop. This in turn may be attributed both to the early start of the flooding, which may have damaged the small rice plants, as well as to the long duration of the 1987 flood, which may have made it difficult to harvest the *aus* crop as normal.

Although floods pose the most important threat to agricultural production, other types of natural hazards are found in the area. A hail storm hit the upazila on April 5, 1986, and although it only lasted for about 10-15 minutes, it caused, as table 5.1 show, substantial damages to some of the some winter crops, especially the *MV-boro* crop.

Table 5.1. Major crop damages in Madaripur upazila 1986-88

	Total damage (in acres)	Percent of crop area damaged	Loss in tons	Value of loss (in taka)
<b>1986 hail storm</b>				
MV-boro	4065	65	9146	40 243 500
Local boro	724	36	652	2 867 040
Sugarcane	300	21	4501	4 800 000
<b>1987 flood</b>				
Aus	15296	66	6852	36 710 400
Broadcast aman	17835	63	9986	53 505 000
Jute	41	0,6	20	186 550
<b>1988 flood</b>				
Broadcast aman	21902	80	12262	65 706 000
Transplanted aman	795	100	890	4 770 000
Aus	2069	9	927	6 165 600
Jute	120	1,3	76	612 000
Sugarcane	495	54	5542	3 712 500

Source: Upazila agricultural office, Madaripur.

## ***Population and ownership of land***

### *Population growth and migration*

According to the latest population census available, Madaripur Upazila had a total population of 268 394 in 1981. Of these approximately 58,000 lived in Madaripur town. The population density in 1981 was 942 person per km<sup>2</sup>, well above the average for both the Faridpur (old) district and Bangladesh as a whole (605 and 609 persons per km<sup>2</sup> respectively). The long term population growth in Madaripur upazila for the period 1921-81 has been summarized in table 5.2.

The figure shows a relatively moderate rise in population up to the 1941 census with a rather sharp decline between the 1941 and 1951 censuses. This apparent decline has, most likely, several explanations, the most important being that the 1941 figures probably are set artificially high. Ahmed (1958) and GOB (1977) claim that as part of the political struggle leading up to the partition of Bengal in 1947, both the Hindu and Muslim communities tried to manipulate the 1941 census.<sup>2</sup>

Census figures for the period following independence show a steady growth in population. Compared to the national average however, the Faridpur region had the lowest growth rates in Bangladesh in the period 1951-81 (Miranda 1982, table 2.12). Madaripur had even

lower growth rates, in the period 1951 to 1981. Total population increased by about 44% in Madaripur upazila, compared with 68% for the Faridpur region, and 107 % for Bangladesh as a whole.

Table 5.2. Population in Madaripur upazila 1921-91

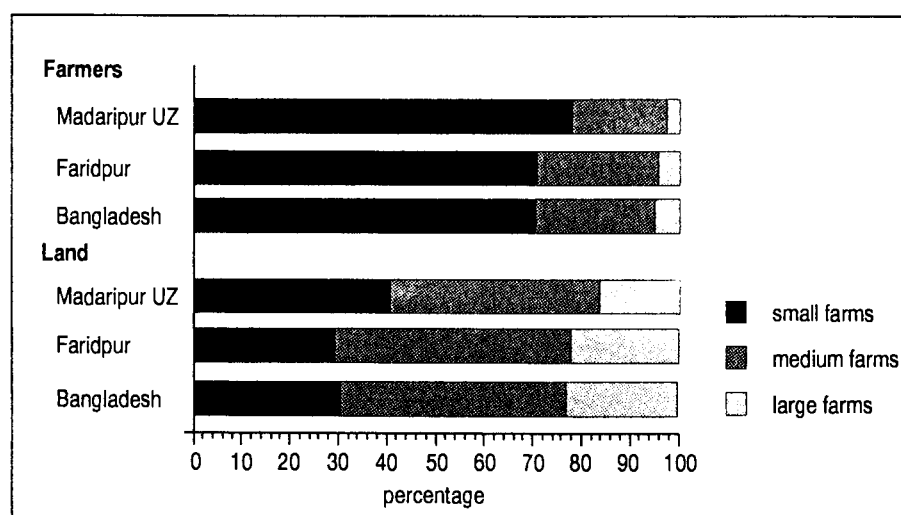
Year	population	MADARIPUR		BANGLADESH
		intercensal growth no	intercensal growth %	intercensal growth %
1921	168,554	10,459	6.2	7.1
1931	179,003	35,133	19.6	18.1
1941	214,136	-27,293	-12.7	0.2
1951	186,843	19,554	10.5	20.9
1961	206,397	21,571	10.5	40.6
1974	227,968	40,430	17.8	21.8
1981	268,398	106,705	39.8	n.a
1991(est.)	375,103			

Sources: Gallagher et al (1982). Estimate for 1991 taken from LGEB (1986). Figures on intercensal growth for Bangladesh taken from Miranda 1982, table 2.1

The relatively slower population increase in this period is explained by Gallagher et al. (1982) by a high rate of migration from the district. It is, in general, difficult to find reliable sources of information on internal migration patterns in Bangladesh and, consequently, on migration to and from the Faridpur/Madaripur areas. Ahmed, in his account from the late 1950s claims that there has been a flow of immigrants to new river-built land in the Faridpur region, as well to the focal points of the jute trade business, among them Madaripur town (Ahmed 1958, 294). The most recent district gazetteers published in 1977, but compiled between 1969 and 1977, claim that "*migration is not an economic factor in Faridpur*" (GOB 1977, 56). More recent studies indicate that migration has become more important during recent decades. Rashid (1977) claims that Faridpur is among the districts of Bangladesh with the highest emigration, but do not substantiate this claim with empirical evidence. In an analysis based on data from the 1961 and 1974 population censuses, Miranda (1982) found that of all the districts in Bangladesh, Faridpur, Comilla and Noakhali were the three most important sources of life-time immigrants to Dhaka. Beside Dhaka, the Khulna district also received a substantial number of immigrants from Faridpur.

### *Land ownership*

Distribution of land, the most important productive asset in Bangladesh has been summarised in figure 5.6. Compared with both the national average and the Faridpur (old) district as a whole, Madaripur differs on two important aspects. Firstly, a comparatively larger proportion of farmers are classified as small farmers. Secondly, this group of small farmers owns a proportionately larger share of available agricultural land, than do farmers of Faridpur and of Bangladesh as a whole. Average farm size in Madaripur is 1.76 acre per farm, clearly lower than the national average of 2.26 acre per farm.



*Note:* Definitions of farm size classes on basis of operated land including homestead and uncultivated land. The classification used is the standard definition used in the agricultural census where households are classified as follows; small farm household : 0.05-2.49 acres of land, medium farm household: 2.50-7.49 acres, large farm household 7.50 or more acres. A household with less than 0.05 acres of land is defined as a non-farm household, the figure thus refer only to farm holdings and land operated by such.

*Sources:* Figures for Bangladesh and Faridpur: BBS 1986a. Figures for Madaripur BBS 1989b .

*Figure 5.6 Land distribution 1983/84.*

## ***The non-agricultural economy***

### *Basic infrastructure*

For a long time Madaripur has been an important communication centre. Char Muguria, now a part of Madaripur *pourashava*, was, at the beginning of this century, the main economic centre of the sub-division. It was also one of the most important steamer stations and jute shipping centres in Faridpur (old) district. Madaripur's importance was due to both its key location in an important jute producing region, and to its nodal function in the inter-

connecting the Kumar River with the Mudhmati River, was excavated as part of the planning of the “Grand Canal Route”, which was to provide a connection between Calcutta and Assam. This channel, named the “Madaripur-Gopalganj beel route” after the low lying area (*beel*) it passes through, shortened the travel distance between Madaripur and Khulna by 89 miles. The excavation of the channel took place between 1899 and 1905, but the route was opened in June 1904 (GOB 1977).

As the Ariel Khan River changed its course, and sections of the Kumar River gradually silted up, the beel route, and Char Muguria, lost much of their importance.<sup>3</sup> Due to siltation at the offtakes of the Ariel Khan and the Palong, boats travelling between Dhaka and Barisal do not pass through Madaripur any more. There are, however, still several small launches in regular operation between Madaripur and Dhaka. At present, Char Muguria is still a fairly important market and local jute assembling centre, but much of the jute transport is now done by the use of trucks.

At present Madaripur town is linked to the Faridpur-Barisal road by a five kilometer long paved road which leads up to Mustafapur. There are also regular direct bus services to Faridpur and Dhaka. Within the municipality area, and along the main, metalled roads, rickshaws are in operation. There are also bus connections to the western part of the upazila along the main road to Mustafapur and Thakerhat. As figure 5.8. shows there has been considerable expansion of the rural road network in the upazila during recent decades. Internal transport is, however, still mainly based on pedestrian transport and boats. Most of these union roads built by various public works programmes, are low standard earth roads which can only be used by pedestrians. During the monsoon, boat transport is dominant and, in general, both internal and external communication becomes more easier when the land is flooded.

Madaripur upazila has an extensive river network and numerous small *khals*. At the beginning of the 1980s, Gallagher et al (1982) reported that the upazila had a well-functioning drainage system, as most of the major *khals* were regularly re-excavated by the Food for Works Programme. The drainage problems present were mostly small and of local nature, confined to minor depressions. The 1986 Upazila plan book, however, reported that the local drainage system was not working properly, as many *khals* had silted up (LGEB 1986).

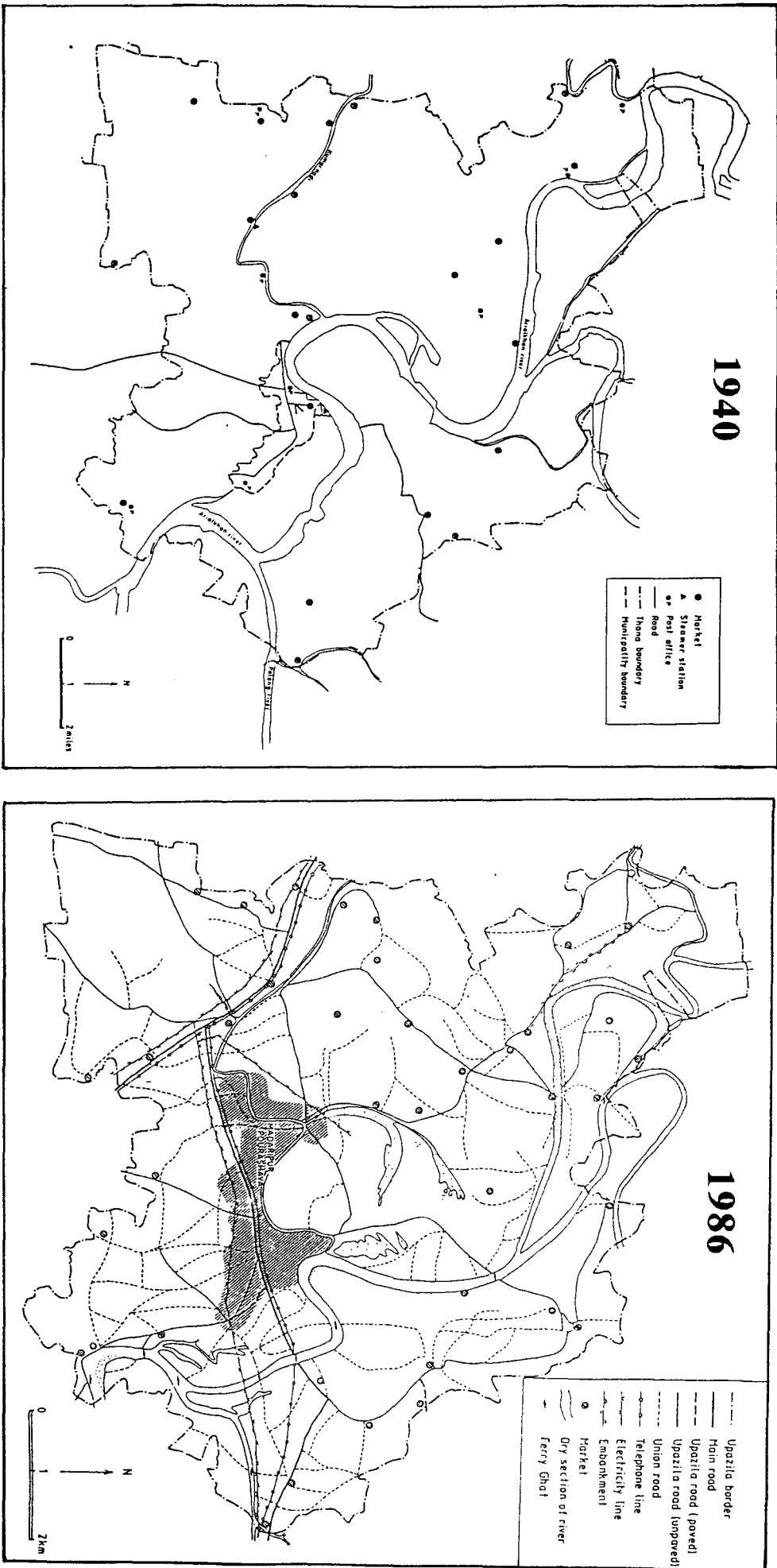


Figure 5.7 Maps showing basic infrastructure in Madaripur upazila 1940 and 1986



Madaripur has never had many structures for flood and drainage. In the 1920 the British built two sluice-gates at Mustafapur and Chaukder *khal* by in order to prevent water from the Padma entering Gopalganj *beel* via the Ariel Khan. However, these sluice-gates have not been in operation since the beginning of the 1970s. As regards embankments for flood protection, the 1986 plan book identified only one combined road and embankment in the upazila, along Mithaspur *khal* in Bhadurpur and Dudkhali unions. However several other roads, including the road from Madaripur town to Madra via Bhramondi, provide some flood protection as they tend to slow down overland river flow. Such roads do not provide efficient flood protection as they lack the necessary sluice-gates. In many cases such roads may in fact prolong flooding, as they hinder post-monsoon drainage of the land.

#### *Non- agricultural employment*

Madaripur is situated in a region which both in the past and today is dominated by agriculture. According to Jack, Faridpur was, at the beginning of this century: “*..not only preponderantly, but exclusively an agricultural district, that part of the population which is not engaged in the production of crops being almost exclusively engaged in services of different kinds to the agricultural community.*” (Jack 1975, 67).

He estimated that 23 percent of the population in Faridpur were non-agriculturalists. Of these 10 percent were employed in services or were supported by the rent of land, 6 percent were engaged in trade, and 8 percent in industry. Of this last 8 percent, only 3 per cent “*...could by any stretch of the imagination be called skilled labour*” (Ibid, 67). He identified only two major industries in Faridpur: fishing and weaving, the latter being in decline.

Later descriptions of the local economy give more or less the same picture, a district totally dependent upon agriculture and agriculturally related services and small scale production. In 1925, O'Malley claimed that “*Agriculture almost monopolizes the energies of the people of Faridpur; little is manufactured for export; and with the exception of jute pressing there is scarcely an organized industry*” (cited in GOB 1977, 157) The only industry of any scale was jute pressing, in 1920 47 establishments employed about 4 800 workers (GOB 1977). After partition in 1947, this industry declined, leaving only a few jute presses in Char Muguria and Madaripur in operation.

In 1962-63 the Bangladesh Small and Cottage Industries Corporation (BSCIC) carried out a survey of small and cottage industries. The survey showed that three major activities, *gur*

(molasses) production, pottery and weaving, comprised 84 percent of total employment in cottage industries in Faridpur district. In small industries, food processing, and most importantly foodgrain processing, provided more than 50 percent of employment (GOB 1977)

When it comes to Madaripur upazila, very little information on the non - agricultural sector before the beginning of the 1980s, is available. The first comprehensive assessment of the situation is found in the 1982 thana plan book (Gallagher et al.1982), where a general overview of non-agricultural production and employment in both the *pauroshava* and the upazila is presented. According to this study, traditional cottage industries, such as *gur* production, dominated in terms of persons involved (table 5.3). The dominant "urban" industries at the beginning of the 1980s were jute processing, and the production of bricks and *bidis*' (local cigarettes).

Table 5.3 Employment in main industries in 1982.

<u>Activity</u>	<u>Units</u>	<u>Employment</u>	<u>Remarks</u>
<b>Cottage industries</b>			
Dheki	27 000 housh.	7500	10 % of 75 000 earning income
Handlooms	570	1855	
Pottery	30	1350	
Gur (molasse)	8 800 housh.	26400	part time
Carpentry (boats)		600-800	seasonal
<b>Urban industries</b>			
Brickfields	11	4000	seasonal
Jute mill	1	1350	
Bidi production	5	388	
Food processing	54	181	
Tailoring	52	133	
Forestry/saw mills	16	89	
Mech./ electric rep.	88	194	
Paper and printing	11	34	
Transport	34	45	

Source: Gallagher et al 1982

It is important to notice, however, that many of the more traditional non-farm activities are of a highly seasonal nature. One of the most important activities, brick making, only takes place during the dry winter season. In general, there are fewer non-agricultural income opportunities available during the monsoon than in the dry winter season.

Unfortunately, Gallagher et al (1982) do not present an overview of all types of non-farm activities in the upazila, as neither trade nor other type of services were included in their

account. However, these activities were included in a separate review of the employment structure within the *paurashava*. In connection with the preparation of the thana plan, a census of all establishments within the town was carried out. This census showed that almost 12,000 persons were engaged in various establishments in the town. Not surprisingly, it also showed that trade and services were the most important activities as regards employment, such activities accounting for almost 60 percent of non-farm employment in the town.

In 1986, a nationwide census of non-farm establishments was carried out. According to this, 38,775 persons were engaged in various non-farms establishments in Madaripur upazila. This amounts to approximately 19 percent of Madaripur upazila's population above 10 years of age.<sup>4</sup> On basis of this figure it may be a reasonable “guesstimate” that at least half of the 62,000 households in the upazila had household members earning income from non-agricultural activities. The figures on urban employment from 1982, and the non-farm census in 1986 are to some extent comparable. The figures indicate a growth in urban employment from about 11,900 in 1982 to 14,900 in 1986, a 25 percent increase in this period.

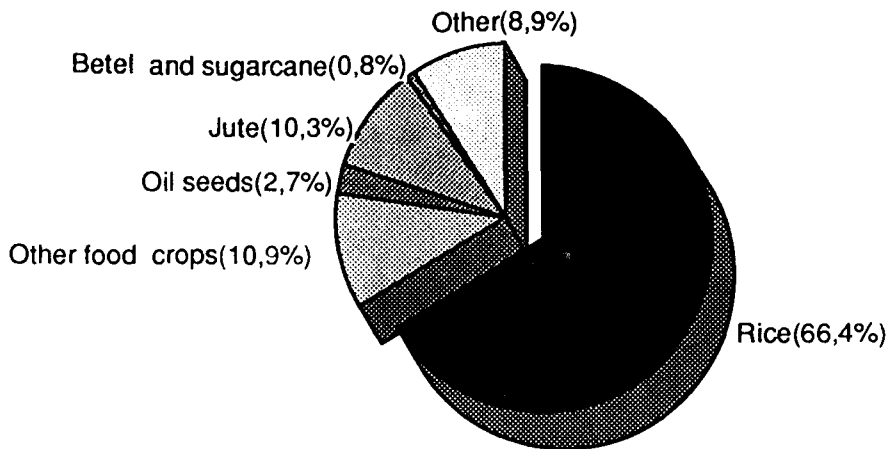
## ***Agricultural development***

### *Traditional agriculture*

In his account of life in Faridpur, Jack presented a land of abundance:

*“The life of the cultivator in Eastern Bengal is in many ways a very happy life. Nature is bountiful to him, the soil of his little family farm yields in such abundance that he is able to meet all his desires without excessive work. He can produce the food of his own family and sufficient to purchase everything else which he requires from a few acres of land that he can cultivate unaided without overwork.”* (J. C. Jack 1975, 38).

According to Jack, the peasant mainly focused his attention on a on a single rain-fed monsoon rice crop, or if the land was suitable, a jute crop. Only occasionally would this be supplemented with a second, winter crop. Rice was the main crop, two thirds of the land being used for rice production. Jute, the main cash crop, covered about 10 percent of the land (figure 5.8).



Source: Based on Jack 1975, table page 88.

Figure 5.8 Main crops grown in Faridpur 1906-10

Although Jack describes a traditional, subsistence oriented peasant society, he also describes a society linked to both local and international markets. On the basis of his comprehensive set of data, he claimed that about four-fifths of all agricultural families were involved in selling crops, while two-fifths bought food grain. The large number of farmers involved in market transactions is explained by the introduction of jute in the latter part of the 18th century.

*“Nowadays the cultivator tends to grow jute on all the land fit for the purpose and to grow rice and other food crops on the remainder. If that remainder is insufficient to supply the family requirements in food, he prefers to buy rather than reduce the amount of land under jute”* (ibid, 85).<sup>5</sup>

Although this involvement in the international jute market could be remunerative, it also meant a high risk, due to price fluctuations on the international jute market.

*“At the beginning of the present war the jute market collapsed completely, with the result that for the first time for many years the cultivators of East Bengal were short of money with which to buy their food; and it is probable that it will be many years before they again become so trustful as to grow less food than the family needs for consumption of the year”* (ibid, 86).

Seventy years later the cropping pattern was not fundamentally different, except, perhaps for a more intensive growth of rain-feed winter crops as wheat, pulses and oilseeds. According to Gallagher et al (1982), the dominant crops in Madaripur at the beginning of the 1980s were broadcast (deepwater) *aus/aman*, which were commonly grown intermixed (table 5.4). These were usually grown in combination with rainfed winter crops such as oilseeds (mustard), pulses and wheat. Double cropping of paddy was not common.

Table 5.4 Common crop combinations in Madaripur upazila 1982.

<u>Summer crops</u>		<u>Winter crops</u>
Broadcast <i>aman/aus</i>	—	Oilseeds/ pulses
Broadcast <i>aman/aus</i>	—	Wheat
Jute	—	Oilseeds/ pulses/wheat
Fallow (deep water)	—	Local <i>boro</i>
Sugarcane	—	Sugarcane

Source: Gallagher et al. 1982.

The 1983/84 agricultural census shows that the most important monsoon crops, measured in coverage were *aus* and *aman* rice, and jute. The most important winter crops were various types of pulses (mainly *Chola*, *Mushur* and *Khesari*), and to a lesser extent, oilseeds (mainly mustard).

In a national comparison it is worth noting that robi crops, such as oilseeds and pulses, covered a substantially larger share of the gross cropped area in Madaripur than in Bangladesh as a whole (30.4 versus 11 percent). In addition, although rice was also the most important crop (47.9 percent) in Madaripur, the area devoted to this crop was well below both the average for the Faridpur region and for Bangladesh as a whole (54.4 and 70.0 percent respectively).

Less than five percent out of the total rice area was planted with modern varieties in 1983/84, compared to the national average of 14.5 percent. Slightly more than five percent of the net cultivated area was irrigated and this is also well below the national average of 19.9 percent. Cropping intensity was estimated to be 243, well above the national average of 171.

In sum the cropping pattern in Madaripur in the first half of the 1980s can be described as predominantly traditional, with little land under irrigation and very limited use of modern rice varieties. Rice was the most important crop grown in the upazila, but robi crops, such as pulses and oilseeds, did play an important part in the overall cropping pattern.

#### *Agricultural changes in the 1980s*

Due to a lack of reliable disaggregated time-series data, measuring agricultural change on community level is, in general, a difficult task in Bangladesh. It is not possible to measure long term agricultural changes at community level on the basis of the available agricultural censuses. The 1960 agricultural census presented data on the sub-division level (now district), the 1977 census provided data down to (old) district level. Only the latest

1983/84 agricultural census provided disaggregated information below district level (upazila, union and mouza). When assessing changes on low geographical levels, one therefore has to rely on other, more scattered and not so readily comparable pieces of information.

With the sources available, however, it has been possible to put together comparable data on some key indicators of agricultural change during the 1980s, and in particular, on the expansion of irrigation. If the argument presented in chapter four, on water being a leading input in the green revolution technology in Bangladesh, is accepted, figures on the expansion of irrigation facilities must be looked upon as a fairly reliable indicator of both the rate and nature of agricultural change taking place. Although it is not possible to measure agricultural change and changes in cropping patterns directly on the basis of available statistics, it is possible at a more general level, to identify some possible new cropping combinations which may result from the introduction of a new irrigated *MV-boro* crop.

As shown in figure 5.9, it will, on relatively high land, be possible to replace a traditional cropping pattern consisting for instance of mixed *aus/aman* + pulses, with a pattern combining a *MV-boro* crop and a transplanted *MV-aman* crop. Such combinations are found in some parts of the upazila (i.e. parts of Kohajapur, Mustafapur, Shirkhara and Jhaudi unions). This clearly implies an intensification as regards land use. On relatively heavily flooded land, as found in large areas of Madaripur, it is not possible to combine *MV-boro* with any other crop. The introduction of an irrigated *MV-boro* crop on this type of land will, in fact, imply a reduction in cropping intensity. This development is found in *Char Bhramondi*, the village presented in more detail in chapters five and six.

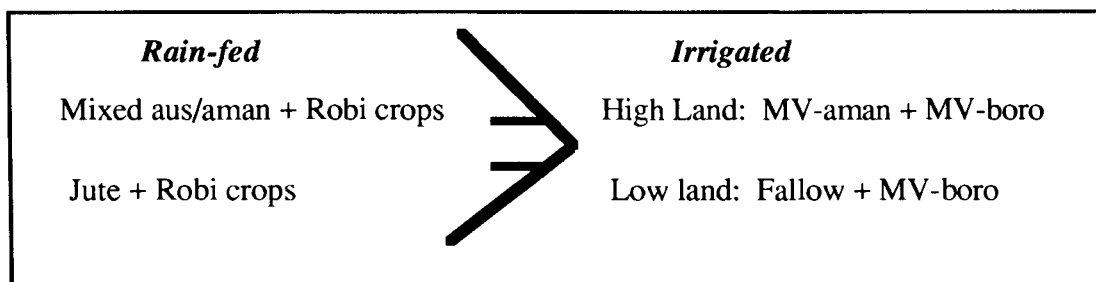


Figure 5.9 Alternative paths of change in cropping patterns

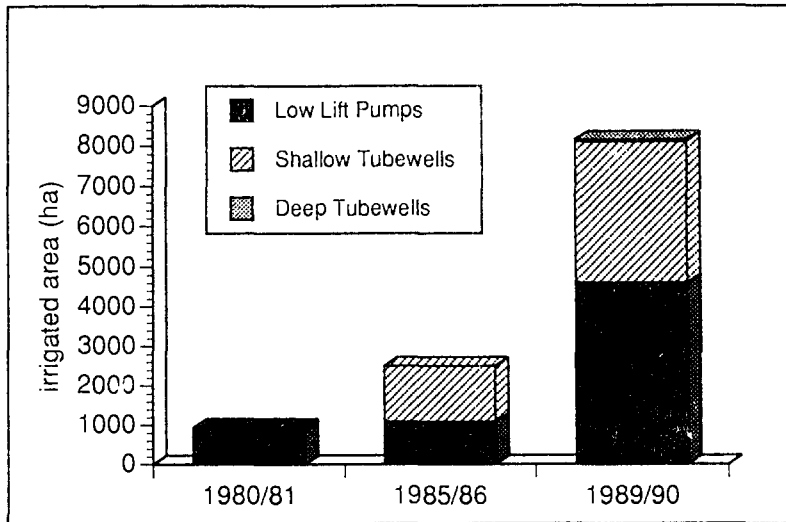
*The spread of irrigation*

Irrigation by low lift pumps (LLP) was introduced in Madaripur upazila during the Pakistan period. All pumps were, at that time, owned by BADC, and rented out to co-operatives/water user groups on a seasonal basis. BADC records show that as early as in 1970/71, 61 pumps were fielded in Madaripur upazila. This number increased slowly to 148 at the beginning of the 1980s (Gallagher et al 1982). The first shallow tubewells (STW) were introduced in Madaripur in the middle of the 1970s, and rapidly gained popularity. In 1976 three tubewells had been distributed by BADC, in 1981/82, this number had increased to 54. Unlike LLPs, STW have never been rented out through BADC, all tubewells have been sold to the farmers.

Due to the policy changes in the minor irrigation section, the rental programme was phased out during the 1980s, and in Madaripur, most of BADC's stock of old low lift pumps was sold off between 1982 and 1986. In 1986, irrigation schemes operated by low lift pumps sold by BADC during the 1984/85 season were visited, and the owners or managers interviewed.<sup>6</sup> This survey showed that one of seven pumps (engines) sold were not used for irrigation, but were used exclusively as ricemills; and that one of six pumps had re-entered the market either by sale or rental, only one year after they had been purchased. It was reported to be relatively easy to purchase or rent pumps on the second-hand market in the upazila. The most important source of both spare parts and mechanics was also the private sector and not BADC which had been the main supplier under the rental programme. This seems to be due to a combination of both accessibility and price. Spare parts sold by private dealers were reported to be cheaper and more easily accessible than BADC supplied spares, which were of better quality, but more costly. Private mechanics were also commonly preferred to BADC appointed mechanics, as they often lived in the villages and therefore available on shorter notice than BADC mechanics, who had to be collected from Madaripur town. Cost of repair tended to be the same regardless of who repaired the pump.

Although BADC continued to sell new pumps after the termination of the rental programme, an increasingly larger share of the pumps fielded have, during recent years been traded on a private basis, both on the local second-hand market and through a number of dealers in the larger cities, primarily Dhaka and Barisal. BADC's records probably give a reasonably accurate picture of irrigation coverage at the beginning of the decade, while the STW programme was still, new and the privatisation of low lift pump irrigation had not gained much momentum. After this period, BADC records become less reliable. Figures on the

situation in 1986 and 1990 are therefore based on information provided by the Upazila agricultural office.<sup>7</sup>



Sources: 1980/81: BSS 1983 table 3.78, 1985/86; LGEB 1987 table 5.7, 1989/90; Upazila agricultural office.

*Figure 5.10 Expansion of minor irrigation in Madaripur 1980-90*

As figure 5.10 shows there was substantial growth in the area irrigated by irrigation equipment in the upazila between 1980 and 1990, especially in the last half of the period. In 1980 less than five percent of the net cropped area in the upazila was irrigated, in 1990 this had risen to close to 39 percent. As regards choice of irrigation technology, it is worth noting that while the expansion of irrigation until 1980 was almost entirely based on low lift pumps, the expansion between 1980 and 1985 was mainly based on shallow tubewells. In the latter part of the 1980s, however, expansion was again mainly based on low lift pumps. Unlike many other areas of Bangladesh, deep tubewells have never been of any importance in Madaripur. In fact the two DTWs in use in the upazila in 1990 were installed after 1986.

As can be seen from figures 5.11 and 5.12, there are noticeable differences between the unions both as regards irrigation coverage and the type of irrigation technology in use. Although one can say that, to a considerable degree, areas which initially lagged behind caught up with the more progressive areas during the late 1980s, some areas, especially in the northern part of the upazila (Dhurail, Chilerchar, Shrikara) are still well behind in irrigation coverage.



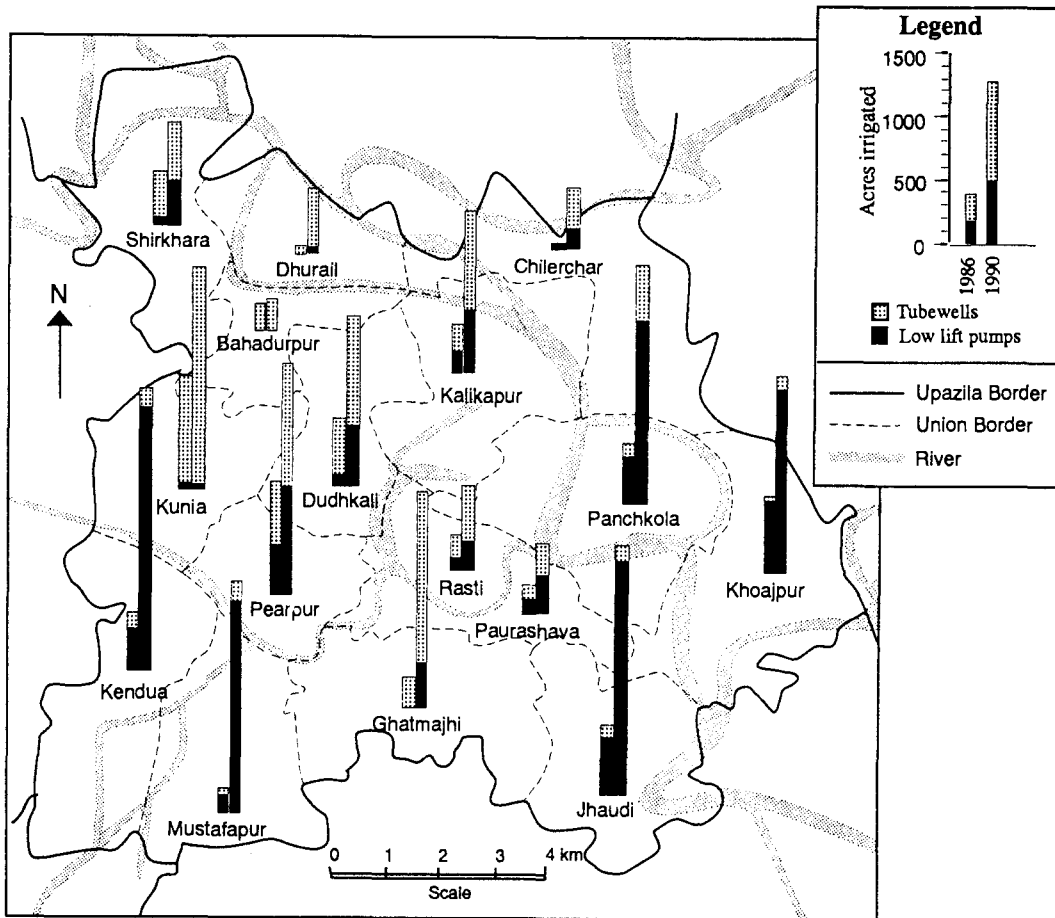
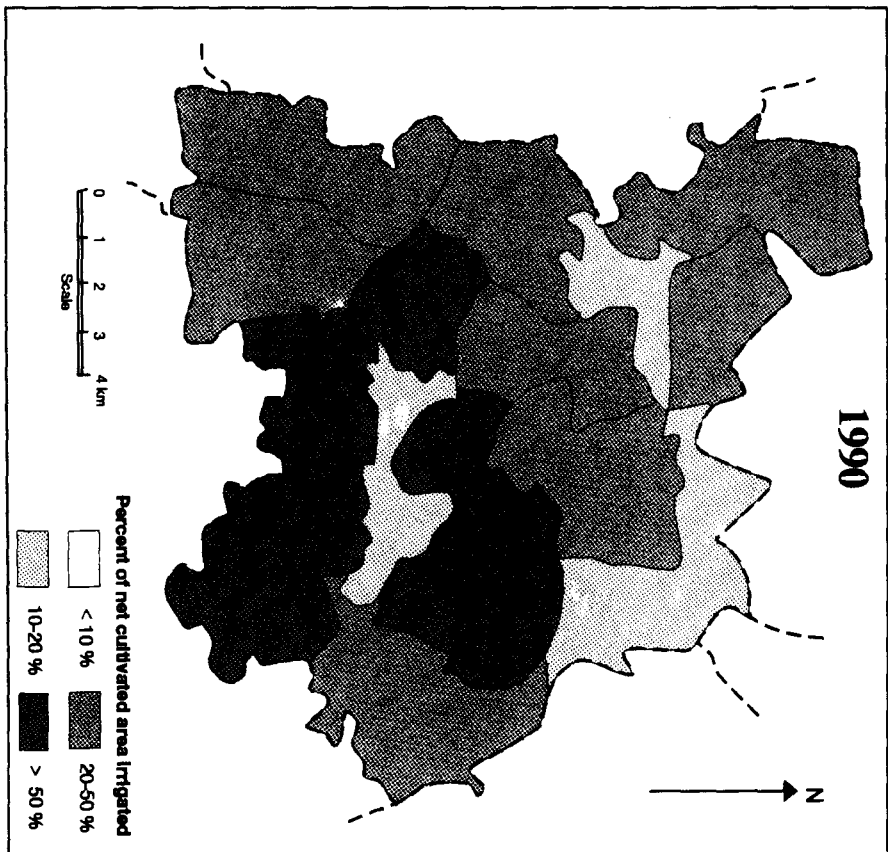
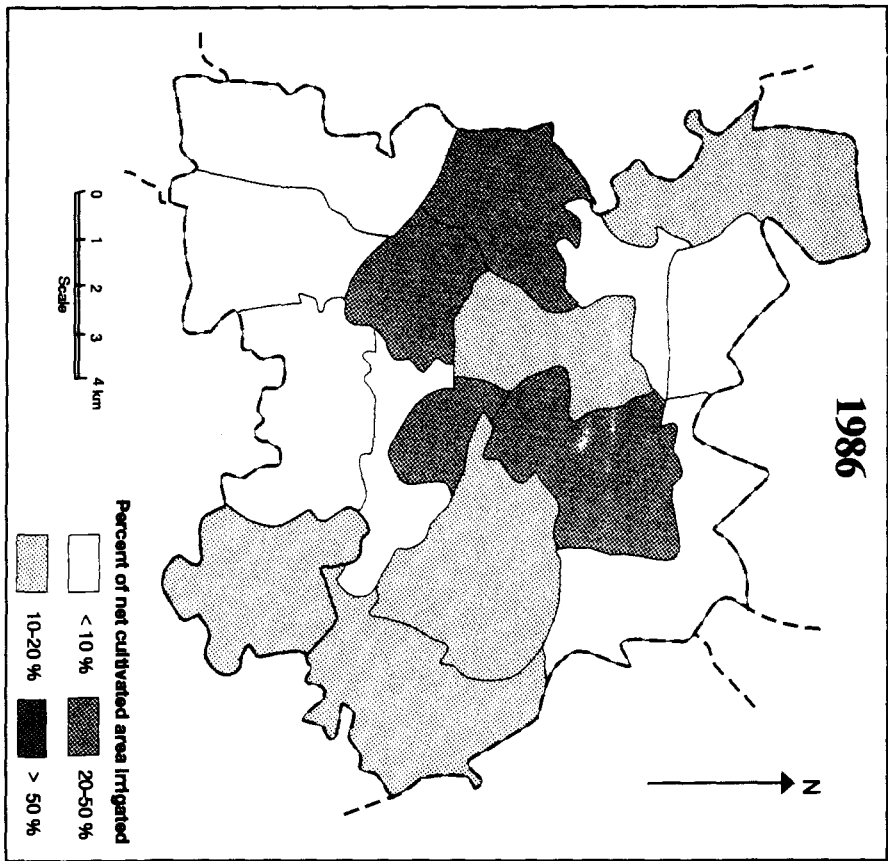


Figure 5.11 Area under irrigation according to source of irrigation 1986 and 1990

It is likely that a variety of basic physical features, especially soil, topography, and water availability, can explain much of the local variation. Some unions, such as Durail and Chilerchar, mainly consist of newly formed land dominated by sandy soils and an undulating topography and are therefore not suited for irrigation at all. In other areas, water availability is the limiting factor. In Jhaudi and Pachola, there are several good surface water sources, while in other unions, such as Dudhkali, there are few such sources. Reliable information on ground water availability is lacking, but BADC experiences with STW indicate that there is considerable variation among unions. In some areas the sub-soil strata is not suited for STW because of problems with natural gas, (Kendua, Mustafapur), whereas others unions, such as Kunia, seem to have excellent conditions for STW.

In summary, some unions are not suited for irrigation at all, because of soil or topographical characteristics, or because adequate water sources are lacking.



5.12 Map showing unionwise irrigation coverage in Madaripur upazila 1986 and 1990.

In other areas only one type of irrigation technology can be used, while a few unions have favourable conditions for both technologies. In the latter case, the farmers will probably choose LLPs, as both initial capital costs and operating costs are lower than for STWs. In addition, LLPs are easier to operate and have fewer technical problems.

The relationship between technology and environment may, however, change over time. In Kunia union, irrigation by LLPs was common prior to 1980, but as the Kumar River gradually went dry during the late 1970s, the farmers gradually shifted to STWs, so that in 1990, irrigation in this union was almost entirely based on tubewell irrigation.

Although ecological variations at micro level probably can explain much of the variation in irrigation coverage, other explanations may be as relevant. In the late 1970s, president Zia launched a “canal digging revolution” under the Swanirwar programme. One feature of this programme was the re-excavation of one main irrigation channel in each sub-division of the country, using voluntary labour. In the then Madaripur sub-division, a channel in Khoajpur union was selected for this purpose, and, as a part of this programme, 58 one cusec LLPs were distributed free of cost among farmers along the channel.

#### *Distribution of fertiliser and seeds*

Fertiliser distribution from BADC rose steadily during the first half of the 1980s, while in the latter part of this period available data show a decline in sale (Figure 5.13). There is, however, no reason to assume that this reflects a real decline in fertiliser use in the upazila, rather the decline can be explained by the fact that in the last part of the 1980s, an increasingly larger share of fertiliser has been sold through private dealers.<sup>8</sup> In 1989, there were at least 14 private fertiliser wholesaler dealers established in Madaripur town. These dealers bought fertiliser outside the BADC system, and resold it to small traders as well as to the farmers directly.

As regards the distribution of modern seeds, BADC has a seed distribution office in Madaripur. Figures on annual distribution available from this office show that there has been considerable variations in distribution from year to year. It is difficult to explain these annual variations, but it is worth noting that distribution of *MV-boro* seeds was highest in the two post-flood seasons of 1984/85 and 1988/89. The available statistics do not provide information regarding varieties distributed. But according to the upazila agricultural office BR 11, 14 and 16 were the most used varieties for *MV-boro* production, BR 12 and 16 for *MV-aman* production.

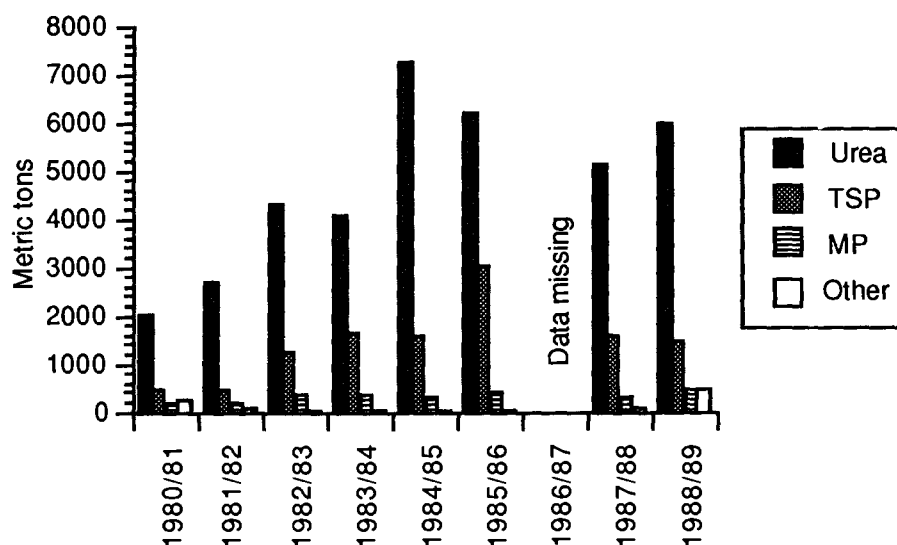


Figure 5.13 Fertiliser distributed through BADC in Madaripur upazila 1981-89

## Concluding remarks

In this chapter I have tried to describe some general features of Madaripur upazila, as well as some of the more long term economic changes which the upazila has gone through this century, and in the 1980s in particular.

At the beginning of this century, J. C Jack described the southern part of Faridpur, including Madaripur, as a booming part of the district. Similarly, subsequent accounts described a society which, due to its fertile soil, attracted new settlers to the region. *"The progressiveness of the south was the result partly of healthiness and natural fertility and partly of the formation of rich alluvial accretion along the Padma and Meghn which attracts settlers from areas where land had been diluviated"* (GOB 1977 52).

In addition, the growth in population was seen to be a result of *"the general prosperity of jute trading during the decade which attracted settlers for employment"* (GOB 1977, 53). Cases of immigration and emmigration were considered a result of changes in the major river system, as: *"Settlers from adjoining districts were attracted by the fertile alluvial accretions in Faridpur, especially if their own land had been cut away by the erosion of those two rivers. Similarly emigrants from Faridpur went to settle in the chars thrown up in Bakerganj"* (GOB 1977, 56).

Gallagher et al (1982) claim that this period of prosperity in the first part of the century was followed by a period of stagnation and economic decline in the 1960s and 1970s. The relatively low population growth rate figures, and assumed large emigration rates, are seen as key indicators of this stagnation.

Both Ahmed (1958) and GOB (1977) see the favourable physical environment as a main underlying cause of prosperity at the beginning of the century. Gallagher et al suggest a number of possible explanations for the later decline :

- \*The region lacked a major city which could attract urban expenditures and absorb rural migrants.
- \* There had been few public development programmes in the region
- \*The region has relatively few overseas migrants sending home remittances.
- \* The changing focus in regional economic linkages, from trade links between Calcutta and Dhaka before partition, to a new axis Dhaka-Chittagong after partition, has contributed to the stagnation
- \*The area was already densely populated and the absorption of a further population increase has therefore been difficult.

Although they discuss several possible explanations, they end up focusing on the environment as a decisive factor behind the district's prosperity, by concluding that *"..perhaps the most important reasons of all was related to the changes taking place in Faridpur's river system"* (ibid, 5). The main reason for this was the reduced water availability both in the dry and monsoon season, caused by changes in the national river system. This hampered agricultural production, fishing, and water transport in the region.

This focus on environmental aspects and environmental changes may be important, but, to some extent, it underestimates the effect of other factors which may lie behind the stagnation. The effects of the partition in 1947 were most likely dramatic. It meant cutting off the links to the jute processing industry in Calcutta, it also meant that Madaripur lost much of its importance as a node in a larger transport network. Likewise, there is reason to believe that the gradually declining demand for jute on the international market must have contributed to the economic stagnation in this jute producing region.

However, while there are signs of economic decline, there are also clear indications of growth. There was a substantial growth in the non-agricultural economy in the 1980s.

There has also, as discussed above, been a remarkable development of rural infrastructure during the last 40 years.

What seems clear from the various descriptions, is that the traditional livelihood system was a highly productive system, based on fertile soil and an abundance of water. Traditionally, crop production was based on the production of jute as a cash crop, and on deepwater rice paddy as the principal subsistence crop. This, in combination with other sources of food such as fishing, was a system which, for a long period, was able to provide food and income for a large and growing population. It was also a system which could not be intensified beyond a certain point, without major changes.

The introduction of modern small scale irrigation in the late 1960s made it possible to change to a new system, thereby increasing agricultural production. It was, however, an opportunity which was not fully explored before the end of the 1980s.

## NOTES

- <sup>1</sup> The silting up of Kumar inbetween Char Muguria and Thakerhat is the outcome of a rather complex interplay between the various rivers which slow down the water flow in this specific channel several times during the flood season. These processes are described more in detail in Gallagher et al 1982.
- <sup>2</sup> The great Bengal famine in 1943, which according to Sen (1981) may have caused up to 3 million deaths, may explain part of the decline, as at least some parts of Faridpur district was hard hit by the famine. The district gazetteers claims that the Faridpur district had among the highest number of deaths of all districts (GOB 1977, 25). Sen refers to a study of five villages in Faridpur which estimate that 15 percent of the population in these villages were "wiped off" during 1943 (Sen 1981, 210). Also of importance may be the independence process in 1947 which caused migration to India among the large Hindu population of Faridpur, without any corresponding immigration of Muslim settlers into the same area. According to Ahmed 1958 few muslim immigrants (*Muhajirs*) settled in Faridpur (see map 51 and table L p 296)
- <sup>3</sup> It is unclear how important this route actually was. The District Gazetteers claims that the scheme "did not prove to be a success due to failure to maintain sufficient depth at the eastern offtakes of the channel from Padma" (GOB 1977, 151). Ahmed claims that the connection to Calcutta is "very important to the jute trade" (Ahmed 1958, 240)
- <sup>4</sup> LGEB (1986) estimate total population to 318 902 persons in 1986. The 1981 census showed that about 64 percent of the population in Madaripur was above 10 years of age.
- <sup>5</sup> Such heavy dependence on production for an international market was not a new thing, as at least the northern parts of Faridpur (old) district belonged to the core indigo producing regions of the 19th century (Ahmed 1958)
- <sup>6</sup> The results from this survey have been presented more in detail in Lein 1987.
- <sup>7</sup> The 1990 data these were collected through the local extension workers ("block supervisors") in the upazila. Figures for 1986 are taken from LGEB (1986), how these have been compiled is not known.

<sup>8</sup> In addition an unknown, but most likely considerable amount of seeds and fertilizer was distributed free of charge after the floods in 1987 and 1988, through the local upazila agricultural office.

## CHAPTER SIX

***THE SPREAD OF IRRIGATION IN CHAR  
BHRAMONDI******Introduction***

Whereas the preceding chapter described the spread of irrigation in Madaripur Upazila as a whole, I will in this chapter discuss this process in more detail, on the basis of observations from a single village. Besides focussing on the spread of irrigation, a number of other, related issues will be discussed. I will describe how irrigation schemes are organised, identify the owners of pumps, as well as those controlling the different irrigation schemes in the village. A part of the chapter is devoted to a description of some selected schemes, primarily in order to capture the more dynamic aspects of control over schemes. Two other issues will also be discussed in the last sections of the chapter; cost and return to the owners of the irrigation pumps, as well as access to water.

*Char Bhramondi* is a village located a few kilometres to the south of Madaripur Paurashava. This village was initially chosen as study area in 1986 due to the presence of a number of irrigation schemes, all based on low lift pumps, but organised under different forms of ownership and management. Information on all irrigation schemes in the village were collected in 1986 (9 schemes) and later in 1990 (26 schemes). This chapter is based mainly on information from these two rounds of interviews.

The *mouza*, or revenue village, which the present study area is a part of, can be separated into two separate entities. The inner part of the *mouza* is the established part and consists of stable land forms and old settlements. This land is locally classified as medium and high land. The outer part of the *mouza*, which is separated from the inner part of the village by a small *khal*, is a *char* area, geologically formed through siltation and changes in the Ariel Khan river. Most of the *char* is more than 30-40 years old and is relatively stable, with well established homestead areas. However in the southern part of the *char*, new land is still being formed, this being a continuation of a more long-term south-ward growth of the *char*. The land in *char* is mainly low land and is heavily flooded during the monsoon.



When it comes to basic social amenities, the two areas also differ. The inner part of the mouza is connected to Madaripur-town by a semi-paved road passing through the local market centre. This centre has a bi-weekly market (*hat*), some small grocery shops, a union parishad office, a seed godown, a mosque and a primary school. The outer area is connected to the Madaripur road and the inner part of the mouza, by a number of foot paths and bamboo bridges. There is no market in the *char*, but there is a mosque and a small grocery shop. Although both the inner and outer area belongs to the same revenue village, most people refer to the inner and outer parts as two separate villages; *Bhramondi* and *Char Bhramondi*. This partition of the *mouza* must be seen as an outcome of a historical process where as the *char* has grown and stabilised and the homesteads have become more established and population has increased, the outer area has gradually been acknowledged as a separate social and geographical unit.

I will in this section focus mainly on the outer area, the area that constitutes the village *Char Bhramondi*.<sup>1</sup> The village comprises the physical area where the irrigation schemes described here are located, but in most aspects the village as such, is not the main unit of investigation. Rather, it is the irrigated land around the village and those who farm this land, which compose the main focus. Much of the land in *Char Bhramondi*, both irrigated and non-irrigated, is owned by farmers living in *Bhramondi* and other surrounding villages. And so many of the irrigation schemes in the village are controlled by people living outside *Char Bhramondi*.

## ***A description of the irrigation schemes in Char Bhramondi***

The first irrigation scheme in the village was set up in the late 1960s and is still in operation. However, the real expansion of irrigation began in the first part of the 1980s. There was a gradual increase in irrigation schemes in the first part of this decade, so that in 1986 there were altogether nine irrigation pumps operating in nine separate irrigation schemes. By 1990 the number of pumps had increased to 28 being used in 26 different schemes. In 1986 a total of 145 acres were irrigated, four years later 500 acres were under irrigation (figure 6.1). These rather dramatic changes were quite visible in the landscape. During the winter of 1986 the irrigation schemes lay as green islands in an otherwise brown and barren landscape, whereas in 1990 large parts of the village was green, with only a few barren fields among a sea of green.

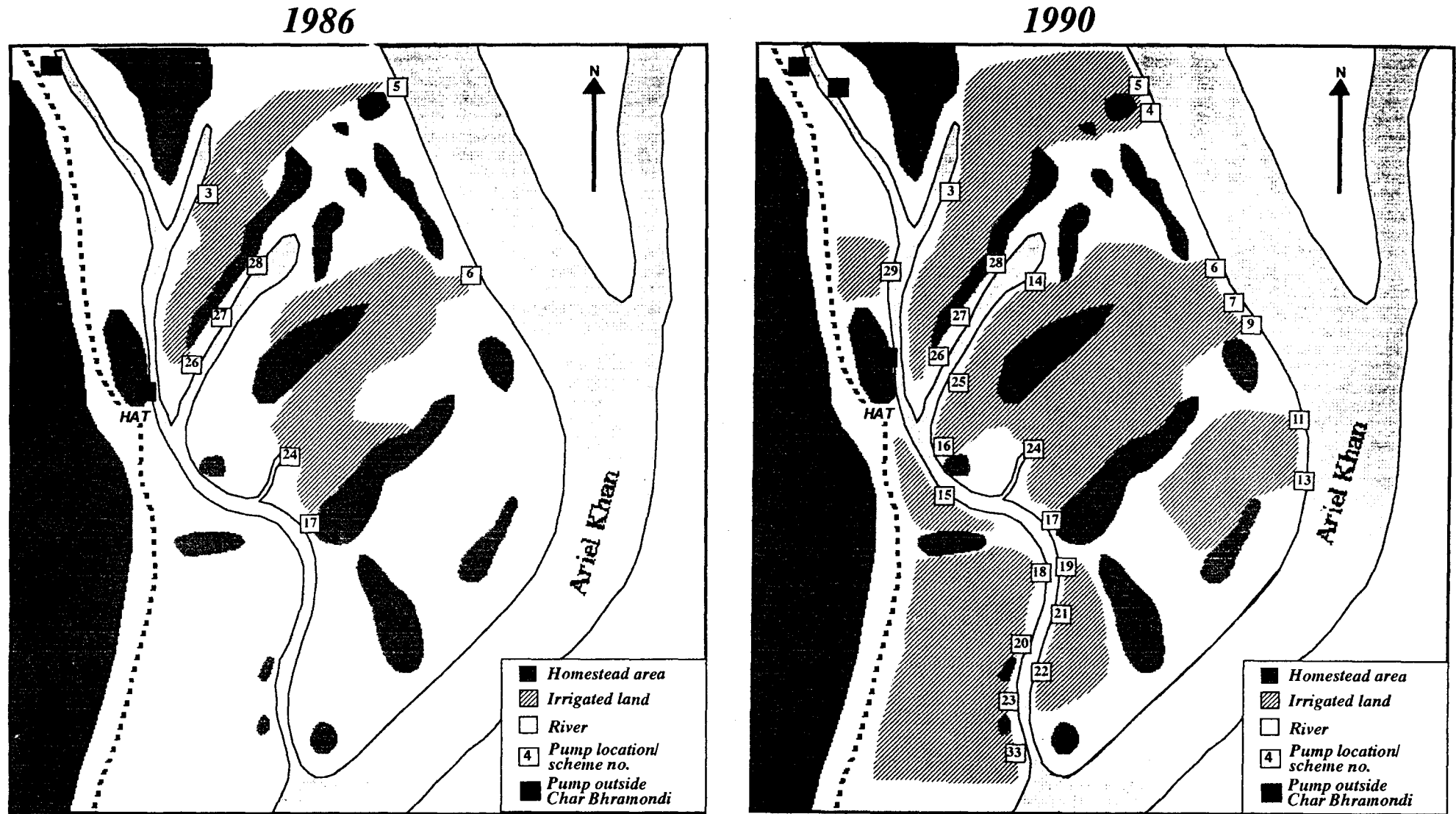


Figure 6.1 Map showing approximate location and coverage of irrigation schemes in Char Bhramondi 1986 and 1990

### *Organisation of the schemes*

The physical set up of the irrigation schemes in the village is quite simple. All irrigation schemes are based on low lift pumps utilising surface (river) water, there are no mechanised tubewells in use. The pumps are mounted beside the river in small huts built both to protect the pump from the sun and rain, and to provide a sleeping place for the night guard/machine operator. From here the water is pumped up from the river through iron pipes and led into an open earth drain, only one scheme had a section of this first main drain made of concrete (*pucca*). The main drain is usually divided into 2 or 3 secondary drains leading water to the different part of the scheme. From these main drains the water is led to the different plots, either by letting the water flow from plot to plot, or through smaller channels. As the drains in most cases are flooded during the monsoon, they have to be rehabilitated prior to every irrigation season. The construction and maintenance of the main drains is the responsibility of the pumps owner, and is usually done with the help of hired labour. The smaller drains are constructed and maintained by the farmers whose land is under irrigation.

Whereas the physical set up is quite simple and roughly more or less similar in all schemes, the organisational arrangement tends to be more complex and varied. The operation of this type of irrigation scheme can be in general divided into three main tasks; the overall financial and organisational management, the operation and maintenance of the machines and the distribution of water to the land. In some schemes these tasks are undertaken by the same person, in schemes with a larger command area they are usually divided among several people.

The overall financial and operational responsibility connected with the operation of the scheme will in most cases be the responsibility of a 'scheme manager'. In some cases this will be the owner of the pump, but it is also quite common that this task is undertaken by a specially appointed manager, often a relative of the pump owner. In some schemes the owner of the pump makes a shareholder-agreement with a local farmer who then actually manages the scheme. The tasks of the manager include ia. responsibility for organising the scheme, to make the arrangements with the farmers, to supervise the construction of drains, solve conflicts, and arrange payment of water etc.

The manager may in some cases be directly involved in the operation of the pump, but whether this is the case, depends both on the skills and status of the manager, as well as the size of the scheme. In larger schemes it is common to have an especially appointed machine operator or 'driver'. He is responsible for running and maintaining the machine, and to the extent he has the skills, also for repairing the machine. The driver will in most cases also be

involved in the actual water distribution, but in some of the larger schemes there will be one or two additional 'linemen' responsible for distributing water onto the different plots. Both the 'driver' and the 'linemen' are usually appointed on a seasonal basis (5-6 months), against payment either in cash or kind (paddy).

During the season each plot is watered every second or third day. Water is provided according to area, normally water is provided until there is 1-2 cm of water standing on the land. The water distribution is supposed to be controlled by the driver/linemen, in general the farmers themselves are not allowed to open the ditches and let water into their own land. The problem of illegal leaking is however common, especially in periods of water shortages, for instance caused by technical problems. In such cases the farmers will be in the field, trying to leak water into their own plots as best as they can. Our experience from *Char Bhramondi* indicate that the number of farmers in the field during the operation of the pump is a fairly reliable indicator of how well an irrigation scheme is running. In well managed schemes there will be few farmers in the field, as they can be fairly secure that their land will get a fair share of water, whereas in schemes with problems, farmers will feel that they have to be in the field in order to secure adequate water supply to their own plots.

*Table 6.1 Irrigation schemes in Char Bhramondi 1986 and 1990.*

	1986	1990
<i>No of schemes</i>	9	26
<i>No. of pumps</i>	9	28
<i>Irrigated area (acres)</i>	145	500
<i>Average command area</i>		
- per scheme	16	19
- per pump	16	18

The command areas of the 26 schemes operating in the village in 1990 varied from 3 to 52 acres, with an average of 19 acres (table 6.1). This is slightly above the 1986 average of 16 acres. But as two schemes have more than one pump, coverage per pump was more or less the same in 1990 as in 1986. In any case most command areas are small compared to the 60 acres commonly referred to as the potential command area of a two cusec pump. This small coverage can hardly be explained by physical barriers such undulating topography, sections with sandy soils, *khals* etc., which may make it physically difficult to set up larger schemes. The main reasons are organisational and social. First, it is difficult to run schemes beyond a certain size, even small schemes may involve 40-50 different farmers and more than 100 plots. Second, competition and conflicts over command areas may lead to fragmentation. This will be discussed in more detail in later sections.

## *Ownership of pumps and control over schemes*

It is important to distinguish between control over an irrigation scheme and ownership of a pump. When using the term scheme I refer both to the land irrigated and the drains. A scheme is not owned by anyone, rather it will, to a varying degree, be controlled by a person or group of persons. This control is however not fixed, there may, as some of the cases presented below show, be several changes in control over the different schemes. The term pump refers to the low lift pump and the engine running this. A pump is owned by a single person or, in some cases a group, and can be shifted from scheme to scheme between seasons.

### *Types of ownership*

In 1986 the nine irrigation schemes in *Char Bhramondi* were operated under three different types of ownership/management systems. Two were owned and operated by landless irrigation groups organised by Proshika. Two schemes were operated by loosely organised farmers groups, whereas the remaining five were owned and operated by individual farmers. In 1990 four schemes were operated by landless groups, five schemes were operated through various types of shareholder systems, whereas the remaining 17 schemes were owned and operated by individuals.

*Table 6.2 Type of operation and ownership of pumps in Char Bhramondi 1986 and 1990*

	1986	1990
<i>Operation of schemes</i>		
- Proshika groups	2	4
- shareholder schemes	2	5
- single farmers	5	17
<i>Total</i>	9	26
<i>Ownership of pumps</i>		
- Proshika groups	2	4
- Hired	2	5
- Individually, by person involved in scheme	5	19
<i>Total</i>	9	26

What the shareholder schemes have in common, is that there are at least two persons involved in setting up and running the scheme. Their contribution may differ, it may be in the form of capital and/or of own labour. It proved to be quite difficult to get a good overview over these agreements, both as regard to sharing of expenses and especially how

profits were divided. The latter maybe partly because most of these schemes were rather new, and so far have had very little profit to share.

All shareholder schemes in *Char Bhramondi* involve only two or three persons. A much more complex shareholder scheme is found in *Bhramondi*. Here a newly set up scheme is divided into 32 shares, owned by 16 shareholders. However, one of the shareholders, a jute mill employee and rich landowner, dominated the scheme by owning 13 shares. The shareholders, which together operate 50-60 acres of land in the scheme covers about 200 acres, provided capital according to their shares in the business. The five cusec pump is electrically powered, a electricity line was established specially for this pump. The cost of setting up the line, about 100 000 taka, was raised by altogether 33 households in the neighbourhood. The shareholders have also built a short pucca drain from own funds, and were in 1990 trying to persuade the upazila to build an extension. If the operation of the scheme worked out well, the group planned to use the engine in a rice mill at the local market after the season.

In both the shareholder and individually operated schemes, a wide range of people were involved. Relatively land rich farmers were involved in irrigation projects and some of these were involved in more than one scheme. At the same time several schemes were controlled by local persons with their principal income outside agriculture, in various types of trade or as employees in public or private institutions.

*Table 6.3 Control over irrigation schemes in Char Bhramondi 1990*

	<i>Number of schemes</i>
Public/private employees	5
Businessmen	7
Farmers involved in petty business	5
'Pure' farmers	5
Landless irrigation groups	4
<i>Total</i>	26

The situation in *Char Bhramondi* in 1990 has been summarised in table 6.3. Slightly less than half of the schemes (12) were controlled by persons with their principal income outside agriculture, either as employees in governmental or private companies (bank, jute mill) or through their own business, primarily in the form of trade. The third category, farmers involved in small businesses consists mainly of farm households who may own and operate much land, but who in addition have diversified into various types of non-farm activities such as seasonal trade, boat operation etc. Less than one fifth of the schemes were controlled by what can be termed 'pure farmers,' farmers relying solely on income from

agriculture. Although many schemes were run by people with employment and income outside agriculture, those running the scheme did in most cases also have some land in the scheme, only in six schemes did the operators possess no land in the command area.

It has been claimed that the rapid expansion of irrigation during the 1980s has been mainly based on very liberal public credit programmes. This can however only at best be a part of the true situation in Char Bhramondi. The purchase of pumps here was financed both the owners themselves, as well as by the help of institutional and non-institutional credit. Of the 28 pumps in operation in 1990, only 12 had been purchased with the help of a loan. Total cost for these 28 pumps was about 526 000 taka, out of this roughly 300 000 taka, or 57 %, was covered by loans. The expansion of irrigation after 1986 seems to be also only partially financed by loans, among the 18 pumps purchased after 1986, nine were partially or totally financed with the help of loans. Of these nine pumps, five were financed by loans from private banks, two loans came from Proshika and two were private loans.

### ***Irrigation schemes in Char Bhramondi, some case studies***

Although the aggregate figures reported above give valuable information on several important aspects of the situation, it may be useful to look more in detail into some individual schemes and how they actually are organised and operated. On the following pages some of the schemes in the village are described in more detail. Some of the main issues raised through these case studies are discussed again in more detail in later sections of this chapter.

The command area of **scheme 3, 26, 27 and 28** are approximately 50 acres, well within the capacity of a single two cusec pump. There is no visible topographical or other physical constraints in the area that can explain the existence of such a large number of schemes. Initially **scheme 26** was part of **scheme 27** but prior to the 1984/85 season farmers in the southern part of this scheme decided to start their own scheme, as they found water supply in their part of the scheme to be inadequate. They hired an old pump and appointed a farmer-cum-businessman, also responsible for running another scheme in a neighbouring upazila, as manager for this new scheme. As the farmers not were satisfied with the operation of the scheme in the first season, they found a new manager. This led to a conflict with the old manager, the pump had to be relocated, and some new drains had to be built. The scheme was from that time operated by a local boat owner-come-farmer. In 1990 a new pump, distributed to a local Jayata party (JP) member as part of the government flood

rehabilitation programme, had been installed in the scheme. The pump was rented for 5000 taka per season.

**Schemes 3 and 5** are run by Razzak and Moti Mollah. These brothers, who live in a neighbouring village, are rich and influential. They own and operate a great deal of land in *Char Bhamondi*. Moti Mollah is also an employee of a bank in Madaripur town. The pump in **scheme 3** was originally located at the site of **scheme 5**, but was relocated in 1984. This shift was partly due to the fact that the new location at the main river gave a more reliable water supply than the old location. The relocation also made it possible for the brothers to bring more of their own land under irrigation. In 1986 the brothers operated one fourth of the land in **scheme 3**. After the relocation parts of the old scheme fell outside the boundaries of the new scheme and some of these local farmers therefore organised the continuation of a smaller scheme, covering land previously irrigated by the Mullah brothers pump. In 1989 Razzak and Moti Mollah bought a new pump and installed it in **scheme 3**. At the same time they regained control over **scheme 5** and shifted their old machine to its first location. In the same season they also received funds from the Upazila Agricultural Office, to build a new *pucca* drain in this scheme. Later the brothers have also invested in a third pump which is used in **scheme 4**, this was however operated under the name of another farmer.

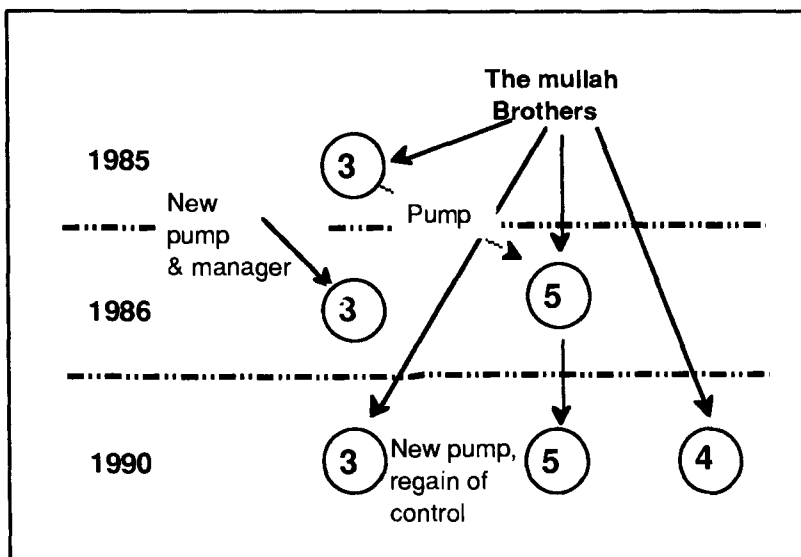


Figure 6.2 Irrigation schemes controlled by the Mullah brothers

**Scheme 6 and 20** are both controlled by Abdul Alim. He is the son of one of the most land-wealthy households in the village. Beside being farmers, the sons of the household are involved in the seasonal jute and paddy trade. In 1990 they were also actively engaged in



the local upazila chairman elections, supporting the JP candidate. Abdul Alim was in 1986 involved in a dispute over a command area with one of the landless irrigation groups in the village. In 1984 this group, 'Adharsa Krishi Somity', started **scheme 6**. The next season Abdul Alim organised a new scheme next to the groups command area. This new scheme was set up as a "joint venture" between a local pump owner and Abdul Alim with the latter responsible for operating the scheme.

This new scheme included seven acres of land previously not irrigated, as well as four acres of land previously irrigated by the landless group. As the group had a written contract for three seasons with the farmers in the area, the group demanded compensation for the loss of command area. After negotiations it was decided that the group should obtain a partnership in this new scheme, the group would cover half of the expenses for running the scheme and receive half of the income from the whole scheme (11 acres). Abdul should however still be responsible for managing the scheme.

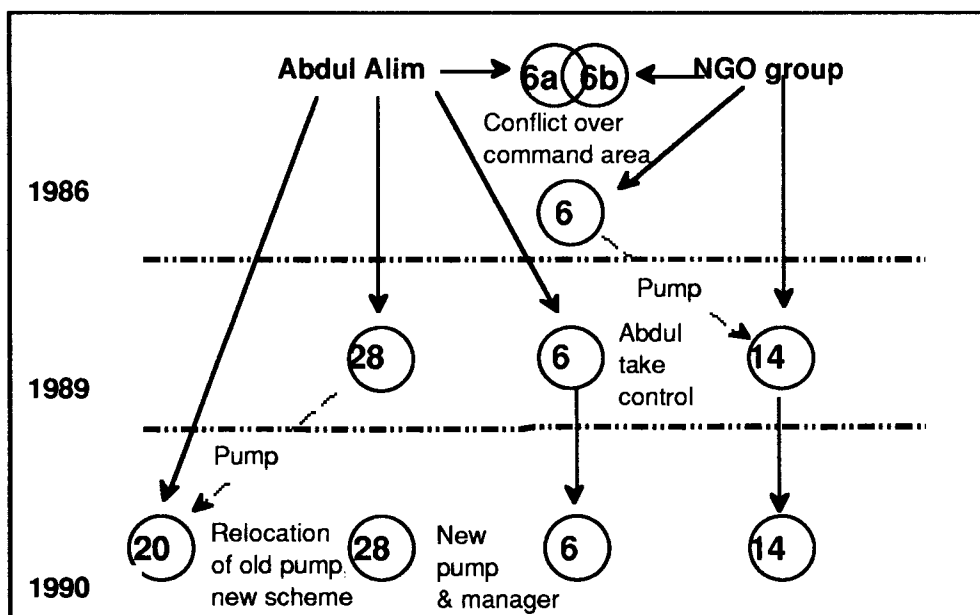


Figure 6.3 Irrigation schemes controlled by the Abdul Alim

During the season it soon became evident that Abdul was not willing to operate the scheme according to the agreement. After the first two barrels of fuel, one supplied by the group, had been consumed, the operation of the scheme virtually came to a halt. Water was only distributed to a few of the plots, and after several village meetings among the farmers and a *shalish* meeting with the village *matbars* (village leaders) it was decided that the group should operate both schemes. This decision was taken despite the fact that the group, due to numerous technical disturbances, had substantial problems running their original scheme.

The group repaid Abdul the cost of the drains and fuel consumed, and rented the pump from the original owner. The driver was taken up as a group member and continued in his job.

In 1990 the situation had changed. After the group's three year agreement with the farmers expired, Abdul Alim, whose family owned considerable land in the scheme, made an agreement with some other influential farmers, and took control of the group's scheme. He purchased and installed a new pump. He did not pay any compensation for the drains built by the group. The group on the other hand shifted their pump to a new location and set up **scheme 14**. They have a new three year contract and hope to be able to retrain control over the scheme also after this contract expires.

**Scheme 7** was established prior to the 1989 season and is organised as a "joint venture" between three shareholders. The pump is rented (10 000 taka for the season) from one of the shareholders, a bank employee in Madaripur. The two other shareholders are local farmers and are responsible for running the scheme. None of the shareholders have land in the scheme, but have chosen to get involved in this business because that it was a "familiar business, as they were farmers".

All three shareholders have put up money for the construction of the drain. The bank employee raised the capital from his own sources, the two others took out loans from a local moneylender. Due to a number of technical problems with the engine, yield in the scheme was very low in the first season (15-20 maunds per acre). At the end of the season they received only about 100 maunds of paddy, at a gross value of approximately 20 000 taka. The two farmers were therefore unable to repay their loans after harvest. Despite this they did, due to the problems faced in the first season, buy a second pump, to have in reserve in case of technical problems.

**Scheme 9** is run by a family who owns 52 acres of land. The family has 6 adult sons, of whom three are working in agriculture, three in other non-agricultural activities. They purchased the pump in 1987 with their own money. Operating costs in 1990 were covered by a loan of 15 000 taka from BRDB, organised through one of the female family members, who was a member of a women's cooperative (MSS). They established the scheme because they "felt an obligation to the nation and the farmers, to grow more food". They also regarded the water business as a fairly secure business, giving a good return on investments.

**Scheme 11** is controlled by a farmer with six sons, two of the sons are working outside agriculture. The family also have a mechanised boat and is also involved in various trading activities. The pump was purchased with the help of a loan from a moneylender who also gave credit for operating costs. In the first year, 1989, they lost money and were unable to repay their loans. Prior to the 1990 season they lost some land from the command area, as one of the NGO groups relocated their pump and took over some of their old command area. The main reason they gave for entering into this business was; that they thought it would be profitable and that they, as farmers, “knew this business”. One additional, important reason for investing in the water business, rather than for instance buying a new boat, was that it was easier to raise capital for irrigation projects. A wide range of people were willing to provide capital for irrigation projects, as it was commonly assumed that such investments were secure compared to other investments.

**Scheme 13** was operated by a landless irrigation group, *Bastu Shike Somity*. The group was established in 1985, and started their first irrigation scheme in 1987/88. In 1990 they changed the location of their scheme, as new land had formed by the river and caused problems at the pump site. In the two first seasons the group had little success. In the first season their upstart was too late, in the second year they started very early (mid November) hoping that this would allow the farmers to grow a second *aus/aman* crop after the harvest of the *MV-boro* crop. This however failed.

**Scheme 17.** This scheme is also operated by one the landless irrigation group, *Nurani Bhumihin Somity*. They bought a new pump at the upstart in 1985, but in 1988 they sold this one at a good price and bought a new pump from Barisal. Unlike the other Proshika group they were able keep control of thier command area, also after the initial three year contract expired. The group expected to be able to control the scheme also in the future, as they had the support of the largest landowner in the scheme. He is an old farmer, who claimed to have no interest in getting involved in the “water business”. During the first year of operation this group also supplied pesticides in addition to water, but stopped doing this after the first season<sup>2</sup>. The reason for this is not clear, but according to the driver the provision of such an extra service lead farmers to rely too heavily on the groups efforts, resulting in the farmers losing responsibility for their own crops.

So far the 22 group members have, at least officially, had very little direct income from the scheme and the group has after several years of operation almost 30 000 taka in outstanding loan debt. Some of the group members have however clearly had some personal advantages of being involved in such a scheme. Our detailed investigation of land ownership and sharecropping in the schemes, carried out in 1986, showed that the group members ,both

jointly and individually were sharecropping on plenty of land in the scheme. This may be directly related to the fact that they were group members. In general the landless or near landless will, for a number of reasons, not necessarily be the most attractive tenants from a landowner's point of view. Here, however, it may be a wise and rational choice to have a group member as a tenant, as a group member will, a landowner may assume, have good access to water which again is necessary for a good harvest.

The group has a driver, trained by Proshika, who claims to be the best mechanic in the village. He is at present being used as a mechanic in **scheme 11** and **13**. The leader of the group, Aziz Kha, has from the 1990 season also managed **scheme 18** on a private basis. This scheme is set up as partnership between Aziz Kha and a pump owner from Madaripur Town. The pump owner bears all operating costs, but is paid 8000 taka as rent for the pump. Aziz Kha operate the scheme and will receive 50 percent of the income. The scheme was taken over by the partnership prior to the 1990 season, after disputes between the farmers and the previous manager. This manager had initially agreed to build a crossdam over a small *khal* in the scheme, in order to prevent early flooding of the paddy field. As he failed to do so, the farmers lost much of their crop and therefore decided to organise a new scheme before the 1990 season. Asiz Kha was chosen as new manager because of his experience and good record in running the *somity* scheme

**Scheme 23** is controlled by Abdul Matin. He works at the national telephone company and also owns at least 10 acres of land, as well as three low lift pumps. These are used in three different schemes, one located in *Char Bhramondi*, the two others in a neighbouring village. He is not greatly involved in the daily operation of the schemes, something he has left to three different managers. He raised the initial capital from his own funds and had gone into the "water business" because he thought it was an activity which was comparatively easy to administer and at the same time gave a good profit. His brother owns the pump located in **scheme 22**. He is a farmer, owns about 1 acre of land, and runs this scheme himself. He is also a member of the landless irrigation group operating **scheme 13**. He raised the money for the pump from his brother, through a interest free loan.

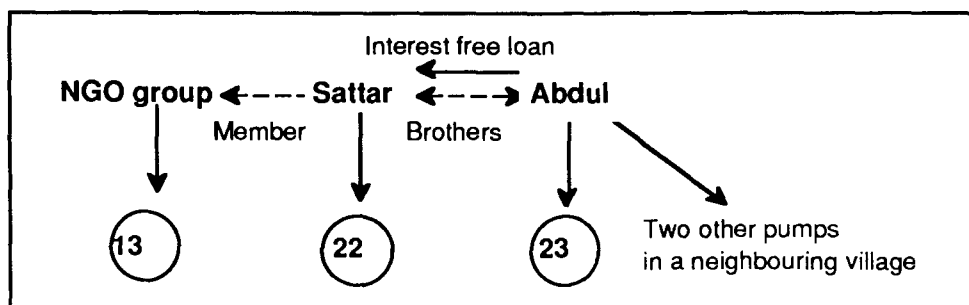


Figure 6.4 Irrigation schemes controlled by Abdul Matin

### *Some general conclusions*

The case studies described above underline two important aspects in regard to the control of schemes. First, they show that there is a wide range of practical solutions in setting up a scheme, many different actors are involved in the water business. Although the case should not be overstated, there is, however, also some evidence which points at a increasing centralisation of control over irrigation schemes. Some people do, either directly or indirectly control several irrigation schemes in the village and some of them are actively investing, or in other ways, expanding their engagement in this sector.

A second observation is the rather dynamic situation in regard to the control over the various schemes. As some of the cases-studies show, the control of schemes will in many cases shift from season to season. In some cases this will be so, because the pump owner chooses to relocate his pump to a more suitable site. More important are, however, changes that take place because the farmers are dissatisfied with the operation of a scheme. If a scheme is not well run, the farmers will, at least in some cases, try to find a new pump owner/manager to run the scheme.

This may have something to do with the type of irrigation equipment used. Unlike a deep tubewell, a low lift pump can be installed without any large fixed investments. This means that a group of dissatisfied farmers can by-pass a pump owner or manager simply by installing a new pump into an already existing scheme. If necessary the pump can be installed on a neighbouring plot, with only some minor changes in the drain system. This is not possible in DTW based schemes, where the fixed cost of instalment is very high and where the sinking of the well is clearly of a much more permanent character. This means that he who controls the tube-well and the land where the tubewell is installed will be in a much more powerful situation vis a vis the farmers with land in the command area, simply because the situation, from the farmer's point of view, is less flexible.

The lack of *pucca* drains is often put forward by the pump owners/scheme managers as the main explanation for the small size of the command areas and represents a major problem in running the schemes. This is most likely a plausible explanation as the water loss in earthen drains is large and the maintenance/reconstruction costs of drains after the monsoon season may be quite substantial, some where in the range of 4-5000 taka per season. The construction cost of a pucca drain is quite large (50-100 000 taka) and such drains will normally only be built if it is funded by the upazila or some other agency. In order to obtain such an investment sum one needs good connections with the local bureaucracy. Although the construction of such pucca drains may be justifiable on the ground that it reduces water

loss and maintenance costs, it can have the less fortunate side effect that it may increase the pump owner's control over the scheme. The investment gives the scheme a more permanent character, and makes the option of re-location a less viable alternative for the farmers.

Subdivision of existing schemes by setting up of a separate scheme within an existing scheme, seems to be a quite common feature. It can be due to a number of factors, in some cases a farmer in one specific part of a scheme will become dissatisfied with the water distribution in his part of the scheme and will try to organise a new separate scheme in order to improve water access. In some cases a new scheme is started, partly serving an existing scheme and partly serving new land yet to be irrigated. And in some cases, where different schemes constitute a continuous area, the actual size of the scheme may differ from year to year as, farmers with land along the boundaries of irrigation schemes can choose in which scheme they will take water from.

Changes in the control of existing schemes sometimes involve a more direct confrontation between different persons or groups of persons. This confrontation can be between the pump owner and the farmer with land in the scheme, or it may be between two pump owners competing for the control of a scheme. Some of the cases discussed here indicate that farmers can have a substantial influence over the operation of a scheme and may in practice decide which pump-owner is going to run a scheme. The influence, however, may differ from scheme to scheme. Though it is most likely pump-owners such as the Mullah brothers and Abdul Alim (who are large landowners in the village and who own much land in the schemes they operate), have a good control over their schemes. Resultingly they will maintain control, as long as they do not directly mismanage the schemes.

As one of the main goals of Proshika's irrigation project was to weaken traditional dependency relations, one would expect the landless irrigation groups to face open hostility from the rural elite. In none of the groups visited were such hostilities reported as a major problem. But during the 1985 season some sand was put into the fuel tank of the machine belonging to *Adharsa Krishi Somity*, the group competing with Abdul Alim for control over a command area. This led to numerous technical problems and a very unstable water supply in the groups scheme. The group claimed not to know exactly how this happened and whether it actually was a deliberate attempt at sabotage, or simply done by playing children.

## *Cost and return<sup>3</sup>*

During the interviews many pump owners stated that they had become involved in the water business because they saw it as a fairly secure and profitable business. On the basis of information provided by the pump owners in *Char Bhramondi*, it is, in a rather crude way, possible to assess to what extent this perception fits the real situation; do the pump owners earn money on the irrigation schemes?

To calculate a return for the village's irrigation schemes is not without its problems as it is difficult both to estimate true expenses and income. Variable costs can be calculated fairly easily on basis of the information provided by pump owners, on fuel use, labour expenses and repair costs. etc. As table 6.4 shows, approximately 50 % of operating costs go to fuel and lubricants (mobile) purchases. Local labour costs (maintenance of drain labour used in operation ) amount to slightly less than one third of total operating costs. <sup>4</sup>

*Table 6.4 Average cost of operation in irrigation schemes in Char Bhramondi*

<u>Type of cost</u>	<u>Taka</u>	<u>%</u>
<i>Maintenance of drains</i>	4413	18.4
<i>Fuel</i>	10114	42.1
<i>Mobile</i>	1956	8.1
<i>Labour</i>	4180	17.4
<i>Repair</i>	2950	12.3
<i>Other</i>	424	1.8
<i>Total operating costs</i>	24037	100.0

It is more difficult to ascertain actual income. Information about income in kind (crop share), or cash was provided by the pump owners, but it is also possible to calculate total income simply by assessing the amount of paddy a pump-owner should receive, given a certain yield and an agreed crop share for water.<sup>5</sup> Not surprisingly these income figures do not correspond well. Income calculated through the latter mentioned procedure is in most cases substantially higher than the income figures given by the pump owners. This can mean that pump owners systematically underestimate their income, but it can also be that the pump owner receives less than what he should receive. In some cases farmers may feel that the crop share previously agreed to is too high in relation to the actual pumping required during the season, and they may therefore openly (or more likely concealed) try to get away with a smaller share to the pump owner. This happened in one scheme in the village and in at least one case the farmers had simply refused to pay the agreed amount, as there had been little need for irrigation during the season.

Table 6.5 Net return in irrigation schemes in Char Bhramondi 1989

	<i>Per scheme</i>			<i>Per acre</i>		
	<i>min.</i>	<i>average</i>	<i>max.</i>	<i>min.</i>	<i>average</i>	<i>max.</i>
<i>Costs</i>	12 810	23 976	56 400	692	1 097	2 541
<i>Income</i>	22 750	58 881	164 063	2 188	2 695	3 281
<i>Net return</i>	-5113	24 905	107 663	-394	1 298	2 401

Note: Calculations are based on information from the 20 schemes from which full information on costs and income for 1989 are available.

The figures showing the costs and returns of the schemes in the Char Bhramondi are presented in table 6.5. The table clearly illustrates the occurrence of considerable variations in net return among schemes. Some operators undoubtedly make a profit. The largest scheme in the village most likely generated a net return of about 100 000 taka in 1989. Only in two schemes was there notable loss and in both these cases this was due to technical problems, inflicting high repair costs and excessive mobile costs. In general it seems that as long as one is able to run the machine smoothly and avoid major outlays for the repair of the machine most schemes gave fairly acceptable returns to the pump-owner.

The figures referred to above only take into consideration direct operational costs, capital costs are not included. In most schemes the operation costs are financed by the pump owners themselves. Of the 24 schemes we have information from about this, 11 schemes were operated with the help of loans in the 1990 season. The average size of these loans was 19 000 taka. Institutional credit was the most common; four irrigation groups obtained their loan from Proshika, three pump-owners obtained bank loans, and one financed the operation with loans from BRDB.

Only in two cases were operations based on loans from private moneylenders. In both these cases loans were to be repaid in kind (paddy) after harvest. The terms were 8 maunds of paddy per 1000 taka loan, which when monetarised is equivalent to an interest rate of about 60 %. One operator received an interest free loan from a relative. The actual cost of seasonal capital will vary with source of capital. If one assumes a 17 % interest rate, seasonal capital costs for an operation will average about 2000 taka per season.

A simple way of assessing machine costs is to adjust this to the normal rental rate for an irrigation machine in this area. This will vary, but an average normal rate will be in the range 6000- 8000 taka per season. Construction costs for drains are more difficult to ascertain, a rough estimate of about 2000 taka per season may seem plausible. Total capital costs may roughly be estimated to somewhere between 10 000 and 12 000 taka per season.



If these costs are taken into consideration, the average scheme will still show a profit at somewhere between 10 000 and 12 000 taka per season.

#### *Changes in payment system*

One interesting issue which deserves attention is the changes in the payment system for water, which took place between 1986 and 1990. There exists several types of terms for the payment of water but most of them can be classified along two principal dimensions; mode of payment and cost sharing system. Regarding the mode of payment there are two types in use; cash and crop share payment. With regard to the cost sharing payment, the pump owner can either bear all costs or part costs of providing water. An example of the latter is a commonly used agreement where the farmer buys the fuel individually, and the pump-owner provides water according the amount fuel provided. This is again combined with a fixed, seasonal cash fee to the pump owner.

	Cash Payment	Crop Share
Pumpowner all costs	I	II
Pumpowner part of costs	III	IV

*Figure 6.5 Possible combinations of payment systems in irrigation schemes*

In 1986 water was paid for in cash by all schemes in *Char Bhramondi*, except for Proshika's two landless irrigation schemes. In the cash payment schemes the water sellers were paid according to area, the typical rate being 1500 taka per acre. The two Proshika groups used a crop share system where the group covered all the costs of providing water against a share of standing crop. In 1986 the two groups claimed 1/3 and 1/4 of the crop respectively. The higher crop share in one of the schemes was explained by it being a new scheme with large, initial investment costs. In addition this new group also provided pesticide application without extra cost to the farmers. Like in *Char Bhramondi*, cash payment was clearly the most common system of payment in Madaripur upazila in 1986. Our own survey of irrigation schemes in Madaripur upazila, carried out in 1986, showed that only 5 out of 27 irrigation schemes used a crop share payment system in the 1985 season.

In 1989, 19 out of 24 schemes in *Char Bhramondi* used crop share payment. Of the remaining five, four used cash payment of type I, and one of type III. In 1990 crop share payment had become even more common and was used in 24 of 26 schemes. Both in 1989 and 1990 the restitution was 1/4 of the standing crop in schemes based on crop share payment.

Crop share payment will under normal circumstances give a higher price for water than in cash payment systems. A rough calculation indicates the price for water to be about 2 800 taka per acre under crop share arrangements in 1990. This is well above the 1500 to 2250 taka per acre paid for water in cash crops schemes. The higher per acre income and consequently higher total income is of course an obvious advantage for the pump-owners, and is most likely the major reason so many prefer this payment system. Some pumpowners also underlined another important aspect: Delays in payment, or outright default, has traditionally been a problem in many irrigation schemes. Many pump-owners prefer the crop share payment system, simply because it is more difficult for the farmers to default on their payment. The payment can, if necessary, be directly collected in the field at the time of harvest.

Despite the disadvantage of the higher cost, the crop share payment method also has some important advantages for the farmers. In cash payment systems water has to be paid in two or three instalments. Normally one instalment has to be paid before transplanting, and one or two before the harvest. In a crop share system payment for water is in practice delayed until after the harvest, and so in essence the system contains an important element of credit. The crop share system also gives incentives for the pump-owners to manage the scheme well, as his income will be directly dependent upon the harvest. Lastly, as in other sharecropping systems, the arrangement also implies a kind of risk sharing, in this case between the pump- owner and the farmer.

The changes in the payment system could possibly be interpreted as a good example of induced, local level institutional change of the type suggested by Hayami and Ruttan (1985). But it could also be seen as a prime example of innovation diffusion. The idea of a crop share payment system, was brought to the village by an outside agent, Proshika. Once introduced it was rapidly accepted by both water sellers and buyers.

In sum it can be argued that the changes in the payment system may in itself be seen as a major driving force behind the spread of irrigation in *Char Bhramondi*. It has made it more

profitable to invest in a pump, and it has made it easier for the farmers to cope with the increased costs and risks linked to the new crop.

### *Access to water<sup>6</sup>*

In addition to our interviews of pump-owners a complete survey of land ownership in the nine irrigation schemes in the village was done in 1986. This survey revealed that 213 farmers owned land in the nine irrigation schemes in operation. Of these it was possible to identify 179 farmers, who again owned 93 percent of the irrigated land in the schemes (135.4 out of 145.4 acres).<sup>7</sup> The same farmers owned an additional 8.6 acres of irrigated land located in schemes outside the village. So that in sum these 179 farmers owned 144 acres of irrigated land. The distribution of land is shown in figure 6.6.

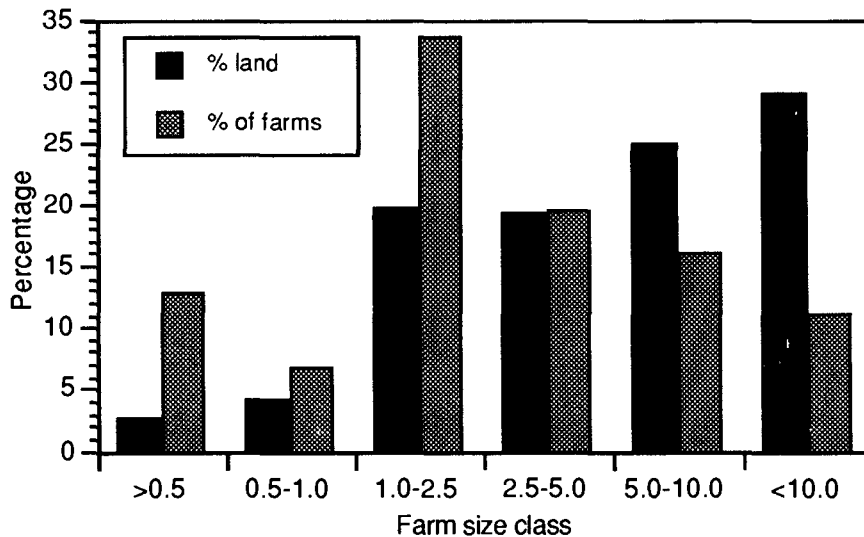


Figure 6.6 Land distribution in irrigation schemes in Char Bhramondi 1986

#### *Land under irrigation*

Table 6.6 shows, as expected, that farmers with comparatively large land holdings have more land under irrigation than farmers with smaller holdings. But at the same time the land under irrigation makes up a much larger share of the small farmer's holdings than in the case of the large holdings. Irrigated land amounts to approximately two thirds of the total land owned by farmers belonging to the smallest farm size group (below 0.5 acres). For farmers in the largest farm size group, the corresponding figure is less than one sixth. An explanation of the negative relationships between farm size and extent of adoption has, as discussed in chapter four has been provided by Rahman (1984): Once a small farmer obtains a plot or two under irrigation and hence is able to take advantage of the new seeds,

this area tends to comprise a larger share of his total land holding than a large farmer's total holding.

*Table 6.6 Irrigated land owned, by farm size 1986*

<i>Farm size class (acres)</i>	<i>No. of farmers</i>	<i>Area</i>		<i>average size (ac)</i>	<i>Irrigated land as % of owned land</i>
		<i>acres</i>	<i>%</i>		
<i>up to 0.5</i>	23	3.4	2.4	0.15	74.2
<i>0.6 - 1.0</i>	12	5.5	3.8	0.46	63.3
<i>1.1 - 2.5</i>	60	26.9	18.7	0.45	27.1
<i>2.6 - 5.0</i>	35	26.3	18.2	0.75	21.4
<i>5.1 - 10.0</i>	29	35.5	24.7	1.22	17.6
<i>above 10.0</i>	20	46.4	32.2	2.32	14.6
<i>Total</i>	<i>179</i>	<i>144.0</i>	<i>100.0</i>	<i>0.80</i>	

In total 230 farmers operated land in the schemes. We were able to identify 212 of these farmers (table 6.7). These 212 farmers operated some irrigated land located outside the village, so in total these farmers operated 155.6 acres of irrigated land. The sharecropping system clearly has a redistributive effect in regard to the access to water. First, the number of farmers operating land is higher than the number of farmers' owning land in the scheme (213 vs. 230). Second, the system enhances the small farmers access to irrigated land. Farmers with the smallest land holdings (below 0.5 acres) owned only 3.4 acres of irrigated land but operated 18.0 acres. These 18 acres were operated by altogether 43 farmers; 23 operated both their own and rented land, the remaining 20 only rented land. Consequently the rich farmers operate less land than they own. For instance, farmers owning more than 10 acres of agricultural land, on average owned 2.3 acres of irrigated land, but operated only 1.7 acres.

*Table 6.7 Irrigated land operated, by farm size 1986.*

<i>Farm size class (acres)*</i>	<i>No. of farmers</i>	<i>Area</i>		<i>average size (ac)</i>	<i>Irrigated land as % of operated land</i>
		<i>acres</i>	<i>%</i>		
<i>up to 0.5</i>	43	18.0	11.6	0.42	80.0
<i>0.6 - 1.0</i>	20	9.5	6.1	0.48	50.0
<i>1.1 - 2.5</i>	61	32.6	21.0	0.53	28.5
<i>2.6 - 5.0</i>	41	28.6	18.4	0.70	19.0
<i>5.1 - 10.0</i>	28	35.1	22.5	1.25	18.0
<i>above 10.0</i>	19	31.8	20.4	1.67	10.7
<i>Total</i>	<i>212</i>	<i>155.6</i>	<i>100.0</i>	<i>0.73</i>	

Note: \*Farm size class according to owned land.

*Sharecropping of irrigated land*

Of the 145 acres the nine irrigation schemes in *Char Bhramondi* comprised in 1986, slightly less than one third (43 acres) were operated under sharecropping contracts. In total 68 farmers leased out land, 100 rented land. As a general rule land was sharecropped out by the large landowners and rented by the smaller land owners. There were also some cases of reversed tenancy, some small farmers leased out land, while some large farmers rented sharecropped land. A detailed account of contracts, farmers and the area sharecropped is presented in table 6.8.

*Table 6.8 Sharecropping out and in by farm size class 1986.*

<i>Farm size class: acres</i>	<i>Sharecropping in</i>		<i>Sharecropping out</i>	
	<i>no of contracts</i>	<i>acres</i>	<i>acres</i>	<i>no of contracts</i>
<i>Up to 0.5</i>	41	11.4	0.7	3
<i>0.5 - 1.0</i>	13	3.6	0.3	2
<i>1.0 - 2.5</i>	34	9.5	2.7	14
<i>2.5 - 5.0</i>	23	6.3	4.8	16
<i>5.0 - 10.0</i>	10	4.7	3.9	14
<i>above 10.0</i>	9	2.1	17.5	56
<i>Total</i>	130	37.6	29.9	105

The high incident of sharecropped, irrigated land does not easily support claims that landowners, when growing MVs will prefer to operate more land directly by the help of hired labour. Detailed information on the number of sharecropping contracts and of the area under lease prior to the introduction of irrigation is not available. It was, however, in general agreement among both landowners and tenants that the number of sharecropping contracts had increased after irrigation was introduced. But at the same time the sharecropped area had declined. This meant that more farmers rented less land after the introduction of irrigation than they did before irrigation was introduced. This increase in number of sharecropping contracts may be seen as a strengthening of the traditional patron-client relationship, as the number of farmers depending on a few landowners increased with the introduction of irrigation and the new rice.

There are several reasons for the existence of so many sharecropping contracts on the irrigated land in the village. A large number of contracts existed because a handful of rich landowners living outside the village had leased out all their land. The fact that all schemes were comparatively new can also provide a partial explanation. A new scheme will imply a high risk of failure due to financial problems or lack of the technical or managerial competence needed to run a scheme. A number of landowners stated that they preferred to minimise their personal risk by sharecropping out land in the initial years. After the new schemes eventually had proven their viability, they planned to reclaim the land and operate it

with the help of hired labour. Some land was also leased out due to on-farm management constraints. Several of the largest landholders had several irrigated plots located in different irrigation schemes and had, according to their own statements, problems in supervising all this land with the family labour available. They therefore preferred to lease out plots located far away from the homestead. In another case of reversed tenancy, the landowner leased out irrigated land simply because he lacked capital to operate the land himself. He owned plenty of land, but lacked working capital and was not willing to take out loans required.

A similar land holding survey as the one done in 1986 was not carried out in 1990. It is therefore not possible to say to what extent the situation had changed between 1986 and 1990. It was, however, claimed to be fairly easy to obtain a sharecropping lease on irrigated land in 1990 also. But it was also claimed to be easier to obtain a contract for *aus/aman* (rain-fed) land. This may indicate that the competition for lease rights for irrigated land was tougher than on rain-fed land, either because there were more people interested in leasing land, or because landowners were more interested in operating the irrigated land themselves, leaving the less productive *aus/aman* crop to the sharecroppers.

### ***Concluding remarks***

The development described here is in many respect similar to the development described in the two preceding chapters. During the late 1980s there was a rapid expansion of irrigation schemes in Char Bhramondi. This expansion was based on private initiative, both in regard to the ownership of pumps and the control of irrigation schemes. The large number of schemes in the village, and the small command areas of most schemes, does not seem to be a very efficient use of resources. Theoretically the 500 acres irrigated in the village, could have been irrigated by 9-10 pumps, instead of the 26. There are many reasons for why there were so many schemes: First, it is clear that although the schemes are small in areal coverage, they are, from an organisational point of view, large schemes, even small schemes involve a large number of farmers and plots. Second, some of the schemes have been established as a result of conflicts between pump-owners and farmers. Third, the large number of schemes is also due to the fact that there are many actual and potential water entrepreneurs competing for a share of the 'water business'.

There was in 1990 undoubtedly a certain degree of competition among pump-owners with regard to the control of irrigated land. It also seems clear that in some schemes, the farmers can have considerable influence on the operation of the scheme and can replace a

pumpowner they are dissatisfied with. A pump-owner will in many cases not have a fixed monopoly on delivering water in a scheme. But at the same time it seems that in some cases, where the pump-owner himself owns an amount of land in the scheme, he will have a much more secure and tighter control over a scheme.

In *Char Bhramondi* it seems that a rather wide range of organisational solutions have emerged after the policy reforms. Some schemes were controlled by landless irrigation groups, some by various forms of shareholder groups, and some by individual farmers, as well as nonfarmers. As discussed in chapter four, there has been some concern that the policy reforms would bring forward a new group of powerful 'water lords'. What is clear from this study, as well as others, is that the new owners of irrigation equipment do not necessarily have any notable amount of land. 'Waterlords', if such exist at all, are not necessarily landlords. This does not imply that land-rich farmers are not engaged in the water business, rather on the contrary, many well to do farmers invest in irrigation equipment. But at the same time it is clear that privatisation has made it possible for other groups to involve themselves in this business.

Many of the pumps in operation in the village in 1990 were owned by persons whose main income comes from activities outside the agricultural sector. These persons engage themselves out of the fairly clear objective of earning money. They simply regard the 'water business', as a fairly secure, profitable and easily managed type of business. And a pump scheme can, if operations runs smoothly, obviously be very profitable. But it can also be a deficit business should serious technical problems or large crop losses due to natural calamities occur. Although these non farming pump-owners have engaged themselves in this business in order to reap a surplus in agriculture, it is clear that there is also a more positive side to this engagement. These persons have brought much needed capital into the agricultural sector, first of all through the investment of their own funds, but also through their access to public credit institutions.

When viewing the access to water, the findings from 1986 show that all groups of farmers have access to water. At the same time access to water is to a large extent a reflection of the underlying land holding pattern; land-rich farmers have most land under irrigation simply because they have more of all types of land. There is however, on the basis of the evidence available from this study no reason to claim that the distribution of water is biased against the small farmer. Rather there is some evidence to the contrary, at least in the sense that as the relatively land-poor farmers have the larger share of land under irrigation.

**NOTES**

- <sup>1</sup> According to the 1981 population census, 897 households with 3778 family members lived in the Mouza in 1981 (BSS 1985). LGEB, 1987 estimated the 1986 and 1991 population to be 4151 and 4466 respectively.
- <sup>2</sup> This season the group demanded 1/3 crop share in exchange for water + pesticides.
- <sup>3</sup> As the data was collected during the 1986 season, all figures in this section refers to the 1985 and accordingly only the schemes operating in this season.
- <sup>4</sup> In most cases driver-linemen will receive part of their payment in kind (paddy), this has however been monetarized at a rate of 200 taka per maund .
- <sup>5</sup> This is calculated by (yield x area of scheme) x 0.25. From this 1/8 crop share is deducted for harvesting costs.
- <sup>6</sup> The data presented in this section is taken from Lein (1988), chapter 7.
- <sup>7</sup> By "identify" we mean; that we were able to collect information about total land holdings. In the remaining cases we have not been able to collect this information , but only the amount of land owned in the nine irrigation schemes. We refer only to agricultural land, homestead land is not included.



## CHAPTER SEVEN

***AGRICULTURAL CHANGE IN CHAR  
BHARAMONDI******Introduction***

I will in this chapter describe in more detail some of the consequences of the spread of irrigation discussed in chapter six. First, I will describe the changes in land use caused by the introduction of new irrigated crop. Following on from this I address the impact these changes have had on labour use and other inputs. In the last section I will deal with the impact on production, costs and returns.

The empirical part of this chapter is based on the interviews of farmers operating land in *Char Bhramondi*. In 1986 all farmers operating land in the nine schemes in operation at that time, were registered. Of these a small sample of 41 households were selected for more extensive interviews. Of the 41 households interviewed in 1986 we were able to find, and re-interview, 33 households in 1990. Except where otherwise stated, all figures in this chapter are based on the responses from the households included in both the rounds of interviews. The interviews in 1990 covered basically the same issues raised in the 1986 survey, but some new issues, mainly related to flood damages were also included.

***Household characteristics***

Some key figures of the 33 households included in the sample are presented in table 7.1 below. As can be seen from this table the average size of households had declined somewhat between 1986 and 1990, due to a decrease in the number of adult household members. All the households included in the sample operated agricultural land and hence obtained part of their income from crop production. In 1986, 28 and in 1990, 22 household members provided regular income from sources outside agriculture. Of the 16 households with non-farm income in 1990, eight had regular income from various types of services (army, bank, shops), four households were involved in petty trade of agricultural products, while four households were involved in various types of business activity: One household

owned several shops in Madaripur, another household owned 25 richshaws, while the fourth household was involved in the water business, operating two low lift pumps.

*Table 7.1 Household characteristics*

	1986	1990
<i>Household characteristics</i>		
Number of household members	306	287
Average size of household	9.3	8.7
Number of children under 15 years of age	119	119
Adults per children under 15 years	1.6	1.4
<i>Sources of livelihood(no. of households)</i>		
Cultivation of own land	12	8
Cultivation of own land + agricultural labourer	3	9
Cultivation of own land + non-agricultural income	18	16

Note: "Own land" also include land sharecropped in

The increase of households with additional income coming from household members working as agricultural labourers, is due to the fact that 6 households had sons who had started working as daily labourers between 1986 and 1990. In addition to these types of income, seasonal part time fishing was a common activity among many households.

Land ownership varied from zero to 32.5 acres of agricultural land, with an average of 3.8 acres (table 7.2). Only five households (15 percent) owned more than 15 acres of agricultural land. Despite the fact that the sample mainly consisted of marginal and small farmers, a majority of the households claimed to have purchased more land than they had sold since the formation of the household. It is also somewhat surprising to notice that although the households had experienced substantial crop damages over last seasons due to floods and hail storms, this did not seem to have forced farmers to sell off land. Only a single household had sold land between 1986 and 1990, where as four household had bought land.

*Table 7.2 Land ownership 1990*

<i>Average size of land owned (acres)</i>	3.8
<i>Farm size (number of households )</i>	
- less than 1 acre	12
- 1-5 acres	16
- more than 5 acres	5
<i>Land transfer since formation of household</i>	
- No of households net purchasers	12
- No of households net sellers	9
<i>Sharecropping</i>	
- Households sharecropping <u>in</u> land	9
- Households sharecropping <u>out</u> land	4

## Changes in cropping pattern and crop damages

### Changes in cropping pattern

Traditionally the cropping pattern in the *char* area has been organised around two monsoon crops; mixed *aus /aman* and jute, grown in combination with rain-fed winter crops being mainly pulses and mustard-seed (figure 7.1). But large parts of the land, especially on the sandy land along the Ariel Kahn river, was left fallow during the winter season, or used for growing cattle fodder. The only exceptions from this main cropping pattern were some local *boro* grown along the edge of the inner water bodies, and some sugarcane grown on the highest plots in the village.

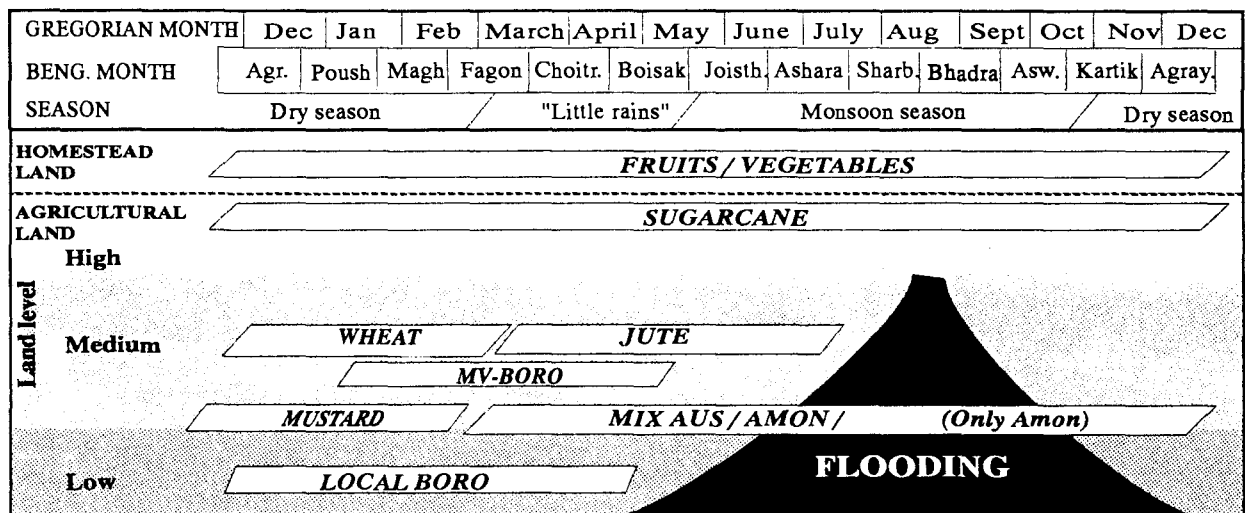


Figure 7.1 Cropping calendar in Char Bhramondi

The two rounds of interviews clearly show important changes in cropping patterns both in regard to the number of crops grown and the area used for different crops. Although the new irrigation schemes have clearly initiated some important changes in 1986, the cropping pattern in the village was still dominated by the rain-fed monsoon crops. But what now seems clear, is that the rapid spread of irrigation machines in the late 1980s made a substantial impact on the choice of the cropping pattern taken among the interviewed households. The average number of crops per household had declined from an average of 5.2 in 1986, to 2.8 in 1990 (table 7.3). And whereas 29 out of 33 households reported that they grew four or more crops in 1986, only 13 reported this to be the case in 1990.

Table 7.3 Number of households cultivating various crops, 1986 and 1990

Crop	1985/86	1989/90	Change
<i>Aus</i>	1	-	-1
<i>Aman</i>	7	1	-6
Mixed <i>aus/aman</i>	26	7	-19
Local <i>boro</i>	2	6	+4
MV- <i>boro</i>	32	30	-2
Wheat	28	6	-22
Mustard-seed	24	15	-9
Pulses	18	2	-16
Sugarcane	4	3	-1
Jute	29	19	-10

The decline in the area under monsoon rice, jute, and various robi crops shown in figure 7.2, is remarkable and can only be explained by a greater emphasis on irrigated *boro* rice within the households choice of crop composition. These are all crops which in various ways compete with MV-*boro* for both land and their seasonal period. MV-*boro* implies a tendency towards single cropping as it is difficult to combine this crop with other crops such as transplanted *aman*, due to the nature of flooding in this area. The extensive use of MV-*boro* is not only the outcome of the individual farmer's free choice. Once other farmers adopt MV-*boro* it becomes increasingly more difficult for a farmers not to follow, simply because it creates a lot of practical problems to follow a completely different cropping pattern from plots located in the middle of an irrigation scheme.

The picture that emerges from the data collected from Char Bhramondi is the same as reported in a large number of studies of the green revolution. Namely a process of change from crop diversity towards a simpler and more uniform cropping pattern. This may, however, not be a permanent and irreversible situation. A number of attempts at 'fine tuning' the cropping pattern to allow for new crop combinations were in a process of being tried out by the farmers. In one irrigation scheme farmers had started growing MV-*boro* as early as November in order to grow *aman* after the *boro* harvest. In another scheme the farmers had tried to grow wheat before the MV-*boro*, this delayed the start of the MV-*boro* season until March. Both these experiments had resulted in low MV-*boro* yields, but they show that farmers were actively trying to establish a more complex cropping pattern around the yet relatively newly adopted irrigated MV-*boro* crop. With regard to cash crop production, some changes can be observed. In 1986, 30 farmers grew jute and/or sugarcane, the two principal cash crops grown in the village. In 1990 this number had declined to 19. Other cash crops were not common in and around the village, as there were hardly any farmers who grew other crops for sale.<sup>1</sup>

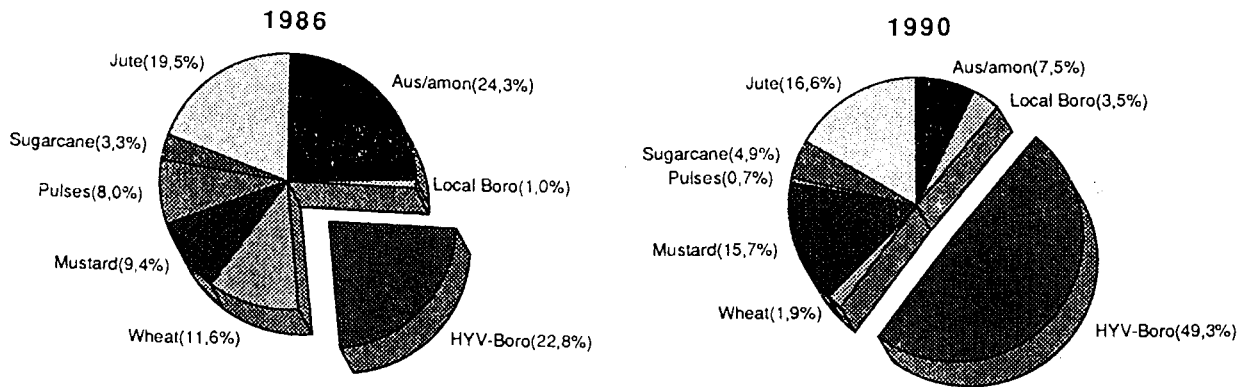


Figure 7.2 Crops grown by the interviewed households in Char Bhramondi 1986 and 1990 (Percentage of gross cropped area)

### Crop damages

In 1990 we asked the farmers questions relating to major crop losses over the last five seasons and the main causes of these losses. The answers show that all crop damage had been caused by natural hazards or operational problems in the irrigation schemes. No farmer reported major losses due to plant diseases or insects attack. The village was hit hard by both the 1987 and especially the 1988 flood. In 1987 those farmers interviewed reported losses in the range of 60-100 percent of standing monsoon rice crops, whereas all except one reported a 100 percent loss in 1988. The 1988 floods also caused damage to crops on relatively high lying land, not so much because the absolute height of the water level, but because water rose very rapidly during some crucial periods early in the growing season. In addition to the damages to *aus* and *aman*, the farmers also reported various damages on other rain fed crops during the last five seasons. For instance, abnormally high rainfall in October 1989 caused damages in the range of 50-100 percent to the newly sown pulses and mustard crops.

Although most damage was reported on rain-fed crops, substantial losses were also reported on the irrigated *MV-boro* crop. The 1986 hailstorms caused a near to total damage to the *MV-boro* crop in the village. Although such hailstorms have a devastating effect when they occur, a more frequently faced problem is damage to the *MV-boro* crop caused by disturbances in the operation of the irrigation schemes. Such disturbances may, as discussed in chapter six, be due to technical or organisational problems. In such cases, yield is commonly reduced by as much as two thirds or more, compared to more normal situations.

In at least three irrigation schemes these disturbances were of such an extent in 1989 that they caused a substantially lower *MV-boro* yield than normal.

Despite such uncertainties and actual losses experienced with the new crop, the farmers seemed very strongly to perceive irrigated *MV-boro* as the only possible way out of the immediately felt flood problem. Given the timing and duration of the floods in this area it is at present not possible to grow a modern, transplanted variety during the monsoon. Although the farmers seem to be aware of the uncertainties related to the cropping of *MV-boro*, and despite the fact that many farmers questioned the economic viability of the new crop, it was in sum regarded as a better alternative than continuing with the traditional monsoon rice crops. Carlstein (1982) claims that a fundamental characteristics of irrigation is that it relaxes some of the capacity constraints related to the physical environment, but at the same time it introduces a number of social constraints. In the case of *Char Bhramondi* it seems that the farmers prefer the latter type of constraint.

## *Use of labour*

### *Cropping practices*

The cropping practices in Bangladeshi agriculture have to a large extent remained unchanged for centuries. Land is usually prepared with the help of human labour, bullocks and a few farm tools. For the production of rice, the land is first ploughed several times across using a bullock drawn wooden ard. Then the large blocks are crushed by hand before the soil is levelled with the help of a wooden levelling stock, drawn behind the bullocks with the ploughman standing on top as an extra weight. After preparation of the land, the seed is either broadcasted directly on the land, or in case of some varieties transplanted. In the latter case, the seedlings are prepared in specially designed seedbeds, these often being wet, low lying plots along newly constructed roads and embankments. During the season the main labour demanding tasks are weeding and thinning operations which are done 1 to 3 times during the season. This is done manually, with the help of a small specially designed knife. Harvesting is also done manually with the help of a small sickle.

After harvesting, the paddy is transported to the homestead where the paddy is processed. This processing can be divided into three major operations; threshing/winnowing, boiling/drying and husking. Threshing is done either by hand beating or with the help of cattle walking over the paddy.. This operation is usually done within or nearby the homestead. Winnowing involves separating grain and chaff and is done by the women within the homestead. Parboiling and drying is done either in the homesteads or at large

ricemills with boiling and drying facilities. Husking can be done in three different ways. Traditionally, paddy has been processed by woodendheki within the homestead by the women. This type of threshing was used for both domestic and commercial purposes. At present it is used almost exclusively for domestic purposes. Husking by dhekis has been replaced by small electric or diesel powered rice hullers at an increasing rate over the last 30 years. These are located at the local markets (*hats* and *bazaars*). Although these hullers mainly are used by the farmers directly for processing of their own paddy, they are also used by some smaller traders. Husking can be done in larger, commercial mills with parboiling and drying facilities. But these mills which are located in selected rice centres and rural towns and are used exclusively by various types of traders. In 1986 there was a small ricemill located at *Bhramondi hat*, in 1990 this had closed and people in *Bhramondi* and *Char Bhramondi* had to bring their paddy to Madra or Kulpoddi *bazaar*, the latter a market located in the outskirts of Madaripur town.

The introduction of irrigation, new varieties and increased use of chemical fertiliser has in *Char Bhramondi* not changed these traditional cropping practices in a fundamental way. Land preparation for irrigated rice is done in the same way as for traditional rice, but part of the ploughing is done after water is let onto the land, and levelling and puddeling is done with the land under water. As irrigation requires a relatively uniformed levelled land some extra labour may have to be put into levelling the land before land preparation takes place. Such investments in landseque capital can even in the relatively flat landscape of Bangladesh represent a large investment which often has to be carried out over several seasons.

Some new operations have been introduced with the new crop. The farmer will have to spend some time on applying fertiliser, but this is a little time consuming task. He may also, especially in the case of badly managed irrigation schemes, have to oversee the application of water on his land and this can be a time consuming operation. But perhaps of more importance than the actual duration of the new tasks, is the fact that application of water sets certain requirements on the timing of other operations. For instance, the final preparations of land has to be done with water in the fields and this co-ordination requirement may create a seasonal shortage of both labour and bullocks.

In production of other crops, the operations and farm implements used are basically the same as for production of rice. However, some robi crops such as mustard and pulses do not necessarily require ploughing if the seeds are sown before the land goes completely dry after the monsoon. Production of jute implies a number of labour intensive, post-harvest operations such as soaking and stripping of the fibres. In areas outside the hinterland of

modern sugarmills, sugarcane is commonly manually crushed on the farm before the sugar (*gur*) is taken to market.

### *Changes in labour use*

The labour requirement varies substantially both between various operations as well as crops. On the basis of a set of group interviews, the “normal” labour requirements for various crops and operations in this village were attained, as presented in table 7.4.<sup>2</sup> The figures must be seen as rough indicators, since actual use of both human and animal labour will, for several reasons, vary substantially among different farmers. Although the figures for ‘man-days’ may differ from other similar studies, they show the same basic relationships. Crops such as jute and *MV-boro* are substantially more labour demanding than others, and some operations such as weeding and transplanting, are definitively more labour demanding than others.

Table 7.4 *Labour use for various crops grown in Char Bhramondi (mandays and ghatas per acre)*

<i>Crop</i>	<i>OPERATIONS</i>					<i>Total man-days</i>	<i>Ghatas</i>
	<i>Land prep.</i>	<i>Sowing</i>	<i>Weeding</i>	<i>Harvest.</i>	<i>Other</i>		
<i>MV-boro</i>	23	25	33	16	2	99	9
<i>Aus/aman</i>	20	1	35	12	1	69	8
<i>Wheat</i>	18	1	6	20	1	46	6
<i>Pulses</i>	9	1	11	10	1	32	n.a
<i>Mustard</i>	9	1	15	20	1	46	n.a
<i>Jute</i>	27	1	39	20	1	88	9

The table shows the new *MV-boro* crop as a labour intensive crop compared to the other major crops grown in the village. But if post-harvest operations are included, jute may in total be the most labour demanding crop.<sup>3</sup> The main reason for the higher labour use in *MV-boro* production compared to other rice crops is due to the difference in sowing technique. Whereas a farmer can broadcast more than 1 acre of land per day, he will in general only be able to transplant 0.02 to 0.06 acres a day. Unlike other areas where transplanting of for instance *aman* have been common for a long time, the transplanting technique in this area was introduced along with *boro* crop. In 1986 many large farmers complained about lack of trained labour for this operation and preferred to pay on a per acre basis for this operation, commonly 100 taka per 0.20 acre.

Land is still prepared either with their own or hired animals, there are no power tillers in use in the village. Hired animals are normally organised as a so-called *ghata*, usually on a per day basis. A *ghata* consists of a ploughman and two sets of bullocks/cows working in turn;



one set tilling while the other is taking rest. The labor used for preparing land for various crops is basically the same; between 8 and 10 ghatas per acre. The only exception is mustard and pulses which need less preparation and often will be grown without much land preparation.

One of the important aspects related to labour use is the relationship between the use of hired and family labour. It is commonly assumed that the introduction of MV rice varieties will lead to an increased use of hired labour compared to traditional crops. This can both be explained by a higher total labour demand, as well as the more marked seasonality of the labour requirements making it difficult to manage with only family labour. On the basis of the rather rough estimates provided by the farmer, it seems that the share of hired labour varies between 15 and 80 percent of all labour inputs. Except for some farmers with very small amounts of land under irrigation, all farmers will to some extent use hired labour, mainly for weeding and harvesting operations.<sup>4</sup>

Payment for hired labour is organised in various ways. Land preparation and weeding is usually paid on a per day basis, whereas transplanting often, at least among the most land rich farmer is based on fixed sum for a certain area. Harvesting of rice crops is paid in share of harvested crop; 1/9 or 1/8 for MV-*boro* and 1/4-1/6 for *aus/aman*. Harvesting of jute and *robi* crops is normally paid on a per day basis. In 1986 the common daily wage for agricultural labourers was between 15 and 20 taka per day, in 1990 the wage level had risen to 20-25 taka per day. This is paid for a six hour working day (08.00 to 14.00) which, unlike other areas in Bangladesh, is the commonly practised working day in the Madaripur area. Labour is hired both on an individual basis, and, especially for operations such as weeding and harvesting, in the form of informal labour groups lead by a labour *sardar*.

The use of chemical herbicides instead of manual weeding is a practice which according to Jayasriya and Shand (1986) is rapidly spreading in many areas of Asia. This practice had not been taken up in the village. Various types of pesticides against plant diseases and insects are however used. In 1986 the application of pesticides were normally done by the farmers on an individual basis. In 1990 we found a new profession in the village, some landless labourers had obtained spraying equipment from the upazila agricultural office and were selling pesticide application to the farmers against cash payment. The common fee was 30 taka per acre per application.

The implications of the introduction of a new rice crop on total labour use in agriculture can only be assessed when taking into consideration the total changes in the annual cropping pattern induced by the new crop. de Vylder (1982) present estimates done by Clay (1978)

which shows that the new rice technology can have had both negative and positive effects on annual labour requirement. On the basis of various crop combinations, Clay (1978) found that the new technology can lead to changes in annual labour use varying from a 13 % reduction to a 170 % increase.

As discussed above it is in this area difficult to find crops which can be combined with the new rice crop. The introduction of MV-*boro* crop does in practice imply a tendency towards single cropping in the area. The overall impact of such a change will be depend on the which crops and what crop combinations are being replaced (table 7.5). A change from a combination of mixed *aus/aman* and pulses towards a single MV-*boro* crop implies a small reduction in total labour use (- 2 %), a shift from jute +mustard implies a more substantial (26 %) reduction. In practice the reductions may be smaller, both because the estimates on labour requirement for mustard and especially pulses are high estimates. Many farmers grow pulses with considerably less labour input than the above figures suggest. In addition, not all land was utilised during the winter seasons, some plots are left fallow.<sup>5</sup>

Options D and E in table 7.5 shows the potential increase in labour demand on relatively flood free land where it is possible to grow a rain-fed MV-*aman* in addition to a irrigated MV-*boro* crop. In *Bhramondi* farmers were establishing such a cropping pattern on the high land that is protected from river flow by the main road passing through the village.

Table 7.5 Annual labour requirements under various cropping patterns.

	Cropping pattern	New	Labour days acre/year		
			Old	New	% change
<b>A</b>	Mixed <i>aus/aman</i> + pulses	MV- <i>boro</i> + Fallow	101	99	- 2
<b>B</b>	Mixed <i>aus/aman</i> + mustard	MV- <i>boro</i> + Fallow	115	99	-14
<b>C</b>	Jute+ mustard	MV- <i>boro</i> + Fallow	134	99	-26
<b>D</b>	Mixed <i>aus/aman</i> + pulses	MV- <i>boro</i> + MV- <i>aman</i>	101	198	+96
<b>E</b>	Jute+ mustard	MV- <i>boro</i> + MV- <i>aman</i>	134	198	+56

The changes in cropping pattern, despite the reduced cropping intensity, most likely do have a limited effect on the total labour requirement. Though the seasonal shift in labour does effect the labourers in the village. The change means that the peak labour demand in agriculture comes at a time of the year when seasonal wage labour opportunities outside agriculture are at their best. During the winter season there will be work available both in various construction activities, on some of the many brick-fields in the town, or in various

public employment programmes. According to some landless labourers in the village it was fairly easy to find such work during the winter season, it was also usually better paid than agricultural work.

The new cropping patterns have effected the seasonal migration pattern in the village. In the early 1980s, 10 to 12 boats, each carrying approximately 30 men, would leave the village for harvesting local and MV-*boro* in the Syleth district. These men would leave in April and stay in Syleth for approximately one month, hence those involved in this would not be back in time to be able to participate in harvesting of MV-*boro* in the village. In 1985 several labourers involved in this migration claimed that they would stay in the village as the prospects for receiving employment in agriculture had clearly improved. In 1990 we were told that this seasonal migration had stopped completely.

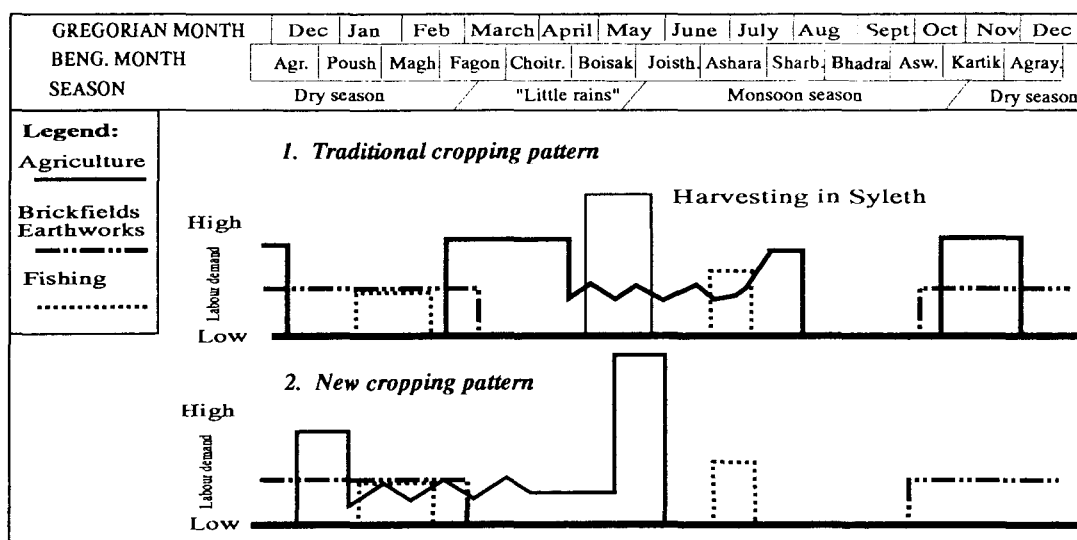


Figure 7.3 Changes in major labour patterns in Char Bhramondi

## *Use of modern inputs and changes in output*

### *Use of fertilizer and pesticides*

One of the main objectives of the policy reforms described in chapter four was to liberalise the distribution system for fertiliser. In 1986 the impact of these policy changes were already noticeable in Madaripur. Private dealers were selling fertiliser at the nearest *bazaar* and some smaller dealers were operating on the local *hat* in *Bhramondi*. In 1990 fertiliser could be purchased at the small, local grocery shop in *Char Bhramondi*.

In 1986 fertiliser was applied to a number of crops. The most frequent and extensive use was on *MV-boro*, but a number of farmers reported use on crops such as mustard, wheat and jute and to a lesser extent *aus/aman*. In 1990 the use of fertiliser was much more concentrated to the *MV-boro* crop. The rate of fertiliser use on both jute and other rice crops and to some extent also mustard, had declined (table 7.6). The reasons for such a development may be many. It may be explained by a combination of capital constraint and a tendency towards a decline in net return on some crops. This issue will be discussed in more detail in the section reporting on costs and returns.

Table 7.6 Fertiliser use on various crops 1986 and 1990. - Percent of farmers growing a crop using fertiliser.

Crop	1986	1990
<i>MV-boro</i>	100	100
Mustard	67	63
<i>Aus/Aman</i>	54	0
Jute	76	5
Wheat	86	67

For *MV-boro* the overall use (application rate) of fertiliser per acre had gone up from 1986 to 1990 (figure 7.4). At the same time there had been a shift in the fertiliser mix, as the use of Urea and TSP had gone up whereas use of MP had declined.<sup>6</sup> As regard prices paid for fertiliser these had remained virtually unchanged in the period. In 1986 the price varied between 4 taka/kg for MP and 4.75 taka/kg for Urea and TSP. In 1990 the farmers reported more or less the same prices.

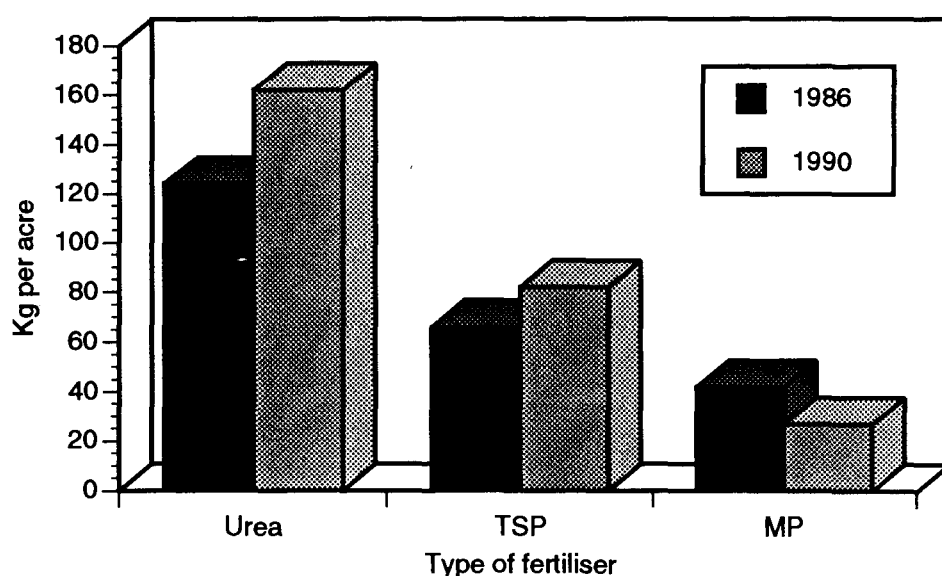


Figure 7.4 Use of chemical fertiliser on *MV-boro* 1986 and 1990

In 1986 we found no systematic relationship between farm size and total use of fertiliser, while the 1990 figures show a weak positive relationship. As regards choice of type of fertiliser there is clear negative relationship between use of MP and farm size both in 1986 and 1990.<sup>7</sup> The fact that small farmers applied more MP than large farmers *may* be explained by price differences among the various fertiliser types, as MP is 0.50-0.75 taka/seer cheaper than the other two main types of fertiliser in use, poor farmers may choose to use a larger amount of MP simply because its cheaper.

As discussed above, insects and diseases were not a major cause of crop losses, neither in 1986 nor in 1990 did the farmers report major problems with insects or plant diseases on the MV-*boro* crop. This is reflected in the relatively low level of costs for pesticides. The fact that average cost was lower in 1990 than in 1986 (215 vs. 269 taka/acre), can indicate a lower incident of pest and diseases in 1990 compared to 1986. It may however also be explained by the emergence of the new system for applying pesticides, which may be more cost-effective than the old system based on individual purchase and application.

#### *Changes in output*

As discussed in chapter four there is no doubt that production of MV-*boro* does give a substantially higher yield than other rice crops. In 1986 average yield among the households growing mixed *aus/aman* was 22 maunds per acre, in 1990 as low as 17 maunds per acre. The average yield for MV-*boro* was in 1986 79 maund per acre, in 1990 this had fallen to 69 maunds/acre<sup>8</sup>.

A reduction in average yield may seem surprising, given the higher fertiliser use in 1990 compared to 1986. It may have several explanations. Some farmers put forward the classical 'ricardian' explanation; that more marginally suited land has been taken in use for MV-*boro*, this forcing the average yield down. Others claimed that the soil gradually was losing its natural fertility due to the increased fertiliser use, and that this will result in lowered yields. Although both these explanations may be plausible, the low yield in 1990 may also more directly be explained by extraordinary disturbances in some irrigation schemes.

As regards relationship between yield of MV-*boro* and farm size, no systematic relationship can be found either of the rounds of interviews.<sup>9</sup> This is hardly surprising, as discussed in chapter four, different studies from Bangladesh have ended up in quite contradictory results as regards the relationship between farm size and fertiliser use. A more surprising finding

was that there was no positive relationship between yield and fertiliser use, nor was there any relationship between yield and money spent on pesticides.<sup>10</sup> As regards the first issue a lack of a positive relationship may be due to the effect of two intervening variables not accounted for here, differences in land quality and labour use. As regards the latter this may be explained by the fact that insects/plant diseases in general obviously was not a very prominent problem in the village.

### ***Changes in cost and return.***

As table 7.7 show, per acre cost of producing *MV-boro* is substantially higher than for other crops. This is mainly due to the costs of water and fertiliser which stand for slightly less than 50 percent of total cost in the case of *MV-boro*, against only seven percent for jute. Whereas human labour cost amounts to more than half of total cost in the case of jute, such costs amounts to only about one third of costs in the case of wheat and *MV-boro*. The most profitable crop, measured in total net return per acre is *MV-boro*, but measured per unit of product, mustard gave higher net return.

Of the major crops grown in the village, both jute and *aus/aman* gave 1990 negative a net return per acre on a full cost basis in 1990. A negative return on a full cost basis should not be interpreted as a loss in absolute sense, rather that return to family labour is below the current market rate. If return is calculated on a cash cost basis, all crops show a positive return. As can be seen from table 7.7, net return to family labour per labour day put into production varies substantially from crop to crop, from as low 11 taka per day for *aus/aman*, up to 64 taka per day for *MV-boro*.

Cost of production for *MV-boro* in 1986 and 1990 is compared in table 7.8. Here costs for 1986 have been calculated on basis of two different assumptions, in alternative A water is paid in cash at a rate of 1500 taka per acre per season, in alternative B water is paid as crop share. The table show that the most dramatic increase in costs in the period 1986-90 is a result of change in payment system for water. When leaving the change in costs of water out of the picture, the table shows that the most substantial increase is cost of hiring bullocks. This is not surprising, there is lack of bullocks in the village, especially in the peak season. This is reflected in the price of bullocks, which are higher in the beginning of the *MV-boro* season, than in other seasons.

Table 7.7 Cost and return various crops 1986 and 1990.

	<i>MV-boro</i>			<i>Jute</i>		<i>Mustard</i>		<i>Aus /amon</i>		<i>Pulses</i>		<i>Wheat</i>	
	<i>1986a</i>	<i>1986b</i>	<i>1990</i>	<i>1986</i>	<i>1990</i>	<i>1986</i>	<i>1990</i>	<i>1986</i>	<i>1990</i>	<i>1986</i>	<i>1990</i>	<i>1986</i>	<i>1990</i>
<i>COSTS</i>													
Human labour	1980	1980	2475	1790	2200	920	1150	1380	1725	640	800	920	1150
Animal labour	1000	1000	2000	1125	2250	375	750	1000	2000	375	250	750	1500
Water	1500	2978	3485	0	0	0	0	0	0	0	0	0	0
Fertilizer	1070	1070	1264	355	30	625	591	271	0	56	0	563	113
Seeds	428	428	638	79	100	60	100	428	638	228	30	525	525
Pesticides	269	269	215	0	0	0	0	0	0	0	0	0	21
<b>Total cost</b>	<b>6247</b>	<b>7725</b>	<b>10077</b>	<b>3349</b>	<b>4580</b>	<b>1980</b>	<b>2591</b>	<b>3079</b>	<b>4363</b>	<b>1299</b>	<b>1080</b>	<b>2758</b>	<b>3309</b>
Labour costs as % of total costs	32	26	25	53	48	46	44	45	40	49	74	33	35
Cash Cost	4267	5745	7602	1559	2380	1060	1441	1699	2638	659	250	1838	1634
Cash cost as % of total cost	68	74	75	47	52	54	56	55	60	51	26	67	65
<i>INCOME</i>													
Yield*	79,1	79,1	68,7	20,4	12,3	13,2	8,4	21,6	17,1	13,4	6	25,4	14,3
Price received*	151	151	203	201	303	330	443	166	200	270	n.a	157	240
Gross value of production	11905	11905	13946	4100	3727	4356	3721	3586	3420	3618	n.a	3988	3432
<i>NET RETURN</i>													
Per acre, full cost	5658	4180	3869	751	-853	2376	11308	507	-943	2319	n.a	1230	123
Per acre, cash cost	7638	6160	6344	2541	1347	3296	2280	1887	782	2959	n.a	2150	1273
Per maund	72	53	56	37	-69	180	135	23	-55	173	n.a	48	8,6
Per labour day	77	62	64	29	15	72	50	27	11	92	n.a	47	28
Benefit/cost ratio	1,9	1,5	1,4	1,2	0,8	2,2	1,4	1,2	0,8	2,8	n.a	1,5	1,0

Table 7.8 Cost and return MV-boro 1986 and 1990

	1986		1990	Change in %	
	A	B	C	B to C	A to C
Human labour (99 mandays)	1980	1980	2475	25	25
Animal labour (8 <i>ghatas</i> )	1000	1000	2000	100	100
Water	1500	2978	3485	17	132
Fertiliser	1070	1070	1264	18	18
Seeds	428	428	638	49	49
Pesticides	269	269	215	÷20	÷20
<i>Total cost</i>	<i>6247</i>	<i>7725</i>	<i>10077</i>	<i>30</i>	<i>69</i>
Yield*	79.1	79.1	68.7	÷13	÷13
Price received*	150.5	150.5	203	35	35
<i>Value of production</i>	<i>11905</i>	<i>11905</i>	<i>13943</i>	<i>17</i>	<i>17</i>
<i>Net return, full cost</i>					
per acre	5658	4180	3869	÷8	÷32
per maund	72	53	56	6	÷22
<i>Benefit/cost ratio (full cost)</i>	<i>1.9</i>	<i>1.5</i>	<i>1.4</i>		

As shown in chapter six, sharecropping was common in the irrigation schemes in the village. The usual conditions for sharecropping of rain-fed land is that tenants provide all inputs, while the product is shared between landowner and sharecropper on a 50:50 basis. On irrigated land different agreements were in use. In cases where water is paid in the form of crop share, sharecropper have to provide all inputs, except water which is paid in the form of share of standing crop. In most cases sharecropper will get 50 percent of total crop and the landowner the remaining 1/4 of the crop.<sup>11</sup> There were however some exemptions from this most common agreement, in some cases the 75 percent of crop remaining after water is paid for, will be shared 50:50 between the landowners and sharecropper. In cases where water is paid in cash, the sharecropper pays for water, but is in return allotted 3/4 of the crop.

An indication on the average net return to sharecropper and landowner under the most common sharecropping condition in 1990 is presented in table 7.9. The calculations show a small positive return when costs is calculated on a full cost basis. The figures indicate that net return to sharecroppers labour will be about 4 taka above the common daily wage rate in the village. For the landowner, the return will, under this particular sharecropping condition, be only marginally higher than net return on self-operated land (3869 vs. 3485 taka /acre). These figures indicate that sharecropping under these conditions is fairly remunerative for the sharecropper. Under some of the other-crop share arrangements,



where landowner keep a larger share of product, net return to sharecropper will be substantially lower.

*Table 7.9 Return to landowner and sharecropper*

	<i>Taka per acre</i>
<i>Gross value of production</i>	13946
<i>+Water costs (1/4 of prod.)</i>	3485
<i>+Landowners share (1/4 of prod.)</i>	3485
<i>Sharecroppers gross return</i>	6973
<i>+Cost of production (excluding water)</i>	6587
<i>Sharecroppers net return, full cost basis.</i>	387

*Note:* The calculation is based on a crop share arrangement where water is paid with 1/4 of total crop and where landowner receive 1/4 and sharecropper 2/4 of total product.

*Source:* All figures taken from table 7.8

In table 7.4 above I assessed changes in labour demand caused by various new cropping patterns. In table 7.10 below net return per acre under various cropping patterns is assessed in a similar way. Regardless of whether changes in return is compared on a crop to crop basis (table 7.7), or whether the comparison is done on basis of changes in cropping pattern (table 7.10), the conclusion seems to be fairly consistent, it is profitable for the farmers to adopt the new crop, net return per acre will be higher even though the cropping patterns may include fewer crops per year.

*Table 7.10 Net return per acre under various cropping patterns (cash cost basis)*

	<i>Cropping pattern</i>		<i>Net return per acre</i>		
	<i>Old</i>	<i>New</i>	<i>Old</i>	<i>New</i>	<i>% change</i>
<b>A</b>	Mixed <i>aus/aman</i> + mustard	MV- <i>boro</i> + Fallow	3062	6344	+107
<b>B</b>	Mixed <i>aus/aman</i> + wheat	MV- <i>boro</i> + Fallow	2055	6344	+208
<b>C</b>	Jute+ mustard	MV- <i>boro</i> + Fallow	3626	6344	+75
<b>E</b>	Jute+ wheat	MV- <i>boro</i> + Fallow	2620	6344	+142

## ***Financing the new crop***

Although water is paid in kind, the new MV- *boro* crop is still a comparatively cash intensive crop as much of the inputs needed must be purchased. Farmers can raise money for buying inputs such as fertiliser, pesticides, and if needed, also ploughing, either by

having one or more household members earning money outside agriculture or by growing cash crops for sale. A third solution is to finance the costs by seasonal loans. The two first strategies were, as described above, actively pursued by most farmers both in 1986 and 1990. While it may be difficult to see consistent patterns of change as regards non-farm employment and cash crop production between 1986 and 1990, more clear changes could be seen when it comes to agricultural credit.

Out of the 33 households interviewed in 1990, three sharecropped out all their land and were therefore, according to the sharecropping conditions, not responsible for the cash inputs. The remaining 30 households had, according to their own estimates, a total cash need of 217,500 taka for MV-*boro* in the 1990 season. Out of this 63 percent would be own funds, the remaining 37 percent would be raised through various loans. Eleven farmers managed without any types of loans which means that the remaining 19 farmers were heavily dependent upon loans to finance their MV-*boro* crop. Similar figures on estimated total costs in 1986 are not available so it is not possible to do a direct comparison with the situation in 1986. But information on amount of loans taken for producing MV-*boro*, as well as sources for credit is available for both 1986 and 1990. When comparing these figures some important changes can be observed.

The figures in table 7.11, which refer to altogether four seasons, indicate a remarkable increase in amount of funds raised through private loans, whereas the amount borrowed from the official bank system had declined. As regards conditions for repayment of private loans there was also some remarkable changes. Whereas 6 out of 7 loans were to be repaid in cash in 1986, 29 out of 30 loans were to be repaid in kind in 1990. The rate of repayment was the same in all these 29 loans, 8 maund of paddy (312 kg) per 1000 taka in loan. If one assume an average market value of 200 taka per maunds of paddy, and a average length of these loans of 6 months, this equals an interest rate of 10 percent per month.

The figures in table 7.11 undoubtedly reflects some fundamental changes in the credit system which has taken place in-between the two rounds of interviews. The fact that private loans has gained in importance as a source of credit for MV-*boro* during the last seasons as was openly acknowledge by the farmers. They claimed that these loans were not mainly provided by moneylenders (*Mahajans*) in the more traditional sense of the word. Rather a wide range of people was involved in this system, from large landowners to richshaw pullers, jute mill workers and ordinary farmers, all with that in common that they have a cash surplus, often seasonal, available for investment. According to the farmers the moneylenders regards this types of crop loans as a good way of disposing a often

occasional cash surplus. These loans were regarded as relatively secure, the money is tied up for a limited time (6 months) period, and at the same time the loans give a good return. These findings fits well with Maloney and Ahmed (1988) who claims that moneylenders in the more traditional sense, stands for a relatively small part of total rural credit in Bangladesh, and that relatives neighbours and local rich people is the most common source of rural credit.

*Table 7.11 Summary statistics loans for MV-boro 1985/86 and 1989/90*

	1985 & 1986	1989&1990
<i>Number of loans</i>		
Private	7	30
Bank	14	8
Total	21	38
<i>No of farmers with loan</i>	16	23
<i>Total amount loaned (taka)</i>		
Private	5 650	110 300
Bank	68 400	72 000
Total	74 050	182 300
<i>Average per loan</i>	3 526	8 681
<i>Average per farmer</i>	4 628	7 926

## ***Marketing of products***

Despite a strong subsistence oriented agricultural sector in Bangladesh, many have noticed that a substantial share of rice production is marketed. In one study Quasem (1987) found that about 23 percent of total production was marketed, others have reported findings in the range from 12 to 40 percent (Usami 1987). All kind of producers seems to participate in the trading of paddy, for instance Quasem (1987) found that 3/4 of all farmers in his sample marketed parts of their production. Also small and marginal farmers with a production well below annual family consumption, market a share of their products after harvest in order to raise cash for various purposes. As regards marketing area of paddy and rice it is reason to assume that a large share is local of nature and takes place within a rather limited geographical area. And rice trade is most likely more local than trade with paddy (Usami 1987).<sup>12</sup>

Although most of the paddy is consumed in the rural area and despite the fact that studies show that most trade is circular exchange within limited area, inter-regional trade of paddy does exists. This trade does take place not only because some areas are deficit while other and surplus producing regions, some of trade is also due to variances in cropping patter as

well as difference in varieties produced in different localities. Thus a region with an surplus in rice production can at the same time be both an exporting and importing region. Trade and processing of paddy is to a considerable extent seasonal.

There are a large number of trader and middlemen involved in the marketing system with to some extent specialised to some extent overlapping functions.<sup>13</sup> A *Bepari* is a trader involved in selling and buying commodities either directly from them producer or from other traders. Usami (1986) distinguish between to types of *beparis*; local and *bideshi* (outside) *beparis*. The former is mainly involved in collecting marketable surplus production from the local farmers, often with the help of agents. A outside *bepari* purchase this surplus for resale to retailers in other areas. The *bepari* will in most cases sell and by commodities with the help of an *arodtar*. The traditional function of the *arodtar* is to act as an intermediate agent linking selling and buying *beparis*. For this he charges a commission per unit of traded goods. In 1988 the common commission for rice was 3 taka per maunds, with a price of rice varying from 300-425 taka/maunds this gives a commission of between 0.7 to 1.0 percent of value. It has however also been reported that in some cases the *arodtar* will himself act as an *bepari*, buying and selling on his own expenses (Maloney et al 1988, Crow 1987, Mizoguchi 1987).

A *paiker* is an agent who buy and sell on behalf of an *bepari*. In some cases he will also operate as an *bepari* on his own. A *feriwalla* (or only *feri*) is a peddler who buys and sell various types of commodities in the village, directly from house to house. In return for these goods he is often paid in kind (rice or paddy) which he sell to an *paiker* or *bepari* for cash. Although these *feris* are not mainly preoccupied with trade of the agricultural commodities included here, it is reason to assume that a considerable amount of paddy and rice is marketed through the *feris*.

Little is known about the personal end economic relationships between different types of traders but the relationships are most probably complex with many geographical and personal variations. In general much of the trade is organised entirely around personal, unwritten agreements based upon personal trust. According to Maloney et al (1987) there hardly exist any comprehensive studies in Bangladesh on how traditional business transactions are financed. From the evidence available it seems clear that much commodity trade is heavily tied to various credit arrangements, in most cases informal. In some cases transaction is based on a 40-60 percent cash basis the remaining being credit, in more exceptional cases credit may amounts to 80 percent of traded value Maloney et al (1987).

The changes in cropping pattern described above, have induced some important changes in the paddy trading system in *Char Bhramondi*. While *MV-boro* to a large extent was marketed in 1986, only 5 farmers reported sale of *MV-boro* in 1990. In-between 1986 and 1990 *MV-boro* had replaced *aus/aman* as the principal subsistence crop among the households interviewed. Most of the paddy that is marketed from the farmers in *Char Bhramondi* is not sold locally, Madaripur has in fact no large paddy market. Traditionally paddy from this part of Faridpur region has been exported to some of the large regional paddy markets located around Barisal town. On these markets, paddy from different parts of the country is traded both for re-sale to other markets in the south-western parts of Bangladesh, but also for re-sale to more distant markets, in Dhaka and Syleth.

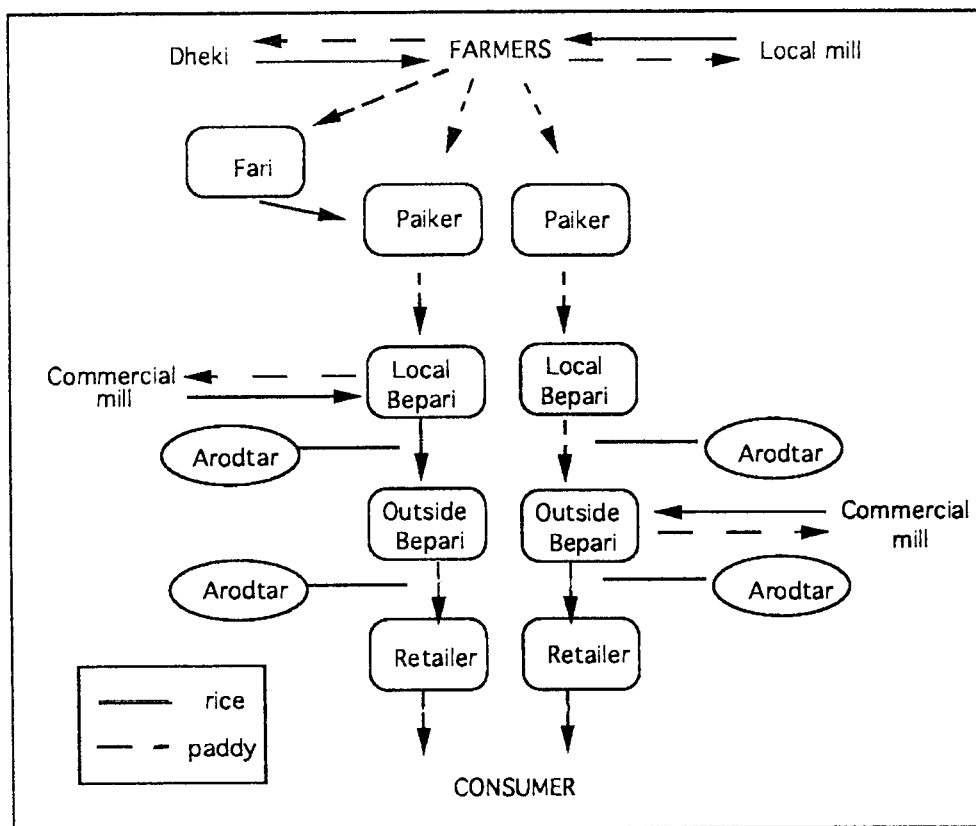


Figure 7.5 Outline of paddy and rice trade system

The paddy sold from Madaripur, is either processed in Barisal before its is resold in the form of rice, or it is sold as unprocessed paddy to *beparis* from other areas of the country. Previously farmers in this area used to sell surplus *aman* to *paikers* coming from Barisal after the harvest in October/ November. After the introduction of *MV-boro*, this sesasonal trading pattern has shifted completely, now most sale is taking place after harvest of *MV-boro* in May/June.

The paddy is normally sold to *beparis* or *paikers* coming to the area with own boat, the actual sale of paddy take place in the homestead. As regards economic relationships between the various rice traders Crow (1987) claim that the degree of vertical integration in this business has been underestimated. Both Maloney et al (1988) and Crow (1987) reports that in some cases *arodtars* will forward crop loans to surplus farmers through *beparis* and/or *paikers*. These loans are repaid in kind (*dadan*) after harvest. Whether such agreements are widespread is not known, what might be more common is that the *arodtar* gives loans for working capital to *beparis* and *paikers*. Not in any cases did we find any type of credit relation between the farmers and the buying *bepari*.

### ***Concluding remarks***

The findings from *Char Bhramondi* indicate that the introduction of irrigation and *MV-boro* lead to a rather dramatic seasonal re-arrangement of agricultural production. The cropping pattern shifted from being organised around a rain-fed monsoon rice crop, most prominently mixed *aus/aman*, to a irrigated winter rice crop. This led to an reduction in both cropping intensity and crop diversity, first of all because it led to a reduction in land available to winter crops such as oilseeds and pulses. Despite this simplification of cropping pattern, the overall labour demand was little effected, the new crop was clearly more labour demanding than most other crops grown. The new crop was also more expensive to produce than traditional crops, the cost of producing *MV-boro* more than double than cost of producing mixed *aus/aman*. At the same time yield per acre was substantially higher, so that in sum farmers net profit was considerable higher when producing *MV-boro* than other crops. This relationship also holds both when comparing on a crop to crop basis as well as when comparing annual cropping patterns. A comparison between the situation in 1986 and 1990 indicates that there is some evidence of declining yield. There is also some evidence of declining return from production of *MV-boro*, due both to the decline in yield and increase in costs.

Although the new crop is much more dependent upon cash inputs than the traditional crops, the farmers seem to have been able to raise the necessary funds for the new crop. This is somewhat surprising as this change it took place in a period where most farmers had experienced heavy losses due to hailstorms and floods. The fact that they was able to raise the necessary capital, despite these losses, is due to several factors. First, there is some evidence of a certain flow of resources into agriculture from others sector of the economy. This flow has taken the form of non-agricultural income among household members, as well as in the form of non-institutional credit. Second, it reason to believe that the changes

in water payment system discussed in chapter six, had made it easier for the farmers to accept the new crop, as the this new payment system reduced the farmers requirements for cash.

## NOTES

- <sup>1</sup> The driver in one of the Proshika groups presented in chapter 6 had in 1990 stated to grow tomatoes for sale on the market in Madaripur town. The scale of this experiment was very modest, but the initial experiences indicated that it could be a very profitable as the prices for tomatoes were in 1990.
- <sup>2</sup> The assessments of labour requirements is based on a set of group interviews carried out in 1986 and 1990. Initially questions on labour us for different crops and operations were included in the household questionnaires. It did however prove to be extremely difficult and time consuming to obtain this information as farmers commonly growing 6-7 different crops found it difficult to give detailed information on labour used on different operations for each of these crops.
- <sup>3</sup> Khan et al (1980) found that one fifth (18 out of 88 mandays) of total labour use for jute were in post-harvest operations.
- <sup>4</sup> As our data only contain disaggregated information on the use of hired labour for MV-boro, it is not possible to make any direct comparison among crops on this aspect.
- <sup>5</sup> I have earlier estimated the cropping intensity prior to the introduction of irrigation to about 170, and have on basis of old and new land use pattern estimated that in total there would be a small (11 percent) increase in total annual labour requirements along with the introduction of the new crop.(see Lein 1988)
- <sup>6</sup> A paired T-test show that the differences in means as regards use of Urea and MP is significant on a 5 % percent probability level.

<sup>7</sup> A regression with land owned as the independent variable.gave the following results:

Dependent var.	R <sup>2</sup>	T-value	N
Tot. fertiliser 86	0.016	0.666	29
Urea 86	0.003	-0.364	29
Mp 86	0.346	3.777	29
TSP 86	0.000	-0.044	29
Tot. fertiliser 90	0.188	2.548	30
Urea 90	0.105	1.816	30
Mp 86	0.206	2.699	30
TSP 86	0.071	1.464	30

<sup>8</sup>The difference is however not statistically significant, a paired T-test analysis give a probability of 0.107 (N=27).

<sup>9</sup>A regression with land owned as the independent variable.gave the following results:

Dependent var.	R <sup>2</sup>	T-value	N
Yield 90	0.001	-0.128	30
Yield 86	0.000	0.067	29

<sup>10</sup>A regression with fertiliser use

Dependent var.	R <sup>2</sup>	T-value	N
Yield 86	0.067	1.387	29
Yield 90	0.024	0.823	30

With cost of pesticides as independent variable:

<b>Dependent var.</b>	<b>R<sup>2</sup></b>	<b>T-value</b>	<b>N</b>
Yield 86	0.077	-1.383	25
Yield 90	0.000	- 0.048	26

- <sup>11</sup>We do not have information on to what extent these sharecropping agreements have additional, more individual conditions, other have however found such to be quite common(see i.a Dutta 1990, Jansen 1987).
- <sup>12</sup>In a survey of all marketing movements within a thana (previously name of a upazila) showed that 92 percent of all trade movements were contained within the study area, only 8 percent were movements in and out of the thana (Tarrant 1978). Unfortunately the study do not provide separate figures on rice /paddy trade movements
- <sup>13</sup>The functions of the various traders and middlemen are also described in Maloney et al 1987.



## CHAPTER EIGHT

*CONCLUSION**Introduction*

As stated in chapter one, the most concrete objectives of this study have been to document *what* happened in Madaripur and *Char Bhramondi* in the late 1980, to try to find out *why* it happened and to identify some of the *effects* this change had on both individual farmers and the local society. These questions have been addressed in some detail in chapters five, six and seven. As such the present work can be read as a case study, documenting recent agricultural changes in small region in Southwest Bangladesh.

Besides presenting and analysing an interesting case, I have had wider ambitions with the present study. A second objective stated in chapter one was to provide a contribution to an on-going discussion on how this type of agricultural change in general best could be analysed and explained. What is the most appropriate theoretical approach? And further, how far can agricultural change be described and analysed with the help of general theories or models? Or—must such changes rather be perceived as being basically historically and geographically unique processes?

In this concluding chapter I will start by discussing to what extent I think the various models of agricultural development presented in chapter three, can be used to explain what has happened in Madaripur and *Char Bhramondi* over the last few years. I will also try to present an alternative framework for interpreting agricultural change. This framework is based on the writings of H. Brookfield (Brookfield 1972, 1984).

As stated in the introduction, a third objective of the study was to try to assess the impact of agricultural change on the rural society. The last part of the chapter presents a brief discussion on the importance and effects of the changes currently taking place in Bangladesh agriculture, or to put it another way; the effects of the green revolution on rural Bangladesh.

## *Explaining agricultural change*

In chapter three I presented a number of models commonly used to explain agricultural change. They have to a considerable extent directed the empirical focus of the study, as they have guided my more inductive investigations in the field in certain directions, towards an interest in some types of issues, some types of variables and some types of interpretations. Some elements of these models have, throughout the preceding chapters, been used to interpret various aspects of the situation in *Char Bhramondi* and Madaripur in general. I will here only present a brief overall assessment of to what extent, and in which ways these various models provide some insight in the process of agricultural change.

Theories of social and spatial diffusion of agricultural innovations have been central in many studies of agricultural change. Diffusion theories see information about new practices as the key variable in the diffusion process. When farmers do not innovate it is because they lack information about the innovations. A key element of the green revolution technology in Bangladesh, modern, mechanised irrigation, was introduced in the upazila in the late 1960s. It is thus not likely that lack of information about core elements of the new technology has been the major limiting factor explaining the relatively slow spread of the new technology up to the mid-1980s. In the late 1980s the farmers rapidly took into use innovations which has been known, and in use, in the village for more than two decades. The situation in Madaripur and *Char Bhramondi* over the preceding decades can therefore perhaps best be described as an example of a 'suspended' or delayed diffusion.

There is however some important elements of the more recent changes which may be best understood from diffusion perspective. The changes in water payment system observed in the village can most likely best be perceived as the outcome of a diffusion process. The new crop share payment system was brought to the village by an outside agent, the NGO Proshika. And the idea rapidly gained in popularity, as it was a means which solved some important problems for both the farmers and the pump owners. In a similar way the spread of new forms of ownership, described in chapter five, must in itself be interpreted as a process of diffusion. The rapid expansion of irrigation schemes has obviously much to do with the spread of knowledge about how such small scale irrigation can be organised and financed. The main problem linked to explaining the changes with the help of diffusion theory, relates to an issue which diffusion theories in general have been criticised for paying too little attention to, namely access to the resources required to adopt innovations. This is a point to which I will return.

According to what I have termed economic explanations of agricultural change, innovations are adopted basically because farmers find it profitable to do so. The calculations presented here and elsewhere clearly show that there is a sound economic basis for adopting the new technology. Despite the higher costs, net return is higher both when comparing on a crop to crop basis, as well as when comparing old and new cropping patterns. As to the question of risk and risk-minimising behaviour, there is, contrary to what seems to be a widely held opinion, good reasons to argue that adoption of irrigation and MVs must be seen as a risk-reducing change. The adoption of the green revolution technology must here be seen as a means of reducing the impact of floods and flood-related damages.

Although adoption in general undoubtedly must be regarded as the result of sound economic calculations among the farmers, one important problem remains, namely to explain the timing of the adoption. Although there is some evidence of the development of a more favourable rice-fertiliser price ratio in the late 1980s, there are no immediate reasons to assume that the profitability of the new crop has increased substantially over the last decade and that this alone may explain the growing interest in the new rice technology. The question is rather why have farmers not adopted the new crop earlier, at a time when it may have been more profitable to do so. One, at least partial, explanation may be the 1987 and 1988 floods, which clearly exposed the economic risk of *not* innovating. The experiences from the two floods clearly showed the economic disadvantage as well as the subsistence risk, linked to *not* adopting the new technology.

The types of models which I have presented under the heading structural explanations, are, I will agree, to some degree theoretical contributions which are more concerned with explaining why adoption does not take place, rather than to explicitly explain adoption. The basic underlying reasoning of many contributions has been that the interplay between the nature of the technology, and the working of rural societies and markets, is such that the use of the new technology has been possible for only the more resource-rich group of farmers. This argument is to a large extent refuted by the present study as well as other studies, small farmers have been both able and willing to adopt.

There may be several reasons for this. Firstly, the capital intensity of the new technology has been overestimated. To take the new technology into use, does not necessarily require very much capital, especially as a farmer can get access to water without investing in a pump, and because water can be paid for in the form of crop share. Once a farmer has access to water, he will utilise varying amounts of other inputs such as labour, fertiliser and

pesticides. The actual use of these inputs may be far from optimal, seen from a technical or economic point of view, but it will lead to higher production and a better economic result than production of TVs.

The present study also indicates that many farmers have various sources for financing the new crop. This can be institutional or non-institutional loans. It is also commonly household income from non-agricultural activities. In sum resource constraints will not be such a decisive factor in limiting the spread the new technology, as often assumed.

One issue which has been pointed out as a main, structural constraint to agricultural growth has been the problems linked to appropriation and utilisation of Bangladesh's vast water resources. Boyce (1986) have forcefully argued that the problems of setting up efficient collective institutions for utilising the available water resources have been a major constraint to agricultural development in Bangladesh. In *Char Bhamondi* the recent development has proved that it is possible to overcome this impediment. Here it has been possible both to raise the necessary capital and to organise a considerable number of irrigation schemes over the last few years. The spread of irrigation has not been based on co-operatives or public ownership of pumps as common under the old policy, but through a market system, where pumps are privately owned and where water is sold as a commodity.

Population based theories see population growth and increased population pressure as main driving force behind agricultural change. In general Bangladesh is a densely populated country and a large share of rural households have problems producing enough food. Boyce (1986) found on basis of an analysis of regional and historical data, a positive relationship between population pressure and agricultural growth, and sees this as an support for the theory of induced innovations. The current study can only throw some limited light on this issue. What is clear is that the region for a long time has been very densely populated. The high population density seems to have lead to high out-migration rates, population pressure seems not to have induced any major change in production system, at least not until the 1980s.

So what are the conclusions to be drawn from this study as regards the usefulness of the theoretical approaches presented in Chapter three. As briefly discussed in chapter three the two economists Bliss and Stern in their study explicitly choose a single village as a testing ground for various theories of rural development. They concluded their empirical investigations in the following manner:

*“We shall suggest that certain of these theories taken together, can explain much of what we found. On the other hand some important features are not easily explained .... We did not find that the village accorded with any single simple theory and we had to draw upon several models to explain its various features.”* (Bliss and Stern 1982, 298)

The problem of actually utilising different theoretical contributions for explaining the changes in Madaripur and *Char Bhramondi* illustrate a more general issue discussed in chapter three. That is the use of, on the one hand specific historical and geographical explanations and on the other hand, use of explanations based on the use of general models and theories. In the case presented here the theoretical contributions discussed so far only partially explain what has happened. One reason may be that the ‘wrong’ type of theories been utilised, but it may also be that such general theories have limitations as regards explaining processes of change.

### ***Explaining agricultural change – an alternative framework***

In chapter three I discussed some of the writings of H.Brookfield where he has presented what can be interpreted as a more general framework for how agricultural change in general best can be understood. This is an approach which gives room for both theory based explanations, as well as for inclusion of specific historical events and circumstances. It is an approach in the sense that it does not set out to explain agricultural change, but rather provide a guidance or framework for making sense of observed processes. In the following I will try to apply such a framework for interpreting the changes in Char Bhramondi and Madaripur .

In such an approach three basic issues are fundamental. Firstly, one have to look for *pressure for change*. This can be pressure to produce enough food to feed the family, or a strongly felt need to avoid the impact of natural hazards Secondly, one have too look for *opportunities for change*. This can be agro-ecological or economic opportunities. Thirdly, there will *constraints to change*, this being physical or social or economic. These impediments has to conquered if change is going to take place. In short I will argue that one has to look for geographical and historical ‘pockets of opportunities’ in order to understand why change takes place.

A basis for understanding agricultural change is that there must be a perceived need for undertaking such a change. Boserup sees subsistence needs as the main driving force

behind change. Brookfield claims that there may be other, social forces which may induce change. It is not difficult to see that farmers in Bangladesh in general may have very good reason for undertaking changes which increases the output from the land. Most farms are, when operated with traditional crops, too small to meet the food requirements of the family. There is no doubt that subsistence pressure been an important factor behind the changes observed in *Char Bhramondi* and Madaripur.

Environmental hazard and uncertainties may also act as pressure for change. Brookfield (1984) emphasises that agricultural production constantly is subject to environmental uncertainties, and that innovation adoption should be perceived a risk-taking strategy for reducing uncertainties in order to gain advantage. During our visit to *Char Bhramondi* in 1990 the farmers themselves pointed out the 1987 and 1988 floods, and the substantial crop damages caused by these two floods on the rain-fed monsoon crops, as a main driving force behind the expansion of irrigation in the village.

Although the 1987 and 1988 floods undoubtedly must be seen as a triggering force behind the agricultural changes which has taken place, floods and flood damages in itself cannot explain the pattern of innovation adoption which has taken place. Floods have for decades been a returning problem in this area, the main impact of these previous floods seems rather to have been leading to agricultural stagnation rather than growth. The main difference in the late 1980s compared to previous flood situations is that new opportunities for adjusting to the flood problem have been opened up.

Although both subsistence needs and environmental hazard provide pressure for change, this is, as the history of Bangladesh shows, not enough to trigger off changes; farmers must have opportunities for change. That means that first there must be suitable technical opportunities. On one level this has obviously been directly linked to the development of new agricultural technology within national and international research centres. However, we have argued that the observed changes in *Char Bhramondi* may have less to do with development of new technical solutions as such. The farmers in Madaripur have in the late 1980s adopted technologies which, with some modifications, have been well known in the area for more than 20 years.

Available technology may not lead to actual use. A second, and quite obvious condition is that farmers must have access to the available technical opportunities, either through markets or administrative institutions. There is good reason to argue that recent policy changes in the agricultural sector improved farmer's access to already existing technology, and that the experiences from Madaripur and *Char Bhramondi* shows that recent policy

reforms in the agricultural sector have improved farmer's access to vital inputs such as irrigation equipment and fertiliser. A key to understand the agricultural changes which have taken place in *Char Bhramondi* and other parts of Bangladesh, is thus the political and institutional changes in the minor irrigation sector which were initiated in the first half of the 1980s and, which markedly improved the access to existing modern agricultural technology.

But needs and opportunities in the form of suitable technology and institutional arrangements which makes the technology available to the farmers, are only necessary conditions for change, it may not be enough to actually set off change. There will always be important physical as well as economic social constraints which may prevent change. And when substantial changes takes place, as in *Char Bhramondi*, it means that it has been possible to overcome these impediments to change.

The agricultural innovations discussed here require capital, both for buying and running pumps as well as for crop production. As underlined by Brookfield (1984), it is necessary to have a surplus in order to be both able and willing to innovate. In our case, innovation adoption has taken place in a period of excessive and repeated crop damages due to floods and hailstorms, and there must have been little room for surplus generation within the agricultural sector itself in this period.

Maybe one of the most important effects of the reforms within the agricultural sector and the minor irrigation sector in particular, has been that it has stimulated a inflow of capital generated outside the agricultural sector itself. The heavy involvement in various irrigation schemes in *Char Bhramondi*, by people with their principal income outside the agricultural sector, indicates that there has been a flow of capital from non-agricultural sectors to the minor irrigation sector. In a similar way the increase in credit relations between a number of non-agriculturists and farmers indicate a resource flow to agriculture in this particular period. This flow may be very temporal and is by no doubt motivated by a hope of extracting funds out of the agricultural sector. Nevertheless this flow may have been crucial in setting off an process of agricultural modernisation.

The recent development in the minor irrigation sector which has been a key to recent agricultural changes, indicate that the social impediments to utilisation of available water resources, identified by Boyce (1986), have been somewhat overestimated. As discussed above, the experiences from *Char Bhramondi* and elsewhere, show that farmers have been able to organise suitable collective solutions which have made it possible to utilise the important water resource.

## *Impact of the green revolution*

As discussed in chapter two, the introduction of the green revolution technology has commonly been assumed to have an a rather dramatic impact on rural societies. Some have maintained that it would solve the world hunger problem, others have claimed that it only leads to increased differentiation and polarisation within the rural societies. In this last section I will comment upon some issues related to the impact of the new agricultural technology.

There already exists ample empirical evidence from Bangladesh which stands in stark contrast to claims that the spread of the new technology has been limited to the most resourceful farmers. As discussed in chapter three, many studies show that even the small farmers have access to, and have been able to take advantage of the green revolution technology. The findings from *Char Bhramondi* clearly support this view. Following from this it is therefore difficult to argue the spread of these innovations can be regarded as the main driving force behind a process of differentiation and polarisation in rural Bangladesh, as for instance claimed by Rahman (1989). Several studies, including the present one, show that the use of irrigation, MV and fertiliser will improve the production capacity and increase economic return on all types of farms, including the smallest farms. The new technology does thereby contribute to the consolidation of the small farm.

At the same time it seems clear that the introduction of the new technology will increase the absolute economic gap between different groups of rural people. This is so due to at least two reasons. Firstly, the already relatively land rich farmers gain most in absolute terms, simply because they have more land on which they can utilise the new and more profitable technology. Secondly, some groups in the rural society, including the more wealthy farmers, are able to capture a substantial share of other farmers' production gains. This happens through several mechanisms. Firstly, a transfer of resources takes place through the interest paid on the informal loans many farmers need in order to have some working capital for MV-*boro* production. Secondly, a share of the production gains is captured through the land rent (crop share). As shown in the present study, the conditions for sharecropping of land has been altered along with the introduction of the new technology and this has secured the landowner a higher land rent.



Thirdly, a substantial share of the production gains have also been siphoned off through the water market. What is clear from the present study is that the owners of the irrigation equipment do acquire a substantial part of the benefits, as one fourth of total product goes as payment of water. Although there are large differences in cost and hence net income among the various schemes, one can assume that a substantial share of the value of product goes as net profit to the pumpowner.

As discussed above some critics of the policy reforms in Bangladesh agriculture have claimed that by opening up for private ownership, a group of local "water lords" would take control over the water resources thereby reaping a substantial share of the benefits accruing from use of MVs. Lewis (1991) have argued that owners of irrigation equipment can be divided into two main categories, those who had obtained a tubewell primarily to irrigate their own land, and those who see a tubewell primarily as an income generating asset. One could add a third category, wealthy and powerful farmers (landlords) using a pump or tubewell as a means to maintain social and economic control in a locality. This may be done either by denying some groups of farmers water, or by using the pump in a more positive way to strengthen patron-client relationships.

The term 'water lord' may fit better this third category, than the new 'water entrepreneurs' that have invested in irrigation equipment in order to earn money. The policy reforms have obviously led to the emergence of a more commercially oriented water market, involving more directly profit-oriented pump owners. This may have weakened the position of the more traditional land-cum-water lords, one may assume they enjoyed much better conditions some years back, when access to irrigation equipment was a much more scarce, and when those who got hold of a pump or tubewell, in practice had more or less monopoly on irrigation in a village. In practice the policy reforms in the minor irrigation sector seems to have contributed to a weakening of more traditional patron-client relationships on this particular arena.

Bhauri et al (1986) have on more general terms argued that there are processes in contemporary Bangladesh, such as increased tenancy and use of hired labour, which contain features leading to the persistence of the small farm. They have used the expression "persistence and polarisation" for describing social and economic changes taking place in rural Bangladesh. Although perceived from a quite different perspective, I think this expression to a considerable extent also summarises the impact of the green revolution in Bangladesh agriculture.

### *The effect on agricultural labourers*

One issue that have attracted much attention has been the impact of the green revolution technology on the rural labour markets, and to what extent agricultural, labourers will gain from the new technology. Several studies including the present, show that production of MVs in general are more labour demanding than TVs. Large scale spread of MVs can therefore potentially have a positive impact of the rural labour market. The actual overall impact on labour demand will, however, also be determined by other factors, such as the actual change in cropping pattern brought about by the introduction of MVs, changes in cropping practices (e.g. from broadcasting to transplanting) accompanying change in cropping pattern. In addition the actual increase in labour demand will depend on to what extent labour saving innovations (mechanical power tillers, herbicides) will be adopted. It is clear that actual change in labour use will be highly dependent on the rate of mechanisation. Mechanisation will normally replace labour, but it may in certain situations have a certain positive effect on total labour use, if a shortage of draught animals hamper production, or if more rapid land preparation allows a higher cropping intensity.<sup>1</sup>

In *Char Bhramondi* the total annual labour demand had neither increased or decreased with the introduction of MV-*boro*. This so because the increase in labour demand following this crop have been set off by a decrease in cropping intensity. This may, however, be a feature confined to flood prone areas of Bangladesh. In other areas cropping intensity, and especially labour demand will most likely increase with the introduction of an irrigated winter crop.

To what extent the new crop will improve the employment situation for agricultural labourers will differ from locality to locality. This will depend not only on which changes in cropping pattern that are brought about, but also to what extent the new labour demand fit in seasonally with other income generating activities and employment opportunities. In *Char Bhramondi* the peak labour demand in MV-*boro* production came in the main, traditional seasonal migration period. The total job opportunities did not increase much, rather the introduction of a new crop meant that more employment opportunities were available locally

In *Char Bhramondi* there were no use of modern labour displacing devices in the form of power tillers or herbicides. This may however only be a transitional phenomena. Draught power is an already scare input. This is reflected both in the substantial increase in cost of hiring bullocks which occurred between 1986 and 1990, as well as more direct complaints among the farmers that access had become increasingly difficult. It is not a very daring

prediction to suggest that mechanical power tillers will be the next innovation to be adopted in the village.

In the present study only the direct labour effects have been addressed. Some have claimed that the secondary effects of agricultural growth may be of much more importance for those depending on non-farm income. The American economist John Mellor (1986) has argued that agricultural growth based on the green revolution technology, may have important linkages effects to other sectors of the economy. Of special importance is the increased demand for non-agricultural products and services following from increased agricultural incomes. This, argues Mellor, will lead to a growth in the local non-farm economy, in which the rural landless and marginal farmers will find new income opportunities. Internationally there exist several studies which do lend some support to what sometimes is presented as the theory of an agriculture led growth. In a Bangladeshi context this is a relatively little explored topic, although at least one study give some support to the theory (Hossain 1987).

As mentioned in the introductory chapter, my original idea with the present study was to focus on agricultural growth linkages in a Bangladeshi context. I wanted to try to give an answer to whether the changes taking place in Bangladesh agriculture today, actually can be regarded as a major driving force behind a local economic growth process. As the reader will have noticed, I never came beyond the first part of the equation; the process of agricultural change. That means that there is a study still to be done.

## **NOTES**

- <sup>1</sup> Mugtada (1975) and Assaduzzaman (1979) argue that increased mechanisation very likely will accompany the introduction of new varieties as the adoption otherwise will be constrained by seasonal labour shortages and lack of drought power. Gill (1983), on the other hand claims that mechanisation primarily will have a labour displacing effect and lead neither to increased production, nor higher cropping intensity.



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