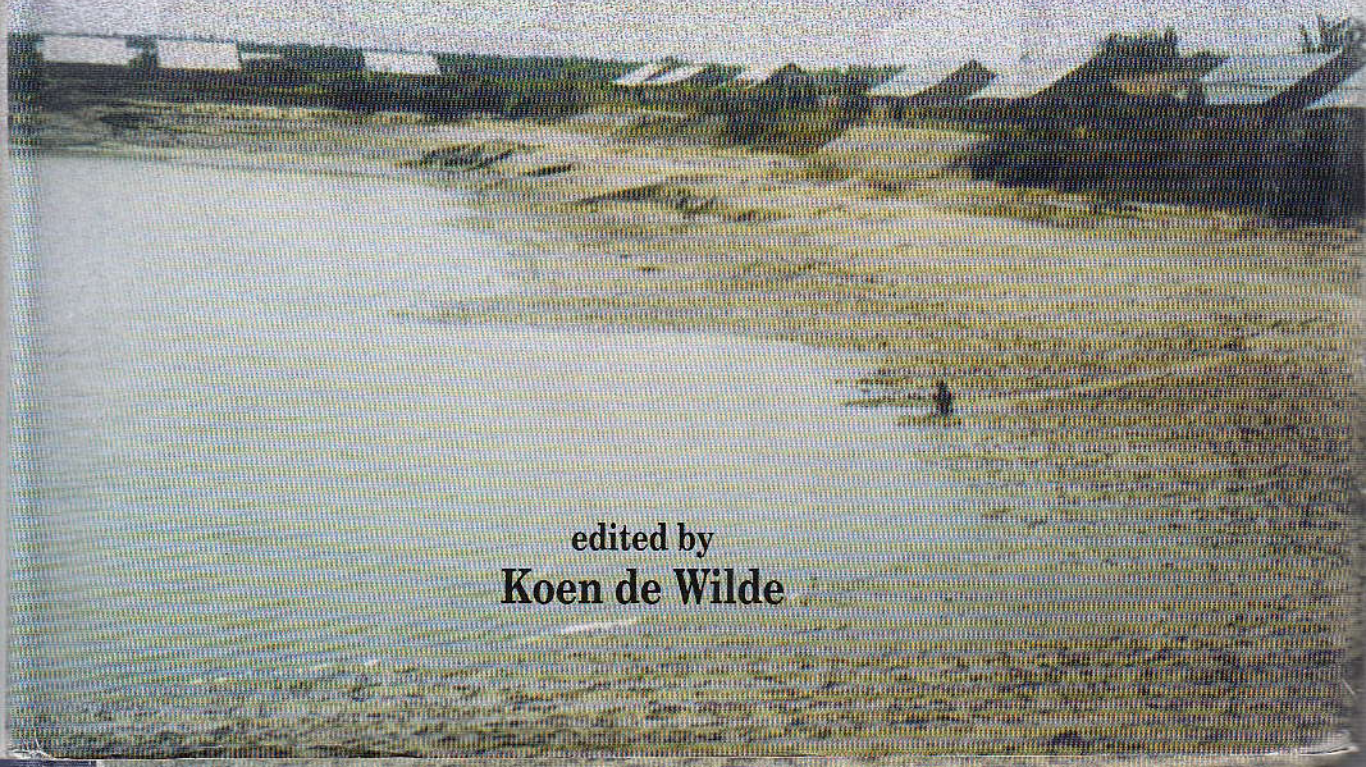
OUT OF THE PERIPHERY

Development of Coastal Chars in Southeastern Bangladesh



edited by
Koen de Wilde

A range of vulnerabilities and an unfulfilled potential for development are the main features of the coastal belt in the southeastern part of Bangladesh. On a day-to-day basis the people living on the coastal belt has to address vulnerabilities as diverse in nature as drainage congestion and the salinity of the soil constraining agricultural yields, cyclones and storms that pose risks to lives and property. Additionally, a heterogeneous social environment with undue influence of well positioned land grabbers can make life and living difficult.

In the newly formed areas along the coast of the Bay of Bengal, the government is hardly present, leading to low access to public services. Promoting development in such a situation is a considerable challenge.

This book describes and reflects upon how the response to this challenge was given shape in *char* areas in the southern part of Noakhali District. It is primarily based on the experiences in the Char Development and Settlement Project, a development intervention financed by the Governments of Bangladesh and The Netherlands.

The main purpose of the book is to provide lessons that can be applied in any future development programme in the *chars*. The book should be of interest to policy planners, soil scientists, students of sociology, anthropology and NGO's involved in poverty alleviation.

(See back flap)

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Abbreviations

AC(L)	Assistant Commissioner (Land)
AES	Agriculture Extension Specialist
BADC	Bangladesh Agricultural Development Corporation
BARI	Bangladesh Agricultural Research Institute
BRRI	Bangladesh Rice Research Institute
BWDB	Bangladesh Water Development Board
CBA	Cost Benefit Analysis
CBD	Char Baggar Dona
CBT	Char Bhatirtek
CDS	Community Development Specialist
CDSP	Char Development and Settlement Project
CEP	Coastal Embankment Project
CERP	Coastal Embankment Rehabilitation Project
CM	Char Majid
CPP	Compartmentalisation Pilot Project
CV	Cluster Village
DAE	Department of Agricultural Extension
DC	Deputy Commissioner
DLRS	Directorate of Land Records and Surveys
DPHE	Department of Public Health Engineering
DTW	Deep Tube Well
EC	Electric Conductivity
EIRR	Economic Internal Rate of Return
EPI	Extended Program for Immunisation
FAP	Flood Action Plan
FCD	Flood Control and Drainage
FCDI	Flood Control and Drainage/Irrigation
GIS	Geographical Information System
GM	Green Manure
ha	Hectare
HYV	High Yield Variety
IDS	Institutional Development Specialist
IPM	Integrated Pest Management

IRR	Internal Rate of Return
LCS	Labour Contracting Society
LGED	Local Government Engineering Department
LRP	Land Reclamation Project
LV	Local Variety
MES	Meghna Estuary Study
MHWL	Mean High Water Level
MOU	Memorandum of Understanding
MoWR	Ministry of Water Resources
mS/cm	Milli Simons/centimetre
MV	Modern Variety
N-RAS	Noakhali Rural Action Society
NGOs	Non Governmental Organisations
NPV	Net Present Value
NSC	National Steering Committee
O&M	Operation and Maintenance
PAP	Project Affected People
PC	Polder Committee
PDS	Productive Development Section
PMC	Project Management Committee
PP	Project Proforma
PWD	Public Works Datum
RWMA	Rapid Water Management Appraisal
SCF	Standard Conversion Factor
SMC	School Management Committee
SPC	Sub Polder Committee
SRDI	Soil Research Development Institute
SRP	Systems Rehabilitation Project
STW	Shallow Tube Well
SWMC	Surface Water Modelling Centre
SWR	Shadow Wage Rate
T-Aman	Transplanted Aman
Tk	Taka
UNO	Upazila Nirbahi Officer
TOR	Terms of Reference
UTFC	Upazila Task Force Committee
UP	Union Parishad
WMC	Water Management Committee

Glossary

boya	ancestral claim on land
char	newly accreted land
jotdar	big landowner
khas	government-owned (land)
khatian	land title
kobuliyat	deed of agreement between the government and the person applying for khas land
lathial	muscleman
nothi	settlement case
proja	tenant
salish	mediation
samaj	traditional village institution
tahshil	lowest level revenue unit
tahshildar	revenue official at the tahshil level
taka	Tk., local currency
union porishad	local government at the union level comprising several villages

Preface

Background

This book is about development of *chars* in the southeastern part of Bangladesh. The book is primarily based on the experiences of the Char Development and Settlement Project (CDSP), a Bangladeshi-Dutch development effort that started in 1994 in the south of Noakhali District. The *chars* are the newly accreted low lying lands along the coast of the Bay of Bengal formed by a process of sedimentation of the silt that is carried into the Bay by the Ganges-Brahmaputra-Meghna system.

In terms of sediment, this system is the river system with the highest discharge in the world. A small part of the sediment settles on low lying lands in the delta, resulting in the formation of new land. Although land in the delta is also lost due to erosion, surveys have indicated that there is on average a net land accretion of 1,600 hectare per year.

Being convinced that ultimately social and economic benefits can be accrued from this accretion of land, the Governments of Bangladesh and The Netherlands initiated the Land Reclamation Project (LRP) in 1978. In the period till 1991 the focus of this project shifted from land reclamation (surveys and accretion trials) to the consolidation of existing young land. In order to honour both kinds of activities and to overcome a number of management problems, LRP was split into two. After an interim period of LRP of three years, the Meghna Estuary Study project (MES) and the Char Development and Settlement Project (CDSP) started in 1994.

The brief of MES was to continue and expand the water based surveys and to draft a Master Plan and subsequently a Development Plan for the Meghna estuary. CDSP's overall and long term aim was formulated as seeking "to contribute to the economic and social development of the char areas in south eastern Bangladesh, in particular by settling landless people on newly accreted land and by extending support to the settled households". CDSP concentrated its activities on land settlement and land development in three *chars* of Noakhali District (see map on page xx for their location). One of the core areas of attention was the official settlement of households on government (*khas*) land. Other activities related to water management infrastructure (embankments, sluices, drainage *khals*), and to infrastructure as cyclone shelters, houses and roads. The project was active in productive development and provided social service facilities. More information on CDSP's interventions can be found in the next paragraph.

In the second phase of the project, which began in September 1997, another project objective gained in prominence. The project kept focusing on the actual development of three char areas, but at the same time used the experiences to develop a methodology for char development. This more abstract objective was formulated as follows: "to design and test a generally applicable approach for sustainable char development that is economically viable, socially acceptable and technically feasible, by implementing activities in three char areas". The present report is the result of the process of methodology development.

The contents are based on experiences in CDSP and are therefore limited to one particular phase of char development: the transfer from unprotected land to protected polders. The report does not refer to development of land that is unprotected and will stay so for some time to come. In many cases land is unprotected because it is as yet too low to be embanked, but there can be other reasons as well. In future however, CDSP will give attention to unprotected areas and will simultaneously work in areas that are or will be protected.

This book seeks to provide guidelines for development of chars in southeastern Bangladesh that are suitable to be protected. It can be considered as a sort of manual for future projects, not so much by prescribing a number of off the shelf recipes, but by discussing issues and by reporting on responses developed for particular problematic situations.

The book is based on the experiences in CDSP while working in the field. For most of the components these experiences were earlier summarised and reflected upon in Technical Reports, very often combined with an assessment of initial or expected benefits of interventions. An overview of the series of Technical Reports can be found in Annex 2 of Part I.

This publication is obviously not the final word on the development of chars. The methodology will be further refined and given more depth after a few years of CDSP II. The experiences with working in unprotected areas will add to the value and applicability of future publications on the subject.

CDSP's Activities

CDSP concentrated its interventions in three chars of Noakhali District: Char Baggar Dona II (2,083 ha.), Char Majid (1,291 ha.) and Char Bhatirtek (1,785 ha.), while extending very limited support to Char Baggar Dona I, which was developed in the LRP period. The current population (end of 1999) of the three chars is estimated at 41,000. The program had the following components:

1. Land Settlement — The settlement of 5,000 households on government (*khas*) land, as a realisation of the government policy to distribute *khas* land, including newly accreted land, among landless people. The households received the official ownership deed (*khatian*) for an average of 1.5 acres per family at the end of the settlement process.
2. Infrastructure — Activities included peripheral water management infrastructure (embankments, sluices, drainage *khals*), and internal infrastructure as cyclone shelters, houses and roads. In total 30 km. of embankments and two sluices were constructed, while a total length of 104 km. of drainage *khals* were (re)excavated. To improve transport 75 km. of rural roads inside the three chars were constructed and five bridges. In the social sector, 34 clustered villages were developed with 990 houses, 17 cyclone shelters were built, while 212 deep tubewells and around 4000 toilets were installed.
3. Productive Development — The project was active in productive development, in particular agriculture and less so in aquaculture. Much of the efforts with regards to field- and homestead crops was geared towards improvement of cultivation methods and introduction of modern varieties through group extension methods,

supported by field tests. As far as pond fisheries is concerned, attention was given to improved techniques and management practices.

4. Institutional and Community Development — CDSP helped to establish a number of field level institutions as for instance Polder- and Sub Polder Committees, Water Management Committees and tubewell user groups. Through local NGOs, a community development program was started in two of the three chars, in particular among the population of the clustered villages.

Structure of the Book

The book consists of four parts. Part I reflects in a comprehensive manner the lessons learned in CDSP in the five years of its existence. It can be called a methodology report, reflecting the best practice with regard to *char* development. It tries to develop guidelines and highlights issues that came to the forefront during CDSP. It covers all the sectors in the CDSP program of activities and concludes with an assessment of the financial and economic feasibility, comparing the costs and the benefits of a char development program.

The other three parts are devoted to particular clusters of activities. They can be seen as elaborations of certain sections of Part I. Part II is on the benefits of the land settlement program. It gives a picture, based on a sample survey, of the effects of the land settlement component of CDSP. It must be mentioned that at the time the process of land settlement in the three polders was not yet completed.

Part III dwells on water management and the related infrastructure. It describes the dynamic physical environment of the *chars* and pays attention to design, operation and maintenance of water management related structures. The Part opens with people's participation in water management.

Part IV, as the title gives away, is on the relation between water, soils and crops. The agro-ecological conditions are described and the constraints they impose for growing crops. Attention is given to land classes and landuse and to the various field- and homestead crops. Institutional matters are dealt with as well. Part IV is concluded with an assessment of the implications of the lessons of CDSP for crop production in protected coastal areas.

Overview Map: Satellite Image of the Noakhali Coastal Area

Part I

Guidelines for Development of Coastal Chars in Southeastern Bangladesh

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INTRODUCTION

Part I of this book is an account of the lessons that were learned during the implementation of the Char Development and Settlement Project. It is a comprehensive paper dealing with all the components of CDSP. The aim is to give information on the most adequate method of development of *chars* which is the reason that the word "guidelines" is central in the sub title.

In chapter 1 an overview is given of the potential for socio-economic development of char areas and of the required interventions to realise that potential. The access to land is the first subject, followed by the required protective and internal infrastructure that make further development possible. Subsequently the possibilities for productive development are discussed, with emphasis on field crops and aquaculture. Social services and community development conclude this chapter.

In a way, chapter 1 is devoted to the question *what* to do when improving the economic situation and livelihood of char settlers. Chapter 2 addresses the question *how* to do it. It is about the sequence and the management of the required interventions. It describes the actors involved and the division of responsibilities between them, as well as issues of co-ordination.

Chapter 3, the last one, is on the costs and benefits of interventions in char areas and is therefore about the *why* question. It gives attention to the comparison between economic benefits and costs and touches upon other more intangible benefits as social advancement and security.

Chapter 1

THE DEVELOPMENT POTENTIAL OF CHAR AREAS AND THE REQUIRED INTERVENTIONS

1.1 SOCIAL AND PHYSICAL FEATURES OF CHAR AREAS

Char areas can be characterised by a set of specific features that set them apart from other parts of Bangladesh and that justifies a different development approach.

In physical terms, coastal chars are newly accreted from the sea and are consequently low lying. This makes them vulnerable to floods and cyclones from the Bay of Bengal. Their soils have a relatively high salinity with relatively low contents of organic materials, which causes low fertility compared to older land. Chars find themselves in a dynamic physical environment, that changes over the seasons and over the years. Saline intrusion is a constant threat.

The population of chars consists for a large part of migrants, originating from other places that were eroded or that could no longer sustain their livelihood because of any other reason. The settlers are not a homogeneous group but form a cultural mix, with less social cohesion than in other areas. There is, for instance, no kinship network. Char population in general is poor and has a low degree of education. In many chars a strong patron/client relationship can be found. If the deprivation trap of rural poor in general can be described as an interlocking pattern of powerlessness, vulnerability, isolation, physical weakness and poverty, especially the first three elements are more pronounced in the case of settlers in char areas.

Institutionally speaking, chars are practically virgin territory. Service delivery mechanisms from government agencies are not or hardly present, while the private sector is usually limited to small shops. NGOs are often present, but in less density than in other areas of Bangladesh.

In an environment where vulnerability is the most pregnant feature, additional investments of the settlers can only be expected if they are provided with some sense of security. Much of the CDSP intervention was geared towards that purpose. Infrastructure brought protection against floods and cyclones, land settlement enhanced security by providing access to land through legal ownership while productive development increases the possibility to hold on to this newly obtained asset. Project activities aimed at reducing insecurity and at the same time attempted to realise the development potential that the chars offer.

This chapter gives information on that potential, on the interventions that were undertaken in the framework of CDSP and on the lessons that can be drawn from the experiences accumulated over five years. It starts with the issue of distribution of *khas* land (paragraph 2.2) and moves subsequently to the provision of infrastructure (2.3) Productive development (2.4), in particular with regard to agriculture and fisheries, and improvement of the availability of social services (2.5) form the second half of the chapter.

1.2 LAND SETTLEMENT

1.2.1 Point of Departure: Illegal Settlers and *Jotdars*

Any land newly accreted from the river bed is vested in the hands of the government and is called *khas* land. According to law, this land is in principle available for distribution among landless households. The distribution is a drawn out process, culminating in the handing over of the official title deed (*khatian*). Unofficial autonomous settlement on *khas* land is however a common practice in the coastal region. These autonomous settlers are mostly from other coastal *chars* and offshore islands who lost their land due to erosion or due to natural process of pauperisation. Possession on *khas* land is secured through a number of factors. Factional lineage is instrumental. It is characterised by political affiliation, kinship bondage and previous neighbourhood relationships. A power broker, in many cases with ancestral links with newly accreted char land tends to extend support and patronage to intending settlers coming from the same area. These settlers mix in the chars with settlers from other areas which often results in a melting pot of people originating from several places. In the CDSP areas, one can find for example settlers from Ramgati, Hatia, Bhola and Sandwip.

The autonomous settlement leads to a situation in which the official process of land settlement cannot start with a clean slate. Settlers are already present in the new chars, many with actual control over more than the maximum number of acres which are the official ceiling stipulated in the law. The law setting the ceiling has changed from time to time. At the time of the start of CDSP it was two acres.

Powerful people, commonly known as *jotdar*, and settlers controlled by them occupy more land while late comers end up with tiny plots of homestead only. Informal transfer of money to power brokers to sustain possession and to get their influence to obtain the official title is common.

Findings of a survey carried out by CDSP are presented in paragraph 2.2.5, reflecting the land occupancy status prior to the official settlement process in the chars. It is very difficult to ascertain, how many actually have full control over their possessions, as many settlers are mere *bagadar* (sharecropper) of the real possessor who lives in far away places including the district headquarters and receives half of the produce without any investment.

1.2.2 The Procedures for Land Settlement

Land settlement is a very cumbersome and lengthy process entailing several stages. The process applied in CDSP basically followed the rules as laid down in the law of 1987. In order to make the process more efficient, certain adjustments were made in CDSP.

The whole process under CDSP can essentially be divided into two broad stages: (a) surveys and allied activities and (b) the actual settlement procedures with at the core the preparation of the *khatian*. CDSP's contribution was to structure the whole process of surveys more clearly and to simplify a number of steps in the settlement procedures.

The survey part of the settlement process starts with a *diara* survey to the newly accreted land carried out by the Directorate General of Land Records of the Ministry of Land. The result of the *diara* survey is a map of the area and a report on the status of the land. Because for most of the land the situation has drastically changed since the *diara* survey due to autonomous settlements, CDSP has introduced the plot to plot survey. This is a census survey investigating the status of each plot of land. It provided information on whether the land is *khas* land or private land, who controls the land and what the legal basis, if any, of this control is. The results of the plot to plot survey are scrutinised by the Upazila Agricultural Land Development and Management Committee and subsequently accepted by the Ministry of Land. The next step is the drafting of a list of landless households (candidates for land settlement) and the acceptance of the list by the Upazila Committee and a similar committee at District level. The households concerned receive a certificate that the family is landless, issued by the Assistant Commissioner (Land), a Upazila level officer. The last step of the survey part is the matching of supply and demand: the available *khas* land is matched with the lists of landless households. The result is the allotment sheet which reflects the allocation of land, quantity and location, for each household.

The settlement procedures start with the issuance by the AC (L) of the *kabuliyat* to the households that are included in the allotment sheet. It is a confirmation that the household concerned will receive a certain quantity of land in a certain location. From the government side this *kabuliyat* used to be signed by the Deputy Commissioner, the Additional deputy Commissioner (Revenue), the Upazila Nirbahi Officer and the AC(L). Under the new rules of 1997, only AC(L) has to sign. Also the settlers themselves (husband and wife) sign the document. The AC(L) sends the *kabuliyat* to the tehsildar (official that covers a Union or part of a Union) who collects *salami* (one Taka). The next step before the 1997 rules was registration at the office of the SUB Registrar (of the Ministry of Law). Then the AC(L) begins with preparing the *khatian*, the official title deed. This official signs the *khatian*. The whole procedure is completed with the handing over of the *khatians* to the settlers concerned.

In case of the CDSP *chars*, earlier data indicating status of land ownership, furnished by the Ministry of Land (office of the Deputy Commissioner, Noakhali), revealed that about two-thirds of the areas was *khas*. This provided the basis for the survey in order to prepare a list for eligible candidates for land distribution.

CDSP carried out a plot to plot land survey from May 1995 to June 1996 (in two spells during the dry period). The main objective of the survey was to determine the status of the land and its possessor. Fifteen teams, each with one surveyor and two *chainman*, were engaged to do the work. Each team could survey about five to ten acres of land in a day. A questionnaire was used to obtain information on the name of the possessor (including the name of the spouse), amount of land possessed and its location, number of household members, type of possession (whether a lease was taken or have ownership title was obtained), data on previous settlement (if a settlement case is ongoing), period

of stay in the locality, type of land use (agriculture, homestead, pond, bazaar, school, mosque, road, canal, embankment), any dispute (whether there is any court case). The survey was done as per the settlement map of the *Diara* Settlement, Directorate of Land Records and Surveys (DLRS).

Survey data, after consolidation, provided the basis for selection of candidates for *khas* land and the preparation of allotment sheet in favour of the candidate.

As mentioned above, settlement rules underwent a change in 1997 (see annex 1). Although settlement under CDSP is being done under the previous rule with some adjustments, the settlement process has seemingly been further simplified in the new rules. The registration of land has been skipped. It may be mentioned that the staff of another Ministry (Ministry of Law) is involved in land registration. The rules of 1997 also include the provision of handing over of the possession of land to the landless. The rules of 1997 coupled with "survey and allied works" as practiced in CDSP seem workable.

1.2.3 Clustered Village

An implicit objective of the land settlement program is socio-economic rehabilitation of the destitute families. Clustered villages (CV) on large blocks of *khas* land were built to this end, each village accommodating 30 households on the average. CDSP built 34 CVs in three polders where 990 households have got shelter. Each household received 0.16 acre of homestead land including a share of a common pond, plus a tin-shed house, provided by the Ministry of Land, and a water-sealed latrine free of cost. In general the clustered village settlers have no or very little, less than one acre, agricultural land.

Initially, many settlers in the polders were not willing to live in a clustered village as they already had a developed homestead with a pond, courtyard and matured trees. Only the poorest of the poor opted for a house in the CVs. Once the construction of these CVs was complete, relatively better off persons also became interested to have a house in the CV and started arranging their old homestead in the name of another member of the family (brother, son, etc.). UP Chairmen and members have also become active in selecting their "own people" in the CVs. As a result, several changes were made in the original list of CV candidates approved by the Upazila Task Force Committee.

Most of the CV settlers are recent immigrants to the polders or are too weak to occupy any land for agriculture. While they were accommodated in the CVs, many of them did not receive any cultivable land. In case they now have agricultural land, it will usually be less than one acre. The main reason for this unfortunate situation is that the CV settlers did not possess any cultivable land before while not enough "surplus land" could be recovered from other people's possession for distribution amongst them. Settlement with a small plot of homestead without any cultivable holding is not enough for economic rehabilitation and whether these people will stay in the CVs in the future is therefore an open question.

The experiences in CDSP with clustered villages should in time be carefully evaluated and compared with assessments of similar settlements elsewhere in Bangladesh in order to come to well founded conclusions for future char programs.

1.2.4 The Constraints as Experienced in CDSP

Timing of Project Activities

Although CDSP commenced in September 1994, the component on land settlement began in July 1995. The first year (up to June 1996) was used for carrying out a plot-to-plot land survey. The actual settlement operation started afterwards. The Upazila Task Force Committee (see the procedures in annex 1 for the role of this Committee) met for the first time in August 1996 and scrutinised 1,378 applicants. CDSP was supposed to end in August 1997. The target of settling 4,000 families in the stipulated period was too ambitious. The project period was extended to July 1999, but the target was increased to 5,000 households. It has become absolutely clear that land settlement should be among the first activities in any future char development effort.

Plot-to Plot Survey

The objective of the survey was not clear to all people, nor was it explained properly. Some leakage has also been reported during the survey. These had the following consequences:

a. Land has been surveyed in the name of the absentee *boyadar* (person with ancestral claim) or of the absentee *jotdar* who controls land by engaging a *baga dar*. The *bagadar* possessing the land listed it in the name of his absentee "patron", as he was not aware of the government rule that the possessor will get a preferential treatment in getting *khas* land.

b. Few members of the survey teams manipulated land occupancy data by showing a certain plot of land possessed by one in the name of another. Accordingly allotment sheets were prepared. In several cases, the problem was detected after the hand over of the *khatian*. Subsequently, extra field sessions on land claim verification had to be organised and faulty *khatians* had to be revised.

c. People had rough ideas about how much land they were possessing. After the survey, the actual amount of land was recorded using measuring equipment. But this information was not shared with the respondents. At a later stage, the claim of some persons was in conflict with what was shown in the allotment sheet and ultimately in the *khatian*. This created a lot of confusion and misunderstanding.

Task Force Approval

a. Sometimes the Upazila Task Force Committee (UTFC) could not meet because the Upazila *Nirbahi* Officer (Upazila Executive Officer) was not available. In many cases the UNO should have but could not attend field hearings. This situation has led, for instance, to the fact that the list of candidates for settlement on *khas* land is being prepared since August 1996, whereas the UTFC has not yet been able to finalise the selection of all candidates till May 1999.

b. The UTFC is headed by the UNO; the Chairmen of the Union Parishads are members. The process of approval has been delayed either because the UP Chairman did not agree with the list of candidates or the list had been lying on the desk of the UNO for a long period. According to the rule, the UNO has to

dispose it within 15 days. This deadline has not been complied with on many occasions.

Kabuliyat Signing by the Landless

a. Both husband and wife need to be present to sign the *kabuliyat* (in case the candidate is a married person). During the slack, dry, season, male members of *char* households migrate to other districts for a job. It has been shown in a study that almost half of the male workforce migrates at least for a month during the lean season. Although field sessions during the dry season seem more convenient in terms of physical accessibility, people are generally available during the *aman* season (July-December). Similar problems are faced at the time of *kabuliyat* registration.
b. Sometimes people do not show up as they are influenced by the propaganda of *jotdars* that they will not get land through CDSP. Sometimes delay in the settlement process (selection of candidates by the UTFC) reinforces this belief in the mind of the people who are often vulnerable to such propaganda.

Preparation of Khatian

a. Too much deskwork is involved in the whole process and the administrative apparatus in the office of the Assistant Commissioner (Land) (AC(L)) is not sufficiently equipped with the required number of staff. The staff of these offices are not used to handle so many settlement cases within such a short period of time.
b. The AC(L) has a key role in the settlement process. The amount of work involved necessitates a full-time AC(L) for a CDSP-like settlement operation. This was not arranged. The AC(L), as many other Upazila and District level officers, was involved in a wide range of activities and hence could not do justice to CDSP work.

Land Allocation

One implicit objective of the land settlement program was to foster development based on equity. This could be achieved in an ideal scenario where each family is provided with the same amount of acres of land. There was however autonomous settlement prior to the inception of the project. Eviction of all settlers in order to make a start with a clean slate possible was practically not feasible and would have caused considerable social conflict. Given the limited amount of land available, the ideal of an equal share for everyone was illusive. Under the circumstances, CDSP opted for an approach to legitimise possessions within the framework of government rules, including the two acre ceiling. The project was confronted with two broad scenarios:

- Some were occupying more than two acres who had to surrender the "surplus land".
- Some were occupying less than two acres and were allocated more if "surplus land" could be recovered from those occupying more land.
    a. Those who were occupying more than two acres were not willing to surrender the "surplus land". Often a compromise formula was adopted where the extra

land was allocated to a nominee of the original land-grabber, either a son belonging to the same household, or a second (or third, and so on) wife, or a henchman. In practice in many cases the transfer of "surplus land" to the rightful beneficiaries did not yet materialise.

b. In case the "surplus land" was allocated to a *bona fide* landless candidate, the latter did not know where the land was located.

c. The land-grabbers are influential people in the *char* context. They also occupy important positions in the local government council (*Union Parishad*) and have in many cases been included in the Polder Committees (PC), Sub-Polder Committees (SPC) and Water Management Committees (WMC). Members of these committees have been rendering important contributions to project activities like planning of physical infrastructure, operation and maintenance of water management infrastructure and conflict resolution at the field level. Some of them however manipulated the process of land settlement in their self-interest. It has not been possible to bypass the local power structure on many occasions. Concerted efforts from the community would have been useful to offset the influence of the power brokers. In many areas, NGOs have been found to work as pressure group. NGOs having partnership with CDSP are too weak to do that.

Perception

a. For a long period, officials of the Ministry of Land considered CDSP as a project for housing in clustered villages and the settlement work did not receive due importance. After the expiry of the Project Proforma of the Ministry of Land at the end of June 1998, land settlement activities in the field came to a halt as there was no decision from the Ministry in this regard. The work resumed after three months following the preparation of a revised PP.

b. The Ministry of Land is the implementing authority of the land settlement program through the offices of the Deputy Commissioner and the Asst. Commissioner (Land) at the field level. Consultant staff were supposed to play an advisory role in this regard. In reality, a lot of implementation and co-ordination works have been performed by the consultant staff, which should have been done by the staff of the implementing agency. The preparation of allotment sheet is entirely done by the consultant, while the consultant staff does the bulk of the work related to the selection of candidates, land claim verification and signing of the *kabuliyat* by the candidates.

c. In the perception of the people, CDSP consultant staff has the image of the executor of the program. This created a lot of confusion. Consultant staff has been performing a host of works and was present in almost every stage of the settlement operation, except the most important one, the signing of the document. It would have been better if the Ministry of Land officials had more interaction with the people on day to day issues pertaining to settlement which would probably help them to gain a better insight in the field situation and make them more responsive to the people.

1.2.5 The Change in the Position of Landless Households

Despite the constraints highlighted above, it seems no exaggeration that the settlement program has been able to bring a qualitative change in the lives of the people in many ways. A comprehensive account of these benefits may be possible to record once the settlers are fully rehabilitated on the land, both in terms of ownership and other opportunities. However, some of the impacts are worth mentioning already.

Security and Equity

The official title to land gives a sense of security to the settler. As land is the most critical resource in the *char* area, access to land is considered as a basic tool of empowerment.

The settlement program of CDSP was intended to give legal title to the landless. This had the following consequences:

a. Some households got legal title to land which they had already been possessing;
b. Some households got more land (not exceeding two acres) than what they had been possessing;
c. Some households who did not possess any land before received some land;
d. Some households had to surrender some land occupied by them earlier and retained up to two acres only.

Analysis of available data (up to mid-June 1999) shows that the land distribution pattern has become relatively more equitable than the pre-settlement occupancy pattern. The *Gini Coefficient*, an indicator between 0 and 1 measuring the degree of inequality of distribution, was 0.25 after the settlement. This is significantly lower than that of the pre-settlement occupancy (0.42).

It may be mentioned that two-fifths of the settled households received one acre or less and together they got one-fifth of the total land allocated. On the other hand, land could not be recovered from some households occupying large tracts of land (more than 2 acres) and somehow these households had been able to retain the "surplus" land by getting it in the name of other family members or henchmen. Hence the program has not been able to deliver optimum result in terms of equity, but nevertheless succeeded in bringing about a more equal distribution pattern.

The first table below gives the pattern of land distribution at the start of the project. This pattern was the result of autonomous settlement and is skewed in favour of *jotdars*. A small proportion of households controls a larger proportion of land: 20% of the households were found to occupy more than two acres each and together they occupied 46% of *khas* land in the three polders. The second table reflects the post-settlement distribution.

Economic Status

Farming has become a major source of income and employment for many households who had earlier been living mainly on wage labour. A legal title invariably influences decisions on medium and long-term investments on land. This is manifested in the increasing trend in pond excavation, the construction of better houses by the settlers and more intensive use of homestead land for growing vegetables as the settlement process moves on. An indicative measure of economic enhancement would, however, necessitate more time.

TABLE 1.1
Land Occupancy by Households at the Start of CDSP

Holding size (acre)	Household	Area (acre)	Percentage		Cumulative percentage	
			Household	Area	Household	Area
0	67	0	1	0	1	0
Up to 0.5	1248	316	23	4	25	4
>0.5-1.0	1049	791	20	11	44	15
>1.0-2.0	1904	2827	36	39	80	54
>2.0-3.0	763	1807	14	25	94	79
>3.0-4.0	141	482	3	7	97	85
>4.0-5.0	84	380	2	5	99	91
>5.0	77	678	1	9	100	100
Total	**5333**	**7281**	**100**	**100**	–	

Source: Plot-to-plot Land Survey, CDSP, 1995-96.

TABLE 1.2
Post-settlement Pattern of Land Distribution

Holding size (acre)	Household	Area (acre)	Percentage		Cumulative percentage	
			Household	Area	Household	Area
Up to 0.5	411	146	14	4	14	4
>0.5-1.0	742	573	25	16	39	20
>1.0-1.5	761	980	26	27	65	46
>1.5-2.0	1040	1968	35	54	100	100
Total	**2954**	**3667**	**100**	**100**	–	–

Social Impact

A legal title to land enhances the social status and negotiating power too. As the title is given in the name of both husband and wife, it helps in creating a condition for strengthening the position of women within the family. Widowed or divorced women are entitled to receive a land title exclusively in their name. Unilateral divorce or abandonment of a woman by her husband is quite common in the villages. In case a woman is divorced or is subject to repression by the husband, the settlement will be cancelled as per the condition of the *kabuliyat*.

Retention of Land

Legal ownership should go together with effective control over land on a long-term basis in order to increase the security of the settlers. Retention of land has been a problem in the context of the socio-economic milieu. Even if some people own land, they are often compelled to rent it out under different tenancy arrangements (sharecropping, lease or mortgage) as they have no means to cultivate it. This trend is likely to diminish after the completion of the settlement process and once they are exposed to other opportunities like access to credit. It has been found in Char Baggar Dona-I that over 93% of the settler households have been continuing as "owner-operators" since they received their land title in the late eighties.

1.2.6 Land Settlement in Future Char Programs

The land settlement activities in future char programs should make full use of the lessons learned in CDSP. This chapter describes the CDSP experience, both the positive points and the drawbacks. In this concluding paragraph the major lessons are summarised.

As the settlement process is cumbersome and time-consuming it should start earlier than was the case in CDSP and should be the first in the sequence of interventions. Another reason for an early start is the importance of the outcome of a number of the stages of the land settlement process for other activities in the overall char program, as shown in chapter 3 (paragraph 3.2).

A combination should be sought between the 1997 rules and the parts of the CDSP procedures that aimed at shortening the whole process. The distinction between survey and allied works on the one hand and preparation of *khatian* on the other hand, has been useful and should be maintained. The plot-to-plot survey has been instrumental in the identification and selection of landless candidates for settlement.

Not the handing over of the *khatian* should be considered as the last stage of the process, but the actual possession of the land. Settlers with "surplus land" have to transfer in practice the control over the land to the new owners. The retention of the possession should be monitored. The capability of retaining the land is increased if all settlers receive a title on cultivable land. In CDSP this was in many instances not possible with regard to the settlers in clustered villages.

Much attention should be given to the transparency of the whole process. The "rules of the game" should be explained to the prospective settlers. They should be continuously informed about the results of the consecutive stages of the process. The Polder Committees should be involved in dissemination of information, while findings might be publicly displayed. The Polder Committees could also play a role in the process of feed back from settlers to the authorities.

The bureaucracy dealing with land settlement affairs should be properly equipped to do so. Adequate staffing and full time availability of all concerned government officials related to the settlement operation for the entire program period is absolutely needed. Arrangements and safeguards to that effect should be taken up in the Project Proforma of the char development program concerned. Computerisation of parts of the process is likely to improve efficiency and accuracy. Frequent transfer of key land settlement officials like Asst. Commissioner (Land) and UNO hampers continuity, delays the process and should consequently be avoided.

Government staff should implement all stages of the settlement program. The consultant staff should restrict its role as much as possible to advice and quality control. The Ministry of Land in Dhaka should closely monitor the whole program. It may be considered to involve a third party for monitoring, such as an independent institute or an NGO.

The distorting role of *jotdars* has been mentioned above at several places. In practice it will probably not be possible to entirely circumvent this group. But efforts should be made to mobilise the landless against them. In future programs NGOs should be stimulated to play an active role in this respect.

1.3 INFRASTRUCTURE

1.3.1 The Physical Environment

The Dynamic Environment of Chars: Accretion and its Effects

Chars are coastal flats stretching out in front of large sections of the Bangladesh coast. There is a great variety in chars. The youngest chars are mud flats supporting little vegetation, dissected by tidal creeks, subject to frequent flooding during high tides. The oldest chars are already consolidated lands, supporting annual cropping and more or less permanent homesteads, despite the fact that the lands are unprotected and vulnerable to cyclones and so called tidal bores: minor, but more frequent cyclones doing extensive damage to crops. The great diversity among the three CDSP areas already illustrates the great variety in coastal chars.

The Baggar Donas are older chars, consolidated and located rather far inland. Their main outlet for drainage is a tidal river which, however, suffers from siltation, char forming, at the mouth. The consequence is that the tide has weakened and does not provide as much drainage opportunities as one would wish. In addition the river carries runoff from the inland and the high discharges during the monsoon suppress the tidal effect. Around the Baggar Donas the surface water is sweet during extended parts of the year, as long as the discharge from the inland is substantial. Once the discharges decrease the surroundings turn saline. Despite the fact that the Baggar Donas are older chars, they are not particularly high topographically. Parts have remained relatively low for a number of reasons, which are not known in detail.

Char Bhatirtek is rather different. It is a consolidated char, but topographically higher than the Baggar Donas. It is located along the wide mouth of a tidal river and there is a strong tide along its outer embankments. This provides a good opportunity for drainage. When CDSP started in 1994 and as long as the area was unprotected, fishing was an important activity. The daily flow in its tidal creeks provided great opportunity for fishing. The area was dotted with large fish nets, which have decreased in numbers since the protection was completed.

Char Majid, the third CDSP area, resembles Bhatirtek in part and partly it is like the Baggar Donas. It is draining into a creek system of rapidly accreting mud flats. The outfall channel of Char Majid, rather long due to progressing siltation, silts up as well. This renders frequent cleaning a necessity. Frequent cleaning is a maintenance cost. If resources do not come off regularly, the drainage of Char Majid will become problematic.

The foregoing shows that every char to be protected is different: their environment is dynamic, changing all the time; areas with strong tide may have lost it after years, low areas become high, other areas, if not sufficiently protected, may disappear.

The dynamics of the chars can be approached in two ways: (i) the sea-facing front: the accretion and erosion process and (ii) the hinter land: the drainage problems as caused by continuous accretion of the foreland.

The accretion and erosion process in the Bay of Bengal is difficult to predict. Only at medium term (10-20 years), conclusions can be drawn on which areas will likely accrete and which will erode. For physical char development two aspects are important: the minimum land level for empolderment and the accretion rate in front of planned polders in view of drainage opportunities. The rate of accretion depends on the initial (sea bottom

or land) levels, silt content of the sea water and tidal movements. The initial increase in land level can be very high (up to several meters per year) and then slows down. At last the land levels will only further increase during flooding at spring tides.

In general, the MHWL + 1m PWD is taken as the minimal land level suitable for empoldering. This level is reached in most cases only after minimally 20 years and often the land is already occupied by that time. Occupation of land leading to construction of rice fields surrounded with bundhs, hampers the full accretion of land.

Land accretion has direct consequences for the hinter land. The coast line, moving south, lengthens drainage paths. The siltation blocks river mouths, which can not be cleaned everywhere and all the time. Furthermore the older lands are still subject to subsidence lowering the head in relation to the drainage base. The problem of drainage congestion as a result of accretion and siltation is widespread. Examples are the areas draining on the Noakhali Khal and the south western part of the Muhuri Irrigation Scheme. As explained before, also the CDSP polders Char Baggar Dona and Char Majid are prone to drainage problems.

Empolderment of newly accreted areas downstream of the old lands often improves the drainage situation in the old lands, because the hitherto outfall channels prone to siltation become drainage canals in the newly constructed polder.

From the foregoing the following major lessons can be learnt:

- The dynamic and often unpredictable environment requires a flexible planning with a maximum time horizon of 20 years.
- Char (polder) development can not be done in isolation. During the planning the direct surrounding environment has to be taken into account: future accretion of the surrounding areas determines the drainage design and O&M requirements, while the effects on the upland drainage situation have to be considered.
- The dynamics of the surrounding environment are quite complex. In view of the scope and design of CDSP kind of projects, support from appropriate institutes like MES and the Surface Water Modelling Centre (SWMC) is required in the planning stage to get a better understanding of the dynamism surrounding the polders.

So far CDSP and its predecessor LRP have worked in relatively small confined areas. The main purpose of the land-based component of LRP and CDSP is to determine a methodology for char development, assuming that the main physical components of the surrounding environment would be addressed by other projects: accretion/erosion by MES and upland drainage aspects by FAP4 and FAP5.

Now char development is continuing in CDSP II at a larger scale and with a more regional function, the need is felt that char development should be embedded in a wider plan. The planned Integrated Coastal Zone Management Project could provide such a wider framework for char development, addressing the earlier mentioned issues in a proper context.

The Tide

The tide is important for the CDSP polders, because it is one of the factors that determines the drainage opportunities for the polders. Tidal movements vary largely along the coast of the Bay of Bengal because of the complex network of tidal channels between

islands and mudflats. Sea levels are higher in the monsoon than in the dry season, mainly because of the change of wind direction over the Bay of Bengal.

Maximum water levels in the Noakhali Khal vary from 2.50 m PWD in the dry season up to 5.00 m PWD in the monsoon. Spring tides vary from 6.5 m (monsoon) to 5 m (dry season) and neap tides from 1.5 to 4.0 m.

The actual tidal movements at the sluice locations depend on the distance to the sea, the discharge capacity of the sluice outfall channel and khals they drain on and on the flow from the hinterland. In this respect there is a great difference between the Baggar Donas on the one hand and Bhatirtek and Majid on the other. Bhatirtek and Majid have sufficient tide for drainage, almost equal to the tide in open water. The Baggar Donas have a far weaker tide, of around 0.2 m. This is caused by their location inland and by the fact that the tidal river they drain on, has started silting up. In this respect the Baggar Donas have become part of the old land. During the monsoon, surface water levels inside the polder are equal to those outside.

Rainfall and Evaporation

The south east coast has a pronounced wet and dry season, with a monsoon period from April to October and a dry season from November to March. Average annual rainfall amounts to 3400 mm of which 95% is concentrated in the monsoon. Details of rainfall characteristics are provided in the agricultural part of this report. For the physical environment it is important to note that during the monsoon rainfall exceeds evapotranspiration by far, even during dry monsoons. A low rainfall intensity is about 15 mm/day for periods of 10 days and more. A high rainfall intensity, suitable for drainage design, is about 30 mm/day, which results in a drainage requirement of about 3 l/sec/ha.

In the dry season evaporation surpasses the rainfall, resulting in an upward movement of the soil-moisture with effects on resalinisation of the top soil as will be discussed in the next section.

Soils and Groundwater

The soils vary from fine sands to silty loam/silty clay loam to loam. The soils have in common that they have a high moisture retention capacity, strong capillary characteristics (up to 3 m) and a low permeability.

Groundwater levels are around field level during the monsoon. With the end of the rains the groundwater level drops rapidly up to 3-5 m below field level to again increase in a short period with the first rains in April/May.

Monitoring of groundwater levels in LRP and CDSP shows that in all areas a so called deep drainage flow exists from the char areas towards the sea. Estimates of the magnitude of this deep drainage flow vary from 500 to 1000 mm/season.

Soil Salinity

Emerging *chars* get less frequently flooded by sea water as the accretion process progresses. As soon as the young lands are only flooded during spring tides, the monsoon rains are able to wash the salts out of the upper soil layer. At that time rice cultivation during the monsoon becomes possible. Resalinisation of the top-soils after

the monsoon occurs rapidly through capillary rise from the saline ground water and through saline sea water intrusion. When the accretion process continues and the land levels become higher, the period of sweet environment in the top soil becomes longer and *aus* (pre-monsoon) and sometimes rabi (winter) crops can be grown at the higher parts. Saline water intrusions, mainly occurring in the pre- and post monsoon periods, however replenish the salts in the soil profile.

Empolderment of the chars prevents the saline water intrusions and thus accelerates the desalinisation process as compared to the situation in unprotected chars. Experience in the LRP and CDSP polders has learnt that desalinisation of the upper parts of the soil (up to 60 cm) takes around 10 years (see also par. 2.4.2). However after five years the process is advanced to such a stage that agriculture is possible during all three agricultural seasons albeit for a limited number of (salt tolerant) crops in the Aus and Rabi season, while after 10 years most crops can be grown. Desalinisation of the deeper layers (more than 1 m) may take a period of 20 years.

Desalinisation is possible because of the excess of rainwater over evaporation during the monsoon period. Excess rainwater is discharged through:

1. Surface water flow from the fields towards the drains;
2. Shallow drainage flow: sub-surface flow from the fields towards the drains,
3. Deep drainage flow: sub-surface flow towards deep khals outside the chars and the sea.

The majority of the excess rainwater is discharged through the surface water flow. This flow however has limited effect on desalinisation as it is only flushing the upper soil layer. Also the effect of the shallow drainage flow is limited. The magnitude of the flow is relatively small due to the low permeability of the soils and the relatively extensive drainage network density. In trying to accelerate the desalinisation process, LRP experimented with a more intensive drainage network to increase the shallow drainage flow. The conclusion was that the desalinisation process could be hardly influenced with intensified drainage.

The deep drainage flow is probably the main agent in the desalinisation process.

During every monsoon the rains wash the salts to a greater depth. Because of the soil characteristics this process is rather slow and resalinisation occurs during the dry season. The soils of the chars contain predominantly fine pores, which retain water strongly by capillary forces, even when the ground water drops low. Originally, the water in the pores is saline. The rains tend to wash the salts out of the soil, but only to a limited depth. Below that depth the water in the pores remains salt, while a decline in the groundwater tables only empties a small portion of the pores. After the monsoon, capillary rise brings the salt back to the upper layers, where it affects the crops. However without the replenishment of the salts after empolderment, the annual salt balance becomes negative and every year the salt has to come from greater depth. In the end, the amount of salts moving up will become negligible. The time required to reach that situation is estimated at about 20 years, but substantial data to confirm that figure are lacking.

A major limitation of soil and water conditions in the CDSP polders is, that *boro* cropping with irrigation water pumped from the subsoil, is not possible. The deeper groundwater, even that within the reach of a shallow tube well, will remain saline for some time. How

long it takes for the groundwater to become sufficiently sweet to support irrigation of a boro crop is unknown. That may take longer than 20 years.

From the foregoing it may be concluded that the salinisation and resalinisation processes are understood in qualitative terms. It is important that the process is better understood in quantitative terms, because:

1. A better insight in the factors of desalinisation (soil characteristics, rainfall, drainage flows) will increase the replicability of the methodology to other areas with different characteristics.
2. One of the most profitable crops in Bangladesh is boro rice. It is therefore important to know whether or not and when in the desalinisation process, boro could be a feasible crop in the chars.

Surface Water Levels and Salinity

Surface water levels and the salinity of the surface water are greatly affected by empolderment and this, above all, during the major part of the dry season. After the monsoon, the land users drain their excess water out of the polders up to a certain level. Once that level has been reached, the sluices are closed. The water levels inside the polders then are determined by the evaporation and the deep drainage flow, with a possible component of seepage of outside water through the embankments into the polders, if outside levels remain high for a prolonged period of time. After the monsoon the surface water inside the polder is sweet. Salinity measurements of the polder surface water show that water remains sweet all through the dry season when the sluices remain closed. The water quality is such that it is suitable for irrigation, not for human or animal consumption. The amount of water contained in the drainage system, however, is too limited to be used for irrigation on a large scale. Land users having land along a drain, use the water for irrigating their rabi crop.

Water levels outside the polders are determined by the sea level and remaining runoff during the dry season. That level may be rather different from the water levels inside the polders. Outside water in the khals surrounding the polders is sweet during the monsoon but turns saline from September onwards depending on the distance to the sea and the runoff from the upland areas. With the start of the rains in April/May the outside water becomes again sweet. So empolderment affects environmental conditions of the surface water inside the polders substantially.

Monitoring of Physical Parameters

CDSP was less research-oriented than its predecessor LRP. Monitoring of water and soil parameters in the three char areas was limited to:

- Water levels and salinity at sluice sites, inside and outside the polders together with sluice operation
- Ground water levels
- Rainfall
- Soil salinity

Monitoring of surface water levels and salinity gives insight in the rationale of sluice management, contributes to improvement of extension messages, provides insight in the tidal movements including the drainage capacity. This type of monitoring has to continue in future char development projects. The measurement of groundwater levels in the 3 chars confirmed the phenomenon of deep drainage in the three different char areas and should also continue in new areas.

Rainfall has been measured in all three CDSP areas and should be measured in the future in new areas. Rainfall records are determinant in understanding soil, water, crop, and salinity relations. Rainfall figures of a CDSP rainfall station are, by definition, measured over a relatively short period. That means that no long term interpretations can be made. The recorded rainfall figures therefore need to be linked to a back-up station with a sufficiently long record. For the present project area the Noakhali station is used. When CDSP will move to the Muhuri and Hatia areas, it will be necessary to find a backup station in those regions.

In order to get a better insight in the salinisation and desalinisation processes in quantitative terms, the monitoring program should be extended in the future with measuring the determinants in the process. Possibilities are setting up a water/salt balance study in selected areas and collection of geo-hydrological data.

1.3.2 Peripheral and Water Management Infrastructure

Infrastructure in polder development can be divided into:

- Main (peripheral) infrastructure: embankments, sluices and main drainage system,
- Internal infrastructure: roads and bridges/culverts, cyclone shelters, fishponds (in cluster villages), water supply and sanitation infrastructure and houses.

Due to the difference in character between the peripheral and internal infrastructure in terms of planning and involved institutions, the different types will be discussed separately.

The BWDB is responsible for planning and implementation of the main infrastructure. Planning is mainly determined by physical factors like land levels and main creek system; involvement of the char population is planning is very limited.

Planning and implementation of the internal infrastructure is the mandate of the LGED. Involvement of the char population in the planning has been quite extensive. Polder Committees (PC) and Sub Polder Committees (SPC) were largely involved in decisions on location of roads, cyclone shelters, tube wells, etc. Also in monitoring of the implementation the PCs and SPCs played an important role.

Construction of houses in the cluster villages was the responsibility of the Ministry of Land.

The role of the consultant in infrastructure was an advisory and monitoring one. The consultants were involved in the establishment of the participatory planning system (PCs and SPCs), in approval of designs, and in monitoring of the quality control.

The main peripheral infrastructure consists of sea-facing embankments, interior embankments, the main drainage system and sluices. The design of the three polders is based on the feasibility studies, conducted during the LRP period. Detailed design of the infrastructure is done by the BWDB, according to the BWDB design standards and

procedures. In fact, CDSP followed the standard BWDB procedures for planning and design of FCD projects.

Main lessons learnt in planning and implementation of the main infrastructure are —

Feasibility Studies

The feasibility studies on which the three polders are based can be considered to be of pre-feasibility level. Consequently issues that normally are addressed during the feasibility stage, needed to be solved during the (pre-)implementation phase. This especially refers to location and capacity of sluices, capacity of the drainage system, the surrounding environment of the polders in terms of accretion and erosion processes and the drainage of the hinterland. In realising this shortcoming, CDSP paid more attention to the quality and detailing of the feasibility studies for future char development projects: i.e. Muhuri Accreted Area.

Detailed Designing

Detailed designing is the responsibility of the Design Department of the BWDB, whereas the consultants advise on the designs and approve.

The relationship with the Design Department appeared to be problematic: there were considerable delays in completing the designs. This is especially true for the Majid sluice, which was delayed for more than 18 months. With respect to drainage design, drawings became available after the works had been completed. Details on which the designs were based were not made available such as the sizes of the areas draining through drain sections and sluices. In addition, considerations about the amplitude of the tide at the sluice locations were lacking.

As the relationship with the BWDB Design Department is an ever returning issue in FCDI projects, it may be considered in future to contract design of polder infrastructure out to local consultants. BWDB and CDSP consultants then are responsible for specifying the requirements, comment and approve the designs.

Implementation Aspects

Quality control is the mandate of the BWDB whereas the consultant monitors the quality control. In the initial two years of CDSP the quality of the works was a main issue leading to discussions between contractors, BWDB and consultants. Works were often rejected by the BWDB and the consultant, leading to delays in the implementation schedule. In the course of the project, quality gradually improved. Two aspects appeared to be crucial in this respect:

- The existence of a quality monitoring unit of the consultant with an adequate capacity. The monitoring manual as developed by SRP was utilised for this purpose and adapted (simplified) for CDSP conditions.
- Training of contractors on quality control. Two training sessions were conducted for contractors on BWDB/LGED construction standards.

Progress in implementation of earthwork (embankments and roads) was in general according to planning. Major delays occurred in the construction of sluices because of

the earlier mentioned delays in design and defaulting contractors. The Char Majid Sluice was only operational in May 1999, 3 years later than originally envisaged. As a result also delays occurred in the excavation of the drainage network which can only be done after the polder is fully protected.

An important consequence was that protection in Bhatirtek and Majid was achieved much later than envisaged. This had consequences for the other CDSP programs: the measuring program, the agricultural and fishery extension programs and the social development program. It also had consequences for the land users, delaying developments in their cropping.

Serious delays occurred in the implementation of the LGED works during the entire project period. Main reasons were the initial insufficient LGED staffing in Noakhali and the earlier mentioned strict control on quality.

Embankments

Most coastal chars are subject to two kinds of flooding: floods from the sea bringing in saline water and floods from the inland bringing fresh water. CDSP polders, therefore, in broad terms, know two kinds of embankments: sea facing and interior embankments.

Saline water flooding with harmful effects occurs once in the four years on average. These floods may damage crops, inundate fishponds and hamper the desalinisation process as discussed in para 2.3.1. Most of these saline intrusions cause little damage to homesteads with no loss of life. Sea facing embankments protect the areas against sea water flooding, but provide limited protection against major cyclones. Coastal forest belts situated in front of the sea facing embankments increase the degree of protection. However, cyclone shelters remain required to give protection to human lives in case of major cyclones.

Dimensions of the sea facing embankments in CDSP are according to BWDB standard based on maximum water levels occurring once in the 20 years with a freeboard of 1.50 m.

The interior embankments of the CDSP polders provide protection against flooding from the inland. The water of the floods is sweet and may cause instantaneous damage, but no damage on longer term to the soil. Also for the interior embankments BWDB standards were used, based on a 1:20 years water levels, but with a freeboard of 0.9 m. Difference is made between interior embankments (along rivers) and marginal embankments (inland and along canals).

Sluices and Drainage Systems

The sluices provide protection as part of the embankments, but above all, they provide facilities to manipulate water levels inside the polders. Not only can water be drained, but it can be retained as well, when required. This facility can be fully used when there is sufficient tide and the sluice can discharge freely. But also in cases in which the tide is weak, the sluices prove their value.

Due to the weak tide, manipulation of water levels is not well possible during the monsoon in the Baggar Donas. However, immediately before and after the monsoon, when outside water levels fall, the water on the inside can be manipulated. During the

TABLE 1.3
Main Dimensions of Embankments in CDSP Polders

Type of embankment	Crest level	Crest width	Side slope	Side slope	
	M PWD	m	land		
Char Baggar Dona					
Interior	6.10	4.20	1:2	River	1:3
Marginal	6.10	3.00	1:2	Land	1:2
Char Bhatirtek					
Interior	6.40	4.20	1:2	River	1:3
Marginal	6.00	3.67	1:2	Land	1:2
Char Majid					
Coastal	7.10	5.00	1:2	Sea 1:5	
Interior	6.50	4.25	1:2	River	1:3

heart of the dry season, the gates remain closed. The outside water is considerably higher than the water inside and it is saline. The water inside remains rather sweet.

Because of the tide in Bhatirtek and Majid, water levels can be manipulated during the monsoon. Outside the monsoon, the use of the sluices is much the same as in the Baggar Donas. In summary, operation of the sluices has three major benefits, which should be fully appreciated:

- Water can be retained such that fields do not loose their water too quickly. There is a limit to this. Once water levels have fallen too low, they can not be restored unless there is rain
- During the dry season, the water inside the polders remains far sweeter than water outside. Water quality is suitable for irrigation but marginal for human and animal consumption.
- One may expect that better control of water levels inside the polders, together with sweeter water, stimulate the desalinisation process of the soil.

In this context three comments need to be made. First, Water Management Committees quickly perceive the benefits of sluice operation. They do not have to be trained in that respect. Second, in leaving sluice operation to the WMCs, they choose for agriculture and not for capture fisheries. This comment will be taken up again later.

The third comment touches a rather basic issue. Sluices with only flap gates drain an area in an uncontrolled way. The lowest tide determines the water level inside. That is often too low. With low water tables, rice fields loose their water too quickly and land users are inclined to block drains. With sliding gates this becomes different. Land users could agree on a water level to be maintained. Sluices in char areas should have both flap- and slide gates.

Drainage Network

Tidal flats have tidal creeks by which the water enters and leaves. When tidal flats are turned into polders, the most practical thing to do is to use the creeks as drains, especially if the lands are already occupied and cultivated as was the case in the three CDSP polders. Tidal creeks are formed by nature. Drainage engineers use design criteria

such as that defined units of land, for instance 100 hectare or less, should have access to the drainage system. The drainage system is then divided into a primary, secondary and tertiary systems. This usually leads to higher drain densities than the tidal creeks provide.

The practice of CDSP was to make primarily use of the existing creek system. Additional drains were formed along embankments and roads by utilising the borrow pits as drainage canals. No additional tertiary or field drains were constructed. The drainage network thus formed has an average and quite uniform drain density of 20 m/ha (Char Baggar Dona II 19.2 m/ha; Char Majid 21.1 m/ha and Char Bhatirtek 20.1 m/ha)

The lesson learned during CDSP is, that the density of the tidal creeks, provides adequate drainage under the circumstances. As will be discussed in the section on agriculture (2.4.2), only 15% of the lands are classified as low lands which have less production opportunities as compared to the medium and high land classes. It is still to be investigated whether the 15% low lands could be turned into medium lands by excavating additional (secondary or tertiary) drains or that the elevation is just too low to provide adequate drainage facilities.

LRP provided a rather dense drainage system in Baggar Dona I. Although the drain density of primary and secondary drainage network is 11.5 m/ha, the tertiary drain density is 55 m/ha. This was related to the issue of settling co-operative societies on pieces of land of about 30 ha. Each piece of land had access to the drainage system, which resulted in a rather dense system. This design was possible because the lands of Baggar Dona I were not occupied at the start of the project. According to LRP's own conclusions, the dense system did not lead to a quicker desalinisation of the soils.

Drainage of the Hinterland

In the design of the polder drainage system, the drainage of the entire watershed has to be taken into account. This was sufficiently done in the case of Char Majid. In Char Baggar Dona II, problems occurred with the neighbouring area at the northern part, where people cut the interior embankment to relieve the drainage congestion in their area. It is not yet completely clear whether this is due to an error at the time of designing (1988), or that the drainage situation has changed over the years because of the silting up of the Baggar Dona. The example shows anyway that sufficient insight is required in the siltation processes for properly designing as argued before.

1.3.3 Internal Polder Infrastructure

Planning and implementation of the internal infrastructure is primarily the mandate of the LGED. Involvement of the char population in the planning has been quite extensive. Polder Committees (PC) and Sub Polder Committees (SPC) were largely involved in decisions on location of roads, cyclone shelters, tube wells, etc. (see 2.3.4.). In monitoring of the implementation the PCs and SPCs played an important role. Construction of houses in the clustered villages was the responsibility of the Ministry of Land.

Roads

At the outset of the project in 1994, the communication within the three polders was deficient, but comparatively speaking not much different from the national picture.

There were 14.1 km of type B feeder roads and 46.75 km of rural roads (total of types R1, R2 and R3). Combined road density (length of road in km per square km) was 1.182, around the same as the national figure in 1995 of 1.109 for the same type of roads (see table below).

In total 16 km of feeder road (type B) and 60 km of rural roads (type R1-R3 combined) were built by the project in the three polders. All roads were constructed by LGED. Quantity and location were the outcome of intense consultations with the PCs and SPCs. The project brought the density of rural roads to 1.402, and for feeder roads (carpeted) to 0.583.

TABLE 1.4
Density of Feeder Roads (Type B) and Rural Roads (R1, R2, R3)

Density in Km. / Km^2	Feeder Rd Type B	Rural Rd R1, R2, R3	Total
CDSP (1994)	0.274	0.908	1.182
CDSP (1998)	0.583	1.402	1.986
Noakhali Dist. (1998)	0.041	2.136	2.177
Bangladesh (1995)	0.104	1.005	1.109

The table shows that the project area now is around 14 times better off in terms of feeder roads (type B) than the District of Noakhali as a whole, while it is lagging behind as far as rural roads is concerned. It must be observed that most of the feeder roads are on the border of the polders, serving a wider area; of the 20.1 km only 2.4 km is inside the polders. Still the density of feeder roads is comparatively very high. This raises the question whether it would have been better if more rural roads had been built at the cost of feeder roads. The per kilometre costs of feeder roads are ten times as high as of rural roads (Tk. 2,330,500 against Tk. 232,365).

A simple survey, based on structured interviews with SPC members and on focus group discussions, has shown that the following benefits are seen to be the consequence of the improved road network:

- Many more rickshaws are available who ply in all seasons of the year;
- Travel time to the nearest bus stop or bazaar has been much reduced;
- Costs of transport have become lower;
- The number of shops has significantly increased (which also led to higher sub-contracting rates), the number of bazaars grew only a little;
- More goods are available; and
- The price of land has increased.

Loss of agricultural land and waterlogging were the disadvantages of more roads mentioned by the respondents.

There seems to be little doubt about the net beneficial impact of road construction. However, while planning roads in future char programs, national and District figures on road density should be taken into account, in addition to the priorities put forward by the population represented in Polder- and Sub Polder Committees.

Cyclone Shelters

Under CDSP 17 cyclone shelters were constructed. They were rather unevenly distributed over the three polders (seven in Char Majid, eight in Char Bhatirtek and two in Char Baggar Dona II) because the decision to built them was essentially taken by the Polder- and Sub Polder Committees. In Char Baggar Dona for instance, the population preferred roads above cyclone shelters. Obviously no objective criteria for a certain number of people per shelter was applied.

Of the 17, 11 are used as school, three as satellite clinic and one as office of a local NGO. Two have no other specific use than as shelter; in future one of them may be used as NGO office. Since their completion, about two years ago, the cyclone shelters were indeed used as such on two occasions. Structured information is however not available. The use of cyclone shelters for schools, health clinics, community centres etc. should be properly planned and, if required and feasible, the design should take the future function into account.

Houses in Clustered Villages

Through the Ministry of Land, a total of 990 houses were provided for all the households settled in the 34 clustered villages. The design and the quality of materials was such that the houses were a relatively easy prey for storms. In future programs the responsibility for construction of houses should be given to LGED. The settlers themselves should have more say in the design (in particular the women who are after all the primary users of the space in the house) and should be more involved in the actual construction. Better use should be made of the knowledge and experience with regard to hazard resistant housing which is available in government agencies (in particular LGED), educational institutions (as the Bangladesh University of Engineering and Technology) and NGOs (BRAC, Grameen Bank, Bangladesh Red Crescent Society and others).

Tubewells and Toilets

Need assessments in char areas invariably indicate that access to drinking water is one of the highest priorities of the char population. At the outset of CDSP, in September 1994, the project area, with a population estimated at about 30,000 at the time, had 203 working pumps for drinking water of which 71 STWs, 105 DTWs and 27 rowing pumps. In general, these pumps were installed by DPHE, Red Crescent or NGOs. Most of the owners of DPHE installed tubewells had relations with or belonged to the local elite. Through CDSP another 210 DTWs were added, taking the total to a little over 400 pumps. Taking into account an increase of the population to around 40,000, this means a density of around 100 persons per pump. This is higher than the DPHE norm of 120 persons per DTW and 70-100 persons per STW. It can be assumed that the project area is now slightly better off than, on average, other areas of the country.

Because of the arsenic problem, the project only installed DTWs, which was done by LGED. The selection of the sites was done in consultation with the Sub Polder Committees. A first SPC proposal of 468 pumps was narrowed down and revised by consultant staff to a final selection of 210. In that first proposal the density would

become too high, while the SPC list was clearly biased towards its own members and their relatives. The following five criteria were maintained for site selection:

1. 10-12 families should live within 5-7 minutes walking distance from the tubewell;
2. The tubewell should be accessible during the rainy season;
3. The site should be safe for women according to social norms;
4. No other sources of water should be available within a radius of 5-7 minutes walking distance; and
5. The users should, as an indication of their interest, pay a contribution.

These criteria were discussed with DPHE and LGED.

The selection process included small group meetings (3-5 households), large group meetings, discussions with the SPCs and finally approval by the Chairmen of the Polder Committees.

The baseline situation in 1994 for toilets is not known. With CDSP assistance 2760 toilets (five rings, one slab) were sold to char dwellers in scattered villages for Taka 100 per set, while another 990 sets were provided free of costs to the inhabitants of cluster villages.

In any future char development program, the density of the tubewells should be in line with the norms of the DPHE. The selection of the sites should be done in consultation with and with the approval of the Sub Polder Committees. In the selection process a proper base map, showing the areas that have the greatest need for tubewells, should play an important role. The accessibility and the number of households per tubewell should both be taken into account.

The process of selection should be preceded by a mass campaign to make the population aware of the planned activities. Health education efforts geared towards the use of water should start a year before the actual installation of pumps is undertaken. The example given by CDSP with regard to maintenance of tubewells by training of women of caretaker families and by distribution of toolboxes should be followed.

Infrastructure related to drinking water and sanitation should in future programs be brought under the responsibility of DPHE, the government agency to whose mandate these matters belong.

Fish Ponds

In unprotected land, subject to frequent flooding, fish ponds are unattractive. The floods provide an opportunity for the fish to escape. In addition, on unprotected land the potential of capture fisheries may be still substantial. Empolderment changes all that. The embankments are a serious obstruction to fish migration into the polders. The sluices, the only entrance for fish, are closed part of the time. In addition empolderment changes the fishes' environment in the polders to a large extent. Water tables may be different during most of the dry season and the water remains sweet. Judging from the reactions of the land users in the polders, their priority is not fishing but cropping.

It should be acknowledged that capture fisheries decrease in protected areas. To what extent that is the case is unknown, due to the difficulty of assessing the amounts of fish caught, before and after empolderment.

Protection, however, provides good opportunities for fish cultivation in ponds. Information on production of fishponds is given in section 2.5. The ponds will not be flooded any more and water quality can be better controlled. The great limitation is that ponds fall dry, during the dry season. However, the time at which they fall dry, varies greatly among ponds. It can be delayed by excavation. The groundwater data suggest that excavation to about 3 m is a sensible proposition. Deeper ponds may develop problems with the stability of their slopes.

Loss of water from the ponds is generally blamed on seepage. That may be slowed down by providing organic food to the fish, which would better seal the bottom and slopes. However, evaporation is by far a larger actor with respect to the loss of water. In addition, there may be ponds which have positive seepage, certainly when they are located near to embankments and the outside water remains high. Details about the factors which determine the loss of water from fish ponds are largely unknown and may be investigated. However, the targets of a such a campaign need to be better defined.

In the meantime fish ponds do not solve the problems of people who spent part of their time on capture fisheries before empolderment, or, who depended on catching fish for their diet. Those issues should be brought up more clearly in CDSP, than has been done in the past.

1.3.4 Institutions Involved with Polder Infrastructure

From the side of the government agencies, the BWDB and the LGED were the main parties involved with infrastructure in CDSP. The Ministry of Land was responsible for the construction of the houses in clustered villages. CDSP, especially the consultant team, assisted the formation of field level institutions which were involved with either the planning and construction or the operation and maintenance of polder infrastructure. They were the Polder- and Sub Polder Committees, the Water Management Committees and the tubewell user groups.

Polder Committees and Sub Polder Committees

The primary objective of creating Polder- and Sub Polder Committees was to give shape to the participation of the settlers in planning and implementation of internal polder structure. Once established the Committees acquired some additional roles. The Committees were always meant to be temporary; they would exist till the completion of the polder infrastructure. The formation process of the three Polder Committees (PC) and 16 Sub Polder Committees started late 1995 and was completed mid 1996; they were all dissolved in June 1999. In principle each *mouza* had its own SPC; membership ranged from 9 to 25, depending on the size of the *mouza*. Members were selected by the population through a series of meetings at bazaar- and *mouza* level. In all cases the local power elite had representatives in the SPCs. Women were very much under represented, constituting only about 10 % of all members. SPC members selected the PC members. The Chairman of the Union Parishad covering the majority of the polder was considered the Chairman of the PC, in case the polder covered more than one Union.

The Committees, especially the SPCs, were instrumental in the planning of the various components of the infrastructure within the polder. The members drew up a list of demands for structures in their area. They proposed new roads, bridges and culverts and

identified existing structures in need of renovation. They identified submerged areas and then made plans for drainage canals and determined the number of required cyclone shelters and tubewells. All this was done without a financial framework and consequently these wish lists had to be reviewed. Consultations between the Committees, the consultants team, BWDB and LGED ultimately resulted in a physical plan. Probably the most vital contribution of the SPCs was the assistance with the determination of the location of the structures.

Once the implementation of the plan had started, the Committees provided comments on the designs and on the quality of the works. If shortcomings were detected, the agencies concerned or the consultants were informed. Both PCs and SPCs, especially the presidents and secretaries, played a role in management of conflicts, for instance in cases where opposite views on the location of structures existed or where land had to be given up for construction of roads and cyclone shelters.

Water Management Committees

CDSP's institutional framework is based on the Guidelines of the Ministry of Water Resources, but adapted to the specific circumstances of the project. Major deviations are related to the fact that CDSP is not a purely water management project, but has multi-sectoral activities.

With the implementation of the water management system, the need to form the appropriate institutions for its operation and maintenance became evident. Formation of Water Management Committees (WMCs) started at the end of 1997. WMCs are organised at the basis of a water management system (WMS), being the area draining on one sluice. In total 6 WMCs have been formed: one each in Char Baggar Dona I and II and Char Majid, and three in Char Bhatirtek. For Char Bhatirtek a federation of the three WMCs has been formed to co-ordinate and solve conflicts on water management issues between the three neighbouring water management systems.

The process of formation of WMCs started with meetings in each of the water management systems with 8-10 people (farmers as well as fishermen) of each water management area and the PC - and SPC members as participants. In Char Majid and in Char Baggar Dona II also people from outside the polder were invited because of water congestion problems in adjacent areas. Through a series of meetings the plenary session selected the WMC members, with in principle one representative of each of the water management areas. Total membership ranges from 13 to 15. Every WMC has two women members: one UP member and one user of water living in the area. The process of formation was completed in the summer of 1998.

Monitoring of the WMC shows that the performance is quite promising. Main indicators are:

- WMCs meet regularly and "real" water management issues are on the agenda, and decisions are made.
- WMCs participated actively in the establishment of the Maintenance Plan (see below).
- WMCs take responsibility for O&M tasks through:
  - Operation of the sluice,

- Persuading people to remove cross-dams in the main drainage system at the start of the monsoon,
- Mobilising people to remove debris before, bridges, culverts and sluices, and
- Prohibiting fishing activities in a canal section of 60 m before the sluice.

The promising performance of the WMCs may be partly due to the fact that many of their members were involved in the project at an early stage: the planning of the internal design of the polder. Monitoring over a longer period is required to assess whether the created institutions appear to be sustainable.

Tubewell Users Groups

These groups consist of female members of the main users households around a tubewell (households that are dependent on one particular tubewell and that financially contributed to the well). The objective of the groups are to create a forum for discussion on shared community assets and on operation and maintenance of tubewells and toilets, as well as to create a sense of ownership of the tubewells. The members of each group selected two caretaker families. They received training and are supposed to do the regular maintenance activities as daily cleaning of the platform and monthly opening and washing of the head, checking of the nuts and bolts etc. They have to promote the use of tubewell water for all household purposes and prevent any prohibited activities at tubewell sites such as washing clothes.

1.3.5 Operation and Maintenance

Operation of Water Management Structures

Operation of the systems appears to be quite straightforward. During the monsoon the sluice is opened to drain excess water from the polder areas. The sluice remains open until the fields are properly drained for harvesting; after that the sluice is again closed to retain the sweet water within the polder for the dry season. Khal water is used, being at minor scale, to irrigate homestead gardens and rabi field crops. The sluice remains closed until excess rainwater needs to be drained in the next monsoon.

It has to be noted that above described pattern in sluice operation is only observed since the WMCs took over the responsibility of sluice operation from the BWDB sluice kalashi. Before that time the sluices were often opened during the dry season for fishing purposes. Not so much to let in fish fry for stocking the khals, but for an easy catch by putting a fishing net behind the opened sluice door. The disadvantage from the farmer's point of view is that saline water enters the polder hampering the utilisation of khal water for irrigation. The foregoing shows that with sluice operation by WMCs the farmers' interests are predominant in decision-making as also appears to be the case in other FCDI projects.

CDSP's investigations on sluice management taking into account the catch fishery component are not conclusive. Efforts to monitor the decrease in catch fisheries after empolderment failed; furthermore the possibilities for letting in fish fry for stocking purposes have not been investigated. One of the reasons is that letting in saline water is not favoured by the farmers, another is that the long term effects on the

desalinisation process are not known. In future, these aspects need to be investigated more systematically.

Maintenance of Water Management Structures and Roads

As far as maintenance is concerned, CDSP at present has a maintenance plan for all its areas. The plan goes into details about the infrastructure to be maintained, the expected costs of maintenance and who does the maintenance. It is important to note that the maintenance plan makes a distinction between formal maintenance responsibilities and cost sharing for maintenance. Parties who do not have formal responsibilities, may share in the cost.

Components of the maintenance plan are:

- Maintenance requirements are drafted on the basis of the area of a WMS, therefore taking the WMC as the focus organisation for maintenance.
- A data base of all infrastructure has been compiled and maintenance requirements including costs are defined for the next five years.
- A distinction is made between preventive, periodic, emergency maintenance and rehabilitation.
- The (joint) responsibilities for maintenance between the parties involved: WMCs, Union Parishads, LGED and BWDB are defined.

The maintenance plan has been extensively discussed between all parties involved. The plans for each water management system have been signed by the involved parties: UP Chairman, WMC manager, Executive Engineer BWDB and Executive Engineer LGED. This implicitly means a recognition of the WMCs by BWDB and LGED. The maintenance plan provides a solid base for future maintenance. Monitoring its implementation is required. Main indicators will be:

- Inclusion of the maintenance requirements in the annual budgets of the BWDB and LGED,
- Mobilising resources by the UPs,
- Mobilising resources (cash and labour) by the WMCs,
- Actual implementation of the maintenance as agreed upon in the plan.

1.4 AGRICULTURAL AND HOMESTEAD PRODUCTION

1.4.1 Introduction

Empolderment creates a more secure and a more productive environment through protection from saline flooding and improved drainage, which presents new opportunities to farmers. Polder development as undertaken by CDSP has been shown to be reasonably profitable, and its cost efficiency can still be improved (see chapter 4). It is the role of a polder development program to facilitate all farming households, including sharecroppers, in exploiting these new opportunities. These guidelines are meant to assist in the design of appropriate interventions in the area of productive development, in particular agricultural and homestead production. They are based on the experiences, results and lessons learnt by CDSP and its predecessor LRP in four coastal polder areas, as reported in 'Soil,

Water and Crops' (CDSP Technical Report no. 25). It describes the steps to be taken in the development of agriculture and homestead production in newly empoldered areas and the assistance to be provided to farmers to exploit the new opportunities.

1.4.2 Agro-ecological Conditions in New Char Areas and their Changes

Newly empoldered land presents a dynamic situation where changes in physical and biological conditions allow a gradual change in production practices. A polder development program must anticipate these changes and facilitate adoption by farmers of appropriate productive practices. This must be based on adequate information on likely and actual changes in agro-ecological conditions.

The data needed for a characterisation of agro-ecological conditions and their changes are described in the following paragraphs, as well as the methods to collect them. The main components are:

- Mean monthly rainfall and frequency analysis of rainfall occurrences (for 10 day totals);
- Mapping of the area for land classes and salinity; and
- Representative soil sampling for textural and chemical analysis.

Rainfall and Cropping Seasons

Agriculture in the coastal areas is essentially rainfed. In the CDSP polders, the opportunities for (groundwater) irrigation are practically nil within the foreseeable future. Seasonal rainfall is therefore an important factor constraining the options for farming.

There are three distinct cropping seasons, viz.:

- The Kharif-I or pre-monsoon season, from April through June;
- The Kharif-II or monsoon season, from July through October; and
- The Rabi season, from November through March

Knowledge of the average monthly rainfall distribution allows a broad assessment of an area's suitability for growing certain crops and crop sequences. In order to assess the climatic risk associated with cropping, however, the frequency of occurrence of above or below average rainfall must be known.

Historical rainfall data for Noakhali and their relationship with crop growing cycles were analysed in CDSP Technical Report no. 25. In the period between 1974 and 1996 mean monthly rainfall figures recorded at Noakhali station range from 3 mm in December to 733 mm in July. A frequency analysis of rainfall was carried out to estimate the likelihood of excessively high or low rainfall at specific times during the season. This information is needed to assess the risks of crop failure due to excessive or deficient rainfall.

Similar analyses should be carried out for new polders, using long term data from a suitable reference station. Rainfall should also be recorded in the new polders to relate crop performance as affected by drought, salinity and inundation to rainfall occurrences. Furthermore, comparison of short term rainfall series in the polders with those of the reference stations allows an estimate of long term rainfall expectations and risk for the new areas. The same set of rainfall data is needed for the water management interventions (see CDSP Technical Report no. 22 and section 2.3.1 of this document).

Land Classes.

Land classes are defined here as clusters of landtypes which combine a number of physical characteristics with relevance for productive potential. Well-defined land classes are important for farmers to choose appropriate land use options and must be taken into account in a demonstration and extension program. Land classes should therefore be identified at the beginning of a char development program. CDSP's approach to land classification was based on a combination of farmers' own classification of their plots combined with objective criteria based on surveys of seasonal water depths. Farmers' own classification will of course not be available until they have used the land for a few years. In a partially settled or unsettled polder, therefore, only objective survey data can be collected. They should be validated with farmers' classification once the polder has been settled.

Unprotected char land which is prone to regular saline inundation is only suitable for monsoon paddy production. Once a char is protected, *aman* paddy remains the principal crop, grown in the entire cropping area, but options for aman cropping increase while conditions for pre-monsoon and rabi cropping improve gradually. Physical factors for distinguishing land classes must be related to:

1. The growing conditions during the Kharif-II (aman paddy) season, affecting the choice of aman varieties, timing of operations, etc.
2. The growing conditions during the other seasons, affecting the choice of year-around cropping patterns, in particular the potential for different Kharif-I and rabi crops.

Three major land classes were distinguished by CDSP. These classes (see table) were found to coincide largely with farmers' own classification in *Uchu* (High), *Majari* (Medium) and *Nichu* (Low).

A simple classification in three land classes based on combinations of 4 criteria:

			land class		
	criteria	"levels"	high	medium	low
1.	usual water level during the Kharif season (June-Sept)	0-20 cm	x		
		20-40 cm		x	
		> 40 cm			x
2.	maximum water level during the Kharif season (3-7 days)	10-30 cm	x		
		30-50 cm		x	
		50-100 cm			x
3.	usual 'transplanting window' (for T-Aman)	after 15 July	x	x	
		after 15 Aug			x
4.	time field usually starts drying naturally	15 Oct-15 Nov	x	x	
		after 15 Nov			x

A description of the three land classes is as follows:

Land Class 'High'

This is land that can be planted with T-aman early, because there is no risk for deep inundation by accumulating rain water. The land is prone to dry temporarily in case of

short dry spells, which may lead to 'resalinisation' early in the aman season. HYV may do well in wet years and less well in dry ones. Early planting of rabi crops is possible, provided the salinity status of the soil permits.

Land Class 'Medium'

The usual water levels are somewhat higher than in the "high" class but there is little risk for inundation to more than 30-45 cm in the middle of the monsoon. The land is not as prone to drying and resalinisation in case of dry spells. This land is most suitable for HYV paddy and can be planted early, provided the preceding crops allow. Fairly early rabi planting is possible, if the T-aman crop is planted and harvested sufficiently early.

Land Class 'Low'

This land is prone to fairly deep flooding at any time during the monsoon, due to accumulating water. T-aman can only be planted once water levels start declining, from the middle of August to as late as the middle of September. The land is not suitable for HYV paddy and farmers usually grow the *kajalshail* variety. Planting of rabi crops is not possible before late December to early January and rabi crops may be damaged by early flooding (May). The land may be left fallow during the rabi season because of the risk of early flooding.

Land Surveying

Topographical and land level maps. Land classes are related to inundation and flooding conditions and therefore to topography and distance from main drains. A proper topographical and elevation map of the entire polder is therefore needed to relate land classes to the overall physical conditions in the polder. Such maps are also required for land and water engineering activities (see Technical Report no. 22) and should be prepared at the start of the program.

Land class surveying. Although the land conditions will change appreciably after protection and excavation of drains, it may be expected that land classes as distinguished by farmers before protection will not change in a major way. For reasons of convenience it is recommended that during the plot-to-plot survey (see sections 2.2.5 and 3.2) the surveyors also record the land class of each individual plot, according to farmers' own classification [*Uchu* (High), *Majari* (Medium) and *Nichu* (Low)].

Mapping

The information on land class from the plot-to-plot survey is transferred to a GIS system for mapping. An overall map is then prepared showing the dominant land classes in the different parts of the polder (within an area where a particular land class is dominant there will of course always be fields which belong to one of the other classes). Comparison of the overall land class map with the topographical and land level maps will help in analysing the factors affecting overall land class distribution. It will also provide guidance for the need for water management interventions.

Soil Salinity

Salinity is an important determinant for soil capability and should therefore be used as a factor in land classification. It may be seen as a 'modifier' which puts restrictions on possible crop choices. Once the peripheral infrastructure (embankment and sluices) are in place the initial overall decline in soil salinity will be fairly rapid and will slow down thereafter. The evolution of soil salinity with time after protection was monitored by LRP and by CDSP. From these data, a 10 year trend was derived for the decline in salinity for the four CDSP polders, as shown in the following figure.

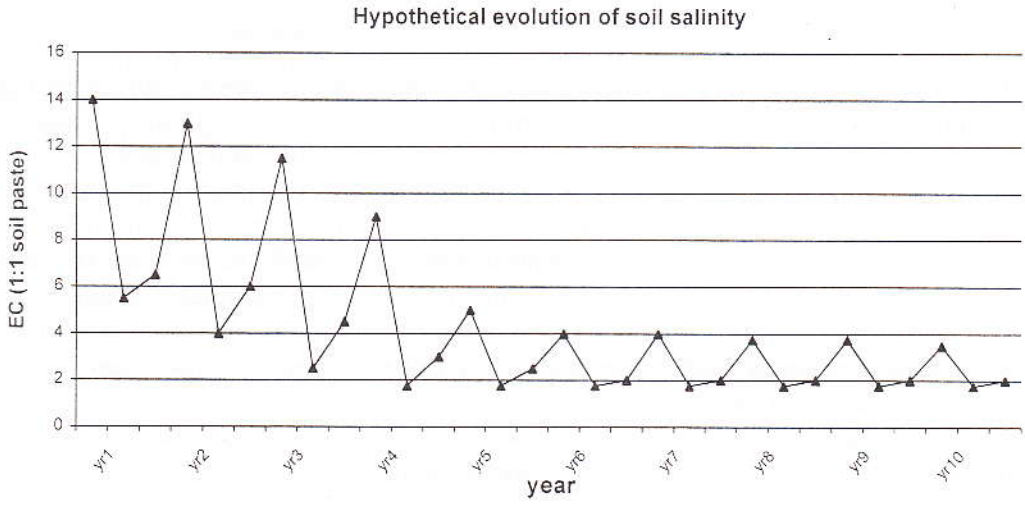

Fig. 1.1. Expected Trend of Top Soil Salinity after Empolderment
(EC stands for electrical conductivity; the higher the EC value, the higher the salinity)

Although the same overall trend is likely to occur also in new coastal polders, there may be differences caused, for example by differences in rainfall and deep drainage. There may also be important local differences in salinity which affect opportunities for cropping and these must be taken into account when designing a technology testing and extension program.

Salinity Surveying

As soon as a polder has been protected, an initial polder-wide salinity survey should be conducted around the middle of February to establish the baseline situation. The sampling density should be based on a sampling grid of 100 × 100 m. Relative salinity figures are more important than absolute ones, so the use of simple field measurement equipment should be considered. A sub-sample should be used to establish the relationship between the field measurements and more accurate laboratory measurement. The baseline data should be transferred to the GIS system to generate a salinity pattern map.

The evolution of soil salinity patterns across the polders should be regularly monitored. This does not have to be done at the same scale as the initial baseline survey, but may be done sample-wise by zones. Initially, year around monitoring is needed to monitor the

changes over seasons. Later on the frequency may be reduced. It should be assessed whether simple field equipment can be used or laboratory measurements are needed.

Zonation

The land class map in combination with the salinity map will allow a zonation of the polder to target interventions and choose representative locations in each zone for testing of innovations. More or less homogeneous agro-ecological zones should be defined for planning purposes.

Soil Fertility

Information on soil texture and chemical composition is also needed for technology targeting, especially for recommended fertiliser rates. Apart from salinity, changes in chemical soil characteristics are not directly affected by empolderment and initial soil analyses will provide a good indication for the need for soil amendments to attain satisfactory crop yields. Soil analyses, however, are expensive and time consuming and should be kept to a minimum. It is recommended that after establishment of the land class map (based on the plot-to-plot survey) a limited number of soil samples is taken in each broad land class to obtain a first impression of the fertility status and its variation. Once the complete zonation is ready (including salinity patterns) more systematic sampling can be done according to zones.

To monitor changes due to changes in land use and land use intensification, limited soil analyses should be repeated once every 3 years by zones.

1.4.3 Land Use and Its Changes

The land use options farmers have change with the evolution of polder conditions. A development program must continually adjust to these changing conditions. Actual land use should therefore be regularly monitored and mapped, using GIS.

The baseline survey and the plot-to-plot survey, carried out at the beginning of polder development (chapter 3), offer an opportunity to collect information on land use. The best time for the survey is the month of November, when most farmers, including the migrant ones, will be present for the aman harvest. For each plot the surveyors should record the crops grown during the current season (at the time of the survey), as well as during the two preceding seasons. In following years, land use should be monitored through transect surveys, which can be carried out much more rapidly. The procedure, as partially used by CDSP in 1999 is as follows:

1. Choose two representative transects which cover all variations occurring in the polder in terms of land classes and salinity conditions;
2. Divide the transects into a small number of segments, corresponding with major land class differences; identify landmarks to locate the segments in the field;
3. Fixate the location of the transects and the landmarks in the GIS map;
4. At survey time, record the crops present in all plots adjacent to the transect lines, separately for each segment of the transects; and

5. Calculate the percentage of all plots used for each crop along each of the segments of the transect lines.

The transect surveys should be repeated every two or three years in each of the three seasons to monitor changes in land use.

Land classes and land use are expected to be closely related. Land classes reflect production potential and there should therefore be much similarity between maps based on land classes and on actual land use. If there are major differences, they must be caused by factors not included in the criteria used for distinguishing different land classes. CDSP found, for example, that considerable areas in CBD-II were only used for local T-aman, although the land class map suggested no differences with areas where cropping intensity was much higher. It was suspected that land tenure relations were behind it but this was not verified. Such differences can be important for the design of a development strategy.

1.4.4 Promoting Development of Agricultural and Homestead Production

Choice, Evaluation and Demonstration of Technology

A development program must focus on 'best-bet' technologies and interventions associated with each land class and with the homestead area. The program must establish a partnership with farmer groups, through line agencies and NGOs, to assist them in making the best choices for crop production. Due attention should thereby be given to the specific interests of different groups of producers, such as sharecroppers. The approaches to choice of technology are discussed in this section while the extension and group approaches are treated on pages 38 and 39.

Field Crop Production

Crop choice. Which crops should be promoted depends on the stage of evolution of polder conditions. Initially, practically only T-aman can be grown, but as salinity declines, the opportunities for aus and rabi cropping improve. The scope for rabi season irrigation (and boro rice production) in the CDSP polders were minimal because of salinity of the accessible groundwater sources. There was only some limited scope for irrigation with surface water from drains and creeks. Whether there are accessible sources of sweet groundwater in new polders must be investigated.

Conditions for dry-seeded aus production are initially poor because of pre-monsoon salinity and the crop should not receive emphasis during the first few years after empolderment. In Char Bhatirtek and Char Majid aus cultivation started increasing after about three years. The effect of salinity can be avoided by transplanting aus in late May or early June, but this results in late planting and lower production of aman and even of the following rabi crop. Once conditions are favourable, some HYV may be introduced, such as BR21, which is relatively early maturing.

During the first year after embankment, a start can be made with testing and demonstration of HYV of T-aman paddy. They may be grown in areas where water control conditions are good, in particular in medium land and where soil salinity is lowest. In subsequent years new HYV rice varieties should be tested and demonstrated

according to their suitability for each land class. New varieties were promoted by CDSP according to locally observed water management conditions, but in the future targeting of varieties to specific land classes should be done more systematically.

Farmers themselves will monitor the salinity conditions during the rabi season and experiment with different rabi crops. A development program can assist by participatory testing and demonstration of varieties of those crops which have the best potential at different stages of desalinisation. Chilli and sweet potatoes are least sensitive to salinity and improved varieties of these crops may do well from the second year after protection, especially in the less saline soils. As from the second year, groundnuts may also be promoted, avoiding saline areas and fields. Khesari, although rather sensitive, may be grown fairly early, because it is often relayed into rice stubble, before salinity builds up. Improved khesari varieties may be offered for farmers to try. High value crops such as onions, garlic and tomatoes may be promoted for favourable salinity conditions from year three onwards.

Production Technologies

Apart from crop species and varieties several other technologies and interventions should be considered to promote production development in new polders. Some potential technologies and interventions will be common to all land classes, while others are class specific. Examples of interventions with relevance across land classes are:

1. Promotion of IPM in rice, especially perching for stemborer control and the organisation of farmer field schools;
2. Identifying niches for green manuring crops in the different cropping patterns, requiring a minimum of additional labour and other costs (e.g. *Sesbania*, pigeon pea, *Stylosanthes*);
3. Verification of potassium, zinc and sulphur response of T-aman through simple on-farm tests; and
4. Stimulating the development of an input supply system for agrochemicals and simple equipment (e.g. weeders, threshers).

Examples of land class-specific technologies and interventions to be considered are:

High Land

- Early maturing HYV for T-aman paddy, e.g. BR30 and BR31, to escape early post-monsoon drought, especially when grown after Aus; a newer early maturing variety is BR32; and
- A green manure crop interplanted into an early rabi crop, which can produce biomass once the rabi crop has been removed.

Medium Land

- Early and medium maturity HYV for T-aman paddy (BR10 and BR30/31/32);
- Early maturing rabi crop varieties to escape early monsoon water logging; and
- A green manure crop interplanted into an early rabi crop.

Low Land

- Medium to late maturing HYV for T-aman paddy which can tolerate extended periods of water depths of 40 cm or more after tillering; and
- A green manure crop as an 'improved fallow', e.g. planted into the T-aman stubble

Homestead Production

Promotion of homestead production during CDSP was less than successful for a variety of reasons, among them the difficulty of attracting and keeping staff specialised in homestead production. Nevertheless, stable and productive homesteads are important for polder development and a new program should put due emphasis on homestead productive development. The program should consist of three components:

- Promotion of useful tree planting;
- Fish farming in homestead and communal ponds (discussed in section 2.5); and
- Intensive vegetable production.

Tree Planting

Early on in the program, conditions are favourable for a limited range of tree crops, viz. dalim (*Punica granatum*), mahogany, lemon, guava and coconut, for which improved planting material is available. After a few years, a wider range of species can be considered. Villagers' own preferences should guide the choice of species. Promotion of local nurseries, either communal or commercial is to be preferred over supply of seedlings from outside sources.

Vegetable Production

Based on the LRP/CDSP experiences, the promotion program should have the following characteristics:

- The vegetable production 'model' should be simple. Experience shows that complicated bio-intensive gardening methods with many components will not be adopted. Initially, a combination of raised beds, fencing and production and use of compost is adequate. New elements may be tried once the simple model is well established.
- Preference should be given to those species for which seed can be easily obtained by farmers, preferably by producing their own seed, from a reliable NGO intervening in seed supply or from local shop keepers.
- The production technology should be documented in detail in Bangla and English in the form of a loose leaf, updateable extension manual for homestead production.
- Field agents involved in promotion of homestead production should have their own individual vegetable garden for self-training and demonstration.

Group Approach to Technology Testing and Agricultural Extension

Initially, CDSP used a conventional extension approach of individual demonstration (contact) farmers and extension farmers. In 1998 a group approach was introduced, consistent with the national extension policy to adopt participatory approaches through

farmer groups. In a new program, a group approach to technology testing and extension should be vigorously adopted. Any type of grassroots group with interest in productive development should be eligible. The groups should be considered as autonomous 'clients' for agricultural services, not as tools for the extension service. They should not be passive 'consumers of technology' but active partners in the development process.

Groups should satisfy the following criteria:

- They should not be established by the program itself or by the Department of Agricultural Extension (DAE) for the sole purpose of productive development activities but rather be existing or new groups established by NGOs or other organisations for grassroots mobilisation purposes (e.g. tube well users, cluster villages, credit and loan groups, NGO-groups).
- They should be multi-purpose and deal both with field crops and with homestead production.

Within the group there should be no difference in status (e.g. no distinction between 'demonstration farmers' and others) and participation in tests and demonstrations should be entirely voluntary. Different farmers may be involved in different activities, according to their own preference. Those working on a particular technology (HYV, new rabi crop, green manure, winter vegetables, vegetable production, tree planting, etc.) may form a sub-group or 'focus group'. Farmers may be members of more than one sub-group and join and leave at will.

Specific attention should be given to the distinction of different target groups within the farming community who may have different technological requirements. Examples are sharecroppers and part time or migrant farmers.

Work on field crops and homestead production through the groups should be jointly planned. Implementation of the two program components through different groups should be avoided, although there may be different sub-groups dealing with field crop and homestead production within the same overall group.

The program will involve some simple testing with new varieties, green manure production, etc. This should be done in locations which are representative for the major zones, based on land classes and salinity (see section 2.4.2). Some groups should therefore be chosen in representative locations where new technologies are tried out. Otherwise, the approach will not be different from that used with the other groups. Once a technology has been shown to be profitable and suitable for adoption it should be further disseminated through the other ('multiplier') groups.

Line agencies and program personnel should receive short intensive training in participatory extension methodology through a national agency with capabilities in modern extension approaches. Regular planning and monitoring meetings should be held between program and line agency staff on one hand and the grassroots organisations and NGOs on the other. They should develop a partnership rather than a top-down extension relationship.

In new polders, the density of line agencies and NGOs will be low which will constrain the rate of testing and dissemination of new technologies. The program may therefore stimulate NGOs to establish themselves in a new polder area for mobilisation of the population, as well as providing avenues for productive development.

CDSP made little use of the rural schools for extension purposes. They should be closely involved in the future, especially in tree planting and vegetable production. It serves the three purposes of (i) demonstrating technology to parents and children, (ii) contributing children's nutrition through the fruits from the school orchard and (iii) providing some extra income to teachers.

Improving Input Delivery

A stable input supply for agricultural production is essential for development. Rapid dissemination of proven varieties, for example, requires ready availability of seed close to farmers. Private initiative should play an important role in input supply in new polders. Experience shows that small shopkeepers move in as settlement increases and DAE have undertaken some successful steps to license shopkeepers for the sale of fertiliser and agricultural seeds. Seeds of horticultural crops and small equipment may also be sold through shopkeepers.

Input supply should be monitored regularly and interventions to improve the functioning of the supply chains should be developed accordingly.

Role of Line Agencies and NGOs

Line Agencies

In view of the aim of 'mainstreaming' polder development, existing national agencies and organisations should play a major role from the start. The role of a development program is to facilitate development activities by national, regional and local agencies, not to create parallel structures. CDSP has gone a long way in working through national organisations in productive development, especially DAE. In a new polder close collaboration with DAE personnel will again be needed.

More can be done in the future to associate organisations such as the Bangladesh Rice Research Institute (BRRI), the Bangladesh Agricultural Research Institute (BARI), the Soil Research and Development Institute (SRDI) and the Bangladesh Agricultural Development Corporation (BADC) with polder development. For on-farm technology testing, for example, a contract should be established with BARI to provide on-farm research services in the polder areas through the farmer groups. This could involve stationing a BARI officer with each of the polders, backstopped by BARI senior scientists and logistically supported by the program. The program may have to provide funding for employment of such officers by BARI. Such an arrangement would give the program direct access to technologies generated by research. SRDI should be contracted for precisely defined soil surveys (see section 2.4.2).

NGOs

NGOs working with grassroots groups should assist the villagers to formulate their needs for services, including agricultural services. In that role they are part of the 'demand side', while the line agencies and the development program are the 'supply side' for services. NGOs and farmer groups should therefore not be seen as actors to be used for the program's purposes but rather as clients for its services. Collaborative arrangements with NGOs should reflect these different roles.

The roles of the NGOs should be to:

- Mobilise farmer groups and help them in formulating demands for external assistance;
- Assist the groups in interacting with technical agencies;
- Disseminate technical messages to group members and provide support for adoption; and
- Provide feedback to technical agencies.

1.5 FISHERIES

1.5.1 Ponds in the Chars

According to a land survey carried out by CDSP in 1995-96, the total area of ponds inside the three polders (Char Baggar Dona-II, Char Majid and Char Bhatirtek) accounts for 3.4% of total land area under "private use". About one-fifth of the households occupying *khas* land possesses a pond. It is likely that many more households possess "ditches" which may eventually become "ponds". It may be assumed that many households will excavate a pond (or turn ditches into ponds) when they start receiving a legal title on their land and the land is protected. As the excavation of ponds is costly, people seem to be reluctant to invest unless there is security (see also 2.3.2, page 26).

The average size of pond, according to the findings of the land survey, is 0.25 acre. It may be mentioned that the average size of non-derelict ponds in Bangladesh is 0.24 acre. The majority of the households possess a small pond of up to a quarter of an acre. The bottom 20% households (with respect to the size of pond possessed, i.e., up to 0.10 acre each) possesses 6% of pond area, while the top 8% possesses 24% of pond area, each pond in this category being more than 0.5 acre in size.

The situation has undergone some change during 1995-98. As many as 34 clustered villages were created with one communal pond of about 1.5 acre in each clustered village. Besides, more people have excavated new ponds or re-excavated their old ponds/ditches.

A survey of 123 fishponds undertaken by CDSP in 1998 revealed some interesting characteristics of the ponds in the *chars*. These are summarised below:

a. The large majority of the surveyed farmers (85%) own the pond individually, while 15% of the farmers share the ownership with others. Renting of a pond occurred only in one case.

b. Aquaculture is a relatively new phenomenon in the three polders: around one third of the ponds is younger than 5 years and another one third is between 5 and 15 years. Only a few ponds (6%) were established more than 25 years ago on the old lands in Char Majid and Char Baggar Dona II.

c. Around two third of the ponds are seasonal. These ponds have a depth of less than 3 m. and dry out at the end of the dry season between February and May depending on the depth.

Ponds had a very low level of production before the inception of CDSP. According to 1994-95 baseline data, average yield per ha was 485 kg. This was much lower than the

national average of 1,820 kg per ha in the corresponding year. In the first year of CDSP intervention (1995-96), the yield of fish in demonstration ponds was 1,124 kg per ha. Yield further increased to 2,014 kg in 1996-97 and to 3,351 kg in 1997-98.

Findings of the survey show that pond aquaculture accounts for a substantial share of income and consumption of the households. Some major findings are presented below:

a. Pond aquaculture is a household activity performed by both women and men in many households (about 50%). One-fourth of the ponds are almost exclusively managed by women.

b. Fish is an important item in the meal. People eat a meal with fish at least four days a week on the average. Consumption of fish is slightly higher in winter than in summer.

c. The majority of households do not go for fishing outside the *char*. About one-third of the households fishes outside the *char* occasionally and another one-tenth does this quite often.

d. The pond is the main source of "table fish", followed by *khal* and market. However, *khal* fish is a more important source of income for households who sell fish.

The average number of species cultured in respective ponds was five. The most popular species were *katla* and *tilapia* cultured by 84% farmers, followed by *rui* (74%), *grass carp* (45%) and *silver carp* (42%).

Rice bran was the most widely used fish feed (74% farmers), followed by straw (39%) and grass (34%). One farmer has been found who used banana leaf as fish feed. The extent of fertiliser use was very low. Only 6% farmers used TSP and cow dung and another 3% used urea. Only one farmer treated the pond with lime.

1.5.2 Extension Efforts

Efforts have been made by the project to introduce improved techniques and management practices for pond aquaculture among the *char* population.

Broad extension messages delivered by CDSP for the char population with respect to pond aquaculture may be summarised as follows:

- Application of lime;
- Pond stocking;
- Application of fertilisers;
- Preparation and application of feed; and
- Deepening of the pond to about 10 feet.

Farmers' attitude toward these messages is, in general, positive. However, the majority households mentioned that they would not invest in further deepening of their respective ponds. With respect to application of lime and pond stocking, there is hardly any attitudinal difference between demo/extension farmers (both old and new) and "control farmers" (others in the *char*). With respect to application of fertilisers and preparation and application of food, demo/extension farmers responded positively to a slightly higher extent than the "control farmers". This may be considered as a direct impact of training.

1.5.3 Major Observations and Lessons for the Future

Farmers are often captive of certain traditional values, ideas and practices, which can affect the productivity negatively. Training and motivation can improve the situation. Some of these practices and ideas are mentioned below:

a. Farmers tend to stock more fingerlings than what is recommended, based on the idea that it would maximise the output, which is contrary to reality. It may be mentioned that farmers often try to keep as many fingerlings as possible in the pond anticipating that some would eventually die. It has been observed that about 25% of the fingerlings die after stocking.

b. Farmers are found to stock species of their own choice. *Tilapia* is the most common species which they stock expecting quick growth and frequent harvests to meet day to day consumption requirements. *Tilapia* is not recommended for perennial ponds where *carp* varieties are cultured as it hampers the growth of *carp* varieties.

c. Farmers tend to apply more feed than what is required undermining the fact (often due to ignorance) that unused feed creates a problem through decomposition.

d. Many farmers are prejudiced against the application of cow dung to the pond as the pond water is also used for other domestic purposes.

For future interventions in the field of aquaculture, the following lessons should be borne in mind:

a. A minimum water level of one meter throughout the year is recommended. This helps in extending the growing period of fish and has a positive impact on productivity. Hence, the farmers should be encouraged to re-excavate their ponds to the desired depth if they intend to culture *carp* varieties.

b. While training farmers on pond management, cultural practices of the people should be borne in mind. The example of using cow dung may be cited in this respect. Although the use of pond water should not be recommended for any domestic purpose because of hygienic reasons, still the people use it for almost all purposes except drinking. A pond is a part of household life. Application of cow dung should be recommended in those cases where there is a tube well "within reach" and the people are aware of the hazard of using pond water for domestic purpose.

c. In the perception of the people, training has been found to be the single most critical factor contributing to higher productivity.

d. Exposure to demonstration ponds and discussion with demonstration farmers helps other farmers to get acquainted with improved technology and management. A group of demonstration farmers, thus, forms the nucleus of technology dissemination to a larger population.

In future char development programs attention should be given to the effects of the typical char environment, as relatively high soil salinity, on pond fisheries, while in the feasibility stage the impact of embankments on capture fisheries should be carefully studied.

1.6 SOCIAL SERVICES

1.6.1 Health

Due to a lack of reliable data on morbidity and mortality, it was not possible to construct a reliable picture of the health situation at the beginning of the project. People in chars are dealing with health problems by seeking curative care that is available. This will often be the advice of a private practitioner cum drugseller in the nearby bazaar. Usually the men of the household will visit these practitioners, also in cases when the complaint is that of a woman. People will probably also to a considerable extent self-medicate, using home remedies or buying drugs in which they came to believe.

Government health care is hardly present in char areas. There is a Upazila Health Complex in Char Jabbar, adjacent to the current CDSP polders, but it is not effectively functional. Most of the time there is no medical officer. Patients are attended to by a medical assistant. It is more or less the same story for the Union Health Sub Centre in Char Bata. Maybe the mobile EPI services (Extended Program for Immunisation) represent the most effective delivery mechanism, although problems with staff presence and supply of vaccine do hamper the level of services.

With a view on its limited time frame and resources, CDSP could not address the health care situation in any significant way. Support was given to the training of 42 Traditional Birth Attendants. The EPI program received some logistical assistance, while three satellite clinics, run by the Upazila Health Complex in Sudharam Upazila, were provided with furniture and a weighing machine. These satellite clinics are held in cyclone shelters built by the project and operate every other week.

The experiences of CDSP as far as health care is concerned are too limited to base well-founded recommendations on for this sector for future char projects. One conclusion is that health care is too important and too specialised to be included in a multi-sectoral water oriented program. It deserves to be brought under a separate project, possible combined with other social services.

Another form of health-related support to the social sector, the provision of deep tubewells and sealed latrines, was earlier described in this report (in paragraph 2.3.3). These activities were obviously also aimed at improving the health status of the char dwellers. It should be recognised however that the results of other interventions, such as making available a greater variety of food, especially vegetables, and decreasing the chances of flooding, are likely to have contributed to an improved health status as well.

1.6.2 Education

The rate of literacy in char areas is very low. According to the population census of 1991, in some villages it is below 10% for the population over 7 years and even less than 5% for women.

There were 19 primary schools in or very close to the project area. The Department of Education runs only one of them, while giving modest salary support for teachers (four per school) to the others. The enrolment as percentage of the age group is 46% for boys and 34% for girls. At the start of the project, 14 schools were located in thatched houses, while none of them had proper furniture or teaching materials. Nine schools had no toilet or drinking water. The schools were run by School Management Committees (SMCs),

but often these were not fully aware of their function. Consequently the expected assistance and co-operation did not materialise. Supervision by the Government, through the Assistant Upazila Educational Officer did not take place.

Within its means, CDSP could only respond to this situation in a limited way. Ten primary schools were shifted to newly built cyclone shelters. Furniture and teaching aids were provided to 18 schools, while 72 teachers and members of 18 SMCs received training.

What was said for health in the previous paragraph, can be repeated for education.

The sector tends to be marginalised in a program with an emphasis on water management and production. A separate education project, or combined with health care, might be a better way to promote education in char areas.

One of the few lessons learnt are that the use of cyclone shelters for educational purposes is indeed a cost effective one. The Department of Primary Education should appoint supervisory staff especially for schools in char areas. The Department should give much attention to training of teachers and of the SMCs.

Chapter 2

THE SEQUENCE AND MANAGEMENT OF THE INTERVENTIONS

2.1 INTRODUCTION

Chapter 1 demonstrated that social and economic development of the char areas through realisation of their potential asks for a wide range of interventions, not only from different sectors but also different in nature. To make the chars safe for habitation and to make them more suitable for productive purposes, protection against flooding from the sea is necessary by building embankments. To control water levels and- flows, sluices in the embankments are needed. On the social side interventions are required to provide security to the people through a title on the land they live and work on and to give them access to basic necessities as shelter, drinking water, education-, health- and sanitary facilities. To strengthen the economic base of the settlers, extension on productive activities is essential, as well as supplies of inputs and some infrastructural provisions, as the excavation of ponds. It cannot be expected that the settlers, in particular in view of their vulnerable situation, can do all that on their own without support. Outside assistance is indispensable to accelerate the development process. To honour and stimulate the settlers' own initiatives and to maximise their involvement in all these efforts, institutions at field level must be formed.

The outside support has to come from governmental and non-governmental organisations, with or without international contributions. Looking at the required interventions, not one but a number of governmental institutions must participate, while the same can be said of NGOs. The harmonisation of activities, the avoidance of overlap and of diverging isolated sectoral approaches poses a planning and management challenge, faced before in other development situations as for instance in the well known integrated rural development- and area development programs. This chapter, especially the second part, is about that challenge and the lessons of CDSP as far as institutional relations are concerned.

The chapter starts with another sort of relationships, the ones between the activities themselves. Many, if not all, of the interventions and their impact are interdependent on account of the fact that they aim to benefit the population that shares the same geographical space. A number of these activities can be implemented parallel to each

other, a number however are sequential: they can only be implemented after others have been completed. The sequence of activities in char development is the subject of the next paragraph.

2.2 THE SEQUENCE OF ACTIVITIES

As was mentioned in the introduction of this report, CDSP focused on the transformation of unprotected char lands into protected *polders* with embankments and a newly designed system to drain water. The very first step in this process usually is the identification of unprotected chars that fulfil certain criteria. In case of CDSP these were very much the availability of a reasonable amount of *khas* land where landless households can be settled and a sufficient land level of the area. After the identification feasibility studies have been carried out, some more elaborate than others, in order to assess the potential for development and to formulate the interventions needed to realise that potential. Apart from setting the stage for the actual implementation, such studies are understandably required as well for the process of approval by government agencies. Because the feasibility studies have major consequences for what is actually going to happen in the area, involvement of the population during the study is essential. There are however a number of considerable constraints in this respect. In many cases the population that have settled in unprotected areas will be land grabbers with other motives than only their own settlement. Usually people will not be organised yet, so it is difficult to find a platform to discuss the plans, while very often many of the people that will ultimately live in the area, are not yet present. With all these drawbacks in mind, the feasibility study team has to find some kind of mechanism to find out the views of the settlers. Given the constraints in participation of the ultimate beneficiaries, the feasibility studies should probably not go into too much detail of the planned interventions.

The ultimate impact and sustainability of development oriented interventions in char areas are for a part determined by their sequence. Sequence is of importance because some activities can only take place or will be much more effective if other activities have been implemented earlier. On the whole, the order of interventions in time is to a great extent determined by considerations of people's participation and by technical considerations. In the reality of char development programs, two clusters of interventions form the primary blocks that set conditions that are necessary for the implementation of other activities. They are on the one hand the land settlement process and on the other hand the construction of protective infrastructure.

The outcome of the first steps of the land settlement process, the plot-to-plot-survey which establishes the current situation of land ownership (*khas* land, ancestral claims, existing legal titles etc.) and the consolidation of the survey, open the way for the physical planning of the area to be protected. Because the ownership status of all land is known, locations for internal infrastructural works as roads, cyclone shelters and clustered villages can be identified. The outcome of the survey is therefore critical for a major part of interventions aimed at char development.

A few steps further in the land settlement process, after the preparation of the allotment sheets, it is known which households are going to be settled where. After that the efforts of forming field level institutions as for instance the Sub Polder Committees and Polder Committee can start, because the electorate for these institutions is defined.

Also Water Management Committees can be established, due to the fact that the location of the water management systems with the sluice as the apex structure, was already known earlier as an outcome of the other primary block of activities, the design of the protective infrastructure.

While the plot-to-plot survey is the gateway to internal physical planning and the allotment sheets to more permanent forms of people's participation, completion of the protective infrastructure is needed before the construction of the internal infrastructure can actually start. Roads can be built because the possibility of flooding is greatly reduced. The same applies to houses, cluster villages, fish ponds and sanitary facilities. Cyclone shelters and tubewells could be built without the protective works being completed, but in practice the lack of a physical plan (see above) might make that undesirable.

In practice, outside agencies face a dilemma when starting in an unprotected but already (partly) inhabited area. The people already living there are in want of some form of protection that can be given by cyclone shelters, while access to drinking water is by all seen as a top priority. The provision of cyclone shelters and tubewells would certainly fulfil felt needs, but at the same time might attract other people to a physically vulnerable situation, running the risk of seeming to legitimise illegal settlement. Also the location might be at variance with physical plans for the area that are developed at a later stage. In such a situation, there is no other prescription to give than that agencies should act as they think fit in that particular circumstance, keeping the overall objective of the program in mind.

It could be argued that also the protective infrastructure can only be taken up after the allotment sheet is prepared, because then it is known whom to consult, for instance, for the alignment of the embankment and the location of the sluices. There are two pragmatic arguments however that lead to the recommendation to start the design right at the outset of the program. One is that the location of the protective structures are nearly totally determined on the basis of physical features; in most cases there is little room for many or significantly other alternatives. Another reason is the loss of time this would cause. The design and construction of embankments and sluices is already time consuming and any delay should be avoided as much as possible. Experiences in CDSP give no reason to suppose that start on construction activities will stimulate unwanted migration into the area that would interfere with the process of land settlement. Immigration will probably take place anyway. Only the rumour that the area in question is targeted for a project might cause people to move in. The conclusion is that the design and construction of peripheral infrastructure and the settlement process can be undertaken simultaneously.

Experiences in CDSP to date indicate that for completion of all the works related to protection and development of as yet unprotected chars, a period of about five years is required. The better part of the first year is needed for a study at feasibility level, while much of the second year will be spent on carrying out the initial more detailed surveys as the baseline survey on socio economic data and the plot to plot survey on the land situation. The second year is also needed to prepare the implementation of the peripheral infrastructure, such as the detailed design and the issuing of tender documents. Planning of the internal infrastructure can also start in the second year, followed by detailed designs in the third year. Year three, four and five are needed to complete all physical works and the process of land settlement.

Until now the discussion focused on the sequence between components of char development, as presented in the previous chapter. Each of the individual components can be broken down into a series of activities, which, in most cases, have to be carried out in a particular order. This sequential pattern for the various components is given below. The activities in *italics* are activities from other components that have to be completed first before the activities in the component concerned can proceed. The normally printed activities are sequential within the component, but can generally be executed parallel to activities in other components.

Land Settlement

1. *Feasibility study (with certain type of participatory mechanism)*
2. Plot-to-plot survey land/baseline survey
3. Consolidation land survey
4. Start land settlement process
   a. Public scrutiny
   b. Upazila Task Force approval
   c. Allotment sheet
   d. *Kabuliyat* signing by settlers
   e. Kabuliyat signing by DC
   f. Registration
   g. Khatian hand over
5. Monitoring of actual possession of land.

Protective Infrastructure

1. *Feasibility study (with certain type of participatory mechanism)*
2. Detailed designs of embankments, sluices and main khals on basis of feasibility study
3. Acceptance of detailed design and final alignment of embankments, location of sluices and khals by population, using the same participative mechanism as in feasibility study
4. Construction of embankments and sluices
5. Excavation of khals.

Internal (Transport and Social) Infrastructure

1. *Feasibility study (with certain type of participatory mechanism)*
2. *Plot to plot survey land/baseline survey*
3. *Consolidation land survey*
4. *Formation of SPCs and PCs*
5. Physical planning of social and transport infrastructure in constant consultation with SPCs and PC

6. Acceptance physical planning plan by PC
7. Detailed design of clustered villages, cyclone shelters, houses.
8. Installation of test tubewells
9. Acceptance detailed design by PC
10. Implementation internal infrastructure (transport and social infrastructure) of polder.

Agricultural Development

1. *Feasibility study (with certain type of participatory mechanism)*
2. *Plot-to-plot survey land/baseline survey/land type survey*
3. *Consolidation land survey*
4. *Identification or, if required, formation of farmer groups*
5. Training of DAE staff
6. Training of groups of farmers
7. Tests
8. Demonstrations, extension work.

Aquaculture Development

1. *Feasibility study (with certain type of participatory mechanism)*
2. *Plot-to-plot survey land/baseline survey*
3. *Consolidation land survey*
4. *Physical planning of social and transport infrastructure in constant consultation with SPCs and PC*
5. *Acceptance physical planning plan by PC*
6. *Detailed design of clustered villages, cyclone shelters, houses*
7. *Excavation of ponds*
8. *Formation of fishery groups*
9. Training of staff of Department of Fisheries
10. Training of fishery groups
11. Tests
12. Demonstrations, extension work.

Community Development

1. *Feasibility study (with certain type of participatory mechanism)*
2. *Plot-to-plot survey land/baseline survey*
3. *Consolidation land survey*
4. Formation of NGO groups
5. Start of community development work through NGOs.

Formation of Field Level Institutions

1. *Feasibility study (with certain type of participatory mechanism)*
2. *Plot-to-plot survey land/baseline survey*
3. *Consolidation land survey*
4. Formation of SPCs and PC
5. Formation of Water Management Committees
6. Identification or, if required, formation of farmer groups and of fishery groups
7. Formation of tubewell user groups, caretaker families.

2.3 THE ACTORS INVOLVED

2.3.1 Low Density of Institutions

After independence Bangladesh embarked upon an ambitious afforestation program. The backbone of these efforts was formed by the policy decision of the Government to lease all newly accreted lands to the Department of Forestry for a period of at least 20 years. After 20 years a committee can decide whether to release the land to the Ministry of Land for settlement or whether to continue the lease of the Forestry Department. As a result, forests can be found along vast stretches of the coast, and consequently also representatives of the Forestry Department. In many unprotected char areas this is the only government presence, in some cases in a rather hostile environment. It must be observed here that in practice no land was released for settlement in the coastal areas by the Forestry Department after the afforestation program started.

In those areas where land is available for settlement, other branches of the government become gradually visible, often starting with the officers of the land registration and land settlement institutions. In the sequence of activities described earlier in this chapter, the BWDB comes in rather early for construction of protective infrastructure: embankments and sluices. In many coastal areas BWDB is already historically present because of its involvement with the Coastal Embankment Project and later the Coastal Embankment Rehabilitation Project. The protective works are followed by the internal infrastructure as roads, cyclone shelters, houses and tubewells, in which LGED and DPHE have prominent roles. After that social service organisations as the Departments of Health and Education can be expected, making use of the created infrastructure.

The government services are usually present with a much lower density than in older, more settled areas. For instance, in the CDSP polders, the Health Department runs only satellite clinics in cyclone shelters twice a week in the three project chars. In these chars there are at present 20 primary schools, of which only one government school; the others are run by School Management Committees with only marginal support (some allowance for the teachers) from the Department of Education. The area has no High School. The Department of Agricultural Extension is present in the chars but its Block Supervisors have to cover more households and a larger area than in other parts of the country.

On the whole it can be said that it has been a merit of CDSP, as a secondary but significant impact, that it facilitated the mainstreaming of hitherto marginalised char areas by stimulating a process of drawing in of government service delivery systems. Examples are, among others, the extension services of DAE and the Department of

Fisheries and the construction activities and maintenance support of LGED and BWDB. Sudharam (Sadar) Upazila of Noakhali District is, area-wise, one of the largest upazilas in the country. Plans exist to create a new upazila in the most southern part, which would mean that a great number of government services would come closer to the char population. This might not be a direct result of CDSP, but the project no doubt contributed to this development. At Union level a similar trend has already started. At the end of the 1980s, out of Char Jabbar Union four new Unions were created. Another division like this is to be expected elsewhere in the project area, with support from the population.

Similar observations can be made for non-governmental organisations and also for forms of community organisation in the chars. NGOs had no strong presence, while the usually heterogeneous char population did not have a history of co-operative bonds or other forms of community organisation. As shown below, CDSP supported further involvement of NGOs in the chars and both CDSP staff and NGOs worked on field level institutions.

Also the private sector is usually hardly present in char areas. The combination of construction of (peripheral and internal) infrastructure and of extension activities to exploit the improved environment for production has, however, led in the three CDSP polders to an upswing of the private commercial sector. The number of shops increased more than twofold, while new trades found their way to the markets in and around the project areas. Mechanical workshops have increased in number. Some of the settlers brought new crafts with them, new to the char where they now live.

Earlier, while dealing with the construction of roads (see 2.3.3), the impact of the improved transport facilities was discussed. Most of the markets expanded their command area, which for some local markets had a negative effect because they had to face more competition. The reduction in transport costs opened up the markets causing a decrease in prices of goods that were imported into the area, while at the same time some locally produced goods became more expensive. Although the number of rice husking and crushing mills increased in places adjacent to the project polders, in general the interventions did not result in any significant increase in manufacturing activities. The growth of the private sector was to a large extent limited to the service sector. Financial institutions did not yet establish branches in the polders, but the improved communications made banks elsewhere more accessible.

In the process of drawing services towards the char areas, CDSP had to deal with, or, in other words, was constituted of a number of institutions, governmental and non-governmental, big and small. In the following paragraphs they pass in review, followed by a discussion on the co-ordination between them.

2.3.2 The Most Important Government Institutions Involved and the Distribution of Tasks Between Them

In case of CDSP, the Ministry of Water Resources (MoWR) acted as the apex body of the project. The umbrella Technical Assistance Project Proforma was issued by this Ministry, while there were three individual PPs: MoWR (for the activities of the BWDB), the Ministry of Land and the Ministry of Local Government and Rural Development (for the work of the Local Government Engineering Department). The Secretary MoWR chaired the National Steering Committee (see 2.4.4. below).

The most important implementing agencies in CDSP have been the Ministry of Land, the BWDB, the LGED, the Department of Agricultural Extension, the Department of Fisheries, the Department of Health and the Department of Education. Their work in CDSP, and in general in char areas, are conform their mandate and are briefly described below.

One of the characteristics of char areas is that, since they are newly accreted land from the sea or riverbed, they offer possibilities of distribution of *khas* land among landless households. The process of identification of *khas* land and of settlement was the subject of paragraph 2.2.2 of this report. There it became clear that the Ministry of Land, especially through its representatives at District level, the Deputy Commissioner and his staff, is the responsible institution.

The Bangladesh Water Development Board is responsible for all the protective infrastructure, which mainly consists of sea facing- and interior embankments and sluices to control the water flows through the embankments. The BWDB is also involved in (re)excavation of main drainage channels.

The Local Government Engineering Department is for a great deal in charge of the infrastructure within the newly created polders. Major works in case of CDSP were the rural roads, the bridges and culverts in the roads, the cyclone shelters, the tubewells and the toilets. In future projects, and in general in char areas, it seems only natural that the Department of Public Health Engineering takes care of tubewells and toilets.

The Department of Agricultural Extension has the responsibility for all interventions related to field crops and homesteads. Most important activities in case of CDSP were the testing of various methods of extension, formation of groups of demonstration farmers, the testing of different varieties leading tot the composition of suitable packages for char areas. Experience in CDSP has learned that more attention has to be given to the supplies of inputs such as fertiliser and good quality seeds. The private sector has an important role to play in this respect and must be stimulated by the government to take up that role. Other agricultural organisations that contributed to the project were BRRI and BARI.

The Departments of Fisheries and of Livestock (at national level both under the Ministry of Fisheries and Livestock) have a similar responsibility for aquaculture and livestock as DAE has for agriculture. Testing of suitable production methods and extension form the core of their work. In future, more attention should be given to the impact of protective infrastructure on capture fisheries and to the position of marine fisheries in the livelihoods of the coastal population. Livestock is particularly significant in, as yet unprotected, char areas. Animal health is obviously a major issue in that sector. CDSP extended only marginal support to the livestock sector, which is the reason why this sector has not been discussed in this report.

The Department of Forestry did not participate in CDSP to date, but, as was indicated earlier, has great responsibilities in coastal areas. The Department is the custodian of newly accreted land. Plantation of mangroves and trees provide a protection against floods and cyclones while it stimulates further accretion and stabilisation of land. The Department is the main actor for social forestry activities as the planting of trees alongside roads and embankments. Experience has shown that trees are a defining factor in providing protection for houses in the chars against heavy storms. They also can diminish evaporation in fresh water reservoirs like ponds and *beels*.

2.3.3 Local Government Bodies

From the time of launching of CDSP, the Union Parishads were related to its planning and implementation through membership of its Chairman or members in field level institutions. The Chairman of the Union Parishad with the largest area in each of the polders was made Chairman of the Polder Committee and thus was well informed about each of the project activities. The UP Chairman is ex-officio member of the Water Management Committees in the Union concerned. In Char Bhatirtek, one of the UP Chairmen is president of the Federation of WMCs. The UP Chairmen are members of the Upazila Task Force Committee that plays a key role in the land settlement process.

There is considerable double membership between the Union Parishads on the one hand and the PCs and WMCs on the other. Around 30% of the PC members also sit on the UP; the same percentage applies to the WMC members. For the SPCs this is much lower: 4%.

The links of future char development programs with elected local government institutions, in future the Upazila Parishad and the Union Parishad, are of great importance. Already in the design of the program these links should be taken care of. The Parishads should have a role as *institution* and not only through the inclusion of its members in other institutions.

2.3.4 The NGOs

In 1994, eight NGOs were based in Noakhali that were more or less involved in work in char areas, four national and four local ones. CDSP opted to work closely with local organisations for work with Labour Contracting Societies (LCSs) and for community development in clustered villages. The selected NGOs were Sagorika, Upoma and N-RAS. Supervision and support of their work was carried out by the consultant team of CDSP, while on an intermittent basis support was given by BRAC as well. The LCS work started in 1996, the community development activities only in the beginning of 1998. For the community development work, which was limited to the clustered villages, the NGOs formed their own groups. The NGOs in general did commendable work as far as the LCSs are concerned, while it is too early yet to draw conclusions for the community development.

The number of NGOs active in the chars has not increased over the years. Some local initiatives to form new NGOs did not succeed. Some of the NGOs, however, intensified their work in the chars, partly in the framework of CDSP.

It has become clear that capability building of local NGOs deserves high priority if they want to play any substantial role in coastal development in future. To give this aspect proper attention, the task of strengthening local NGOs, that have the great advantage of knowing the area and the local issues, should in future programs be given to an established and recognised national NGO.

2.3.5 Field Level Institutions

CDSP realised the involvement of the population by promoting and actively supporting the establishment of a number of field level institutions:

- Polder Committees (PC) and Sub Polder Committees (SPC) in particular for planning of internal polder infrastructure;

- Water Management Committees (WMC) for operation and maintenance in each of the water management systems;
- User groups of water and sanitation facilities for operation and maintenance of those facilities; and
- Groups formed by NGOs in clustered villages for community development purposes.

Each of them has been dealt with already earlier in the report. The SPCs and PCs have clearly proven their value in the planning process, especially with regard to the planning of the internal infrastructure as roads, bridges, cyclone shelters and tube wells. They also were instrumental in the formation of the Water Management Committees. The experiences with WMCs, although still over a short period, are encouraging. The tubewell user groups have proven to be valuable, especially with regard to O&M issues. All these field institutions should be included in any future char development program.

The composition of these institutions need however attention. In paragraph 2.3.3. the overlap of memberships of UPs and PCs, SPCs and WMCs was mentioned. There is substantial influence of UP members on PCs and WMCs, much less so on SPCs (which in practice did much of the work with regard to internal polder infrastructure). There is also a relatively high level of membership in the institutions of persons (non UP members) that can be considered to belong to the social elite of their area: 14% in PCs and 13% in WMCs; for SPCs it is 6%. Combined with the UP members these percentages would be 45%, 44% and 10% respectively.

Women are underrepresented in the institutions. In CDSP 23% of PC members and 17% of SPC members were female. Currently the WMCs consist for 12% of women. The tubewell users groups are exclusively female, while there are male and female NGO groups of clustered village settlers.

Both the gender imbalance and the considerable influence of the top of the social structure in the field level institutions have to be addressed in future programs. A system of quotas for women and for representatives of disadvantaged groups might be considered, but only as a temporary measure. The dominant influence of the UP is a general phenomenon in the country. The population should be made aware of the importance of the composition of local government bodies and be stimulated to stand for election in these bodies. In particular young people and women should be targeted.

2.3.6 The Team of Consultants

To assist with the implementation of CDSP, a team of consultants was contracted by the Netherlands government under an agreement between the two governments. The team's main function was to advise the implementing institutions mentioned in 2.3.2 to 2.3.4 In addition, the consultants were involved in:

- Carrying out surveys and monitoring activities;
- Performing co-ordinating tasks if another body was not available;
- Providing training to implementing agencies; and
- Controlling the quality of the infrastructure constructed under the project.

The team consisted of seven Bangladeshi and one expatriate consultant who were permanently present in Noakhali, supported by four expatriate consultants on short term

basis (for six months a year on average). The fields covered by the consultants were land settlement, land and water engineering, quality control of infrastructure, agricultural extension, institutional- and community development, socio-economic matters and project management. The support staff (technical and administrative staff) amounted to around 50, all Bangladeshi.

In view of the fact that the government functions are not yet fully developed in char areas and the scattered presence of NGOs in those areas, the support of consultants in any sizeable future char development effort seems advisable. It should however be made absolutely clear to everyone involved what the exact role of the consultant team is. Especially the division of tasks between government agencies and consultants should be explicitly stipulated and intimated to the char population.

2.4 CO-ORDINATION ISSUES

2.4.1 Introduction

The harmonisation of activities, the avoidance of overlap and of too diverging and isolated sectoral approaches towards the population were termed as a management challenge in the introduction to this chapter. It is indeed a challenge to combine the blessings of efficient operation with the need of co-ordination. The previous paragraphs have made it clear that, with so many institutions involved, co-ordination is an absolute necessity.

In case of CDSP a model was chosen not of a central agency in charge of char development, but of implementation by Governmental line agencies with certain mechanisms for co-ordination. These mechanisms were developed at national- and at District level, but need to be extended downwards to local government body levels as well. Co-ordination to date was very much provided by typical project instruments, while for future char development efforts more permanent mechanisms might be identified or developed.

Below, the co-ordination mechanisms at field level, project level and national level are addressed, the horizontal co-ordination as it were. For the connection between those levels no special project arrangements were put in place. Between project (District) level and national level the links followed the normal lines within government organisations, while the consultant team maintained contact with donor representatives. The link between field- and District level was given shape by Upazila officers for the government services, by NGO staff and by consultants, especially the field co-ordinators posted in each of the polders. A pattern of contacts between the WMCs and agencies as BWDB and LGED is emerging.

2.4.2 Co-ordination Among Field Level Institutions and the Link with Local Government

The institutional environment at field level in the chars where CDSP was active consisted of the following seven institutions: Polder Committees, Sub Polder Committees, Water Management Committees, tubewell users groups (all established in the CDSP framework), NGO groups, Labour Contracting Societies (organised by NGOs) and School Management Committees (formed by the Department of Education). Of these, the PCs and SPCs are

temporary. They were abolished at the end of the project period, after all internal polder infrastructure was completed. The question is what the need and mechanisms are for co-ordination among those field level institutions and what their links are to the local government structure.

The needs for co-ordination among these institutions were in practice met by a pattern of bilateral meetings and not by an umbrella platform where they all come together. The PCs and SPCs co-ordinated with the Union Parishad and with LCSs through meetings. The WMCs had meetings with the UPs concerned. The meetings were held on initiative of the groups or of NGOs and consultant staff. WMCs also met with representatives of LGED and BWDB on operation and maintenance issues. The double memberships of UPs and PCs and WMCs (see 3.3.3) provide implicitly an instrument of co-ordination.

A thorough evaluation of the effectiveness of this pattern of co-ordination did not take place, but the impression exists that it worked satisfactorily enough. If, in future, stronger forms of co-ordination are required, it seems to be the task of the local government bodies, especially the Union Parishad, to arrange that.

2.4.3 Co-ordination at Project — and District Level

CDSP worked in two upazilas of Noakhali District. In practice project level and District level were the same. The project was very much locked into the District administration. The consultants worked closely together with the various government institutions at District level. At that level however, there was no natural host organisation that can be responsible for co-ordination of an interdisciplinary and inter-sectoral project as CDSP. A project instrument was created called the Project Management Committee (PMC). Members of the PMC are representatives of all involved governmental agencies, of the three local NGOs participating in community development efforts of CDSP and of the consultant team. The PMC, with in total 15 members, is chaired by the Project Director CDSP.

Although the PMC was meant to meet every month, in reality around eight meetings per year took place. The attendance rate was around 70%. Meetings concentrated on practical issues with regard to the progress of project interventions. Discussions usually were structured component-wise (land settlement, infrastructure, productive development, social sectors). The PMC can be considered effective in bringing the issues regarding the progress on the table and in informing all parties involved on the progress. More attention should be given in future to inter-component relationships. Much of the co-ordination work was taken care of by consultants during bilateral contacts with the various participating institutions. In future a proper representation of field level institutions in the PMC should be considered to strengthen the ties between field- and District level.

Co-ordination at District level is of great importance for every char development effort, given the importance of the mandate of the District level administration. An instrument as the PMC is certainly needed, but it should be closer linked with existing regular co-ordinating mechanisms in the District administration such as the District Co-ordination Development Committee.

CDSP has found out to its cost that co-ordination between the staff of the different components of the project needs full attention of project management. Co-ordination is compounded by the fact that project staff consists of both government officials and

consultants (both long- and short term), most of them located in different offices. Some of the less than optimal results of CDSP can, for a part, be explained from lack of internal communication. Mechanisms should therefore be put in place to avoid sectoral isolation, and even sectoral rivalry, and to prevent situations where activities of different components interfere with each other. In particular, the creation of small thematic committees should be considered to co-ordinate particular clusters of activities. For instance, one such cluster could be 'Productive Development', with participation by key staff of the program and line agencies in agriculture, homestead development, fisheries and water management. The committee should meet monthly and invite other actors to attend as need arises. It should not degenerate into a formality but develop as a brainstorming forum where new ideas arise and new approaches are developed. The thematic or issue based committees could be seen as sub-committees of and should report to the Project Management Committee.

Another aspect of co-ordination at project level and a lesson from CDSP is the need for a systematic flow of information from the grassroots upwards through the organisational layers and regular analysis of that information. More should have happened in this respect in the past, which would have resulted in more effective co-ordination between the project components. An example is the information gathered by block supervisors of the DAE. Their valuable information on farmers' constraints and opportunities was not effectively digested and used as an input in the program's planning process. In a future program, there should be a systematic and explicit system for generating and using a continuous flow of bottom-up information. A short monthly bulletin in Bangla and English could be considered which summarises the issues raised by farmers through the different field activities. This information would be important for all sections of the project and should be one of the inputs into the monthly thematic committee meetings.

2.4.4 Co-ordination at National Level

For co-ordination at national level, a National Steering Committee for CDSP was constituted. The NSC, chaired by the Secretary MoWR, consists of representatives of MoWR, the Ministry of Local Government and Rural Development, the Ministry of Land, the Ministry of Agriculture, the Ministry of Fisheries and Livestock, the Planning Commission, BWDB, LGED and the Royal Netherlands Embassy. The Project Director (of BWDB) and the Team Leader of the consultant team of CDSP are invited as well. In general the Ministries are represented by an official of the rank of Deputy- or Joint Secretary.

The intention was to have two NSC meetings a year, which indeed was realised in practice: during nearly five years of CDSP, 11 meetings took place. The level of attendance was about 80%, which can be considered satisfactorily. The Meghna Estuary Study project shared the same Steering Committee and meetings on CDSP and MES were in practice consecutive.

The discussions during the NSC meeting were for a great deal devoted to the progress of project activities and to the bottlenecks hampering progress. Approval of PPs, utilisation of funds and size of Annual Development Plans of the concerned line agencies were recurrent issues. The preparation and the results of the mid-term evaluation were important subjects in 1997, while during the last year attention shifted to planning of a

possible next phase. The fact that MES belonged to the mandate of the same Steering Committee helped the co-ordination between the two, in particular as far as the feasibility studies implemented under these projects were concerned. Studies carried out by MES, as for instance on South Hatia/Nijhum Dwip, were drawn into the planning of CDSP.

The NSC was undoubtedly effective with regard to the exchange of information on the activities of the various implementing agencies. It also facilitated the solutions of problems causing delays in progress. It played a key role in the planning of the next phase of CDSP. All parties agree that an institution as the NSC must be continued in future. Efforts must be undertaken to move the discussions beyond the mere progress of the project, although this will continue to be an important subject, and to debate more policy oriented issues on coastal development as well. In this respect, the contents and institutional set-up of the upcoming Integrated Coastal Zone Management Program is very significant for the future functioning of the NSC as well. Transfer of a project-tied NSC to a Permanent Steering Committee for coastal areas might be considered.

Chapter 3

BENEFITS AND COSTS OF CHAR DEVELOPMENT

3.1 INTRODUCTION

In this chapter an effort has been made to compare costs and benefits of CDSP in relation to the three polders Char Baggar Dona-II, Char Majid and Char Bhatirtek. It addresses the question why a char development program should be undertaken at all. While economic aspects are important, non-economic considerations like equity and security may sometimes overrule these. The next paragraph summarises those non-economic benefits, while paragraphs 3.3 to 3.6 are entirely devoted to the economic ones.

The technical assistance effort in CDSP is also a learning experience, a study effort to build enough knowledge to improve the direction and size of investments in future. As such, these are long term benefits of CDSP (and the earlier LRP), and possibly more important than the short term feasibility of its present activities.

3.2 NON-ECONOMIC BENEFITS

In the introduction of Chapter 1, the vulnerability of the coastal chars and its settlers has been emphasised and the efforts of CDSP to give the population some sense of security has been highlighted. Other concepts that capture the non-economic beneficial impact of the project interventions are equity, access and awareness.

The peripheral infrastructure of embankments and sluices provided protection against environmental hazards as flooding and salinity intrusion and consequently contributed to security of life and property and to improvement of the economic potential. Security related to property was further enhanced by the process of land settlement, ultimately resulting in a situation where many of the settlers have an official title deed on the land. The possession of such a title increased the social status of the households concerned and their bargaining power. The stronger economic base enhanced the possibilities to indeed hold on to the newly acquired land. The combined effect was an enhanced capacity to loosen the grip, if it was there, of the *jotdars*.

The land settlement efforts brought about distribution of land which was more equal than at the outset of the project. Apart from the greater access to land, the population indeed had greater access to safe drinking water close to their homes (especially

important for women), to sanitary facilities and to social services as health and education. The chances on a better health status increased by the availability of drinking water and health care, as well as by the possibility of a greater variety in diet (for instance the availability of vegetables and fish).

The higher level of awareness is probably the most intangible benefit and the one most difficult to prove, but the impression exists that it is significant. Communication with other areas decreased the isolation. The mobility increased, also of women, and with that a greater sense what is happening elsewhere in their environment. The knowledge base of the char dwellers on a number of subjects was broadened, especially with regard to new technologies that can be applied for a higher economic production.

3.3 INCREASE IN ECONOMIC PRODUCTION

The direct economic benefits generated by the project can be summarised as follows:

1. A shift towards HYV (or MV) for T-*aman* already after one year of closure of the embankment, on all medium and wet high lands;
2. An extra *aus* crop starting three years after protection, but only on high and low lands;.
3. More rabi crops after one year, now also on medium land (before only on high), and a shift towards HYV;
4. Reduced crop losses due to floods (once every 5 years before);
5. More and better (HYV) homestead crops (vegetables) from one year onwards;
6. Increased fish production because of proper management of culture ponds.

More indirect benefits resulting from the improved transport facilities, among them the boost to the private sector, have been mentioned earlier. These indirect benefits are not taken up in the analysis of this chapter.

The analysis is based on an economic lifetime of 20 years. In many projects a longer lifetime is taken as the basis for cost/benefit calculations. With a view on the dynamic physical environment of char development programs (see 1.3.1), a period of 20 years seems warranted.

About 4,000 ha (of the total 5,000) in the three polders is cultivable land, the rest is occupied by houses (incl. homesteads), roads, canals, dykes and ponds. T-aman development can take place on 3,000 ha, 75% of all the land (where there was almost no HYV before), an extra aus crop on 1,200 ha (30% of the land), new rabi crops on an extra 2,000 ha (50% at least), and improved gardening on roughly 150 ha. The realisation of these full benefits roughly takes ten years, but grows rather quickly. Both LRP and CDSP provide examples of quick adoption of new technologies. These assumptions, for a part supported by evidence, lead to the following pattern of agricultural benefits:

Aman

An introduction of HYV on about an additional 400 ha per year is assumed for seven years only, so that then almost all of the potential land (2,800 of 3,000 ha) will be under HYV. Local varieties will improve from 1.2 t/ha to 1.5 t/ha in three years, starting

one year after protection, whereas HYV yields will then increase from 2.2 t/ha to 3 t/ha in four years. Further yield increases due to intensive extension (fertiliser etc.) have been ignored. However, a general output increase of 10% per year after completion of the embankment is taken into account, as before there was considerable flood damage (once every five years), which amounts every year to 480 tons (10% of 1.2 t/ha × 4,000 ha).

Therefore, extra production of aman paddy will grow as follows: 1,280 tons in year 2, 1,760 tons in year 3, 2,320 tons in year 4, 2,880 tons in year 5, 3,480 tons in year 6, 4,080 in year 7, and then every year 4,680 tons for the remaining part of the 20 years period. Total incremental output due to the project will be 76,640 tons.

Aus

A new aus crop will now be possible on 1,200 ha max, starting after 3 years, say 20% each year, 240 ha, until year 9, and say then at the end HYV introduced on 50% of the land. Again, yield increases due to desalination will be captured. Local varieties will increase from 1.4 to 1.6 tons in three years, HYV from 2.6 to 3.0.

Aus paddy output will grow as follows: 456 tons in year 4, 980 in year 5, 1,572 in year 6, 2,096 in year 7, and from year 8 onwards 2,620 tons every year. Total incremental output in 20 years due to the project will be 39,164 tons.

Rabi

An extra 20% of cultivable land will be brought under rabi crops every year for the five years after year one after protection, 400 hectares each year, so that in year six the optimum of 2,000 ha will be reached. The spread of HYV is taken into account indirectly by allowing for yield increases for HYV due to soil salinity declines, which varied from 25 (garlic) to 100% (chillies), the others being close to 70%.

Starting from an average net income from one hectare of rabi crops of about Tk 9,000 (97/98 prices) before empolderment, based on an equal distribution (0.2 ha each) of the main crops khesari (Tk 2500 per ha), groundnuts (Tk 10,000 per ha), chillies (Tk 14,500 per ha), garlic (Tk 15,000 per ha) and sweet potatoes (Tk 3,000), net benefits from rabi crops will grow from Tk 3.6 mln in year 2 to Tk 54.7 mln at the end of the project. Incremental incomes due to the project will total Tk 638.7 mln.

Homestead Gardens

Vegetable growing can now reach gross margins of Tk 50-100,000 per ha (in 97/98 prices), as new crops and better varieties can now be grown with flood protection, mainly for home consumption. A 20% net increase in production, caused by improved soil conditions resulting from empolderment, on a total homestead area of not more than 150 ha (about 5000 households having 0.03 ha on average) is assumed. If the extra costs are deducted, this would lead to annual benefits of roughly Tk 15,000 × 150 is Tk 2.2 mln. Adding another Tk 0.8 mln per year for some new possibilities, already visible, for tree growing (jackfruit, coconut, leechees), would lead to a total of Tk 3 mln per year. Over the lifetime of the project this would mean extra net incomes of Tk 57 mln.

Fish Ponds

Improved culture fishing will be possible on roughly 200 ha, i.e. an average pond of 0.05 hectare for 4,000 households. Evidence shows that returns can grow rapidly with better management, five times its cost in three years, but declining again after the project support end (to three times cost). Paddy-cum-fish culture can lead to an extra fish output of 375 kg/ha at minimal cost, without harming the paddy crop. There is however an (unknown) negative project effect from the disappearance of capture fishing. As it is technically possible to manipulate sluices in such a way that some water may enter the new polders before the monsoon, without harming the crops, that loss does not have to be large. Moreover, if one ignores the extra benefits from paddy-cum-fish culture that has now become possible, one probably compensates for any loss due to stopped capture fishing. Yet, future monitoring of capture fishing before starting new polders is necessary.

It seems fair to assume output increases without any more extension up to 1,500 kg/ha. Therefore, an additional 1,000 kg/ha fish (over 500 kg/ha at the start) can be predicted from five years onwards. On the total of 200 ha this would lead to the following additional output: 40,000 kg in year 2 (700 kg/ha, 200 kg/ha more than before), 80,000 kg in year 3, 120,000 kg in year 4, 160,000 kg in year 5, and an extra 200,000 kg of fish every year from year 6 onwards.

This would lead to the following net returns from fishing (in 97/98 prices): Tk 0.96 mln in year 2, Tk 3 mln in year 3, Tk 4.8 mln in year 4, Tk 6.8 mln in year 5, and Tk 8.8 mln from year 6 onwards.

Total Benefits

Total benefits from the project (paddy, vegetables, fruits and fish) are estimated at Tk 1,415 mln over its lifetime, or average annual benefits of Tk 74.5 mln. Per household that would be an annual income increase of about Tk 10,500, per capita Tk 1,800 (14% of national per capita income in 97/98), and per hectare of cultivable land Tk 18,600, and Tk 14,500 per ha of total land.

This can be compared with investment cost of Tk 58,000 per ha of total land, Tk 75,000 per ha of cultivable land, Tk 42,000 per household and Tk 7,250 per capita. Annual O&M cost were Tk 1,020 per ha (of total land) or Tk 715 per household.

It is clear that the major benefits originate from the extra rabi crop that is now possible (45% of benefits) and the introduced HYV aman (30%). The extra aus crop and fisheries provide another 10% each and the homesteads 4%. Present response by farmers shows that the increased security (flood protection, title deeds) does provide an encouraging incentive to invest in the land, which was not present without the project.

3.4 COST OF DEVELOPMENT OF THE THREE CDSP POLDERS

Total expenditure of CDSP for the period 1994-1999 will be Dfl 18.8 mln, as funded by the Dutch government, which was equal to Tk 423 mln at the start. Out of this amount Dfl 11.8 mln has been for financial assistance, with the balance of Dfl 6.6 mln for technical assistance. The Government of Bangladesh contributed nearly Tk 87 mln mainly for staff and some infrastructure.

Major expenditure items were: cyclone shelters Tk 64 mln, roads Tk 48 mln, sluices Tk 31 mln, canals Tk 28 mln, bridges and culverts (and one closure) Tk 23 mln, embankments Tk 19 mln, clustered village houses Tk 20 mln and ponds Tk. 19 mln, tubewells Tk 9 mln and other smaller items (offices, toilets) Tk 8 mln.

While cyclone shelters are very valuable, saving human lives, these have little to do with the direct economics of char development, and may therefore be excluded from this picture. The same applies to houses, tubewells (for drinking water only), toilets (and offices) which mainly serve a social purpose, reducing total project investments in this context to Tk 169 mln.

Technical assistance is usually excluded from a CBA as well, as this is supposed to be for transfer of knowledge and training — the extra benefits of which are assumed to equal its costs in the long run — and for donor supervision, not directly related to any immediate economic impact. However, additional staff requirements and overheads necessary for the project's present implementation should be taken into account (see also FPCO Guidelines, 1992, partly updated in 1994). Therefore, it seems fair to include a part of the technical assistance in the investment cost, as this replaced some additional staff requirements from normal line agencies such as the BWDB and (partly) LGED. A 15% of the technical assistance budget has been incorporated in the investment cost for this (10% long term foreign consultants, 40% long term Bangladeshi consultants, 25% of equipment and operational cost), totalling Tk 23 mln over the five years.

This brings total investment cost to Tk 192 mln. The sensitivity analysis will take up other assumptions (higher and lower shares), also with respect to other (social) cost items now excluded, to verify the impact of these assumptions.

Other investments in the project area but funded from non-CDSP resources that should be taken up on the cost side are: an amount of Tk 70 mln for sluices and embankment in Char Bhatirtek spent by CERP (from 1996 onwards, excluding Tk 30 mln of the expenditure assumed to be for non-project area); an amount of Tk 22 mln invested in Baggar Dona-II before CDSP (through LRP) for an embankment, sluice and drainage canal.

However, as a smaller sluice could have been built for Majid than the actual one, which serves a sizeable area outside the char as well (with additional benefits), an amount of Tk 6 mln has been deducted from the actual investment cost.

This brings the total investment cost for the economic development of the three chars at Tk 299 mln, or about Tk 58,000 per ha. Per household in the project area (estimated at 7124 in 1998; see CDSP Technical Report no 13) that would be Tk 42,000, and per person (estimated at 41,319) about Tk 7,250. But if these costs are allocated to each of the three chars, then investment cost per char has been: Baggar Dona-II (2083 ha) Tk 84 mln, Majid (1281 ha) Tk 88 mln, Bhatirtek (1785 ha) Tk 127 mln. Per hectare that would be approximately Tk 40,000, Tk 69,000 and Tk 71,000 respectively. The low figure for Baggar Dona-II partly reflects the lower cost of structures in 1991.

Costs of operation and maintenance of these new structures can only be estimated at this stage. Maintenance costs are estimated at Tk 1,000 per ha, i.e. Tk 5 mln annually for the three chars. The annual costs of operating all structures in the three chars (3 to 4 months a year) are estimated at Tk 0.1 mln. Per household involved that would be annual O&M cost of Tk 715, and per hectare Tk 1,020.

3.5 COSTS AND BENEFITS OF CHAR DEVELOPMENT

Comparison of project costs and benefits takes place through the framework of a formal Cost-Benefit Analysis (CBA). Such a framework distinguishes between a financial and an economic analysis, whereby the former adopts domestic market prices and the latter economic (shadow or 'border' prices). This framework has been recommended in the Guidelines for Project Assessment (FPCO, 1992, partly revised in 1994), and a useful set of conversion factors (to translate financial into economic prices) has been provided.

The table on the next page shows the formal financial and economic cashflow of the project. The lifetime of the project is taken as 20 years, and the official discount rate of 12% has been adopted. Constant 1997/98 prices are used, therefore assuming all investment costs to take place in one year (year 0). This increases investment cost from the actual Tk 299 mln to Tk 340 mln, in view of inflation rates in the three preceding years of 6.2%, 1% and 7% (and an average of 6% during 1991-94). In constant terms, investment cost per hectare are Tk 66,000 on total land, and Tk 85,000 per ha cultivable land. Although some project works were still ongoing in 97/98 (and Bhatirtek was not fully closed until mid 1999) benefits started occurring from 1996/97 onwards, in partially closed polders, i.e. from year 2.

If economic (or shadow) prices are introduced, both costs and benefits will be different from the financial analysis.

A Standard Conversion Factor (SCF) of 0.9 has been applied to materials used for construction, which are mostly domestic anyway (with a small foreign input component). This is relatively high compared to other studies (and the Guidelines) but seems on the safe side. A Shadow Wage Rate (SWR) of 0.75 has been adopted for unskilled labour, but not during the aman season (when there is full employment). This rate is applied to all labour, including family labour, the extra requirements of which, as a result of project benefits, were fully costed in the financial analysis. While it is useful to see if even fully costed labour would leave a surplus of benefits over costs, this is more relevant in an economy with full employment than in Bangladesh. Here one might argue for a heavy reduction of its price in view of limited opportunities, particularly during the slack season (and done so by some studies).

The economic price for paddy has been put at Tk 7,350 per ton, a conversion factor of 1.05, in line with other recent studies (which all differ substantially from the Guidelines). For other crops (rabi) the SCF of 0.9 has been used, with homestead and fish prices unchanged. Prices of other agricultural inputs (fertiliser, seeds etc.) have not been changed, balancing between various options for slight increases and/or decreases.

Applying these shadow prices to the project leads to the following corrections. As investment cost consisted of 40% domestic material cost, 40% unskilled labour and 20% skilled labour (ignoring profit) and foreign inputs (both conversion factor of 1), economic investment cost will be Tk 366 mln. O&M has now been set on Tk 4 mln per year, as much of this consists of labour cost, which together with a SCF for domestic materials and an inflation correction of 8% make a difference now. No public works will take place during the aman season when labour is not cheap.

Economic benefits will all be higher than the financial ones, as labour cost have been reduced (70% of production costs), paddy prices increased, but other crop prices reduced. The results are shown in the table.

TABLE 3.1

Economics of Char Development (in mln Tk; constant 97/98 prices)

Year	Financial Cost	Financial Benefits	Financial Cash Flow	Discount factor at rate (%) 12.0%	Discounted Financial Cash Flow	Economic Cost	Economic Benefits	Economic Cash Flow	Discounted Economic Cash Flow
0	340.0	–	−340.0	1.000	−340.0	292.0	–	−292.0	−292.0
1	5.0	–	−5.0	0.893	−4.5	4.0	–	−4.0	−3.6
2	5.0	15.6	10.6	0.797	8.5	4.0	16.3	12.3	9.8
3	5.0	24.2	19.2	0.712	13.7	4.0	25.4	21.4	15.2
4	5.0	35.6	30.6	0.636	19.4	4.0	37.9	33.9	21.5
5	5.0	48.8	43.8	0.567	24.9	4.0	52.3	48.3	27.4
6	5.0	63.4	58.4	0.507	29.6	4.0	67.8	63.8	32.3
7	5.0	71.3	66.3	0.452	30.0	4.0	77.2	73.2	33.1
8	5.0	77.8	72.8	0.404	29.4	4.0	84.9	80.9	32.7
9	5.0	79.3	74.3	0.361	26.8	4.0	86.5	82.5	29.8
10	5.0	81.0	76.0	0.322	24.5	4.0	88.2	84.2	27.1
11	5.0	82.7	77.7	0.287	22.3	4.0	90.0	86.0	24.7
12	5.0	84.4	79.4	0.257	20.4	4.0	91.9	87.9	22.6
13	5.0	86.3	81.3	0.229	18.6	4.0	93.9	89.9	20.6
14	5.0	88.2	83.2	0.205	17.0	4.0	96.0	92.0	18.8
15	5.0	90.2	85.2	0.183	15.6	4.0	98.2	94.2	17.2
16	5.0	92.4	87.4	0.163	14.3	4.0	100.5	96.5	15.7
17	5.0	94.7	89.7	0.146	13.1	4.0	102.9	98.9	14.4
18	5.0	97.0	92.0	0.130	12.0	4.0	105.5	101.5	13.2
19	5.0	99.5	94.5	0.116	11.0	4.0	108.1	104.1	12.1
20	5.0	102.1	97.1	0.104	10.1	4.0	110.9	106.9	11.1
Total	**440.0**	**1,414.5**	**974.5**	–	**16.5**	**372.0**	**1534.4**	**1162.4**	**103.8**
		IRR:	12.5%					EIIR:	15.5%

As the table shows, the project turns out to have a positive balance of financial benefits over cost, at least under our present assumptions and discounted at the official rate of 12%, but only just so. The financial Net Present Value (NPV) is Tk 16.5 mln, and the financial Internal Rate of Return (IRR), using the standard formula, is 12.5%, just above the official discount rate. The discounted cash flow only turns positive in the 19th year, indicating a long payback period and a marginal balance only. With a shorter life time the project would not be feasible financially.

In economic terms however the outcome is more positive. The economic NPV is Tk 103.8 mln and the economic IRR (EIRR) 15.5%. The (discounted) Benefit-Cost ratio now rises up to 1.3, whereas it was only just above 1.0 financially. Payback period is now only 13 years.

The economic costs are Tk 68 mln lower than the financial ones, 15%, and the benefits Tk 120 mln or 8% higher than the financial ones. This is largely the result of rightly taking into account that labour is not a full cost to the economy, in view of high seasonal unemployment and therefore lower opportunity cost than the market wage would suggest. Farmers get more paid working days *with* than *without* the project, and these extra days should not be costed at peak market wage, and the 40% investment cost spent on labour also creates (temporary) employment.

Therefore, from the point of view of the whole economy, the investment costs are less than the financial ones, because of the employment effects in a situation of large unemployment in slack seasons. The benefits are also higher in these seasons than the direct financial ones, implying that the project is feasible because it also has indirect implications (e.g. on employment of underemployed farmers). As the difference between the financial and economic analysis is exactly the indirect project impact, this outcome shows that the indirect effects of char development (on the economy) really make it a feasible exercise. On direct effects only, the results are not impressive.

3.6 SENSITIVITY ANALYSIS

The financial and economic analysis shows that char development in Bangladesh, as undertaken through CDSP, is a feasible enterprise under certain assumptions. Financially, it is only marginally so (without irrigation), as confirmed in other studies, and the project can hardly support cost increases. If investment cost per hectare (of cultivable land) exceed Tk 85,000 (1997/98 prices), then the financial feasibility will disappear.

Low investment cost in Baggar Dona-II depressed the overall average just enough in our case, as investment in Majid and Bhatirtek was relatively expensive. The former needed less embankment per ha than the latter two, thanks to its position near Baggar Dona-I's embankment and old land. Baggar Dona-II needed a relatively small sluice and drainage system as no outside area had to be taken care of as well, as in the case of the other two polders.

Such cost considerations clearly ought to be taken care of in the design stage (or pre-feasibility). Technically, it should be possible to reduce investment cost by at least 10%, as the improved road network could be less dense (closer to 1991 targets than upwards revised 1994 ones), with maybe smaller roads or less tarmac, and possibly smaller sluices. These technical designs were never undertaken with an eye on financial benefits, and there is always some room for manoeuvring without hampering benefits.

Reducing 'red tape' and 'leakages' of funds, e.g. during tenders, and increasing speed of operations will also help control costs, and maybe save another 10%. The extent to which one wants to include technical assistance in the investment cost also remains arguable, although the project does not seem to support much more than 15% of its cost, as assumed in this case.

The extent to which farmers introduce HYV for aman and plant new rabi crops is very important, and remains to be monitored (also changing farm budgets) and supported (through extension) as much as possible, as the project can also not support much decline in financial benefits. A reduction of 5% already will lead to a break even of costs and benefits, a NPV of zero. But while the planned introduction of HYV aman (and yields) might be rather optimistic, benefits for rabi crops may turn out to become higher than planned in view of an unforeseen shift towards more remunerable crops (chillies etc.).

However, presently unforeseen factors may frustrate the very encouraging immediate response by farmers in future. The loss of capture fishing may turn out to be larger than assumed here, and soil erosion and siltation (elsewhere) may also create future disbenefits that will depress a positive outcome. At least, projects like CDSP, should ensure that potential benefits are captured as much as possible, and a number of good suggestions for 'best-bet' interventions and technologies are already available.

Fortunately, the results are rather robust in economic terms, as moderate shadow prices were used, maybe except for labour. Lower (economic) prices for domestic materials would still be in line with other analyses, profits (of contractors) might have been deducted (no benefit to the economy, just an internal transfer of funds), and a higher paddy price could have been justified as well as a price reduction for (domestic) agricultural inputs (fertiliser). Therefore, even if the unemployment assumption was relaxed by increasing the SWR somewhat (say 10%), the project would still be feasible economically. But in view of prevailing fluctuations in seasonal wages in the project area, the applied SWR does not seem to be an exaggeration.

Only if the financial (and economic) cost were 35% higher than now, the project would break even in economic terms (economic NPV 0, EIRR 12%). The financial NPV would then be minus Tk 104 mln and the financial IRR 9 %. In economic terms char development could also support some reduction of benefits, as only a 25% reduction would break economic costs and benefits even. A 10% reduction would still keep up the economic NPV (TK 61 mln) and EIRR (14%).

3.7 CONCLUSION

It seems fair to conclude that out of an economic and financial point of view, char development is a feasible exercise, although economically more so than financially. Apparently, the indirect effects on the whole economy matter much, especially the fact that labour has low opportunity cost, in view of prevailing unemployment during the slack season. However, the results show that a clear cost-effectiveness is warranted in designing polders, also to ensure that O&M indeed takes place as needed, as without proper O&M project benefits might dry up before 20 years.

At several places in the report non-economic beneficial effects of project interventions can be found, which were summed up at the start of this chapter. Increased physical

security, greater access to land and social services and a higher level of awareness of the settlers were seen as the most significant ones. These enhanced their status and gave them a better position from which to deal with the power brokers in their areas. And it provided many of the settlers with an opportunity to escape from the physical, social and economic periphery where they were caught in at the time of migration into the chars.

Although both the economic and the less tangible benefits have to be further proven and consolidated in the years to come, they seem to outweigh the costs and to support a case to continue efforts in the field of char development. There are a number of areas in the coastal belt of Bangladesh where land is high enough and planned development can be started. For some, as Muhuri Accreted Area and South Hatia, already detailed feasibility studies have been carried out. This report is an attempt to review the experiences in five years of CDSP, to distil the lessons and translate them into guidelines that can be of use in future char development programs. These guidelines indeed aim at "economically viable, socially acceptable and technical feasible" interventions, as the objective of CDSP prescribed.

Annex 1

PROCEDURES FOR LAND SETTLEMENT

ANNEX TABLE 3.1
Stages of Land Settlement as per Rule of 1987

Sl. No.	Stages of land settlement
01	Preparation of the list of *khas* land and display on the Notice Board of public offices
02	Objection, if any, within seven days and disposal of objections within 30 days
03	Appeal to the Deputy Commissioner (DC) within 30 days and disposal within 45 days
04	Eviction of unauthorised settler
05	Application invited from landless people on prescribed form
06	Scrutiny of application and publication of the candidates selected/rejected by the Upazila Task Force Committee (UTFC)
07	Preparation of priority list by the Upazila Nirbahi Officer (UNO) and objection settled by the DC within 15 days
08	The list of selected candidates to be submitted to the DC
09	Settlement case to be prepared in the name of husband and wife and *jomabondi* to be prepared by the Surveyor and the *Kanungo* along with a traced map of the land
10	Asst. Commissioner, Land- AC(L) forwards the case to the DC for approval through the UNO and the Additional Deputy Commissioner, Revenue – ADC(R)
11	After approval, a *salami* (fee) is taken by the *Tahsilder* (TDR) from the applicant
12	The *Kabuliyat* is taken by the AC(L) who forwards the case to the DC for approval through the UNO and the ADC(R)
13	On receipt back of the case it is sent to the Sub-Registrar (SR) by the AC(L) for registration
14	After collection of one copy of *Kabuliyat* from the SR, AC(L) prepares the *Khatian* by mutation process and receives *Khatian* fee
15	*Khatian* is sent to the TDR office where the *Jot* is prepared for collecting Land Development Tax
16	One copy of the *Khatian* is handed over to the candidate and the case record is sent to the ADC(R) for preservation
17	One copy of the registered *Kabuliyat* is handed over to the candidate

ANNEX TABLE 3.2
Stages of Land Settlement Under CDSP

Sl. No.	Stages of land settlement
01	Plot-to-plot land survey to know the status of land and the possessor
02	Consolidation of survey sheets and preparation of list of *khas* land
03	Selection of landless candidates, land claim verification and receipt of application from the candidate on prescribed form
04	Preparation of priority list and approval by the UTFC
05	Preparation of allotment sheet and signature of the candidate on the *Kabuliyat*
06	Opening of settlement case and *jomabondi* by the AC(L), forwarded to the DC through the UNO and the ADC(R) for approval
07	After approval, *salami* is collected by the TDR and the settlement case is sent to the SR for registration at the field level
08	On receipt of Deed of Registration, the AC(L) prepares *Khatian* by mutation process
09	The *Khatian* is sent to the TDR where *Jot* is prepared for collecting Land Development Tax
10	Copy of the *Khatian* and the registered *Kabuliyat* are handed over to the candidate

ANNEX TABLE 3.3
Settlement Rules of 1997

Sl. No.	Stages of land settlement
01	The Upazila Agricultural Land Management Committee will prepare preliminary list of agricultural *khas* land and make wide publication
02	Objection within 30 days before the Upazila Committee and decision by 15 days and publication of the final list
03	Appeal within 15 days and decision by 15 days to the District Committee
04	Appeal to the National Committee within 30 days and decision within 60 days and then the final list to be published
05	Application to be invited from the landless within one month
06	Within one month the Upazila Committee will finalise scrutiny of the landless and prepare the list of selected candidates and distribute land
07	Within 21 days of the distribution of land to the landless by the Upazila Committee, AC(L) will initiate the settlement case and send the proposal to UNO
08	UNO will send the same to the DC within 21 days
09	DC will put up the same to the District Committee within 30 days and after approval send it to AC(L)
10	AC(L) after taking one taka *salami* will execute the *Kabuliyat* in favour of the landless and open the *Khatian* within 15 days
11	Within 15 days of *Kabuliyat* execution, Upazila Committee will hand over possession of land to the settlement holder

Annex 2

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Part II

Benefit Assessment of Land Settlement Program

M. A. Latif

Chapter 4

INTRODUCTION

The Char Development and Settlement Project (CDSP) is a multi-sectoral project of the governments of Bangladesh and the Netherlands. The project has been developing three polders in the coastal *chars* of Noakhali district. Names of the polders are Char Baggar Dona-II (CBD-II), Char Majid (CM) and Char Bhatirtek (CBT). Settlement of the landless on government-owned *khas* land is a core component of the project. The CDSP allocates *khas* land as per the Government Khas Land Distribution Policy of 1987. The project commenced in September 1994. Total area of the three polders is 5,149 ha. During the inception of the project it was found that there was 3,070 ha of *khas* land available for distribution among the landless. The rest of the land was under private ownership (already settled). The target of CDSP was to settle 5,000 households on the *khas* land in three polders with legal title by June 1999. Each settler household will get maximum two acres of land. Earlier. a plot-to-plot survey was done to identify eligible candidates for settlement. By end December 1998, over 2,300 households received land title.

As part of the benefit monitoring activity of the project, a survey was done during February-April 1999 to assess the benefit of the land settlement program. The settlement program was conceived in terms of:

a. Legal claim on land (security of title);

b. Access to land by hitherto landless people (ownership); and

c. Increased possibility of retention of land (effective control on a long-term basis).

A full assessment of the land settlement program could not be done as the process is still going on.

Both quantitative and qualitative data were collected. A sample survey with a structured questionnaire was used. Besides, group discussions were held in the form of a Rapid Rural Appraisal (RRA) using a checklist. Moreover, some case studies were done to portray the social dynamics.

Thirty settlers from each polder were interviewed to obtain relevant information. The survey also included Char Baggar Dona-I (CBD-I), which was developed by the Land Reclamation Project (LRP) in the eighties. Respondents were selected from a list of

settlers who had already received official title of ownership. Case Studies were done in three CDSP polders to highlight issues with respect to the following:

a. A farmer getting official title on land which s/he occupied earlier;
b. A farmer who could not occupy any land earlier but has eventually received some land;
c. A farmer who has not been able to get possession of land even after receiving the title;
d. A farmer who, after receiving title and possession, has lost it.

Findings of the survey have been presented in Chapter 5, while findings of the RRA obtained through group discussions and the case studies have been presented in Annex 1.

Respondents mostly belong to the first category (a) because CDSP has allocated land on the basis of possession. In category (b) the number of the respondents is very insignificant, for the same reasons as stated for category (a). So most of the case studies have covered the last two categories.

Chapter 5

SURVEY FINDINGS

5.1 PERIOD OF ARRIVAL IN THE POLDER AREA

It has been observed that settlers first occupy the newly accreted *char* land, make small dykes around the occupied plots and later construct a house on it. At the initial stage the new *char* is not habitable. Many occupants feel reluctant to leave their old areas to settle on a new land.

The people settled in two different ways. The first and the most dominant way is the occupation of land either directly with the patronage of a *jotdar* (one who controls a large area of *char* land) or a group of *jotdars*. Second way is the purchase of "possession" either from the *jotdar* or another occupant.

Table 5.1 shows the distribution of respondents by year of land occupation and/or the purchase of possession of land. There is little difference between the pattern of year of arrival and that of occupation/possession of land.

TABLE 5.1
Distribution of Respondents by Year of Land Occupation/Possession

Year of land Occupation/possession	CBD-II	CM	CBT	CBD-I	Total	
					Number	%
Before 1975	10	0	2	2	14	12
1975-80	9	5	13	8	35	29
1981-85	5	13	6	0	24	20
1986-90	4	11	6	20	41	34
1991-94	2	1	3	0	6	5
Total	**30**	**30**	**30**	**30**	**120**	**100**

5.2 AVERAGE FAMILY SIZE AND EARNING MEMBERS PER HOUSEHOLD

Table 5.2 shows the average family size of the respondents. The average family size is the highest in Char Baggar Dona-I and the lowest in Char Majid. The average family size is higher than the national figure.

TABLE 5.2
Average Family Size

Study area	Average family size
CBD-II	7.0
CM	6.8
CBT	7.4
CBD-I	8.0
Average	7.3

Table 5.3 shows the average number of earning members per household. It is the lowest in Char Bhatirtek and the highest in Char Baggar Dona-I.

TABLE 5.3
Average Earning Members per Family

Study area	Average earning member
CBD-II	1.4
CM	1.2
CBT	1.0
CBD-I	1.5
Average	1.4

5.3 LAND OCCUPATION AND POSSESSION

Table 5.4 shows the average amount of land occupied by the respondent at the outset. Among the three polders of CDSP the highest average land occupation took place in Char Bhatirtek with 2.38 acres per household and the lowest in Char Majid with 1.52 acres.

TABLE 5.4
Average Amount of Land Occupied by the Respondents at the Outset (acre)

Category of land	CBD-II	CM	CBT	CDSP	CBD-I
Homestead	0.09	0.14	0.08	0.11	0.22
Pond	0.06	0.16	0.07	0.10	0.14
Cultivable	1.46	1.22	2.21	1.63	1.38
Total	**1.62**	**1.52**	**2.38**	**1.84**	**1.74**

Besides occupation of land, some respondents purchased "possessions" from those who occupied land initially. There were some occupants who left the area either owing to hardship in the area or migrated to other *chars* for some other reason. Apart from them, some settlers have also bought the possession of land from the *jotdars*. Table 5.5 shows the purchase of land possession by the respondents. Table 5.6 shows purchase of land possession and occupation of land together.

Table 5.7 shows the process of land acquisition by the respondents. It has been found that about 30% of land have been acquired through purchase of "possession". This is the highest in Char Bhatirtek and the lowest in Char Majid. The high proportion of possession

purchase of land is indicative of migration of the settlers and of the more complex situation in land settlement. Some people being frustrated with the settlement process have left the area selling their possessed land.

TABLE 5.5
Average Land Possession Purchase by the Respondents at the Outset (acre)

Category of land	CBD-II	CM	CBT	Total
Homestead	0.12	0.06	0.16	0.11
Pond	0.05	0.02	0.16	0.07
Cultivable	0.37	0.20	1.24	0.60
Total	**0.54**	**0.28**	**1.56**	**0.78**

TABLE 5.6
Average Land Possession/Occupation (acre)

Category of land	CBD-II	CM	CBT	CDSP	CBD-I
Homestead	0.21	0.20	0.24	0.22	0.22
Pond	0.11	0.18	0.23	0.17	0.14
Cultivable	1.83	1.42	3.45	2.23	1.38
Total	**2.15**	**1.80**	**3.92**	**2.62**	**1.74**

TABLE 5.7
Distribution of Land by Type of Acquisition

Study area	Land occupied by the respondents (acre)	% of land possessed through	
		Occupation	Possession purchase
CBD-II	64.66	75	25
CM	53.34	85	15
CBT	117.48	61	39
Total	**235.48**	**70**	**30**

This also indicates the role of the *jotdars* who constitute a major party in "possession sale". Moreover, poverty due to low employment and low productivity of land and high extra-legal expenditure for land settlement in the pre-CDSP period compelled many original settlers to sell their land possession and leave the area. Another reason for selling possession is the *khas* land distribution policy of the government. A household is entitled to get allotment of *khas* land up to a certain amount (maximum two acres as per the rule of 1987). People, who occupied more land, have sold the possession of the "surplus" land. This happened mostly before the commencement of CDSP. For expediting the allotment process, CDSP has given an opportunity to allocate "surplus land" in the name of their nominees. As a result, the possession sale of surplus land for this particular reason has diminished.

Table 5.8 shows the distribution of respondents by type of land acquisition. It is seen that about one-third of the respondents have settled in the three polders through purchase of land possession. The purchase of land possession is the highest in Char Bhatirtek and the lowest in Char Majid.

TABLE 5.8
Distribution of Respondents by Type of Land Acquisition

Study area	Total no. of respondents	Number of respondents				
		Occupants	Possession	Purchase	Occupation and possession purchase	Others /Unspecified
CBD-II	30	19	8	2	1	
CM	30	24	6	0	0	
CBT	30	12	15	3	0	
Total	**90**	**55**	**29**	**5**	**1**	

CDSP carried out a plot-to-plot survey to identify the possession of land under each possessor with a view of allotting land on the basis of possession. Table 5.9 shows the average possession of land during the survey or before receiving the *khatian* (title). Compared with Table 5.6 it is seen that the average land possession of the respondents has decreased. It has been observed that this has occurred mostly due to split in the families.

TABLE 5.9
Average Amount of Land Under Possession During the Plot-to-plot Survey (acre)

Category of land	CBD-II	CM	CBT	Average
Homestead	0.27	0.21	0.27	0.25
Pond	0.12	0.18	0.24	0.18
Cultivable	1.46	1.11	2.01	1.43
Total	**1.85**	**1.50**	**2.52**	**1.86**

Table 5.10 shows the average amount of land received in the *khatian*. It is seen that the average amount of land received is relatively higher in Char Bhatirtek and lower in Chat Majid. It also shows that it is lower than the average amount of land that the respondents possessed before receiving the *khatian* (see Table 5.9). However, it is not the true picture of land allotment as many respondents have taken or are in the process of taking land allotment of their surplus land in the names of their nominees, mostly their sons or some other relatives. A small amount of land they have to hand over to CDSP for distribution among the other landless.

TABLE 5.10
Average Amount of Land Received Officially (acre)

Category of land	CBD-II	CM	CBT	Average
Homestead	0.24	0.21	0.29	0.25
Pond	0.07	0.17	0.19	0.15
Cultivable	1.27	0.96	1.17	1.14
Total	**1.58**	**1.34**	**1.65**	**1.54**

5.4 DISTRIBUTION OF LAND IN CDSP

One household is entitled to receive maximum two acres of land as per the rule of 1987 followed in CDSP. People received land title mainly based on previous possessions.

Enough land was not available for everybody. Table 5.11 shows that about half of the households got land 1.50 acres or less. Few households received more than two acres of land in the sense that more than one *khatian* was reportedly given to the members of the same household showing different names as if they were independent unit of households.

TABLE 5.11
Distribution of Land Recipients by Size of Holding

Holding (acre)	CBD-II		CM		CBT		CDSP		CBD-I	
	#	%	#	%	#	%	#	%	#	%
0.01-0.50	0	–	1	3	0	0	1	1	–	–
0.51-1.00	8	27	4	13	5	17	17	19	–	–
1.01-1.50	7	23	13	43	5	17	25	28	–	–
1.51-2.00	14	47	12	40	18	60	44	49	30	100
2.01+	1	3	0	0	2	7	3	3	–	–
Total	**30**	**100**	**30**	**100**	**30**	**100**	**90**	**100**	–	–

5.5 PRESENT LAND HOLDING PATTERN AFTER ALLOTMENT FROM CDSP

Table 5.12 shows the present landholding pattern of the respondents. This has been analysed for three reasons. First, some of the respondents have retained their "surplus" land with them. Secondly, some respondents have more than one *khatian* to retain the surplus land. On the other hand, some have not got the possession of land even after receiving *khatian*.

When CDSP carried out the plot-to-plot survey in 1995-96, the settlers were not very much specific about the land classification. It has been observed that they identified a ditch as a pond in one case and did the opposite in another case and/or included it as homestead land.

TABLE 5.12
Average Landholding of the Respondents (acre)

Category of land	CBD-II	CM	CBT	Average
Homestead	0.28	0.20	0.24	0.24
Pond	0.11	0.20	0.21	0.18
Cultivable	0.99	1.02	1.70	1.24
Total	**1.38**	**1.42**	**2.15**	**1.66**

The amount of land received in the *khatian* is lower than that of the present landholding status in Char Baggar Dona-II. It is true both for total land and for arable land though this trend is not applicable in the other two polders. In Char Baggar Dona-II it is due to the fact that many respondents have not received the possession of their allotted land. On the other hand, in Char Majid many respondents have not handed over their non-allotted surplus land to CDSP or to its allottee. Beside, in Char Bhatirtek, the existence of joint families with more than one *nothi* is a reason for a bigger holding than the amount mentioned in the *khatian*.

5.6 RECOVERY OF SURPLUS LAND

There are some respondents who have surplus land after receiving *khatian*. CDSP wants to recover that surplus land from the occupation of those respondents for distribution among others who possess no land or a smaller amount of land. It has been observed that some of the respondents have not yet handed over surplus land while others have already handed over land to other allottees. Table 5.13 shows that 29% of the respondents had surplus land and 35% of them have already surrendered the surplus land.

According to the survey, the respondents were found to occupy 167.22 acres of land of which 19.04 acres was "surplus" (11%). Some settlers already surrendered their surplus land, to the extent of 8.04 acres (42% of total surplus land). That means, the remaining 11 acres (58%) is yet to be handed over. With respect to total area under the possession of the original possessors, only 7% are yet to be handed over (11 acres out of 167 acres).

TABLE 5.13
Disposal of Surplus Land

Study area	Respondents with surplus land			
	Land to be surrendered*		Actually surrendered**	
	#	%	#	%
CBD-II	10	33	5	50
CM	10	33	2	20
CBT	6	20	2	33
Total	**26**	**29**	**9**	**35**

Notes: *With respect to total respondents; **With respect to those who had surplus land.

5.7 EXPENDITURE FOR LAND ALLOTMENT

To obtain a *khatian*, one has to pay a certain amount of fee (cost of registration) to the government. The amount may vary from time to time. First it was taka 320 and then was enhanced to taka 700 in two spells during the project period. It has been reported that apart from this fee, many settlers had to incur extra-legal expenditure, such as bribing the middlemen and power brokers before the inception of CDSP. In CDSP extra-legal expenses have not been reported. The brokers have lost their importance though once they played an important role in land allocation.

Table 5.14 shows that extra-legal expenditure before CDSP. It was very high in Char Baggar Dona-II and relatively low in Char Bhatirtek. In Char Bhatirtek too, people had to pay a lot of money to the *jotdars* on different pretexts, such as DCR, land records, toll for the *lathial* (musclemen), etc., to secure possession of land at the initial stage. These are not included in this calculation because the respondents find it difficult to give accurate data due to memory lapse. At a later stage, there was some social mobilisation steered by a NGO and many of them stopped paying such tolls.

Before CDSP, each settler of Char Majid spent taka 1183 on the average. Though the settlers did not pay any toll to the *jotdars* like the settlers in Char Baggar Dona-II and Char Bhatirtek, they had to pay taka 800 each in 1988-89 to the *tahshil* office at the advice of the Chairman of the *Union Parishad* for *salami* (fee) though the official rate was only eight taka. At that time, many settlers sold their jewellery, utensils, poultry,

goats, etc. It has been reported that the Chairman of the *Union Parishad* reportedly made this arrangement with the officials from the *char* to the district level of land settlement authority for completing the land settlement process.

TABLE 5.14
Average Expenditure for Land Settlement (taka)

Paid To	CBD-II	CM	CBT	Average
Ministry of land	358	373	383	371
Extra-legal expenditure before CDSP	10600	1183	666	4150
Total	**10958**	**1556**	**1049**	**4521**

5.8 LAND POSSESSION

The allotment of *khas* land to the landless is a necessary condition for the success of *khas* land distribution, while getting possession over the allotted land is the sufficient condition. Tables 5.15 and 5.16 show the possession status of land by the recipients. It is seen that in Char Majid almost all the respondents (97%) have received the possession over their allotted land fully, while in Char Baggar Dona-II only half of the respondents have established control over their land fully. In Char Majid, land occupation was almost equal in most cases and therefore there was less scope for "redistribution". Some influential absentee *jotdars* however occupied a large chunk of land. CDSP had problem in recovering land from those *jotdars*. In total, respondents have been able to establish possession over 87% of land allotted to them by CDSP (till the time of the survey).

TABLE 5.15
Distribution of Respondents by Possession Status of Allotted Land

Possession	CBD-II		CM		CBT		Total	
	#	%	#	%	#	%	#	%
Fully	15	50	29	97	26	87	70	78
Partially	14	47	1	3	3	10	18	20
Not at all	1	3	0	0	1	3	2	2
Total	**30**	**100**	**30**	**100**	**30**	**100**	**90**	**100**

TABLE 5.16
Distribution of Allotted Land by Possession Status

Possession status	CBD-II		CM		CBT		CBD-I	
	Acre	%	Acre	%	Acre	%	Acre	%
Land under possession	35.12	74	40.01	99	44.84	90	119.97	87
Land not under possession	12.55	26	0.32	1	4.91	10	17.78	13
Total	**47.67**	**100**	**40.33**	**100**	**49.75**	**100**	**137.75**	**100**

5.9 LAND LOSS

In the study area, the settlers lose land in three different ways, either through direct sale, gift or acquisition by CDSP for building infrastructure in the polder. Though the

respondents, in some cases, could not state whether their land was acquired by CDSP, most of them mentioned that part of the land possessed by them was not allotted in their names/*khatian,* and it was *khas* when it was acquired by CDSP. However, it has a negative economic implication on the land-poor people. Table 5.17 shows the loss of land to CDSP for infrastructure development activities. About 43% respondents in three polders have lost land. Average land lost to CDSP is about 0.25 acre (among those who lost land). With respect to the total respondents, the average land loss stands at 0.11 acre. In a Focus Group Discussions, it was revealed that there were incidents of land sale. Three respondents in Char Bhatirtek and one on Char Baggar Dona-I admitted it.

TABLE 5.17
Land Loss Due to Infrastructure Building by CDSP

Study area	Respondents lost land		Average land (acre) with respect to	
	Number	Percentage*	PAP**	Total
CBD-II	8	27	0.15	0.04
CM	17	57	0.24	0.14
CBT	14	47	0.33	0.15
Total	**39**	**43**	**0.25**	**0.11**

Notes: *With respect to total respondents; **Project Affected Persons (PAP).

5.10 LAND OWNERSHIP PATTERN

Post-settlement (after receiving official title) landownership pattern of the respondent households have been shown in Table 5.18. The present study has considered the cultivable land as the basis for land ownership categorisation as it is very important for subsistence. There are some "landless" households in the sense that they do not possess any cultivable land. In Char Baggar Dona-I, all households were settled in 1986-89, each household receiving 2.50 acres of land including 2.00 acres of cultivable land.

TABLE 5.18
Distribution of Households by Land Ownership

Cultivable holding (acre)	CBD-II	CM	CBT	CDSP	CBD-I
0	6	–	3	9	–
0.01-0.50	2	3	–	5	–
0.51-1.00	6	12	11	29	–
1.01-2.00	16	14	11	41	30
2.01+	–	1	5	6	–
Total	**30**	**30**	**30**	**90**	**30**

Table 5.19 shows the percentage distribution of cultivable land by different land size groups. About 25 percent land is possessed by the "land ownership group" with more than 2.00 acres each, and they constitute about 7 percent of total respondents in CDSP. They are mostly from Char Bhatirtek where they possess about 50 percent of total land though they constitute 17 percent of all households of Char Bhatirtek. In this polder, five respondents have more than one *khatian* and one of them has 9.00 acres of land over which he claims ancestral right.

TABLE 5.19
Distribution of Land by Land Ownership Groups (percentage)

Cultivable Holding (acre)	CBD-II N=29.69	CM N=30.43	CBT N=51.16	CDSP N=111.28	CBD-I N=57.74
0.01-0.50	2.9	2.8	–	1.5	–
0.51-1.00	16.4	32.3	15.8	20.5	–
1.01-2.00	80.7	57.8	34.1	53.0	100
2.01+	–	7.0	50.0	24.9	–
Total	**100**	**100**	**100**	**100**	**100**

5.11 LAND MANAGEMENT

Table 5.20 shows the distribution of the respondents by the management pattern of their own land. It is seen that one quarter of the respondents with land possessions are absentee landowners, which means that they either share out or mortgage out all their land. Absentee ownership is the highest in Char Bhatirtek. It is to be noted that in Char Baggar Dona-II, six recipients have not got possession of cultivable land and in Char Bhatirtek, two have sold their cultivable land and one has not received the possession of the cultivable land.

TABLE 5.20
Distribution of Landowners by Type of Land Management

Study area	No. of landowners with possession	Own management		Absentee ownership	
		Number	%	Number	%
CBD-II	24	20	83.3	4	16.7
CM	30	23	76.7	7	23.3
CBT	27	18	66.7	9	33.3
CDSP	81	61	67.8	20	24.7
CBD-I	30	28	93.3	2	6.7

Table 5.21 shows the distribution of own land by management pattern. It is seen that about 30 percent land has been sharecropped or mortgaged out by the land recipients. This is the highest in Char Baggar Dona-II. with about 35 percent. The predominance of land mortgage indicates that the land recipients are in financial crisis. Mortgage has a general implication in the long run on land retention status. In different studies it has been found that mortgage is the first step of land loss. Generally, people try to retain land through mortgaging out instead of selling out with a hope that their economic condition will improve in near future and they will be able to recover the land. In most cases, they cannot recover the land or they sell part of the land to retain whatever amount is left. This process gets perpetuated and the small landowners lose their land bit by bit. So, the mortgage out of land is an indication of future land loss by the land recipients.

5.12 FARM HOUSEHOLDS

Table 5.22 shows that 72 percent of the total land recipients in CDSP have their own farms against 28 percent of non-farm household. The number of non-farm households is high in Char Bhatirtek.

TABLE 5.21
Distribution of Land by Type of Land Management

Study area	Land under own cultivation		Not under own cultivation					Total
			Sharecrop out		Mortgage out		Total	
	Acreage	%	Acreage	%	Acreage	%	%	%
1	2	3	4	5	6	7	8 (5+7)	9 (3+8)
CBD-II	20.06	65.4	6.74	21.9	3.89	12.7	34.6	100
CM	20.62	67.8	2.54	8.3	7.27	23.9	32.2	100
CBT	39.87	74.4	4.32	8.1	9.37	17.5	25.6	100
CDSP	80.55	70.2	13.60	11.9	20.53	17.9	29.8	100
CBD-I	48.28	83.6	3.00	5.2	6.46	11.2	16.4	100

TABLE 5.22
Data on Farm Households

Study area	Farm households		Non-farm households		Total	
	#	%	#	%	#	%
CBD-II	23	77	7	23	30	100
CM	23	77	7	23	30	100
CBT	19	63	11	37	30	100
CDSP	65	72	25	28	90	100
CBD-I	28	93	2	7	30	100

Table 5.23 shows the distribution of farms by farm size. It is seen that there in no dominant size of farm in CDSP polders, though in Char Baggar Dona-I the farm category of 1.01-2.00 acres group is dominant.

TABLE 5.23
Distribution of Farms by Farm Size (percentage)

Farm size (acre)	CBD-II	CM	CBT	CDSP	CBD-I
	N=23	N=23	N=19	N=65	N=28
0.01-0.50	13.0	13.0	0	9.2	0
0.51-1.00	26.1	21.7	15.8	21.5	7.1
11-2.00	39.1	26.1	26.3	30.8	71.4
2.01-5.00	21.7	30.4	21.1	24.6	7.1
5.01+	–	8.7	36.8	13.8	14.3
Total	**100**	**100**	**100**	**100**	**100**

Table 5.24 shows the distribution of operational land by farm size groups. Farms above the size of two acres account for three-fourths of the total farms in CDSP.

5.13 MODE OF TENANCY

Table 5.25 shows the distribution of farm area by mode of tenancy. It is seen that more than half of the farm area in CDSP polders is taken under sharecropping or mortgage systems. This is relatively high in Char Majid, while it is much lower in Char Baggar Dona-I.

TABLE 5.24
Distribution of Farmland by Farm Size (percentage)

Farm size (acre)	CBD-II	CM	CBT	CDSP	CBD-I
	N=37.27	N=54.86	N=83.71	N=164.29	N=78.28
0.01-0.50	3.2	1.5	0	1.2	–
0.51-1.00	13.4	7.6	2.6	6.5	2.6
1.01-2.00	38.4	13.3	9.2	16.7	46.1
2.01-5.00	44.9	45.0	14.7	30.6	10.8
5.01+	0	32.6	73.5	45.1	40.5
Total	**100**	**100**	**100**	**100**	**100**

TABLE 5.25
Distribution of Farm Area by Mode of Tenancy

Area	Own Land Cultivated		Land cropped under tenancy arrangements					Total
			Sharecrop in		Mortgage in		Total	
	Acreage	%	Acreage	%	Acreage	%	%	%
1	2	3	4	5	6	7	8 (5+7)	9 (3+8)
CBD-II	20.06	53.8	14.01	37.6	3.20	8.6	46.2	100
CM	20.62	37.6	31.44	57.3	2.80	5.1	62.4	100
CBT	39.87	47.6	31.20	37.3	12.64	15.1	52.4	100
Total	80.55	45.8	76.65	43.6	18.64	10.6	54.2	100
CBD-I	48.28	61.7	26.40	33.7	3.60	4.6	38.3	100

5.14 OCCUPATIONAL PATTERN

Table 5.26 shows the occupational pattern of the respondents before and after arrival at the polder. A significant change of occupation has occurred in farming and sharecropping as there are now more people in these two categories. On the other hand, there are less people in occupations like wage labour, petty trade, etc.

TABLE 5.26
Distribution of Households by Main Source of Income

Main source of income	CBD-II		CM		CBT		Total		CBD-I	
	BF	AF	BF	AF	BF	AF	BF	AF	BF	AF
Own land Farming	1	8	1	2	3	5	5	15	1	9
Share cropping	2	3	5	8	4	6	11	17	7	3
Farm labour	16	11	19	14	9	11	44	36	18	13
Petty trade	2	1	0	1	8	4	10	6	1	2
Transport labour	1	2	2	0	1	1	4	3	1	1
Fishing	3	1	2	2	0	0	5	3	1	0
Others	5	4	1	3	5	3	11	10	1	2
Total	**30**	**30**	**30**	**30**	**30**	**30**	**90**	**90**	**30**	**30**

Notes: BF = Before; AF = After.

5.15 ACCESS TO FOOD

Table 5.27 shows the food sufficiency status of the respondents. An overwhelming majority of the households in all polders have a food deficit. There are some households who have not got land possession and in these cases, food sufficiency status has not been considered. It may be mentioned that many farmers may grow enough food grain for their subsistence, but have to sell it after the harvest to repay loan and/or to buy other essentials. Data show that only one-tenth of the households are able to earn their living in terms of their needs.

TABLE 5.27
Distribution of Households by Food Sufficiency Status

Status	CBD-II	CM	CBT	Total	CBD-I
Surplus	0	1	2	3	1
Subsistence	0	2	4	6	2
Deficit	30	27	24	81	27
<5 Months	7	2	4	11	1
6-9 Months	14	14	10	38	24
>10 Months	6	11	8	25	2
No land possession	3	0	2	5	0
Total	**30**	**30**	**30**	**90**	**30**

5.16 PROBLEMS IN THE LAND SETTLEMENT PROCESS

CDSP has simplified the land settlement process. It has reached the doorsteps of the land recipients, freed the allotment system from corruption and malpractice and wiped out the middlemen from the process substantially. However, there are some problems within tolerance limit as described by the beneficiaries.

The respondents appreciate the settlement process of CDSP. However, they have pointed out a few problems which are presented in Table 5.28. It appears that comparatively there are more problems in Char Baggar Dona-II. In Char Baggar Dona-II, settlement process lags behind, as the plot-to-plot survey was not done carefully. Some respondents reported that *nothi* had been cancelled and renewed following objection from another party. It has not only delayed the settlement process but also has raised the cost of settlement. Some respondents mentioned that other settlers and/or jotdars had occupied their land. In some cases, CDSP has given allotment of one piece of land to one occupied by another person. Some respondents have reported that they do not have any idea about the location of the allotted land.

5.17 RECOMMENDATIONS

The respondents have given recommendations for improving the settlement system as shown in Table 5.29. The most important recommendation is the land measurement by CDSP and officially handing over of land to the recipients along with a map and plot number. Such an effort will reduce not only social tension but also will free them from the clutches of the village power brokers who always exploit them on different pretexts.

TABLE 5.28
Distribution of Respondents by Problems Faced During the Settlement Process

Nature of problem	CBD-II	CM	CBT	Total
	N=30	N=30	N=30	N=90
Land occupied by others/*jotdars*	7	1	1	9
Original possessors did not get priority rather those who possess land by dint of 1988-89 allotment got priority	3	–	–	3
Plot-to-plot survey was not done properly (objective was not clear, people were not explained properly, *jotdars* de-motivate the settlers	2	–	–	2
Cancellation of *nothi* and renew of *nothi* following objection, increased settlement cost	2	–	–	2
Local surveyors mitigate border dispute between two plots; hence its credibility is sometimes questionable	2	–	–	2
Land has not been correctly recorded in *khatian* (one's land has gone to other's *khatian*, sometimes land under one's possession has been dropped out and/or one got land from another)	2	–	2	4
Land location was not exactly known by the recipients, land has not yet been handed over officially to the recipients	6	–	2	8
Land under possession has not given to the possessors	2	2		4
Land in the *khatian* is less than amount recorded in the *kobuliyat*	–	–	2	2
Weaker party cannot establish possession before the survey team	–	1	–	1

Note: Multiple answers were recorded.

TABLE 5.29
Distribution of Respondents by Suggestion for Improvement

Suggestion for improvement	CBD-II	CM	CBT	Total
	N=30	N=30	N=30	N=90
After allotment, land should be measured by CDSP and officially handed over to the land recipients	20	19	21	60
Plot-to-plot survey should be done more carefully (i.e. the objective should be explained to the people through meetings with all the people and not only with the elite and some polder committee members)	3	–	–	3
Local MoL staff should not be appointed for plot-to-plot survey	2	–	–	2
During allotment, possession before the allotment of 1988-89 should be considered	4	–	–	4
Border dispute between two plots should not be handled by CDSP surveyors	2	–	–	2
Land should be properly classified in the plot-to-plot survey (i.e. homestead. Pond, etc.).	1	–	2	3

Note: Multiple answers were recorded.

Chapter 6

CONCLUSION ON LAND SETTLEMENT

CDSP has reached the doorsteps of the beneficiaries and reduced their burden/harassment. Once they used to run after the land office and were the prey of rent seekers/land brokers. Now, the land brokers have become weak. CDSP has resolved many outstanding land disputes.

CDSP allocates land on the basis of land possession. Hence the recipient does not need to recover land occupied by others. This has, with few exceptions, ensured land possession and eased social conflict over the land possession.

CDSP has reduced the cost of land settlement substantially.

CDSP carried out a plot-to-plot survey before the commencement of land settlement activities. It was done with utmost sincerity and dedication though some problems remained in Char Baggar Dona-II.

The settlers have great resilience power to fight against all sorts of odds and to keep land under possession. They have made land cultivable out of the mud.

The experience of Char Baggar Dona-I shows that people do not sell any land though the situation is different here. The rehabilitation facilities from the side of the authorities, including credit and input support, were better and the amount of land allocation was higher than in Char Baggar Dona-II.

After arrival in the polders the main income sources of the respondents' households have changed because of increased farming and sharecropping. It also contributes in their food sufficiency status though the majority of the households has a food deficit for a considerable period of the year. The increased productivity and higher crop intensity can change the situation. The polders have improved the land quality freeing it from salinity and tidal surge. But in Char Baggar Dona (I and II), water logging has become a serious problem.

In Char Baggar Dona-I, the social status of the people has improved, after receiving land. Now they can mitigate their own disputes without outside intervention.

People highly regard the senior personnel of CDSP and government land authority for their sincerity and dedication and they believe that those people want proper implementation of the land settlement program. However, in CBT people have expressed their concern about the malpractice of the grassroots level land personnel, i.e. the *tahshildar*, from the government side.

To ensure participation of the people, CDSP has involved the Polder Committee members. Though they help CDSP in resolving social problems yet there are concerns about their sincerity in land matters.

In order to expedite the process of settlement, CDSP had to accommodate candidates chosen by power brokers and thus compromised with its principles of land distribution.

It has been reported that many land grabbers have established or are on the way to establish their ancestral rights or legal claims on land on the basis of previous *nothi* given before CDSP but not cancelled yet. CDSP is not taking this legal aspect into consideration, nor it provides legal support to the settler. In absence of CDSP the land recipient may face problems.

CDSP has allotted land to some non-possessors of land. They have been given land occupied mostly by powerful persons. If CDSP does not recover this land and hand over to the recipients the illegal occupants will never relinquish it voluntarily.

Many people express their concern that even if CDSP recovers land from those illegal occupants and hand it over to the recipients, they would not be able to retain it in the absence of CDSP, because those powerful illegal occupants will recapture it either evicting them forcibly or giving them some nominal price for the land.

The study was done on the basis of a list provided by the Land Settlement Unit of CDSP and the settlement process was only half-way. The cases that were dealt with were probably in better condition in terms of land possession by the occupants. Allotment of land occupied by illegal settlers was done after this study. The recovery of land was obviously a critical issue for those cases. The process of recovery of land from the illegal occupants was not very encouraging. The District Administration should gear up its efforts to recover those lands for handing over to the settlers that were allotted the land.

Annex 1

FINDINGS OF THE RRA

A.1 CHAR BAGGAR DONA-II

Settlement History

When Char Baggar Dona-II (a part of Char Baggar Dona) appeared from the riverbed people from Ramgati led by some *jotdars* occupied most of the land claiming it their ancestral land. The people of Sudharam led by some other *jotdars* also had ancestral claim over the land. Both parties were backed by their respective district and Upazila authorities. Fake papers were made by the contesting parties to defend their claims. Looting, setting fire on houses and clash between the *lathials* were a regular feature.

Apart from the *jotdars*, other interest groups also played a role. Some Co-operatives came into existence. Land was leased in the name of co-operatives and then distributed among the people paying subscriptions. The local *tahshildar* (revenue collector) came into the scene and mobilised the landless people for DCR. He engaged some of his own people in the area to mobilise the landless to have DCR from his office. However, he gave DCR to the people who were possessing land. It has been reported that he had interest in keeping the land *khas* to make profit from DCR. He, being from Sudharam, also favoured the people from Sudharam. With his backing the landless group ousted many other interest groups, the so-called co-operatives, and kept land *khas*.

CDSP and Land Settlement Activity

CDSP has earned credibility for its performance in land settlement. It has taken the land allotment package to the doorsteps of the beneficiaries and made it free of corruption and malpractice. It has involved local people i.e. the Polder Committee and the Sub-Polder Committee to identify the land possessors and to resolve other conflicting issues regarding land settlement.

Land Allocation as per Possession

During 1988-89 land allotment, the authority gave land without considering the possession of land. Rather they gave it on the basis of the 'Diara' map making plots on it. As a result, one got the allotment of land possessed by and so forth. The situation was so grave that even one's homestead went to another. Moreover, one person got allotment in different plots of land. The people had to exchange their plots through mediation. CDSP allotted the agreed exchanged plots to parties with their consent. This has mitigated land disputes.

Plot-to-plot Survey

CDSP carried out a plot-to-plot survey to identify the possessors of land with an objective of land distribution on the basis of possession. It seems that before carrying out this survey CDSP was not aware of the complex scenario of the land possession, and could not set any standard rule for possession identification to address the situation.

Legacy of 1988-89 Land Allotment on CDSP

The 1988-89 allotment was done not on the basis of land possession, but rather on the desk. As a result many people lost their possessed land and got land from other people. This caused problem

for the CDSP survey team to identify the possession. In some cases the surveyors considered the physical possession, in other cases they considered the *nothi* of 1988-89.

Lack of Understanding

During the plot-to-plot survey many possessors claimed land on the basis of possession while others claimed possession over the same land on the basis of 1988-89 allotment though the latter had exchanged it already with another person. If their claims over the land possession do not contradict with others' claim, then there is no problem. But in case of conflicting claims, problems arise. This mainly happened as the CDSP could not make the people clearly understand the purpose of the plot-to-plot survey and could not bring the concerned parties with claims together during the survey.

Many people could not understand the objectives of CDSP as they saw many such plot-to-plot surveys done by others. They took it as a routine exercise to recover surplus *khas* land. Moreover, they had an understanding that land allotment of 1988-89 was final on the basis of which people took the possession of land after a long hassle. The power elite, who was also involved in maneuvering 1988-89 allotment and got land allotment in the names of fake landless people, made the people understand that CDSP would not be able to give any new land allotment. The people were more convinced by those power elite because the land authority did not officially cancel the earlier allotment. As a result, many people did not come forward to identify their own plots and those who were with the surveyors took advantage of it.

Leakage in the Survey

One member of the survey team reportedly adopted unfair means in Char Baggar Dona-II. Before CDSP he was a surveyor in Noakhali Land Department. He had good linkage with the local leaders who took land allotment from him in exchange of favours. During the survey he favoured them keeping pre-CDSP land allotment intact as much as possible. It should be noted that in the other two polders no such complaint was heard.

Sharecroppers and Land Settlement

Some land possessors made a deal with their sharecroppers and/or mortgage holders that the latter would get land in their names but the land would eventually go to the former. After receiving *khatian*, many sharecroppers and mortgage-holders shifted away from that agreement. Subsequently, CDSP has given the opportunity to own land in more than one name. The former land possessors now want to take advantage of it and are delaying the process of settlement by raising objections to the allotment in the names of their sharecroppers.

Polder Committee and Land Allotment

CDSP often consulted the polder committee members for resolving land disputes. It has been reported that the members are not always neutral and scrupulous. Moreover, some of them were once involved in manipulating the land allotment process before CDSP. So they try to do things in the same way as they have done before.

Land Allocation and Possession

CDSP allocates land on the basis of possession. It also gives away land from the illegal occupants. Many have got land on paper. But they even do not know where their allotted land is. In many cases, the *jotdars* and/or the previous possessors have not surrendered the possession of the land to them.

Absentee Ownership

In the past, many outsiders got land allotments in the area. CDSP has been successful in many cases to cancel those allotments, but not in all cases. The last category of absentee owners are the relatives of the local power brokers. When CDSP calls them for signing the *kobuliyat*, the brokers bring them in the area and keep them in their houses. The local people do not raise any objection to avoid animosity.

Delay

The common allegation against the land allotment process done by the land settlement officials is that they harass the people by delaying the process and keep the people moving around day after day. CDSP has reached the doorstep of the beneficiaries. However, people still complain about delay in some cases.

A.2 CHAR MAJID

Settlement History

When Char Majid was formed, people mainly from the mainland, i.e. Char Bata, occupied land with the backing of the local UP Chairman. People from four different *samaj* occupied four parts of the *char*. The Chairman nominated some leaders for each part for settling people with not more than 2.00 acres each. Besides, the Chairman occupied a large chunk of land.

When the *char* appeared there was competition to get possession over the land. A group of *muktijoddhas* (freedom fighters) encroached into a large tract of Char Majid in the west. Another party from Maijdee under the banner of Nistar Party also occupied land in Char Majid. The settlers ousted both the parties from the area with the tacit backing of the Chairman and some other local leaders.

Land Settlement before CDSP

The Chairman made an arrangement with the land officials for land settlement. It was decided that everybody would pay Tk. 800 for a *nothi*. Many people had to sell their assets to arrange the money.

Moreover, many outsiders took land allotment from the *tahshil* office. They used to bring police during the harvest and take away half of the produce. They opened court cases against the land possessors and harassed them to tame them so that they would leave the possession of land to them.

The land allotment was done in the office on the basis of the 'Diara' map in which no location of homesteads and other plots were shown. Allotment was given randomly. As a result, most of the allottees did not get the land they had possessed and got the land that was under the possession of another person. It created serious problems in the locality.

CDSP and Land Settlement

When CDSP made the previous allotment null and void and started giving settlement on the basis of existing possession, settlers became optimistic as it solved the problem of possession. Most of the absentee *nothi-holders* gave up, though few absentee *nothi-holders* somehow managed to get land through CDSP.

Land Retention Status of the Beneficiaries

About 1% land recipients have already sold their land, and about 30% have already mortgaged out their land mainly for meeting consumption needs and for paying dowry. Incidence of land sale is

more in the southwestern part of Char Majid where many migrants from Hatia have recently settled buying land from the people who got land either from CDSP or from land office before CDSP.

Handing Over of Land Possession

The respondents requested for handing over the possession of land with accurate measurement by the CDSP surveyors. Many people possess more land than their allotted land while there are others in the reverse situation. When the people occupied land at the beginning, they used mundane instruments. As a result, land measurement was not accurate. The possessors have been occupying land and no one have bothered about it. After the official land allotment, some are found with less land and some with surplus. It is necessary to recover the surplus land and to hand over its possession to the person who got the title for it.

A.3 CHAR BHATIRTEK

Settlement History

When the *char* was formed, the *jotdars* from different areas occupied land. Each *jotdar* settled their own people locally termed as *proja*, giving land and promising a land title while taking money from them. The *jotdars* settled them with 1.20 acres each. Subsequently, some *jotdars* were ousted by rival *jotdars* and they have been eventually ousted by the landless groups and the government authority which declared the land *khas*. When the government started distributing land among the landless, many settlers deserted their previous patrons and got united first under the leadership of some junior partners of the big *jotdars* who deprived them, and later under the banner of a NGO (*Nijera Kori*).

Some *projas* joined the landless groups formed by the NGO, while others with a relatively large amount of land remained against them. Since the government allotted 2.00 acres of land for each family, some *projas* could not take allotment of all their land. So, they took land allotment in a fake name. The landless groups raised objections and got it cancelled. It became a fight between the landless groups and the *projas*. The latter group also managed false papers in favour of their "ancestral rights", and some of them got allotment of *khas* land from the land office.

Mistrust of *Nijera Kori*

When CDSP carried the out plot-to-plot survey the landless groups organised by the Nijera Kori did not co-operate. Rather they opposed it claiming allotment of 2.00 acres of land for everyone. The *Nijera Kori* groups recovered land from the possession of many absentee *nothi-holders* and *boya* claimants. However, they took it away from them forcibly in 1991 through a violent clash. There are disputes over the possession claims of these lands. When the plot-to-plot survey was conducted, the *boya* and the *nothi-holder* groups could establish their possession claim without any dispute, and later some of them got allotment from CDSP. If the landless groups would have co-operated with the survey team, there was a possibility of establishing their possession rights over those lands. This was stated by a landless group leader, repenting for their non-co-operation during the plot to plot survey.

Compromise with the *Jotdars*

CDSP has made provision for giving allotment of all possessed land to a family if it fulfils the criteria. Many people with large amount of land have opened cases in the court claiming ancestral rights and took moratorium against allotment activities with a view to delay the land settlement

process. Some of them have also got a verdict from the court in their favour and many more are reportedly on the way to get it. Many people have alleged that the GP (government pleader in the district court) does not move the cases properly. CDSP has come to an agreement with the *boya* claimant that they (the latter) would withdraw the cases and CDSP would allot them all land in their possession in the name of their family members.

Polder Committee

There is an allegation against the members of polder committee for nepotism and favouritism. Some of them have also taken advantage of land allotment. CDSP takes the help from the Polder Committee members to identify the absentee *nothi*-holders as well as the eligible landless candidates. The Polder Committee members are taking advantage of it.

Land Sale

It appears from the group discussions that more land sale and transfer have taken place in CBT. In one group discussion the participants made a list of 20 land recipients who had sold their land.

Absentee *Nothi*-holders

Many new settlers from Hatia settled in the area buying land possession from the absentee *nothi*-holders from Maijdee. During plot-to-plot survey, possession of land was recorded in the names of those absentee *nothi*-holders. They understood that CDSP would not give them land. So they sold the possession of their land. CDSP allotted that land in the name of the "buyers" in possession.

Discrepancy Between the *Kobuliyat* and the *Khatian*

About 10 persons among the Landless Group of Nijera Kori and 30 in total have not got the amount of land they signed for in the *kobuliyat*.

A.4 CHAR BAGGAR DONA-I

Settlement History

The land was officially settled in 1986 in the name of thirty co-operatives.

Collective Ownership

Nijera Kori organised 30 co-operative societies with 30 members each. Each society is registered with the Department of Co-operative. In the initial years they cultivated land collectively and then abandoned this approach as they suffered losses.

Demand for Individual *Khatian*

The respondents unanimously want to have individual *khatian* instead of collective ownership under the co-operatives, though Nijera Kori is against individual *khatians*.

Social Status

People's social status after receiving land, as they perceive, has improved. Now they can mitigate their own disputes without outside intervention. The *salish* (village court) system has improved with dispensation of better and impartial judgement. They can contest in the UP election and can get elected as UP Member. They can play vital role in electing the UP Chairman.

Economic Condition

Their economic condition has improved. Now they get employment in their own land. They get produce from their land and many of them also do sharecropping. Recently, there has been some setback due to the problem of water logging in the polder.

Annex 2

CASE STUDIES

B.1 CHAR BAGGAR DONA-II

A Farmer Who Got a Land Title

Shahjahan is about 55 years old. He has a family of 8 members with two earning members. Neither he nor his wife has schooling. Three sons and one daughter attend primary school. He is linked with the local political scene. He is the supporter of Manik, UP member, the rival of the present UP Chairman.

He came here from Char Bhatirtek where he settled from Ramgati after his ancestral village was eroded by the river. He was a rickshawpuller in Char Bhatirtek. He has come to Uttar Bagga through his father-in-law who was one of the early settlers in the area occupying about 16.00 acres of land and was a supporter of *jotdars* from Noakhali side.

Shahjahan was given 2.00 acres of land by his father-in-law who had more land than he could have in his own name and in the name of his seven sons. Shahjahan tried to get land allotment from the *tahshil* office and bribed the *tahshildar* Tk. 500. But the *tahsildar* did not give him the land. Rather at the persuasion of Bhulo Neta (a local leader) he gave his allotment to some outside people.

Though once his father-in-law and brothers-in-law were supporters of Bhulo Neta, later they had a confrontation with him over the possession of a plot, and they physically assaulted him. Consequently, he took revenge by depriving them from land allotment in coalition with the *tahshildar*.

Shahjahan through other patrons of the village kept living on that land as a sharecropper. Bhulo Neta took a share of the produce from him. When CDSP carried out plot to plot survey he established his possession right over the land. CDSP gave him 1.23 acres of land in his name cancelling the previous allotment. However, Shahjahan wants to get the rest 0.87 land though CDSP has given his allotment to the previous allotment holders.

A Farmer Who Got Land Title on Disputed Land

Robiul Hossain aged 45, is a beggar. His wife is 35 years old. He has three children. His eyesight is poor and he cannot work hard. He has been begging for last two years. He is from Hatia. He was squatting on 0.02 acres of land in the polder.

CDSP has built a Cluster Village (CV) near his homestead and has selected him for the CV, allotting a house and 0.16 acre of land in the CV and another 0.26 acre cultivable land. However, he did not get the possession of the cultivable land and he does not know where that land is located. He is not concerned about the possession of this land but rather about his homestead land, more precisely with his house in the cluster village (in CV No 1).

A certain Abu Mea is trying to get possession of his house where he is residing. It is also on the land allotted to him. But the house is allotted neither in his name nor in anyone else's name. On the other hand, Abu has received both arable land and a house in a cluster village. But the cluster village is not mentioned. So, he wants a house in CV No-1. With the help of two journalists from Maijdee, he influenced the concerned officer to allot a house for him in CV No 1.

Though Abu is squatting on the foot of the embankment his economic condition is better than Robiul's. It is reported that he sharecrops and mortgages land and he has a reasonable income. People say that Abu gave 20 kg chili from his own production to a surveyor who recorded the land under his possession falsely. His social status is also better than Robiul's.

Abu wants Robiul to leave CV No.1, but its inmates and the people of the neighbourhood are in favour of Robiul. Even the inmates of CV No.2 and CV No.7, which have vacant houses, favour Robiul. The UP Chairman and Members and the people of the Bazaar Committee of Pankher Bazaar also prefer him.

To occupy Robiul's house, Abu brought police who evicted Robiul and took him to settle in CV No.2. But the people of CV No.2 foiled this attempt. Then Abu lodged a false rape case against Robiul and three other persons of CV No.1. He also alleged that the others took money from Robiul.

Both UPOMA, a NGO that works among the CV settlers, and CDSP want Abu to settle in a vacant house in CV No.2, but he refuses. He does not come to any compromise with the inmates of CV No.1 and defies their authority, but a financially solvent person having a good linkage with powerful quarters, is not ready to drop his demand. On the other hand, Robiul, a poor man, cannot leave CV No.1 because his livelihood is there. In the first place he produces vegetables in his old homestead. Moreover, his wife is employed in the locality. But in a new place it would be difficult for her to manage employment. Now his wife can not go out for work, fearing that Abu in her absence will enter the house.

Land Allotment without Possession

Mosaraff is 50 years old and his wife Sakera is 48 years old. They live in Madhya Bagga. He has got land and a house in a cluster village and another 1.23 acres of arable land from CDSP. But he is not interested to leave his homestead that he has built bit by bit over a long period.

He was in Char Gazaria in Ramgati upazila under Lakshmipur district. He sold his land in Char Gazaria as the river erosion was posing a threat to his land and homestead. So he sold land and homestead and settled in Char Baggar Dona through Khurshed Neta, a *jotdar* from Ramgati, buying the possession of land from the *jotdar*. He used to pay Khurshed money whenever he asked for it on any pretext, such as DCR, land record, *lathial* charge etc.

He has homestead land of 0.60 acre, a pond of 0.40 acre and 1.80 acres of arable land(all are now disputed).

He bought 0.80 acres of land at a value of Tk. 3,500 from Bhulo Neta, a local influential *jotdar*. He also paid him money for getting land allotment from the *tahshil* office. However, he did not get any land allotment, though he used to have DCR for 1.23 acres of land through Bulo Neta. But the land for which he had DCR was not in his possession and he even did not know where this land was. Bhulo Neta gave him the same amount of land around his homestead. He knew it, but was content with this land possession with a hope that one day Neta would manage official papers for this land. CDSP found that the land belonged to Neta who had a court injunction against allotment activities. So, CDSP could not give him the allotment of the land he possessed and gave him the land for which he had a DCR and another 0.16 acres of land in a cluster village. But CDSP has not handed over this allotted land.

After the land allotment by CDSP Bhulo Neta created pressure on him to relinquish his land on the ground that he had received land from CDSP. Bhulo Neta wants Tk.3,500 for a piece of land for homestead. He has warned him not to disclose it to anyone and threatened him in case he would do that. Now Bhulo takes half of Mosaraff's harvest by force.

A Farmer Who Got Land Title but Lost his Land

Abu Hashem, aged 70, is head of a four-member family. He is a carpenter. He has 0.28 acre of homestead land, 0.32 acre of pond and 0.10. acre of agriculture land (he has sold 0.80 acre).

When Char Baggar Dona came up, he settled here occupying 1.200 acres of land. The land was full of *uri* (weeds) and he claimed it. Besides, he also sharecropped land. He settled in Char

Baggar Dona selling his houses and inherited land in his ancestral village. When he came here there was dispersed settlement in the area. He was as a follower of Sharif Ullah Patwary, a leader of a landless group, which settled many people in the area. He paid a subscription of TK. 4000 to the group to get land for four members, but ultimately got no land from the group.

He faced fierce competition over the land under his disposal from several rival groups of which *Boya* claimants (who claimed ancestral right) was the strongest group. The rival groups took away almost all his land keeping only 2.00 acres for him.

He also fought a battle with the people of Char Baggar Dona-I when they tried to evict the people of CBD-II. He was taken in to police custody several times. His son was detained for two months. He had to spend Tk. 30000 for the litigation over land disputes since his settlement in this *char* during the 1988-89 land allotment.

He tried to get land allotment from the *tahsil* office. He incurred an extra-legal expenditure of about Tk. 3000 to get settlement. He managed this expenditure by selling trees and mortgaging land. The *Tahsilder* claimed another Tk.1000 but he failed to pay it and consequently he could not obtain any *khatian* for his land.

He signed *kobuliyat* for 1.22 acres of land from CDSP. He has another 0.50 acres of *khas* land in his possession, and CDSP has given allotment of 0.25 acre from this land to his neighbour. On the other hand, he has given 0.16 acre of land in the name of his son (as a separate household) to ensure the possession of land under him. The CDSP surveyor advised him to give some land in his son's name so that he could get some land in his name elsewhere. Hashim claims that the surveyor took money from him for this favour. Consequently, his son has got another 0.50 acre of land but has not yet received the possession as a powerful person is occupying it.

He sold 0.80 acre of land to repay the loan and to meet other expenses.

B.2 CHAR MAJID

A Farmer Who Got Land Title but Lost his Land

Abdul Ali is about 60 years old and is handicapped with a defunct left hand. He was born in Char Badu and from there he migrated to Pir Baksha where he stayed for three years. Following the river erosion in Pir Baksha he migrated to Char Bata, his ancestral area. He also experienced river erosion in Char Bata, but the eroded area accreted again. This is now a part of Char Majid. Ali has been in Char Majid for about 8 years though he occupied land in 1984.

Ali settled here with the ancestral claim but the land was declared as *khas*. Some people from the north, e.g. Char Bata, came with *nothi* taking land allotment from the *tahshil* office. They were followers of the local UP Chairman. But Ali refused to relinquish his possession. Abu Taher Mia, the leader of the Sundia faction, backed him. Ali, influenced by his patron Abu Taher, did not give Tk. 800 to the *tahshil* office for land allotment for which the Chairman made arrangement with the land officials.

He applied for land settlement three to four times but his application was not taken into consideration as his opponent group opposed it. He received 1.29 acres of land from CDSP.

A Farmer Who Lost his Land to CDSP without Any Compensation

Zainal Abedin lives in Char Majid. He is about 40 years old. He has a seven-member family. He occupied land 17/18 years ago when it came up from the riverbed. He built a thatched house five years ago and has been living there since then.

Zainal occupied 2.00 acres of land. During the 1988-89 land allotment, he paid a *salami of* Tk.800 though the official fee was Tk. 8.00 only. He paid it as per the directive of the Chairman. When CDSP started, the land again became *khas*.

CDSP acquired his 0.40 acre of land for infrastructure development in the area and the rest 1.60 acres remained in his possession. Later, CDSP acquired the remaining 1.60 acres too for

construction of a cluster village (CV) without giving him any compensation. He was included in the first list of CV inmates. But his name was later dropped from the list. Only 13 persons from the first list got allotment in the CV. The other 17 were selected mostly from the mainland outside the polder. It has been reported that the concerned authority took money from the new settlers. Now he occupies a house in the CV "illegally". He is being pressurised to vacate the house in the CV.

He applied for *khas* land and signed a *kobuliyat*. But he has not yet received any *khatian* from CDSP. He is not sure whether he would get any land at all. CDSP is going to wind up soon. This has intensified his agony.

A Farmer Who Got Land Title but Lost His Land

Nuruddin, aged 45, lives in Char Majid. He received 1.22 acres of land from CDSP of which 1.02 acres is arable, 0.08 acre is homestead and another 0.12 acre is pond.

He had ancestral land in Char Bata, which was eroded, by the river Meghna. When it came up again he could not record that land in his name though the influential people recorded their land again. So, he became landless. He was squatting in the mainland. When Char Majid surfaced from the riverbed, he occupied 1.22 acres of land. He came here in 1984. He has a thatched house and a few trees on the homestead. He has a family of 8 members. His wife is a member of Shagarika, a local NGO.

In the first four years, he used to have DCR from the *tahshil* office. In 1988-89 he paid Tk. 800 to the *tahshil* office. At that time he was fishing in the Bay. His wife managed money by selling poultry, but they did not get land allotment. CDSP gave him land allotment on the possession basis and he did not spend any extra money.

He sold about 0.80 acre land (he did not admit it and claimed that he has mortgaged it) to pay back a loan borrowed for the marriage of his daughter and later for the post-mortem and other rituals for his daughter who died at her in-law's house. He claims that she was beaten to death while her in-laws say that she had committed suicide. The dead body was taken to the Noakhali Sadar Hospital for post-mortem. The police came to the spot. He spent about Tk. 10000.

A Farmer Who Lost Land

Harunur Rashid is about 37 years old. He was born in Char Torap Ali. He was squatting there on *khas* land but was evicted by a *jotdar*. Then he settled in Char Bata on his father in-law's land. He occupied 0.84 acre of land in Char Majid and later built a house. The *jotdars* tried to resist his settlement in the area.

Some *jotdars* from Char Bata took allotment of the land possessed by him. They took the harvest with the help of the police. The *jotdars* brought police, arrested him twice and took money from him on both occasions, Tk. 2000 and Tk. 1000 respectively. He fled away from home during the harvest fearing police action.

When CDSP came in the area, the *jotdars* disappeared. He does not face any threat from the *jotdars* now. He will get the *khatian* for his land soon. However, he has already sold 0.24 acres of land to repay his loan that he borrowed for the treatment of his ailing son and for consumption. Moreover, he also borrowed money from moneylenders for paying the police.

B.3 CHAR BHATIRTEK

A Farmer Who Got Land Title

Abul Qashem is 40 years old and his wife is 35 years old. They have seven children. He is the treasurer of the Bazaar Committee and has a good reputation for his honesty and modest behaviour. He has two houses in the local market, and in one he runs a grocery.

His father settled here with his two sons including Qashem and one daughter. His father first migrated to Sonadia from Ramgati following a river erosion. From Sonadia he settled in Nabagram through a certain Mojibur Rahman Amin with 4.80 acres of land in exchange for Tk. 2000. Amin assured him of the land title. However, Amin did nothing in this regard and rather took money from time to time on different pretexts, such as DCR for land, case at court, *lathial* charge for protection in the *char*, etc.

When they realised that Amin did nothing for the land title, they asked him to show papers. Amin reacted and demanded more money. Then they left him and joined a landless group of Nijera Kori. Then Amin became hostile. Qashem had a grocery shop in the village where mostly the *boya* claimants i.e. members of Amin's group, lived. They boycotted him and did not buy any goods from his shop. To avoid embarrassment he shifted the shop.

When he became a member of the landless group, the opponent group opened two court cases against him, one for hijacking and another for attacking the *boya* people. However, in both cases he was acquitted.

When CDSP came in the area Qashem got land allotment for 2.00 acres, and his brother who lives in a separate house also got 2.00 acres. He is possessing another 0.40 acre for which he managed a title in his nephew's name.

A Case of Land Possession Denied by *Jotdars*

Habibullah, aged 60, has seven members in the family. His son, a rickshawpuller, is the main income earner for his family. Once he was a jute mill worker in Narayanganj. He left the job because of old age and settled in Kabirhaat squatting on the road side. He came into contact with a certain Nurul Islam, alias Bhumikompo Nurul Islam, a *jotdar* from Nabagram who brought him to Nabagram for settlement and gave him a small piece of land on the bank of a canal, close to the river.

Gradually the river shifted to the north and more land came up. Habibullah gradually acquired possession of newly accreted land and made it cultivable. CDSP has given him allotment of 1.49 acres of land including a homestead of 0.20 acres on the basis of possession. However, he has got the possession over 1.01 acres only. A certain Gonesh from Kabirhaat denies his right over 0.48 acres of arable land. Gonesh reportedly purchased this land from a *boya* claimant, and took the court injunction over this land allotment. Habibullah, a very simple man, is neither aware of court action nor does he understand its implication. He only knows that he has got this land from CDSP, and he is the owner of this land. He said with a sad voice: "They (Gonesh) have land and other properties. We are landless and we have got this land. If we cannot hold this land, please shoot us."

A Farmer Who Got Land Title but Lost his Land

Golap Rahman, known as *Biscuit Bepari* for his biscuit and bread business, is about 40 years old. He has a family of eight members. He lived in a village near Kabirhaat. He had a rice business in Kabirhaat but the income was inadequate. He got 0.40 acre of land from his father together with his other two brothers and a sister. This was not enough for his family. So he migrated to Baishakhi Mouza buying the possession of 1.22 acres of land at a cost of Tk. 11000.

Then he started the business of biscuit and bread in the area. He bought goods from Kabirhaat. But he suffered losses in his business. He used to bring goods from the suppliers on credit that piled up gradually. He paid it back by mortgaging his land. His economic condition worsened when he developed pain in the stomach.

Golap Rahman already got the *khatian* for his land through CSDP. But he is going to lose his land soon. He borrowed Tk.3000 some years back and it has now compounded to Tk. 15000 with

interest. He has no means to pay it back except selling land. A negotiation for land sale is going on through the village leaders. The value for the land has been fixed at Tk.55000. He will sell all his land including his homestead and pond. He does not know where he will go after selling his land.

A Farmer Who Got Land Title but Lost his Land

Maleque is about 70 years old. His sons who live in separate houses help him occasionally, and they have given him 1.20 acres of land, out of 2.00 acres that has been allotted to them by CDSP.

He came to *this* char from Ghoshbag. He settled in Nabagram through a certain Enam Mia Chowdhury. He got 4.80 acres land. Enam claimed land as a caretaker of a Waqf estate but his rivals, other *jotdars*, claimed ancestral rights over it, and settled their own people. As a result, conflict surfaced between Enam's group and the other *jotdar* group, particularly with the group of Mojibur Rahman Amin. Consequently, a violent clash took place between the contesting parties and Enam was ousted from the area. Hence Maleque, a *lathial* of Enam, lost his patron and also his land and influence.

When his group was ousted from the area the rival group took his land away from him and put pressure on him either to leave the area or to join them. They also took money from him on different pretexts and demolished his house. He was looking for ways to get out of this situation and at last he became associated with Nijera Kori which helped him to form organisation of landless people. He along with other landless people formed an organisation in Nabagram.

Maleque had 4.40 acres of land in his possession, and got 2.00 acres of land settlement from CDSP in his own name and the rest, including homestead and pond, have been allotted in the name of his sons. However, he has sold his own 2.00 acres at Tk. 30000 to repay his outstanding loan.

Part III

Land and Water Engineering

J. M. Groot

Chapter 7

PARTICIPATORY WATER MANAGEMENT

7.1 PARTICIPATORY WATER MANAGEMENT IN BANGLADESH DURING CDSP

7.1.1 The 1994 Guidelines of the Ministry of Water Resources

At the start of CDSP, there were guidelines of the Ministry of Water Resources specifying fields of participatory water management. These fields were:

- Planning and design.
- Actual management.
- Maintenance and cost recovery.
- Involvement of beneficiary groups.

The guidelines foresaw:

- Establishment of Project Councils.
- Establishment of Water Management Organisations at three levels:
  - Groups, at the level of the smallest hydrological unit.
  - Committees, as soon as two or more groups were involved.
  - Associations.

There was no clear indication of what the smallest hydrological unit was. Project Affected People (PAP) or beneficiaries other than farmers, were to be represented at Project Council level, rather than at Water Management Organisation level.

7.1.2 The SRP Proposals

In 1998, the Systems Rehabilitation Project (SRP) launched new proposals with respect to Participatory Water Management. Their merit was that they recognised the role of local government, the Union Parishad (UP), in water management, an issue that had been neglected in the discussions.

SRP foresaw the establishment of Water Management System Committees at upazila level to handle water management matters. Such committees would have a similar status

as the existing upazila development co-ordinating committees. Union chairmen were supposed to play an important role in the committees. At a lower level, SRP proposed a Water Management Block meeting, not a Water Management Block Committee. The Water Management Block meeting could be convened by the Water Management System Committee, if required. The Block meeting might assign compulsory tasks and duties and impose mandatory contributions on individuals and groups of stakeholders.

7.1.3 The 1998 Guidelines of the Ministry of Water Resources

The 1998 guidelines of the Ministry of Water Resources maintain the three tier set-up of the earlier version, with a slight change in terminology. The lowest level was named Water Management Group, the second level Water Management Association and the third Apex Water Management Association. The Water Management Association consists of office holders of the Water Management Groups together with representatives of other recognised occupational groups and women groups.

The area under a Water Management Group would be smaller than 1,000 ha. The groups do not need to be registered and could be established without founding document or bylaws. Groups may form associations. Associations covering areas of a few thousand hectares, may form Apex Water Management Associations. Associations and apex associations must be legally registered. BWDB and Local Government will develop procedures for recognition of groups, associations and apex associations.

The terminology Water Management System was reserved for areas under a Water Management Association and higher. The boundaries of systems are mainly delineated on hydrological grounds.

Local Government Councils, from the level of the Gram up to the District, may take the initiative to form Joint Water Management Committees for systems largely lying in their areas. Representatives of BWDB and local government departments, if required, will be members of the joint committees, however, local stakeholders and residents, representatives of associations and groups, must always constitute a voting majority.

7.2 CDSP'S CHOICES

7.2.1 Initial Choices

In a change from LRP, CDSP abandoned the link between drainage issues and land settlement. But also with respect to the set-up of people's participation, CDSP followed a different approach. There were two reasons for that. First, CDSP's activities were not confined to water management only. The Project was intended to be multi-sectoral, including activities such as agricultural extension, provision of sanitary and health facilities, education and others. The second reason was, that CDSP's project area consisted of three separate areas, which were small by water management standards, be it that those areas contained well defined water management systems more or less independent from their surroundings.

From the beginning CDSP opted for the establishment of Polder Committees (PC) and Sub-Polder Committees (SPC), which participated in the multi-sectoral planning process. As water management was one of the activities, the PCs and SPCs handled water management matters as well.

Later during the Project, as planning made place for implementation and still later for O&M, the latter being mainly O&M of roads and water infrastructure, the need for Water Management Committees (WMC) grew. CDSP developed its own WMC guidelines, which for reasons of history and size of the project area, do not fully synchronise with the Ministries guidelines of 1998. The text of CDSP's guidelines can be found in the Maintenance Plan, which will be discussed at the end of this report. It is important to note that in the CDSP guidelines, the role of local government, mainly at union level, is fully recognised. This reflects the actual situation. Union Parishad members, ex officio or not, have always played an important role in CDSP activities.

7.2.2 Present Situation

With the 1998 Government guidelines on the table and CDSP entering a new phase of life, the question has been raised what the future will be for the PC, the SPC and the WMC. The idea is that the PC and SPC will disappear soon. As for the WMC, due to the small size of the polders, it will be candidate to become a Water Management Group, possibly merging into a larger association with surrounding groups.

The statements above should not be interpreted as meaning that during the coming phase, CDSP should already do away with PC, SPC and try to fit the WMC into a larger structure. The PC and SPC have proven their value and in the future CDSP's activities will remain multi-sectoral, requiring feedback from the population, from the planning phase on. The WMCs of CDSP at present play a crucial role in the development of an O&M structure in which CDSP is quite advanced, given its Maintenance Plan to be discussed elsewhere. So, CDSP should proceed on the same road it is on, keeping one eye on Government guidelines and the other on its own targets.

The present situation is that WMCs have been established in all four CDSP areas, including Baggar Dona-I. The latter area is worth mentioning as CDSP, due to its Terms of Reference (TOR), mainly undertook rehabilitation activities in the area and little monitoring. The efforts made to extend O&M activities to Baggar Dona-I serve to prepare the area for the following CDSP phase, under which all four polders will have the same status. The two Baggar Dona areas and Majid each have their own WMC.

The situation is different in Bhatirtek. In Bhatirtek the construction of two sluices, Nabagram (CDSP) and Kalmi sluice (sluice 17), has been finished, one by CDSP (Nabagram) and one by the Coastal Embankment Rehabilitation Project (CERP). The latter, Kalmi sluice, is under additional consideration, as the sluice has been equipped with flap gates only, lacking sliding gates, which are essential to retain water, when outside water is low.

A third sluice, Gangchil sluice (sluice 3) is still under construction by CERP. When it is finished, it will drain land within the present CDSP area and land outside. The boundary between the two areas is not water tight. Certainly as long as the sluice is not functioning, water may enter the CDSP part from outside. The incoming water does not affect the Nabagram and Kalmi areas, as their boundaries are more or less closed.

In view of these complications and also because of the population's uneasiness with respect to assuming responsibilities for unfinished sluices, land users in Bhatirtek still preferred one WMC for each sluice, as in the case of sluice committees and CDSP has agreed to that. So three WMCs were established in Bhatirtek. For the Gangchil area

provisions have been made for the situation after sluice completion, when the area under the jurisdiction of the WMC will have to be extended. That should be part of the programme for the coming phase. Above the three WMCs a federation of WMCs has been created, covering the entire Bhatirtek area. In view of the Government guidelines, it would be better to use the terminology Association instead of Federation.

Chapter 8

THE PHYSICAL ENVIRONMENT

8.1 RAINFALL

8.1.1 Evaluation of Rainfall Data

Long term, daily rainfall data are available from Noakhali station, which has a record since 1976. After March 1997 no data have been collected yet from the Meteorological Department by CDSP. The data set discussed here is the same as the one used in the Water, Soils and Crops report (see Part IV of this book).

The daily rainfall figures of the Noakhali station are available in CDSP's files. Table 1 of this report shows the maximum, minimum, median and quartile values for every month and the yearly totals. It should be noted that the figures for the different months and the yearly totals, listed on the same line in the Table, in most cases have occurred in different years. They are not related. The table provides a means to determine whether a particular month or year during CDSP's lifetime has been dry, wet or average.

As it turns out, all years of which there are records, 1994, 1995 and 1996 have been rather wet. The yearly totals are between the second quartile value and the maximum.

To monitor the rainfall in the different polders, rainfall data were collected at the site offices. As there is only one site office for both Baggar Donas, there is one rain gauge there. Monthly and yearly totals, are shown in Table 8.1. There are however quite some months with missing data.

The available data of Noakhali station and those of CDSP, barely overlap. It is therefore not possible to determine whether there are great differences between the coastal chars and Noakhali station. For the same reason it is not possible to make checks on the accuracy of either data set.

Great attention should be given to the continuity of rainfall recording in the polders for the data to be useful.

8.1.2 Analysis and Drainage Requirement

Using the Noakhali records, the Water, Soils and Crops Report determined quartile values of 10-days sums. The daily rainfall intensity derived from these sums is about 30 mm/day,

TABLE 8.1
Rainfall Data of Noakhali Station and CDSP Stations.

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Noakhali													
Minimum	0	0	0	0	65	306	448	242	189	13	0	0	1,263
1st Quartile	0	7	13	96	227	489	629	520	350	65	0	0	2,395
Median	0	26	63	153	383	632	663	605	438	167	16	0	3,145
2nd Quartile	2	57	110	285	456	746	812	793	521	339	64	11	4,194
Maximum	31	173	401	511	910	1,169	1,295	967	696	587	256	46	5,780
CDSP													
Bogra Donna													
1996	–	–	–	–	–	–	–	453	289	355	65	4	–
1997	0	47	108	28	314	157	1,072	490	688	107	No Data	No Data	5,008
1998	6	58	220	75	353	218	926	816	377	266	75	No Data	5,388
1999	0	0	0	–	–	–	–	–	–	–	–	–	–
Majid													
1997	–	–	–	18	80	236	961	610	No data	No data	No data	No data	–
1998	No data	No data	205	218	551	213	731	834	453	258	124	0	5,585
1999	0	0	0	–	–	–	–	–	–	–	–	–	–
Bhatiretek													
1997	No data	No data	34	29	77	80	353	159	221	42	0	7	–
1998	22	31	132	295	532	277	671	810	248	192	100	0	5,308
1999	0	0	0	–	–	–	–	–	–	–	–	–	–

for the upper quartile and about 15 mm/day for the lower, during the months June to August. The monthly values of Table 8.1, being monthly figures, yield comparable values. Apparently for periods between 10 and 30 days there is little change in average rainfall intensity. The data also show that during relatively dry monsoons (lower quartile values) rainfall still exceeds evaporation by far. Evaporation values are expected to be 3-5 mm/day, so there is a daily surplus of about 10 mm/day during dry monsoon months.

The upper quartile values may be used to derive a drainage requirement to be used in drainage design. If one subtracts from the average value of 30 mm/day an evaporation of about 4 mm/day, the requirement becomes 26 mm/day, which is equivalent to a drainage requirement of about 3 l/sec.ha.

Against this one may argue, that 10 days are a rather long period to base a drainage requirement on. If one would do the same analysis for 5 or 3 days periods, the drainage requirement would be higher. This is correct. However, water storage on the land is large. In addition, as discussed in the chapter on Design and Implementation, drain densities are low. The overall evaluation is that 10-days rainfall amounts form a good basis for a daily drainage requirement. The evaluation is also based on the experience of the Compartmentalisation Pilot Project (CPP) in Tangail, where similar conditions exist and where peak drainage discharges remain below the 10-days rainfall excess.

A final answer in the matter could only be obtained from discharge monitoring. However, as explained in the Design and Implementation chapter, such monitoring is rather complex and costly, while results will remain confusing due to uncertainties in other parameters.

The Status Report concludes that LRP and BWDB used a drainage requirement of 38 mm/day or 4.4 l/sec.ha in their designs. In view of the fact that design capacities of the drains so far have not been a major problem, on the contrary there may be over-capacity, one may scale the drainage requirement down in future designs.

8.2 GROUNDWATER DEPTH

8.2.1 Introductory Remarks

Because of LRP's experience that the salt content of the groundwater was highly erratic, monitoring of groundwater salinity was discontinued during CDSP. Only data on groundwater depths were collected. It should be noted that at the time CDSP started groundwater measurements in the Baggar Donas, LRP's piezometres had been disturbed and new piezometres had to be installed.

All groundwater levels are in m PWD and not in m below the land surface. It is important, however, to realise that those land levels are not representative for the lands in the respective polders. The piezometres were installed in the compounds of the field offices, the surface of which was raised to keep the compounds above average flooding conditions. As discussed in the section on mapping, there is no satisfactory assessment of average land levels in the CDSP areas.

8.2.2 The Measurements

Measurements in the Baggar Donas started after the monsoon 1996, those in Char Majid in February 1997 and in Bhatirtek in January 1997.

The purpose of the ground water measurements is:

- To establish whether differences in groundwater level exist between the three areas.
- To collect data about the behaviour of the groundwater, in particular about its depth during the dry season.
- LRP mentioned the existence of the so called deep drainage flow, groundwater flow from the chars to the sea, in the Baggar Donas. It is of interest to see whether that flow also occurs in the other CDSP areas. For that purpose, three piezometres are required, with filters at different depth.

Char Baggar Dona. Average ground water levels during the monsoon in Char Baggar Dona are at about 4.6 m PWD, which is about the level of the surrounding land. There is little difference between the deep and shallow piezometre during those months. During the dry season water levels may drop as deep as 0.3 m PWD. When groundwater levels fall, during longer periods of time after October, a difference between the shallow and the deep piezometre shows up. This indicates that a deep drainage flow occurs. The difference may be as much as 0.6 m (April 1998). A quantitative estimate of the deep drainage flow in mm/day can not be given, however.

Char Majid. Average groundwater levels during the monsoon are about the same as those in Baggar Dona although somewhat higher (4.6-4.8 m PWD). There is little difference between the deep and shallow piezometres during those months. Water levels during the dry season do not drop as deep as in the Baggar Donas. The greatest depth recorded is 1.53 m PWD in May 1997. After initials rains, groundwater tables start rising again. Also in Majid there is a difference in level between the deep and shallow piezometres after the monsoon, which is more than a meter in March and April 1998. The difference occurs particularly between the deep piezometre and the one of medium depth. It seems as if it becomes noticeable later after the monsoon, than in the Baggar Donas.

Char Bhatirtek. Average groundwater levels during the monsoon are considerably higher, 5.4-5.6 m PWD, than in the other areas. This reflects the higher land levels in Bhatirtek. Already during the monsoon, there is a consistent water level difference between the shallow and deep piezometre of about 0.2 m, which continues after the monsoon. The difference reaches values of more than 1.5 m during May 1997, which is larger than in Majid. However, the groundwater does not drop as deep as in the other areas. The greatest depth recorded is about 2.2 m.

8.2.3 Deep Drainage Flow

In conclusion, there are similarities and differences in groundwater behaviour between the different areas. In all cases there is a deep drainage flow. Differences probably reflect characteristics of the land, water levels in surrounding areas, the permeability in the sub-soil, or still others. It is important to know, however, that the groundwater depth is influenced by other factors than evaporation alone. Deep drainage flow plays a role.

Groundwater tables drop so deep that ponds and other surface water bodies will feel the impact, although the effects can not yet be predicted. Although the conclusions from the groundwater measuring programme are still somewhat vague and have limited impact on the methodology for char development, it is recommended to install similar

piezometre sets at future field office sites in new areas. It is important to identify differences in conditions. Groundwater is a basic physical component and its behaviour should be followed.

Although the existence of deep drainage flow in all three areas has been established, its magnitude is unknown. The question is whether it is relevant to know more about it. There should be no illusion that deep drainage flow can be slowed down. The most practical applications would relate to fish ponds. According to CDSP's Technical Report No 20 (Culture fisheries in coastal chars, April 1999), 30% of the fish ponds never dry out, 44% dry out in March and April. Before March, 16% dry out and after April 10%. Seepage (deep drainage flow) is considered the main cause. To reduce it organic manure is recommended.

Evaporation from fish ponds is expected to be larger than seepage. It may be effective to slow evaporation down, or, there may be cases where seepage is incurable. Seepage from fish ponds is probably very location sensitive. Soil conditions may be important but also the distance to embankments. Fish ponds near embankments are expected to receive positive inflow through the embankments. If that is substantial, the ponds will have a higher salinity than in the case there is only negative seepage.

A measuring programme can be designed to know more about such matters. However, the programme is expected to be somewhat complicated, although not expensive. Because of its complexities it is advisable to pay attention to the design of the programme and to have it supervised by a Bilateral Associate Expert.

8.3 WATER LEVELS AT THE SLUICES

8.3.1 General

The Tables 8.2 and 8.3 (at the end of this part) give monthly averages of water levels and salinity levels inside and outside the polders, near sluices. Measurements in the Baggar Donas started in November 1996.

No water levels were collected at the Char Majid sluice. After the sluice was completed, in August 1998, there were difficulties with the operation of the gates. A temporary embankment was maintained outside the sluice which prevented water levels to be measured. In Bhatirtek water level measurements started at Nabagram sluice in January 1998, after the sluice had been completed during the 1997 monsoon.

Water level observations were done three times a day. The daily values are averages of the three readings. In 1998 a start was made with the recording of gate openings. If a gate was closed a 0 was put down, for an open gate a 1 and for a partially opened gate a 0.5. The Baggar Dona sluices have three gates, so the maximum value is 3. The Nabagram sluice has 2 vents and the maximum value is 2. As gate openings were recorded three times a day and the values were averaged for the day, decimal values different from .5 may appear.

8.3.2 The Baggar Donas

After the monsoon, water levels inside the Baggar Dona polders drop off gradually to levels of about 1.5 m PWD. When the rains return, the water levels shoot up again. There are differences between the years. The year 1998 seems to have lower levels

outside the monsoon than 1997. There are also differences between the two polders: Baggar Dona II consistently has lower water levels inside than Baggar Dona I, although the differences are small. The inside water levels fall despite the fact that outside water levels remain relatively high. During the heart of the dry season, the sluices remain closed and, as Table 8.3 shows, salinity levels near the sluices, are high.

The conclusion is, that during the dry season, when the sluices are closed, the water levels inside the polder are left to evaporation and the water seeping out of the polders by the deep drainage flow. These components apparently exceed the possible leakage through the sluices and positive seepage, from the higher outside water through the embankments into the polder.

Water levels, both inside and outside, start rising with the onset of the rains. At the same time the sluices are being operated and, as Table 8.2 shows, salinity decreases suddenly below the danger level, which is at about 5 mS/cm. During the full monsoon, the months June-September, inside and outside water levels are about the same. This deviates from the general concept about coastal polders, namely, that such polders have a certain control over the water levels inside, by proper manipulation of the sluices in concordance with the tide.

The information on the operation of the gates shows that gate operation starts in May and continues into October. During the peak of the monsoon, the gates are almost permanently open. During 1998, this was more the case in Baggar Dona II than in Baggar Dona I. This probably reflects the problems Baggar Dona II had with the public cut, and outside water entering the area. After the monsoon, drainage opportunities increase because the outside water drops below that at the inside. At the same time the gates are closed more often. This indicates that water is being retained during those months. One should bear in mind that in this respect 1997 is probably more representative than 1998. Due to the prolonged flood during the latter year, outside water levels remained high for a longer period of time.

There are no indications that the sluices have insufficient capacity. That would show up as a water level difference between the inside and outside, with all gates open. Instead, in cases when all gates are open, daily readings inside and outside the polders, show remarkably the same values. Water level fluctuations are relatively small. So, during the monsoon, the polders are part of the surrounding land as far as water levels are concerned.

8.3.3 Tides in the Baggar Donas

If there is tide around a polder and one takes readings of the water levels on the outside, about the same time every day, tidal level fluctuations would show up. However, tidal fluctuations are barely noticeable. One has to conclude that the tide in the Baggar Donas has become weak and is in the order of magnitude of 0.2 m at most. During the monsoon, the tidal fluctuations are suppressed by the high discharges in the Bagua Nadi.

This is probably a change from LRP days. The Bagua Nadi is considered prone to siltation and is in a state of change. The FAP 5 report considered the Bagua Nadi a dead river, predestined to silt up to a large extent. The inhabitants of the area confirm that. In the past, the tide was stronger than at present and the area could be better drained during the monsoon. So the Baggar Donas are becoming part of the old land and the drainage problems there.

TABLE 8.2

Water Levels Inside and Outside CDSP Areas Near the Sluices. All Levels are in m PWD

		January	February	March	April	May	June	July	August	September	October	November	December
Char Baggar Dona I													
1996	Inside	–	–	–	–	–	–	–	–	–	–	2.23	1.97
	Outside	–	–	–	–	–	–	–	–	–	–	–	–
1997	Inside	2.02	1.84	1.61	1.51	1.52	2.52	3.43	3.07	3.11	2.78	No data	1.90
	Outside	2.40	2.24	2.26	2.31	2.68	2.73	3.31	3.19	2.83	2.31	No data	1.90
	Gate	No data	–	–	–	–	–	–	–	–	–	–	–
1998	Inside	1.72	1.61	1.72	2.24	2.48	2.90	3.66	3.46	2.92	2.32	2.09	No data
	Outside	1.77	1.65	1.81	2.17	2.46	2.95	3.59	3.44	3.05	2.51	2.30	No data
	Gate	0.00	0.00	0.00	0.10	0.60	1.50	1.80	3.00	2.80	1.00	0.70	No data
1999	Inside	1.89	1.94	1.62	–	–	–	–	–	–	–	–	–
	Outside	1.98	2.47	2.48	–	–	–	–	–	–	–	–	–
	Gate	–	–	–	–	–	–	–	–	–	–	–	–
Char Baggar Dona II													
1996	Inside	–	–	–	–	–	–	–	–	–	–	2.39	2.23
	Outside	–	–	–	–	–	–	–	–	–	–	–	–
1997	Inside	2.17	1.89	1.53	1.32	1.72	2.62	3.80	3.87	3.76	3.44	No data	2.08
	Outside	2.33	2.22	2.32	2.29	2.48	2.69	3.75	3.86	3.64	3.16	No data	2.09
	Gate	No data	–	–	–	–	–	–	–	–	–	–	–
1998	Inside	1.71	1.54	1.55	2.38	2.69	3.14	3.98	4.03	3.83	3.15	2.65	No data
	Outside	1.86	1.86	1.82	2.31	2.60	3.13	3.93	4.02	3.75	3.02	2.51	No data
	Gate	0.00	0.00	0.10	0.20	0.70	0.70	2.90	3.00	2.70	0.90	0.20	No data
1999	Inside	2.47	1.78	1.49	–	–	–	–	–	–	–	–	–
	Outside	2.33	2.49	2.20	–	–	–	–	–	–	–	–	–
	Gate	–	–	–	–	–	–	–	–	–	–	–	–
Char Bhatirtek (Nabagram sluice)													
1998	Inside	3.04	2.87	3.26	3.79	3.92	4.40	4.09	4.44	4.98	4.93	4.55	4.57
	Outside	3.05	2.85	3.27	3.50	3.71	3.90	4.03	4.03	3.99	3.86	3.81	3.74
	Gate	–	–	–	1.00	1.00	0.20	0.80	0.90	–	–	–	–
1999	Inside	4.00	3.46	–	–	–	–	–	–	–	–	–	–
	Outside	3.18	3.68	–	–	–	–	–	–	–	–	–	–
	Gate	–	–	–	–	–	–	–	–	–	–	–	–

TABLE 8.3

Salinity Levels Inside and Outside the CDSP Areas, Near the Sluices. All Values are in mS/cm

		January	February	March	April	May	June	July	August	September	October	November	December
Char Baggar Dona I													
1996	Inside	–	–	–	–	–	–	–	–	–	–	2.50	7.7
	Outside	–	–	–	–	–	–	–	–	–	–	No data	–
1997	Inside	12.20	15.80	22.00	12.90	17.70	10.40	1.30	0.50	No data	–	No data	–
	Outside	–	–	–	12.70	18.40	9.50	1.40	0.50	No data	–	No data	–
1998	Inside	19.80	25.20	24.70	2.70	4.80	1.40	0.60	0.40	0.70	1.60	No data	–
	Outside	19.30	26.40	22.30	2.80	4.80	1.40	0.60	0.40	0.70	1.60	No data	–
1999	Inside	9.40	4.30	15.10	–	–	–	–	–	–	–	–	–
	Outside	14.80	9.40	15.30	–	–	–	–	–	–	–	–	–
Char Baggar Dona II													
1996	Inside	–	–	–	–	–	–	–	–	–	–	1.80	7.00
	Outside	–	–	–	–	–	–	–	–	–	–	No data	–
1997	Inside	11.30	15.60	22.30	12.80	18.30	9.00	1.50	0.30	0.40	0.30	No data	–
	Outside	–	–	–	12.10	18.00	10.30	1.60	0.30	0.40	0.40	No data	–
1998	Inside	11.50	15.50	22.80	4.50	4.90	1.10	0.80	0.40	0.40	1.00	No data	–
	Outside	20.90	22.60	20.40	4.60	5.00	1.10	0.80	0.40	0.30	1.00	No data	–
1999	Inside	3.40	8.10	11.10	–	–	–	–	–	–	–	–	–
	Outside	6.50	10.70	15.00	–	–	–	–	–	–	–	–	–
Char Majid													
1999	Inside	No data	9.10	11.90	–	–	–	–	–	–	–	–	–
	Outside	No data	19.5	20.0	–	–	–	–	–	–	–	–	–
Char Bhatirtek (Nabagram sluice)													
1999	Inside	3.40	7.70	–	–	–	–	–	–	–	–	–	–
	Outside	3.50	18.80	–	–	–	–	–	–	–	–	–	–

Nevertheless there are still benefits to be drawn from the embankments and the sluices. Those will be brought up at the end of this chapter, after the discussion of the physical environment.

8.3.4 Bhatirtek

The few water level data available in Bhatirtek, already show that there is a significant difference with the Baggar Donas. Almost all through the 1998 monsoon, which had a prolonged flood, there was an opportunity to drain, with the average outside level below that at the inside. Nabagram sluice has 2 gates. The maximum value for the gate opening is 2, when all are fully open. It appears that even during the peak of the 1998 monsoon, the capacity of the sluice is used for about 50%. The gates are apparently actively operated.

After the monsoon, the Nabagram area maintains an inside water level which is considerably above that at the outside. People retain their water. Noticing this, one may understand the objections of the land users in the Kalmi area, against their Kalmi sluice, further down along the embankment. Kalmi sluice has flap gates only and no manual control. The area is continuously depleted of its inside water, which causes accelerated drying of the fields. The Kalmi sluice was constructed by CERP. Designs were made in the early 1990s. Since then, the understanding has grown that land users not only need drainage but also water retention during certain periods of time.

The water level records of Bhatirtek show a relatively strong tide, with a maximum amplitude of more than 1 m. So the Nabagram sluice allows a better control of the inside water levels during the monsoon than in the Baggar Donas. Actually the water levels maintained, during and outside the monsoon, should be related to some land level measure, an average land level, or, the level of the lowest 20-30% of the land, or still other. Due to the lack of proper topographical information such a reference is missing.

8.3.5 Char Majid

Due to the late completion of the Majid sluice and the subsequent difficulties with the operation of the gates, water level measurements could only be started after March 1999. According to the local population, Char Majid has favourable tidal conditions as Char Bhatirtek. However, siltation conditions in its outfall cannel are less favourable.

8.4 SALINITY LEVELS

Table 8.3 shows the monthly averages of the salinity levels measured at the sluices. Up to January 1999, there were 8 measuring locations in the Baggar Donas. After January 1999, the number of measuring locations was reduced to 2, 1 in each polder.

Due to the late completion of the sluices in Majid and Bhatirtek and also due to persistent failures of equipment, the only salinity data within those polders are from 1999. In January still 8 measuring locations were envisaged, 4 in Char Majid and 4 in Char Bhatirtek.

The evaluation of the salinity levels near the sluices of the Baggar Donas can be short. Salinity levels at the polder side are about equal to those at the river side. Although the sluices do not leak large quantities of water, as discussed in the previous section, leakage apparently is large enough to render the salinity contents at both sides of

the sluice almost equal. Salinity contents near the sluices change abruptly when the rains start. After the monsoon, the water stays sweet up to December-January. After that it becomes saline. This is in accordance with LRP findings.

The salinity measurement inside the Baggar Donas show that the inside water remains rather sweet all through the year. There are a few exceptions at the locations 5 and 6, which can not be explained. As the dry season proceeds, the salinity increases gradually, but never reaches the high levels on the outside.

The data in the other two polders are too few for a thorough interpretation. According to Table 8.3, the sluices in both polders may appear rather water tight, as salinity levels inside remain below those outside. However, in Majid, outside water was kept from reaching the sluice, due to repair. Salinity levels inside the polders also show that the water remains rather sweet.

8.5 EVALUATION OF PROTECTION AND DRAINAGE WORKS

8.5.1 Embankments

The Flood Control and Drainage (FCD) facilities, which the Project provides are embankment, sluices and drains. The embankments provide protection against two kinds of flooding: flooding from the sea and flooding caused by runoff from the inland. Floods from the sea, caused by tidal bores and cyclones bring saline water. Floods from runoff carry sweet water.

Flooding with sea water is harmful to the soil. Present thinking is that it may take five years or more before the situation from before the flood is restored, although there are no firm figures to prove it. All flooding, be it with fresh or saline water, causes damage to crops and fish cultivation in ponds, as fish escapes. High floods cause damage to homesteads and may threaten human lives, irrespective of whether the water comes from the sea or the inland.

The protection the sea facing embankments of the CDSP polders provide against the sea, may be considered safe. In Bhatirtek, this is true for the Nabagram and Kalmi area and will be true for the entire polder after the Gangchil sluice has been completed.

The interior embankments of the CDSP polders provide protection against flooding by runoff from the inland. Against such floods, the Baggar Donas have been fully protected except for some culverts in the eastern embankments, which should not cause problems during normal monsoons. During floods, they could easily be closed, if required. The public cuts in the northern and western embankment of Baggar Dona II seem to threaten the protection against runoff, not so much because they can not be closed easily but because the outside population does not allow it. A similar development is, that the outside population increasingly seems to divert runoff through the culverts in the eastern embankment into the polders.

To what extent these activities alleviate the flooding situation outside the polders, is not clear. As argued in the previous sections, due to the weak tide, the Baggar Donas become part of the old land and cutting the inland embankments during floods barely helps the outside nor affects the inside. That can be substantiated. During the 1998 floods, Baggar Dona I and II were more or less equally affected, while Baggar Dona II must be considered more exposed to floods from the north.

The northern embankment of Char Majid does not provide full protection from runoff either, as there are culverts in the northern embankment. The area along Bashkali khal, which receives most water from the outside, had damage in 1998, although not as extensive as the Baggar Donas.

The Nabagram and Kalmi areas in Bhatirtek did not suffer from flooding caused by runoff from the outside areas, or rather, the drainage system and the sluices could cope with the quantities coming in.

8.5.2 Sluices

The sluices provide a facility to manipulate water levels. Not only can water be drained but water can also be retained when required. This facility can be fully used in the Nabagram area, where there is sufficient tide, both during the monsoon and the dry season. One may assume that the same is true for Majid, only there the facility has a cost, namely the regular excavation of the outfall drain.

Manipulation of water levels is only possible in the Baggar Donas during the dry season. Immediately before and after the monsoon there is limited manipulation of the sluice. During the height of the monsoon the gates remain closed. During the monsoon, the gates remain open and water levels inside become equal to those outside due to the lack of tide. In Bhatirtek and probably also in Majid, the gates are manipulated during the monsoon as well. The tide makes drainage possible. Outside the monsoon, sluice manipulation becomes more or less the same as in the Baggar Donas.

Such operation of the sluices has three benefits:

- Water can be retained so that fields do not loose their water too quickly. There is a limit to this. Once water levels have fallen too low, they can not be restored unless there is rain
- The water inside the polders remains far sweeter than that outside. However, in this respect, one should realise that an electric conductivity (EC) value of 0.5 mS/cm is already marginal for human and animal consumption. Water in the drains soon reaches higher salinity contents. That in ponds may remain sweeter.
- One may expect that lower water levels inside the polders and sweeter water, stimulate the desalinisation process of the soil.

8.5.3 Damaging Events During CDSP's Lifetime

Table 8.4 shows two dated damaging events during CDSP's lifetime. The purpose is to argue that the benefits of flood protection occur not only during rare calamitous events, with loss of life, homesteads and crops but during more frequent minor damaging events as well. The latter may cause only loss or damage to crops and fish ponds. Drinking and domestic water facilities become saline. After flooding with saline water outbreaks of diseases are more likely.

The first damaging event in Table 8.4, the tidal bore, can be estimated to have a frequency of once in five years. The 1998 flood had a frequency of about once in 20 years as far as flood levels is concerned. Major damage, however, was caused by its long duration, which was rather exceptional, three months of flood unceasingly.

TABLE 8.4
Two Damaging Events During CDSP's Life Time

Data	Kind of event	Areas affected	Status of protected	Kind of damage
May, 1995	Tidal bore	Baggar Donas	Fully protected	No damage
		Char Majid	Embankment under construction	Damage to roads under construction 60% of Aus/Aman destroyed All fisheries ponds overflown and damaged by saline water 50% of land flooded with saline water Drinking and domestic water facilities destroyed by saline water Outbreak of diarrheal diseases.
		Char Bhatirtek	Embankment under construction	Damage to roads under construction 75% of Aus/Aman crop destroyed All fisheries ponds overflown and damaged by saline water 50% of land flooded with saline water Drinking and domestic water facilities destroyed by saline water Outbreak of diarrheal diseases.
Monsoon 1998	Flood	Baggar Donas	Lack of tidal drainage Three major periods	Aus crop destroyed covering 30% of area Aman seedlings destroyed Shortage of seedlings 30% Aman crop seedlings Late planting of damaged Aman 30% reduction in yield Only few homesteads were sightly damaged 70% of fishponds were flooded. Fish escaped.
		Char Majid	Embankments completed Sluice partially operational	20% of Aman crops damaged over 20% of area 20% Aman seedlings destroyed.
		Char Bhatirtek		No substantial damage.

Chapter 9

DESIGN AND IMPLEMENTATION OF WATER INFRASTRUCTURE

9.1 MAPPING

Maps have been of poor quality during the entire lifetime of CDSP. This is partly due to reliance on existing maps, which are generally of poor quality in the country and partly due to the lack of resources to make use of advanced mapping facilities. Up to the present moment, representative land levels, differences in level between high and low lands are still insufficiently known. It would, for instance, be very helpful if average field levels of the different WMAs were known. It is certainly recommendable to undertake professional mapping from the beginning in new areas.

Presently, prospect for better mapping is brighter than they were at the time of CDSP's start. Facilities in the country have greatly improved. CDSP has already used those as may be concluded from the maps in the Feasibility Study of Muhuri Accreted Area (CDSP, November 1998) and the Coastal Char Study (CDSP, January 1999).

Attention should be given to the development of thematic maps, for drainage, roads, land types, topography, land levels and combinations of those. For design and implementation of infrastructure accurate detailed topographical land level maps are essential. Mapping of surrounding areas should extent as far as the watersheds of the different sluice systems reach. This prevents over-design of sluices. The Majid sluice, the Nabagram sluice and the Gangchil sluice are probably over-designed.

9.2 DESIGN

9.2.1 Embankments and Sluices

The design of drains, embankments and sluices has been discussed in CDSP's Final Report Infrastructure (Technical Report No 14, January 1999). In this section only the design of drains and to a lesser extent that of the sluices will be commented upon, with emphasis on land and water engineering aspects.

9.2.2 Drain Density

The design of the drainage systems, khals and sluices, in the CDSP areas lacks essential elements. One of them is a norm for drain density. As will be explained, drain density is

more or less imposed by topographical conditions. Others elements are lacking due to poor quality in design on behalf of the Board. This is a structural problem, however, not easily solved by the Board or others and certainly not by CDSP. Finally, there is a problem in the mapping of the polders themselves and of the outer areas.

The drainage systems excavated in the char areas originate from the tidal creek system that was in existence before empolderment. One may notice that from the configuration of the khals as they appear on the maps. Drainage designs and, more importantly, budgets for rehabilitation and implementation, adapt to those patterns. An important consequence is that the length of drain per hectare is fixed from the outset and that it varies, even within one and the same area. A clear example is Char Baggar Dona-II, where the drain density in the western part of the polder is far higher than in the eastern part.

The drain density in meters of drain per ha, are given in Table 9.1 for the different areas. They have been calculated from the data presented in the report on the Rapid Water Management Appraisal (CDSP Technical Report 15, January 1999).

TABLE 9.1

Drain Density in Meters per ha (main and secondary drains) in the Different CDSP Areas

Char Baggar Dona-I (including tertiary drains)	12.5 m/ha (72.5 m/ha)
Char Baggar Dona-II	19.2 m/ha
Char Majid	21.1 m/ha
Char Bhatirtek	7.2 m/ha

The low values in Bhatirtek can be explained by the fact that the area stretches along the Noakhali khal and that drains are rather short. The Noakhali khal actually functions as main drain. The values of Majid and Baggar Dona II, being the highest in the table, must be considered low. One would expect values of about 30 m/ha, but such general values should be used with caution.

The interesting part of the table is the information on Baggar Dona I. The density of the main and secondary drainage is low. However, taking into account the tertiary drainage as well, being the drainage system designed for the co-operative societies, the drain density increases to more than 70 m/ha. The question whether this intense drainage has resulted in better production was repeatedly raised during the project, but could not be answered on the basis of hard figures. One reason was that the TOR of the Project considered Baggar Dona I as more or less complete. As a result, there were budgetary constraints to do extensive monitoring. Another reason was that CDSP had limited access to the land users of the area, due to uneasy relations between the Project and an established NGO in the area.

The data available and the general knowledge of CDSP after five years, suggest that no substantially higher production is reached in the area of the co-operative societies. Whether that is due to factors within the physical, the social or the economic environment is not clear. It has already been established during LRP that the higher drain density does not significantly accelerate desalinisation.

As the Water, Soils and Crops Report argues, the main factors influencing the cropping potential in the chars is the time period elapsed since the start of protection and

the efforts the land users have invested to upgrade their land once protection is more or less assured.

There is an important lesson to be learnt from this. Excavating the tidal creek system for drainage purposes, after protection suffices for the time being. Higher investments in a more dense drainage system can not be justified at present. This does not mean, however, that the present situation is optimal.

9.2.3 Quality of Drainage Design

As far as the drains is concerned, BWDB's design cell never submitted detailed designs to CDSP for approval or for information. The documentation that was submitted were excavated amounts and expenditures after construction. As a result, up to the present day, CDSP is in the dark with respect to the drainage criteria applied. On the other hand it should be admitted, that the drainage systems do not suffer from a great lack of capacity neither in the drains nor in the sluices. BWDB has designed on the conservative side, using its considerable experience.

This should not hide the fact that still uncertainties exist with respect to basic design parameters. The first is a drainage requirement in terms of litres per second and per ha (l/sec.ha) or millimetres rain per day. This has been discussed already elsewhere in this report, in the section about rainfall. Quantitative monitoring of drainage outflow out of the polders, mainly the Baggar Dona polders, has not been possible. Such measurements are rather complex in terms of hydraulics and instrumentation and they should not be given high priority during the coming phase.

Another example is, that details of the outflow conditions assumed in the designs of each sluice, are not known. Outflow conditions are expected to be different, hard to predict and dynamic, i.e. changing with time. However, there is a difference between not knowing certain conditions but assuming them and hiding the assumptions. In the present situation, the design circle of the Board is suspected of not making assumptions at all but submitting standard designs only. An example is Nabagram sluice. The 1998 data suggest that even under extreme flood conditions, only half of the capacity of the sluice is used.

Due to the lack of proper maps, watershed sizes have been difficult to establish. In Char Majid, part of the area north of the polder discharges through the sluice, but its exact size is not known. With respect to assessing the size of the watershed of the Gangchil sluice, the situation is similar. In both cases the sluices are expected to be overdesigned.

9.2.4 Spoil Deposit

Current BWDB's drainage designs are deficient in solutions for spoil deposit during rehabilitation of old drains or excavation of new ones. Solutions for spoil deposit should be part of the design. The present situation is, that the matter is solved haphazardly during implementation. Worse is, that such solutions are not discussed with the land users on whose land the spoil is deposited and that the spoil does damage. In the Baggar Dona areas spoil deposits caused blockage of field drains, much to the annoyance of the land users.

The other side of the picture is that communities often have good use for the spoil, as material to increase the level of their land, homesteads, sections of roads etc. This involves extra costs of larger transport distances and other costs. This should not be an

argument to do away with planning of spoil deposit. The matter should be discussed with the land users in the same way as other elements of implementation are discussed.

9.2.5 The Depth of Drains

The question whether the drainage system should be given an overdepth, has come up from time to time during CDSP. The argument is that a deeper drainage system can contain more (supposedly fresh) surface water, which would be beneficial. It should be pointed out that the amount of surface water contained in drainage systems is rather limited and that deepening the drains only adds marginal amounts. The price one pays for deepening the drains is high. Side slopes become less stable and siltation from the sides slopes increases. It is sensible, therefore, to maintain existing design criteria and not to try overdepth.

9.2.6 Flap Gates and Sliding Gates

The complaints of the land users about Kalmi sluice, which only has flap gates and no sliding gates, illustrate that water management in the char areas, and not only there, is not about drainage and flood protection alone, but that water retention is an essential part. The data collected by CDSP in the Baggar Donas and in the Nabagram area, confirm how essential water retention is. CDSP has taken the initiative to try to equip the sluice with sliding gates, which is the proper thing to do.

The lesson learnt is that in future sluice design in the char areas, provisions should be made that gates can be controlled manually by the land users. It involves a greater operation effort, as drainage through flap gates goes by itself, while gate operation requires attendance. The pros and cons should be discussed with the PCs and SPCs during the planning stage. The matter is important for water management.

9.2.7 Future Approach to Drainage Design

Some of the design elements discussed above are outside the control of the Board's designer, others are not. However, on the whole, the evaluation of the design efforts made by the Board is negative. The most important complaint is that the designs do not provide details on the parameters used. This implies that if the drainage systems develop problems, no correction of design parameters is possible. What is worse, designs can not be optimised, for instance with respect to cost.

The solution would be to involve local consultants in the design of drainage systems, not only the sluices but the earth work as well. They should be asked to submit all design details. BWDB and CDSP would approve or disapprove.

9.3 PROGRESS OF IMPLEMENTATION

9.3.1 General

Full details on the completion of all infrastructure constructed under CDSP can be found in the annexes of CDSP's Final Report Infrastructure of January 1999. The report, however, does not cover infrastructure components which were outside CDSP's responsibility such as the CERP sluices and certain road building programmes.

The implementation of the flood control and drainage systems was entrusted to BWDB. The implementation remained behind schedule in many cases, to the extent that Char Majid and Bhatirtek remained unprotected during more than one additional monsoon.

Delays in the completion of the protection is significant because it also holds up work on water management and O&M issues, the establishment of WMCs and the measuring programmes. As a result progress in these fields is less than originally anticipated.

9.3.2 Embankments

Work on the embankments of the Baggar Dona areas was mostly resectioning. No vital flood protection works were required. The works were completed more or less on schedule.

The completion of the sea dike in Char Majid ran into delays. It was planned to be completed before the monsoon of 1995. Parts, however, remained unfinished until after the monsoon of 1996. With the sluice being completed only after the monsoon of 1998, Char Majid remained unprotected until that date.

The Bhatirtek embankments, as far as essential for the protection of the area, were completed in time during the monsoon of 1996. As construction of the sluices ran into delays, the Nabagram area remained unprotected until the end of the monsoon of 1997, the Kalmi area up to the monsoon of 1998.

9.3.3 The Sluices

At the start of CDSP, the sluices of the two Baggar Dona areas were operational and no substantial additional work was planned nor executed. The completion of the Majid sluice was envisaged before the monsoon of 1997. Its construction extended into the monsoon of 1998. When the sluice was completed, its gates did not function properly.

Delays also occurred with respect to the implementation of the sluices in the Bhatirtek area. The Nabagram sluice to be constructed by BWDB under CDSP was planned to be completed before the 1997 monsoon. In fact it was finalised after the monsoon. The other two sluices in Bhatirtek, Kalmi and Gangchil were constructed by CERP. CERP is co-financed by the World Bank. Due to issues arising between the World Bank and BWDB, not related to CERP, the construction of the two sluices was suspended temporarily until 1996. The Kalmi sluice was completed before the monsoon of 1998. Gangchil sluice is still under construction at the closing of the present phase of CDSP.

9.3.4 The Drainage Systems

The construction of the drainage system in Baggar Dona I was completed according to plan. Part of it was ready before the monsoon 1995, the other part before the 1996 monsoon. As the sluice was already there, there were no delays due to late construction. The same applies to Baggar Dona II, although the 1996 excavation works extended up to the end of the monsoon, which of course is undesirable for drainage purposes.

Progress in Majid was worse. The original planning envisaged finalisation of the drains before the monsoon of 1997. As it turned out completion of a considerable part of the works had to wait until the early part of the 1998 monsoon.

Excavation of drains in Bhatirtek proceeded according to planning. Works were finished before the monsoons of 1997 and 1998.

Chapter 10

OPERATION

10.1 GATE OPERATION

Operation and maintenance are often considered one activity. Yet the two components are rather different. For that reason the two are separated in this report.

Operation of drainage systems usually is rather passive, as compared to operation in irrigation, where gates have to be changed all the time. Irrigation systems have an operational staff. The staff in charge of drainage systems mainly do maintenance with occasional interventions at gates, pumping stations etcetera.

Drainage systems along the coast, depending on the tide, require more operation. The concept is that during periods in which drainage is required, a sluice attendant opens the sluice when outside water is low and closes it again when the tide becomes too high. This implies daily attendance to the sluice.

However, as explained in Chapter 8 of this report, sluice operation is barely done during the monsoon in the Baggar Donas due to the absence of tidal movement. Sluices remain open all the time. Sluice operation is important after the monsoon when the land users want to drain excess water out, but on the other hand do not want to overdrain. In a similar way operation is important before the monsoon, when the initial rains may cause an excess of water, but certain water levels still need to be maintained. During the heart of the dry season, sluices remain closed, to keep saline water out and to retain the relatively fresh water inside.

The situation is different in the Nabagram area in Bhatirtek, in the sense that there, the sluice is operated during the monsoon as well. Outside the monsoon, sluice operation is more or less similar to that in the Baggar Donas. The situation in Majid is expected to be similar to that in Nabagram. However, data to support that statement are not available. However, it seems a sensible working hypothesis for the future.

The data give the impression that the population knows what to do and CDSP can not provide much technical support on the subject. This does not mean that the situation is optimal. But being realistic, CDSP can not provide much support for further optimisation.

CDSP's tasks in the matter is, to see to it that possible conflicts are channelled via the WMCs. CDSP can provide impartial and technical advice and it could mediate. In some cases it may be able to provide technical support.

It is also clear that gate operation is far from being a full time job. One could agree that the local population itself should be able to take care of it.

10.2 GATE OPERATION AND FISHERIES

During CDSP, quite some discussions have been held about the relations between gate operation and fisheries. A main point was, whether there were periods during the year, when gates need to remain open in order for the fish to enter the polders. The discussions have not yielded clear answers. Chapter 8, however, provides a rather different picture of physical conditions than was inherently assumed in the past.

In the first place there is the matter of access to the polders for the fish. Before the construction of embankments there were a multitude of openings by which fish could enter the area. After construction of the embankments, the openings have been reduced to one, which in addition is gated. During the early months of the year, the months during which the fish migrate, the gates are only open, when excess water needs to be drained out. If there is no excess, the gates remain closed.

The water in areas without embankments is saline during an important part of the dry season. In addition the water levels are relatively high. As Chapter 8 shows, in the polders the water remains more or less sweet, while water levels are considerably below those on the outside. In other words, empolderment changes the environment for fish drastically which certainly limits the chances for a compromise between fisheries and empolderment.

Stocking the drainage system with fingerlings is not a realistic solution. There is the problem of who pays the cost and who catches the fish. Leasing out sections of the drainage system for fish culture can only be done if there is no substantial drainage flow and if temporary compartments are made in the drains. Cross bunds have to be cleared before the monsoon, however. Under these requirements it may be better to turn to other surface water bodies, which are not part of the drainage system.

The conflict between capture fisheries and empolderment exists and one should acknowledge that a compromise between the two is difficult. The people who suffer, are those without fish or money resources of their own to obtain fish. Further, professional fishermen are losing part of their territory and income. Those are issues to be addressed by CDSP. In addition, the CDSP data show that because of the protection provided by the embankments, more is invested in fish ponds and their yields may rise dramatically.

Chapter 11

MAINTENANCE

11.1 THE MAINTENANCE PLAN

It is clear that infrastructure, once erected, needs to be maintained. The important questions with respect to maintenance of infrastructure are:

- What needs to be maintained?
- What does it cost?
- Who pays?

Answers to those questions should be part of a maintenance plan.

Since about a year, CDSP has a Maintenance Plan, which is about to be issued as a Technical Report. The underlying philosophy of the Maintenance Plan has been to remain realistic, to acknowledge the difficulties, particularly that of financing and to come up with proposals that are workable and about which a discussion can be started with the WMCs. BWDB, LGED and the Union Councils are partners in the discussions and the plan. There is no illusion that the plan will have a perfect start. The important point is, that it is discussed and viewed as something that can be achieved.

11.2 ELEMENTS OF THE MAINTENANCE PLAN

11.2.1 Types of Maintenance

The Maintenance Plan starts with a classification of types of maintenance, which is common knowledge:

- Preventive or routine maintenance
- Periodic maintenance
- Emergency maintenance
- Rehabilitation

Under each type of maintenance, the Plan lists a number of activities, which are applicable to the situation in the chars. The list is not final, activities can be added, removed or adapted.

11.2.2 Infrastructure Components

After the types of maintenance and the activities that go with them, the Plan lists the infrastructure components which require maintenance. The list of infrastructure components is based on an infrastructure database, which is in the files and the computers of the Project. Under each infrastructure component, the plan lists the activities which belong to their periodic and preventive maintenance. Again, those lists are not final.

The components of infrastructure are:

- Embankments, sea dikes, interior and marginal dikes and roads cum-embankments.
- Drainage khals, under which:
  - **Main khals**
  - **Secondary khals**
  - **Outfall channels**, i.e., outfalls downstream of the sluices, which convey the tidal system.
  - **Tertiary khals**
- Sluices
- Culverts
- Bridges
- Feeder Roads B
- Rural (earthen) roads

It should be noted that roads are included. They are not so much part of the drainage system but they are an important part of the infrastructure. In addition roads contain culverts and bridges and those are a part of the drainage system.

The Plan contains a table with all components, the types of maintenance required and the frequency with which it should be carried out and the parties who share the cost.

11.2.3 Maintenance Responsibilities

A distinction is made in the Plan between formal maintenance responsibilities and cost sharing. Parties without formal responsibilities may share the cost. It is recognised that BWDB, LGED and UP may have difficulties to find the resources to fulfil their responsibilities. Here, other partners come in, among whom the WMCs are most important.

About this proposal for cost sharing two meetings were convened with all parties concerned and a memorandum of understanding (MOU) was drafted, agreed upon and signed by the parties.

This cost sharing of the WMCs takes the form of voluntary labour supplied by beneficiaries or other contributions. Such efforts are to be mobilised by the WMC and UP, together. In this respect, one may recall that according to the Ministries 1998 guidelines, BWDB a Local Government may recognise Water Management Associations and that these Associations may raise resources from its members.

Contributions from the WMCs particularly apply to routine maintenance. Periodic maintenance often is costly and requires professional skills and tools and can not be undertaken by voluntary labour.

In addition, it is recognised, that periodically funds become available from different avenues such as related projects, donors, NGOs, World Food Programme, Upazila and Zila councils. The WMCs are called upon to develop alertness to collect information on such avenues. They should approach potential donors and apply for such funds. In this respect, they should establish regular contacts with the UP, Upazila and Zila councils and similar organisations.

11.2.4 Summary of Costs

Table 11.1 gives a summary of the annual cost and the annual cost per ha for the different areas. The costs have been distributed among the different parties, BWDB, LGED, UP and the WMCs. Under the latter heading, there appear: voluntary labour, which has been estimated in mandays and recalculated into Taka, initiator costs, contributions and own resources. The latter terms need some explanation.

Initiator costs are costs which have to be made but are borne by the ones who caused the damage. An example are the cross dams, which are constructed annually across the drains, after the monsoon, either for access to the homesteads or for fishery purposes. The approach is not to forbid such practices, but as soon as such works are perceived, to approach the owner or initiator and agree that they will be removed before the next monsoon.

One may find some seemingly inconsistencies in the table. For instance, main khals and secondary khals have initiator costs in the Baggar Donas but not in other areas. The reason is that the Baggar Donas, being the oldest CDSP areas in use, still have a number of such cross dams which need to be removed. The intention is to recoup the cost from the initiators. In the other areas, the approach described in the previous paragraph, will be introduced and the costs are born by the initiator of the cross dams.

Contributions may be expected from particular beneficiaries who have an high interest in certain repairs. The example is a cut across a road which gives access to a bazaar. In first instance the cut should be repaired by the initiator. If he is not known, the shop keepers in the bazaar may make a contribution to have the road repaired.

Own resources apply to the borrow pits in Char Baggar Dona-I. These borrow pits are used for fish cultivation and are leased by the owner, BWDB or UP, to users. The lessee pays for the use. It has been agreed that such resources, originating in the area proper, are used for O&M of infrastructure.

11.2.5 Evaluation of the Costs

The costs in Table 11.1 were put together by CDSP staff using different criteria, such as BWDB and LGED standards, consultations with UP and WMC members, engineering criteria. The final results appear to be realistic and acceptable to all parties. It appears that the average annual costs lie between 623 and 745 Taka per ha per year. Exceptions are the Gangchil area, which has an annual cost of 994 Tk/ha per year and Char Majid, where the costs are 1,442 Taka per year per ha. It should be noted that emergency maintenance and large scale rehabilitation are excluded.

A first observation is that all areas are rather small and that individual items, which for certain reasons are very costly, have a great impact on the total maintenance costs. The sluices probably have overcapacity. In the Baggar Donas this is difficult to tell, due to the near absence of tide, but the capacity of the Nabagram sluice is used only half.

TABLE II.1

Maintenance Costs and Their Sharing for the CDSP Areas

All cost, except annual cost/ha are in 100.000 Taka (Lac Taka)

Infrastructure Component	Quantities	Responsibilities for Cost Sharing							Annual Cost
		BWDB	LGED	UP	Water Management Committee				
					Voluntary Labour	Initiator	Contributions	Own Resources	
Char Baggar Dona I									
BWDB Infrastructure									
Embankments	1.3 km	1.00	–	0.10	0.10	–	–	–	1.20
Sluice	1 pce, 3 vent	0.61	–	–	0.02	–	–	–	0.63
Main khals	8.6 km	3.00	–	–	–	0.22	–	–	3.22
Sec Khals	12.5 km	1.40	–	–	–	0.21	–	–	1.61
Tertiary khals	96 km	–	–	–	Users	–	–	–	0.00
Borrow pits	8.75 km	–	–	0.20	0.20	–	0.30	0.18	0.88
LGED Infrastructure									
Feeder Road B	0 km	–	–	–	–	–	–	–	–
Rural road	20 km	–	1.40	1.00	–	–	–	–	2.40
Bridges	1 piece	–	–	0.02	–	–	–	–	0.02
Box Culverts	4 piece	Maintenance included in maintenance of the road				–	–	–	0.00
Pipe culverts	28 piece	–	0.63	0.25	–	–	–	–	0.88
Total Baggar Dona I		**6.01**	**20.3**	**1.57**	**0.32**	**0.43**	**0.30**	**0.18**	**10.84**
Total maintenance cost in Taka per ha (1,740 ha)									**623.00**

(Contd.)

(Continued)

Infrastructure Component	Quantities	Responsibilities for Cost Sharing							Annual Cost
		BWDB	LGED	UP	Water Management Committee				
					Voluntary Labour	Initiator	Contributions	Own Resources	
Char Baggar Dona II									
BWDB Infrastructure									
Embankments	11 km	1.20	–	0.10	0.10	–	–	–	1.40
Sluice	1 pce, 3 vent	0.45	–	–	0.02	–	–	–	0.47
Main khals	14.6 km	4.80	–	–	–	0.20	–	–	5.00
Sec khals	22 km	2.00	–	–	–	0.80	–	–	2.80
Tertiary khals	none	–	–	–	–	–	–	–	–
Borrow pits	none	–	–	–	–	–	–	–	–
LGED Infrastructure									
Feeder Road B	7 km	–	2.36	–	–	–	–	–	2.36
Rural road	17 km	–	1.16	0.50	0.10	–	–	–	1.76
Bridges	1 piece	–	–	0.08	–	–	–	–	0.08
Box culverts	10 piece	Maintenance included in maintenance of the road				–	–	–	0.00
Pipe culverts	15 piece	–	0.30	0.20	0.10	–	–	–	0.60
Totals Baggar Dona II		**8.45**	**3.82**	**0.88**	**0.32**	**1.00**	**0.00**	**0.00**	**14.47**
Annual maintenance cost in Taka per ha (2,083 ha)								**695.00**	

(Contd.)

(Continued)

Infrastructure Component	Quantities	Responsibilities for Cost Sharing							Annual Cost
		BWDB	LGED	UP	Water Management Committee				
					Voluntary Labour	Initiator	Contributions	Own Resources	
Char Majid									
BWDB Infrastructure									
Embankments	5.5 km	1.90	–	–	–	–	–	–	1.90
Sluice, (incl. one north embank)	2 piece 8 and 3 vent	1.08	–	–	0.04	–	–	–	1.12
Main khals	8 km	3.00	–	–	–	–	–	–	3.00
Outfall khal	3 km	6.00	–	–	–	–	–	–	6.00
Sec khals	15 km	1.44	–	–	–	–	–	–	1.44
Tertiary khals	None	–	–	–	–	–	–	–	–
Borrow pits	None	–	–	–	–	–	–	–	–
LGED Infrastructure									
Feeder Road B	10 km	–	2.96	–	0.16	–	–	–	3.12
Rural road	21 km	–	1.00	0.32	–	–	–	–	1.32
Bridges (incl. 3 foot bridges)	5 piece	–	–	0.15	0.06	–	–	–	0.21
Box culverts	10 piece	Maintenance included in maintenance of the road				–	–	–	–
Pipe culverts	13 piece	–	0.20	0.10	0.06	–	–	–	0.36
Totals Char Majid		**13.42**	**4.16**	**0.57**	**0.32**	**0.00**	**0.00**	**0.00**	**18.47**
Annual maintenance cost in Taka per ha (1,281 ha)									**1,442.00**

(Contd.)

(Continued)

Infrastructure Component	Quantities	Responsibilities for Cost Sharing							Annual Cost
		BWDB	LGED	UP	Water Management Committee				
					Voluntary Labour	Initiator	Contributions	Own Resources	
Bhatirtek (Nabagram area)									
BWDB Infrastructure									
Embankments	6 km	0.56	–	–	–	–	–	–	0.54
Sluice	1 pce. 3 vent	0.24	–	–	0.01	–	–	–	0.25
Main khals	6.5 km	1.40	–	–	–	–	–	–	1.40
Sec khals	6.5 km	–	–	–	–	–	–	–	–
Tertiary khals	None	1.00	–	–	–	0.31	–	–	1.31
Borrow pits	None	–	–	–	–	–	–	–	–
LGED Infrastructure									
Feeder Road B	None	–	–	–	–	–	–	–	–
Rural road	12 km	–	1.00	0.46	–	–	–	–	1.46
Bridges	None	–	–	–	–	–	–	–	–
Box culverts	2 piece	Maintenance included in maintenance of the road				–	–	–	–
Pipe culverts	6 piece	–	0.12	–	0.06	–	–	–	0.18
Total Nabagram area		**3.18**	**1.12**	**0.46**	**0.07**	**0.31**	**0.00**	**0.00**	**5.14**
Annual maintenance cost in Taka per ha (690 ha)									**745.00**

(Contd.)

(Continued)

Infrastructure Component	Quantities	Responsibilities for Cost Sharing							Annual Cost
		BWDB	LGED	UP	Water Management Committee				
					Voluntary Labour	Initiator	Contributions	Own Resources	
Bhatirtek (Kalmi area)									
BWDB Infrastructure									
Embankments	0.5 km	Cost included in other embankments			–	–	–	–	–
Sluice	1 pce, 4 vent	0.35	–	–	0.01	–	–	–	0.36
Main Khals	2.1 km	0.34	–	–	–	–	–	–	0.34
Sec Khals	5.5 km	1.00	–	–	–	0.23	–	–	1.23
Tertiary khals	None	–	–	–	–	–	–	–	–
Borrow pits	None	–	–	–	–	–	–	–	–
LGED Infrastructure									
Feeder Road B	None	–	–	–	–	–	–	–	–
Rural road	7.0 km	–	0.40	0.10	0.04	–	–	–	0.54
Bridges	None	–	–	–	–	–	–	–	–
Box culverts	5 piece	Maintenance included in maintenance of the road				–	–	–	–
Pipe culverts	3 piece	–	0.12	–	–	–	–	–	0.12
Total Kalmi area		**1.69**	**0.52**	**0.10**	**0.05**	**0.23**	**0.00**	**0.00**	**2.59**
Annual maintenance cost in Taka per ha (385 ha)									**673.00**

(Contd.)

(Continued)

Infrastructure Component	Quantities	Responsibilities for Cost Sharing							Annual Cost
		BWDB	LGED	UP	Water Management Committee				
					Voluntary Labour	Initiator	Contributions	Own Resources	
Bhatirtek (Gangchil area)									
BWDB Infrastructure									
Embankments	5.0 km	1.10	–	–	–	–	–	–	1.10
Sluice	1 pce, 12 vent	0.88	–	–	0.02	–	–	–	0.90
Main Khals	7.5 km	1.60	–	–	–	–	–	–	1.60
Sec khals	5.5 km	1.60	–	–	0.08	–	–	–	1.68
Tertiary khals	None	–	–	–	–	–	–	–	–
Borrow pits	None	–	–	–	–	–	–	–	–
LGED Infrastructure									
Feeder Road B	None	–	–	–	–	–	–	–	–
Rural road	12.0 km	–	1.00	0.46	–	–	–	–	1.46
Bridges	2 piece	–	–	0.08	–	–	–	–	0.08
Box culverts	4 piece	Maintenance included in maintenance of the road				–	–	–	–
Pipe culverts	6 piece	–	0.12	0.10	0.02	–	–	–	0.24
Total Gangchil are		**5.18**	**1.12**	**0.64**	**0.12**	**0.00**	**0.00**	**0.00**	**7.06**
Annual maintenance cost in Taka per ha (710 ha)									**994.00**

The Char Majid and Gangchil sluices seems to have an overcapacity as well. Also embankments are relatively expensive as they protect rather small areas. Next one may wonder whether areas of this size need feeder roads. But roads are a controversial subject. They are known to be expensive and are the first to be excluded if budgets are tight. Yet they usually attract much development and rural roads in the char areas are vulnerable during the monsoon.

The sluice in the Gangchil area, the embankments and the drainage system serve larger areas than Gangchil alone. During the next phase of CDSP, as soon as the construction of Gangchil is completed, and the area under the WMC has been expanded, a more realistic assessment of implementation and maintenance costs can be made.

In Majid the maintenance cost of the outfall channel weighs heavily on the total and the average. Before the implementation of the Majid sluice, there was a discussion whether the sluice should be built in the south east corner of the polder, discharging into Nangulia khal, which is tidal. However, also the Nangulia khal probably has a limited lifetime, which can not be predicted. The long outfall channel, sensitive to siltation, therefore, is part of the problematic drainage situation of almost all char polders.

11.3 MAINTENANCE AWARENESS

During the first half of 1998, an inquiry was done by the Institutional Development Specialist (IDS) of the Project into the perception of SPC members regarding the present quality of infrastructure and the maintenance responsibilities. It appeared that the SPCs were more or less satisfied with the quality of cyclone shelters, main drains, (pipe) culverts, embankments, bridges, the sluices, the site offices and the paved roads. They were less satisfied with the quality of secondary drains, rural roads and the cluster villages.

Their perception of who maintains what, was according to common knowledge. However, there was a great number of infrastructure components, specific for CDSP areas, of which the SPCs did not know who had to maintain them. The only item they thought they should maintain themselves, were the pipe culverts. For all other infrastructure they mentioned others who should do the maintenance. They did not feel committed.

The SPCs did not have much faith that the present quality of infrastructure would be maintained during the coming five years. In this sense they were realistic. The major structures were expected to remain in reasonable condition. Minor structures, earth work, roads, paved or not, are expected to deteriorate.

The results of the inquiry confirmed the feeling, already present, that a campaign on maintenance awareness should be started, providing extension to the SPC and the general public and raising the subject of self reliance in maintenance. Extension material, already available with the Water Board and LGED, is being collected. The Maintenance Plan, discussed above, provides a framework for and is part of the maintenance awareness campaign.

Parallel to the maintenance awareness campaign, attempts are going on to find workable solutions to practical problems. An example are the cross bunds in the drain. The person who makes one, should take it out before the monsoon. A person who cuts a road to rid himself of excess water, should repair it again after his problem is solved. He could install a pipe and spend money and effort on that and/or he could try to find funds for the

pipe, among people who complain. It is not CDSP's task to invent such solutions. The population, the WMC and the UP should do that. It is CDSP's task to mediate, start discussions, avoid conflicts. Social control within the polders is important. It is legitimate to use that. The adagium is that water management to a large extent is a matter of negotiations.

11.4 THE PUBLIC CUTS IN THE BAGGAR DONAS

Public cuts in the western and northern embankments of Baggar Dona II have been plaguing CDSP since 1996. Before the start of CDSP, such cuts were already there, but they have been closed during the rehabilitation of the embankments under CDSP. The areas north of the Baggar Donas suffer from permanent drainage problems due to the progressive silting of the Bagua Nadi.

The public cuts were made under conditions of relatively intensive consultation between the parties, BWDB, CDSP and representatives of the Local Government. At that time there were a PC and SPCs in Baggar Dona II but there was no WMC. The Union Chairman involved, has his constituency both inside Baggar Dona II and in the area to the north, suffering from the bad drainage, which puts him into a dilemma. His dilemma was appreciated and from the beginning there have been attempts to find a compromise acceptable to the parties.

The khal running north of the Baggar Dona II embankment, on the outside, was excavated by CDSP, but that did not solve the problem. Closing the public cut is not acceptable to the outside land users. The most recent proposal is to close the public cut to a certain level and agree that if water reaches so high that it overtops the cut, it is Baggar Donas bad luck. If the outside water remains below the top of the cut, nobody from the outside touches it.

It is not fully clear what the advantage for outside land users is to drain via Baggar Dona II. After all, the whole area drains via the Bagua Nadi and, as said before in this report, the Baggar Donas have become part of the old land. The advantage could be marginal or not fully rational. The latter should not be excluded, which is all the more a reason to keep the matter on the table.

There is a similar risk in Char Majid for public cuts. Although the old sluice in the northern embankment has been maintained, but not expanded, there are still drainage problems to the north. Once the sluice in Majid becomes operational, the risks of public cuts will increase. This makes it important to try to find a solution for the problem in Baggar Dona II. Any negotiated solution is better than no solution. Negligence of the issues should be avoided.

11.5 COST RECOVERY

Cost recovery is much talked about in FCD(I) projects and often not in a very practical way. An example were the co-operative societies in Baggar Dona I under LRP, whose maintenance tasks were expanded to the primary and secondary systems without much background and preparation.

It is clear that strict requirements of cost recovery should not be pushed strongly from the outside in the CDSP situation, neither upon Project staff nor land users. That would collide with the progress made so far with the Maintenance Plan.

Part IV

Water, Soils and Crops

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Md. Hassan

Chapter 12

INTRODUCTION

Empolderment creates a new environment through protection from saline flooding and improved drainage, which presents new opportunities to farmers. The objective of the Productive Development Section (PDS) of CDSP was to assist farmers in using these new opportunities by introducing and demonstrating new varieties of existing and potential crops and novel production techniques. Since it takes time for the line agencies to start playing their mandated role in new polder areas, CDSP was to step in to temporarily provide the necessary extension and other services, to be taken over by the line agencies.

CDSP was preceded by the Land Reclamation Project (1978-1992) which developed Char Baggar Dona-I as a pilot polder and carried out an extensive research programme in a 40 ha experimental farm in that polder. CDSP was more extension- and less research oriented and concentrated on the provision of extension services, combined with monitoring of salinity conditions and landuse in three new polders: Char Baggar Dona-II (CBD-II), Char Bhatirtek (CBT) and Char Majid (CM). Some monitoring continued in CBD-I. CBD-I was protected from 1978, CBD-II in 1990, and CBT and CM in 1996. Protection against saline flooding in the southern part of CBT, however, is still not complete since the main sluice remains to be completed. The CM sluice, though completed, is not yet functioning properly and is currently being repaired.

Development of agricultural and homestead production in the polders was the major objective of the PDS. Initially, the programme in close collaboration with DAE used an extension approach based on a network of 'demonstration' and 'extended' farmers. There were 10 demonstration farmers in Char Baggar Dona-II and 5 each in Char Majid and Char Bhatirtek, each surrounded by 5 extended farmers. Technology introduction occurred through the demonstration farmers and was passed on later to the extended farmers. As from 1997, a group approach was adopted with involvement of NGOs. The extension methods are described in more detail in CDSP Technical Report no. 16.

An important subsidiary objective of the programme was the development of a methodology for future polder development. The experiences of CDSP are therefore documented extensively to serve as a basis for future projects. This document provides information on the agro-ecological environment of farming in the polders and the lessons learnt in stimulating agricultural and homestead development.

Chapter 13

AGRO-ECOLOGICAL CONDITIONS AND THEIR CHANGES

The new production environment resulting from flood protection, water control and decreasing salinity in the polders should be effectively exploited. Good knowledge of the production environment is a prerequisite for targeting improved crop production technology. The following paragraphs present an analysis of the agro-ecological conditions in the protected chars (polders) and their evolution.

13.1 RAINFALL AND CROPPING SEASONS

There are three distinct cropping seasons in the area, viz.:

- The *Kharif-I* or pre-monsoon season, from April through June;
- The *Kharif-II* or monsoon season, from July through October; and
- The *Rabi* season, from November through March.

Mean monthly rainfall is shown in Table 13.1 and Fig. 13.1 shows how the cropping periods and growing cycles of various crops as related to the average rainfall pattern.

TABLE 13.1
Mean Monthly Rainfall Recorded Between 1974 and 1996 at the Noakhali Station

April	182
May	365
June	642
July	733
August	641
September	441
October	206
November	45
December	8
January	3
February	42
March	81

Source: Bangladesh Meteorological Department.

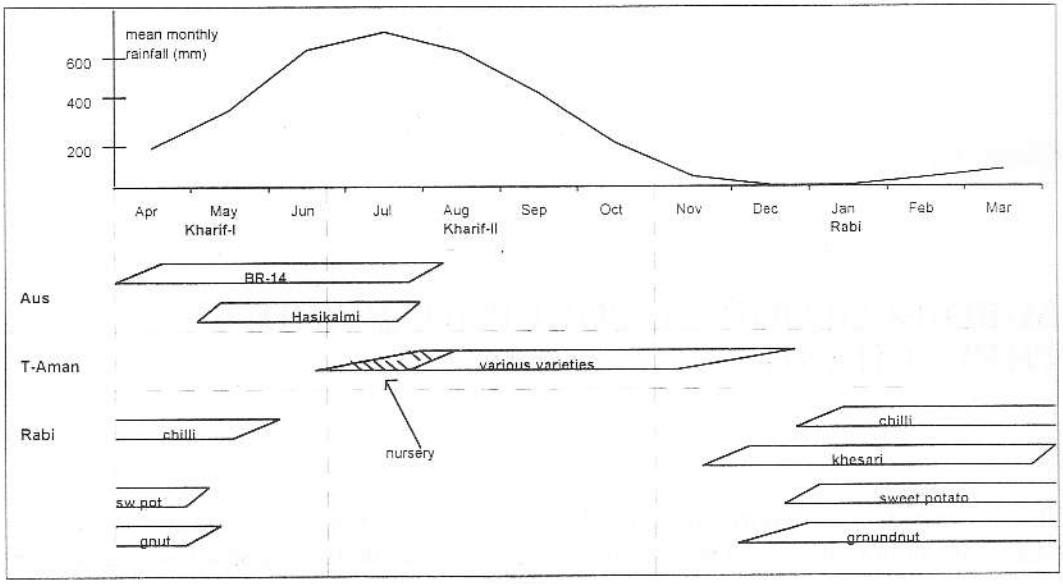


Fig. 13.1. Cropping Periods and Growing Cycles of Crops in Relation to the Average Rainfall Pattern

Knowledge of average rainfall distribution allows a broad assessment of an area's suitability for growing certain crops and crop sequences. In order to assess the climatic risk associated with cropping, however, the frequency of occurrence of above- or below average rainfall must be known. A frequency analysis of rainfall was therefore carried out to estimate the likelihood of excessively high or low rainfall at specific times (Fig. 13.2) during the season. The data are also for Noakhali, which is the only station near the project area with a sufficiently long record. The analysis will be used later on to interpret findings from the project's on-farm tests and demonstrations.

13.2 SOIL CHARACTERISTICS

Little information is available on soil texture, but an analysis of moisture retention for the different soil textural classes in CBD-I was carried out by LRP[1]. It shows that soil moisture is at 50% volume up to pF 2, which corresponds with a groundwater table at 1 m. Further downward movement of the water table to 3 m (pF 2.5) only results in a decrease of equilibrium moisture retention to 30-40%. Upward movement due to evaporation will usually exceed downward movement due to a decreasing water table. This results in salt accumulation in the topsoil in the dry season unless evaporation is reduced by special measures, such as tillage and/or a soil cover.

Chemical analyses of soils from farmers' fields in CBD-I, CBT and CM were carried out in 1995 and repeated in 1998, in the latter case with additional samples from CBD-I, including the former LRP experimental farm. The results are shown in Table 13.2.

[1] *Groot, J.M., 1995*. Mission Report No. 12, Land and Water Engineering, CDSP, Noakhali.

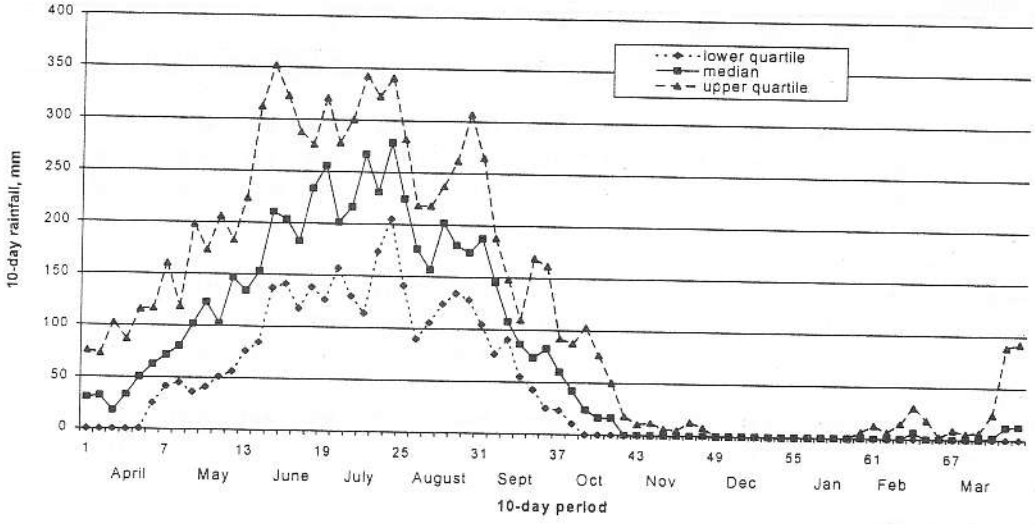


Fig. 13.2. Median and Upper and Lower Quartiles of 10-day Moving Rainfall Sums (5 day overlap), Noakhali, 1974-1996

TABLE 13.2

Average and Range of Soil Nutrient Content of Farmers' Fields; SRDI Analyses

a. Topsoil and subsoil in 4 polders, 1998 analysis

	pH	OM	Ca	Mg	K	N	P	S	B	Cu	Fe	Mn	Zn
		%	meq/100 ml soil			0/00			ppm (microgram / ml soil)				
Baggar Dona-I													
0-10 cm	N =												
Average	**7.44**	**4.51**	**8.34**	**2.26**	**0.28**	**0.11**	**10.46**	**171.20**	**1.32**	**4.02**	**78.20**	**67.00**	**13.00**
Minimum	7.00	3.33	5.00	1.70	0.20	0.01	6.12	65.00	0.89	3.07	44.00	56.00	4.00
Maximum	7.80	5.45	12.40	2.70	0.52	0.17	15.13	295.00	1.90	4.64	128.00	95.00	27.60
10-20 cm	N =												
Average	**7.68**	**2.91**	**12.44**	**2.22**	**0.33**	**0.09**	**13.31**	**159.40**	**0.93**	**1.93**	**37.76**	**72.00**	**13.37**
Minimum	7.00	2.08	5.30	1.70	0.20	0.07	5.54	97.00	0.40	1.54	22.80	36.00	2.34
Maximum	8.00	4.07	17.20	2.70	0.72	0.15	26.12	256.00	1.36	2.15	78.00	102.00	23.20
Baggar Dona-II													
0-10 cm	N =												
Average	**7.64**	**4.32**	**10.44**	**2.62**	**0.42**	**0.14**	**8.71**	**165.60**	**1.07**	**3.91**	**85.60**	**79.60**	**9.95**
Minimum	7.40	2.95	8.90	2.20	0.29	0.10	5.75	63.00	0.21	1.92	28.00	52.00	3.40
Maximum	7.90	6.40	14.20	3.40	0.69	0.17	15.57	252.00	1.83	5.12	204.00	106.00	26.80
10-20 cm	N =												
Average	**7.54**	**2.91**	**12.02**	**2.66**	**0.26**	**0.11**	**8.00**	**135.60**	**1.01**	**2.84**	**56.80**	**88.80**	**13.94**
Minimum	7.20	1.44	8.60	2.20	0.16	0.08	5.41	73.00	0.74	1.68	26.00	42.00	5.20
Maximum	7.70	4.59	16.50	3.40	0.50	0.14	13.79	208.00	1.43	5.78	162.00	156.00	19.28
Bhatirtek													
0-10 cm	N =												
Average	**7.49**	**3.99**	**8.19**	**2.60**	**0.48**	**0.13**	**12.73**	**220.14**	**1.04**	**6.62**	**83.14**	**97.71**	**19.00**
Minimum	7.20	2.87	6.20	2.10	0.24	0.11	5.78	139.00	0.36	5.42	56.00	44.00	9.20
Maximum	7.70	5.51	10.20	3.10	0.63	0.16	18.80	321.00	2.02	7.84	146.00	132.00	29.80

(Contd.)

(Continued)

	pH	OM	Ca	Mg	K	N	P	S	B	Cu	Fe	Mn	Zn
		%	meq/100 ml soil			0/00			ppm (microgram / ml soil)				
10-20 cm	N =												
Average	**7.69**	**2.84**	**11.91**	**2.81**	**0.40**	**0.10**	**11.71**	**175.00**	**0.66**	**9.12**	**49.71**	**75.14**	**19.77**
Minimum	7.40	1.81	7.90	2.30	0.24	0.07	6.12	116.00	0.29	1.48	20.00	44.00	10.20
Maximum	7.90	4.64	15.90	3.00	0.55	0.13	19.09	282.00	0.99	19.40	122.00	128.00	28.60
Majid													
0-10 cm	N =												
Average	**7.49**	**3.87**	**9.91**	**2.66**	**0.43**	**0.14**	**11.68**	**229.14**	**0.39**	**5.85**	**114.29**	**93.14**	**10.43**
Minimum	6.80	2.87	5.40	1.80	0.19	0.11	7.50	21.00	0.01	2.62	28.00	52.00	2.44
Maximum	7.90	4.63	16.70	3.50	0.78	0.17	19.74	442.00	1.22	9.12	288.00	130.00	21.40
10-20 cm	N =												
Average	**7.86**	**1.98**	**12.80**	**2.56**	**0.32**	**0.08**	**9.36**	**143.00**	**0.57**	**3.04**	**32.57**	**61.71**	**16.25**
Minimum	7.10	1.15	6.40	1.80	0.13	0.07	6.25	16.00	0.10	1.32	24.00	44.00	3.54
Maximum	8.30	2.62	17.60	3.00	0.55	0.10	12.99	261.00	1.75	4.78	48.00	84.00	36.40
Research Plot (CBD-I)													
0-10 cm	8.00	3.15	7.60	2.80	0.42	0.12	12.85	37.00	0.96	6.20	78.00	100.00	4.60
10-20 cm	7.80	3.05	7.50	2.80	0.38	0.11	11.55	42.00	1.01	5.54	58.00	96.00	9.80

b. Comparison of 1995 and 1998 analyses; topsoil only, partially overlapping fields[1]

CBD-II													
1995	7.56	1.06	9.02	3.08	0.09	0.17	10	10.20	0.38	4.18	68.80	20.80	0.34
1998	7.64	4.32	10.44	2.62	0.42	0.14	8.71	165.60	1.07	3.91	85.60	79.60	9.95
CBT													
1995	7.28	1.30	8.04	2.68	0.13	0.13	7.80	22.40	0.69	5.90	87.80	24.00	0.23
1998	7.49	3.99	8.19	2.60	0.48	0.13	12.73	220.14	1.04	6.62	83.14	97.71	19.00
CM													
1995	7.62	0.96	8.48	3.08	0.16	0.29	9.4	19.00	0.44	6.40	77.20	21.00	0.68
1998	7.49	3.87	9.91	2.66	0.43	0.14	11.68	229.14	0.39	5.85	114.29	93.14	10.43

[1]Notes on the analyses: **Units**: the figures were reported by SRDI as content per (100) ***ml*** of soil (dried and ground samples). For conversion to contents per (100) ***grams*** of soil (standard), divide by 2??

OM%: the large differences between 1995 and 1998 suggest that the figures in the two years mean different things; possibly the data for 1995 were for OC% and those of 1998 for OM% (= OC% x 1.73).

S: it appears that the 1995 data were for sulphate-S and those of 1998 for total S.

Zn: It is not clear what the 1998 data represent, probably not ppm. The 1995 data look OK.

No major differences are apparent between the four polders, in spite of the considerable differences in age (in terms of time since establishment of the embankments). Only the lower K-content in CBD-I may reflect a higher cropping intensity over a longer number of years.

Tentatively, and considering the uncertainty associated with the reported analyses (see notes below the table), the following conclusions can be drawn (IRRI[2], 1978):

- The soils are deficient in N, P and Zn;
- K and perhaps S status approach the critical level; some soils may respond to these elements, others may not.

[2] *International Rice Research Institute, 1978*. Soils and Rice. Los Baños, Philippines.

Table 13.2 also shows that the pH was generally between 7 and 8. There is a pronounced seasonal pH trend, which is shown in Fig. 13.3. The high pH may lead to micronutrient problems and aggravate Zn deficiency.

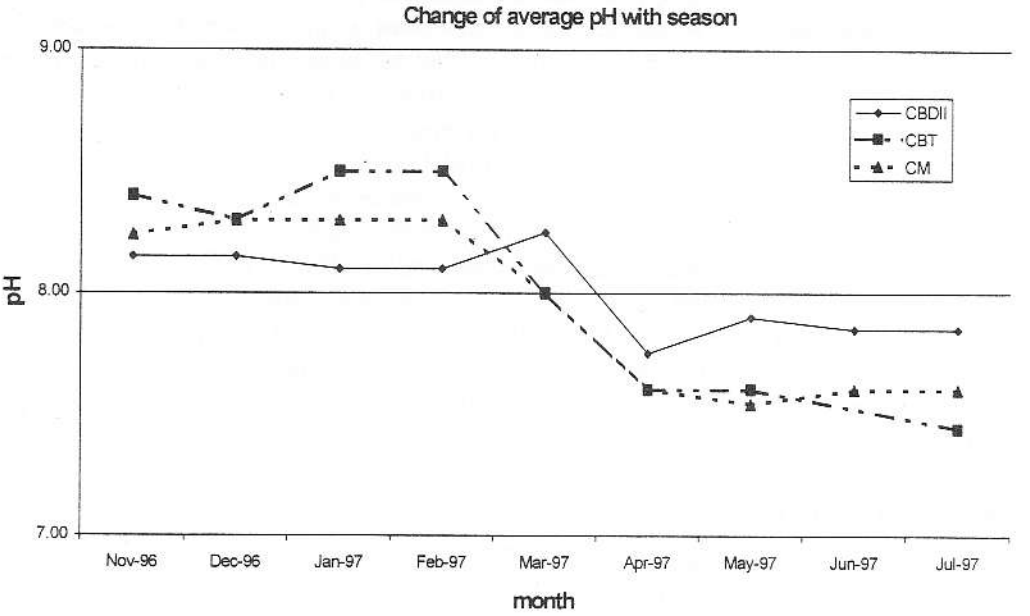


Fig. 13.3. Seasonal Trend of pH in Top and Sub-soil, CBT, 1996-1997

13.3 HISTORY OF WATER MANAGEMENT CONDITIONS IN THE POLDERS

Unless a system is empoldered and made waterproof, water management in a true sense is not possible. For better water management, along with empolderment, other infrastructural developments are equally required such as construction of sluices to regulate water intake and outlets and excavation of an internal drainage system. Embankments give protection from many hazards. It protects the area from outside flood and saline water from cyclones and tidal surges, while drainage and sluices help to remove excess rain water. Water retention for dry season use inside the system is also possible due to the combined facilities of embankments, khals and sluices. Embankments, as a whole, have considerable impact on the overall water management as well as crop production in CDSP polders.

Before empolderment, farmers had little choice on crop culture and practices due to frequent tidal influence in which flood water entered and caused flooding along with intake of saline water causing crop damage. Tidal effects made internal drainage unfavourable to the farmers by silting up the internal drainage system.

In CDSP, out of the 4 polders, Char Majid is comparatively new. Char Baggar Dona-I is the oldest polder which was improved during the period of LRP. Char Baggar Dona-II was developed after Char Baggar Dona-I, whereas in Char Bhatirtek empoldering started during early eighties, but protection was not completed until 1999.

Char Baggar Dona-I

The infrastructural improvement started in this polder during the late seventies to early eighties when LRP started working in this polder. The main embankment was constructed in 1981-82. Before that time the area was prone to frequent flooding and inside drainage congestion. As soon as the embankment was constructed on the northern side and along the left bank of Bagua River in 1982-83, agricultural activities increased manifold. Farmers started *aman* cropping with confidence. Due to saline conditions, rabi and *aus* were not practised. Local aman was the main crop. The sluice construction was completed in 1986-87, before which flood and tidal water were always a threat even for local aman. After the sluice was constructed, the polder became completely watertight and farmers were confident in cropping. HYV was not practised at that time, but local aman and a few rabi crops were practised. Drainage conditions further improved with construction of the sluice and excavation of the drainage khals inside the system and water management became easier. More HYV along with local aman, rabi and aus are now in practice. However, the flood situation of 1988 combined with the public cut in Char Baggar Dona-II embankment caused flooding in this polder and the aman crop was delayed about a month which caused some impact on yield.

Char Baggar Dona-II

Empoldering started in this polder at the same time as in Char Baggar Dona-I, but this polder was much more vulnerable to tidal flooding, saline water intrusion and internal drainage congestion. After empoldering and subsequent construction of the main sluice in 1987, local aman crop was in practice with confidence because of good water management. The overall water management condition was still not favourable, as the internal drainage system was not improved. Rabi was hardly practised due to soil salinity problems. After CDSP intervened in 1994, all infrastructures (sluice, embankment, and drainage system) were rehabilitated and improved. This largely improved the water management situation of the polder. Outside flood and saline water cannot enter. This has developed in such a manner that about 20-30% area of aman was brought under HYV practice and there is an increasing trend of more aus and rabi crops. However, due to silting up of the Bagua River, drainage of the area outside the polder became difficult during the last 3-4 years. As a result, people to the north cut the embankment and divert outside water into the polder causing flood inside. This makes water management difficult during the monsoon, causing flood damage to crops and properties.

Char Bhatirtek

This polder lies on the right bank of Noakhali khal. Before the eighties, the land was completely open to the tides and flooding with saline water intrusion. No water management was possible and crop production was uncertain. The first empolderment program under CEP was started during the early eighties on its eastern side with a gap along the left bank of the existing Petkata khal. This partially built some confidence among the farmers and local aman varieties were practised without any rabi crop. When CDSP started in 1994, a number of rehabilitation and improvement works of infrastructure took place. The gap along the Petkata khal was closed as an embankment.

the eastern side was empoldered, sluices constructed and internal drainage was improved. As a result, the water management situation was improved. Local and HYV aman are produced, while coverage under rabi and homestead gardening increased. Water is stored in the khals by closing the sluice gates in dry season. Excess drainage in the monsoon is drained out through the sluices (Nabagram and Kalmi). The southern Gangchil area, however, is still unprotected because the Gangchil sluice is still incomplete. Once this sluice is complete, the whole polder will be under good water management.

Char Majid

Char Majid is very young in age compared to the other Chars. Before CDSP's intervention in 1994, the whole area was vulnerable to tidal floods and saline water intrusion. Soil was saline and crop production was an uncertain phenomenon. Flood water and internal drainage problem frequently resulted in submerged areas. There was practically no water management possible. In 1995, CDSP empoldered its eastern and southern boundary but total flood protection was still not possible until recently when the sluice was completed. The polder area is now under complete water management. Local and HYV aman are practised without problem. A substantial area is under rabi and aus crop in this polder.

13.4 EVOLUTION OF SOIL SALINITY

Soil salinity conditions are dynamic and show both an annual and a long term trend. The long term trend, measured in CBD-I by LRP (1:2.5 soil paste extract) is shown in Fig. 13.4[3]. In a given year, salinity was highest at the beginning of the pre-monsoon season. Overall salinity decreased during the first 5 years after empolderment and remained fairly stable thereafter.

Fig. 13.5 shows the seasonal trend of soil salinity (1:1 soil paste) in CBD-II, CBT and CM in 1996-1997. Comparison with the LRP data requires data conversion. Assuming that EC(1:1 soil paste) ≈ 1.75 EC(1:2.5 soil paste extract) (see Annex I), Table 13.3 shows that in 1997 the soil salinity conditions in CBD-I (7 years after embankment closure) was similar to those in CBD-I in 1985, suggesting that soil salinity had also stabilised. In CM (1 year after full embankment closure), the situation in 1997 was similar to the early years of CBD-II and salinity may be expected to decrease further.

TABLE 13.3

Highest (pre-monsoon) and Lowest (monsoon) Soil Salinity in the Four Polders, Converted to EC (1:1 paste)

	CBD-I (LRP)			CDSP (1997)		
	1979	1982	1985	CBD-II	CM	CBT
Highest	12.1	14.2	4.6	4.5	8.3	14.0
Lowest	4.2	1.6	1.4	1.7	1.8	2.1

[3] *Groot, J.M., 1995*. Mission Report No. 12, Land and Water Engineering, CDSP, Noakhali.

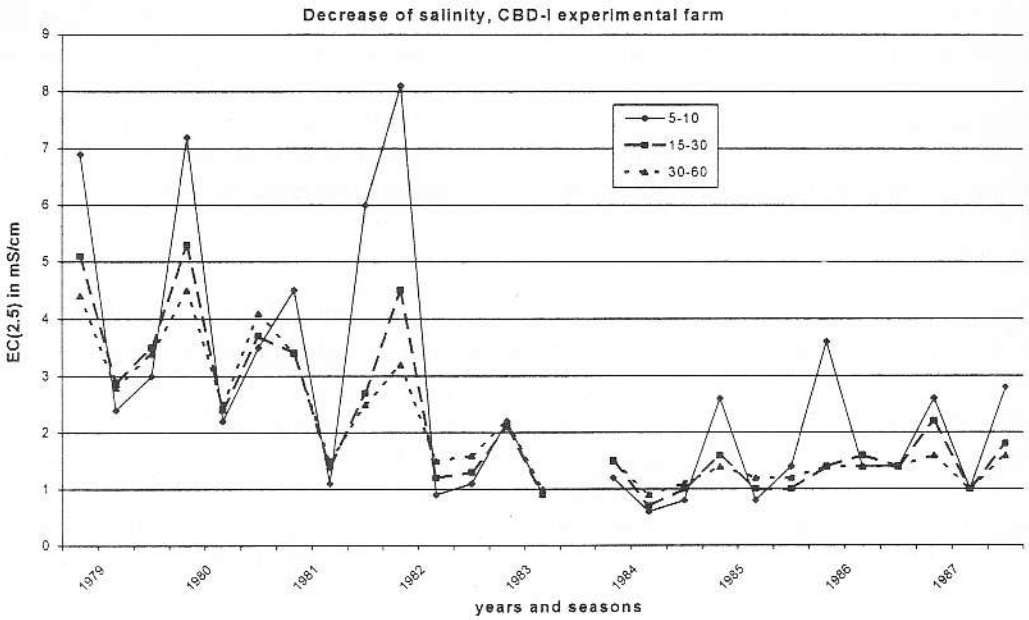


Fig. 13.4. Long Term Salinity Trend, CBD-I, 1979-1987, LRP Data

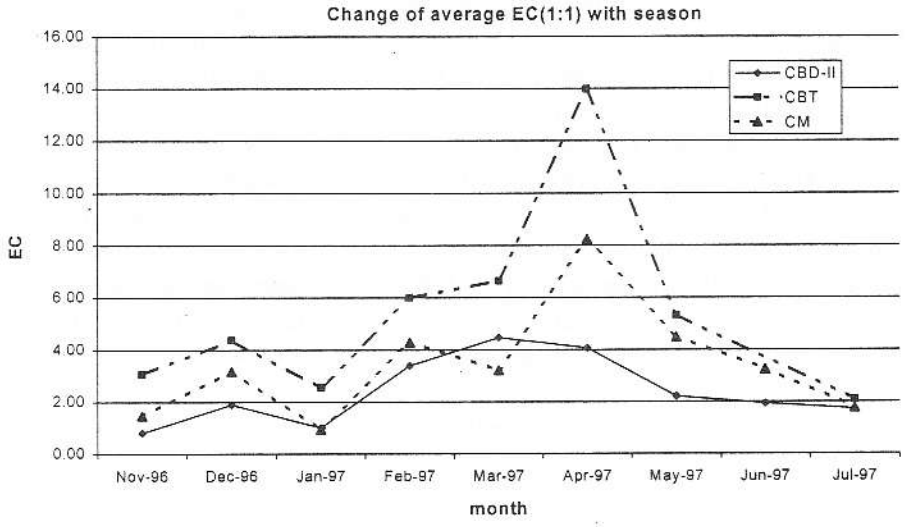


Fig. 13.5. Seasonal Trend of Soil Salinity (1:1 soil paste) in CBD-II, CBT and CM in 1996-1997

The same applies to CBT, but salinity levels there were systematically higher than in CM. This may have been due to occasional saline water intrusions through the incomplete sluice. One of the five sample fields in CBT was known to have been affected and had a considerably higher salinity in April 1997 than the other fields.

The seasonal salinity trends of top- and sub-soil are given for CBT in Fig. 13.6 and show that salinity stress is most pronounced in the top 10 cm.

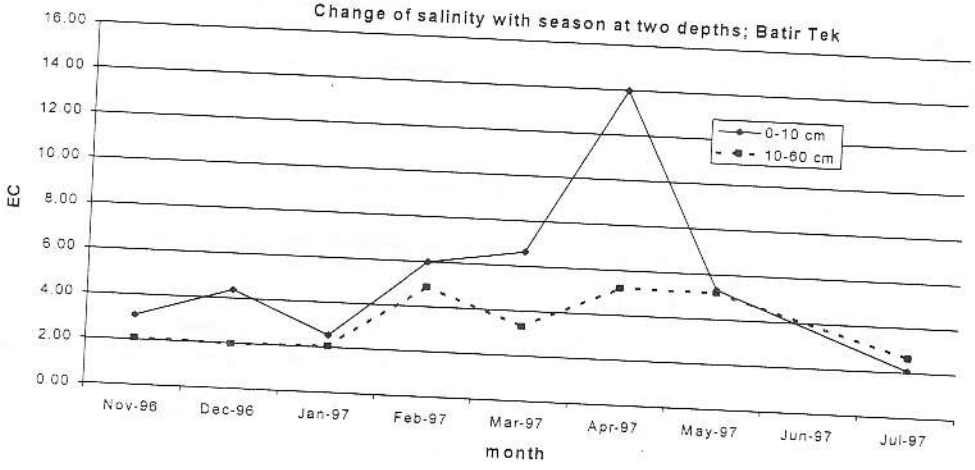


Fig. 13.6. Seasonal Salinity Trends of Top and Subsoil are given for CBT, 1996-1997

CDSP Soil salinity measurements were interrupted in 1998 due to organisational problems in connection with SRDI. The measurements have been resumed at the end of 1998.

We may conclude that the LRP findings on the evolution of soil salinity after empolderment were confirmed by the CDSP measurements. Under similar soil and drainage conditions, soil salinity decreases during the first 4-5 years after empolderment, after which further decline will be very slow. This hypothetical trend is shown in Fig. 13.7. It has important implications for the opportunities in the development of agricultural productivity, as will be discussed in the following sections.

More systematic monitoring of soil salinity, including the distribution of salinity levels across the area, will be needed in a next polder development programme.

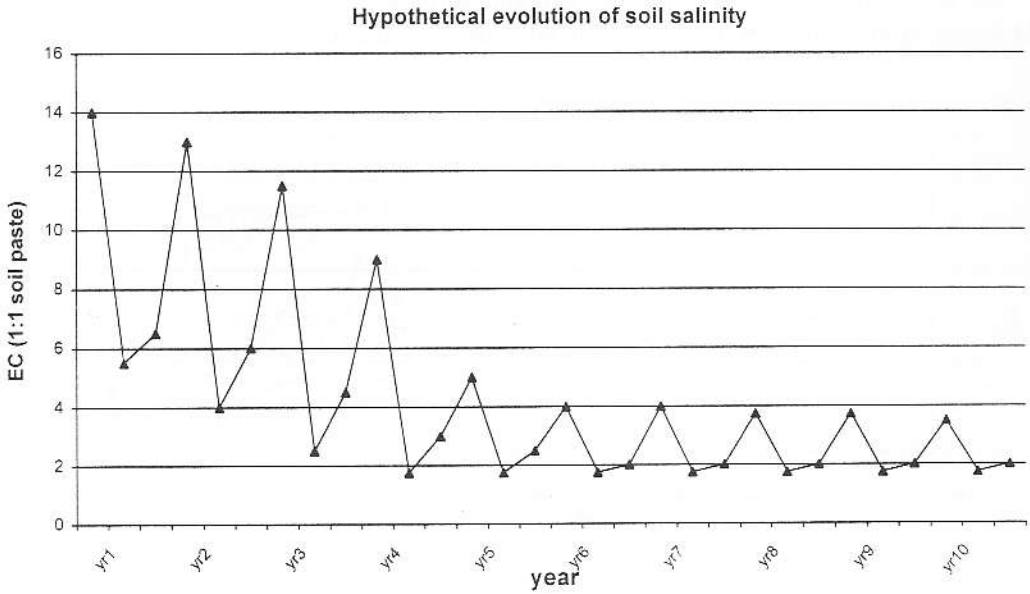


Fig. 13.7. Expected Trend of Top Soil Salinity after Empolderment

Chapter 14

LAND CLASSES AND LANDUSE

Land classes are defined here as clusters of landtypes which combine a number of physical characteristics with relevance for productive potential. Land classes and landuse are expected to be closely related. Land classes reflect production potential and there should therefore be much similarity between maps based on land classes and on actual landuse. If there are major differences, they must be caused by factors not included in the criteria used for distinguishing different land classes. Such differences can be important for the design of a development strategy. In CDSP, landuse mapping preceded the mapping of land classes, but here land classes are discussed first.

14.1 LAND CLASSES

Criteria for Land Classification

Mapping of land classes requires the identification of physical factors which are important in determining landuse. A first observation is that in the Kharif-II season the land will always be used for *aman* paddy production. Aman paddy will therefore be the core of any cropping pattern. Physical factors for distinguishing land classes should therefore be related to:

1. The growing conditions during the Kharif-II season, affecting the choice of Aman varieties, timing of operations, etcetera.
2. The growing conditions during the other seasons, affecting the choice of year-around cropping patterns, in particular the potential for Kharif-I and Rabi crops

The following criteria for land classification were proposed:

1. *Usual water levels during the Kharif-II season (July-October)*
   (significance: this factor determines which type of Aman paddy variety can be grown; HYV have a lower tolerance for continuously high water level)
2. *Maximum water level during the Kharif-II season (3-7 days)*
   Is the field sometimes inundated deeper than the usual level for 3-7 days? (significance: Aman fields should not be deeply inundated for more than a few days; varieties have different sensitivity)

3. *Usual 'transplanting window' (for T-Aman)*
   What is the earliest possible transplanting date? (significance: this determines the variety of Aman paddy that can be grown: after August 15 not suitable for current HYV, after August mainly Kajalshail, after September no Aman transplanting)
4. *Time a field usually starts drying naturally*
   (significance: affects choice and timing of rabi crop)

Three major land classes may be distinguished in terms of combinations of the above criteria as shown in Table 14.1. As it turns out, these classes coincide largely with farmers' own classification in *Uchu* (High), *Majari* (Medium) and *Nichu* (Low).

TABLE 14.1
A Simple Classification in Three Land Classes Based on Combinations of 4 Criteria

		land class		
criteria	"levels"	high	medium	low
1. usual water level during the Kharif season (June-Sept)	0-20 cm	x		
	20-40 cm		x	
	>40 cm			x
2. maximum water level during the Kharif season (3-7 days)	10-30 cm	x		
	30-50 cm		x	
	50-100 cm			x
3. usual 'transplanting window' (for T-Aman)	after 15 July	x	x	
	after 15 Aug			x
4. time field usually starts drying naturally	15 Oct-15 Nov	x	x	
	after 15 Nov			x

A description of the three land classes can be made as follows:

Land Class 'High'

This is land that can be planted with T-Aman early, because there is no risk for deep inundation by accumulating rain water. The land is prone to fall dry temporarily in case of short dry spells, which may lead to 'resalinisation' early in the Aman season. HYV may do well in wet years and less well in dry ones. Early planting of rabi crops is possible, provided the salinity status of the soil permits.

Land Class 'Medium'

The usual water levels are somewhat higher than in class I but there is little risk for inundation to more than 30-45 cm in the middle of the monsoon. The land is not as prone to drying and resalinisation in case of dry spells. This land is most suitable for HYV paddy and can be planted early, provided the preceding crops allow. Fairly early rabi planting is possible, if the T-Aman crop is planted and harvested sufficiently early.

Land Class 'Low'

This land is prone to fairly deep flooding at any time during the monsoon, due to accumulating water. T-Aman can only be planted once water levels start declining, from

the middle of August to as late as the middle of September. The land is less suitable for HYV paddy and farmers usually grow the Kajalshail variety. Planting of rabi crops is not possible before late December to early January and rabi crops may be damaged by early flooding (May). The land may be left fallow during the rabi season because of the risk of early inundation.

Land Classification Survey

After the Rapid Water Management Appraisal (see CDSP Technical Report no. 15), a survey was conducted to collect additional information on land classes in Char Majid, Char Bhatirtek and Char Baggar Dona-II during 1998. The survey was conducted by the CDSP surveyor using the maps produced by the RWMA. A questionnaire was developed for collecting information on land classes and land suitability on the basis of water levels and crops grown in the area during all seasons. Initially the questionnaire was tested in the field by the AES and the surveyor together. First of all the surveyor had a discussion with the local farmers and collected the information on how they themselves classified the land (Nama, Majari, Uchu), after which he measured water levels.

The survey was conducted from August to September of 1998 when the transplanted Aman rice was still in the field. A member of the survey team took a copy of the map to the field and started the survey in each area after physically identifying the area in the map. He located the area and recorded the water depth, crops grown, varieties during the period of survey. Finally the farmers were asked which crop and variety they planted in Uchu Jami, Majari Jami and Nichu Jami. The surveyor recorded this information in the relevant column and proceeded to the next area. In this way the data collection sheet for every single area was completed through the day. Finally the surveyor put colour codes against each depth and area thereby producing maps showing the dominant land class for each area according to water depth. The results are shown in Maps 14.1a to 14.3b, which combines data from the land class survey with those of the (plot-to-plot) landuse surveys conducted earlier (see section 14.2). The maps show the dominant land class in the different areas. Within an area where a particular land class is dominant there will always be fields which belong to one of the other classes.

In the criteria originally proposed to distinguish landtypes, salinity was not a factor, since it is expected to change over time. The decline of salinity will, however, be very slow after an initial fairly rapid decrease. It will therefore be better in the future to consider salinity as a factor in land classification. Soil salinity may be seen as a 'modifier' which puts restrictions on possible crop choices. There has been no systematic assessment of the pattern of soil salinity occurring in the polders. Such an assessment should be carried out in the future to establish soil salinity maps.

Soil characteristics were also advanced as an additional determinant but not enough was known about soil variability. Soil texture may be a factor in drought sensitivity. Another important factor is land tenure. Landuse in some areas may be influenced by the fact that the land is 'owned' by absentee landowners as argued in section 14.2. All these factors may put restrictions on the choices farmers really have. They may explain differences between land capability classes and current landuse and some of them may be mapped separately and overlaid on the land classes map.

14.2 LANDUSE

All the cropping patterns in the area are organised around T-Aman grown during the monsoon season as the major and most reliable crop. Salinity is less of a problem during the monsoon, even in unprotected chars, except when saline water intrudes and damages a standing crop. Farmers therefore will start growing local varieties of T-Aman in newly settled (unprotected) chars.

T-Aman is transplanted over a long period, from mid-July to early September. When salinity allows, it may be preceded by *aus* paddy, grown in the early monsoon and followed by a rabi crop, grown on residual moisture or remain fallow (Fig. 14.1). Which pattern is used by a farmer depends, apart from economic considerations, on land class and salinity.

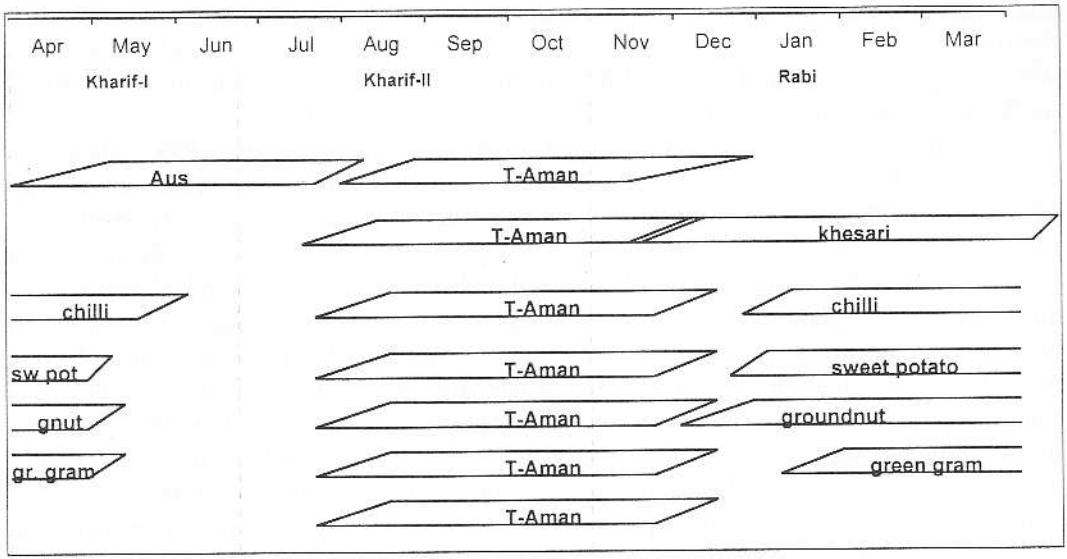


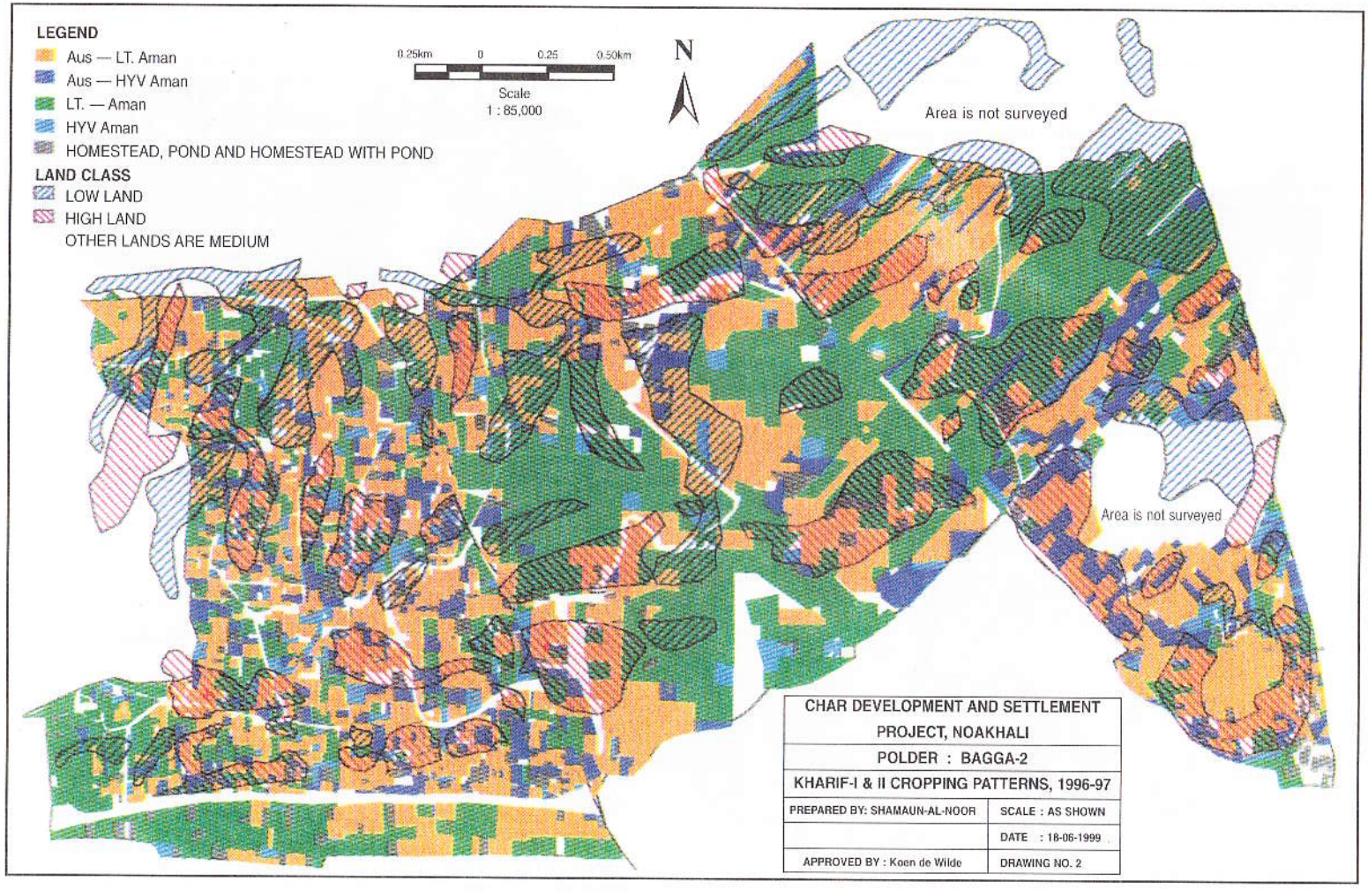
Fig. 14.1. Major Cropping Patterns in the Polder Areas

In 1996, a detailed plot-to-plot survey was conducted, recording the landuse of all plots in the three polders in 1995 and 1996. Methods, data and maps resulting from this study were published in CDSP Technical Report no. 21. Maps 14.1 to 14.3 show the distribution of major cropping patterns for the 1996/97 season according to the survey, in combination with the major soil classes.

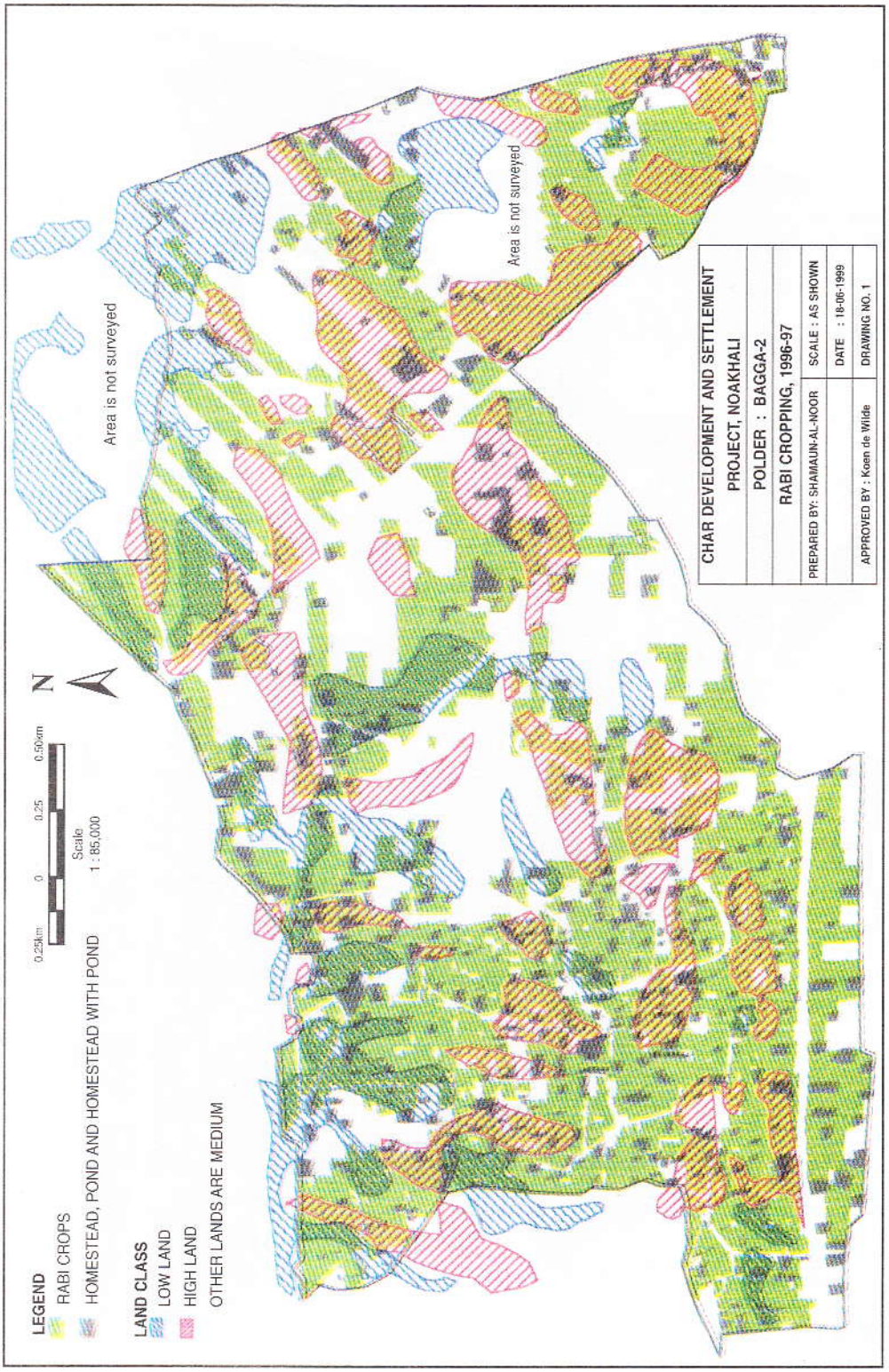
The following conclusions can be drawn:

Baggar Dona-II

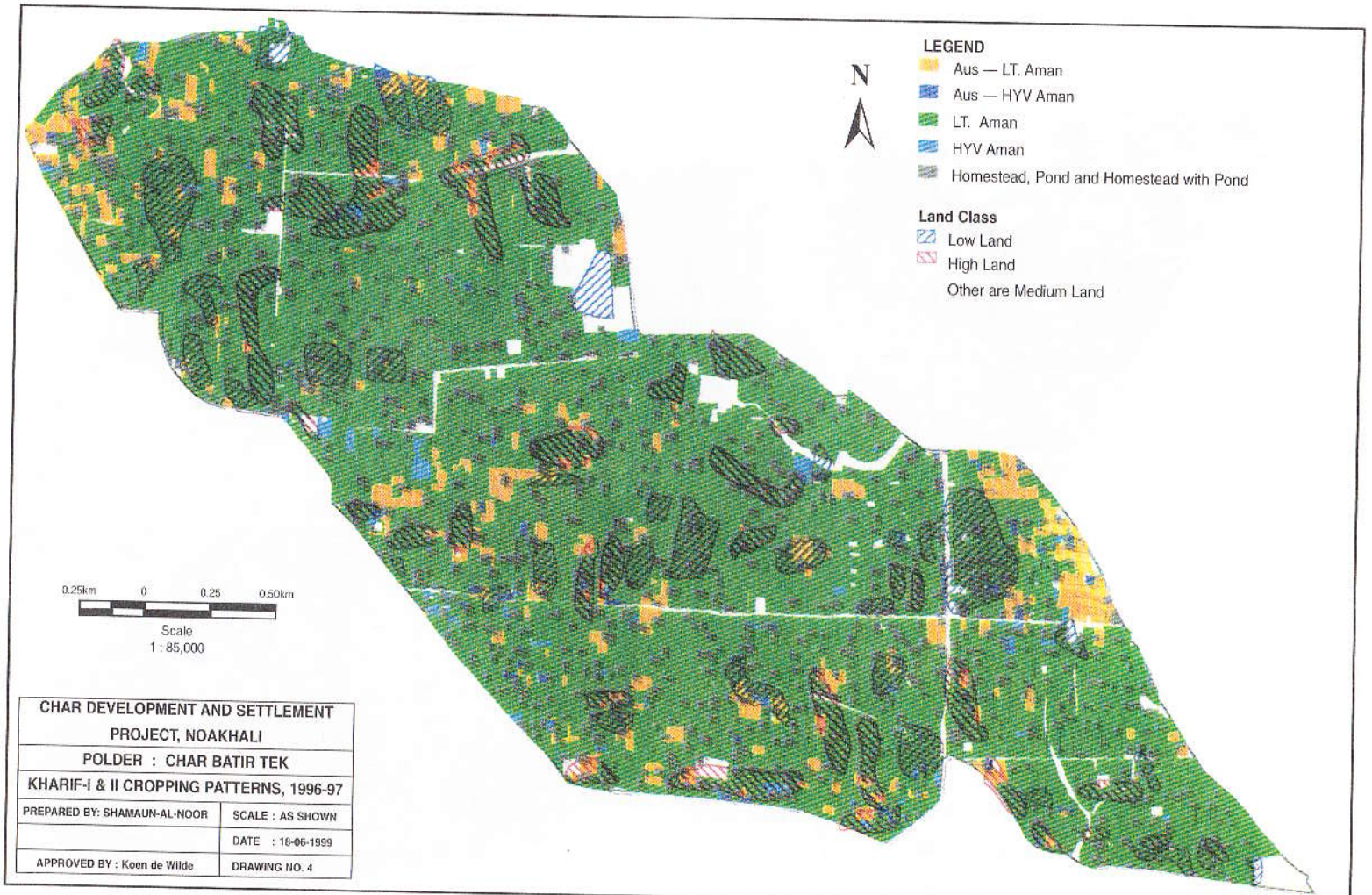
- There was no obvious relationship between major landclasses and the cropping patterns in the Kharif I and II seasons;
- There are some fairly large areas in the centre and the northeast where the only crop grown was local T-*Aman* (no rabi); this may be related to land tenure relations, local salinity may also be a factor; these factors need to be verified.



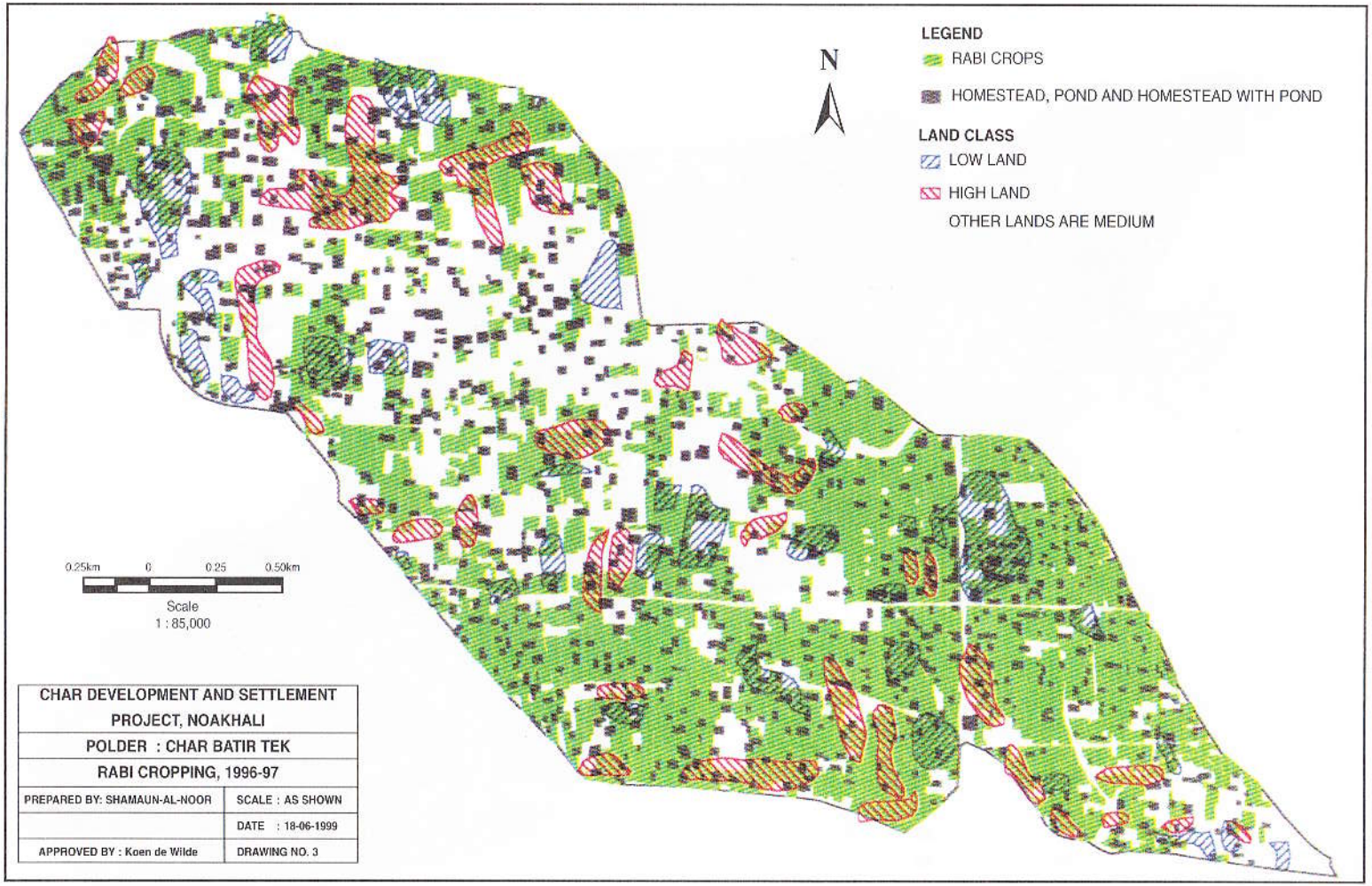
Map 14.1a: Bagga Dona Kharif—I and II Cropping Patterns



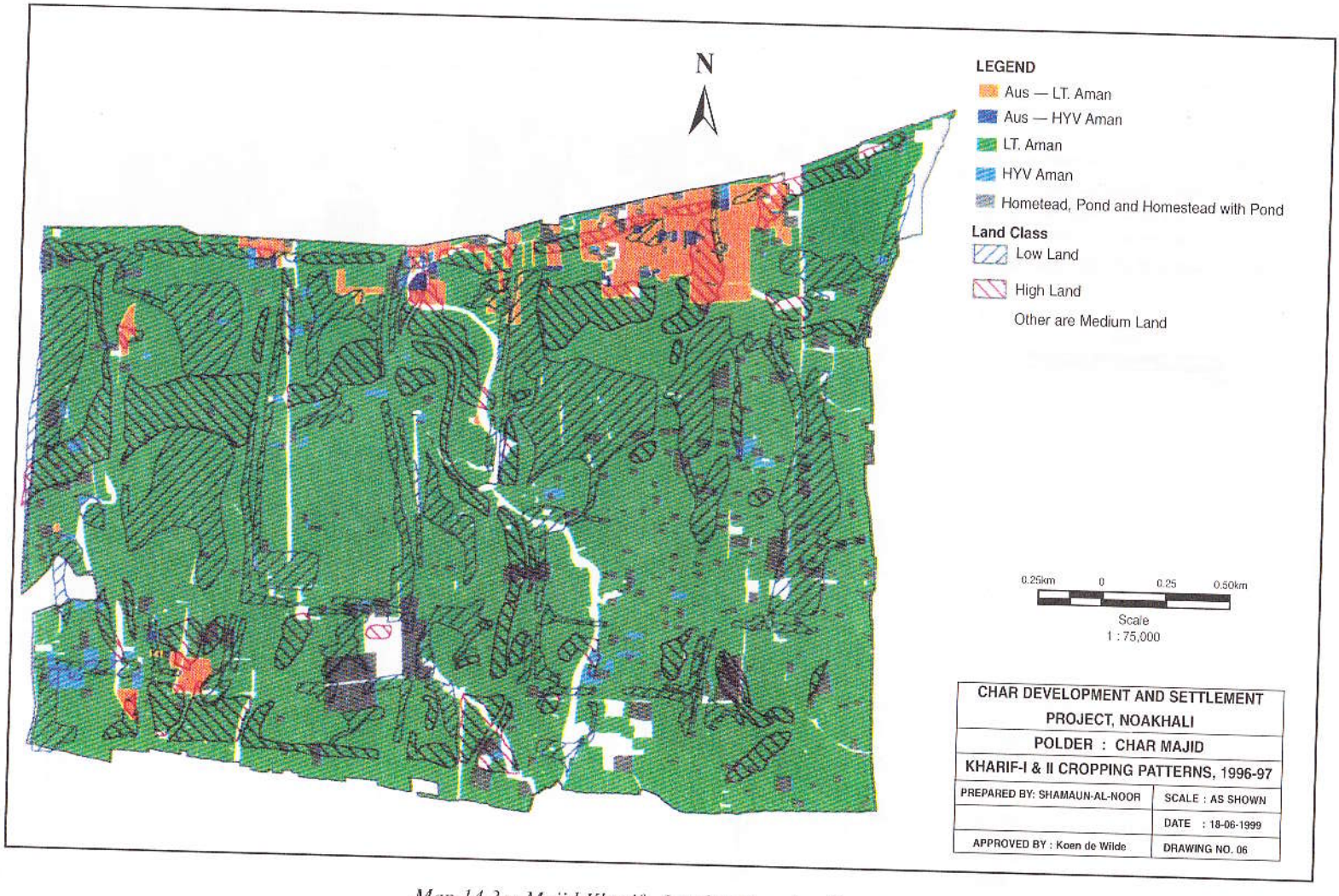
Map 14.1b: Bagga Dona Rabi Cropping



Map 14.2a: Bhatirtek Kharif—I and II Cropping Patterns



Map 14.2b: Bhatirtek Rabi Cropping



Map 14.3a: Majid Kharif—I and II Cropping Patterns

Map 14.3b: Majid Rabi Cropping

Bhatirtek

- Most of the area was still under local T-*Aman*; some concentrations of the *Aus*-T-*Aman* pattern in the eastern and western part may be due to longer protection from saline water intrusions;
- Rabi cropping follows the same pattern, with less rabi in the centre (below the unfinished sluice) and in the southeast (also adjacent to a recently finished sluice).

Majid

- Most of the area was still under local T-Aman; the concentration of the Aus-T-Aman pattern in the northeast is associated with high land conditions;
- The reduced rabi cropping in the southern half coincides with a predominance of low land; the area also has a direct connection with the sluice which was completed only in 1998; conditions were probably more saline.

Since landuse is a dynamic phenomenon, especially with the changing conditions in the polders, regular updates on landuse are needed to monitor changes occurring over time. The plot-to-plot survey, however, is too time-consuming to be used as a routine tool. During the Rabi and Kharif-II seasons of 1999, therefore, a simple verification survey was conducted to record changes in landuse. The methodology consisted of two diagonal transect walks across each polder, recording the crops grown in fields on both sides of the transects. The location of the transects was chosen to cut across the major variability observed on the landuse maps. Percentages of fields planted to the different crops were thus obtained, which can be compared with the percentages of the area under the same crops measured in the plot-to-plot survey. A possible bias may result from differences in the average size of the plots planted to each crop. This can be corrected in the future by separately measuring the area of a sample of plots for each crop.

The results of the 1999 transect surveys, compared with he data from the 1996 plot-to-plot survey are shown in Tables 14.2 to 14.4.

TABLE 14.2

Percentages of Land Used for Different Rabi Crops, in 1995[1] (plot-to-plot survey) and in 1999 (transect survey)

Crops	CBDII		CM		CBT	
	1995	1999	1995	1999	1995	1999
Groundnut	4.48	11.57	0.27	7.54	0.23	3.89
Chilli	4.71	10.77	8.59	6.79	11.35	12.42
S. Potato	3.61	5.73	2.72	5.06	5.39	7.9
Cowpea	0.00	7.90	0	3.34	0.00	2.51
Mungbean	0.00	5.96	0	2.16	0.00	0.63
Garlic	0.00	2.29	0	2.59	0.00	2.38
Onion	0.00	0.00	0	0	0.00	0.13
Soybean	0.18	0.69	0	0	0.00	0
Till	0.18	0.00	0	0.11	0.00	0
Maize	0.00	0.34	0	0	0.00	0.38

(Contd.)

(Continued)

Crops	CBDII		CM		CBT	
	1995	1999	1995	1999	1995	1999
Khesari	4.52	11.68	5.74	6.68	3.33	3.64
Linseed	2.35	7.22	5.04	3.99	8.26	9.03
Tomato	0	0.11	0	0.32	0.00	0.63
S. Gourd	0	0.69	0	0	0.00	0
Egg plant	0	0.57	0	0	0.00	0.25
Mustard	0.09	0.11	0	0	0.00	0
Spinach	0	0.11	0	0	0.00	0
Sunflower	0.23	0	0	0	0.00	–
Potato	0	0.00	0	0	0.00	0.12
Fallow	79.65	34.26	77.64	61.42	71.44	56.09
Total	**100**	**100**	**100**	**100**	**100**	**100**

Note: [1]The figures for 1995 are percentage of cropping area, while those for 1999 are percentage of the (number of) plots (see text).

TABLE 14.3

Percentages of Land Used for Aus in 1995[1] (plot-to-plot survey) and in 1999 (transect survey)

Crops	CBDII		CM		CBT	
	1995	1999	1995	1999	1995	1999
Aus LV	57.2[2]	22.4[3]	0	9.9	4.3	16.1[3]
Aus HYV	2.0		0		0.7	
Fallow	40.8	77.6[3]	100	90.1	93.0	83.9[3]
Total	**100**	**100**	**100**	**100**	**100**	**100**

Notes: [1]The figures for 1995 are percentage of cropping area, while those for 1999 are percentage of the (number of) plots (see text).

[2]This figure looks suspiciously high and may be due to an error of data transfer.

[3]At the time of observation (May) several Aus seedbeds were observed which were yet to be transplanted; the real figure for Aus will therefore be higher and that for fallow lower.

TABLE 14.4

Order of Importance of Area Under Different Rabi Crops, 1995 and 1999

CBDII		CM		CBT	
1995	1999	1995	1999	1995	1999
chilli	khesari	chilli	groundnut	chilli	chilli
khesari	groundnut	khesari	chilli	linseed	linseed
groundnut	chilli	linseed	khesari	sweet potato	sweet potato
sweet potato	cowpea	sweet potato	sweet potato	khesari	groundnut

It is clear from these data, that the area under rabi crops has strongly increased in all three polders, with the newer polders lagging behind the older one (Baggar Dona-II). This is probably due to the declining soil salinity, which improves opportunities for rabi cropping. There has also been a shift towards more groundnuts as the salinity conditions improve (Table 14.4). The increasing importance of Aus with time probably also reflects the decline in salinity (see Fig. 15.1).

Chapter 15

AGRICULTURAL CROP PRODUCTION

A large number of tests and demonstrations of crops, varieties and management practices were carried out by CDSP in the three polders, starting in 1995. Prior to CDSP, the Land Reclamation Project (LRP) also conducted a considerable number of trials over a period of 10 years (1980-1990), mainly in an experimental farm of about 40 ha, located in the CBD-I polder. This report presents mainly CDSP data, arranged according to the three cropping seasons. Relevant LRP results will be discussed as well.

Results of tests and demonstrations are only indicative for the suitability of new technology. The final and only proof for a successful technology is its active adoption by farmers. Studies have therefore been conducted on the adoption of the demonstrated technology. Summaries of the 1998 adoption study are given with each crop or technology reviewed in the following paragraphs. The study interviewed 56 farmers in the three chars, all located around CDSP demonstration farmers, who had been exposed for up to 3 years to the recommended technologies (see CDSP Technical Report no. 17).

15.1 KHARIF-I

Aus Paddy Varieties, Fertiliser

Various Aus varieties were demonstrated in farmers' fields between 1995 and 1998. The results are shown in Table 15.1.

There was only partial consistency in the choice of improved varieties for demonstration over the years, with only BR-14 featuring in all years. Also, the fertiliser rates were different in different years and a higher rate was applied to the improved variety than to the local one. The rates applied are shown in Table 15.2. In 1998, however, fertiliser application in the demonstrations was left to the farmers. The amounts they applied also varied with variety (Table 15.2). Apparently they anticipated a higher fertiliser effect on the improved variety. Overall, the improved varieties (except IR8) outyielded the local by 50-100%, while in practically all cases BR-14 did better than BR-21. A disadvantage of BR-14, however, is that it matures 10-20 days later than Hasikalmi and BR-21 (Table 15.3).

In 1998 a simple farmer-managed fertiliser test was carried with BR-14 and Hasikalmi and a moderate rate of fertiliser to verify the fertiliser effect. The results are shown in Table 15.4. It is clear that the improved varieties did better irrespective of fertiliser.

TABLE 15.1

Yields (t/ha) Obtained in Aus Variety Demonstrations, 1995-1998

Variety	1995				1996				1997						1998			
	BD-II[1]		CBD-II		CBT		CM		CBDII		CBT		CM		CBT		CM	
	N	Main Yield	N	Main Yield	N	Main Yield	N	Main Yield	N	Main Yield	N	Main Yield	N	Main Yield	N	Main Yield	N	Main Yield
BR-3			8	3.70														
BR-14	3	3.91	32	3.09	5	2.01	7	1.89	3	3.56	1	2.69	1	2.81	10	2.92	9	2.70
BR-21									6	3.00	1	3.33	3	2.34	10	2.70	9	2.50
BR-26			2	3.49														
IR8	2	2.69																
Hasikalmi	3	2.09	44	1.74	10	1.14	15	1.11	10	1.59	5	1.14	5	1.14	10	1.15	9	1.71
Average	8	3.02	86	2.46	15	1.43	22	1.36	19	2.34	7	1.68	9	1.72	30	2.26	27	2.30
Failed due to salinity[2]			4						3		1							

Notes: [1]The tests conducted in CM and CBT failed due to saline flooding; [2]Not included in the average yield.

TABLE 15.2
Fertiliser Rates Applied in the Aus Variety Demonstrations

Variety	Kg/ha of $N/P_2O_5/K_2O/S/Zn$				
	1995	1996	1997	1998[1]	
				N	P_2O_5
Improved	60/40/40/10/-	90/80/80/20/4	90/80/80/-/-	20-50	0-30
local (Hasikalmi)	40/40/30/10/-	60/40/20/-/-	60/40/20/-/-	0-30	0-20

Note: [1]Range, decided by farmers.

TABLE 15.3
Average Growth Cycle of Aus Varieties in the 1996-1998 Demonstration

Variety	1976	1997	1998
BR-14	120	100	122
BR-21	n.a.	110	112
Hasikalmi	95	99	111

TABLE 15.4
Yields (t/ha) in an Aus Variety-Fertiliser Test, 1998

Char	Variety	F_0	F_1 (40/30)
CBT	BR-14	2.48	3.43
	Hasikalmi	1.01	1.44
CM	BR-14	2.15	2.47
	Hasikalmi	1.45	1.75
average	BR-14	2.31	2.95
	Hasikalmi	1.23	1.59

In 1984, LRP obtained the best results with BR14 (1288 kg/ha) and BR15 (1158 kg/ha) at a fertiliser rate of 40/40/0.

Salinity

The results of Table 15.2 show consistently higher yield in CBD-II (the oldest polder) than in CBT and CM, while there was no difference between the latter two. This is probably due to the higher soil salinity in the newer polders (see section 13.4). Complete crop failures due to salinity also occurred only in CM (1995) and in CBT (all years). The effect of soil salinity was verified by plotting the 1997 yields of BR-21 and Hasikalmi against salinity, measured in April (the number of fields with BR-14 was too small).

Fig. 15.1 shows that the yields of both varieties tended to decline with salinity, especially at salinity levels exceeding 6 mS/cm (1:1 soil paste).

The decline of BR-14 was steeper but its yield was higher than that of Hasikalmi irrespective of salinity level.

Crop Management

In ordinary years with rains starting by late April, farmers will usually broadcast or deep dibble the seed. Dibbling the seed into a standing chilli crop is quite common. When

there is early rain they may establish a seedbed and transplant the seedlings. This was the case in 1998 and in 1999.

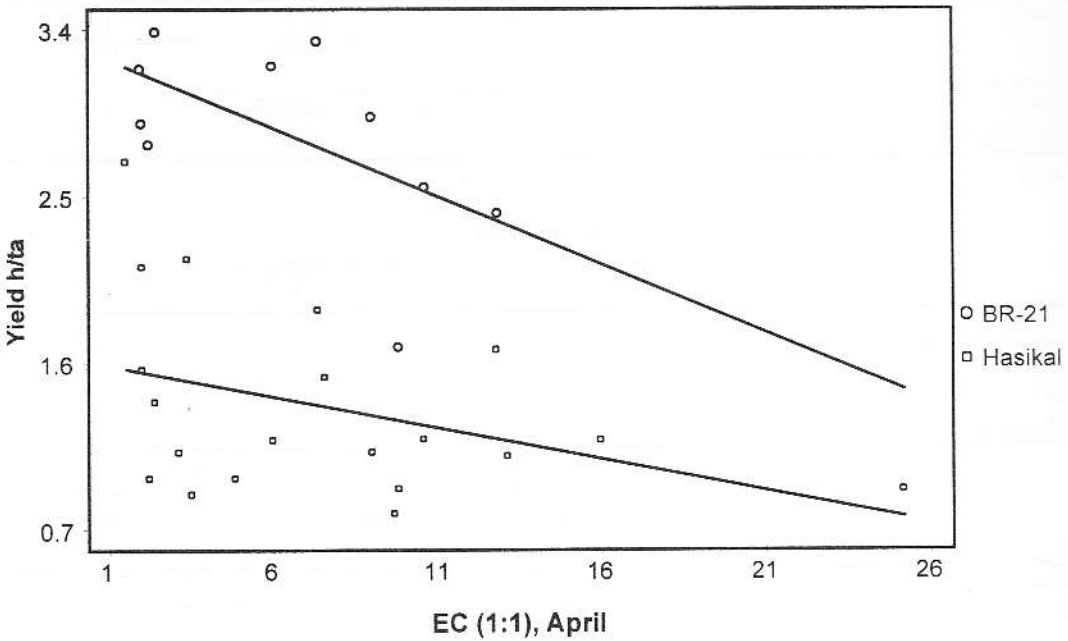


Fig. 15.1. Response of Aus Yield to April Soil Salinity, 1997, all Polders

In 1995, problems were observed in the CDSP demonstrations with germination and establishment of direct-seeded Aus due to drought and salinity, especially in CBT and CM. From 1996 onwards, therefore, deep placement of the seed (3-5 cm) was recommended. LRP also recommended deep dibbling with 6-8 seeds/hole of 10 cm deep, after observing poor yields of around 600 kg/ha in 1981. From 1984 onwards yields were between 1250 and 1500 kg/ha with local varieties.

Adoption

According to the 1998 adoption study, among demonstration and extended farmers 35.7% of the respondents had sown HYV of Aus (18% before CDSP), all of them in CBD-II, including 18% BR-14. Farmers observed that the available HYV had a long growth duration, which requires early sowing when salinity is still high. Hasikalmi remained the most extensively grown variety.

Deep dibbling was said to be the traditional practice in the area, practised by 76% of the respondents.

Conclusions

Both BR-14 and BR-21 were superior in yield to Hasikalmi with and without fertiliser. BR-14 is, however, too late maturing to really make an impact in the area. It may hamper timely planting of T-*Aman*, especially when the first rains are late, and this delay may even carry over into the next rabi season, leading to late planting of rabi crops. The

advantage of BR-21, which produced somewhat less than BR-14, is its early maturity. From the available data, there is no justification for more than a moderate fertiliser rate of 40 kg N and 30 kg P_2O_5 per ha. The effect of S and Zn is not clear, but the low S and Zn status of the soil and the effects reported by LRP (see below) justify some more work in a new Char Development Programme. Deep dibbling is recommended, but is was already widely practised.

Table 19.1 (in chapter 19) shows the Aus yields which may be expected at different stages of polder development.

15.2 KHARIF-II

T-Aman Varieties

Several T-Aman varieties were chosen for demonstration between 1996 and 1998, as recommended by BRRI, in comparison with the two major local varieties. The results are shown in Table 15.5, excluding those varieties which were only grown in a small number of cases.

TABLE 15.5
Yields (t/ha) Obtained in Aman Variety Demonstrations, 1995-1998

	1996/97						1997/98						1998/99			
	CBD-II[1]		CBT		CM		CBD-II		CBT		CM		CBDII		CBT	
	N	Mean Yield	N	Mean Yield	N	Mean Yield	N	Mean Yield	N	Mean Yield	N	Mean Yield	N	Mean Yield	N	Mean Yield
BR-10	13	3.51	5	2.22	1	3.31										
BR-22	50	2.64			12	2.60							28	3.92	23	3.93
BR-30	60	3.12	3	2.60	20	2.79	15	2.68	7	1.99	1	1.80	28	3.91	23	3.81
BR-31							44	2.53	23	2.43	22	2.46				
Kajalshail	58	1.29	4	1.37	28	1.13	60	1.54	30	1.40	30	1.24	27	2.09	24	2.21
Rajashail	53	1.14	2	0.87	23	0.92	10	0.96	4	0.90	13	0.91				
Average	234	2.14	14	1.86	84	1.71	129	1.96	64	1.81	66	1.59	83	3.32	70	3.30

The improved varieties yielded substantially better than the local across the board. In 1996/97 BR-10 yielded significantly better than the other MV, but in 1998/99 the difference with BR-30 was not significant.

As with the Aus tests, the fertiliser rates were different in different years and a higher rate was applied to the improved variety than to the local one. The rates applied are shown in Table 15.6. The higher yield of the improved varieties may be partly due to the higher fertiliser rate applied to the former.

TABLE 15.6
Fertiliser Rates Applied in the Aman Variety Demonstrations and Tests

Variety	Kg/ha of $N/P_2O_5/K_2O/S/Zn$		
	1996	1997	1998[1]
Improved	90/80/80/20/4	90/80/80	48/25
Local	60/40/20/-/-	60/40/20	30/17

Note: [1]Left to farmers' choice.

Apart from overall yield potential, the choice of variety depends also on its growth duration in relation to the length of the available growing season. Table 15.7 shows the field duration (transplanting — harvest) of the demonstrated varieties in the 1996/97 and 1997/98 seasons. Field duration was shorter as planting was later for all varieties, with Rajashail responding most strongly, because it is strongly photosensitive. This is further illustrated for the full range of transplanting dates in 1997/98 in Fig. 15.2.

TABLE 15.7

Median Transplanting Date and Field Duration of T-Aman Varieties, 1996/97 and 1997/98 Seasons

Variety	1996/97		1997/98	
	Median Planting Date	Median Field Duration	Median Planting Date	Median Field duration
BR-10	12/8	130	30/8	121
BR-22	14/8	131		
BR-30	16/8	116	12/8	126
BR-31			9/8	126
Kajalshail	13/8	124	12/8	133
Rajashail	13/8	96	21/7	122

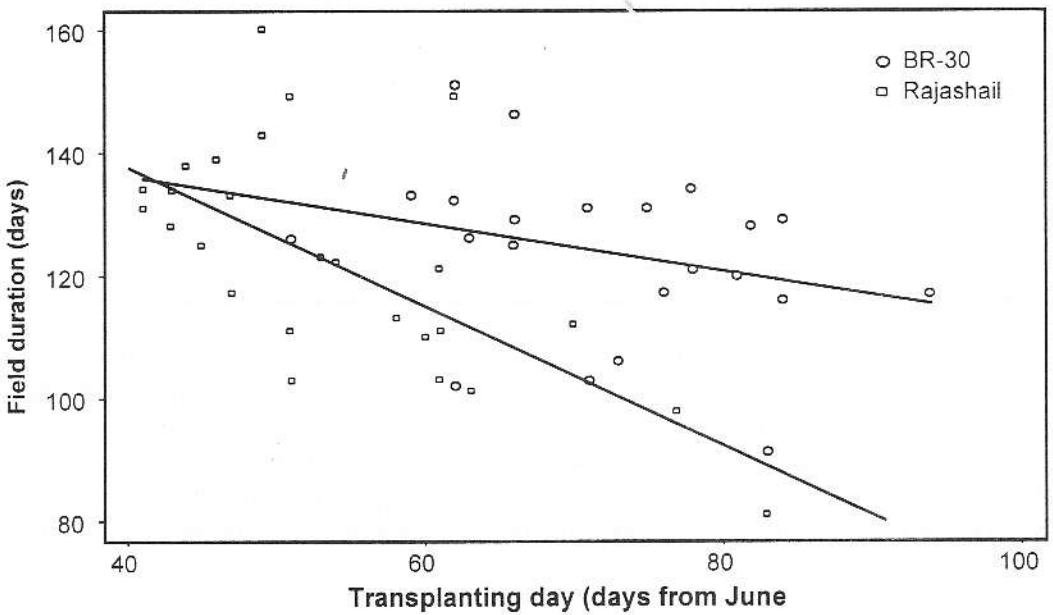


Fig. 15.2. Relationship Between Date of Transplanting and Field Duration of BR-30 and Rajashail, 1997/98 Aman Season

Rajashail is therefore not suitable for planting after July because the shortened growth duration results in low yield (see Table 15.5). The variety is being replaced in the area by MV. From Table 15.8, combined with the time trend of Fig. 15.2 it can be concluded that BR-30 and BR-31 mature 10-14 days earlier than BR-10. This makes them more suitable

for August planting than BR-10, because of less risk of end-of-season drought and earlier availability of the land for Rabi.

None of the current improved T-Aman varieties are, however, suitable for planting after late August. They would not be able to complete their cycle normally because of the drought risk as from mid-October and the onset of the dry season early November (Fig. 13.2, chapter 13.1). Kajalshail is less sensitive to late season drought and remains the preferred variety for very late planting.

TABLE 15.8

Average Yields of Improved and Local T-Aman Varieties, 1980-1990, LRP Experimental Farm

	1980		1981		1982		1983	1984	1985	1986	1989	1990
Varieties	F1	F0	F1	F0	F1	F0	F1	F1	F1	F1	F1	F1
improved, average	4973	1579	2590	2381	2853	1357	1677	4010	3643	2090	1722	3195
local, average	2165	1683	1706	2133	2482	1338	1705	2947	3259	1836	1492	2173

LRP also conducted 10 years of variety experiments at the experimental farm in CBD-1. The results, pooled for improved and local varieties, are presented in Table 15.8. Yields fluctuated strongly over the years, but generally they are comparable with those obtained in the CDSP tests and demonstrations. Pajam, BR10, BR11 and BR22 were the best yielders. Kajalshail sometimes performed better than improved varieties in late plantings.

Fertiliser

NPK. No extensive tests were conducted on fertiliser effects on T-Aman. The rates applied in the demonstrations were based on recommendations by BRRI. These rates, however, are much higher than those usually applied by farmers (see the section on adoption below). In order to test the effect of a moderate fertiliser rate on both an improved and local variety, a simple farmer-managed variety x fertiliser test was carried out in 1998. BR-22 and the local variety were grown with or without fertiliser. The fertiliser rate applied to BR-22 was 60/40, to the local variety 40/30, to avoid lodging. Since the trial was farmer-managed, it was left to the farmers to decide whether they would apply fertiliser to the 'non-fertiliser plots'. Table 15.9 shows the results for the fertilised plots compared with those 'non-fertiliser plots', where farmers did not themselves apply any fertiliser.

TABLE 15.9

Grain Yield of T-Aman for Two Varieties with and without Fertiliser, CBT and CM, 1998/99 Season

Variety	Fertiliser	
	no fertiliser	with fertiliser[1]
BR-22	3.38	4.20
Local	2.15	2.68

Note: [1]60/40 for BR-22 and 40/30 for local.

It shows that the average fertiliser effect was about 800 kg/ha of grain for BR-22 and 50 kg/ha for the local variety. This corresponds with a response of about 13 kg per kg of

applied nitrogen for both varieties. In order to verify this effect, the yield of BR-22 in the plots where farmers themselves had applied fertiliser was plotted against the amount of N applied (Fig. 15.3). The response was somewhat higher than according to Table 15.9 but, considering the wide scatter, an estimated response of 15 kg of grain per kg of N (in the presence of P!) seems reasonable.

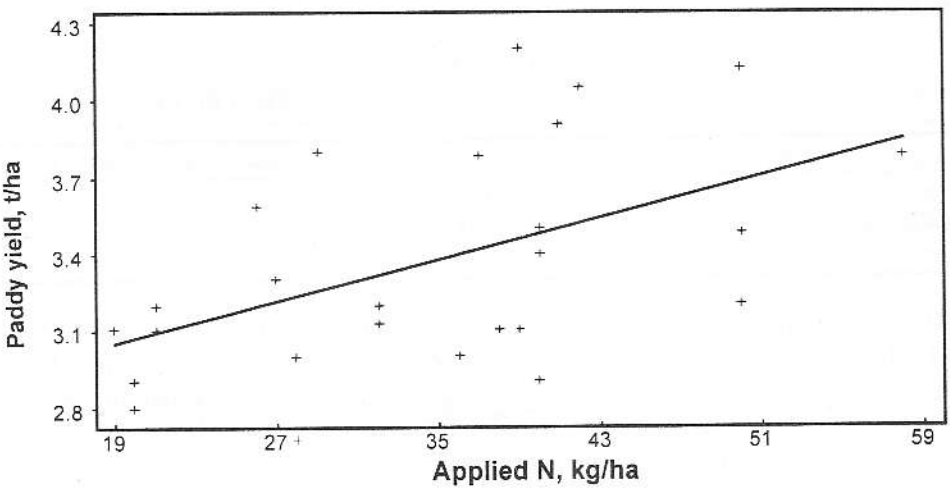


Fig. 15.3. Response of BR-22 to Fertiliser as Applied by Farmers to 'Non-fertiliser' Plots in a Variety × Fertiliser Trial

LRP fertiliser tests, 1980-1983, showed that in two out of the three years, application rates above 60/30/10 were not economical. The responses were, however, erratic. N and P were not varied independently in the fertiliser trials, so only the combined response to N and P was measured. An indication about the effect of P can be gleaned from a 1987 trial on the effect of *Sesbania* on T-Aman yield, which is further reported below. Results are shown in Table 15.10.

TABLE 15.10

P-effect Observed in a 1987 Trial on the Effect of Sesbania on T-Aman Yield, LRP

no Sesbania	yield	increment due to P	with Sesbania	yield	increment due to P
no fertiliser	1221		no fertiliser	1709	
20/0	1436		20/0	1928	
40/0	1510		40/0	2031	
40/40	1804	294	40/40	2598	567

In a 1982 LRP test there was practically no effect of cattle manure up to 8t/ha on the paddy yield. The effect on the following wheat crop was also zero.

K was applied initially by LRP but dropped later for unknown reasons. Our soil analysis indicate that K-status may be critical in some fields but no response data are available.

Micronutrients. LRP reported a considerable response to Zn-sulphate for two out of three years (1984 and 1985), in the order of a 600-900 kg/ha yield increment over a control yielding about 3 t/ha. Zn alone had no effect and it was concluded that the effect was due to S. In 1986 no effect was found, however, and no more is said about it in later reports. In view of the often disappointing effect of the major nutrients, a micronutrient deficiency could still be suspected (Zn and/or S). CDSP did not collect information on micronutrients.

Salinity

The data of Table 15.5 show a somewhat lower T-Aman yield in CBT and CM than in CBD-II, especially for the improved varieties. This may be due to the higher salinity in the younger polders or, generally to their less mature soil conditions. Fig. 15.4 shows a tendency to a yield decrease of BR-31 with salinity measured in November 1997, but the number of data points in the high salinity range is too small to draw firm conclusions.

LRP could not establish a clear relationship between salinity and T-Aman paddy yield in the different plots of the experimental farm (which had large differences in salinity), even in the early years.

Crop Management

Planting and weeding. The CDSP project demonstrated a number of management practices, notably line planting and line weeding. Hand-pushed line weeders were made available to the demonstration and extended farmers.

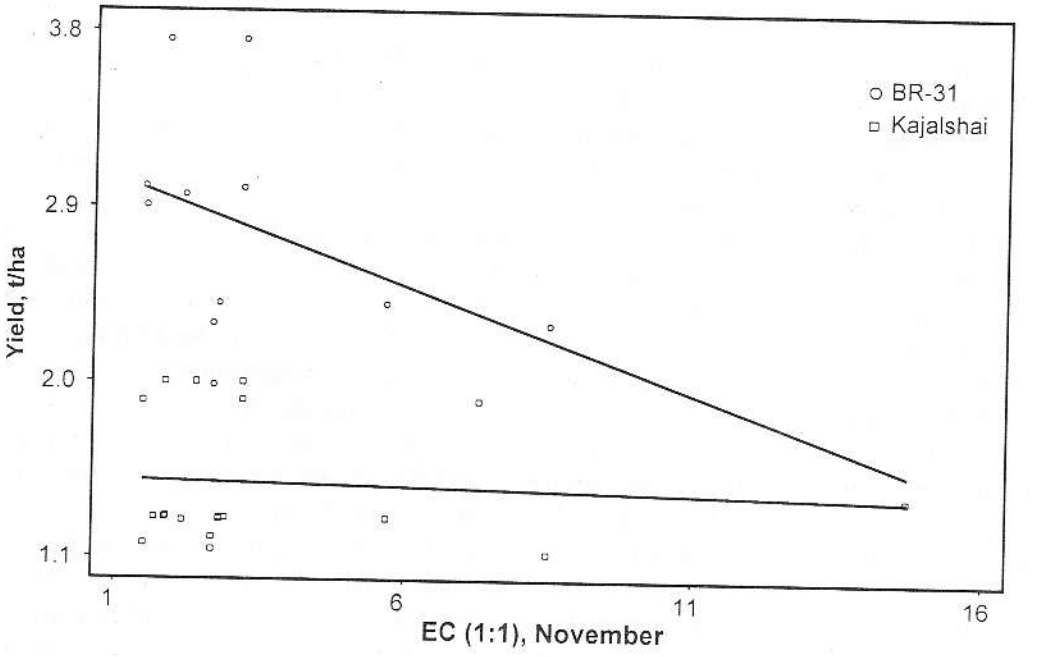


Fig. 15.4. Relationship Between November Soil Salinity and T-Aman Yield, 1997/98 Season

Planting date. Data from LRP on the effect of planting date show that in most years there is little or no effect of transplanting date between 15 July and 15 August. Planting after August 15 will usually lead to lower yields.

Plant spacing. The results from 3 years of LRP trials on plant spacing showed that for both local and HYV there should be around 40 hills/m^2 (spacing of 25 × 10 or 20 × 12 cm) and 2-4 seedlings/hill for HYV and 4-6 for local varieties. A spacing 25 × 20 is certainly outside the optimum range.

Threshing. CDSP made paddle threshers available to all demonstration farmers, to be shared with the extended farmers.

Adoption

Among the T-Aman varieties demonstrated and disseminated by the project, the adoption by demonstration and extended farmers of BR-10 and BR-30 increased from 11 and 7% before the project to 41 and 59 % of the respondents in 1998 respectively. The major limiting factor for further expansion mentioned was seed availability.

Farmers were found to generally apply Urea to both HYV (93%) and to local varieties (84%), at an average rate of, respectively, 37.5 and 22 kg N/ha. For P the percentages and average rates were: HYV: 91% and 28.5 kg P_2O_5/ha and Local varieties: 57% and 20.6 kg P_2O_5/ha.

Line planting was already a common practice before CDSP and there was no increase due to the project. The CDSP-provided line weeder and thresher were quite popular, but they are not yet locally available for purchase (see chapter 17).

Conclusions

Among the improved varieties, the yield potential of BR-10 is probably somewhat higher than that of BR-30 and BR-31. The latter, however, mature earlier by 10-15 days and should be preferred for August planting. After late August, only Kajalshail is suitable. Availability of seed for purchase within easy reach of farmers would stimulate further adoption of improved varieties.

Although the yield differences between the chars are much smaller than in the Aus season, average T-Aman yield was consistently higher in CBD-II than in CBT and CM. This is probably due to the higher salinity level in the latter at this stage of polder development. It seems safe to assume that for T-Aman salinity ceases to be a problem after only a few years without flooding by saline water, except in exceptionally dry monsoons.

A fertiliser rate of 60 kg N and 30 kg P_2O_5 per ha is considered adequate for the time being. It is not clear to what extent the polder soils respond to K and micronutrients (S and Zn). The chemical soil analyses (section 13.2) suggest that Zn is deficient, which may be aggravated by the high pH and low O.M. content. K and S levels may be critical in some fields and not in others. On the other hand, the N-response obtained in the trials (13-15 kg grain/kg of N) is not much lower than usually obtained with conventional N-sources. This would suggest that there are no major deficiencies of other nutrients. In a future Char Development Programme, nutrient responses should get more attention.

The use of the hand-pushed line weeder could expand if it were locally available for purchase.

Table 19.1 (chapter 19) shows the T-Aman yields which may be attained at different stages of polder development.

15.3 GREEN MANURE

Soils in the polder area are immature and they are lacking particularly in organic matter. Responses to inorganic fertiliser are erratic, which may be partly due to the low OM content, partly to micronutrient deficiencies. Green manuring is thought to help in alleviating these problems, directly by adding N to the soil and indirectly by contributing to organic matter. Both LRP and CDSP have emphasised Dhaincha (*Sesbania spp.*) as a potential green manure crop for the polder areas.

In 1995 a test was conducted on the effect of *Sesbania* on the following T-Aman paddy crop (BR 10 and Kajalshail). Sesbania was broadcast in ploughed and laddered soil in late April and ploughed under in early July. The paddy grown after *Sesbania* received a reduced fertiliser rate. The *Sesbania* plots gave about 300 kg/ha higher yield than those without *Sesbania* (Table 15.11). The local variety (Kajalshail) did considerably better with *Sesbania* than without. The results are for CBD-II only, as all plots but one in CM and CBT were damaged by a tidal surge.

TABLE 15.11

Average T-Aman Yields with and without Sesbania as a Preceding Crop, CBD-II, 1995

Sesbania	Fertiliser[1]	N	Aman Var	Mean	Increment
–	90/80/80/20	BR10	3.75		
+	60/80/80/20	BR10	4.05	0.30	
–	60/40/20	Kajalshail	2.40		
+	40/40/20	Kajalshail	3.10	0.70	

Note: [1] $N/P_2O_5/K_2O/S$.

In 1996, a similar test was conducted with all demonstration and extended farmers in the three chars. Out of the 60 farmers in CBD-II, 19 failed to obtain an established stand of Dhaincha, 9 out of 30 in CBT and 22 out of 30 in CM, most of them probably due to salinity damage. The results obtained in the remaining fields are shown in Table 15.12. The effects were similar to those in 1995 for the local variety and about double for the HYV. We may therefore attribute a yield increment of about 700 kg/ha of paddy to the direct effect of Sesbania, in addition to the gain from a reduced fertiliser rate.

LRP conducted similar trials, but separated the effect of fertiliser and green manure. Their results are shown in Table 15.13. The results show a consistent pattern over the years. There was a considerable interaction between fertiliser and green manure in two out of three years (1986 and 1987) and a smaller but still appreciable one in 1988. The average yield increment due to green manure on top of fertiliser was about 800-900 kg/ha of paddy, but only around 400 kg/ha without fertiliser. There was therefore a strong synergistic effect between fertiliser and green manure.

Salinity

Relevant salinity data were only available for part of the participating farmers in the 1995/96 Sesbania tests and only for February 1995. The relationship between Sesbania

TABLE 15.12

Average Sesbania Biomass and T-Aman Yields with and without Sesbania as a Preceding Crop, all Polders, 1996

Treatments			CBD-II				CBT				CM			
Sesbania	Aman variety	Fertiliser[1]	N	Sesbania biomass	Aman yield	Increment	N	Sesbania biomass	Aman yield	Increment	N	Sesbania biomass	Aman Yield	Increment
–	BR-30	90/80/80	20		2.58		6		2.96		6		3.20	
+		60/80/80		17.6	4.11	0.53		13.2	3.71	0.75		12.9	4.01	0.81
–	Local	60/40/20			1.21				1.10				0.99	
+		20/40/20		17.6	2.10	0.89		13.2	1.76	0.66		12.9	1.77	0.78
Sesbania damaged by salinity	19				9				22					

Note: [1] $N/P_2O_5/K_2O$.

TABLE 15.13

Effect of Sesbania Green Manure on the Yield of Fertilised and Non-fertilised T-Aman (BR11), LRP Tests,

1986-1988	1986		1987		1988		average	
treatment[1]	yield	incr[2]	yield	incr	yield	incr	yield	incr
1. no GM, no fertiliser	1022		1221		1607		1283	
2. no GM, 60(40)/40	2087	1065	1804	583	1717	110	1869	586
3. GM, no fertiliser	1258	236	1709	488	2202	595	1723	440
4. GM, 60(40)/40	3052	2030	2598	1377	2515	908	2722	1439

Notes: [1]In 1987 40 kg/ha of N was applied instead of 60; [2]Increment over treatment 1.

biomass yield and soil salinity is shown in Fig. 15.5. If the outlier is ignored, there is a declining trend of biomass with salinity. Furthermore, in some years (e.g. 1996, see above) it is difficult to obtain a good stand of Sesbania in April because salinity is then highest.

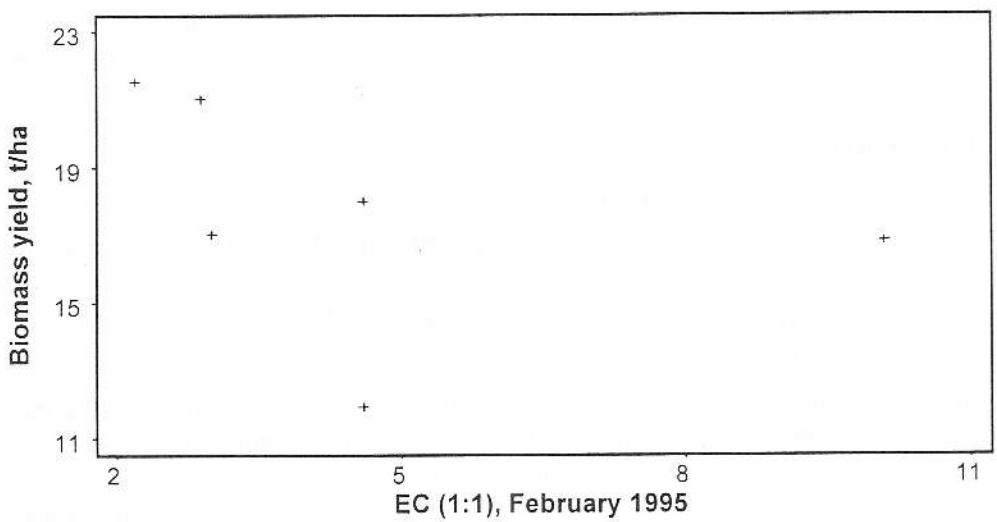


Fig. 15.5. Relationship Between Sesbania Biomass Yield and February Salinity, 1995

Adoption

Adoption by demonstration and extended farmers of Dhaincha as a green manure crop was found to be disappointing. In 1998, 27% of the respondents planted *Sesbania* (mostly in CBD-II), but the crop failed in most cases due to excessive early rains. Farmers were very sceptical about the technology because of the difficulties of establishment and possibly the unsatisfactory gains from the following Aman crop.

Conclusions

Dhaincha, if well established, undoubtedly has an appreciable effect on the following Aman crop, especially when Aman is grown with fertiliser. The additional Aman yield

may then be 800-1000 kg/ha. There are, however, a number of problems which hamper adoption by farmers:

- At the time for Dhaincha sowing, there will be maturing rabi crops in many fields, preventing the establishment of Dhaincha;
- It is difficult to establish Dhaincha in case of salinity or early heavy rains;
- Fields which are left fallow may be intended for Aus paddy; if Dhaincha is planted instead of Aus, the foregone Aus yield is not compensated by the additional Aman yield due to Dhaincha;
- Farmers may be reluctant to invest in a crop which does not yield an immediate product.

A good green manure crop would, however, be very beneficial for the cropping system and ways should be explored to incorporate Dhaincha or another GM crop in the cropping pattern, avoiding the above problems. Some initial work was started in 1999 to interplant Dhaincha in chilli in January and pruning the plants to prevent shading of the chilli. After the chilli harvest, Dhaincha would be allowed to cover the field until Aman is planted. In most plots, however, Dhaincha did not survive due to salinity.

In a future Char Development Programme, more attention should be given to finding a niche for a green manure crop.

15.4 RABI CROPS

The choice of Rabi crops suitable for the polders depends on:

1. The salinity conditions and therefore the period elapsed since the polder was protected from intrusion of saline water;
2. The annual pattern of water conditions in the field and therefore land class, drainage and rainfall pattern.

Farmers are seen to experiment themselves with Rabi crops and it appears that they start growing new ones as the salinity and drainage conditions change. A Char development Programme can assist farmers by promoting varieties and cultivation practices of those crops which are most suitable at a given time and place. The tests and demonstration conducted by CDSP and by LRP before her provide useful information to assess the suitability and potential yield levels of various Rabi crops. The findings are discussed in the following paragraphs, while the implications for suitable cropping patterns are treated in chapter 16.

Yields

Table 15.14 presents an overview of the yield levels attained over the years in the LRP and CDSP tests and demonstrations. Although the data are heterogeneous, they give an impression of the overall yield levels obtainable under the conditions of the polders. The crops which, according to these yield figures, have shown some promise are:

oilcrops	cereals	pulses	vegetables	oilcrops	cereals	pulses	vegetables
sunflower	wheat	**khesari** **groundnuts** soybeans	**sweet potato** **chilli** **garlic**				onion tomato

Most of these crops are actually grown as field crops by farmers, while some are not or hardly grown, viz. sunflower, soybean, onions and wheat. There is no ready market for sunflower and soybeans, which would hamper their adoption. Local soybean processing is practically unknown in Bangladesh. The reason why wheat is hardly grown is not clear.

Some of the crops with low yield potential according to Table 15.14 are actually grown extensively in the fields, viz. linseed, cowpeas and green gram. Cowpea and linseed are, however, often mixed with other species, providing a bonus when yield is good. Green gram can be planted quite late and with light tillage. Tomatoes are mainly grown as a homestead crop.

TABLE 15.14

Averages and Ranges of Yields Recorded for Various Rabi Crops by LRP and CDSP

	LRP, 1980-1989		CBD-II		CDSP, 1995-1998 CBT		CM	
Rabi crop	average	range[1]	average	range[1]	average	range[1]	average	range[1]
Wheat	780	201-1867						
Barley	645	342-1295						
Maize	162	57-240						
Millet	612	0-860						
Linseed	293	0-486			300		190	
Mustard	464	0-1000	460	310-610	460	420-500		
Safflower	553	0-553						
Sunflower	1102		869	470-1030	636	610-710	588	450-830
Castor	598							
Khesari	376	218-553	615	390-790	940		800	
Lentil	404	0-450						
Black gram	524	0-948						
Mung bean	16							
Soybean	622	0-1195			1104	990-1120	1258	0-1800
Cowpea	222	0-289						
Groundnuts	382	0-679	1230		1110		1200	
Field peas	225							
Pigeon pea	183							
Potato	2897	2516-3278						
Sweet potato								
local	5467	0-6094						
Improved	7552	6746-8357	22800		23000		21700	
Chilli	81	0-81	1020		810		870	
Onion	2245				2370	1190-3910	3240	1510-5800
Garlic	487				2980		3140	
Tomato	5716				19217	9750-35000	11307	6000-20000

Note: [1]A minimum of 0 means that a test or demonstration failed completely, usually because of salinity.

Khesari and linseed are usually relayed into a maturing T-Aman crop without any tillage, before the soil gets dry and salinity builds up. Khesari is used for its grain for human consumption as well as for cattle fodder.

Varieties

Varietal tests were carried out by CDSP with groundnuts, sweet potatoes, chilli and Khesari. The results are shown in Tables 15.15 to 15.18. On the basis of these tests, the varieties *Zingabadam* (groundnuts), *Hathazari* (chilli) and *BARI-1* (khesari) were chosen for recommendation and demonstration.

TABLE 15.15
Yield (t/ha) of Two Groundnut Varieties in On-farm Tests, 1995/96-1997/98

	CBD-II		CBT			CM		
Variety	1995/96	1996/97	1995/96	1996/97	1997/98	1995/96	1996/97	1997/98
Dhaka-I	0.81	1.00	0.75	0.93	0.93	0.97	1.02	0.72
Zingabadam	1.18	1.46	1.18	1.28	1.25	1.21	1.39	0.94

TABLE 15.16
Yield (t/ha) of Sweet Potato Varieties in On-farm Tests in 1996/97

Variety	CBD-II	CBT	CM
Daulatpuri	19.93	19.94	18.82
Improved[1]	14.85	14.01	13.86
Average	15.70	15.00	14.69

Note: [1]Average of 4 new lines.

TABLE 15.17
Yield (t/ha of dried chilli) of Two Chilli Varieties in On-farm Tests, 1995/96-1997/98

	CBD-II		CBT			CM		
Variety	1995/96	1996/97	1995/96	1996/97	1997/98	1995/96	1996/97	1997/98
Hathazari		1.26		1.15	0.67		1.27	0.77
Local	1.12[1]	0.80	0.96[1]	0.85	0.55	1.00[1]	0.82	0.65

Note: [1]120 kg/ha N, 80 P_2O_5 and 60 K_2O applied.

TABLE 15.18
Yield (t/ha) of Khesari Varieties in On-farm Tests in 1997/98

Variety	CBT	CM
BARI-1	1.10	0.97
Local	0.78	0.63

Growth duration is an important consideration in the choice of crops and varieties. The crop must mature before or early in the pre-monsoon to avoid water logging. This is particularly important in lower lying areas, which may be inundated early. Table 15.20 shows growth duration of rabi crop varieties tested in different years.

Soil Salinity

In order to assess the potential of various rabi crops at different stages of polder development, information is needed on their response to soil salinity. Since salinity measurements

TABLE 15.19
Yield of Garlic with and without Fertiliser, 1997/98 Rabi Season

Fertiliser	CBT	CM
40/70/60	4.08	3.85
0	1.87	2.43

were taken periodically in several of the farms where the tests and demonstrations were carried out, an assessment of sensitivity to soil salinity could be made. The yields obtained were therefore plotted against the salinity measured in the same farm (not always in the same field). For sweet potatoes and for chilli there was no relationship between salinity measured during the dry season and yield. For groundnuts there was a weak but significant relationship (Fig. 15.6) between yield and salinity in April. Sunflower (only grown in 1995/96) reacted most strongly to salinity (Fig. 15.7).

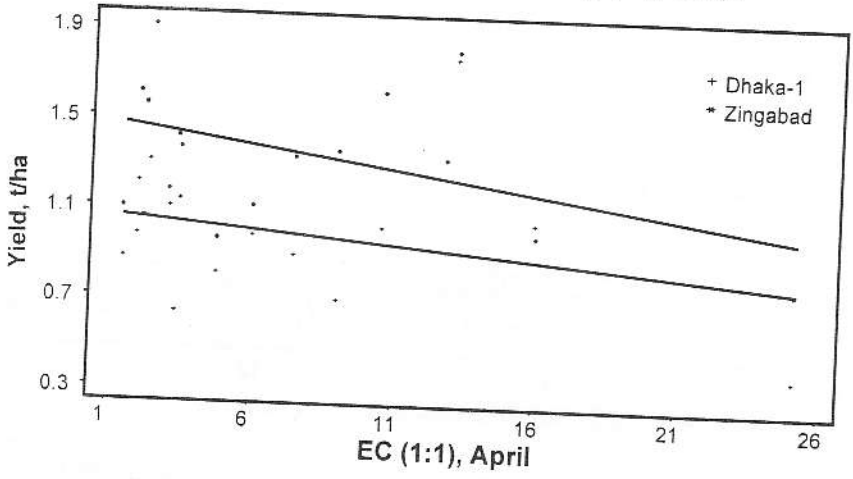


Fig. 15.6. Response of Groundnut to April Soil Salinity, 1996/97 Season, CBD-II, CBT, CM

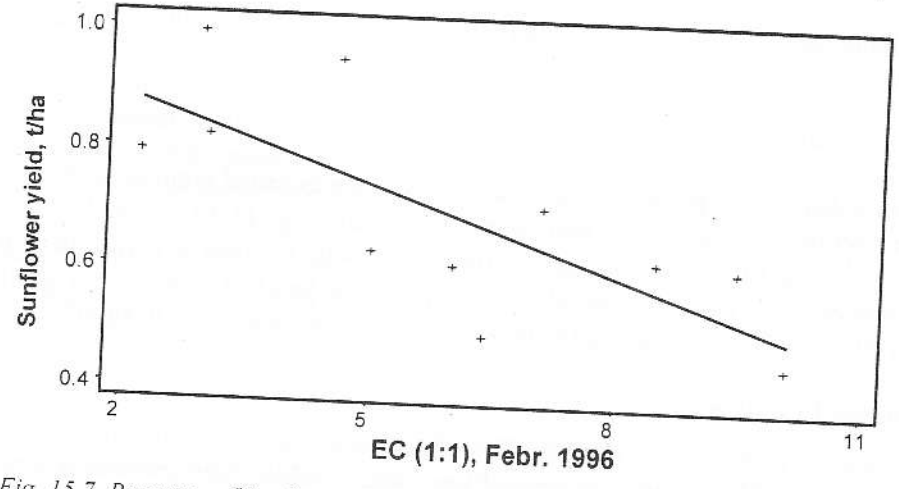


Fig. 15.7. Response of Sunflower to April Soil Salinity, 1995/96 Season, CBD-II, CBT, CM

For Khesari, a clear relationship with salinity emerges from detailed plot-wise measurements conducted in 1982 in the LRP farm's 130 plots. Salinity figures were for 1:2.5 soil paste extract, 'post-monsoon' sampling (date not given, probably late December or early January). If number of very low yielding plots, in spite of low salinity, are excluded, assuming that their low yield was caused by other factors, the relationship between Khesari grain + straw yield and $EC_{1:2.5}$ at 0-15 cm, measured after the monsoon was as shown in Fig. 15.8.

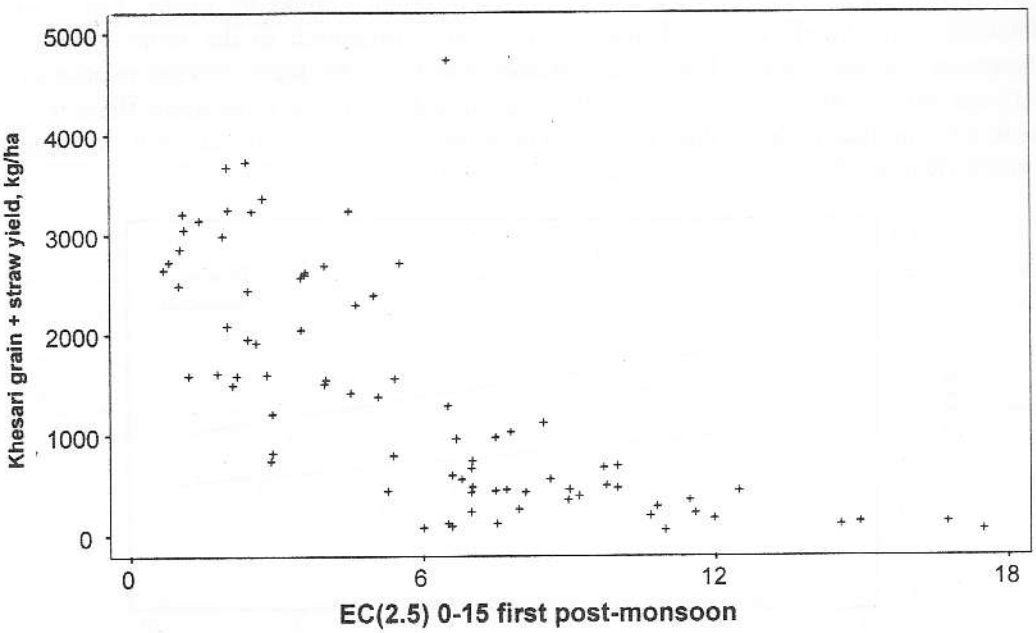


Fig. 15.8. Scatter Plot of Khesari Yield Versus Post-monsoon $EC_{2.5}$ Measured at 0-15 cm

The relationship is curvilinear and the regression of log(yield) against $EC_{2.5}$ results in the following equation:

$$\log (\text{yield}) = 3.561 - 0.106\ EC_{1:2.5}$$

Assuming that grain represents 25% of total weight, the expected grain yield at different post-monsoon $EC_{1:2.5}$ levels are as shown in Table 15.20. Fig. 13.4 (section 13.4) shows that post-monsoon EC (1:2.5) decreased from about 4 to 1.5 over a period of 5 years after empolderment. This corresponds with a potential yield of 350-650 kg grain/ha. Khesari yield may therefore be used as an indicator for the change in soil salinity.

Management Practices

Planting date. CDSP has not carried out work on planting dates but relied on BARI recommendations, LRP results and general knowledge. Table 15.20 presents a summary of preferred planting dates, based on these sources.

TABLE 15.20

Median Planting Date and Growth Duration of Different Rabi Crops, CDSP Demonstrations and Tests, 1995/96-1997/98[1]

	1995/96		1996/97		1997/98	
Variety	Planting date	growth duration	Planting date	grown duration	Planting date	grown duration
Sunflower	24 Dec	112				
Groundnuts						
Zingabadam	2 Jan	129	5 Jan	135	5 Jan	134
Dhaka-1	2 Jan	130	5 Jan	124	5 Jan	131
Chilli						
Hathazari			5 Jan	122	31 Dec	124
Local	22 Dec	160 (?)	5 Jan	104	31 Dec	124
Sweet potato	20 Dec	141 (?)	8 Jan	115		
Khesari						
BARI-1					13 Nov	117
Local	5 Dec	110			13 Nov	117
Linseed					9 Nov	126
Soybean					13 Dec	114
Garlic					6 Jan	97
Onion						
Tahirpari					15 Nov	138
Local					15 Nov	141
Tomato					5 Jan	101

Note: [1]In some years the differences in growth duration between varieties were artificial because the field staff harvested the varieties at practically the same time.

TABLE 15.21

Theoretical Khesari Grain Yield (kg/ha) at Different 'Post-monsoon' Salinity Levels

Method	EC									
EC (1:1 paste)	1	2	3	4	5	6	7	8	9	10
EC (1:2.5 extract)	.6	1.1	1.7	2.3	2.9	3.4	4	4.6	5.1	5.7
expected grain yield	790	690	600	520	450	390	340	300	260	230

Rabi crops and cropping pattern. Rabi crop planting starts immediately after the T-Aman harvest, with khesari and linseed sometimes broadcast in the stubble. Other crops, such as chilli, sweet potato and groundnuts are planted successively in well tilled land. Finally cowpeas and green grams are planted in lightly tilled soil, which may continue up to early February. Some land remains fallow after T-Aman for planting Aus paddy, especially land which is prone to early water logging with the onset of the rains. Late planted groundnuts and chilli may be damaged by early excessive rains which sometimes occur in April (see the rainfall chart of Fig 13.2 in section 13.1).

Tillage and planting method. There are major differences in the way the different rabi crops are grown by farmers. Khesari and linseed are usually broadcast in the T-Aman stubble without any tillage. The same method was tried for soybean (which is often grown that way in Indonesia) with mixed success. LRP, on the basis of its test results, opined that thorough tillage was required, similar to groundnuts. Green gram is

grown by farmers with light tillage only. The other crops are grown in well tilled soil. Especially groundnuts require a fine seedbed. Mulching with rice straw was found by LRP to be beneficial for wheat by reducing evaporation and therefore salinisation of the topsoil. An improved plough had a similar effect on several crops.

Adoption

In the adoption study, among demonstration and extended farmers a positive response and active adoption was reported for the new chilli variety Hathazari (almost 50% of the respondents). The adoption of the sweet potato variety Daulatpuri increased from 30% before CDSP to 70% in 1998. The reaction to the groundnut variety Zingabadam was mixed, in spite of its high yield, good market and adoption by 70 % of the respondents. The complaint was about its long field duration which can cause problems in case of early heavy rains.

Conclusions

The tolerance of Rabi crops to salinity is approximately as follows:

chilli > sweet potato > khesari > linseed > groundnut > millet > soybean > wheat > mustard

An $EC_{1:1}$ of more than 5, measured in December-February would have a yield depressing effect on all crops, perhaps with the exception of chilli, sweet potato and khesari which may tolerate somewhat higher levels. $EC_{1:1}$ of more than 10 in the same period would be prohibitive for all Rabi crops.

It turns out that farmers themselves are good judges of which rabi crops are suitable where and when. Of all the crops tested by LRP and CDSP, the most successful ones were those which farmers planted by their own choice, viz. chilli, groundnut and sweet potato. Soybeans, sunflower, wheat and onions, although suitable according to the test results, are hardly grown by farmers. The problems with sunflower and soybeans are related to marketing rather than technical. The reasons for the practical absence of wheat and onions are not clear and merit further explorations. The results with Khesari were modest, but this crop is grown with minimum effort. Salinity must reach low levels for mustard to become an option

For the late planted rabi crops (chilli, groundnuts), it is important to avoid places which are prone to early water logging. Also, the field duration of the varieties should not be too long.

Mulching would be helpful for reducing vertical water movement and therefore salinity stress in rabi crops. Mulching materials, however, are not readily available, except rice straw which is used for many other purposes, including cattle feed.

Table 19.1 (chapter 19) shows the rabi crop yields which may be attained at different stages of polder development.

As discussed in section 15.3, more attention is needed for finding a niche for a green manure crop without interfering with rabi cropping.

15.5 PESTS AND DISEASES

Except for IPM, which is discussed below, no special control methods for pests and diseases were introduced through CDSP. In the following paragraphs, an overview is

presented of the major pests and diseases attacking the major crops in the polders and the standard control methods recommended by DAE.

Kharif-I and II

*Stem borer (**Chilotraea polychrysus**).* The larvae feed in the leaf sheath for a few days, enter into the stem and out of the growing part of the plants from the base during their feeding which causes the growing shoot to die. This damage is known as dead heart in the vegetative stage of the plant and as "white head" in the ripening stage. *Control measures:* 1. Perching for birds. 2. Cultivation of HYV's 3. Use sweeping net. 4. Hand picking. 5. Finally spray as per the recommendations.

*Rice hispa (**Hispa armigera**).* It attacks all rice crops. Both the adult and grub injure the plants. The damaged portions become white and then brown. The adults lay eggs usually on the lower surface of the leaf, partly inserted into the epidermis. *Control measures*: (1) Collection of hispa beetles by repeated sweeping. (2) Clipping method can remove 75-92%. (3) Cultivation of tolerant varieties, BR-14.

*Leaf roller (**Nephalocrosis medinalis**).* It is common in the Aus season, but also in T-*Aman* season. Adults lay eggs singly on the leaf surface. After hatching the larvae feed on the leaf tip and then roll the leaf. They feed on the green tissues living within the leaf roll. *Control measures:* (1) Perching for predatory birds can greatly reduce the population. (2) Insecticides should be applied only when 25% leaves are damage at maximum tillering stage.

*Case worm (**Nimpula depunelalis**).* It is mainly problem in T-*Aman* crop having stagnant water. Sometimes problem in net seed bed. *Control measures*: (1) Draining out of stagnant water from the infested fields. (2) Perching for the predatory bird. (3) Use of appropriate insecticides at ETL of 25% severely damaged leaves.

Rabi Season

Pod borer. Was seen in green chilli and the necessary measure was taken by perching, while others used insecticide with water.

*Cut worms (**Spodoptera litura**).* Only this year we saw some heavy caterpillar damage in chilli seedlings. Direct spraying and baiting was tried.

Tikka disease. Few black spots were observed in groundnut that is called tikka disease.

15.6 INTEGRATED PEST MANAGEMENT (IPM)

Integrated Pest Management (IPM) is a new technology in the Char areas which we tried to introduce in the CDSP working area. The objective of IPM is to lower pest populations to levels below that causing economic damage. Economic threshold level is the pest population level at which economic damage begins to occur. The economic threshold is one of the principal considerations of the IPM concept. Rice is one of the most important food crops in the country. Various stages of rice crops are available in the field almost throughout the monsoon season which may be attacked by insects. Stem borers are the most important rice pests in the chars. The larvae feed in the leaf sheath for a few days, enter into the stem and out of the growing part of the plants from the base

during their feeding which causes the growing shoot die. This damage is dead heart in the vegetative stage of the plant and "white head" in the flowering stage.

Several IPM methods were demonstrated by CDSP/DAE:

1. Cultivation of HYV and good crop husbandry;
2. Perching for birds;
3. Use sweeping net;
4. Light traps;
5. Hand picking.

The 1998 adoption study revealed that sweeping nets and light traps were hardly adopted by farmers. Netting was found unpractical because of the large areas involved, while the intensity of kerosene lamps as a light trap was insufficient. Perching, however, was widely adopted by the respondents, viz. by 77%.

During the T-*Aman* season in 1998 the effectiveness of perching was explored through field observations on white head symptoms in CBT and CM. In each char, 5 blocks of approximately 5 acres each where perching was practised were chosen. In each block, one 10 × 10 m observation plot was marked out for each variety present in the block. There were 1-4 perching sticks per block. Control plots were marked out in neighbouring fields with the same varieties, but without perching. The distance between perching and non-perching plots was at least 300-500 m. The varieties present were Rajashail, Kajalshail, Greenshail, BR-10, BR-22 and BR-32. The observation plots were marked by ropes and bamboo sticks. Between full flowering and maturity, the total number of white heads was recorded in each plot by walking along both diagonals, each time counting the nearest half of the plot. The results are shown in Table 15.22.

TABLE 15.22
Recommended Planting Dates for Different Rabi Crops

Crop	Recommended planting dates
Khesari	***before 15 Nov***
Linseed	*before 15 Nov*
Wheat	***1-20 Nov***
Groundnut	***15 Nov.-15 Jan (?)***
Soybean	*November*
Chilli	1 Nov.-10 Dec
Sweet potato	***mid January***
Sunflower	November
Garlic	15 Nov-15 Dec
Onion	Oct (seedbed); 15 Nov-15 Dec (transpl.)
Tomato	Sep-Nov (seedbed); Oct-Dec (transpl.)
Cowpea	before 15 Jan
Mung bean	before 31 Jan

There was a highly significant lower number of white heads in the plots with perching sticks, with an estimated reduction of 50%, compared to the non-perching plots. The differences in white heads between varieties were not significant.

TABLE 15.23
Average Number of White Heads with and without Perching

	Yes	No	Average
BR-10	4.5	7.5	6.0
BR-22	4.0	9.0	6.5
BR-30	4.0	11.5	7.8
Kajalshail	5.5	10.3	7.9
Rajashail	5.0	7.8	6.4
Greenshail	6.3	11.1	8.7
Average	4.9	9.5	7.2

Chapter 16

HOMESTEAD CROP PRODUCTION

16.1 INTRODUCTION

The CDSP Homestead production programme ran parallel to the field crops production programme and worked with the same households. In the early years, the programme promoted both homestead vegetable production and tree planting, as a way to quickly establish a stable, productive homestead ecology. In the last two years the programme was limited to the promotion of simple vegetable production techniques and a range of summer and winter vegetables for home consumption and sales. Intensification and diversification of vegetable production was the main aim, in order to provide the household with a year-around balanced nutrition and increase and diversify sources of cash income.

The CDSP Homestead programme was preceded by a similar programme by LRP (1987-1991), conducted in CBDI.

16.2 THE LRP HOMESTEAD PROGRAMME

The LRP programme produced some interesting lessons, which are briefly summarised here for future guidance.

The programme was only concerned with vegetable production, not with tree growing. It consisted of the following elements:

- Year-around vegetable production;
- Relay cropping to maximise the number of crops grown;
- Fencing, bed system, composting, plant care.

For year-around production, the following cropping pattern was developed:

Sept.-Nov.	Dec.-Feb.	Mar-May	Jun-Aug.
amaranth	broccoli	leek	winged bean
cabbage	carrot	pumpkin	amaranth
tomato	kangkong	kangkong	okra
carrot	okra	amaranth	cucumber/corn
radish	Chinese cabbage	long bean	amaranth

A survey was conducted in 1991 to compare the vegetable production by 30 households within and 29 outside the polder, with the following results:

- In the polder more households kept a vegetable garden (2/3 vs. < ½), more women did the gardening, the households ate more vegetables of a wider variety and there was more year-around cultivation;
- No difference was found in the quality of gardening, so the improvement of production techniques was not successful; extension messages on mulching and 'manure tea' (manure soaked in water) for example were not adopted;
- Less suitable species for homestead production were leek, cauliflower and broccoli.

It was also concluded that the extension workers had limited technical skills, e.g. they themselves were not able to raise seedlings. It was proposed that the extension workers should maintain a garden of their own, for self-training and demonstration.

16.3 THE CDSP HOMESTEAD PROGRAMME

The original objectives of the homestead programme were:

- Year round vegetable cultivation, primarily by women;
- Overcome household nutrition deficiencies.

The approach consisted of:

- Increase yield per unit area;
- Produce and preserve seed for next year;
- Introduce improved varieties and production practices.

Initially (1995/96) the homestead program was carried out in 15 demonstration farms in three chars. Later, the number was increased to 20, by adding 5 more in CBDII. Tree planting and kitchen gardening activities were done. Women make a substantial contribution to homestead development activities, so the program was designed for reaching the women. In the first year male farmer were involved but at the end of the year women farmers became interested and started activities.

Homestead Gardening

Demonstration plots measuring between 15m^2 and 50m^2 were set up in all the demonstration farm households. The crops promoted initially were green amaranthus, broadbean, cucumber, zhinga, korala, okra, Indian spinach (summer vegetables) and egg plant, broccoli, country bean, radish, cabbage, chinese cabbage, cauliflower, spinach, carrot, tomato and red amaranthus (winter vegetables). Red amaranth was by far the most popular winter vegetable species.

Chemical fertilisers and pesticides were not used, except for a fertiliser test in 1998. Compost and liquid fertiliser was prepared by the women and used in these demonstration plots. Most of the plots had to be protected from poultry by surrounding the same with nets. After two crops seasons the programme was prepared by DAE and reviewed by DAE and CDSP together. Since farmers cannot produce the seed of carrot, cauliflower, cabbage and broccoli and they had difficulty in obtaining seed, demonstrations with these species were discontinued as from 1998.

Elements from 'Bio-Intensive Gardening' (BIG) were adopted for growing vegetables in the homestead area. BIG is a system for cultivating year round vegetables using organic materials thereby reducing dependence on agro-chemicals. The components of BIG promoted were:

- Composting;
- Raised bed and mulching;
- Preparation and use of liquid fertilisers.

Compost pits, measuring approximately 1.25m^3, were prepared in all the demonstration farm households. Kitchen waste, straw, khesari husk, cow dung, leaf, vines etc. were used for composting. A second pit was also prepared in each homestead for facilitating turning over of the materials. Compost, thus prepared, was used in both winter and summer vegetables. In winter vegetables, the women applied about 1 kg/m^2 and in summer vegetables about 0.5 kg/m^2. Only for red amaranth the amounts applied were considerably lower.

Raised beds are effective in reducing the effect of salinity, by reducing the rate of rise of salinity through capillary action. Raised beds were prepared in all the demonstration farm households prior to raising winter vegetables. Length of the raised bed depended on the size of the plot while width of the beds was approximately 1 m for facilitating intercultural operations. A 20 centimetre furrow was maintained between two raised beds and was used for walking while undertaking intercultural operations. These furrows also facilitated drainage of excess water accumulating after rainfall.

Mulching is the process of covering the soil surface by straw, leaf, water hyacinth etc. for preserving moisture and increasing its water holding capacity. This reduces evaporation which in turn retards capillary rise of salinity. Fifteen out of the twenty demonstration farmers practised mulching for growing winter vegetables.

A simple observation was conducted in 1998/99 with red amaranth, spinach and radish (winter) and kangkong and stem amaranth (summer), with and without urea. The amount of urea applied varied widely, from 20 to 250 kg/ha. Average yields are shown in Table 16.1.

TABLE 16.1

Yields of Some Vegetables with and without Urea; 1998/99 Season

	CM		CBT	
	No Fertiliser	Urea	No Fertiliser	Urea
Summer				
Kangkong	26	42	30	41
stem amaranth (local)	9	10	9	13
stem amaranth (MV)	19	24	13	16
Winter				
Red amaranth	2	10	5	20
spinach	9	16	13	14
radish	23	20	16	13

The data are useful to obtain an impression of the yield levels, but the urea response is not very meaningful, in view of the wide range of rates applied.

Liquid fertiliser was prepared by all the demonstration farmers using leaves of ipil-ipil, rain tree, koroi etc. from the homestead area. These leaves were immersed in water and kept in a water tight earthen pot for 15 to 20 days. This was then applied to the vegetable plot. Liquid fertiliser thus prepared and used in the kitchen garden was analysed in BARI laboratory. Results indicate that it was not helpful for the crops. The practice was therefore discontinued.

The Female Field Assistants visited the demonstration farm households at least once every week and recorded the quantity of vegetables consumed, distributed among relations and neighbours, sold in the marked etc. Overall, about 75% of the vegetables, grown in the homestead area were consumed by the family members, 15-20% was distributed among other people, while only 5-10% was sold. The only exception was tomatoes, of which about 15% was sold. Vegetable growing did therefore not make a major contribution to household income, its importance being primarily in improving household nutrition.

Tree Planting

A tree plantation program was undertaken between 1994 and 1996 with the demonstration farmers. CDSP provided saplings to the farmers according to their interest and training was provided for implementing the program. Two nurseries at CBDII, two nurseries at CBT and three nurseries at CM were established. For some private nurseries we provided technical support and training. Number of planted seedlings and their survival rates are shown in Table 16.2.

TABLE 16.2
Number of Tree Saplings Planted and Survived

Species[1]	CBDII		CM		CBT		Total	
	planted	*survival (%)*	planted	*survival (%)*	planted	*survival (%)*	planted	*survival (%)*
Amra (F)	10	*50*	5	*60*	5	*60*	20	*55*
Dalim (F)	10	*100*	5	*100*	5	*100*	20	*100*
Neem (T)	42	*50*	20	***45***	25	*88*	87	*60*
Kul (F)	10	***40***	5	*80*	5	*60*	20	*55*
Blackberry	10	*50*	5	*60*	5	*80*	20	*60*
Bel (F)	10	*70*	5	*60*	5	***40***	20	*60*
Mehgoni (T)	49	*80*	22	*77*	25	*84*	96	*80*
Arjun (T)	10	*90*	5	*80*	5	*60*	20	*80*
Jack fruit	10	*50*	5	***20***	5	*60*	20	***45***
Amloki (F)	10	*70*	5	*100*	5	*60*	20	*75*
Kodbel F/T)	10	***40***	5	***40***	5	*60*	20	***45***
Jolpai (F/T)	10	***40***	5	***40***	5	***20***	20	***35***
Jambura (F)	10	*60*	5	***40***	5	*80*	20	*60*
Atafal (F)	10	*50*	5	***40***	5	***20***	20	***40***
Lemon	12	*100*	5	*100*	5	*80*	22	*95*
Guava	24	*63*	11	*91*	5	*100*	40	*75*
Mango	10	*80*	5	*60*			15	*73*
Litchi	10	*60*	5	*60*	5	***20***	20	*50*
Coconut	50	*98*	25	*100*	25	*100*	100	*99*
Sisu (T)	20	*55*	10	*90*	10	***10***	40	*53*
Total	**337**		**163**		**160**		**660**	

Note: [1]T = timber; F = fruit.

The survival rates show major differences among species, which probably reflects their sensitivity to salinity. The most resistant species are printed bold in the table, while the most sensitive ones are printed in italics. The former (Dalim (*Punica granatum*), Mehgoni, Lemon, Guava and Coconut) can be promoted at an early stage of a polder development programme.

Insect Pests

The following insect pests were observed:

- *Pumpkin beetles (**Aulacaphora foveicollis**)*. The adult beetles cause damage to young seedlings by feeding on leaves. The larvae live in the soil and cause damage to mature plants by feeding on the roots. *Control measure* (DAE recommendation): Sevin spray, 3 times at 7 days interval.
- *Tobacco cutworm (**Spodoptera litura**)*. Feeds on Radish, Cabbage, Cauliflower, knol-khol. The leaves are eaten. Many larvae may be found feeding inside the infested cabbage heads. *Control measures* (DAE recommendation): Use diazinon 60 EC before the head formation.

Assessment of the Homestead Programme

The homestead programme has suffered from several problems such as frequent staff turnover and lack of clarity about the division of tasks between the agricultural and homestead programme. Also, the concepts underlying the homestead programme were insufficiently clear and explicit. As a result, it is very difficult to fully assess the impact and the relevance of what has been done. In a future programme, the homestead component should get a more prominent place and be fully integrated with the agricultural production activities, both organisationally and technically.

Chapter 17

SEED AND INPUT SUPPLY

The input supply situation in the polders is a real problem. CDSP, through its demonstration programme, has acted as a supplier of seed, fertiliser and some equipment (line weeder, rice paddle thresher), but for real adoption an assured input supply system at the polder level is an essential requirement. DAE/CDSP have assisted some shopkeepers to obtain a dealership for fertiliser from BADC.

During the 1995/96 season all 20 demonstration farmers were provided with a weeder and a pedal thresher, while all 100 extended farmers were provided with a weeder only. The equipment was demonstrated in the field. In 1995 a prototype was obtained from Comilla. Later the design of the weeder was given to a workshop at Sonapur which has started making the thresher and selling it to the farmers. In 1996 the design of the weeder and thresher were given to a local workshop near CBDII (Atkopalia Bazer) which has started making and selling them to farmers. Efforts are underway to activate the local private sector so that farmers can procure weeders and threshers from the local market.

A survey was conducted 1996 by the local BS of DAE in three chars and it was found that there were 229 weeders and 109 threshers with farmers, which means that 109 (229 – 120) farmers had purchased weeders and 89 (109 – 20) had purchased threshers from the local market (Atkapalia, Shantirhat, Thanerhat and Sonapur). Some farmers are renting out their thresher to others.

In a future programme major emphasis should be given to the development of a reliable input supply system by private entrepreneurs. This should cover all essential inputs: fertiliser, seed of agricultural and horticultural crops and small equipment.

Chapter 18

COLLABORATION WITH LINE AGENCIES AND NGOs

CDSP has stimulated line agencies and NGOs to carry out their mandated tasks in the framework of the project and with support from the project. The collaboration in the area of productive development is reviewed in the following paragraphs.

Department of Agricultural Extension

Collaboration with the Department of Agricultural Extension (DAE) has been very good. DAE was involved with the project from the start. Agricultural land survey, farmers selection and programme preparation was done by DAE. Initial training, field days, farmer motivation training and tours were conducted by DAE and CDSP staff together. As from late 1997 the collaboration involved:

- Training, preparation of leaflets and field days;
- Weekly discussions with farmers at the site office;
- Group meetings, farmers motivation training and tour;
- Monthly problem identification in the field by DAE field staff.

In addition, DAE identified and licensed 2 dealers in agricultural inputs in CM, 2 in CBT and 1 in CBD-II.

Bangladesh Agriculture Research Institute

The Bangladesh Agriculture Research Institute (BARI) was involved with CDSP from 1995. They provided seed and planting material of new varieties of different crops. They also provided training in the class room and field. BARI has the national mandate for Farming Systems Research (FSR) and, after discussions with CDSP and field visits, they opened a farming system research site near Atkapalia in 1998 with the intention to work in the saline areas.

Bangladesh Rice Research Institute

The Bangladesh Rice Research Institute (BRRI) was involved with CDSP from late 1995. They provided seed of new rice varieties for the two rice growing seasons.

They also provided training in the field and helped in farmer motivation training and field tours.

Bangladesh Agriculture Development Corporation

The Bangladesh Agriculture Development Corporation (BADC) was involved only in supplying vegetable seeds. In addition to that they licensed 1 dealer in CM and 1 in CBT for the sale of seed.

Soil Resource Development Institute

The Soil Resource Development Institute (SRDI) was involved from the start in an informal manner. They collected soil samples from the field which were analysed for salinity and chemical properties. There was no official memorandum like the one with DAE. This resulted in problems when the contact officer was transferred, leading to some gaps in the data.

NGO Staff

Two NGOs, viz. Sagorika and N-RAS have worked with the CDSP Productive Development Section since late 1997. Three field staff from Sagorika were involved in CM. We provided training but they did not perform their agreed tasks properly, in spite of a lot of discussion between the Sagorika co-ordinator and field staff and CDSP's CDS and CTL. On the other hand N-RAS did well.

Chapter 19

IMPLICATIONS FOR CROP PRODUCTION IN POLDER DEVELOPMENT

19.1 LAND CLASSES, SALINITY AND CROPPING PATTERNS

The major changes in relation to crop production potential occurring in the char areas due to empolderment are:

- Protection from flooding by saline water and a gradual reduction in soil salinity levels;
- Improved drainage.

These changes widen the options for farmers in respect of crop production. In particular, it enables them to:

1. Grow MV of T-*Aman* paddy in areas where water control conditions are good, in particular in land class II (medium land, see section 14.1);
2. Grow *aus* paddy when pre-monsoon salinity has decreased below 6 mS/cm (1:1 soil paste);
3. Grow an increasing variety of rabi crops as salinity declines.

Table 19.1 shows expected crop yields and ranges at different stages of polder development.

Conditions in the polders, however, are not uniform. There are differences in degree of water control, reflected in the land classification introduced in section 14.1. The three broad land classes are different in terms of landuse potential. The findings presented in the previous sections are summarised in Fig. 19.1 which shows the cropping patterns most suitable for each land type. Which of the rabi crops included in each pattern is most suitable at a given stage of polder development may be decided on the basis of the yield expectation of Table 19.1.

In addition to the overall evolution of soil salinity, there will be regional differences. We have only been able to analyse the overall trend, but there is considerable micro-variability in soil salinity over small areas and there is also likely to be salinity patterns across the polders: in some areas salinity may go down more slowly than in others.

TABLE 19.1

Expected Yield Levels (t/ha) of Various Crops at Different Times after Empolderment

Min/max salinity	Years after empolderment: 0 (6/15)		1 (5.5/14)		2 (4/13)		3 (2.5/11.5)		4 (1.75/9)		5 (1.75/5)		>5 (1.75/4)	
	mean	range	**mean**	range	**mean**	range	**mean**	range	**mean**	range	**mean**	range	**mean**	range
Kharif-I														
Aus paddy LV –	**1.1**	0-1.5	**1.15**	0-1.5	**1.3**	0.8-1.8	**1.4**	0.8-2.0	**1.5**	0.9-2.2	**1.6**	1.0-2.5	**1.6**	1.0-2.5
LV +	**1.3**	0-1.7	**1.4**	0-1.8	**1.5**	1.0-2.0	**1.7**	1.2-2.2	**1.8**	1.4-2.4	**1.9**	1.5-2.5	**1.9**	1.5-2.5
MV +	**1.8**	0-2.5	**2.0**	0-2.6	**2.4**	1.0-3.0	**2.6**	1.2-3.2	**2.8**	1.5-3.5	**3.0**	1.5-4.0	**3.0**	1.5-4.0
Kharif-II														
T-Aman paddy LV –	**1.2**	0.6-1.5	**1.3**	0.6-1.8	**1.4**	0.7-2.0	**1.5**	0.8-2.2	**1.5**	0.8-2.2	**1.5**	0.8-2.2	**1.5**	0.8-2.2
LV +	**1.5**	1.0-2.0	**1.6**	1.0-2.0	**1.7**	1.1-2.2	**1.8**	1.2-2.5	**1.8**	1.2-2.5	**1.8**	1.2-2.5	**1.8**	1.2-2.5
MV +	**2.2**	1.1-2.7	**2.4**	1.1-3.0	**2.6**	1.3-3.5	**2.8**	1.5-3.5	**3.0**	1.5-4.0	**3.0**	1.5-4.0	**3.0**	1.5-4.0
Rabi[1]														
Khesari	**0.6**	0-0.8	**0.7**	0-0.9	**0.8**	0.2-1.1	**0.9**	0.2-1.3	**1.0**	0.3-1.4	**1.0**	0.3-1.4	**1.1**	0.3-1.5
Groundnuts	**0.7**	0-1.1	**0.8**	0-1.2	**0.9**	0.2-1.2	**1.0**	0.3-1.4	**1.1**	0.3-1.5	**1.2**	0.3-1.6	**1.2**	0.3-1.6
Chilli	**0.6**	0-1.2	**0.6**	0-1.2	**0.7**	0.2-1.2	**0.9**	0.2-1.5	**1.1**	0.3-1.9	**1.1**	0.3-1.9	**1.2**	0.3-2.0
Sweet potato	**8**	0-12	**10**	0-15	**12**	5-16	**13**	5-18	**13**	5-18	**14**	5-20	**14**	5-20
Soybean	**0.6**	0-0.8	**0.7**	0-0.9	**0.8**	0-1.1	**0.9**	0.2-1.2	**1.0**	0.2-1.3	**1.0**	0.3-1.3	**1.0**	0.3-1.3
Garlic	**1.6**	0-2.0	**1.7**	0-2.2	**1.8**	0.5-2.0	**1.8**	0.5-2.2	**1.9**	0.5-2.5	**2.0**	0.5-3.0	**2.0**	0.5-3.0
Sunflower	**0.4**	0-0.8	**0.5**	0-0.9	**0.6**	0.2-1.0	**0.7**	0.2-1.1	**0.8**	0.2-1.2	**0.8**	0.3-1.2	**0.9**	0.3-1.3

Note: [1]Improved varieties are assumed.

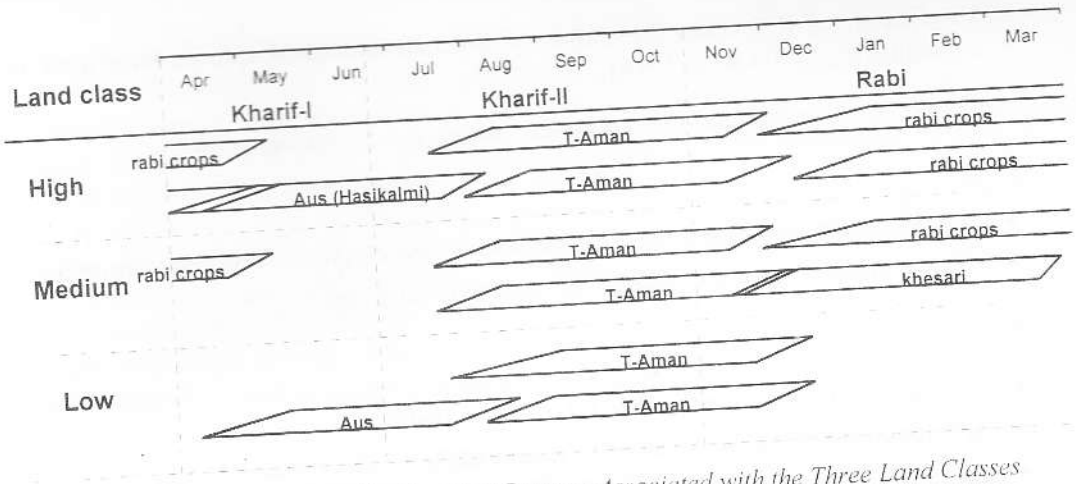


Fig. 19.1. Most Suitable Cropping Patterns Associated with the Three Land Classes

Farmers themselves are probably the best judges for micro-variability. To establish areal salinity patterns, however, polder-wide salinity surveys would be needed. These have so far not been carried out but should be part of a future programme.

19.2 TECHNOLOGIES AND INTERVENTIONS FOR POLDER DEVELOPMENT

A development programme must focus on the 'best-bet' technologies and interventions associated with each land class. Some potential technologies and interventions will be common to all land classes, while others are class specific. Furthermore, the conditions in the polders in terms of salinity, landuse and technology adoption should be monitored.

Interventions with relevance across land classes are:

1. Stimulating the development of an input supply system within the polders for seed, fertiliser, insecticides and equipment (weeders, threshers, improved ploughs), through licensing of local shopkeepers as dealers, under supervision of DAE and BADC;
2. Promotion of IPM in rice, especially perching for stemborer control and the organisation of farmer field schools;
3. Testing and demonstrating new HYV rice varieties for all land classes, according to their suitability for each land class. So far the new varieties have not been targeted to specific land classes but this should be done in the future;
4. Identifying niches for green manuring crops in the different cropping patterns, requiring a minimum of additional labour and other costs (e.g. *Sesbania*, pigeon pea, *Stylosanthes*);
5. Improving the group approach to extension by adopting more participatory methods and increasing the number of groups, including Cluster Villages;
6. Monitoring the evolution of landuse in the three seasons through simple transect surveys;
7. Establishment of soil salinity maps of the polders and monitoring the evolution of soil salinity through stratified sampling;

8. Verification of K, Zn and S response of T-Aman through simple on-farm tests, to be conducted by BARI or BRRI.

Land class-specific technologies and interventions to be considered are:

High Land

- Early maturing HYV for T-Aman paddy, to escape early post-monsoon drought;
- A green manure crop interplanted into an early rabi crop.

Medium Land

- Early and medium maturity HYV for T-Aman paddy;
- Early maturing rabi crop varieties to escape early monsoon water logging;
- A green manure crop interplanted into an early rabi crop.

Low Land

- Medium to late maturing HYV for T-Aman paddy which can tolerate extended periods of water depths of 40 cm or more after tillering;
- A green manure crop as an 'improved fallow', e.g. planted into the T-Aman stubble.

19.3 HOMESTEAD PRODUCTION

In a future programme in new polder areas, homestead production should receive more attention than during CDSP-I. Activities should be undertaken with the following objectives:

- Facilitate rapid establishment of appropriate tree species in the compounds;
- Promote simple homestead vegetable production methods;
- Promote vegetable species which can be easily managed by women, including production and conservation of seed.

The programme should include a simple but effective monitoring component to assess the success or otherwise of the different technologies, with emphasis on independent adoption and dissemination of the demonstrated technology.

19.4 INSTITUTIONAL COLLABORATION

Projects are temporary constructs, to set a development process in motion. The process must be carried forward by the permanent national structures, i.e. the line agencies and the NGOs. It is therefore crucial that these agencies are associated with the development activities from the start. Appointing project field staff should be avoided as much as possible for reasons of sustainability and continuity. The CDSP Agriculture Development Section has had good experiences with this approach. In fact, one of the reasons for the limited success of the homestead production activities is probably that the line agency (DAE) was too little involved.

Without formal agreement, however, it is a problem to work with line agencies. Initially, CDSP had no formal agreement with DAE which caused some problems. Later

we contacted DAE Headquarters and discussed with the Director General, who issued an order to the Additional Director, Agriculture Extension, Chittagong Division and the Deputy Director, Agricultural Extension, Noakhali. After that the collaboration has been good till today. We did not take the same steps with SRDI, and due to the erratic collaboration we have a lot of data gaps.

It will be necessary in the future to establish formal agreements with line agencies. Char development programmes are meant to assist line agencies and other local organisations, not to replace them. They should therefore be enabled to perform their mandated tasks in the new chars, with support from the Char Development Programme. Field staff from involved agencies should be involved in the working area from the start. Recruitment of staff by the project should only be considered for tasks with a limited and temporary objective.

The involved line agency personnel should be assisted with transport facilities, technical assistance, daily allowances and contingency facilities from the project when they work in the project areas. For the field staff a lump sum allowance and transport facilities should be provided by the project.

Annex 1

CONVERSION OF SOIL SALINITY MEASUREMENTS

LRP AND CDSP MEASUREMENTS

In 1982 LRP reported soil salinity data measured on *1:2.5 soil paste extract*. Later on they changed to 1:5 extract. CDSP has reported data measured on *1:1 soil paste*. The relationship between the two measurement methods is needed to connect the LRP and CDSP data.

The following relationship were established by LRP between salinity figures obtained with different measurement methods (LRP Technical Report No 6, pp. 7 ff.):

1. EC (saturated soil paste) = 1 2/3 × EC (1:2.5 soil paste extract).
2. EC (saturated soil paste) < EC_e (saturated extract).
3. EC (1:1 soil paste extract) = 2 × EC (1:2.5 soil paste extract).
4. EC (1:2.5 soil paste) = 2 × EC (1:5 soil paste).

It follow from 3. that:

5. EC (1:1 paste) ≈ 2 × EC(1:2.5 paste)?

6. 1 2/3 × EC (1:2.5 soil paste extract) < EC_e < 2 × EC (1:2.5 soil paste extract).

It follow from 5. and 6. that:

- ***EC_e ≈ 2 × EC (1:2.5 soil paste), and***

- **EC_e ≈ EC (1:1 soil paste)**

Salinity classes, based on electrical conductivity of the saturation extract (EC_e) and EC (1:2.5 soil paste extract) were given by LRP as:

Class	description	EC_e (mmhos/cm)	EC (1:2.5 soil paste extract)
0	non-saline	0-4	0-2
1	slightly saline	4-8	2-4
2	moderately affected	8-16	4-8
3	strongly affected	> 16	> 8

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