Impact Evaluation of Command Area Development in Meghna Dhonagoda Irrigation Project

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Declaration

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ABBREVIATIONS

ADB	Asian Development Bank
AGM	Annual General Meeting
ARD	Associates in Rural Development
BADC	The Bangladesh Agricultural Development Corporation
BRDB	Bangladesh Rural Development Board
BWDB	Bangladesh Water Development Board
BUET	Bangladesh University of Engineering and Technology
CAD	Command Area Development
CADP	Command Area Development Program
CMG	Canal Maintenance Group
DAE	Department of Agricultural Extension
DOF	Department of Fisheries
DORP	Development Organization of the Rural Poor
DPE	Director of Project Evaluation
EMG	Embankment Maintenance Group
EPC	Engineering and Planning Consultants Ltd.
FAO	Word Food and Agricultural Organization
FAP	Flood Action Plan
FCD	Flood Control and Drainage
FCDI	Flood Control, Drainage Improvement and Irrigation
FPCO	Flood Plan Coordination Organization
FWUA	Federation of Water Users Association
GOB	Government of Bangladesh
GPWM	Guidelines for Participatory Water Management
Ha	Hectare
HYV	High Yielding Varieties
IAP	Irrigated Area Performance
IWM	Institute of Water Modeling
LCS	Landless Contacting Society
LGED	Local Government Engineering Department

LGI	Local Government Institution
LLP	Low Lift Pump
MDIP	Meghna Dhonagoda Irrigation Project
MoA	Ministry of Agriculture
MoWR	Ministry of Water Resources
NGO	Non Government Organization
NWPo	National Water Policy
O & M	Operation and Maintenance
PAP	Project Affected Person
PDB	Power Development Board
PIRDP	Pabna Irrigation and Rural Development Project
ToT	Training of Trainers
PWD	Publics Work Department
PWM	Participatory Water Management
PWMA	Participatory Water Management Approach
RWS	Relative Water Supply
SDE	Sub-Divisional Engineer
SO	Sectional Officer
TA	Technical Assistance
WLR	Water Level Ratio
WMA	Water Management Association
WMF	Water Management Federation
WMG	Water Management Group
WMO	Water Management Organization
WMS	Water Management System
WRS	Water Resources System
WUA	Water Users Association
WUC	Water Users Committee
WUG	Water Users Group
XEN	Executive Engineer

ABSTRACT

Improved water management is of utmost importance for flood control, drainage and irrigation schemes in Bangladesh, as nearly 80 million people live and farm on the floodplains. Water management abounds on these floodplains and people have taken measures to cope with water since time immemorial. The crucial importance of FCDI systems for the livelihood of many millions of people makes it necessary to understand water management practice in FCDI systems and to develop appropriate institutions and management strategies for them.

Many studies on water sector in Bangladesh concluded that the intended benefits from FCDI systems have not materialized. This is attributed in part to institutional weaknesses. One of the key approaches for tackling these institutional weaknesses is increasing people's participation in water management. At present the Government of Bangladesh is committed to the participatory development and management of FCDI systems. Earlier, many of the irrigation, drainage and flood control schemes in Bangladesh were jointly managed by the Government and the beneficiaries. Further, it is widely experienced, even in the older schemes, that the beneficiaries are not performing their role well in these jointly managed schemes, and that they fail to become active partners in the day to day management. At present, Bangladesh Water Development Board (BWDB) has been giving emphasis to ensure people's participation for their water systems management following Guidelines for Participatory Water Management (GPWM). Command Area Development Program (CADP) incorporating Participatory Approach of water management following GPWM has been applied in some BWDB projects like Meghna Dhonagoda Irrigation Project (MDIP), Teesta Irrigation Project (TIP) and Pabna Irrigation and Rural Development Project (PIRDP) to some extent. In the present study, field investigation was performed to evaluate the impact of Command Area Development Program (CADP) in Meghna Dhonagoda Irrigation Project (MDIP)implemented from 1996-97 to 2002-2003 taking into consideration the hydraulic, agricultural, socio-economic, environmental and institutional aspects.

For the hydraulic, agricultural, socio-economic, environmental and institutional aspects, the impacts of CADP on the performance of MDIP were assessed comparing the values of selected indicators for the pre and post CADP situations. The hydraulic indicators were used to compare the relative water supply (RWS) and water level for some selected canals with pre (1999) and post (2003) CADP situation. The agricultural indicators directly reflect irrigated agricultural systems. Performance in terms of year wise irrigated area, cropping intensity, yield and production has been used as agricultural indicators. The socio-economic indicators used in this study include fee collection performance and financial self-sufficiency and this relates to long –term impacts of agricultural strategies. Water quality, natural vegetation and fish have been considered as parameters for assessing the environmental impact.

In total 388 Water Management Groups (WMGs) were formed in MDIP during 1998 to 2003 under Command Area Development Program following the GPWM. Forty-one WMGs were selected to assess their performance during the irrigation season of 2003. Sets of indicators were also identified to evaluate the impact of CADP on the performance of the project. Questionnaires were prepared and used for systematic collection of data during the field study.

The results of the evaluation study revealed that RWS to the field and water level in irrigation canals in post CADP situation was higher than pre CADP situation and the actual water levels were very close to Full Supply Level (FSL). This means that overall reliability of the canal system has been improved after CADP in MDIP. RWS values with an average of 0.93 were achieved during post CADP for Boro rice. Moreover this was not satisfactory because RWS value at or close to 1.0 represents scarcity of water. Actual irrigated area has been increased by three times as compared to the benchmark year, 1996-97 and irrigated area coverage increased by about 60 %. Cropping intensity was increased from 200 % to 250 %. Yield for HYV Boro rice was increased from 4 ton/ha to 4.75 ton/ha. Production of HYV Boro rice was increased by about 3 times compared to benchmark year. After the CADP in MDIP, irrigation fee collection was started from 2001-02. And still now it quite insignificant and only from the fee collection, it is not possible to make the project O & M financially self-sustaining. There was no remarkable environmental change for water quality and natural vegetation after CADP in MDIP. But fish production has increased by two times as compared to the benchmark year.

From the institutional aspects, the result of the evaluation study revealed that though all selected WMGs were registered, their activities in all cases were not satisfactory. Still now all farmers are not members of WMGs, only 61 % of selected WMGs were involved in maintaining their field channels and 76 % of WMGs received technical support from BWDB, but all selected WMG members have received training from NGO and BWDB during 1998 to 2003, and there is lack of linkage between WMGs and BWDB project level authority and amount of fee collection is very poor.

Considering all these aspects, the CADP in MDIP produced significant positive results in terms of crop productivity; agricultural returns, supply and distribution of irrigation water. However, efforts should be made to further improve the interaction between the WMG and BWDB and collection of irrigation fee to make O & M of the project sustainable.

Chapter 1

Introduction

1.1 General

The economy of Bangladesh largely depends on agricultural development. Irrigation development is accepted and recognized as an important factor for increasing agricultural production and about 53 % of the irrigable area in Bangladesh has so far been brought under irrigation and the rest is cultivated under rainfed condition (Bari et al., 1999). With increasing population and demand for food, sustainable water management system is the prime need for agricultural sector in Bangladesh. Bangladesh Government has had put maximum emphasis on development of water resources sector to boost up agricultural production to meet ever increasing food demand and to attain self-sufficiency in food. With limited freshwater and land resources, and increasing competition for these resources, irrigated and water– managed agriculture must improve utilization of these resources. Water can no longer be considered a totally free resource, and plans must be developed for its efficient use through better management and rules that preserve everybody's access to it and interest in its development especially in case of Flood control, Drainage and Irrigation (FCDI) systems (Faruque and Choudhry, 1996). The management of FCDI system is, therefore, one of the prime objectives in a land like Bangladesh where agriculture consists of about 60 % of the land use and the majority of the population live near or on floodplains (Datta et. Al., 1999; Wester and Bron, 1998).

It is internationally accepted that improving the productivity of water management system (WMS) is of utmost importance for any country (Bandaragoda, 1999; Brouwer et al., 1992; Kloezen et al., 1997; Ritzema et al., 1996; Snellen, 1997; Vermillion and Sagardoy, 1999; Byrnes, 1992). From different studies of the water sector in Bangladesh it is concluded that improved water management is critical to achieving the intended benefits from the existing water resources system (WRS), and to ensure their sustainability.

The poor performance of FCDI systems indicates that there is scope of improvement of government management system (Sakthivadivel et al., 1999; Perry et al., 1997; Datta et al., 1999; Jordans, 1998). To date, the government mandated water management agency could not achieve targeted maintenance tasks and to ensure a more equitable distribution of benefits. This state of affairs makes it imperative that all those concerned with and involved in the water sector in Bangladesh fundamentally reconsider how FCDI systems should be managed through improved water management practices.

The performance of FCDI systems has often remained below expectations. More than 50 % of the completed projects are not performing satisfactorily due to inadequate planning, but mostly due to lack of proper operation and maintenance (Quassem, 2001; CIDA, 1991). Moreover, they have several major negative impacts, such as the loss of fisheries, navigation and soil fertility and the exacerbation of drainage problems. Lack of stakeholder's participation is considered as one of the most important factors for inefficient output. The National Water Policy has emphasized the establishment of stakeholder's participation for ensuring direct input from people at all levels and fruitful participation of stakeholders in water management through establishing water institutions On the backdrop of the scenario, participation of the stakeholders and for that purpose establishment of water institutions has attained importance in Bangladesh. And the main fact remains that there are many complaints filed by the farmers indicating that the management of the FCDI project is not properly done. Therefore, to improve the performance of Flood Control, Drainage and Irrigation (FCDI) project, beneficiaries should share the responsibilities of O & M and it is essential to have their direct participation right from the project planning/rehabilitation stage (World bank, 1987).

Studies and evaluations of some of the completed water development projects having flood control, drainage and irrigation components show that most of these projects could not derive expected result due to several reasons. The service expected from different project interventions have deteriorated and in some case these are totally inoperative. Thus the aim of the projects has not been fulfilled (MPO, 1991; FPCO, 1992). The major causes for such failures may be summarized as follows:

- non participation of the beneficiaries in the project planning, design, construction and particularly, operation and maintenance of the project;
- inadequacy of fund for regular operation and maintenance of different project features;
- inadequate planning which in some cases could not address properly the future change resulting in more harm and environmental degradation;
- lack of proper co-ordination between different government and non government organizations;
- lack of interest by BWDB and other agencies for maintenance and operation of the project;
- ineffectiveness of concerned government agencies to supply necessary inputs and agricultural extension service to the project and
- other socio-economic causes like inadequate credit facilities, lack of proper institution building, co-operatives, market, transportation, crop price, natural calamities and population boom .

Implementation of the Meghna Dhonagoda Irrigation Project (MDIP) was completed in 1988. The aims of the project were to increase the agricultural production, to create employment opportunity and to improve the living condition of the population. The facilities developed include: 60 km of flood embankment, 61.82 km of main canal, 52.30 km of secondary canal, 73.40 km of tertiary canals, 69 regulators, 7 irrigation conduits, 42 check structures, 17 Escapes, 3 Aqueducts and 387 turnouts (BWDB, 1994). The project has a potential command area of approximately 13600 ha. After completion of the project only a maximum of half the irrigable area received supply of water and the area was declining over the years mainly due to lack of on-farm facilities and poor water management at the farm level (BWDB, 1999).

Under the funding of Asian Development Bank (ADB) and GoB, Command Area Development Program (CADP) has been implemented from 1996-97 to 2002-03 in

Meghna Dhonagoda Irrigation Project (MDIP) through the executing agency of Bangladesh Water Development Board (BWDB).

The main objective of the Command Area Development Program in MDIP was to bring about sustainable increase in winter (Rabi) dry season agricultural production, principally boro rice, by realizing the full potential of the irrigated area of 13600 ha through participatory management of irrigation infrastructure by agencies and beneficiaries.

A brief description of the Meghna Dhonagoda Irrigation Project (MDIP) has been given in Chapter-3. In order to increase the irrigated area and agricultural production, under Command Area Development Program (CADP), re-excavation of 52 km of main and 131 km of secondary & tertiary canals; lining of 28.10 km of secondary and 23.95 km of tertiary canals; rehabilitation of 144 existing turnouts and construction of 538 new turnouts (BWDB, 2003) were carried out. Increasing people's participation in all stages of planning and management of water resources projects is widely believed to be one of the key requirements for their success (BUET, 1992; Byrnes, 1992; BUET, 1995; Rice, 1997; Bandaragoda, 1999). In reorganization of this, the Ministry of Water Resources, Bangladesh developed Guidelines for Participatory Water Management (MoWR, 2001). Participatory approach for water management following these guidelines has been applied in Meghna-Dhonagoda Irrigation Project and 388 Water Management Groups (WMG), 9 Water Management Associations (WMA) and one Water Management Federation (WMF) was formed.

1.2 Importance of the Study

CADP has been implemented in MDIP from 1996-97 to 2002-03 and other irrigation projects with a view to improve the performance of the project. CADP in MDIP mainly focused on the improvement of on-farm water management, participation of the beneficiaries to the system O & M and construction or rehabilitated some physical infrastructure. This study will provide an insight into the physical and institutional interventions carried out in MDIP and their impacts on the performance of the project. Total cost for implementation of Meghna-Dhonagoda Irrigation Project (MDIP) under CADP was significant compared to the initial implementation cost. Participatory approach has been applied in MDIP under CADP and the same approach has also been applied 2 others projects, viz Pabna Irrigation and Rural Development Project (PIRDP) and Teesta Irrigation Project (TIP). Therefore, it is important to know the suitability of the institutional intervention.

As such, there is a need to evaluate the impact of CADP in MDIP. It is with this view in mind that this study was taken up.

1.3 Objectives

The specific objectives are:

a) To assess the performance of Water Management Groups (WMG) organized under the CADP.

b) To assess the impacts of CADP on the performance of the project in terms of irrigation water supply, irrigated area, agricultural production, irrigation fee collection and environmental aspects.

Chapter 2

Literature Review

In the face of increasing cost of irrigation and limiting available resources in our country, the proper performance evaluation of the existing water resources projects is a must in order to take necessary measures to attain maximum possible benefits and to learn lessons for future project planning and development. The performance of a system is represented by its measured levels of achievement in terms of one or several parameters, which are chosen as indicators of the system's goal. It is the measure of effectiveness with respect to the achievement of the desired objectives of the project. The performance of irrigation projects depends on several factors like engineering, agricultural, socio-economic and institutional.

2.1 Water Management Practices in Water Development Projects of BWDB

BWDB is primarily responsible for surface water resource projects development. Table 2.1 shows the existing BWDB schemes by category. For implementation of any new scheme or maintenance of any existing project, time-to-time various approaches were practiced in BWDB projects. Many guidelines were prepared at different times. Very recently i.e. in the year 2000, Government of Bangladesh, has prepared a common guidelines for management of any water systems, which is known as Guidelines for Participatory Water Management (GPWM). BWDB is now trying to follow the new approach i.e. participatory water management for their systems management. In some irrigation project of BWDB, such as Meghna-Dhonagoda Irrigation Project, Pabna Irrigation Project, Teesta Irrigation Project, Chandpur Irrigation Project, the participatory approach for system management is continuing.

2.2 Framework for System Management

As per GPWM guidelines, participation of the local stakeholders is a continuous process in the pursuit of sustainable development. Stakeholders in existing water management systems can establish a Water Management Organization (WMO). The beneficiaries are encouraged and assisted to form different types of Water Management Organization (WMO), such as Water Management Group (WMG), Water Management Association (WMA) and Water Management Federation (WMF). The Organogram for different types and levels of WMO for various sizes of project/ scheme is given in Fig 2.1

Table 2.1: Existing BWDB Schemes by size

Types		**Small (<=1,000 ha)**	**Medium (1,000-5,000 ha)**	**Large (5,000-15000ha)**	**Very large (> 15,000ha)**	**Total**
Project	**No & Area(ha)**					
FCD	No	14	38	24	19	95
	Area	5,122	94,631	213,779	942,771	1,256,303
FC	No	5	11	7	1	24
	Area	2,300	26,212	61,107	159,611	249,230
FCDI	No	6	27	24	9	66
	Area	3,029	77,548	212,789	458,114	751,480
FCDIA	No	-	3	3	7	13
	Area	-	8,420	28,870	650,311	687,601
CFCD	No	9	58	47	22	136
	Area	5,078	172,321	365,557	617,080	1,160,036
D	No	16	43	15	8	82
	Area	7,666	107,624	109,096	303,950	538,336
ID	No	1	6	7	5	19
	Area	-	15,971	57,498	209,065	282,534
SFCD	No	3	9	13	4	29
	Area	1,231	35,686	91,030	133,982	261,929

Source: National Water Management Plan Project, Development Strategy Report, Main Report, and Vol.-2, 2001.

Note: FCD = flood control and drainage; FC = flood control only; FCDI = FCD projects which support irrigation; FCDIA = FCD projects with irrigation pumps and canals; CFCD = coastal FCD; D = drainage only; ID = drainage project with irrigation; SFCD = submersible embankments, as in the haors of the Northeast.

(i) For Project up to 1000 ha.

In such project / scheme, there may be one or two WMOs as indicated below:

- WMG at the lowest level for each smallest hydrological unit as social unit (para / village)
- WMA at the apex level of the project / scheme

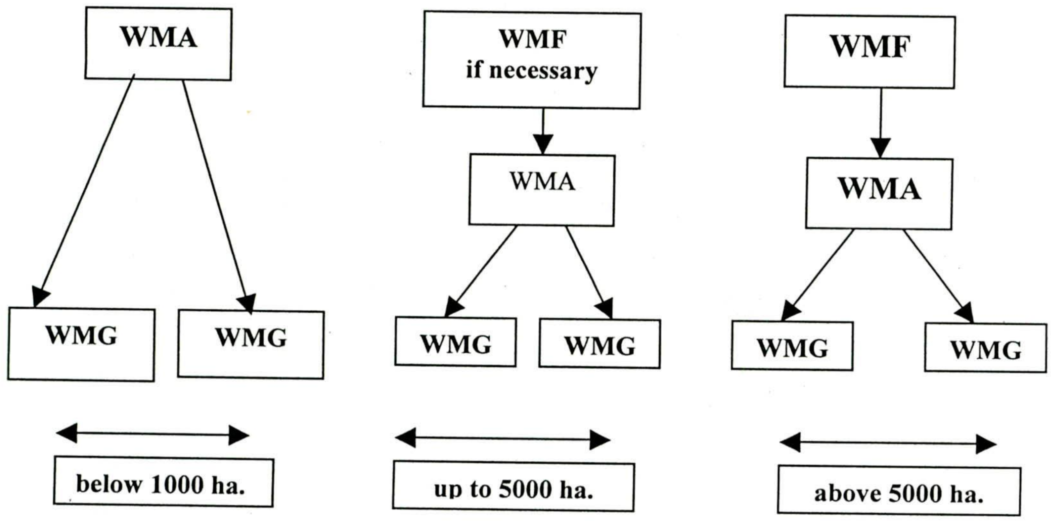


Fig. 2.1: Organogram of Water Management Organization (WMO)

(ii) Up to 5000 ha.

Two WMO for such project / scheme may consist of two or three levels as indicated below:

- WMG at the lowest level for each smallest hydrological unit.
- WMA either at the mid-level for each sub-system of the project / scheme or at the apex level for the project.
- If necessary, WMF at the apex level of the project in case WMA is formed at the mid-level for each sub – system.

(iii) For Project / scheme above 5000 ha.

There are following three WMO:

- WMG at the lowest level for each smallest hydrological unit;
- WMA at the mid-level for each sub system of the project;
- WMF at the apex level of the project;

2.3 Criteria for Evaluation of FCD/I Project

Many research works had been conducted to evaluate the performance of FCD/I projects. Performance evaluation was carried out using indicators and can broadly classified into four groups:

- Hydraulic indicators
- Maintenance indicators
- Agricultural indicators
- Economic, social and environmental indicators

2.3.1 Hydraulic Indicator:

Hydraulic indicators deal with the conveyance of irrigation water from the source (pumps) to the farmer's field by management of irrigation facilities. The hydraulic indicators used in the performance evaluation are adequacy of water supply, efficiency, dependability and equity.

2.3.1.1 Adequacy of water supply

The measure of adequacy proposed by Molden and Gates (1990) is:

$$P_A = \frac{1}{T} \sum_T \left[\frac{1}{R} \sum_R P_A \right]$$

Where, P_A = performance measure in terms of adequacy

$P_A = Q_D / Q_R$, for $Q_D <= Q_R$ otherwise, $P_A = 1$

Q_D =amount of water delivered by the system (mm);

Q_R= required amount of water for consumptive use, leaching, land preparation etc.

R= region or sub-region within water delivery system;

T= time period, one irrigation season;

According to this standard a system is said to be perfectly adequate if the value within the range 0.9 to 1.0 and the system is said to be fair if the range is within 0.8 to 0.9 and poor if it is <0.8.

Some other measures of adequacy are:

Relative Water supply (RWS): This indicator, developed by Levine (1982), compares water availability with actual demand. It is normally expressed as:

$$RWS = \frac{\text{Irrigation} + \text{Effective rainfall}}{\text{Evapotranspiration} + \text{Secpage \& Percolation}}$$

At tertiary level, RWS value greater than 1.5 suggests water is sufficiently abundant that management inputs need not be very intensive, but with values at or close to 1.0

management inputs themselves will not necessarily compensate for the relative scarcity of water.

Water Delivery Performance: The simplest and yet probably the most important hydraulic performance indicator is:

$$\text{Water Delivery Performance} = \frac{\text{Actual Discharge}}{\text{Target Discharge}}$$

Over a longer period of time, however, it may be more useful to modify the ratio by changing discharges into volumes (Clemmens & Bos, 1990; Walters, 1992):

$$\text{Water Delivery Performance} = \frac{\text{Actual Volume}}{\text{Target Volume}}$$

2.3.1.2 Efficiency

A measure of this objective would be the spatial and temporal average of the ratio of Q_R to Q_D (Molden and Gates, 1990) and expressed as:

$$P_F = \frac{1}{T} \sum_{T} \left[\frac{1}{R} \sum_{R} P_F \right]$$

Where,

P_F = performance measure in terms of efficiency

$P_F = Q_R / Q_D$, for $Q_R <= Q_D$ otherwise, $P_F = 1$

According to this standard a system is said to be perfectly efficient if the value within the range 0.9 to 1.0 and the system is said to be fair if the range is within 0.8 to 0.9 and poor if it is <0.8.

Indicator of efficiency has also been discussed in detail by Bos and Nugteren (1993). The most important are:

$$\text{Conveyance Efficiency} = \frac{\text{Total Water Supplied by the Conveyance system}}{\text{Total Inflow into the Delivery System}}$$

$$\text{Overall Project Efficiency} = \frac{\text{Crop Irrigation Water Requirement}}{\text{Total Inflow into the Canal}}$$

$$\text{Distribution System} = \frac{\text{Total Water Delivered to the Field}}{\text{Total Inflow into the Delivery System}}$$

$$\text{Application Efficiency} = \frac{\text{Crop Irrigation Water Requirement}}{\text{Water Delivery to Field}}$$

$$\text{Water Use Efficiency, WUE (\%)} = \frac{ET + S \& P}{IR + R} \times 100$$

Where, ET is the evapotranspiration requirement, S & P is the seepage and percolation requirement, IR is the irrigation water supply and R is the rainfall amount.

$$\text{Irrigation Efficiency, IE (\%)} = \frac{ET + S \& P - Re}{IR} \times 100$$

Where, Re is the effective rainfall and the other variables were defined earlier.

2.3.1.3 Dependability

An indicator of the degree of dependability of water delivery proposed by Molden and Gates (1990) is the degree of temporal variability in the ratio of amount delivered to amount required that occur over a region. This variability measured by:

$$P_D = \frac{1}{R} \sum_R CV_T \left[\frac{Q_D}{Q_R} \right]$$

Where, P_D = performance measure in terms of dependability;

$CV_T \left[Q_D/Q_R\right]$ = temporal coefficient of variation (ratio of standard deviation to mean) of the ratio Q_D/Q_R over the time period T.

$$\text{Dependability of Supply} = \frac{\text{Actual Duration of Water Delivery}}{\text{Planned Duration of Water Delivery}}$$

2.3.1.4 Equity

This measure proposed by Molden and Gates (1990) is define as

$$P_E = \frac{1}{T} \sum_T CV_R \left[\frac{Q_D}{Q_R} \right]$$

Where, P_E = performance measure in terms of equity;

$CV_R \left[Q_D/Q_R\right]$ = spatial coefficient of variation of the ratio Q_D/Q_R over region R.

Delivery Performance Ratio (DPR) can be used to give a quick view of over all equity:

$$\text{Modified Interquartile Ratio} = \frac{\text{Average DPR of best 25 \% of the system}}{\text{Average DPR of worst 25 \% of the system}}$$

2.3.2 Maintenance Indicators

A measure of maintenance performance suggested by Zhi (1989) is to assess the extent to which control structures can be operated as intended.

$$\text{Effectiveness of Infrastructure} = \frac{\text{Number of functioning structures}}{\text{Total number of structures}}$$

2.3.3 Agricultural Indicators

Agricultural indicators measure the contribution of the irrigation activity to the economy in relation to consumption of the increasingly scarce resource, water. These indicators provide the basis for comparison of irrigated agricultural performance. The agricultural indicators used in the performance evaluation are area indicators and production indicators.

2.3.3.1 Area Indicators

Area indicators used for assessing performance in terms of irrigation-supported area include irrigated area, cropping intensity and irrigation intensity. This is the direct indicators and proposed by Zhi (1989) for the assessment of agricultural performance in respect of area irrigated.

$$\text{Irrigated Area Performance} = \frac{\text{Actual Area}}{\text{Target Area}}$$

$$\text{Cropping Intensity Performance} = \frac{\text{Actual Cropping Intensity}}{\text{Target Cropping Intensity}}$$

$$\text{Irrigation Intensity} = \frac{\text{Irrigated area}}{\text{Service area}} \times 100$$

2.3.3.2 Production indicators

This is the most useful agricultural indicator to evaluate irrigated agricultural systems in such countries like Bangladesh where both water and land are limiting resources towards irrigation development. The indicator expressed as:

$$\text{Production Performance} = \frac{\text{Total Production}}{\text{Target Production}}$$

$$\text{Yield Performance} = \frac{\text{Actual Yield}}{\text{Target Yield}}$$

2.3.4 Economic, social and environmental indicators

The socio-economic indicators relate to long-term impacts of operational and agricultural strategies. These indicators have been divided into three primary categories: those relating to economic viability, those relating to social viability and those associated with sustainability of the physical environment for irrigation. Their main utility is to address concerns that may have greater value to policy makers than to irrigate system managers.

2.3.4.1 Economic indicators

The following indicators proposed by Bos et al.(1993) are defined as:

$$\text{Total Financial Viability} = \frac{\text{Actual O \& M allocation}}{\text{Total O \& M requirements}}$$

$$\text{Financial Self Sufficiency} = \frac{\text{Irrigation agency income}}{\text{Total O \& M requirements}}$$

Svendsen (1992) suggested the following indicator and this is expressed as:

$$\text{Fee Collection Performance} = \frac{\text{Irrigation fees collected}}{\text{Irrigation fees due}}$$

2.3.4.2 Social Indicators

For Performance evaluation of Irrigation system on social aspects Das (2001) has proposed some indicators as follows:

$$\text{Irrigation Employment Generation} = \frac{\text{Annual Person Days/ha Labor in Scheme}}{\text{Annual Number Official Working Days}}$$

$$\text{Irrigation Wage Generation} = \frac{\text{Annual Average Rural Income}}{\text{Annual Nation (or Regional)Average Income}}$$

$$\text{Technical Knowledge of staff} = \frac{\text{Number of staff with knowledge required fulfilling Job}}{\text{Total number of staff}}$$

2.3.4.3 Environmental Indicators

Rana (2004) has shown the major items of concern as follows

Impeded drainage and water logging

Increase in sedimentation in the Project area

Decrease in land fertility

Effect on public health and Sanitation

Effect on fisheries

Level of use of pesticides and fertilizers

2.4 Previous Evaluation of Water Resources Projects in Bangladesh

Many research works had been conducted to evaluate the performance of water resources projects in Bangladesh.

Jalal et al. (1974) evaluated the performance of Ganges- Kobadak (GK) Project of BWDB in order to identify the problems and to suggest ways to maximize benefit. G K project is located in the southwest region of Bangladesh in the districts of Kushtia and Jessore. Problems identified by them were siltation in the intake channel, inadequate power supply, poor maintenance of pump house, wastage of water and lack of interdepartmental and also intradepartmental co-ordination. For the improvement of project performance, they recommended the construction of 'ails' around plots and leveling of land; implementation of 7-day rotation system at the tertiary outlet level, improvement of interdepartmental and intradepartmental co-ordination, re-excavation of intake channel, maintenance of pump house and additional power supply.

Hamid et al. (1978) also evaluated the performance of the GK project from the viewpoints of technical, economical and organizational aspects. Among the technical points they have mentioned irregular and inadequate power supply to the pump house; unsatisfactory arrangements for repair and servicing of infrastructure; and inadequate technically trained staff. It has been stated that the project has significant positive impact on crop yields but produced no favorable effect on benefit distribution. They have noticed the organizational problem like lack of co-operation among organizations, lack of control at the lower level in water distribution, lack of power in taking independent decision, etc.

Ahmed (1987) evaluated the performance of Chandpur Irrigation Project (CIP) of BWDB in the Chandpur district on agriculture sectors (cropping pattern, cropping intensity, crop yield and production, agriculture inputs use, population and food balance, impact on fisheries) and socio-environmental aspects (employment opportunities, transportation and navigation, water logging and drainage problem, water hyacinth problem, cooperatives and credits). The study revealed that radical positive change in cropping pattern has taken place in CIP. The cropping intensity has also jumped from 160-170% in pre-project stage to 225% after project implementation. Yields for individual crops have also increased (for T. Aman HYV, yield increased 64.6%). Consequently the total production of rice and others crops has increased significantly. Employment opportunity has increased in agricultural sector, but the project has also reduced the seasonal under-employment, which was a chronic problem in other flood prone areas. Direct benefits were also obvious in case of road transport. Fish production from the open water resources declined 35%. The impact of CIP on fisheries was a glaring example of the ecological consequences of water development projects in Bangladesh. But at the same time it showed how successfully the adverse impacts were overcome by taking proper remedial measures.

BETS (1988) and BUP (1988) evaluated the performance of six Early Implementation Projects (EIP) of BWDB from the technical and socio-economic aspects. These were Polder 35/3, Bitabari Damosh, Bhedrabeel, Mahajan Lauhagonj, Angerolli Haor and Polder 65/A-3. The main issues of the study were: (i) impact of projects on agriculture, (ii) impact of projects on land market tenure system and income distribution, (iii) impact of projects on employment and labour market, (iv) impact of the project on environment and navigation, (v) institutional change due to the implementation of the projects and (vi) the cost benefit analysis of the projects. The constraints found were, insufficient number of gate operator, irregular and untimely operation of gates and irrigation inlets, absence of sluice committee and no standard water management practice in the project areas. The findings indicate that, only one project out of six was maintaining proper operation and water management system, but all the projects succeed in increasing agricultural productivity in the study areas and thereby in increasing overall income. But the impact on the distribution of income has been limited. The benefit generated due to the increased agricultural production has shared on the basis of land ownership pattern so that those who have more land have received larger shares of the benefit. And the employment generated for the landless and the land-poor has been rather limited. This study suggested proposal for improvements of maintenance by (i) sufficient yearly maintenance fund should be placed and (ii) public cut of embankment should be stopped.

Hifaf International (1989) evaluated the performance of thirty-nine small-scale water resources projects of LGED in certain localized areas in Kurigram and Faridpur districts. This study included comparison of agricultural regime during pre and post-scheme periods, potentiality of more intensive cropping through modern agricultural practices and feasibility of irrigation farming through STW or LLP. The adoption of flood control, drainage and irrigation measures has changed the land type from high to mid-high and from low to mid-low. The possibility of flood and drainage congestion resulting crop damage has eliminated. Irrigation technology has been adopted in the project areas in limited scale after implementing the projects. But a noticeable change has taken place in respect of adoption of HYV crop cultivation. No change was observed in respect of credit after the project.

Azad (1990) evaluated the performance of three selected small-scale flood control, drainage and irrigation projects (Sonail Embankment, Naldanga and Chatlar-Fukurhati Beel Project). These are located in Gaibandha and Faridpur districts in Bangladesh. This study evaluated the performance of selected project in terms of crop yield, cropped area, cropping intensity, land use pattern, income distribution and labourforce by occupation in pre and post project condition. The technical and management problems in proper operation and maintenance of the projects were also identified through field observations and questionnaire survey. Cropping pattern of the project areas has been changed from low yielding varieties to high yielding verities. The income of household in the project areas has been increased but the percapita income has not been increased due to growth of population. The existing problems identified were improper operation of gates, lack of regular maintenance of the physical components and absence of standard water management practices in the project areas. This study recommended for the improvement of the utilization of the existing facilities in the project area. A standard operation procedure of structures should be followed and gates should be operated by permanent and trained operators. Embankment and structures should be repaired and maintained properly. A standard water management practice should be followed in the project areas.

Rahman (1990) evaluated the performance of three selected small-scale projects such as Mahajan-Lauhajong project, Polder 65/A-3 project, and Mondakini khal Irrigation project of BWDB. This study visualized the level of their performance from the viewpoints of technical and agro-socio-economic aspects. This study revealed that Mondakini khal irrigation project is a successful one. Its success in respect of different aspect of national development through increased agricultural production and also through socio-economic well-being. Mahajan- Lauhajang project was an incomplete one and Polder 65/A-3 project was in serious state of disrepair; but the result of this study showed their potentiality in obtaining the desired goal if rehabilitated properly. This study revealed that the need for completing the excavation of the drainage canals upto the design requirement in Mahajan-Lauhajong project and raising of embankment height by another meter with reconstruction of breached portion of embankment in polder 65/A-3 project for their proper functioning. It was also felt that completed project should be supported with adequate maintenance fund and fostered by a local project maintenance committee formed of the member from the beneficiaries and backed by BWDB.

FPCO (1992) evaluated the performance of seventeen completed BWDB's FCD/I project in different districts (Rajshahi, Kurigram, Chandpur, Sylhet, Khulna, Bogora, Natore, Jessore, Faridpur, Tangail, Jamalpur, Sunamganj, Feni, Mymensingh and Sirajganj) of Bangladesh. Selected projects were evaluated by multi-disciplinary teams including engineers, natural resources specialists, social scientists and environmentalists using both rapid rural appraisal (RRA) techniques and more intensive household surveys. The study, which took place from January 1991 to February 1992, revealed a wide range of project performance. The study found that, in almost all projects, there was scope for improving O & M. In part, O & M difficulties arise from weaknesses in project planning and design. The study concluded that although there is some involvement of beneficiaries it has not so far been too effective and to recommended ways to increase the participation of beneficiaries and the rural poor in O & M. About one half of the schemes have ERRs below 12%, while most of the remainder have ERRs over 30%. The best results are generally associated with technically simple projects of moderate size (under 10,000 ha.), which seem to have the best chance of meeting local needs. In successful projects, improved water control has led to more productive wet-season cropping patterns. Drainage congestion due to high river levels presents problems in many projects. FCD/I projects often have an adverse impact on capture fisheries and fishing families. Landless households probably benefit less from FCD/I schemes than landowners, but crop intensification provides significant additional employment and normally raises wage rates. Many of the problems are due to weaknesses in project planning and failure to take account of conflicting interests.

IFCDR and BWDB (1992) evaluated the performance of selected six project (Barisal Irrigation Project, Buri Teesta Irrigation Project, Coastal Embankment Project, Polder 46, Karnafuli Irrigation Project, Meghna- Dhonagoda Irrigation Project, Monu River Project) in different parts of the country. The main focus of investigation was on management aspects including engineering, socio-economic and agricultural issues. The performance of six projects were evaluated and reasons for not achieving the desired targets were identified on the basis of review of project documents, field visits, questionnaire survey, discussion with the beneficiaries and project officials. The study revealed that all FCDI projects had positive impact on farming communities, but of various degrees. Also the projects had positive impact on agriculture i.e. increase in crop production and reduce in crop damages; but had negative impact on capture fishery. To improve the efficiency of performance of these projects suggested modifications were (i) proper operation and maintenance and innovative management (ii) improvement of field level management (iii) improvement of project level management and (iv) integration between project level and field level management. More awareness among the farmers was a prerequisite and it expedited by training sessions, demonstrations, and two-way communications between project personnel and beneficiaries.

BWDB (1998) evaluated the performance of Meghna-Dhonagoda Irrigation Project (MDIP) from the viewpoints of technical, social, economic, environmental and organizational aspects to identify problems and to suggest ways to maximize benefit. Majors finding were: (i) the target groups and beneficiaries were not formally involved in the planning, design and implementation of the project cycle; (ii) maintenance of the project physical facilities has not been good and the project never worked as envisaged. (iii) no adequate provision of budget for maintenance works and (iv) lack of co-ordination between beneficiaries and BWDB. For the improvement of the project performance, recommendations were: (a) effective participation of the beneficiaries in all stages should be ensured; (b) water delivery to the farms should be ensured by improving the physical infrastructures (c) functional co-ordination between beneficiaries and BWDB to be established (d) adequate fund should be placed to ensure timely operation, maintenance and repair and (e) institutional structures for regular maintenance should be established.

BUET, BIDS and WL/delft hydraulics (2003) evaluated the performance of thirty sub-projects of Small-Scale Water Resources Development Sector Project Phase I (SSW-I) during the period from April 1996 to December 2002. The Local Government Engineering Department (LGED) implemented these projects. Selected 30 sub-projects located in the western half of Bangladesh. The performance of these projects was evaluated from the viewpoints of technical, social-economic, institutional and environmental aspects. The evaluation focused on the project framework ensuring sustainable operation and maintenance (O & M) of small-scale water resources interventions, with special reference to the (i) institutional set-up through Water Management Co-operative Associations (WMCAs) (ii) quality of the infrastructure and its social acceptability (iii) poverty reduction issues (iv) institutional strengthening of LGED and other agencies involved. Distinction was made between the number of projects scoring more than 70%, regarded as good, the number of projects with a score between 50 and 70%, requiring continuous support and attention, and the number of projects with a score below 50% considered as insufficient. It was found that about 47% of the sampled sub-projects showed a good score on the technical issues and 17 % score below the expected acceptable standards. For the remaining criteria only one out of the thirty projects reach a good score. The valuation of the socio-economic output was highly dependent on the perception of the respondents to the questionnaires in the field. The valuation of these sub-criteria therefore were made based on theoretical relations between the direct socio-economic outcomes such as agriculture, fisheries and employment and the expected distribution of such benefits between the poor and landless people and women. When considering the institutional criteria only one of the thirty sub-projects qualifies with a score above 70%, and about 20% of the sub-projects rank with a score above 60%. For the improvement of project performance this study recommended that (i) enhance involvement and participation of beneficiaries and stakeholders. (ii) focus on enhancement of the Water Management Unit's capacity and capability for identification, formulation, data collection, appraisal preparation, design, construction and supervision of small-scale water resources development schemes; (iii) more attention to the identification and determination of the expected socio-economic outcome of the sub-project, including a thorough baseline survey & study; (iv) specific measures should be taken to ensure that poor people, small farmers and destitute women get benefit from the sub projects.

Islam (2004) evaluated the performance of Narayanganj-Narsingdi Irrigation Project (NNIP). This project located on the left side of the Sitalakhya River in Rupgang upazilla of Narayanganj district. This project was evaluated from the viewpoints of water management, agricultural practices, socio-economic and environmental aspects. The project could not achieve the target of irrigation and drainage due to lack of proper maintenance, lack of proper attention in equitable distribution of irrigation water, absence of farmers participation in water management planning and implementation, non linkage of scattered low depressions with the main drainage canals and pollution of canal water by the effluent of the textile mills discharged into the drainage and irrigation canals without treatment. Water using organizations were formed in the study area but these are not active and there was conflict of interest among the farmers regarding use of irrigation water. Establishment of industries and brickfields in the project area has been appeared as main constraints of irrigation and crop production and has affected the environment negatively. Apart from the constraints mentioned above the cropping pattern in the study area has been changed and cultivation of HYV rice has been increased. Cropping intensity has been increased to about 215%, which is about 105% more than that of the pre project condition. All the pumps are in functional condition and maintained properly. The study concluded that, the project is beneficial to the people although drainage problem has not been completely solved and irrigation target has not been achieved.

Mukherjee (2004) evaluated the performance of three-selected Small-Scale Water Resources Development Sector sub-project of LGED (Brazamul FCD, Agrani CAD and Gangarampur FCD sub-projects) and one medium scale water sector development project (Narayanganj-Narsingdi Irrigation Project) of BWDB. The evaluation focussed on hydraulic, agriculture, socio-economic and environmental aspects. The problems encountered in these schemes were: no clear operational instruction, which lead to conflicts between the technicians and the farmers; no equitable water distribution at field level; no cost recovery; no proper conflict-handling etc. Improper system maintenance and lack of beneficiary participation was found, which was the main reason behind the lesser success of the water schemes. This study revealed that partial decentralization in LGED schemes helps in sustainable agricultural and overall financial development, but almost in every case the rate of farmer's involvement or beneficiary participation in system management was found not satisfactory. This study recommended that the performance of existing FCDI projects can be improved significantly by enabling increased people's participation in local level and by developing a suitable management approach that will have a strong institutional setting. In Bangladesh it is a prime need to develop water management system through participatory approach especially in case of irrigation, drainage and flood control systems.

Chapter 3

Meghna Dhonagoda Irrigation Project

3.1 General

Implementation of the Meghna Dhonagoda Irrigation Project (MDIP) took place from 1979-80 to 1987-88. The MDIP project was taken up to mitigate flood damage through provision of physical facilities along with stable supply of irrigation water and its efficient management. The project was given due priority by GOB in view of its potential contribution to increased food grain production and the resultant higher income, output and employment opportunities. The MDIP favours a strategy for greater agricultural production through more and more HYV paddy practices by using surface water for improved irrigation facilities by LLP. Development efforts in the agricultural sector were aimed primarily at achieving food grain self-sufficiency. Self-sufficiency in food grains at a higher level of per capita consumption was a major objective of the plan. The strategy for realizing that objective was based on policy options favouring increased reliance on private sector initiative, free market economy, reduction of public subsidies and greater domestic resource mobilization. Following this policy BWDB was given strong emphasis on this project for developing a capability for achieving self-sufficiency in food and the need for rationalization of the recovery of project costs.

3.2 Background and Objectives of the Project

MDIP is a multipurpose project that includes flood protection, irrigation and drainage facilities together with agricultural development. The project was one of the FCDI projects originally proposed in the 1964 Master Plan of BWDB, and a detailed feasibility study was made in 1966-67, but the idea was then shelved. The project was re-identified by BWDB and the Asian Development Bank in 1973. Feasibility studies were conducted with ADB funding in 1976-77, and the project was appraised by ADB in 1977. The implementation of the project started in February 1980 and was declared completed in June 1988.

MDIP is ideally located for FCDI because of good potentialities of surface water and the lands of the area. MDIP designated as an irrigation project to provide irrigated agricultural facilities to an area of 14367 ha. . The main design characteristics are a ring embankment around the perimeter for flood protection, and internal networks of irrigation canals to provide water during the dry season and drainage canals to remove excess water from rainfall in the monsoon. Evacuation of drainage water is accomplished by two pump stations, one at the northern and the other at the southern end of the project, which also lift water from the Meghna and Dhonagoda rivers into the canals for dry-season irrigation. Water distribution within the project is mainly by gravity flow, but there are two internal booster pump stations to provide water to comparatively higher areas.

The objectives of the main embankment and drainage system are to protect the project interior from river flooding and drainage congestion during the monsoon, thus improving agricultural conditions (with special reference to encouraging introduction of HYV Aman) and increasing the security of the population, crops and livestock. The objective of irrigation development is to improve soil moisture in Rabi and in early part of Kharif-I and later part of Kharif-II, again facilitating the introduction of HYV paddy. The project's principal objectives were, therefore framed to

(i) Increase agricultural production by shifting cropping practice to higher yielding varieties and expanding dry season crop production;

(ii) Create employment opportunities; and

(iii) Improve the living conditions in the area.

3.3 Location

The Meghna Dhonagoda Irrigation Project (MDIP) is located in the southeast region of Bangladesh within the Chandpur district at Matlab thana. MDIP lies between longitudes 90°30′ and 90°45′ E and latitudes 23°15′ and 23°25′ N .The area is bounded by the Meghna river to the north and the west and by the Dhonagoda and Gumti river in the east and the south respectively (Fig. 3.1). The project site is about 40 km from Dhaka (Kalipur) and 19 km from Chandpur town (Udhamdi).

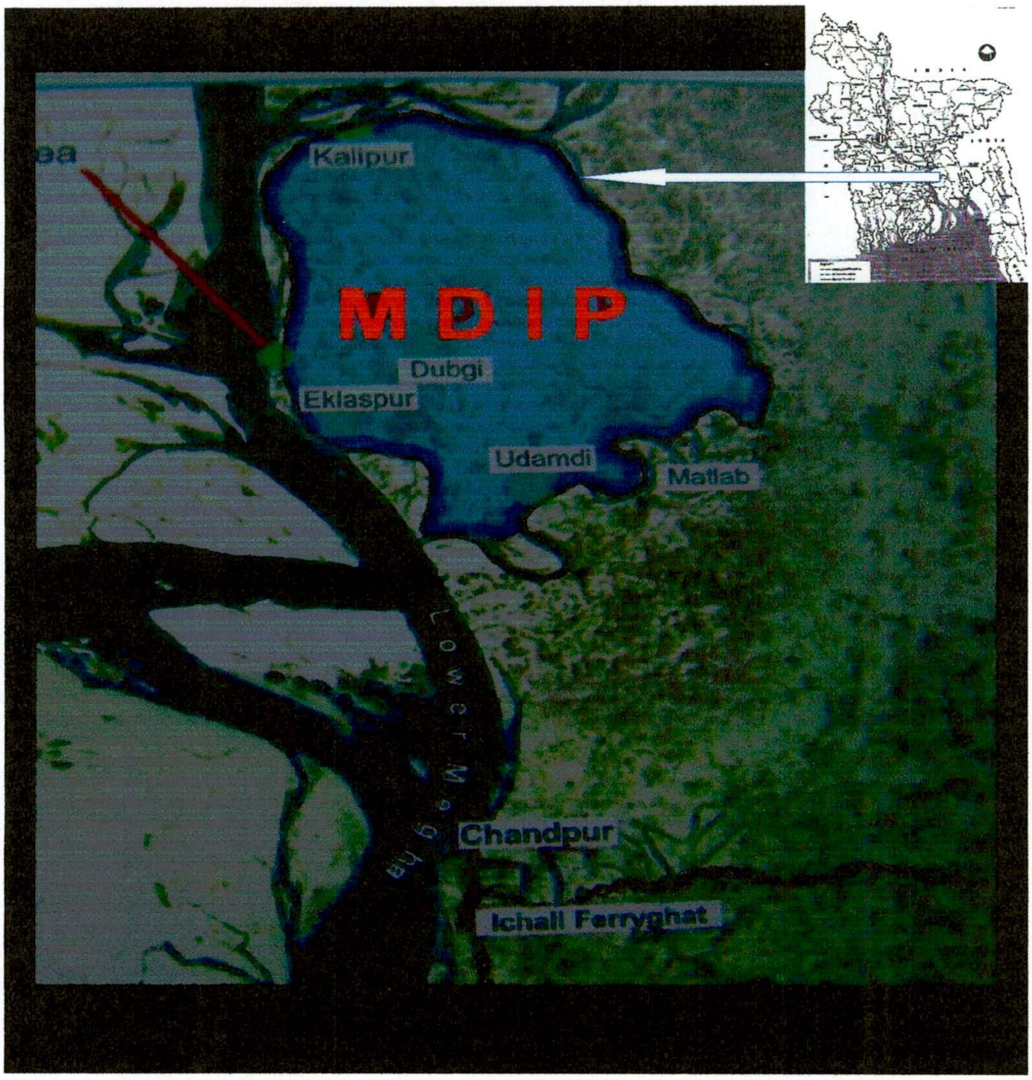


Fig. 3.1: Location map of Meghna Dhonagoda Irrigation Project (MDIP)

3.4 Topography and Soils

Topography: The area is medium-low to low flat plain without well-defined slope. The middle part is slightly lower than fringes with scattered patches of low-lying beels making it saucer shaped. The general elevation ranges from 1.90 to 5.10 metres PWD (BWDB, 1999).

Soils: The area is an alluvial plain. The soil composition is mainly brown sandy silt formed by the sedimentation of silt on top of grey silty sand. The percolation rate for these soils has been estimated at 5 mm/day (BWDB, 1999).

3.5 Climate and Hydrology

Climate: The climate of the project area is of the typical monsoon type. Two mean climate seasons can be distinguished; the rainy season, followed by a transitional season and the dry season followed by another transitional season. Rainy season starting in June and ending in September, the rainy season is caused by the southwest monsoon and characterized by heavy rainfall. Dry Season starting in December to March, the dry season is caused by a dry northeast monsoon winds. The transitional period starts in April and ends in June.

Hydrology: The project is situated at the confluence of the Padma and the Meghna. Due to the presence of such large rivers no water shortages or too low water levels have been observed at the two pump stations Kalipur and Udhamdi. In general, the average water level at the north of MDIP (Kalipur, Meghna River) is higher than the water level at the south of MDIP (Matlab, Dhonagoda River). Mean high and low river water levels are found to occur within June to October and December to March respectively. The water levels are affected by the daily tides. High and low tides in the rivers facilitate drainage of the area, but during the rainy season drainage is mainly possible through pumping.

3.6 Agriculture

The cropping pattern in MDIP depends on the performance of the gravity irrigation system. Irrigation water is mainly used to cultivate HYV Boro rice in the dry season. During the rainy season the main crop was LYV Aman rice and secondly late Aus rice, both are cultivated under rainfed conditions.

3.7 Fisheries

Flood control embankments blocked the spawning and feeding migrations of various fish species from rivers to flood plains, thus reducing fish breeding stocks and reproduction in the drains inside MDIP. The decrease in fish reproduction had a dramatic effect on the fish harvest and fish consumption in the project area. The introduction of small-scale fisheries, the cultivation of fish in small ponds has so far been unable to offset the total production loss, that decreased from 962 tons in 1983-84 to 336 tons in 1991-92 (BWDB, 1999).

3.8 Project Infrastructure

The infrastructure owned, operated and maintained by BWDB consist of flood embankments, pump stations, irrigation canals and structures, drainage canals and communication structures. Salient features of MDIP are listed in Table 3.1.

Flood Embankments: 60 Km flood embankment around the perimeter of the project have been constructed for flood protection during the monsoon. A typical section of flood embankment is shown in Fig.3.2

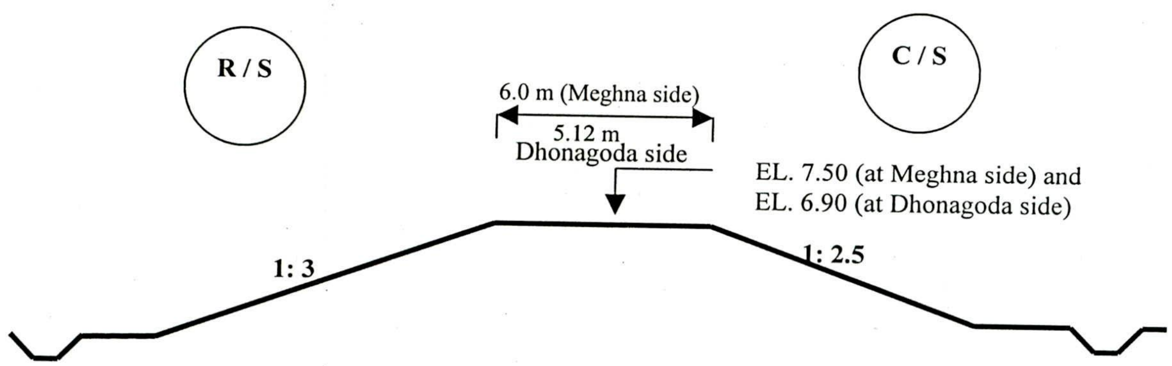


Fig. 3.2 Typical section of flood embankment

Table 3.1: Salient features of MDIP

Location:

District : Chandpur

Thana : Matlab

O & M Circle: Chandpur

O & M Division: MDIP

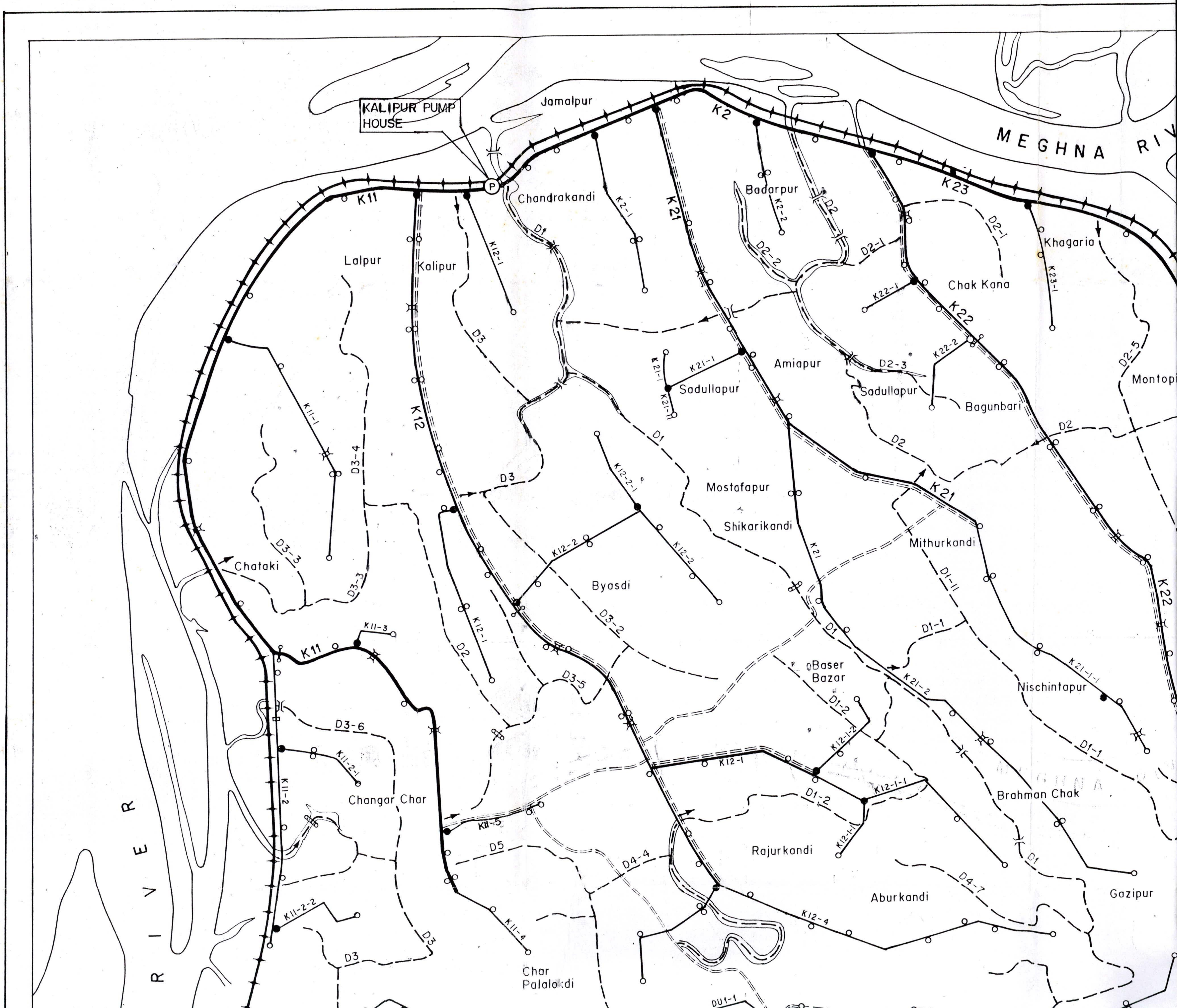
Key Project Features (Before CADP in MDIP)	
Year of Completion	1987 / 1988
First Irrigation Season	1988 / 1989
Gross Area (During BWDB, DPE Survey, 1996)	19,021 ha
Net Area (During BWDB, DPE Survey, 1996)	17,584 ha
Irrigable Area (During BWDB, DPE Survey, 1996)	14,367 ha
Irrigated Area (During BWDB, DPE Survey, 1996)	10,033 ha
Benefited Population (During BWDB, DPE Survey, 1996)	210,000
Benefited Families (During BWDB, DPE Survey, 1996)	45,000
Cropping Intensity (During BWDB, DPE Survey, 1996)	206 %
Flood Embankment	60 km
Main Pump Stations	2
Booster Pump Stations	2
Drainage Channel	125.00 Km
Main Canal	61.82 km
Secondary Canal	52.30 km
Tertiary Canal	73.40 km
Regulators	69
Check	42
Escape	17
Aqueduct	3
Bridge	48
Irrigation Conduit	7
Turnouts	387
Culvert	24

Source: BWDB, 1998 and 1999

Pump stations: MDIP has two main pump stations, Kalipur pump station in the north and Udhamdi pump station in the south. Locations of above pump stations with main canals system are shown in Fig. 3.3. The Udhamdi main pump station also supplies water to two smaller booster pump stations, one at Dubgi (south of the centre) and one at Eklashpur (south west). Both main pump stations Kalipur and Udhamdi are used for irrigation as well as drainage. Figs. 3.4 and 3.5 show the Udhamdi and Kalipur pump houses respectively.

Fig. 3.4: A view of Udhamdi Pump House in MDIP

Fig. 3.5: A view of Kalipur Pump House in MDIP


KALIPUR PUMP HOUSE
MEGHNA RIV
RIVER
Jamalpur
Chandrakandi
Badarpur
Khagaria
Chak Kana
Lalpur
Kalipur
Amiapur
Sadullapur
Bagunbari
Montopi
Mostafapur
Shikarikandi
Mithurkandi
Chataki
Byasdi
Baser Bazar
Nischintapur
Changar Char
Brahman Chak
Rajurkandi
Aburkandi
Gazipur
Char Palalokdi
K11
K12
K2
K21
K22
K23
K2-1
K2-2
K12-1
K12-2
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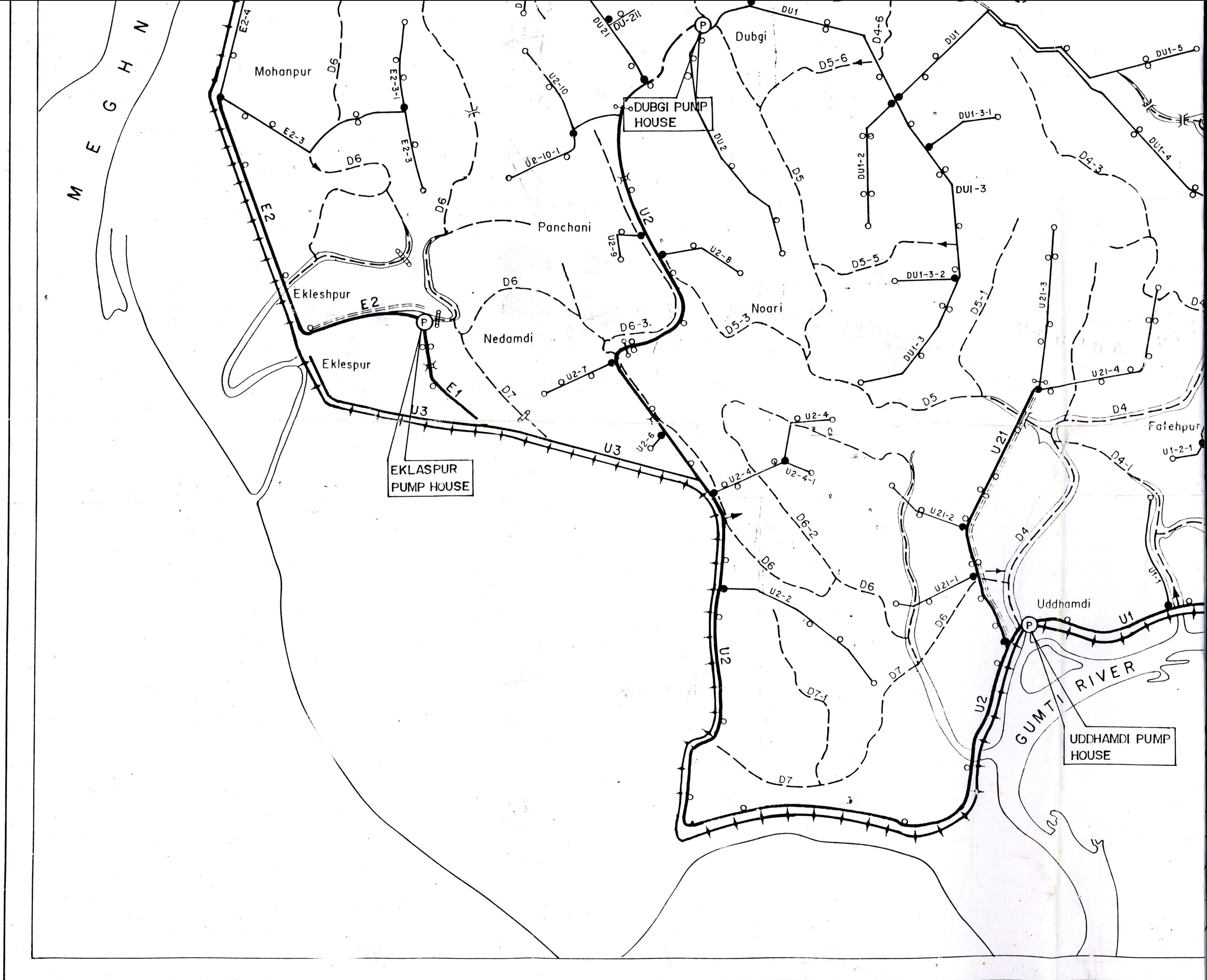
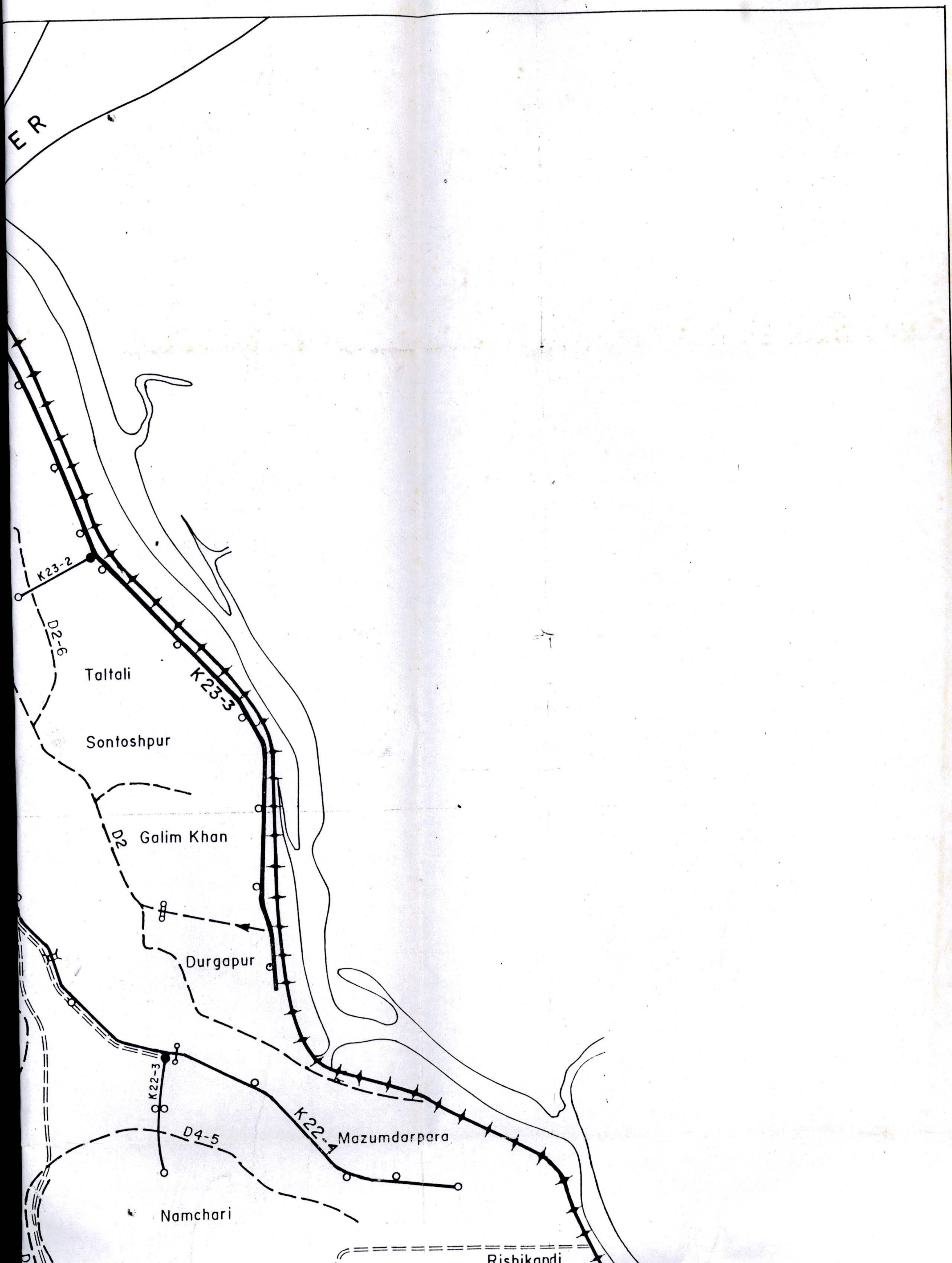
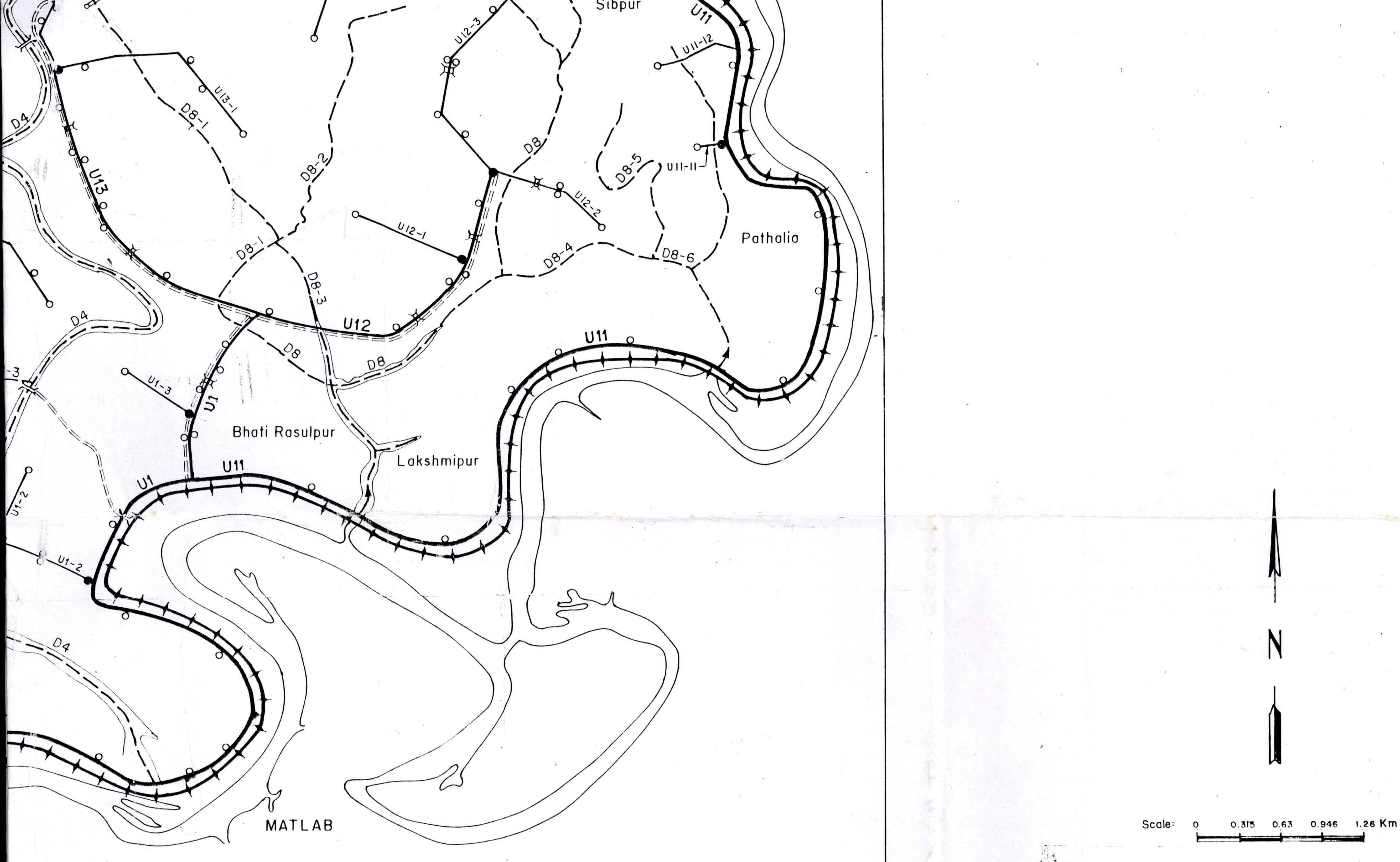


Fig. 3.3 : Location of Main Canals and Pump Stations in MDIP



LEGEND

- Embankment
- Main Irrigation Canal
- Secondery Irrigation Canal
- Tertiary Irrigation Canal
- Irrigation Drainge Canal
- Pumping Station
- Regulator
- Turnout
- Escape
- Check Structure on Irrigation Canal
- Check Structure on Drainage Canal
- Aqueduct
- Irrigation Conduit
- Drainage Conduit
- Bridge
- Foot Bridge
- Conveying Canal
- Existing Transmission Line
- Proposed Transmission Line



Sibpur
U11
U11-12
U12-3
U13-1
D8-1
D4
D8-2
D8
D8-5
U11-11
U13
U12-2
U12-1
Pathalia
D8-1
D8-3
D8-4
D8-6
U12
U11
D4
D8
D8
U1-3
U1
Bhati Rasulpur
Lakshmipur
U11
U1
U1-2
U1-2
D4
MATLAB
N
Scale: 0 0.315 0.63 0.946 1.26 Km

Irrigation Canals: The irrigation system has been divided into eight command areas of main canal (Fig. 3.3). Four main canals systems have been connected to Udhamdi pump station and four other systems to Kalipur pump station.

Irrigation Structures: Main irrigation structures in MDIP are regulator, check, aqueduct, escape, and turnout. Numbers of irrigation structure in main canal system are listed in Table 3.2.

Table 3.2: Irrigation structures in main canal system

Name of Main Canal	Number of Structures							
	TO	**RE**	**CH**	**AQ**	**ES**	**BR**	**FB**	**CO**
U1	72	9	6	0	3	2	5	0
U2	68	17	3	1	2	0	4	0
Dubgi	60	11	7	1	3	0	6	4
Eklaspur	25	5	4	0	1	0	5	0
K11	32	8	4	0	3	0	6	1
K12	50	7	5	0	2	1	3	0
K21	40	7	5	1	2	1	9	1
K22/23	40	5	8	0	1	1	5	1
Total	**387**	**69**	**42**	**3**	**17**	**5**	**43**	**7**

TO = Turnout; RE = Regulator; CH = Check; AQ = Aqueduct; ES = Escape; BR = Bridge; FB = Foot Bridge; CO = Conduit

Drainage Canals: The drainage system consists of a natural system of waterways named khals. The main drainage network consists of 8 inter-linked main drains. Main drains are connected to the pump stations of Kalipur and Udhamdi.

Communication Structures: Only the unpaved inspection road on the flood embankment and banks of irrigation canal are used as an inspection road. Other roads inside MDIP are owned and maintained by the LGED and Union Parishads. Some bridges and culverts over the irrigation canal are also used important structures for better communication.

3.9 Operations and Maintenance

BWDB is responsible for operation and maintenance of the entire project. The Superintending Engineer, Chandpur O & M Circle, BWDB is responsible for overall supervision and co-ordination of the activities. The Executive Engineer, Meghna-Dhonagoda O & M division, located at Chandpur Circle is responsible for all the components of the project. In addition, the Executive Engineer of Mechanical Division located at Chandpur looks after the pumps in the Project. There are 3 Sub-Divisional Engineers (1 Mechanical & 2 Civil) under the Executive Engineer of Chandpur O & M Circle (MDIP office).

BWDB (1998) has enlisted the following O & M problems in MDIP:

i) Inadequate budget allocations and insufficient fund placement ;

iii) Inadequate training program both for farmers groups and staff of different agencies;

iv) Lack of effective beneficiary participation ;

v) Power shortage .

The following steps were suggested by the project authority (BWDB, 1998) for the proper O & M of the project.

- Water user groups will be responsible for O & M of field channels and on farm water management;
- Water users group will be organized by BWDB extension people;
- BWDB will be responsible for O & M of main canal;
- PDB should take care of stable and dependable supply of electricity;

3.10 Field Irrigation and Water Management Status

Field irrigation and water management practices were developed for proper water distribution. Management of water distribution was lacking for achieving agricultural production and productivity. Water management for increasing crop production was being executed through field turnouts and field channels in cooperation with the local farmers.

Water conveyance capacity of the irrigation canals was poor. Most of the sections of the canals including the main and secondary canals appear to have much narrow width, very gentle slope and shallow depth. Water does not reach the further mid and tail ends. The water users of the upstream turnouts divert water more than water required and mid and tail-eiders do not get adequate water. Other problems of irrigation management were frequent breakdown of pumps and non-availability of mechanics in time.

Irrigation facilities in the project area decreased due to the irregular, poor and improper maintenance of the canals and internal conflicts among water users. Water Users Group (WUG), Water Users Association (WUA), Water Users Committee (WUC), and Federation of Water Users Association (FWUA) were formed in the project area to minimize the problems. Conveyance losses in both lined and unlined canals were considerably high. The high conveyance losses caused serious difficulty in delivering water to remote fields. Full supply level cannot be maintained in the canal system due to inadequate canal sections. Crop water rotation was necessary to maintain for maximum irrigation coverage, but it was not practiced properly to maximize water use under ideal crop water rotation program.

It was necessary to ensure wider participation for ensuring distribution of benefits. But WUGs were not effective. Due to lack of coordination between beneficiaries, government organizations and private sector difference in opinion exit between WUGs as well as management committees and BWDB.

An important aspect was the construction of field channels, which had not been done properly. In most cases, an extremely inefficient method of wild flooding was used to irrigate fields, reducing the command area and leading to extreme inequalities.

3.11 Command Area Development Program in MDIP

MDIP is a multipurpose project that includes Flood Protection, Irrigation and Drainage together with agricultural development. But after completion of the project irrigated area was declining over the years mainly due to lack of on farm facilities and poor water management at the farm level (BWDB, 1999). A benchmark study in 1998 was conducted by BWDB. Under benchmark study, it was identified and examined how far the recommendations in the appraisal and project completion report was carried out.

With the aim to increase the actual irrigated area, the Command Area Development Program in Meghna-Dhonagoda Irrigation Project was undertaken and implemented from 1996-97 to 2002-03. Participation of water users was considered a key factor. In MDIP 388 Water Management Groups (WMG) have been established, registered and trained for O & M at the on farm level. To strengthen the sense of ownership of WMG, they were allowed participate in rehabilitation works through contracting societies. A cost recovery arrangement has been developed to ensure a more sustainable system operation. An effective p articipation o f water users for repair and in some cases rehabilitation of the flood protection, irrigation, drainage and communication facilities were realized to increase the irrigated area.

Originally total investment cost for MDIP was Taka 175,04.00 lakh. Total rehabilitation cost including institutional intervention under CADP in MDIP was Taka 12944.00 lakh. This means that the CADP cost about 74 % of initial investment cost (BWDB, 1998 and 2003). The following sections give a brief description of physical and institutional interventions carried out in the project area.

3.11.1 Physical Improvement

The rehabilitation works under CADP include (i) re-sectioning and slope protection of embankment and river bank protection works, (ii) rehabilitation and lining of canals including irrigation structures, (iii) re-excavation of drainage channels including drainage structures, (iv) on-farm works along with turnouts and field channels (v) communication works including access roads, bridges and culvert and (vi) procurement of spare parts for pump house and other mechanical and electrical works. The rehabilitation works of MDIP are mention in Table 3.3. A view of newly constructed turnout under CADP in MDIP is given in Fig. 3.6 and view of lined and unlined field channels are exhibited in Figs. 3.7 and 3.8

3.11.2 Institutional Interventions

As per the new guidelines (GPWM, 2001) the institutional frame work in which the local stakeholders would participate for water management is a 3-tier one and termed as the

Water Management Group (WMG), Water Management Association (WMA) and Water Management Federation (WMF) for projects having area above 5,000 ha. WMG is formed turnout wise, WMA covers secondary with tertiaries and the WMF for the total project. Accordingly, CADP adapted this 3-tier Water Management Organization (WMO). Participatory approach for water management following these guidelines was applied in Meghna-Dhonagoda Irrigation Project and 388 Water Management Groups (WMG), 9 Water Management Associations (WMA) and one Water Management Federation (WMF) were formed (Fig.3.9).

Table 3.3: Rehabilitation works of MDIP

SL. No.	Items of Work	Unit	Quantity
1	*2*	*3*	*4*
1	Re-sectioning of Flood Embankment	Km	38.43
2	Bank protection work	Km	1.09
3	Flood embankment slope protection	Km	1.80
4	Re-excavation of main canal	Km	52.00
5	Re-excavation of secondary and tertiary canals	Km	131.00
6	Construction of new regulator	Nos.	1
7	Turnout rehabilitation	Nos.	144
8	Construction of Turnout	Nos.	538
9	Secondary canal lining	Km	28.10
10	Tertiary canal lining	Km	23.95
11	Re-excavation of drainage Khal	Km	47.17
12	Construction of new Bridge, Culvert and Foot Bridge	Nos.	49
13	Improvement of access roads	Km	4.00
14	Rehabilitation of drainage structure	Nos.	30
15	Rehabilitation of Syphon/ Aqueduct	Nos.	10
16	Construction of Pipe Syphon	Nos.	38

Fig. 3.6: A View of Newly Constructed Turnout in MDIP

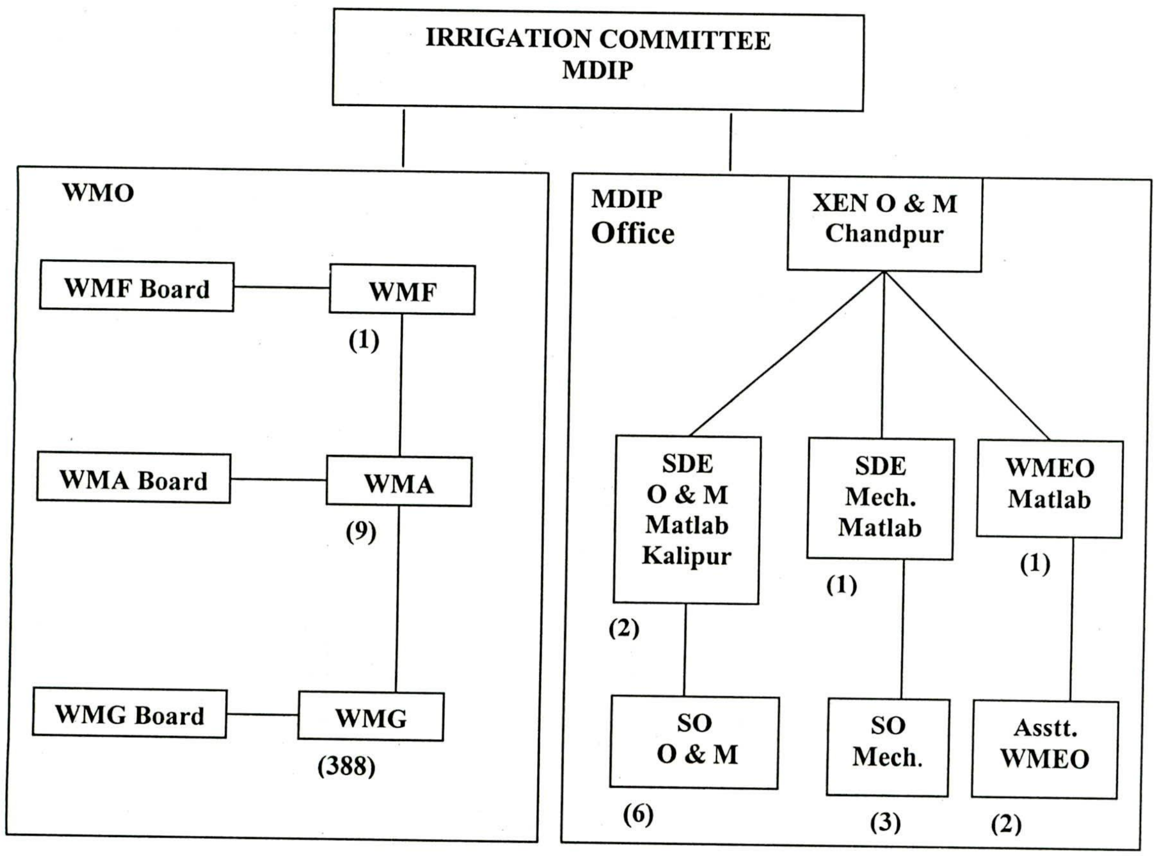
Fig. 3.7: A view of Lined field channel in MDIP

Fig.3.8: A view of unlined field channel in MDIP

All the WMGs and the WMAs were registered. The process of registration was carried out by the extension overseers. In addition, consultants and BWDB's officials frequently visited the cooperative offices in the project area to solve the bottlenecks for WMG registration. Through the process, registration of all WMGs and WMA was completed within June 2003.

Functions of Water Management Groups (WMGs)

- at the start of the season, WMG Board prepares the schedule of water distribution within their turnout area with assistance from the BWDB overseers;
- WMG Board collects an irrigation fee for each member of WMG using the turnout wise chawkbandi map,
- the irrigation fees as well as its use is explained in regular WMGs meeting ,
- WMGs employed a turnout operator,
- Operation & maintenance of on farm facilities including field channels and turnouts are done by WMGs themselves.



N.B.: ( ) indicates the number

Fig. 3.9: 3-Tier Water Management Organization (WMO) in MDIP

Functions of Water Management Association (WMA)

- WMA employs the canal operators;
- WMAs are responsible for the day to day operation of canals and structures;
- WMA will ensure implementation and monitoring of irrigation plans;
- WMA will intervene in case of conflicts which the WMGs have been unable to solve;
- Members of the WMA participate with the sectional officer and Sub divisional Engineer in identifying the maintenance needs of the systems.

Functions of Water Management Federation (WMF)

- WMF will ensure implementation and monitoring of annual irrigation and maintenance plans,
- WMF will assist the SDE O & M and Mechanical and their field staff in the implementation and monitoring of the annual maintenance plan,
- in consultation with the WMG & WMA , WMF will fix the irrigation fee per hectare irrigated land,
- WMF will intervene in case of conflicts which the WMAs have been unable to solve,

Training

The training had been imparted to beneficiaries by professionals of the NGOs and by the experienced officials of BWDB, DAE, and Department of Cooperatives and also by the consultants of CADP under overall supervision of Chief, Water Management of BWDB.

Training by BWDB

Training program from 1998 to 2003 were undertaken under Chief Water Management for beneficiaries were as follows:

- Co-operative Rules;
- Operation and maintenance procedure;

- Water management;
- Irrigation service charge collection;
- Updating of chawkbandi map;
- O & M plans for irrigation and
- Environmental aspect.

Training by NGO

The NGO named Development Organization of the Rural Poor (DORP) was engaged in MDIP. They started their activities in August 1998 and completed the training program by June 2001.The modules of this training program were:

- Beneficiaries Participation;
- Activities of WMGs for on farm water management;
- Process and awareness of irrigation fees collection;
- Women participation for development.

Irrigation Service Charge

Irrigation service charge has been introduced in CADP since 2001 to contribute in O & M activities. Target of irrigation service charge collection has been fixed on the basis of demand notice issued to the farmers who have been receiving irrigation water consecutively for the last 3 years effectively.

Chawkbandi map helps the collection of service charge on the basis of chawk-based booking of irrigation. WMGs were trained to update these chawkbandi maps and to learn how to use them for practical irrigation planning, booking and service charge collection. The updating of chawkbandi maps was completed during the 2002-2003.

Chapter 4

Methodology

4.1 Introduction

To evaluate the performance of irrigation systems, many researchers have proposed and used different performance indicators. The impact of CADP on the performance of MDIP in this study was assessed using indicators which can broadly be classified into four groups; (1) hydraulic, (2) agricultural (3) socio-economic and (4) environmental. Hydraulic indicators deal with conveyance of water from the pump house to the fields. Agricultural indicators deal with the irrigated area, cropping intensity, crop production. Socio-economic indicators deal with the fee collection and financial self-sufficiency. Environmental indicators deal with the impact on water quality, natural vegetation and fish production. To assess the performance of WMG organized under the CADP, some WMGs were selected and a set of indicators was also identified. Their registration status, membership, election of executive members, training, participation in excavation and maintenance of field channel, operation and maintenance of turnouts, irrigation water distribution, conflict resolution and irrigation fee collection status were assessed through field studies. Questionnaires were prepared for systematic collection of data during the field study.

4.2 Assessment of WMGs Performance

To study the functioning of the WMGs, a five-day (5 - 9 June/05) field visit was made in MDIP. In MDIP, there are 388 WMGs for performing on farm level water management. Among them 41 WMGs (which is about 10 % of total) were selected for assessing their performance. Selection criteria for assessing the performance of WMGs were as (1) to cover the whole project area, (2) to include good, moderate and poor types of WMGs and (3) easy communication.

Selected 41 WMG sites were visited during the field study and interviews with the presidents and other members of WMG have been taken about their functioning and performance on on-farm level water management. Performance of selected 41 WMG's has been assessed giving due consideration to the following factors:

Registration, Membership of WMGs and Election of Executive Committee: The necessary information on registration status of WMGs have been collected from the project office and through field studies. According to Guideline for Participatory Water Management (GPWM, 2001) registration of WMGs has been done within the framework of the cooperative societies ordinance, 1984 and the cooperative societies rules, 1987 as amended from time to time. It says that for the legal status of WMO and for signing agreement with the concerned implementing agency the registration of WMG is essential. In line with the GPWM, registration of WMGs was done at first and subsequently of WMAs. For membership of WMGs, the following information have been collected from field studies or interview with WMG's president / secretary / members and from local project office:

- total eligible member for each selected WMG;
- present number of member for each selected WMG;
- present number of female member for each selected WMG.

The necessary information on election of executive committee have been collected from the field survey through discussion with the WMG's president / secretary/members.

Training of WMGs Member: As per CADP guidelines, all the WMG's members should receive training from the different agencies for the effective on-farm water management. During the field investigation, information on this aspect has been collected from the local officials and WMGs members.

Farmers Participation in Excavation and Maintenance of Field Channel: As per CADP guidelines, farmers are fully responsible for maintaining their on-farm field channels. From this point of view, the following information about farmers participation in excavation and maintenance their field channel have been collected from the concern farmer or WMG member:

- WMG wise irrigable area for 2003-04;

- Length of excavated field channel;
- Labour contributed for excavation of field channels;
- Was there any maintenance required or not, if required what types of maintenance was done by them?
- Have they received any technical support from BWDB for excavation and maintenance of their field channels?

Operation and Maintenance of Turnouts: For knowing their role in operation and maintenance of turnout and on-farm water management, the following information has been collected through the field study:

- Was there any turnout operator employed by the WMG? If yes, then has he received any training for turnout operation?
- Was there any maintenance needed for the turnout? If yes, then how the maintenance was carried out and what types of maintenance were done?
- Whether turnout operator maintained a register for proper implementation of water distribution schedule.

Irrigation Water Distribution: During the irrigation period water distribution schedule was very important for on-farm water management. That's why during the field investigation another important question to the WMG member was asked to know whether they have prepared and implemented their water distribution schedule.

Conflict Resolution: During the turnout operation, there are some possibilities of operational conflict. Resolution of these conflicts is important for smooth implementation of irrigation schedule. That's why the following information was collected from the farmers level:

- Did the WMG face the turnout operation conflicts?
- What types of conflicts usually exit in actual field?
- Was the WMG capable to resolve the conflicts? If not then how did they solve it?

Irrigation fee collection: Irrigation fee collection is one of the key factors for sustainable O & M of the project. That's why, the following information have been collected through the interviews with the farmers:

- What was the target for irrigation fee collection during the year 2003-04 for each selected WMG?
- What amount of irrigation fee was actually collected during the year 2003-04 for each selected WMG?
- For collecting the irrigation fees, have they received any support from BWDB?

After getting information from WMGs, it was checked and verified with the local project official documents. Figs. 4.1 and 4.2 show interviews with concerned WMG personnel.

Fig. 4.1: Interview with the president of U21/7 WMG in MDIP

Fig. 4.2: Interview with the president of K1/1 WMG in MDIP

4.3 Impact of Command Area Development Program (CADP)

The impacts of CADP on the performance of MDIP were assessed comparing the values of selected indicators for the benchmark year (1996-97) with those for the subsequent years. In this study, for impact evaluation of CADP in MDIP the selected indicators for the hydraulic, agricultural, socio-economic and environmental aspects are discussed below:

4.3.1 Hydraulic Indicators

The hydraulic indicators are concerned with the assessment of the water supply function of the conveyance system. The hydraulic indicators used in the performance evaluation are relative water supply and water level.

Relative Water Supply (RWS): RWS is used as an indicator of the adequacy of the irrigation water deliveries. This indicator developed by Levine (1982), compares water availability with actual demand, which is defined as:

$$RWS = \frac{\text{Irrigation water supply} + \text{Effective Rainfall}}{\text{Evapotranspiration} + \text{Seepage and Percolation}} \qquad \text{- - - - - - - - - - (4.1)}$$

To estimate the water adequacy, 10-day RWS values are used. For calculating the value of RWS, each of the 4 components of the above equation needs to be determined. Details of calculation are given below:

Irrigation water supply was calculated from the pump operating hours per day for the irrigation seasons of 1996 and 2003. Pump's operating hours have been collected from the local office. All pumps have a rated discharge of 7.22 cumec. Using this discharge value, the volume of irrigation water supply has been calculated for the pre and post CADP situations.

The effective rainfall is only the part of the total seasonal rainfall. Effective rainfall was taken as 80 % of the recorded rainfall. The rainfall data for the years of 1996 and 2003 were collected from BWDB climatic station at Chandpur.

The value of seepage and percolation loss depends on the type of soil. The area of MDIP is an alluvial plain. The majority of the soils in the area was considered medium to fine textured soils and the seepage and percolation rate for MDIP area has been considered as 5 mm/day (BWDB, 1999).

In MDIP, the transplantation of boro rice took place during 14 January till 4 February. Therefore, four transplanting dates namely 14 January, 21 January, 28 January and 4 February were considered for calculation of evapotranspiration. Climatic data e.g. temperature, rainfall, sunshine, wind, humidity and crop data e.g. various transplanting dates, total growth period, duration of growth stage, crop coefficient value for each growth stage are used to calculate the evapotranspiration. Climate data was collected from Bangladesh Metrological Department (BMD) and BWDB climatic station at Chandpur. Crop data were collected from agriculture extension office at Chandpur and from various reports on MDIP. Evapotranspiration value was calculated by the software "CROPWAT" using the climatic and crop data.

Water Levels: The water levels maintained in the main, secondary and tertiary canals were considered as an indicator for adequacy of water supply. Hence, the water level at the head of some selected secondary canal U21 and tertiary canals U21-3 and U21-4 were analyzed and a comparison was made between the actual and target water levels in those canal for both pre and post CADP situations. No water level gauges were installed in the irrigation canal by BWDB in pre CADP situation. In 1999 Institute of Water Modeling (IWM) office installed water level gauges at the head of selected canal and took reading during the irrigation season in 1999. Therefore the water level values for the year 1999 were considered to reflect the pre CADP situation. Water level data used for this analysis. The target water levels were considered as the Full Supply Level (FSL) of that canal. For above selected canals, pre CADP condition's water level for 1999 were collected from Institute of Water Modeling office and post CADP condition's water level data for 2003 and FSL data were collected from BWDB field office.

4.3.2 Agricultural Indicators

These indicators used for comparison of irrigated agricultural performance for the benchmarks year (1996-97) with those for the subsequent years. The agricultural indicators used in the performance evaluation are year wise irrigated area; year wise cropping intensity, year wise yield and year wise production.

Year Wise Irrigated Area: This indicator used for the assessment of agricultural performance in respect of year wise target and actual irrigated area. Irrigation Committee fixes every year's target from the consideration of previous year's achievement. For calculating the value of year wise irrigated area, values of actual irrigated area and target area to be irrigated for the whole project from 1996-97 to 2003-04 were collected from the local project office.

Year Wise Cropping Intensity: The changes in cropping intensity have been treated as an indicator for the project performance. This indicator used for assessment of agricultural performance in respect year wise target and actual cropping intensity. Cropping intensity has been calculated from the ratio of cropped area and total potential area. Under CADP in MDIP total potential area has been considered as 13602 ha. The change in cropping intensity for whole cropped seasons from 1996-97 to 2003-04 was calculated for assessing the agricultural performance. Necessary data have been collected from agriculture extension office at Chandpur and from various reports on MDIP.

Year Wise Yield: The changes in yield have been treated as an indicator for the performance of the project. This indicator has been used to evaluate the target and actual yield variation for HYV Boro rice. The change of yield for Boro rice from 1996-97 to 2003-04 was calculated for assessing the agricultural performance. The values of actual and targets yield for Boro rice were collected from the local agriculture extension office during the field survey.

Year Wise Production: This indicator used in respect of year wise target and actual production for boro rice. This indicator has been calculated for the period from 1996-97 to 2003-04 for assessing the agricultural performance. The values of actual and target production for Boro rice for the whole project were collected from the local agriculture extension office during the field survey.

4.3.3 Socio -Economic Indicators

The socio-economic indicators used in the performance evaluation are fee collection performance and financial self-sufficiency.

Fee Collection Performance: Irrigation fee collection is important for sustainable O & M of the project facilities. This indicator was proposed by Svendsen (1992) for assessment of socio-economic performance in respect of irrigated fee collection. This is expressed as the ratio of irrigation fees collected to irrigation fees due. Irrigation service charge has been introduced in CADP since 2001 to contribute in O & M activities and Tk 460.0 per acre has been fixed as a service charge. Irrigation fees due has been fixed on the basis of demand notice issued to the farmers who have been receiving irrigation water consecutively for the last 3 years effectively. During the field investigation, the values of irrigation fees collected and irrigation fees due for 2003-04 were collected from the concerned farmers or WMG members.

Financial Self Sufficiency: This indicator was proposed by Bos et.al. (1993) for assessment of socio-economic performance in respect of financial self-supporting the project. This is defined as the ratio of irrigation agency income from fee collection to total O & M requirements. During the field investigation, the values of irrigation agency income from fee collection and total O & M requirements for 2003-04 were collected from the local project office.

4.3.4 Environmental Indicators

Continued irrigation brings in both favorable and unfavorable environmental changes in the irrigated area. Therefore the environmental parameters have been considered as the performance indicators of the project. For environment impact assessment, the major items of concern are water quality, natural vegetation and fish production. The necessary data for pre (1996-97) and post (2003-04) CADP situation has been collected from local project office, department of environment and Matlab Thana fisheries office.

Chapter 5

Results and Discussion

Impact of CADP on project performance has been evaluated in terms of institutional, hydraulic, agricultural, socio-economic and environmental aspects. The institutional aspect deals with the performance of selected WMGs during the irrigation season of 2003-04. The hydraulic aspect covers the performance of irrigation system in water supply. Agricultural aspect includes irrigated area, cropping intensity, yield and total production. Socio-economic aspect focuses on irrigation fee collection and financial self-sustainability of the project. Environmental aspect encompasses water quality, natural vegetation and fish production.

5.1 Performance of Water Management Groups

The performance of the selected Water Management Groups (WMGs) during 2003-04 in terms of the some selected indicators have been discussed in the following sections:

5.1.1: Registration, Membership Status and Election of Executive Member

As per Command Area Development Program's (CADP) guidelines, 388 WMGs were formed with the farmers. All WMGs must be registered in BWDB. All farmers are entitled to become members of a WMG and they elected the executive member of Water Management Groups.

According to the questionnaires detailed responses of the selected WMGs during the field survey for 2003-04 in terms of their registration, membership and election of executive member are presented in Table 5.1

Table 5.1: Registration, membership status and election of executive member of selected WMGs.

WMA No	Name of the WMG	Registration Status		Membership					Election of executive committee held	
		Registered	Non Registered	Total eligible member	Present member No.	Present member % of total eligible	Present female member No.	Female member % of present member No.	Yes	No
1	2	3	4	5	6	7	8	9	10	11
1	U1/7	√		50	21	42	4	19.05	√	
	U21/1,2	√		26	23	88.46	4	17.39		√
	U21/7	√		70	27	38.57	4	14.81		√
	U21-3/2	√		50	11	22	2	18.18	√	
2	U12/2	√		70	14	20	2	14.29	√	
	U13-1/2	√		40	15	37.50	2	13.33		√
	U12/1	√		90	11	12.22	2	18.18		√
	U13-2/9	√		85	15	17.65	1	6.67	√	
	U12/3	√		95	15	15.79	-	0		√
	U11/5	√		40	15	37.50	-	0	√	
	U13/2	√		162	16	9.87	2	12.50		√
	U13/5	√		67	15	22.39	2	13.33		√
	U11/2	√		85	20	23.53	2	10	√	
	U12/8	√		43	15	34.88	2	13.33	√	
3	U2/1	√		30	24	80	3	12.50		√
	U2/6	√		95	21	22.11	3	14.29	√	
	U2/11	√		85	16	18.82	-	0		√
	U2/16	√		110	15	13.64	-	0	√	
4	E1/5	√		55	15	27.27	3	20		√
	E2-4/2,3	√		73	16	21.92	2	12.50	√	
	E2-4/5	√		105	15	14.29	2	13.33	√	
	E2/4	√		77	17	22.08	2	11.76	√	
	E2/3	√		68	16	23.53	2	12.50		√

Table 5.1: Registration, membership status and election of executive member of selected WMGs (continued).

WMA No	Name of the WMG	Registration Status		Membership					Election of executive committee held	
		Registered	Non Registered	Total eligible member	Present member No.	Present member % of total eligible	Present female member No.	Female member % of present member No.	Yes	No
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
5	DU1/1	√		55	15	27.27	2	13.33	√	
	DU1-2/4	√		67	15	22.39	2	13.33		√
7	K1/1	√		110	21	19.10	2	9.52		√
	K12/9	√		62	15	24.20	2	13.33	√	
	K12/12	√		80	15	18.75	2	13.33	√	
	K12/14	√		55	20	36.36	3	15	√	
	K12/15	√		110	16	14.55	3	18.75		√
	K1-1/3	√		80	20	25	2	10	√	
	K12-1/1,2,3,4	√		70	20	28.57	2	10	√	
	K121/4,5	√		120	20	16.67	2	10		√
8	K2/1	√		120	18	15	2	11.11	√	
	K2/2,3	√		50	17	34	2	11.76	√	
	K2/5	√		40	20	50	3	15		√
	K2/8,9	√		100	14	14	2	14.28	√	
	K21/1	√		60	20	33.33	3	15	√	
	K21/4	√		94	20	21.27	3	15		√
	K21/5	√		60	15	25	2	13.33	√	
	K21/7	√		110	15	13.64	2	13.33	√	

The performances of the selected WMGs from Table 5.1 are as follows:

- Selected all WMGs were registered;
- Total eligible members for each WMG varied from 26 to 162 with an average of 76;
- Present number of members for each WMG varied from 11 to 27 which represent 10 to 88 percent of the total eligible members;

- The present membership in 38 out of 41 selected WMGs is less than 50 % of total eligible members. This is quite unsatisfactory mainly due to lack of motivation and incentive;
- Present female member for each WMG varied from 0 to 4 with an average of 2;
- Female member % of present member number for each WMG varied from 0 to 19 with an average of 12.36; and
- 59 % of the selected WMGs elected their executive committee members. In case of other WMGs the executive committee members were selected by the members without election. But this is not in accordance with the CADP guidelines.

5.1.2: Training of WMG Members in MDIP

As per CADP guideline, all WMGs members should receive training on on-farm water management. Detailed responses of the selected WMGs according to the questionnaires during the field study for 2003-04 in terms of their training are presented in Table 5.2

Table 5.2: Training of WMG members in MDIP

WMA No	No. of the WMG	Received training from NGO on				Received training from BWDB on					
		Water Management at farm level		Awareness & procedure for irrigation fees collection		Cultivation of modern & high yield varieties		Irrigation water supply to field		Awareness & procedure for irrigation fees collection	
		Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
1	U1/7	√		√		√		√		√	
	U21/1,2	√		√		√		√		√	
	U21/ 7	√		√		√		√		√	
	U21-3/2	√		√		√		√		√	
2	U12/2	√		√		√		√		√	
	U13-1/2	√		√		√		√		√	
	U12/1	√		√		√		√		√	
	U13-2/9	√		√		√		√		√	
	U12/3	√		√		√		√		√	
	U11/5	√		√		√		√		√	
	U13/2	√		√		√		√		√	
	U13/5	√		√		√		√		√	
	U11/2	√		√		√		√		√	
	U12/8	√		√		√		√		√	
3	U2/1	√		√		√		√		√	
	U2/6	√		√		√		√		√	
	U2/11	√		√		√		√		√	
	U2/16	√		√		√		√		√	
4	E1/5	√		√		√		√		√	
	E2-4/2,3	√		√		√		√		√	
	E2-4/5	√		√		√		√		√	
	E2/4	√		√		√		√		√	
	E2/3	√		√		√		√		√	

Table 5.2: Training of WMG members in MDIP (continued)

WMA No	No. of WMG	Received training from NGO on				Received training from BWDB on					
		Water Management at farm level		Awareness & procedure for irrigation fees collection		Cultivation of modern & high yield varieties		Irrigation water supply to field		Awareness & procedure for irrigation fees collection	
		Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
1	2	4	5	6	7	8	9	10	11	12	13
5	DU1/1	√		√		√		√		√	
	DU1-2/4	√		√		√		√		√	
7	K1/1	√		√		√		√		√	
	K12/9	√		√		√		√		√	
	K12/12	√		√		√		√		√	
	K12/14	√		√		√		√		√	
	K12/15	√		√		√		√		√	
	K1-1/3	√		√		√		√		√	
	K12-1/1,2,3,4	√		√		√		√		√	
	K121/4,5	√		√		√		√		√	
8	K2/1	√		√		√		√		√	
	K2/2,3	√		√		√		√		√	
	K2/5	√		√		√		√		√	
	K2/8,9	√		√		√		√		√	
	K21/1	√		√		√		√		√	
	K21/4	√		√		√		√		√	
	K21/5	√		√		√		√		√	
	K21/7	√		√		√		√		√	

From the field investigation it has been seen that the all selected WMG's members have received training from NGO and BWDB during 1998 to 2003.

5.1.3: Farmer's Participation in Excavation and Maintenance Field Channels in MDIP

As per the guidelines of CADP the farmers are responsible for excavation and maintenance of their field channel. As per field investigation, according to the questionnaires detailed information of farmer's participation in excavation and maintenance of field channels are presented in Table 5.3

Table 5.3: Farmer's participation in excavation and maintenance of field channels in MDIP

WMA No	No. of the WMG	Field Channel							Technical Support from BWDB	
		Irrigable Area (ha)	Channel Excavation (m)	Length / unit area (m/ha)	Labor Contributed(man month)	Maintenance				
						Yes	No	Type of work (1/2/3/4)	Yes	No
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
1	U1/7	10.12	600	59.29	10	√		4	√	
	U21/1,2	4.86	300	61.73	7	√		4	√	
	U21/7	10.12	650	64.23	11		√	-	√	
	U21-3/2	8.10	800	98.77	14		√	-		√
2	U12/2	7.29	600	82.30	11	√		2,3,4	√	
	U13-1/2	4.86	250	51.44	5	√		1,3,4	√	
	U12/1	11.34	800	70.55	15	√		1,3,4	√	
	U13-2/9	8.10	500	61.7	9		√	-		√
	U12/3	10.12	250	24.70	6	√		1,2	√	
	U11/5	19.84	1000	50.40	17		√	-		√
	U13/2	23.89	2000	83.72	33	√		1,2,3	√	
	U13/5	7.69	250	32.50	5	√		2,3	√	
	U11/2	22.27	1500	67.36	26		√	-	√	
	U12/8	2.83	250	88.34	6		√	-		√

Table 5.3: Farmer's participation in excavation and maintenance of field channels in MDIP (continued)

WMA No	No. of the WMG	Field Channel							Technical Support from BWDB	
		Irrigable Area (ha)	Channel Excavation (m)	Length / unit area (m/ha)	Labor Contributed(man month)	Maintenance				
						Yes	No	Type of work (1/2/3/4)	Yes	No
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
3	U2/1	14.17	300	21.17	6		√	-	√	
	U2/6	9.31	600	64.45	10	√		3	√	
	U2/11	6.07	500	82.37	9	√		1,2	√	
	U2/16	10.12	800	79.05	14	√		3	√	
4	E1/5	7.29	500	68.58	10		√	-	√	
	E2-4/2,3	8.50	700	82.35	12	√		4	√	
	E2-4/5	10.93	900	82.34	17	√		3	√	
	E2/4	6.88	750	109.01	13	√		2,4	√	
	E2/3	6.07	500	82.37	8		√	-		√
5	DU1/1	5.67	500	88.18	9	√		1,2	√	
	DU1-2/4	8.90	1000	112.36	17		√	-		√
7	K1/1	40.49	1600	39.52	28	√		4	√	
	K12/9	9.76	600	61.47	10	√		3,4	√	
	K12/12	14.00	700	50	12	√		2	√	
	K12/14	18.30	800	43.72	14	√		1,2	√	
	K12/15	16.00	800	50	15		√	-		√
	K1-1/3	35.68	1000	28.03	18		√	-		√
	K12-1/1,2,3,4	9.00	400	44.44	7		√	-	√	
	K121/4,5	18.22	500	27.44	9	√		1,4	√	
8	K2/1	14.26	600	42.08	11	√		4	√	
	K2/2,3	12.22	400	33.00	8	√		2,4	√	
	K2/5	4.07	200	49.14	5	√		1,3	√	
	K2/8,9	17.49	700	40.02	12	√		2,4	√	
	K21/1	11.30	500	44.25	10		√	-	√	
	K21/4	18.96	600	31.65	11	√		2,4	√	
	K21/5	12.85	550	42.80	10		√	-		√
	K21/7	16.59	600	36.17	10		√	-		√

N.B.: 1 = re-excavation; 2 = cleaning; 3 = Slope build up; 4 = Ghog filling

The performances of the selected WMGs from Table 5.3 are as follows:

- Irrigable area varied from 2.83 ha to 40.49 ha with an average of 12.55 ha. for each WMG;
- Length of field channels varied from 200 m to 2000 m with an average of 667 m for each WMG;
- Field channels length per unit irrigated area for each WMG varied from 21.17 m/ha to 112.36 ha/m with an average of 59.34 m/ha ;
- Labour contributed for field channel excavation varied from 5 man-month to 33 man-month with an average of 12 man-month;
- 61 % of selected WMGs took their maintenance responsibility for field channels. This is not satisfactory. This was mainly due to lack of (1) farmer's negligence, (2) lack of WMGs fund for maintenance of field channels. When land owner stays outside the project, then farmers were not interested to take their maintenance responsibility;
- Members of 76 % of the selected WMGs received technical support from BWDB about excavation and maintenance of field channels. Members of 10 of WMGs out of 41 selected WMGs did not receive any technical support from BWDB mainly due to lack of interest and accountability of the concern BWDB personnel.

5.1.4: Performance of WMGs on Operation and Maintenance of Turnouts and Water Distribution within Turnout Command Area in MDIP

As per CADP, responsibility of operation and maintenance of turnouts and on farm water distribution was handed over to WMGs. As per field investigation, the performance on operation and maintenance of turnouts and water distribution within turnout command area are presented in Table 5.4

Table 5.4: Performance of WMGs on operation and maintenance of turnouts and water distribution within turnout command area in MDIP

WMA No	No. of WMG	WMG employed the turnout operator		Operator received any training		Maintenance of turnout carried out by WMG		Type of maintenance work (1/2/3/4)	Register maintained		Water distribution Schedule				Technical Support from BWDB	
		Yes	No	Yes	No	Yes	No		Yes	No	Prepared		Implemented			
											Yes	No	Yes	No	Yes	No
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*
1	U1/ 7	√		√		√		1,4	√		√		√		√	
	U21 / 1,2		√		√		√	-		√	√		√		√	
	U21 / 7	√			√	√		2		√		√		√		√
	U21-3 / 2	√		√			√	-	√		√		√		√	
2	U12 / 2	√		√		√		4	√		√		√		√	
	U13-1/ 2		√		√		√			√	√		√		√	
	U12 / 1	√		√		√		2,4	√		√		√		√	
	U13-2 / 9		√		√	-	-	-	√			√		√		√
	U12 / 3	√		√			√		√		√		√		√	
	U11 / 5	√			√	√		2,3		√	√		√			√
	U13 / 2		√	√			√		√		√		√		√	
	U13 / 5	√		√		√		4	√		√		√		√	
	U11 / 2	√		√		√		2	√		√		√		√	
	U12 / 8		√	-	√	-	-	-	-	√		√		√		√
3	U2 / 1	√		√			√		√		√		√		√	
	U2 / 6	√			√	√		4	√		√		√		√	
	U2 / 11		√		√		√			√	√		√		√	
	U2 / 16	√		√			√		√		√		√		√	

Table 5.4: Performance of WMGs on operation and maintenance of turnouts and water distribution within turnout command area in MDIP (continued)

WMA No	No. of WMG	WMG employed the turnout operator		Operator received any training		Maintenance of turnout carried out by WMG		Type of maintenance work (1/2/3/4)	Register maintained		Water distribution Schedule: Prepared		Water distribution Schedule: Implemented		Technical Support from BWDB	
		Yes	No	Yes	No	Yes	No		Yes	No	Yes	No	Yes	No	Yes	No
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*
4	E1/ 5	√		√			√			√		√		√	√	
	E2-4 / 2,3		√		√	√		1,4	√		√		√		√	
	E2-4 / 5	√		√		√		2	√		√		√		√	
	E2 / 4	√		√			√			√	√		√		√	
	E2 / 3		√		√	√		2	√			√		√		√
5	DU1/ 1	√		√		√		1,4	√			√		√	√	
	DU1-2 / 4	√		√		√		3	√		√		√			√
7	K1/ 1		√		√		√		√		√		√		√	
	K12 / 9		√		√		√			√		√		√	√	
	K12 / 12	√		√		√		2,4	√		√		√		√	
	K12 / 14	√		√		√		3	√		√		√			√
	K12 / 15		√		√	√		2		√		√		√		√
	K1-1/ 3		√		√	√		1	√		√		√		√	
	K12-1 / 1,2,3,4	√		√		√		4	√		√		√		√	
	K121 / 4,5		√		√		√			√	√		√		√	

Table 5.4: Performance of WMGs on operation and maintenance of turnouts and water distribution within turnout command area in MDIP (continued)

WMA No	No. of WMG	WMG employed the turnout operator		Operator received any training		Maintenance of turnout carried out by WMG		Type of maintenance work (1/2/3/4)	Register maintained		Water distribution Schedule				Technical Support from BWDB	
											Prepared		Implemented			
		Yes	No	Yes	No	Yes	No		Yes	No	Yes	No	Yes	No	Yes	No
1	*2*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*		*15*	*16*	*17*
8	K2 / 1	√		√		√		4	√		√		√		√	
	K2 / 2,3	√		√			√	-	√		√		√		√	
	K2 / 5		√		√	√		4	√			√		√	√	
	K2 / 8,9	√		√			√	-	√		√		√		√	
	K21 / 1	√		√		√		1,2	√		√		√		√	
	K21 / 4		√		√	√		4		√	√		√		√	
	K21 / 5	√		√		√		4	√		√		√			√
	K21 / 7		√		√		√	-	√			√		√		√

N.B.: 1 = Replacement of rubber seal; 2 = Gate repairing / greasing, painting; 3 = Pipe replacing; 4 = Earth filling for preventing water leakage

Based on the field investigation, performance of the selected WMGs during 2003-04 in terms of the operation and maintenance of turnouts and on farm water distribution are as follows:

- 61 % of selected WMGs employed the turnout operator and 56 % of that turnout operator received training for turnout operation.
- 61 % of selected WMGs involved in turnout maintenance work e.g. replacement of rubber seal / gate repairing, greasing, painting, pipe replacing;
- 71 % of selected WMG's turnout operator maintained a register for proper implementation of water distribution schedule;
- 76 % of selected WMGs prepared and implemented their water distribution schedule within turnout command area.

Above performance of the selected WMG is not very satisfactory. This was due to negligence of BWDB, insufficient service charge collection and negligence of turnout operation and lack of monitoring.

5.1.5: Performance of WMGs on Irrigation Fee Collection and Conflict Resolution in MDIP

Water Management Groups (WMGs) is responsible for collecting the irrigation fee. As per field investigation, detailed responses of the selected WMGs on irrigation fee collection and conflict resolution are presented in Table 5.5

Table 5.5: Performance of WMGs on irrigation fee collection and conflict resolution in MDIP

WMA No	No. of WMG	Fee collection from WMG member		Use of fee explained in WMG meeting		Conflict in operation of turnout		Type of conflict (a / b / c)	Conflict resolved by WMG		Technical Support from BWDB	
		Amount of fee assessed 2003-04 (Tk.)	Amount of fee collected 2003-04 (TK.)	Yes	No	Yes	No		Yes	No	Yes	No
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
1	U1/7	9000	8000	√		√		c ,b	√		√	
	U21/1,2	5000	3500	√			√	-	-	-	√	
	U21/7	28000	15000	√		√		a	√			√
	U21-3/2	6000	4000	√			√	-	-	-	√	
2	U12/2	7000	3000	√			√	-	-	-	√	
	U13-1/2	5000	2000	√		√		b	√		√	
	U12/1	12000	4000	√			√	-	-		√	
	U13-2/9	-	-		√	-	-	-	-			√
	U12/3	12000	-		√		√	-	-	-	√	
	U11/5	22000	-		√	√		a	√			√
	U13/2	25000	3000	√		√		b	√		√	
	U13/5	9000	2000	√			√	-	-	-	√	
	U11/2	23000	16000	√		√		b	√		√	
	U12/8	3200	-		√		√	-	-			√
3	U2/1	15000	14000	√			√	-	-		√	
	U2/6	9000	7000	√			√	-	-	-	√	
	U2/11	6500	4000	√		√		a	√		√	
	U2/16	11000	8000	√		√		c	√		√	
4	E1/5	8000	2000	√			√		-		√	
	E2-4/2,3	9500	4000	√		√		a	√		√	
	E2-4/5	12000	-		√		√	-	-	-	√	
	E2/4	7000	3000	√		√		c	√		√	
	E2/3	7000	3500	√		√		b	√			√

Table 5.5: Performance of WMGs on irrigation fee collection and conflict resolution in MDIP (continued)

WMA No	No. of WMG	Fee collection from WMG member		Use of fee explained in WMG meeting		Conflict in operation of turnout		Type of conflict (a / b / c)	Conflict resolved by WMG		Technical Support from BWDB	
		Amount of fee assessed (TK.)	Amount of fee collected (TK.)	Yes	No	Yes	No		Yes	No	Yes	No
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
5	DU1/1	6000	2000	√		√		b	√		√	
	DU1-2/4	9000	2500	√			√	-	-	-		√
7	K1/1	16000	10000	√			√	-	-	-	√	
	K12/9	9000	5000	√			√	-	-	-	√	
	K12/12	10000	4500	√		√		a,b	√		√	
	K12/14	11000	7000	√		√		b	√			√
	K12/15	16000	12000	√			√	-	-	-		√
	K1-1/3	16000	7000	√		√		a	√		√	
	K12-1/1,2,3,4	11000	7000	√		√		a	√		√	
	K121/4,5	16000	7000	√		√		c	√		√	
8	K2/1	14020	10000	√		√		a	√		√	
	K2/2,3	8000	6462	√		√		a	√		√	
	K2/5	4024	1000	√		√		a, c	√		√	
	K2/8,9	17284	17000	√		√		a	√		√	
	K21/1	11164	10000	√			√	-	-	-	√	
	K21/4	18734	16500	√			√	-	-	-	√	
	K21/5	12636	10000	√		√		c	√			√
	K21/7	16388	10000	√			√	-	-	-		√

N.B.: a = water distribution schedule, b = drain alignment, c = sub drain preparation

The finding on irrigation fee collection and conflict resolution during 2003-04 for each selected WMGs are as follows:

- Target for irrigation fee collection varied from Tk.3200/- to Tk.28000/- with an average of Tk.11500/-. This variation due to the variable irrigated area for each WMG;

- Amount of fee collection varied from Tk.1000/- to Tk.17000/- with an average of Tk.6100/-, This variation also due to the variable irrigated area for each WMG;
- Amount of fee collection against target for each WMG varied from 0 % to 98 % with an average of 53 %;
- Due to farmer's negligence only 88 % of selected WMGs explained the use of fee in WMG meeting;
- 54 % of WMGs faced the conflict during turnout operation, but they resolved it by themselves. They faced the conflict mainly due to the water distribution schedule, drain alignment and sub drain preparation;
- 76 % of WMGs have received technical support from BWDB.
- 10 out of 41 selected WMGs did not receive any technical support from BWDB mainly due to lack of interest and accountability of the concern BWDB personnel.

From the above findings it has been found that fee collection performance is not satisfactory compared to its target. Target for irrigation service charge was Tk. 460.00 per acre. BWDB officials reported that the following actions have already been taken for improving the irrigation fee collection:

- WMG, WMA, WMF wise meetings are being held regularly;
- Motivation being continued through beneficiaries training and campaigning from door to door;
- Distribution of leaflet and postering have been done in the project areas for the creation of awareness for service charge payment;
- Demand notices issued to the defaulters;
- Miking in the project area being continued for payment of service charge;
- Temporary stoppage of water supply was applied.

5.2 Impact of CADP on Project Performance

Impact evaluation of Command Area Development Program (CADP) in Meghna Dhonagoda Irrigation Project (MDIP) has been performed using some performance indicators. The quantitative and in some cases qualitative values of the selected indicators served as the degree of achievement. In this study, the impact of CADP on the performance of MDIP has been assessed comparing the values of selected indicators for the benchmark year (1996-97) with those for the subsequent years.

5.2.1 Hydraulic Performance

This refers to the assessment of the performance of canal infrastructure in water distribution at the farm level. The indicators include Relative Water Supply (RWS) and Water Levels.

5.2.1.1 Relative Water Supply (RWS)

Relative Water Supply (RWS) is a measure of adequacy of water availability over the cycle of water deliveries within an irrigation system. RWS values for each 10-day rotational period were determined for Boro rice using Equation 4.1 and results are presented in Table 5.6 and Fig 5.1. Calculation details of various parameters related to RWS are presented in Appendix-A from Table A.1 to A.5.

Table 5.6: Relative Water Supply (RWS) for pre (1996-97) and post (2003-04) CADP in MDIP

Time-Decade	Total Water Supply in mm		Effective rainfall in mm/dec		Et_{crop} in mm/dec		Percolation in mm/dec		RWS	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Jan. – 3	0.80	30.84	1.9	3.10	23.10	28.7	40.00	42	0.04	0.48
Feb. – 1	11.71	76.85	3.3	5.30	30.00	36.6	50.00	50	0.19	0.95
Feb. – 2	27.30	76.54	4.1	6.70	32.40	39.5	50.00	50	0.38	0.93
Feb. – 3	21.61	79.54	6.3	8.90	37.30	45.1	50.00	50	0.32	0.93
Mar – 1	27.57	98.12	6.6	15.0	42.70	51.0	50.00	50	0.37	1.12
Mar – 2	31.78	81.41	7.8	18.7	48.10	56.5	50.00	50	0.40	0.94
Mar – 3	38.82	62.41	18.9	28.8	50.40	57.3	50.00	50	0.57	0.85
Apr. – 1	27.53	62.19	31.3	35.1	52.50	58.1	50.00	50	0.57	0.90
Apr. – 2	31.48	63.51	43.0	42.8	54.50	59.6	50.00	50	0.71	0.97
Apr. – 3	26.87	57.89	47.1	45.3	54.20	58.3	48.00	47	0.72	0.98
May – 1	16.27	41.05	47.8	47.4	52.40	55.1	39.00	38	0.70	0.95
May – 2	0.45	15.14	50.2	50.6	48.40	49.7	26.00	25	0.68	0.88
May – 3	0.51	25.78	56.3	31.6	40.20	40.9	11.00	9	1.11	1.15
Average									0.52	0.93

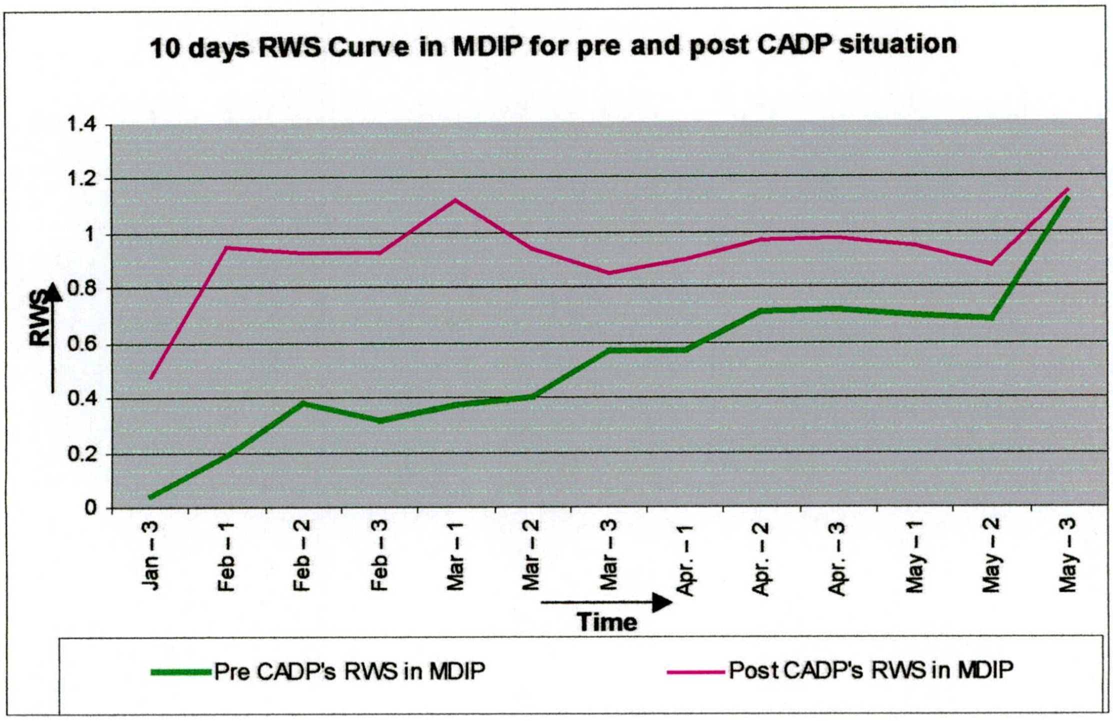


Fig. 5.1: Ten days Relative Water Supply in MDIP for pre (1996-97) and post (2003-04) CADP situation

After CADP in MDIP, It has been shown that Relative Water Supply (RWS) values for Boro rice have been increased significantly after CADP in MDIP. Before CADP average RWS values were found 0.52 and after CADP it was 0.93 i.e. RWS values increased by about 79 %. This resulted because of (1) increase of pump operating hours, (2) increase of awareness of the project management, (3) improved the power supply, (4) improved skill on irrigation water supply. The rotational RWS values varied from 0.48 to 1.15 with an average of 0.93 during post CADP for Boro rice. This wide variation in RWS values was mainly due to improper pump operating schedule. More over this was not satisfactory because RWS value at or close to 1.0 represents scarcity of water.

For better performance of water availability for on farm water management needs to increase the RWS value. For this reason the following action are needed:

- To increase and continue the awareness of the project management;
- To ensure the continuos power supply during the irrigation season;
- To ensure the water supply as per irrigation needs;
- To resolved the conflict between up-land and tail-end farmers;
- To reduced the misuse of irrigation water;
- To increase the awareness of participatory water management.

5.2.1.2 Water Levels

The water levels at the head of some selected secondary (U21) and tertiary canals (U21-3, U21-4) are considered as an indicator for adequacy of water supply. Water levels in pre and post CADP situation and Full Supply Level (FSL) for the above selected canals are presented in Figs 5.2 to 5.4

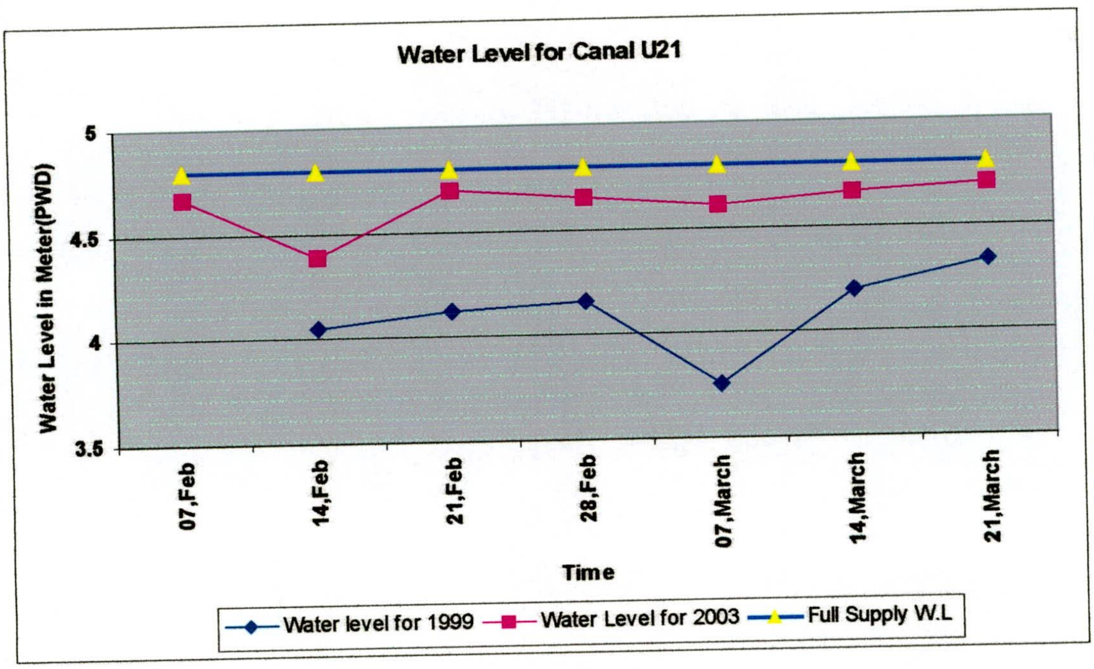


Fig.5.2: Water Levels at the head of canal U21 for pre (1999) and post (2003) CADP in MDIP.

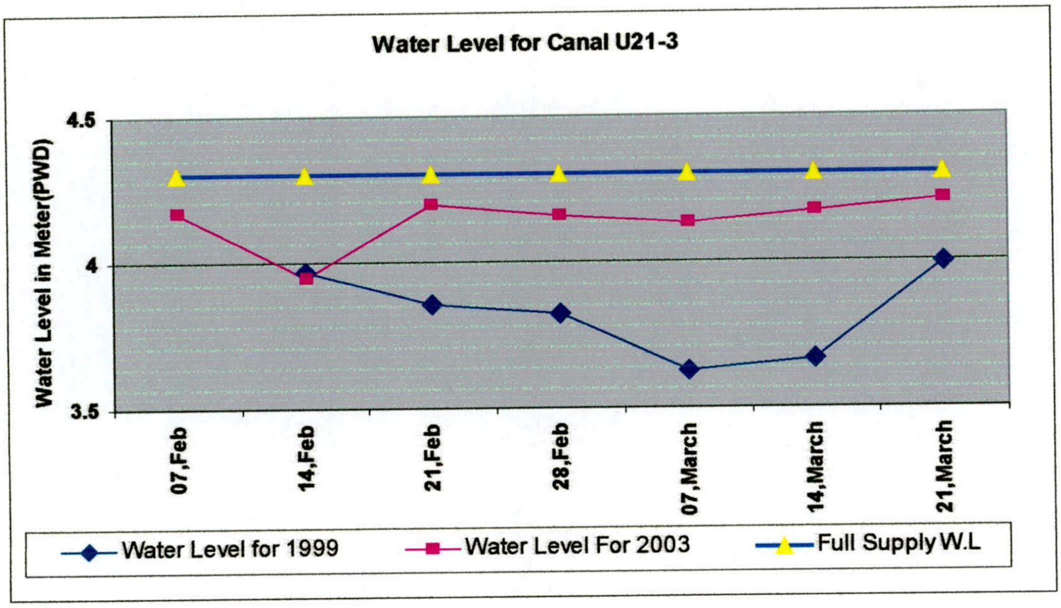


Fig.5.3: Water Levels at head of canal U21-3 for pre (1999) and post (2003) CADP in MDIP.

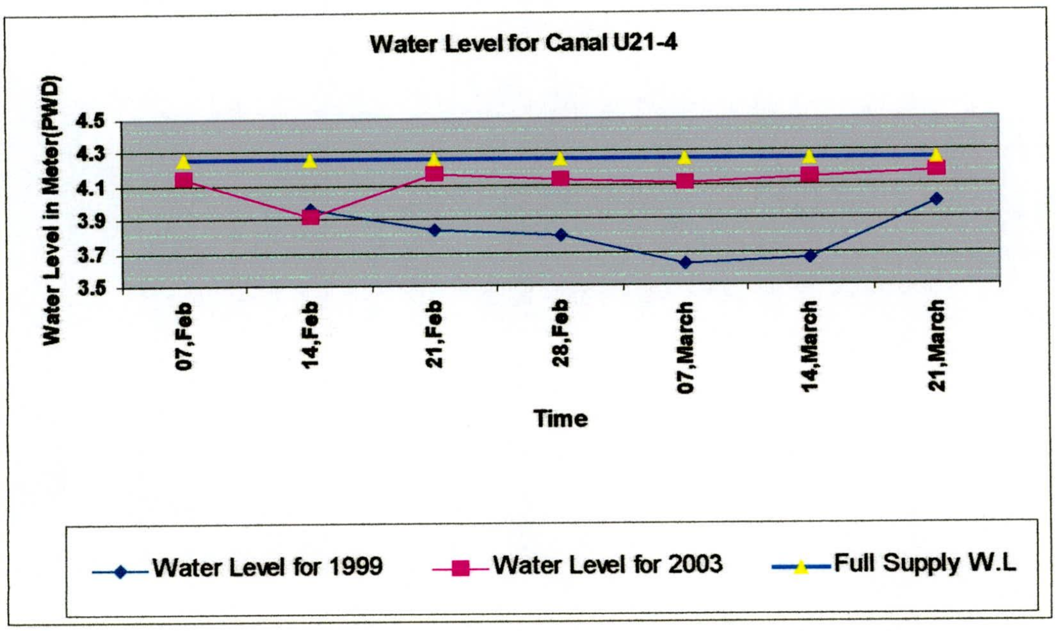


Fig.5.4: Water Levels at the head of canal U21-4 for pre (1999) and post (2003) CADP in MDIP.

After comparison of water levels for post CADP with those for the pre CADP in the selected canals the following observations are made:

- Water level for post CADP period was always higher than pre CADP period; i.e. water level has been improved significantly and it is satisfactory. This was mainly due to some physical rehabilitation of irrigation system as well as improvement in pump and gate operation.
- In post CADP situation, water levels were very close to Full Supply Level (FSL) of that canal. This is more or less satisfactory.

5.2.2 Agricultural Performance

The analysis of agricultural impacts of the CADP in MDIP was focused mainly on the year wise irrigated area, Cropping Intensity, Yield and Production.

5.2.2.1 Year Wise Irrigated Area

This indicator is used for assessing the actual irrigated area covered against target-irrigated area. Results are shown in Fig 5.5.

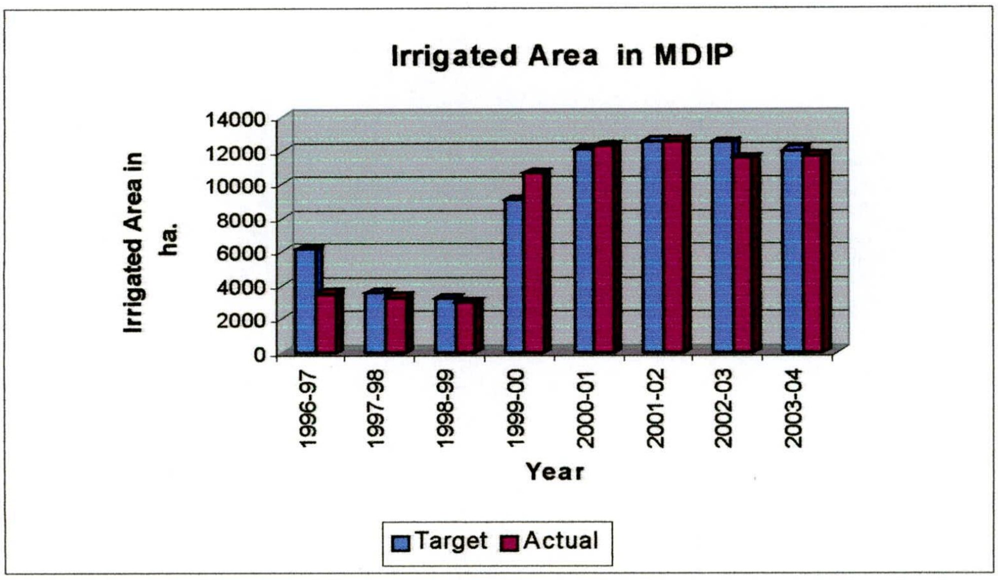


Fig.5.5: Target and actual Irrigated Areas in MDIP from 1996-97(benchmark year) to 2003-04

After field investigation and from Fig. 5.5, the following observations are made:

- After CADP in MDIP, irrigated area of the project has been increased significantly due to (1) better water delivery performance, (2) improved WMG activities, (3) proper rotational program for irrigation and (4) construction of some physical infrastructure;
- Due to rehabilitation work under CADP, irrigation was partially suspended resulting in reduction of irrigated area in 1997-98 and 1998-99 as compared with pre CADP situation;
- In benchmark year target irrigated area was about 6000 ha. And in 2003-04 it was about 12000 ha. . It has been increased by 2 times from the benchmark year;
- In benchmark year actual irrigated area was about 3500 ha. And in 2003-04 it was about 11500 ha. It has been increased by 3 times from the benchmark;

5.2.2.2Year Wise Cropping Intensity

This indicator is used for assessing the cropping intensity for pre to post CADP situation. Results are shown in Fig 5.6. Calculation details are presented in Appendix-A in Table A.6

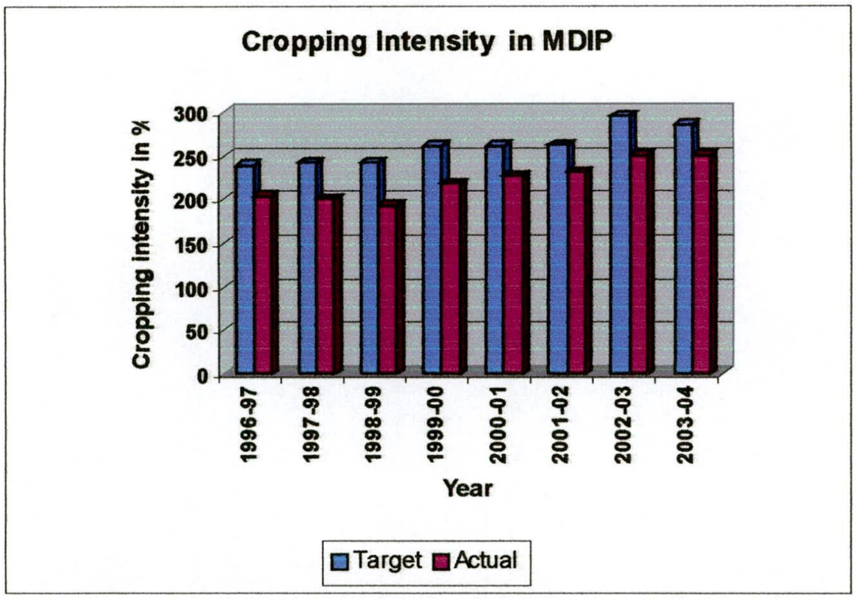


Fig. 5.6: Target and actual cropping intensity in MDIP from 1996-97(benchmark year) to 2003-04

After field investigation and from Fig. 5.6, it is seen that:

- Cropping intensity of the project has been increased from 200 % to 250 % which is more or less satisfactory;
- Target cropping intensity in 1996-97 was about 240 % and from 2001-02 to 2003-04 it was about 290 %. In fact, target cropping intensity was determined without due consideration of the available water resources and no estimates of water requirements was made.

5.2.2.3 Year Wise Yield

Year wise target and actual yield was calculated for HYV Boro rice from the benchmark year (1996-97) to 2003-04 and the results are shown in Fig. 5.7.

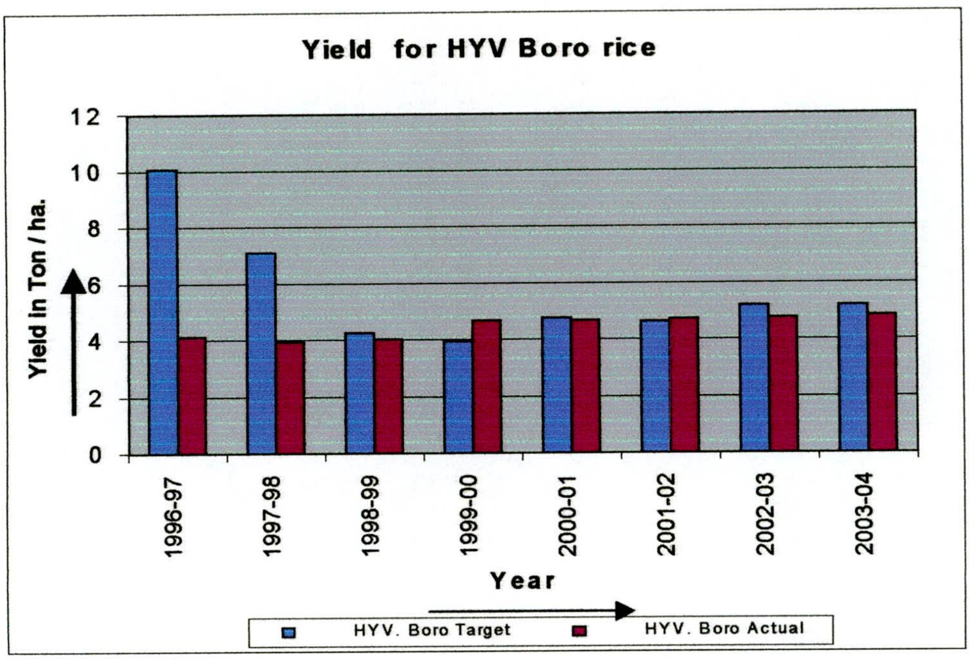


Fig. 5.7: Target and actual yields in MDIP for HYV Boro rice from 1996-97(benchmark year) to 2003-04

From Fig. 5.7 it can be seen that:

- Yield of HYV Boro rice increased from 4 Ton/ha to 4.75 Ton/ha mainly due to the application of balanced fertilizer and the sufficient irrigation water supply as reported by the WMGs member;
- Though in benchmark year target yield was higher than actual yield but in 2003-04 it was very close to actual yield. This may be due to the fact that the target was not correct in the benchmark year;

5.2.2.4 Year Wise Production

HYV Boro rice production from 1996-97 to 2003-04 was determined and the results are shown in Fig. 5.8.

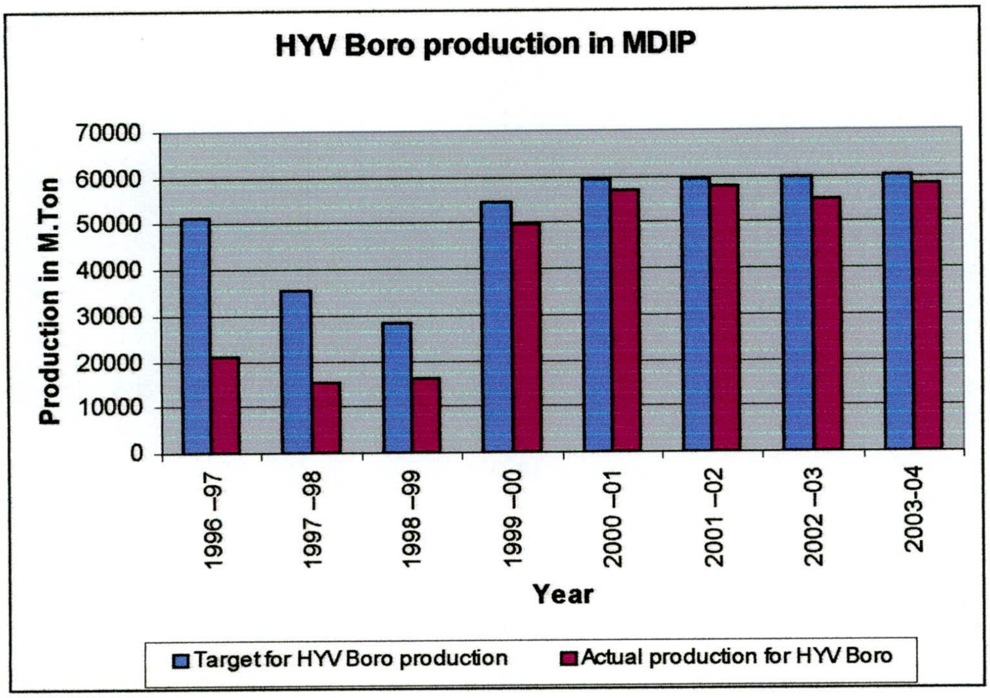


Fig. 5.8: Target and actual production of HYV Boro rice in MDIP from the benchmark year (1996-97) to 2003-04

After CADP in MDIP, HYV Boro production increased significantly and from Fig. 5.8 the following observations are made:

- Actual production increased from 2000 Mt. to 6000 Mt. due to significant increased in irrigated area and yield.
- From 1997-98 to 1998-99, reduction of actual HYV Boro production occurred as compared with the benchmark year. This is mainly due to rehabilitation work during 1997-98 to1998-99 under CADP in MDIP and irrigation was partially suspended.

5.2.3 Socio - Economic Performance

The analysis of socio-economic impact of the CADP focused mainly on the fee collection performance and financial self-sufficiency aspects:

5.2.3.1 Fee Collection Performance

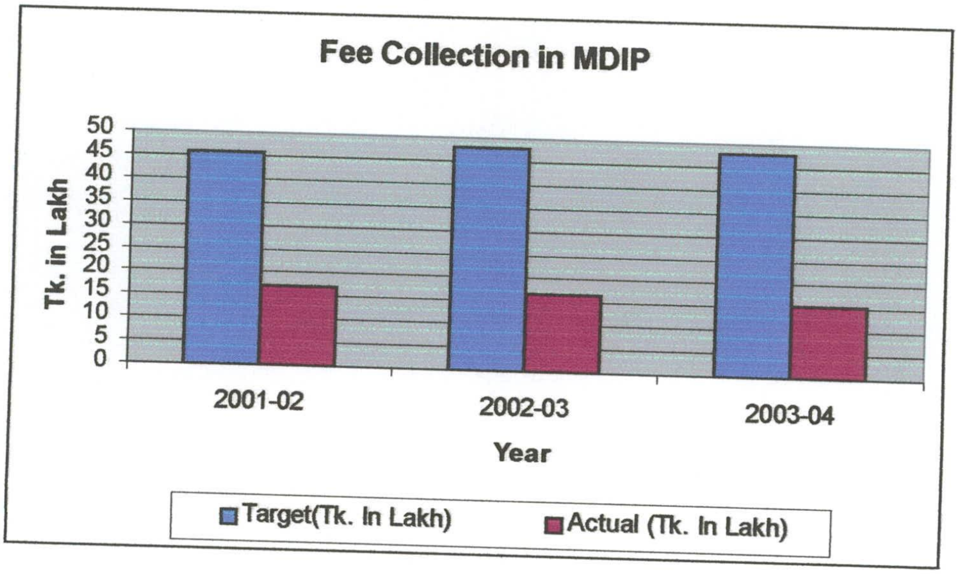


Fig. 5.9: Target and actual irrigation fee collection in MDIP from 2001-02 to 2003-04

After the CADP in MDIP, irrigation fee collection has been started from 2001-02. From Fig.5.9, it is seen that from 2001-02 to 2003-04 average fee collection was Tk.15.00 Lakh and fee collection performance was about 35 %. Reasons for poor fee collection was as follows:

- ❖ There was an idea prevailing among the farmers that the service charge once paid would have to continue paying. If they could avoid it, the government may drop that idea;
- ❖ Farmers were not habituated in making payment of service charge. The idea was new for them;
- ❖ Some of the beneficiaries who did not pay, were instigating others not to pay;
- ❖ Many of the landowners lived outside the project. The landless people cultivate their lands. So, there is a problem of collecting the service charges;
- ❖ The project authority have no legal power to take action against the defaulters and non-payers;
- ❖ Lack of co-operation and internal conflict exists among the WMOs.

5.2.3.2 Financial Self Sufficiency

For the financial year 2003-04 total O & M requirement for project was Tk. 168 Lakh, and irrigation fee collected from water users was only Tk. 15 Lakh for the financial year 2003-04. Hence financial self-sufficiency for the project was 9%. Financial self-sufficiency was very poor and was not satisfactory. To keep irrigation system functioning O & M allocation must be increased and at the same time emphasis must be given on increasing irrigation fee recovery. Without adequate recovery of operation cost, the future of the project will be uncertain.

5.2.4 Environmental Impact

After CADP in MDIP, actually there was no remarkable environmental change comparing pre CADP condition. Pre and post CADP situation, there was no remarkable change in water quality and natural vegetation. But after CADP, fish production increased by two times compared with the benchmark year. This because provision was made in CADP, to increase opportunities for small-scale fisheries development inside the flood embankments and there were some training and monitoring program for increasing the fish production.

Chapter 6

Conclusions and Recommendations

6.1 Conclusions

The following conclusions can be made from the present study.

6.1.1 Water Management Groups Performance

All selected WMGs were registered and received all types of training for on-farm water management from NGO and BWDB during 1998 to 2003. The present members for most of the selected WMGs are below 50% of the eligible members mainly due to lack of motivation and incentive. But their performance in operation and maintenance of on-farm facilities and water distribution were not quite satisfactory during 2003-04 due to negligence of turnout operators and lack of monitoring. The achievement of fee collection was very poor.

6.1.2 Hydraulic Performance

Relative Water Supply (RWS) values for Boro rice from pre (1996-97) to post (2003-04) CADP situation have been increased significantly (0.52 to 0.93). And for 2003-04, it varied from 0.48 to 1.15 with an average of 0.93. But this was not satisfactory because when RWS value at or close to 1.0 then represent scarcity of water.

Water level for selected canal has been improved significantly and it is satisfactory. Water level in post CADP is always higher than pre CADP situation. In post CADP situation, it was very close to Full Supply Level (FSL) of that canal and it is more or less satisfactory.

6.1.3 Agricultural Performance

The CADP in MDIP produced significant positive results in terms of irrigated area, cropping intensity, yield and crop production. Coverage of irrigated area was increased significantly from 3500 ha. (1996-97) to 11700 ha. (2003-04). Cropping intensity for the whole project increased significantly from 200 % to 250 %. For HYV Boro rice, crop yield increased from 4 Ton/ha to 4.75 Ton/ha and production increased from 2000 Mt. to 6000 Mt., which is satisfactory. Resulting agricultural performance was found satisfactory.

6.1.4 Socio-Economic Performance

Economic performance such as fee collection performance and financial self-sufficiency was very poor. From 2001-02 to 2003-04 average fee collection was about 35 % and the financial self-sufficiency only 9 %. This was not satisfactory.

6.1.5 Environmental Impact

There was no remarkable environmental change in water quality and natural vegetation from pre to post CADP condition. But fish production was increased significantly after implementation of CADP.

6.2 Recommendations

Based on the preceding discussions and result of field survey, the following recommendations are, therefore, put forward for to further improves the efficiency of MDIP.

- Effective participation of the Water Management Groups (WMGs) in operation and maintenance and on-farm water management of the project must be ensured;

- Linkage with WMGs and BWDB project level authority must be further improved;

- Tasks and responsibilities of WMGs should be monitored properly;

- For improving the adequacy of water availability over the cycle of water deliverers, the pump-operating hour should be increased.

- For increasing the conveyance efficiency of canal, measure should be taken to reduce the seepage losses;

- For improvement of irrigation service charge collection, all possible actions needs to apply. Engineers, extension officials, revenue officials and the representatives of WMOs need to put their highest efforts for the achievement of target service charge collection.

- Steps need to be taken by BWDB through fund release to timely complete the routine maintenance/modification work so that delivery of irrigation water can be made in time.

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Appendix-A

Table A.1: Climatic data for MDIP area for the year of 2003

Name of Station: Chandpur

	April	May	Jun	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Max^m Monthly Temp. in °C	33.4	33.3	31.4	30.9	31.4	31.8	31.0	29.0	25.6	24.8	27.9	31.7
Min^m Monthly Temp. in °C	23.7	25.0	25.8	25.9	25.9	25.9	24.5	20.3	15.5	14.1	16.2	20.7
Monthly Rainfall in mm	169	259	461	462	404	272	122	37	15	7	24	67
Wind Speed in Km/day	259	216	181	181	164	181	156	112	104	112	121	259
Sunshine in hours	8.4	8.7	5.0	5.4	5.6	5.9	7.3	8.8	9.1	8.8	8.8	8.6
Avg. Humidity in %	74	78	86	87	87	87	83	79	78	74	71	71

Table A.2: Output of Cropwat Software used for calculating Crop water requirement in MDIP

RICE EVAPOTRANSPIRATION AND IRRIGATION REQUIREMENTS

Rain climate station: Chandpur
ETo climate station: Chandpur

Crop: Paddy _Boro
Transplanting date: 14 January

Month	Dec	Stage	Area %	Coef Kc	ETcrop mm/day	Perc	LPrep	RiceRq mm/day	EffR mm/dec	IrReq mm/day	IrReq mm/dec
Dec	2	Nurs	8	1.20	0.25	0.4	1.1	1.7	0.2	1.70	10.2
Dec	3	Nu/La	24	1.18	0.75	1.2	6.2	8.2	1.0	8.07	88.8
Jan	1	Land	64	1.14	1.99	3.2	8.1	13.3	1.6	13.13	131.3
Jan	2	La/In	93	1.11	2.86	4.7	2.4	9.9	1.1	9.84	98.4
Jan	3	Init	100	.10	3.35	5.0	-	8.4	3.7	8.05	88.5
Feb	1	In/De	100	1.09	3.64	5.0	-	8.6	5.3	8.11	81.1
Feb	2	Deve	100	1.08	3.89	5.0	-	8.9	6.7	8.21	82.1
Feb	3	Deve	100	1.07	4.42	5.0	-	9.4	8.9	8.03	64.3
Mar	1	De/Mi	100	1.06	5.04	5.0	-	10.0	15.0	8.54	85.4
Mar	2	Mid	100	1.05	5.64	5.0	-	10.6	18.7	8.77	87.7
Mar	3	Mid	100	1.05	5.75	5.0	-	10.8	28.8	8.38	92.1
Apr	1	Mid	100	1.05	5.83	5.0	-	10.8	35.1	7.32	73.2
Apr	2	Mi/Lt	100	1.02	5.80	4.4	-	10.2	42.8	5.95	59.5
Apr	3	Late	100	0.94	5.32	3.3	-	8.6	45.3	4.09	40.9
May	1	Late	100	0.85	4.83	1.9	-	6.7	47.4	1.98	19.8
May	2	Late	100	0.79	4.49	0.4	-	4.9	15.2	0.00	0.0
Total					**607**	**591**	**180**	**1379**	**277**		**1103.2**

Table A.3: Output of Cropwat Software used for calculating crop water requirement in MDIP

RICE EVAPOTRANSPIRATION AND IRRIGATION REQUIREMENTS

Rain climate station: Chandpur **Crop: Paddy_Boro**

ETo climate station: Chandpur **Transplanting date: 21 January**

Month	Dec	Stage	Area %	Coef Kc	ETcrop mm/day	Perc	LPrep mm/day	RiceRq	EffR mm/dec	IrReq mm/day	IrReq mm/dec
Dec	3	Nu/La	10	1.20	0.32	0.5	1.8	2.6	0.4	2.59	28.5
Jan	1	Land	33	1.18	1.04	1.6	8.1	10.8	0.8	10.69	106.9
Jan	2	La/In	78	1.13	2.42	3.9	8.1	14.4	0.9	14.30	143.0
Jan	3	Init	100	1.10	3.35	5.0	-	8.4	3.7	8.05	88.5
Feb	1	In/De	100	1.10	3.65	5.0	-	8.7	5.3	8.13	81.3
Feb	2	Deve	100	1.09	3.92	5.0	-	8.9	6.7	8.25	82.5
Feb	3	Deve	100	1.08	4.46	5.0	-	9.5	8.9	8.07	64.6
Mar	1	Deve	100	1.06	5.06	5.0	-	10.1	15.0	8.55	85.5
Mar	2	De/Mi	100	1.05	5.63	5.0	-	10.6	18.7	8.76	87.6
Mar	3	Mid	100	1.05	5.74	5.0	-	10.7	28.8	8.36	92.0
Apr	1	Mid	100	1.05	5.82	5.0	-	10.8	35.1	7.31	73.1
Apr	2	Mi/Lt	100	1.05	5.97	5.0	-	11.0	42.8	6.70	67.0
Apr	3	Late	100	1.00	5.66	4.2	-	9.8	45.3	5.30	53.0
May	1	Late	100	0.91	5.16	2.9	-	8.1	47.4	3.34	33.4
May	2	Late	100	0.82	4.63	1.5	-	6.1	50.6	1.03	10.3
Total					**629**	**596**	**182**	**1407**	**310**		**1097.0**

Table A.4: Output of Cropwat Software used for calculating crop water requirement in MDIP

RICE EVAPOTRANSPIRATION AND IRRIGATION REQUIREMENTS

Rain climate station: Chandpur
ETo climate station: Chandpur

Crop: Paddy _ Boro
Transplanting date: 28 January

Month	Dec	Stage	Area %	Coef Kc	ETcrop mm/day	Perc	LPrep	RiceRq mm/day	EffR mm/dec	IrReq mm/day	IrReq mm/dec
Dec	3	Nurs	7	1.20	0.21	0.4	0.5	1.1	0.1	1.05	3.2
Jan	1	Nu/La	13	1.19	0.43	0.7	3.7	4.8	0.3	4.75	47.5
Jan	2	Land	46	1.16	1.48	2.3	8.1	11.9	0.6	11.82	118.2
Jan	3	La/In	84	1.12	2.87	4.2	4.9	11.9	3.1	11.68	128.5
Feb	1	Init	100	1.10	3.66	5.0	-	8.7	5.3	8.13	81.3
Feb	2	In/De	100	1.10	3.95	5.0	-	8.9	6.7	8.27	82.7
Feb	3	Deve	100	1.09	4.51	5.0	-	9.5	8.9	8.12	64.9
Mar	1	Deve	100	1.07	5.10	5.0	-	10.1	15.0	8.60	86.0
Mar	2	De/Mi	100	1.06	5.65	5.0	-	10.6	18.7	8.78	87.8
Mar	3	Mid	100	1.05	5.73	5.0	-	10.7	28.8	8.35	91.8
Apr	1	Mid	100	1.05	5.81	5.0	-	10.8	35.1	7.29	72.9
Apr	2	Mid	100	1.05	5.96	5.0	-	11.0	42.8	6.6	66.8
Apr	3	Mi/Lt	100	1.03	5.83	4.7	-	10.6	45.3	6.05	60.5
May	1	Late	100	0.97	5.51	3.8	-	9.3	47.4	4.56	45.6
May	2	Late	100	0.88	4.97	2.5	-	7.4	50.6	2.39	23.9
May	3	Late	100	0.80	4.09	0.9	-	5.0	31.6	0.20	1.2
Total					**639**	**587**	**173**	**1399**	**340**		**1062.9**

Table A.5: Output of Cropwat Software used for calculating crop water requirement in MDIP

RICE EVAPOTRANSPIRATION AND IRRIGATION REQUIREMENTS

Rain climate station: Chandpur **Crop: Paddy_Boro**
ETo climate station: Chandpur **Transplanting date: 4 February**

Month	Dec	Stage	Area %	Coef Kc	ETcrop mm/day	Perc mm/day	LPrep mm/day	RiceRq mm/day	EffR mm/dec	IrReq mm/day	IrReq mm/dec
Jan	1	Nurs	8	1.20	0.26	0.4	1.1	1.7	0.1	1.72	10.3
Jan	2	Nu/La	22	1.19	0.71	1.1	5.6	7.4	0.3	7.33	73.3
Jan	3	Land	62	1.14	2.15	3.1	8.1	13.3	2.3	13.15	144.6
Feb	1	La/In	93	1.11	3.43	4.7	2.4	10.5	4.9	10.03	100.3
Feb	2	Init	100	1.10	3.96	5.0	-	9.0	6.7	8.29	82.9
Feb	3	In/De	100	1.10	4.55	5.0	-	9.5	8.9	8.15	65.2
Mar	1	Deve	100	1.08	5.15	5.0	-	10.2	5.0	8.65	86.5
Mar	2	Deve	100	1.06	5.68	5.0	-	10.7	18.7	8.81	88.1
Mar	3	De/Mi	100	1.05	5.72	5.0	-	10.7	28.8	8.34	91.8
Apr	1	Mid	100	1.04	5.77	5.0	-	10.8	35.1	7.26	72.6
Apr	2	Mid	100	1.04	5.92	5.0	-	10.9	42.8	6.65	66.5
Apr	3	Mid	100	1.04	5.88	5.0	-	10.9	45.3	6.35	63.5
May	1	Mi/Lt	100	1.01	5.74	4.5	-	10.2	47.4	5.50	55.0
May	2	Late	100	0.94	5.30	3.4	-	8.7	50.6	3.66	36.6
May	3	Late	100	0.84	4.29	2.0	-	6.3	58.0	1.46	16.0
Jun	1	Late	100	0.77	3.47	0.4	-	3.9	16.6	0.00	0.0
Total					**658**	**591**	**176**	**1424**	**382**		**1053.4**

Table A.6: Cropping Intensity Calculation

Sl. No.	Name of Crops	Cropped Area (For benchmark year's 1996-97)		Cropped Area (For year's 1997-98)		Cropped Area (For year's 1998-99)		Cropped Area (For year's 1999-00)		Cropped Area (For year's 2000-01)		Cropped Area (For year's 2001-02)		Cropped Area (For year's 2002-03)		Cropped Area (For year's 2003-04)	
		Target	Achieved	Target	Achieved	Target	Achieved	Target	Achieved	Target	Achieved	Target	Achieved	Target	Achieved	Target	Achieved
1	**Khariff II (July-October)**																
	a. HYV. T.Aman	12000	10729	12000	8607	10000	8510	11000	9500	11025	10300	12300	12000	12400	12100	12500	12100
	b. Local Improved T. Aman	1400	1375	1450	2375	2200	2350	2050	1335	2050	1835	1000	1250	1000	1150	1000	1150
	c. B. Aman	200	200	200	500	200	400	200	1085	200	285	-	-	-	-	-	-
	d. Other crops	300	300	300	322	400	420	300	515	300	415	300	250	200	300	200	300
	Sub Total	**13,900**	**12,604**	**13,950**	**11,804**	**12,800**	**11,680**	**13,550**	**12,435**	**13,575**	**12,835**	**13,600**	**13,500**	**13,600**	**13,550**	**13,700**	**13,500**
2	**Rabi Season (November – February)**																
	a. HYV Boro	9000	5775	9000	3900	7000	4000	9000	10669	10250	10585	12324	12519	12525	11500	12500	11550
	b. Local Boro	-	-	-	45	-	-	-	-	-	-	-	-	-	-	-	-
	c. Wheat	800	910	800	1910	2000	2010	800	1000	900	1000	270	250	100	100	100	100
	d. Potato	600	547	800	447	400	405	400	300	300	300	210	80	50	50	50	50
	e. Sugarcane	600	605	600	605	600	605	600	200	200	200	220	300	500	500	475	500
	f. Oil seed	500	457	500	857	900	915	900	300	500	450	75	75	50	50	50	50
	g. Pulses	500	475	500	970	900	910	900	300	600	580	40	35	100	100	100	100
	h. W. vegetables	500	450	500	450	500	500	500	400	400	400	175	148	200	200	150	200
	i. Others crops	300	300	300	435	300	300	300	285	300	285	70	57	77	77	77	77
	Sub Total	**12,800**	**9,519**	**13,000**	**9,619**	**12,600**	**9,645**	**13,400**	**13,454**	**13,450**	**13,800**	**13,384**	**13,464**	**13,602**	**12,577**	**13,502**	**12,627**

Table A.6: Cropping Intensity Calculation (continued)

Sl. No.	Name of Crops	Cropped Area (For benchmark year's 1996-97)		Cropped Area (For year's 1997-98)		Cropped Area (For year's 1998-99)		Cropped Area (For year's 1999-00)		Cropped Area (For year's 2000-01)		Cropped Area (For year's 2001-02)		Cropped Area (For year's 2002-03)		Cropped Area (For year's 2003-04)	
		Target	Achieved	Target	Achieved	Target	Achieved	Target	Achieved	Target	Achieved	Target	Achieved	Target	Achieved	Target	Achieved
3	**Kharif I (March – June)**																
	a. HYV B. Aus	3731	3400	3806	3400	500	-	-	-	-	-	-	-	-	-		
	b. HYV T. Aus	-	1100	-	1200	5500	195	6000	2700	6145	3091	7000	3530	8000	6500	-	-
	c. LIV T. Aus	-	175	-	175	-	-	500	550	550	550	500	380	2000	750	7500	6550
	d. LIV B. Aus	700	100	700	100	-	3250	-	-	-	-	-	-	2000	200	1750	700
	e. Mixed Aus	-	-	-	200	-	-	-	-	-	-	-	-	-	-	1500	175
	f. Kaon	300	59	300	59	300	315	500	100	300	100	100	60	100	50	-	-
	g. Jute	400	200	400	200	200	293	500	200	500	200	500	230	250	100	100	75
	h. Til	200	220	200	220	200	133	-	-	-	-	-	-	-	-	250	150
	i. S. Vegetables	300	181	300	181	300	134	500	200	500	200	300	120	250	150	-	-
	j. Other Crops	200	190	200	190	600	605	500	100	500	100	200	130	502	170	250	100
	Sub Total	**5,831**	**5,625**	**5,906**	**5,925**	**7,600**	**4,925**	**8,500**	**3,850**	**8,495**	**4,241**	**8,600**	**4,450**	**13,102**	**7,920**	502	200
Grand Total		**32,531**	**27,748**	**32,856**	**27,348**	**33,000**	**26,250**	**35,450**	**29,739**	**35,520**	**30,876**	**35,584**	**31,414**	**40,304**	**34,047**	**11852**	**7,950**
Cropping Intensity in %		239	204	242	201	243	193	261	219	261	227	262	231	296	250	**39,054**	**34,077**
																287	250

Note: In CADP total potential area is 13602 ha

$$\text{Cropping intensity} = \frac{\text{Cropped Area}}{\text{Total Potential Area}} \times 100$$

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