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MINISTRY OF LOCAL GOVERNMENT, RURAL DEVELOPMENT AND COOPERATIVES

RURAL IRRIGATION WORKS STUDY
FINAL REPORT

MAIN REPORT

VOLUME 3: CHAPTERS V, VI, VII, VIII

ENGINEERING CONSULTANTS, INC.
ENGLEWOOD, COLORADO, U.S.A.

PLANNERS, ENGINEERS AND CONSULTANTS LIMITED
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TABLE OF CONTENTS

Executive Summary

		Page
Section 1:	Authority	S-1
Section 2:	Project Description	S-1

Volume 1: Chapters I, II, III

Main Report

Chapter I: Introduction

Section 1:	Authority	I-1
Section 2:	Project Description and Objectives	I-1
Section 3:	General Information	I-2
Section 4:	Agricultural Setting	I-4

Chapter II: Survey/Evaluation Questionnaire and Sub-Project Selection

Section 1:	Introduction	II-1
Section 2:	Development of Survey/Evaluation Questionnaire	II-2
Section 3:	Questionnaire Refinement	II-4
Section 4:	Recommended Survey/Evaluation Questionnaire	II-13
Section 5:	Results of Sub-Project Ranking	II-13
Section 6:	Summary of Sub-Project Ranking	II-21

Annex A: Letters
Annex B: Survey/Evaluation Questionnaire

Chapter III: Agriculture

Section 1:	General Description	III-1
Section 2:	Crop Calendars	III-2
Section 3:	Cropping Patterns	III-3
Section 4:	Supply of Agricultural Inputs	III-18
Section 5:	Credit	III-19
Section 6:	Marketing	III-19
Section 7:	Agricultural Extension	III-20
Section 8:	Research	III-21

Volume 2: Chapter IV

		Page
Chapter IV:	Engineering	
Part 1:	General Design Information	
Section 1:	Design Criteria	IV-1
Section 2:	On-Farm Distribution System Criteria	IV-2
Section 3:	Soil Intake Characteristics	IV-5
Section 4:	Irrigation Stream Size	IV-9
Section 5:	Distribution System	IV-11
Section 6:	Crop Water Requirements	IV-14
Section 7:	Sub-Project Command Area	IV-22
Part 2:	Sub-Project Descriptions, Requirements and Designs	
Preface		IV-27
Section 1:	Sub-Project No. 1	IV-28
Section 2:	Sub-Project No. 2	IV-32
Section 3:	Sub-Project No. 3	IV-36
Section 4:	Sub-Project No. 4	IV-38
Section 5:	Sub-Project No. 5	IV-39
Section 6:	Sub-Project No. 6	IV-44
Section 7:	Sub-Project No. 7	IV-49
Section 8:	Sub-Project No. 8	IV-50
Section 9:	Sub-Project No. 9	IV-55
Section 10:	Sub-Project No. 10	IV-60
Section 11:	Sub-Project No. 11	IV-64
Section 12:	Sub-Project No. 12	IV-68
Section 13:	Sub-Project No. 13	IV-71
Section 14:	Sub-Project No. 14	IV-75
Section 15:	Sub-Project No. 15	IV-79
Section 16:	Sub-Project No. 16	IV-83
Section 17:	Sub-Project No. 17	IV-86
Section 18:	Sub-Project No. 18	IV-91
Section 19:	Sub-Project No. 19	IV-93
Section 20:	Sub-Project No. 20	IV-97
Section 21:	Sub-Project No. 21	IV-101
Section 22:	Sub-Project No. 22	IV-105
Section 23:	Sub-Project No. 23	IV-110
Section 24:	Sub-Project No. 24	IV-114
Section 25:	Sub-Project No. 25	IV-117
Section 26:	Sub-Project No. 26	IV-121
Section 27:	Sub-Project No. 27	IV-124
Section 28:	Sub-Project No. 28	IV-128
Section 29:	Sub-Project No. 29	IV-131
Section 30:	Sub-Project No. 30	IV-136

Page

Part 3: Information Pertinent to Implementation

Section 1:	Specifications	IV-139
Section 2:	Materials	IV-140
Section 3:	Contracting	IV-144
Section 4:	Estimate of Cost	IV-146

Volume 3: Chapters V, VI, VII, VIII

Chapter V: Economics

Section 1:	Introduction	V-1
Section 2:	Economic Analysis	V-1
Section 3:	Financial Analysis	V-19

Chapter VI: Socio-Economic Impact

Section 1:	Introduction	VI-1
Section 2:	Demographic Features	VI-6
Section 3:	Social Organization	VI-11
Section 4:	The Local Economy	VI-17
Section 5:	Impact Assessment	VI-25
Section 6:	Impact Evaluation	VI-32
Section 7:	Recommendations	VI-34

Chapter VII: Environmental Examination

Section 1:	Introduction	VII-1
Section 2:	Environmental Evaluation Methodology	VII-9
Section 3:	Probable Environmental Impacts	VII-12
Section 4:	Recommendation for Environmental Action	VII-23
Section 5:	Impact Identification and Evaluation Form	VII-24

Chapter VIII: Implementation Plan

Section 1:	Recommendations	VIII-1
Section 2:	Background	VIII-5
Section 3:	Objective	VIII-6
Section 4:	Means of Implementation	VIII-7
Section 5:	Manpower	VIII-9
Section 6:	Suggested Training Subjects and Exercises	VIII-24

Bibliography

Page

In Separate Volumes

Appendix A: Specifications
Appendix B: Operation and Maintenance Manual
Appendix C: Design Manual
Appendix D: Structures Lists, Materials Charts, Quantity and Cost Summaries
Appendix E: Maps

Appendix A: General Specifications

Instructions to Tenders	A-1
Tender	A-9
Preamble to Bill of Quantities	A-12
Bill of Quantities	A-12
Appendices to Tender	A-14
Form of Bid Bond	A-18
Form of Contract	A-20
Form of Performance Bond	A-23
General Conditions	A-25
Special Conditions	A-77
Technical Specifications	A-84

Appendix B: Operation and Maintenance Manual

Preface		B-1
Section 1:	The Distribution System	B-2
Section 2:	Low-lift Pumps: Operation, Maintenance and Costs	B-4
Section 3:	Deep Tube-wells: Operation, Maintenance and Costs	B-9
Section 4:	Pump Performance and Pumping Time	B-19
Section 5:	Cropping Patterns and Crop Water Requirements	B-20
Section 6:	Daily and Monthly Allocation of Water	B-24
Section 7:	Example of Irrigation Scheduling	B-27
Section 8:	Pump House Modification	B-30
Section 9:	Khal Maintenance Costs	B-31

Appendix C: Design Manual

Section 1:	Introduction	C-1
Section 2:	Deep Tube-well and Low-lift Pump Distribution System	C-2
Section 3:	Re-excavation of Khals and Construction of Sluiceways	C-8
Section 4:	Structural Design of Sluiceways	C-13
Section 5:	Cropping Patterns	C-16

LIST OF TABLES

Table No.	Table Title
	Executive Summary
S-1	Recommended Criteria for Ranking of Sub-projects
S-2	List of Sub-projects Selected for Design and Development by MRD and USAID
S-3	Summary of Cost Estimates (FAR)
S-4	Summary of Economic Evaluations
S-5	Summary of Annual Financial Returns
S-6	Schedule of Sub-project Implementation
	Chapter II
II-1	Specified Criteria, Weight Factors, Scales, and Maximum Rating
II-2	Recommended Criteria for Ranking of Sub-projects
II-3	Ranking from Survey/Evaluation Questionnaire of Chittagong District Sub-projects Submitted by MRD
II-4	Ranking from Survey/Evaluation Questionnaire of Dacca District Sub-projects Submitted by MRD
II-5	Ranking from Survey/Evaluation Questionnaire of Khulna District Sub-projects Submitted by MRD
II-6	Ranking from Survey/Evaluation Questionnaire of Rajshahi District Sub-projects Submitted by MRD
II-7	Ranking from Survey/Evaluation Questionnaire of Rangpur District Sub-projects Submitted by MRD
II-8	Ranking from Survey/Evaluation Questionnaire of Tangail District Sub-projects Submitted by MRD
II-9	List of Sub-projects Selected for Design and Development by MRD and Approved by USAID

LIST OF TABLES
(continued)

Table No.	Table Title
IIA-1	Approach I: Criteria and Weighted Rating for Selection of Number of Sub-projects from Each District
IIA-2	Summary of Approach I: Total Weighted Points and Number of Sub-projects Recommended for Selection
IIA-3	Approach II: Criteria and Number of Sub-Projects Recommended for Selection
IIA-4	Approaches I and II: Final Recommendation of Number of Sub-projects for Selection
IIA-5	General Information about Sub-projects
	Chapter III
III-1	Existing Main Cropping Patterns and Possible Improved Cropping Patterns with Irrigation
	Chapter IV
IV-1	Soil Intake Test Data
IV-2	Soils Information and Basic Intake Rates
IV-3	Basin Dimensions and Sizes
IV-4	Average Vapor Pressure (9 a.m. and 6 p.m. Observations) in Millibars
IV-5	Mean Monthly Maximum and Minimum Temperatures, in Degrees Celsius
IV-6	Relative Humidity, in Percentages
IV-7	Average Wind Speed, in Kilometers Per Hour
IV-8	Hours of Bright Sunshine

LIST OF TABLES
(continued)

Table No.	Table Title
IV-9	Cloudiness, in Oktas
IV-10	Monthly Reference Crop Evapotranspiration (ETo), in Inches
IV-11	Distribution System Efficiencies
IV-12	Crop Coefficients (kc) for Wheat-based Cropping Patterns
IV-13	Crop Coefficients (kc) for Boro-based Cropping Patterns
IV-14	Land Preparation Requirements and Percolation Losses
IV-15	Mean Monthly Rainfall (Rm), in Inches
IV-16	Crop Evapotranspiration (ETc), Effective Rainfall (Re), and Dependable Rainfall (Rd) for Chittagong District, in Inches
IV-17	Crop Evapotranspiration (ETc), Effective Rainfall (Re), and Dependable Rainfall (Rd) for Dacca District, in Inches
IV-18	Crop Evapotranspiration (ETc), Effective Rainfall (Re), and Dependable Rainfall (Rd) for Khulna District, in Inches
IV-19	Crop Evapotranspiration (ETc), Effective Rainfall (Re), and Dependable Rainfall (Rd) for Rajshahi District, in Inches
IV-20	Crop Evapotranspiration (ETc), Effective Rainfall (Re), and Dependable Rainfall (Rd) for Rangpur District, in Inches
IV-21a	Average Irrigation Requirements (Ia) for T. Aman, in Inches (Highland and Medium Highland)
IV-21b	Peak Irrigation Requirements (Ip) for T. Aman, in Inches (Highland and Medium Highland)

LIST OF TABLES
(continued)

Table No.	Table Title
IV-22a	Average Irrigation Requirements (Ia) for Boro, in Inches
IV-22b	Peak Irrigation Requirements (Ip) for Boro, in Inches
IV-23a	Average Irrigation Requirements (Ia) for T. Aus, in Inches
IV-23b	Peak Irrigation Requirements (Ip) for T. Aus, in Inches
IV-24	Average and Peak Requirements (Ia and Ip) for Wheat, in Inches
IV-25	Existing Irrigated and Non-irrigated Cropping Patterns: Sub-project No. 1
IV-26	Acreage of Crops in Existing Cropping Patterns: Sub-project No. 1
IV-27	Recommended Cropping Patterns with Drainage and Without Irrigation: Sub-project No. 1
IV-28	Recommended Cropping Patterns with Flood Control and with Irrigation: Sub-project No. 1
IV-29	Quantity and Cost Summary: Sub-project No. 1
IV-30	Construction Materials: Sub-project No. 1
IV-31	Existing Irrigated and Non-irrigated Cropping Patterns: Sub-project No. 2
IV-32	Acreage of Crops in Existing Cropping Patterns: Sub-project No. 2
IV-33	Recommended Cropping Patterns with Sub-project Development for Different Land Types: Sub-project No.2
IV-34	Acreage of Crops in Recommended Cropping Patterns: Sub-project No.2
IV-35	Materials Summary: Sub-project No. 2

LIST OF TABLES
(continued)

Table No.	Table Title
IV-36	Existing Irrigated and Non-irrigated Cropping Patterns: Sub-project No. 5
IV-37	Acreage of Crops in Existing Cropping Patterns: Sub-project No. 5
IV-38	Recommended Cropping Patterns with Sub-project Development for Different Land Types: Sub-project No. 5
IV-39	Acreage of Crops in Recommended Cropping Patterns: Sub-project No. 5
IV-40	Materials Summary: Sub-project No. 5
IV-41	Existing Irrigated and Non-irrigated Cropping Patterns: Sub-project No. 6
IV-42	Acreage of Crops in Existing Cropping Patterns: Sub-project No. 6
IV-43	Recommended Cropping Patterns with Sub-project Development for Different Land Types: Sub-project No. 6
IV-44	Acreage of Crops in Recommended Cropping Patterns: Sub-project No. 6
IV-45	Materials Summary: Sub-project No. 6
IV-46	Existing Irrigated and Non-irrigated Cropping Patterns: Sub-project No. 9
IV-47	Acreage of Crops in Existing Cropping Patterns: Sub-project No. 9
IV-48	Recommended Cropping Patterns with Sub-project Development for Different Land Types: Sub-project No. 9
IV-49	Acreage of Crops in Recommended Cropping Patterns: Sub-project No. 9
IV-50	Materials Summary: Sub-project No. 9

LIST OF TABLES
(continued)

Table No.	Table Title
IV-51	Existing Irrigated and Non-irrigated Cropping Patterns: Sub-project No. 10
IV-52	Recommended Cropping Patterns with Flood Control but Without Irrigation: Sub-project No. 10
IV-53	Recommended Cropping Patterns with Flood Control and Irrigation: Sub-project No. 10
IV-54	Quantity and Cost Summary: Sub-project No. 10
IV-55	Construction Materials: Sub-project No. 10
IV-56	Existing Non-irrigated Cropping Patterns: Sub-project No. 11
IV-57	Acreage of Crops in Existing Cropping Patterns: Sub-project No. 11
IV-58	Recommended Cropping Patterns with Sub-project Development: Sub-project No. 11
IV-59	Acreage of Crops in Recommended Cropping Patterns
IV-60	Materials Summary: Sub-project No. 11
IV-61	Existing Irrigated and Non-irrigated Cropping Patterns: Sub-project No. 13
IV-62	Recommended Cropping Patterns with Flood Control but Without Irrigation: Sub-project No. 13
IV-63	Recommended Cropping Patterns with Flood Control and with Irrigation: Sub-project No. 13
IV-64	Quantity and Cost Summary: Sub-project No. 13
IV-65	Construction Materials: Sub-project No. 13
IV-66	Existing Irrigated and Non-irrigated Cropping Patterns: Sub-project No. 14

LIST OF TABLES
(continued)

Table No.	Table Title
IV-67	Recommended Cropping Patterns with Flood Control but Without Irrigation: Sub-project No. 14
IV-68	Recommended Cropping Patterns with Flood Control and With Irrigation: Sub-project No. 14
IV-69	Quantity and Cost Summary: Sub-project No. 14
IV-70	Construction Materials: Sub-project No. 14
IV-71	Existing Irrigated and Non-irrigated Cropping Patterns: Sub-project No. 15
IV-72	Recommended Cropping Patterns with Flood Control but Without Irrigation: Sub-project No. 15
IV-73	Recommended Cropping Patterns with Flood Control and with Irrigation: Sub-project No. 15
IV-74	Existing Irrigated and Non-irrigated Cropping Patterns: Sub-project No. 17
IV-75	Acreage of Crops in Existing Cropping Patterns: Sub-project No. 17
IV-76	Recommended Cropping Patterns with Sub-project Development for Different Land Types: Sub-project No. 17
IV-77	Acreage of Crops in Recommended Cropping Patterns
IV-78	Materials Summary: Sub-project No. 17
IV_79	Existing Irrigated and Non-irrigated Cropping Patterns: Sub-project No. 19
IV-80	Acreage of Crops in Existing Cropping Patterns: Sub-project No. 19
IV-81	Recommended Cropping Patterns with Sub-project Development for Different Land Types with Flood Protection but Without Irrigation: Sub-project No. 19

LIST OF TABLES
(continued)

Table No.	Table Title
IV-82	Acreage of Crops in Recommended Cropping Patterns: Sub-project No. 19
IV-83	Quantity and Cost Summary: Sub-project No. 19
IV-84	Construction Materials: Sub-project No. 19
IV-85	Existing Irrigated and Non-irrigated Cropping Patterns: Sub-project No. 20
IV-86	Acreage of Crops in Existing Cropping Patterns: Sub-project No. 20
IV-87	Recommended Cropping Patterns with Sub-project Development for Different Land Types: Sub-project No. 20
IV-88	Acreage of Crops in Recommended Cropping Patterns: Sub-project No. 20
IV-89	Materials Summary: Sub-project No. 20
IV-90	Existing Irrigated and Non-irrigated Cropping Patterns: Sub-project No. 21
IV-91	Acreage of Crops in Existing Cropping Patterns: Sub-project No. 21
IV-92	Recommended Cropping Patterns with Sub-project Development for Different Land Types: Sub-project No. 21
IV-93	Acreage of Crops in Recommended Cropping Patterns: Sub-project No. 21
IV-94	Materials Summary: Sub-project No. 21
IV-95	Existing Irrigated and Non-irrigated Cropping Patterns: Sub-project No. 22
IV-96	Acreage of Crops in Existing Cropping Patterns: Sub-project No. 22
IV-97	Recommended Cropping Patterns with Sub-project Development for Different Land Types: Sub-project No. 22

LIST OF TABLES
(continued)

Table No.	Table Title
IV-98	Acreage of Crops in Recommended Cropping Patterns: Sub-project No. 22
IV-99	Materials Summary: Sub-project No. 22
IV-100	Existing Irrigated and Non-irrigated Cropping Patterns: Sub-project No. 23
IV-101	Acreage of Crops in Existing Cropping Patterns: Sub-project No. 23
IV-102	Recommended Cropping Patterns with Sub-project Development for Different Land Types: Sub-project No. 23
IV-103	Acreage of Crops in Recommended Cropping Patterns: Sub-project No. 23
IV-104	Materials Summary: Sub-project No. 23
IV-105	Existing Irrigated and Non-irrigated Cropping Patterns: Sub-project No. 24
IV-106	Recommended Cropping Patterns with Flood Control but Without Irrigation: Sub-project No. 24
IV-107	Quantity and Cost Summary: Sub-project No. 24
IV-108	Construction Materials: Sub-project No. 24
IV-109	Existing Irrigated and Non-irrigated Cropping Patterns: Sub-project No. 25
IV-110	Recommended Cropping Patterns with Flood Control but Without Irrigation: Sub-project No. 25
IV-111	Quantity and Cost Summary: Sub-project No. 25
IV-112	Construction Materials: Sub-project No. 25
IV-113	Existing Irrigated and Non-irrigated Cropping Patterns: Sub-project No. 20

LIST OF TABLES
(continued)

Table No.	Table Title
IV-114	Recommended Cropping Patterns with Flood Control but Without Irrigation: Sub-project No. 26
IV-115	Quantity and Cost Summary: Sub-project No. 26
IV-116	Quantity and Cost Summary: Sub-project No. 26
IV-117	Existing Irrigated and Non-irrigated Cropping Patterns: Sub-project No. 27
IV-118	Acreage of Crops in Existing Cropping Patterns: Sub-project No. 27
IV-119	Recommended Cropping Patterns with Sub-project Development for Different Land Types: Sub-project No. 27
IV-120	Acreage of Crops in Recommended Cropping Patterns: Sub-project No. 27
IV-121	Materials Summary: Sub-project No. 27
IV-122	Existing Irrigated and Non-irrigated Cropping Patterns: Sub-project No. 28
IV-123	Recommended Cropping Patterns with Flood Control but Without Irrigation: Sub-project No. 28
IV-124	Recommended Cropping Patterns with Flood Control and with Irrigation: Sub-project No. 28
IV-125	Existing Irrigated and Non-irrigated Cropping Patterns: Sub-project No. 29
IV-126	Acreage of Crops in Existing Cropping Patterns: Sub-project No. 29
IV-127	Recommended Cropping Patterns with Sub-project Development for Different Land Types: Sub-project No. 29
IV-128	Acreage of Crops in Recommended Cropping Patterns: Sub-project No. 29

LIST OF TABLES
(continued)

Table No.	Table Title
IV-129	Materials Summary: Sub-project No. 29
IV-130	Existing Irrigated and Non-irrigated Cropping Patterns: Sub-project No. 30
IV-131	Recommended Cropping Patterns with Drainage but Without Irrigation: Sub-project No. 30
IV-132	Recommended Cropping Patterns with Drainage and Irrigation
IV-133	Quantity and Cost Summary: Sub-project No. 30
IV-134	Quantity and Cost Summary: Sub-project No. 30
IV-135	Summary of Sub-project Costs
IV-136	List, Source, and Cost of Required Materials Chittagong District
IV-137	List, Source, and Cost of Required Materials: Dacca District
IV-138	List, Source, and Cost of Required Materials: Khulna District
IV-139	List, Source, and Cost of Required Materials: Rajshahi District
IV-140	List, Source, and Cost of Required Materials: Rangpur District
IV-141	List, Source, and Cost of Required Materials: Tangail District
IV-142	Recommended Construction Schedule
IV-143	Units Recommended for Construction During First Year
IV-144	Sub-project Cost - Contract No. 1
IV-145	Sub-project Cost - Contract No. 2

LIST OF TABLES
(continued)

Table No.	Table Title
IV-146	Sub-project Cost - Contract No. 3
IV-147	Sub-project Cost - Contract No. 4
IV-148	Sub-project Cost - Contract No. 5
	Chapter V
V-1	Economic Wage Rates for Man Labor
V-2	Economic Wage Rates for Animal Labor
V-3	Derivation of Economic Prices for Fertilizers
V-4	Economic Prices for Seeds
V-5	Economic Prices for Insecticides
V-6	Derivation of Economic Prices for Selected Agricultural Products
V-7	Economic Farm Crop Budgets: Present Situation
V-8	Expected Economic Growth: Future Situation Without Sub-project
V-9	Economic Farm Crop Budgets: Future Situation
V-10	Estimation of Annual Economic Benefits: Sub-project No. 1, Patia Thana, Chittagong District
V-11	Estimation of Annual Economic Benefits: Sub-project No. 5, Saturia Thana, Dacca District
V-12	Estimation of Annual Economic Benefits: Sub-project No. 6, Savar Thana, Dacca District
V-13	Estimation of Annual Economic Benefits: Sub-project No. 13, Bagerhat Thana, Khulna District

LIST OF TABLES
(continued)

Table No.	Table Title
V-14	Estimation of Annual Economic Benefits: Sub-project No. 18, Gomostapur Thana, Rajshahi District
V-15	Estimation of Annual Economic Benefits: Sub-project No. 23, Ulipur Thana, Rangpur District
V-16	Estimation of Annual Economic Benefits: Sub-project No. 27, Basail Thana, Tangail District
V-17	Summary of Annual Economic Benefits due to Sub-project Development
V-18	Crop Irrigation Water Requirements: Sub-project No. 1, Patia Thana, Chittagong District
V-19	Crop Irrigation Water Requirements: Sub-project No. 5, Saturia Thana, Dacca District
V-20	Crop Irrigation Water Requirements: Sub-project No. 6, Savar Thana, Dacca District
V-21	Crop Irrigation Water Requirements: Sub-project No. 13, Bagerhat Thana, Khulna District
V-22	Crop Irrigation Water Requirements: Sub-project No. 23, Ulipur Thana, Rangpur District
V-23	Crop Irrigation Water Requirements: Sub-project No. 27, Basail Thana, Tangail District
V-24	Summary of Costs for Sub-projects Evaluated
V-25	Economic Evaluation Results: Sub-project No. 1, Patia Thana, Chittagong District
V-26	Economic Evaluation Results: Sub-project No. 5, Saturia Thana, Dacca District
V-27	Economic Evaluation Results: Sub-project No. 6, Savar Thana, Dacca District
V-28	Economic Evaluation Results: Sub-project No. 13, Bagerhat Thana, Khulna District

LIST OF TABLES
(continued)

Table No.	Table Title
V-29	Economic Evaluation Results: Sub-project No. 19, Gomostapur Thana, Rajshahi District
V-30	Economic Evaluation Results: Sub-project No. 23, Ulipur Thana, Rangpur District
V-31	Economic Evaluation Results: Sub-project No. 27, Basail Thana, Tangail District
V-32	Summary of Economic Evaluations
V-33	Market Wage Rates for Hired Human Labor and Animal Labor
V-34	Market Price for Seeds at Sub-project Areas
V-35	Market Prices for Fertilizers and Insecticides at Sub-project Areas
V-36	Financial Prices of Farm Output
V-37	Financial Farm Crop Budgets: Present Situation
V-38	Financial Farm Crop Budgets: Future Situation
V-39	Estimation of Annual Financial Returns: Sub-project No. 1, Patia Thana, Chittagong District
V-40	Estimation of Annual Financial Returns: Sub-project No. 5, Saturia Thana, Dacca District
V-41	Estimation of Annual Financial Returns: Sub-project No. 6, Savar Thana, Dacca District
V-42	Estimation of Annual Financial Returns: Sub-project No. 13, Bagerhat Thana, Khulna District
V-43	Estimation of Annual Financial Returns: Sub-project No. 19, Gomostapur Thana, Rajshahi District
V-44	Estimation of Annual Financial Returns: Sub-project No. 23, Ulipur Thana, Rangpur District

LIST OF TABLES
(continued)

Table No.	Table Title
V-45	Estimation of Annual Financial Returns: Sub-project No. 27, Basail Thana, Tangail District
V-46	Direct Costs of Irrigation Water for Major Crops at Sub-project Areas
V-47	Summary of Annual Financial Returns
	Chapter VI
VI-1	Population Densities by District in Bangladesh, 1974
VI-2	Division by Predominant Settlement Patterns
VI-3	Population Projections
VI-4	Household Cycle: Sequence and Timing of Events; Female Roles; Socio-economic/Cultural Stimulants and Constraints
VI-5	Household Cycle: Sequence and Timing of Events; Implications for Family Units and for Individual Females; Status of Women Relative to Men
VI-6	Typical Daily Schedule: One Dubail Woman
VI-7	Proposed Development and Associated Impacts (Rated)
VI-8	Positive (+) and Negative (-) Effects Over the Short and Long Terms
	Chapter VII
VII-1	Sub-projects Selected for Environmental Examination

LIST OF TABLES
(continued)

Table No.	Table Title
	Chapter VIII
VIII-1	Consulting Team Composition
VIII-2	Manpower Requirements
VIII-3	Manpower Plan for First Year of Construction: Chittagong District
VIII-4	Manpower Plan for Second and Third Years of Construction: Chittagong District
VIII-5	Availability of Local Manpower: Chittagong District
VIII-6	Manpower Plan for First Year of Construction: Dacca District
VIII-7	Manpower Plan for Second and Third Years of Construction: Dacca District
VIII-8	Availability of Local Manpower: Dacca District
VIII-9	Manpower Plan for First Year of Construction: Khulna District
VIII-10	Manpower Plan for Second and Third Years of Construction: Khulna District
VIII-11	Availability of Local Manpower: Khulna District
VIII-12	Manpower Plan for First Year of Construction: Rajshahi District
VIII-13	Manpower Plan for Second and Third Years of Construction: Rajshahi District
VIII-14	Availability of Local Manpower: Rajshahi District
VIII-15	Manpower Plan for First Year of Construction: Rangpur District

LIST OF TABLES
(continued)

Table No.	Table Title
VIII-16	Manpower Plan for Second and Third Years of Construction: Rangpur District
VIII-17	Availability of Local Manpower: Rangpur District
VIII-18	Manpower Plan for First Year of Construction: Tangail District
VIII-19	Manpower Plan for Second and Third Years of Construction: Tangail District
VIII-20	Availability of Local Manpower: Tangail District
VIII-21	CAD Team Member Functions

Appendix B

B-1	Lubricants Recommended by Manufacturers of Diesel Engines Used for LLP's
B-2	Lubricants Recommended by Manufacturers of Diesel Engines Used for DTW's
B-3	Lubricants Recommended by Manufacturers of Right Angle Gear Drives
B-4	Average Irrigation Requirements (Ia) for T. aman, in inches (Highland and Medium Highland)
B-5	Peak Irrigation Requirements (Ip) for T. aman, in inches (Highland and Medium Highland)
B-6	Average Irrigation Requirements (Ia) for Boro, in inches
B-7	Peak Irrigation Requirements (Ip) for Boro, in inches
B-8	Average Irrigation Requirements (Ia) for T. aus, in inches

LIST OF TABLES
(continued)

Table No.	Table Title
B-9	Peak Irrigation Requirements (Ip) for T. aus, in inches
B-10	Average and Peak Irrigation Requirements (Ia and Ip) for Wheat, in inches
B-11	First Irrigation - January
B-12	Second Irrigation
B-13	Fifth Irrigation - February
B-14	Sixth Irrigation
B-15	Ninth Irrigation - March
B-16	Tenth Irrigation

LIST OF FIGURES

Figure No.	Figure Title
	Chapter II
II-1	Location Map
	Chapter III
III-1	Crop Calendar for Major Crops Grown in Bangladesh
	Chapter IV
IV-1	Intake Curves
IV-2	Intake Curves
IV-3	Basic Design Charts
IV-4	Cropping Patterns
IV-5	Crop Coefficients (kc) for Wheat-Based Cropping Patterns
IV-6	Crop Coefficients (kc) for Boro-Based Cropping Patterns
IV-8-1	Aricha-Ichhamati Irrigation Project
	Chapter VI
VI-1	Outline of Population and Vital Rates
VI-2	Age-Sex Structure by Agricultural Activity Rural Works Survey, 1979
VI-3	Religious Affiliation
VI-4	Features of Village Organization

LIST OF FIGURES

(Continued)

Figure No.	Figure Title
VI-5	Alternative Resource Allocations for a Rural Bangladesh Decision-Making Unit
VI-6	Impacts of Proposed Development on the Local Economy of a Rural Bangladesh Decision-Making Unit
	Chapter VIII
VIII-1	Implementation Schedule
VIII-2	Schedule of Consultant Services
	Appendix B
B-1	Time Required To Deliver a Given Number of Inches of Water to a Given Number of Acres with a Head of 1.5 cfs
B-2	Time Required To Deliver a Given Number of Inches of Water to a Given Number of Acres with a Head of 1.6 cfs
B-3	Time Required To Deliver a Given Number of Inches of Water to a Given Number of Acres with an Irrigation Head of 1.7 cfs
B-4	Time Required To Deliver a Given Number of Inches of Water to a Given Number of Acres with a Head of 1.8 cfs
B-5	Time Required To Deliver a Given Number of Inches of Water to a Given Number of Acres with a Head of 1.9 cfs
B-6	Time Required To Deliver a Given Number of Inches of Water to a Given Number of Acres with a Head of 2.0 cfs
B-7	Time Required To Deliver a Given Number of Inches of Water to a Given Number of Acres with an Irrigation Head of 2.2 cfs

LIST OF FIGURES

(Continued)

Figure No.	Figure Title
B-8	Time Required To Deliver a Given Number of Inches of Water to a Given Number of Acres with an Irrigation Head of 2.4 cfs
B-9	Time Required To Deliver a Given Number of Inches of Water to a Given Number of Acres with a Head of 2.6 cfs
B-10	Time Required To Deliver a Given Number of Inches of Water to a Given Number of Acres with a Head of 2.8 cfs
B-11	Time Required To Deliver a Given Number of Inches of Water to a Given Number of Acres with a Head of 3.0 cfs
	Appendix C
C-1	Distribution System Structures
C-2	Distribution System Weir Box
C-3	Discharge Table 3'-0" Suppressed Weir
C-4	Weir Gage - Stop Check
C-5	Alternative Canal Sections
C-6	Rajghat DTW. Pucca Drain
C-7	Rajghat DTW. Pucca Drain
C-8	Drainage Sluiceway Definition Sketch
C-9	Schematic of Canal Used to Store Tidal Water
C-10	Brick Arch Culvert
C-11	Sluice Gate - Flap Gate Gate Leaf
C-12	Gear Lift Padestal & Details
C-13	Gear Lift Assembly

LIST OF FIGURES

(Continued)

Figure No.	Figure Title
C-14	Parts of Gear Lift Assembly
C-15	Parts of Gear Lifts & Stem Guide
C-16	Parts of Gear Lift Assembly & Threaded Stem

ABBREVIATIONS

BADC	=	Bangladesh Agricultural Development Corporation
B/C	=	Benefit-Cost Ratio
BRRI	=	Bangladesh Rice Research Institute
BSC	=	Bangladesh Shipping Corporation
BWDB	=	Bangladesh Water Development Board
CAD	=	Command Area Development
CARE	=	Cooperative of American Relief Everywhere
DEM	=	Directorate of Extension and Management
DTW	=	Deep Tube-Well
ECI	=	Engineering Consultants, Incorporated
FAO	=	Food and Agricultural Organization
GOB	=	Government of Bangladesh
HYV	=	High Yielding Variety
IRDP	=	Integrated Rural Development Program
KSS	=	Krishi Sambaya Samities (Agricultural Cooperative Society)
LLP	=	Low Lift Pump
MRD	=	Ministry of Local Government, Rural Development and Cooperatives
PEC	=	Planners, Engineers, and Consultants
RWP	=	Rural Works Program
SAE	=	Sub-Assistant Engineer, RWP
SDE	=	Sub-Divisional Engineer, RWP
STW	=	Shallow Tube-Well
TCCA	=	Thana Central Cooperative Association
TIP	=	Thana Irrigation Program
USAID	=	United States Agency for International Development
WAPDA	=	Water and Power Development Authority
WB	=	World Bank
XEN	=	Executive Engineer RWP

CURRENCY EQUIVALENTS

US $ 1 = Taka 15.00
Taka 1 = US $ .067

WEIGHTS AND MEASURES

1 acre (ac)	=	.405 hectare (ha)
1 bigha (bi)	=	.33 acre (ac)
1 sq mile	=	640 acres (ac)
1 maund (md)	=	82.28 pounds (lbs)
1 maund (md)	=	37.3 Kilograms (kg)
1 metric ton (ton)	=	26.8 maunds (md)
1 seer (sr)	=	2.06 pounds (lbs)
1 cubic foot per second (cusec)	=	0.283 cubic meters per second

GLOSSARY OF TERMS

Aman = Rice sown/planted during March to July/August and harvested in November or December.

Aus = Rice sown/planted during March and April and harvested in July and August.
T. aus = transplanted aus; B. aus = broadcasted aus.

Beel = Marsh or lake; also spelled bill or bil.

Boro = Winter rice, planted during November and December and harvested during April to June.

Char = Newly formed sandy alluvial tract.

Drain = Canal to provide drainage or irrigation water.

Khal = Narrow natural channel of water.

Kharif = Summer season or rainy season.

Kutcha = Temporary, lower grade or dirt structures.

Paddy = Unhusked or rough rice (oryza sativa).

Pucca = Permanent, good quality structures.

Rabi = Winter season or dry season.

Thana = Political sub-division of a sub-division: police station or revenue unit.

Sub-Division = Political division of a district.

CHAPTER V
ECONOMICS

Section 1: Introduction

This chapter presents the economic evaluation and financial analysis of selected sub-projects. It deals with the possible impact of sub-project development in the national economy and on the economic position of individual farmers. It is divided into two main sections namely Economic Analysis and Financial Analysis.

Section 2: Economic Analysis

A. The Nature of Economic Analysis

Economic analysis relates to the effect of the project on the national economy as a whole. The conventional approach to economic studies analyzes incremental costs and benefits due to project development at a fixed level of prices, expecting that any effects of future price changes might bear equally against benefits and costs. This approach recognizes the difficulty of anticipating price changes beyond the short-term.

Due to the nature of the economic analysis, items which are transfers within the economy (such as taxes, customs duties, subsidies, and social welfare outlays) are disregarded. The national viewpoint embraces long-term effects, assumes the absence of war or severe economic depressions, and requires application of known technology in management of project construction and operation.

The incidence of benefits and costs is immaterial to the economic analysis. So long as all beneficial and adverse effects are internalized in the economic study, it is of no consequence to whom the effects accrue; however, for national social analysis, whether or not benefits are distributed among the society's lower income groups is of considerable interest. To guarantee benefits to the less affluent strata of the population, Phase I of this study attempted to select sub-projects in the poorest areas of the country.

B. Determination of Economic Benefits

Benefits are all those identifiable increases or gains in assets or values obtained due to project development. They may be direct or indirect gains in goods, services, or intangible satisfactions and are measurable in either monetary or non-monetary terms.

This study classifies economic benefits as primary and secondary. Primary benefits are those tangible values derived from direct use of project goods and services; they include:

1. Irrigation and drainage benefits: the increase in net farm income due to increase in production or cost reduction.

2. Flood control benefits: the estimated value of the reduction in flood damages or the increase in production due to flood protection.

Secondary benefits are those induced by, or stemming from, use of sub-project products. These include the benefits derived from increased economic activity in the sub-project service area and a share of the profits obtained through the marketing of the increased production from irrigated lands. Also included are intangible benefits; that is, they are benefits that reflect true values but that are difficult, if not impossible, to evaluate in monetary terms. These benefits include better income distribution, improvement of general welfare, job creation, and stabilization of the local economy.

The economic evaluation of sub-projects considers and expresses only primary benefits in quantitative terms.

Benefits from sub-project development of irrigation, flood control, or drainage are measured by the projected future increase in net farm income resulting from increased agricultural production as compared to future conditions without sub-project development. The increase in net farm income is measured by comparing farm budgets of typical farms under both conditions. The assumptions underlying the preparation of farm budgets for the economic evaluation of sub-projects can be summarized as follows:

1. The economic analysis is based on incremental costs and benefits; therefore, fixed costs of production are disregraded.

2. The incidence of benefits is unimportant because the analysis is made from the national point of view.

3. Items that are transfers within the economy (such as taxes and subsidies) are disregarded.

4. Economic prices for inputs and outputs were assumed to be significantly different from market prices; therefore, shadow prices were derived. They appear in another section of this chapter.

C. Sub-Projects Evaluated

To appraise the project as a whole within time and data constraints, the Consultant decided to evaluate only a representative sample of seven sub-projects. These sub-projects reflect the different locations and types of engineering works found on the Rural Irrigation Works Study. Sub-projects selected for analysis are listed below. Sub-project numbers shown here correspond to the numbers assigned to them in Chapter II, Table II-14.

1. Sub-project No. 1, Re-excavation of Khan Mohan Khal, at Patiya Thana, Chittagong District.

2. Sub-project No. 5, Pucca Drain for Kawanara Irrigation Project, at Saturia Thana, Dacca District.

3. Sub-project No. 6, Rajghat Deep Tube-well Pucca Drain, at Savar Thana, Dacca District.

4. Sub-project No. 13, Reconstruction of Fatepur-Baitpur Embankment, Excavation of Khal and Construction of two Sluice Gates, at Bagerhat Thana, Khulna District.

5. Sub-project No. 19, Sluice Gate at Pabdamari Dama, at Gomostapur Thana, Rajshahi District.

6. Sub-project No. 23, Hatia Deep Tube-well Pucca Drain, at Ulipur Thana, Rangpur District.

7. Sub-project No. 27, Reconstruction of Dubail Basail Deep Tube-well Drain, at Basail Thana, Tangail District.

D. Estimation of Economic Prices

Economic, or "shadow", prices constitute an important aspect of the economic evaluation of projects. They are those prices that reflect the real economic value of a commodity or service (its marginal value) or that represent equilibrium conditions on a perfect, competitive-market economy. A perfect, competitive market is one in which factors such as price regulations, subsidies, institutional rigidities, imperfect information, and the immobility of factors of production are absent. Because market imperfections exist in Bangladesh, the determination of shadow prices is necessary to reflect the true value of commodities and services. An agricultural development project requires use of economic prices instead of market prices when evaluating agricultural inputs and farm output. Agricultural inputs include wage rates and the prices of fertilizers, seeds, and insecticides; farm output includes the prices of farm products.

Economic Prices for Farm Inputs: The following paragraphs explain the procedure used to determine economic prices for the economic evaluation of sub-projects for farm inputs and output. Results obtained are shown in Tables V-1 through V-6.

a) Human labor: Economic wage rates for human farm labor are determined to measure the opportunity cost of labor: that is, the value of the marginal output of labor foregone elsewhere because of its use in the project. Due to the present surplus of agricultural laborers in Bangladesh, there are no productive outlets for their energies. Therefore, the marginal value product of such labor is very low; in other words, if laborer is taken away from a rural village where he is producing nothing and if he is put to work producing something somewhere else, then no production is foregone in order to obtain a new product.

Determining the real marginal value product of agricultural labor is very difficult in areas where surplus labor exists. In cases where farmers tend to build their own houses, build their irrigation structures, or work voluntarily in community projects in their spare time, to shadow-price the farmers' labor at zero is not justified. This being the case in Bangladesh, wage rates are shadow-priced at 50% of the market wage rate for each specific sub-project site. Presumably, different economic wage rates exist in the country, this difference arising out of specific local supply and demand labor conditions. Table V-1 shows the different economic wage rates for each of the sub-projects being evaluated.

b) Animal labor is extensively used in agriculture in Bangladesh. Farmers use water buffaloes or oxen for plowing and harrowing. Most farmers own work animals, which they use or rent to neighbors.

Because the supply of working animals available to farmers is limited at the needed time, it was assumed that the economic daily wage rate of work animals is equal to the actual market price. Furthermore, it was found that different wage rates exist in different sub-project areas. These differences are due to

specific supply, demand, and price level conditions. Table V-2 shows the different wage rates for work animals in each of the sub-projects evaluated.

c) Fertilizers: Economic prices for Urea, Triple Superphosphate (TSP), and Muriate of Potassium (MP) were derived according to World Bank price projections.

World Bank price projections are made in current and constant 1978 U.S. currency by the Bank's Fertilizer Unit in conjunction with UNIDO and FAO and are to be used in the appraisal of investment projects that include the production of agricultural commodities. Because of the time required to plan, evaluate, and construct the projects and to achieve full production status, price projections for the year 1985 were chosen. These projections are made for FOB fertilizer prices. To show the real value to the Bangladesh economy, these prices are converted to farm gate prices by first converting FOB prices to CIF prices and then adjusting them to reflect internal transport and other costs. The resulting price reflects their value in the sub-project area (farm gate). Because CIF prices were not available, the BSC provided the Consultant with FIO prices. The BADC provided a detailed breakdown of average port-handling and transportation costs for different areas in the country. Though cost differences in handling and transporting fertilizers for different sub-project areas may exist, the differences are believed to be small and were omitted from the analysis for the sake of simplicity. Table V-3 shows the data used in the derivation of economic prices for urea, TSP, and MP.

d) Seeds: The Government of Bangladesh, through several of its institutions, is involved in the production and distribution of improved seeds for rice, jute, and wheat. Seeds are produced at Government farms or by local contractors. The Government provides close supervision (technical assistance) and all production inputs.

To promote usage of improved seeds by farmers, the Government subsidizes them; however, subsidies are not considered in the economic evaluation, which causes economic prices to differ from market prices. Table V-4 shows the economic prices for seeds in Bangladesh during the 1978-79 growing season.

e) Insecticides and Pesticides To promote the farmers' use of insecticides and pesticides, the Government of Bangladesh subsidizes their price. These subsidies constitute 50 percent of the total value. Most of these products are imported and made available to farmers through the Government's Ministry of Agriculture.

The principal insecticides and pesticides used in the production of rice, wheat, and jute are Copper Exychloride, Carbicorn, Diazinon, and Granosan, with unsubsidized prices equal to Tk 6/lb, Tk 79.10/lb, Tk 14/lb, and Tk 6/lb, respectively. Because of the 50 percent rate of subsidy, the Consultant used a figure twice that reported by farmers in the socio-agro-economic survey as their expenditure for insecticides and pesticides to determine farm budgets for the economic analysis. Table V-5 presents this information for each of the surveyed sub-projects. Price variations are caused by the application of different products to the same or different crops in the different sub-project areas and by transportation differentials.

E. Economic Prices for Farm Output

The sub-project areas evaluated produce mainly rice, jute, wheat, and oilseeds. The Government's regulation of their prices necessitated the determination of their economic prices. Because these commodities are widely traded in international markets, their economic prices were derived according to international price projections. Table V-6 details the data used to obtain these prices. The derivation includes appropriate adjustments for freight, insurance, handling, processing, and quality differentials.

F. Economic Farm Crop Budgets: Present Situation

A socio-agro-economic survey conducted by the Consultant at each sub-project area during June 1979 provided data for preparation of economic farm crop budgets to represent the present situation of typical farms. A register of all farmers in the sub-projects area is kept by the water users' group office; from this register, the Consultant selected random samples. In sub-projects that already have some operating irrigation facilities, farmers with and without irrigation were interviewed. Due to time constraints in conducting the survey and in the manual processing of data, the number of questionnaires completed at each sub-project site was limited to 40. This represents a random sample from 5 to 15 percent of all farmers in small sub-project areas (200 acres or less) and a smaller sample for larger sub-projects.

The socio-agro-economic survey provided information concerning agricultural inputs, crop yields, prices of inputs, and agricultural practices. It provided the basis for development of farm crop budgets to represent current farming conditions, which, in turn, serve as the basis for development of budgets representing future conditions. These budgets enable the estimation of sub-project benefits.

In addition to the socio-agro-economic survey, interviews were conducted with farmers and Government officials in the sub-project areas to obtain information regarding crop intensities, their willingness to have the sub-project developed, present and future cropping patterns, existing marketing facilities, the general welfare of the area, and the mode of operation of the water users' group.

Table V-7 shows the current agricultural inputs and total current production cost for different crops on a per acre basis for the sub-projects evaluated. Total production costs per acre were calculated by multiplying the inputs shown on this table by the prices shown in Tables V-1 through V-4 and by then adding 10 percent for miscellaneous costs.

G. Future Situation Without Sub-Project

To determine sub-project benefits, it is necessary to estimate future agricultural production and income without sub-project development. This estimation provides the basis against which income under future sub-project conditions is compared to determine incremental benefits. This Study assumed that without sub-project development, future production would increase slightly over present levels. Cropping patterns and intensities are not expected to change. Small yield increases are expected to occur due to the efforts of several governmental agencies that are working with the farmers to promote the increased use of fertilizers, pesticides, and improved seeds. Presumably, the future increased availability of agricultural inputs will stimulate increased use and thus will result in higher yields.

Within sub-projects that have existing water distribution facilities, crop land irrigated during the dry season is expected to decrease or, at best, to remain constant. Deterioration of present facilities is expected to occur due to a lack of proper maintenance and repair programs and due to mismanagement of the irrigation system.

Within sub-projects that need re-excavation and/or hydraulic structures, total agricultural production in the near future is expected either to remain constant or to decrease. Farming conditions may deteriorate due to flooding, congested drainage, saline water intrusion, and/or soil salinity build-up.

Table V-8 shows the expected net change in the economic growth of each of the sub-projects evaluated. The future growth factor is used to estimate the future increase over present net crop income under conditions without the sub-project.

H. Future Situation Wiith Sub-Project

Table V-9 shows the future economic farm crop budgets for each of the sub-projects evaluated with sub-project development. These budget estimates considered factors such as:

1. the availability of agricultural inputs and proximity to major population centres

2. sub-project accessibility during wet and dry seasons;

3. the present level of agricultural input use;

4. the present effectiveness of water users' groups;

5. the farmers' degree of enthusiasm for sub-project development;

6. the physical nature of engineering work proposed;

7. the farmers' willingness to provide voluntary labor for construction of facilities.

Information concerning these factors was obtained from the survey/evaluation questionnaire and from the socio-agro-economic survey conducted by the Consultant during Phase I and early in Phase II, respectively.

Tables V-10 through V-16 show the estimation of annual sub-project economic benefits and the crop yields that are expected from the use of the agricultural inputs presented on Table V-9. In general, input use is below recommended levels, and yields are low for the production potential of the land.

Comparison of the economic farm crop budgets for the future situation with those for the present situation yields the following differences:

1. Human and Animal Labor: The expected increase in production, resulting from availability of irrigation water, will increase labor requirements. Additional human and animal labor will be necessary for land preparation, irrigation, and handling of increased production.

2. Seeds: Use of seeds is expected to decrease slightly. Data from the survey/evaluation questionnaire indicate that the current level of seed use is higher than recommended. With little orientation from sub-project officers, farmers will realize the benefits of spending less cash on seeds.

3. Fertilizers: Future use is expected to increase because farmers generally are inclined to use fertilizers where irrigation water is readily available and because government programs devoted to the promotion of fertilizer use will have some effect in sub-project areas.

4. Insecticides: The increased production per acre and increased crop intensity will require more extensive use of insecticides and pesticides. Farmers are expected to increase their use, especially for rice crops.

I. Measurement of Sub-Project Economic Benefits

Tables V-10 through V-16 detail the estimation of annual economic benefits for each sub-project evaluated. Table V-17 summarizes these findings and also shows the incremental economic benefits due to sub-project development.

Tables V-10 through V-16 were prepared from data presented in Tables V-7 through V-9 and from information presented in other chapters of this report. Irrigated and non-irrigated areas for each crop were obtained from Chapter IV. Acreages for the present and future situation for each crop in some cases do not correspond exactly with those of Chapter IV. Instead, crops with similar characteristics were grouped together and the analysis conducted accordingly. This procedure was followed only for crops that had a very small acreage and for which no information was available for estimation of farm budgets.

Estimated crop yields for future conditions are based on present yields, yields of the best farmers in the area, and general characteristics of the sub-projects. Crops and cropping patterns for future conditions were obtained from Chapter IV. These cropping patterns

were derived by using the methodology explained in Chapter III. Areas to be irrigated were obtained by using a methodology, presented in Chapter IV, that assesses water and land availability.

Gross income was obtained by multiplying total production by the economic price of goods. These prices were derived previously in this Chapter and they were equal to Tk 123, Tk 121, Tk 118, and Tk 355 per pound of rice, wheat, jute and oilseeds, respectively.

Total cost was calculated by multiplying the total area planted by the total cost per acre. Total costs per acre for each crop are presented in Tables V-7 and V-9 for the present and future conditions, respectively.

Net income, the difference between total income the total cost for future conditions without sub-project development was derived from the estimated percentage of economic growth for each sub-project, presented in Table V-8.

Tables V-10 through V-16 also show crop intensities of irrigated and non-irrigated areas for present conditions and for future conditions with sub-project development.

J. Sub-Project Costs

Costs used in the economic evaluation were derived from estimates presented in Chapter IV and were computed for each sub-project. Construction costs were directly obtained from estimates presented in Chapter IV and are summarized below. Operation and Maintenance costs were derived from the O & M manual and are also explained below.

Evaluation of project economics requires that only incremental costs and benefits caused by sub-project development be considered. Sub-projects that have DWTs or LLPs already in operation are incurring the O & M costs of these pumps. Therefore, the cost of providing one acre-foot of water with and without sub-project development is estimated to be the same. The cost of actual irrigation was estimated by calculating the acreage of the main crops presently being irrigated, and incremental costs were determined by subtraction. Because the supply of water is unreliable and crops are not getting the water

required for optimum production, it was also assumed that supplemental water was not being provided by the present systems.

Detailed cost estimates were made only for the construction of the main hydraulic structures of sub-projects No. 1 and No. 13, which comprise re-excavation of canals to store irrigation water. Engineering designs and cost estimates of the specific distribution systems were not made. The economic evaluation assumed a construction cost for the distribution system of Tk 9400/acre irrigated. This figure, obtained from cost estimates presented in Chapter IV, is the average cost per acre of brick-lined distribution systems as designedl for all DTW and LLP sub-projects.

1. Sub-project No. 1: Patiya Thana, Chittagong District: Development of this sub-project comprises the re-excavation of a khal, which will have two effects on the farms of the area: first it will drain 760 acres; second, it will store enough water to irrigate 345 acres for boro, wheat, oilseeds, t. aus, and t. aman. (See Table V-18.) T. aus and t. aman will receive supplemental irrigation water only. Boro, wheat, and oilseeds will receive full irrigation, which will be provided by three low-lift pumps.

The pumping O & M cost of providing one acre-foot with an LLP is Tk 103.08 (see p. -10, O & M Manual, for cost data), which totals Tk 79,939 to supply water to 345 acres of command area for a total water requirement of 775.5 acre-feet. Farmers in the area currently irrigate 60 acres of boro, 45 acres on medium highlands and 15 acres on medium lowlands. This requires a total of 221.75 acre-feet, which represents a pumping O & M expense of Tk 22,858. Therefore, the incremental pumping O & M costs of sub-project development are Tk 57,081.

One 2-cusec LLP already in operation at the sub-project area is represented by a sunk annual cost of Tk 12,829, which need not be added to the investment cost. Two 2-cusec LLPs must be acquired to enable farmers to irrigate the 345 acres of command area. Therefore, Tk 25,658 per year must be added to obtain total irrigation costs for this sub-project.

Sub-project costs must include the maintenance of the 1-1/2 miles of re-excavated canal. A cost of Tk 3,275 per mile per year, a total of Tk 4,913, was added to the pumping O & M cost to obtain a total O & M cost of Tk 61,994.

Total construction costs of the sluice gate and re-excavation of khal is Tk 731,000. A distribution system that would enable the LLPs to serve 345 acres would incur a cost of Tk 3,243,000.

Construction costs for this sub-project total Tk 3,974,000. Costs for O & M are equal to Tk 61,994. Additional pump installations will require the equivalent of an annual cost of Tk 29,588.

2. Sub-project No. 5: Saturia Thana, Dacca District: Development of this sub-project comprises construction of lined channels to provide irrigation water for boro, wheat, oilseeds, t. aus, and t. aman. (See Table V-19.) T. aus and t. aman will receive supplemental irrigation water only. Boro, wheat, and oilseeds will receive full irrigation, which will be provided by two 2-cusec LLPs.

The cost per acre foot is calculated by:

$$Y = 147.60 - .0252\ (X),$$

in which Y = cost of 1 acre-foot

X = total water required (acre-foot).

This formula is explained in detail in Section 3 of the O & M Manual.

Therefore, the cost per acre-foot is Tk 103.08, which totals Tk 57,987 to provide water to 158 acres of command area requirements of 562.54 acre-feet. Farmers in the area now irrigate 60 acres of boro on medium highlands, which requires 48.3 in/ac or a total water requirement of 241.5 acre-feet. This represents an expense of Tk 24,894. Therefore, the incremental costs due to sub-project development are Tk 33,093.

Construction costs of the distribution system for this sub-project total Tk 1,524,000 for the 158 acres, or Tk 9,646 per acre.

3. Sub-Project No. 6: Savar Thana, Dacca District: Development of this sub-project comprises construction of lined channels to provide irrigation water for boro, wheat, oilseeds, t. aus, and t. aman. (See Table V-20). T. aus and t. aman will receive supplemental irrigation water only. Boro, wheat, and oilseeds will receive full irrigation, which will be provided by one 2-cusec DTW.

The cost per acre-foot is calculated in the same manner as for Sub-project No. 5. It is equal to Tk 139.37, which totals Tk 45,543 to provide water to the 110 acres of command area for a water requirement of 326.78 acre-feet. Farmers in the area now irrigate 40 acres of boro on lowlands, which requires 30.2 inches/acre, or a total water requirement of 100.67 acre-feet. This represents an expense of Tk 14,030. Therefore, the incremental costs of sub-project development are Tk 31,513.

Construction costs of the distribution system for this sub-project total Tk 967,000 for the 110 acres, or Tk 8,791 per acre.

4. Sub-project No. 13: Bagerhat Thana, Khulna District: Development of this sub-project comprises re-excavation of a khal, reconstruction of an embankment, and construction of two-sluice gates. Its development will drain an area of 640 acres, and the re-excavated khal will store enough irrigation water to irrigate 500 acres of boro, wheat, oilseed, t. aus, and t. aman. (See Table V-21.) T. aus and t. aman will receive supplemental irrigation water only. Boro, wheat, and oilseeds will receive full irrigation, which will be provided by five cusec LLPs.

The cost of providing one acre-foot of water with a LLP is Tk 103.08 (see Section 3 of the O & M Manual for cost data), which totals Tk 207,016 to supply water to the 500 acres of command area for a water requirement of 2,008.3 acre-feet.

No pumps are at the sub-project site and so must be purchased at an equivalent annualized cost of Tk 12,829 each. This is equivalent to an annual expense of Tk 64,145. Maintenance of the 0.6 miles of re-excavated canal will cost Tk 3,275 per mile per year, or a total of Tk 2,385.

The construction cost of proposed structures is Tk 2,069,000. Tk 4,700,000 was estimated to be the cost of developing a brick-lined distribution system, or Tk 9,400/acre.

Construction costs total Tk 6,769,000 and the annual O & M costs total Tk 209,401. Additional pump installations will require the equivalent of an annual cost of Tk 64,145.

5. Sub-Project No. 19: Gomostapur Thana, Rajshahi District: Development of this sub-project comprises re-excavation of a one-mile-long canal that will drain approximately 5,000 acres. Two sluiceways will be constructed to provide flood protection to the area. Water for irrigation of winter crops will not be available.

Re-excavation of the canal and construction of the sluiceways is estimated to cost Tk 2,479,000. An expense of Tk 3,275 per year has been estimated for maintenance of canal.

6. Sub-project No. 23: Ulipur Thana, Rangpur District: Development of this sub-project comprises construction of lined channels to provide irrigation water for boro, wheat, oilseeds, t. aus, and t. aman. (See Table V-21.)

T. aus and t. aman will receive supplemental irrigation water only. Boro, wheat, and oilseeds will receive full irrigation, which will be provided by one 2-cusec DTW.

The cost per acre-foot is calculated in the same manner as for other sub-projects with DTWs. The cost per acre-foot is Tk 138.89, which totals Tk 47,986 to provide water for the 130 acres of command area for a water requirement of 345.5 acre-feet. Farmers in the area now irrigate 35 acres of boro on highlands, which requires 47.3 inches per acre, or a total water requirement of 138 acre-feet. This represents an expense of Tk 19,167. Therefore, the incremental costs of sub-project development are Tk 28,819.

Construction costs of channels for this sub-project total Tk 1,144,000 for the 130 acres, or Tk 8,800 per acre.

7. Sub-Project No. 27: Basail Thana, Tangail District: Development of this sub-project comprises construction of lined channels to provide irrigation water for boro, wheat, oilseeds, and t. aus. (See Table V-23.)

T. aus will receive supplemental irrigation water only. Boro, wheat, and oilseeds will receive full irrigation, which will be provided by one 2-cusec DTW. The cost per acre-foot is equal to Tk 140.77, which totals Tk 38,166 to provide water for the 123 acres of command area for a water requirement of 271.12 acre-feet. Farmers in the area now irrigate 60 acres of boro on lowlands, which requires 30.2 inches/acre, or a total water requirement of 151 acre-feet. This represents an expense of Tk 21,256. Therefore, the incremental costs of sub-project development are Tk 16,910.

Construction costs of channels for this sub-project total Tk 1,117,000 for the 123 acres or Tk 9,081 per acre.

K. Sub-Project Economic Evaluation

Standard evaluation methods were applied for the evaluation of sub-project economics. Internal rates of return and benefit-cost ratios at different interest rates were computed. The internal rate of return is the yield of a sub-project investment and is determined by finding the discount rate at which costs and benefits are related to equal sums.

Sub-project costs and benefits are compared to measure a sub-project's degree of economic justification. Because costs and benefits accrue at different times, they must all be discounted to the values of one particular time. Interest rates of 12, 16, and 20 percent were employed to compute the benefit-cost ratios. A rate of 12 percent is considered to be the minimum acceptable rate of return for investment in natural resource development projects.

The assumptions underlying the estimation of internal rates of return and benefit-cost ratios in this Study can be summarized as follows:

1. All sub-projects were given a usable life of ten years.

2. Salvage value at the end of the ten-year period was assumed to be zero.

3. Full benefits accrue three years after construction of structures is finished. Farmers will attain only 50 percent and 75 percent of total benefits during the first and second years respectively, after construction. The only exception is Sub-project No. 27, for which it is assumed farmers will attain full benefits after the second year because half of the sub-project development area is already irrigated.

Tables V-25 through V-31 present the results of these analyses for each sub-project evaluated.

L. Summary of Economic Evaluations

The economic evaluation results are summarized in Table V-32. Benefit-Cost (B/C) ratios, computed at 12, 16, and 20 percent rates, and the internal rate of return for each sub-project are shown. Summarized results correspond to analysis of incremental costs and benefits.

All sub-projects have a B/C ratio greater than 1.0 at 12 and 16 percent interest rates. At the 20 percent interest rate, only Sub-project No. 27 has a B/C of less than 1.0.

Sub-project No. 19 has the highest B/C ratios and IRR because the sub-project will benefit a large area by providing flood protection and drainage for 5000 acres. Moreover, because no pumps are involved, the cost of O & M is very low.

Sub-project No. 27 has the lowest B/C ratios and IRR because farmers already irrigate about 50 percent of the area to be irrigated with sub-project development. Therefore, the incremental costs are matched against incremental benefits, which are mostly provided by the remaining 50 percent of the area. Furthermore, due to the area's agronomic characteristics, crop intensity with development of Sub-project is the lowest of all DTW and LLP sub-projects evaluated.

In general, the results of the economic evaluation are encouraging and if this sample is taken as representative of all sub-projects, then implementation of all 23 sub-projects designed is recommended. The economic evaluation is considered to be conservative because it includes only direct benefits; because construction costs were calculated for the most efficient and maintenance-free distribution systems, which are also the most expensive; and because the analysis used only a ten-year sub-project life, whereas this type of system can perform satisfactorily for 20 to 25 years.

Section 3: Financial Analysis

A. Introduction

Financial analysis pertains to the farmers' private financial circumstances and should address all costs that are incurred by farmers' in achieving farm production. Its main objective is to reveal the farmers' own gains or losses caused by sub-project development. Financial analysis is used to measure farmers' disposable income and their ability to contribute to repayment of sub-project costs.

It should be understood that of the many vital factors relating to farmers' disposable income, some could not be fully analyzed without more intensive social and agricultural economic studies. These include farm sizes, land ownership and tenancy factors affecting income, crop production expense and revenue sharing for tenant farmers, debt status and debt service costs, farm-family labor supply for on-farm and off-farm work, off-farm income earnings, and existing water charges.

Establishment of water charges must recognize that the first priority demand on a farm's earnings consists of the farm family's living expenses. Data on living costs were not sufficient to incorporate this financial consideration into this study; thus, calculated values herein are likely overstated insofar as they do not represent actual availability for paying water charges. Human subsistence needs will always be the first priority of production and revenues, and when farmers are at or near subsistence income levels, their revenues may not be available for repayments.

Financial returns shown should be considered hypothetical and merely indicative until more thorough investigations can be pursued; however, the methodology is sound and, with the inclusion of more detailed economic and social data on each sub-project situation, will yield credible results.

Financial farm crop budgets were prepared to represent present conditions both with and without sub-project development. Crop yields, cropping patterns, and agricultural inputs are the same as those included in the economic analysis. These budgets differ from those in the economic analysis in that (1) only the hired human and animal labor was considered as a cash cost and (2) a 6 percent credit charge per crop was added.

B. Financial Price of Farm Inputs

Price data for the financial analysis were obtained from the socio-agro-economic survey conducted by the Consultant. Tables V-33 through V-35 show the results of this survey. They include: market wage rates for human labor, market wage rates for animal labor, market

prices for insecticides and pesticides. To obtain a more precise picture of the actual financial situation of farmers, prices were estimated for each sub-project area.

The Government of Bangladesh subsidizes prices of insecticides and fertilizer, at about 50 percent of their value. Prices for these products are fixed every year and are uniform throughout the country. However, cost per pound of insecticide used by farmers varies from place to place due to differences in the type of insecticides needed to control different pests in different crops. Fertilizer prices vary because of transportation differentials and the existence of a black market, which is precipitated by uncertain supplies.

C. Credit

Institutional credit in Bangladesh is available to a very small percentage of farmers. This situation is even more critical for small farmers (two acres of cropland or less). Small farmers usually get credit from friends, relatives or private money lenders. Conditions of the loans change from place to place, but it is well known that money obtained from money lenders carries a very high interest rate (50 percent to 300 percent annually). Because money lending is illegal in Bangladesh, farmers do not like to report it. For this study, a rate of interest equal to 6 percent per crop (equivalent to 16 to 18 percent per year) was used in evaluating the present and future financial situations.

Even though this rate of interest may be considered low, it is the actual rate charged by the Government and private banks. The reader of this report may assess the financial position of individual farmers by assuming different interest rates.

D. Miscellaneous

In addition to the cost of agricultural inputs purchased by farmers and the interest paid for loans, a 10 percent cost for miscellaneous expenses was added to the cost of production to account for expenses other than those otherwise considered, including the costs of transportation, tools, and incidental expenditures.

E. Financial Prices of Farm Output

Table V-26 shows the Government-fixed prices for selected crops during the 1978-79 agricultural year although farmers in Bangladesh usually receive prices slightly better than Government rates for their products. Because the financial analysis is based on incremental benefits, the financial position of farmers is not affected by such discrepancies as long as relative prices remain constant. These prices were used for the financial analysis of the farmers' situation in each sub-project area and for conditions both with and without sub-project development.

F. Financial Farm Crop Budgets: Present Situation

Table V-37 shows the financial farm crop budgets for different crops at each sub-project area evaluated. Data for preparation of budgets were obtained from the socio-agro-economic survey. These farm crop budgets, which reflect the farmers' total cash expenditures, differ from the farm crop budgets prepared for the economic evaluation in three respects:

1. Human and Animal Labor: Only hired human and animal labor are in the financial farm crop budgets because the labor supplied by family members and animals does not represent a cash outlay.

2. Credit: A rate of interest equal to 6 percent per crop, or equivalent to a rate of 16 to 18 percent per year, was applied to the farmers' total cash expenditures.

3. Prices for Agricultural Inputs: The financial farm crop budget analysis used the agricultural inputs' market prices, which are lower than input prices used in the preparation of economic farm crop budgets because the former are subsidized by the Government.

G. Future Situation: Without Sub-Project

The estimation of the future financial situation of farmers without sub-project development made the same assumptions as those made for the economic analysis of the future situation (page V-9). The expected increase in disposable income over that for the present situation was assumed to be equal to the expected economic growth of the sub-project area, as detailed in Table V-8.

H. Future Situation: With Sub-Project

Table V-38 shows the financial farm crop budgets for the future situation whith sub-project development for different crops at each sub-project area being analyzed. The assumptions made in the preparation of this table are the same as those made in the preparation of Table V-6. The reader is referred to that section and that table for details.

I. Measurement of Sub-Project Financial Returns

Table V-39 through V-45 detail the estimation of annual financial returns for each selected sub-project. They were prepared from data presented in Tables V-33 through V-38. The procedure used is the same as that used in the measurement of sub-project economic benefits; the reader is directed to page V-11 for details.

J. Irrigation Water Charges

This section intends to show that farmers have enough disposable income to pay the full costs of providing irrigation water.

Table V-46 shows the costs of providing irrigation water for different crops for the sub-projects evaluated. These costs are based on information provided in the O & M Manual and summarized earlier in this Chapter. The highland boro crop is the most expensive crop to irrigate and is followed, in order, by lowland boro, wheat, and oilseeds. The cost of irrigating t.aus and t.aman are low because they receive supplementary irrigation only. The bottom line of Table V-46 shows the average cost of irrigation for each crop.

Table V-47 contains a summary of annual financial returns per acre for each sub-project. It shows the disposable income obtained by farmers at irrigated and non-irrigated farms for the present and future situation, with and without sub-project development. Because not all sub-projects provide irrigation water and because those that do may not provide water for all farms in the area, increments in disposable income were computed to represent three situations:

Situation 1 shows the increment in disposable income for areas that now irrigate and will be irrigating in the future.

Situation 2 shows the increment in disposable income for areas that do not now irrigate but will irrigate under sub-project development.

Situation 3 shows the increment in disposable income for areas that do not now irrigate and will not irrigate under sub-project development.

Disposable income at all sub-projects for the three different situations will signigicantly increase. Situation 2 shows the greatest increments, and it is this situation that must be closely analyzed for the determination of irrigation water charges. The minimum increment in disposable income in this situation is equal to Tk 3,304 per acre per year for Sub-project No. 1, which provides more than enough income to cover O & M costs, as shown on Table V-46. For a one acre farm in this sub-project area, water charges sufficient to cover all costs of irrigating boro, t. aman, and t. aus are equal to Tk 520.

The Consultant recommends that charges should be in accordance with water use: i.e., benefitted farms should pay the charges; therefore, different rates should be charged for different crops irrigated. Because it would be cumbersome to charge different rates for each crop at each sub-project area, the Consultant recommends that charges be set for each irrigated crop on a district basis. For example, rates of Tk 400/acre and Tk 450/acre of irrigated boro rice could be charged at the districts of Chittagong and Dacca, respectively. These rates should be revised annually and adjusted to reflect changes in prices and in the financial situation of farmers.

K. Recouping Capital Costs

The Government of Bangladesh has not established a formal policy for repayment of irrigation capital costs. Apparently, construction costs are not expected to be repaid, but attempts are made to assess charges for annual operation and maintenance expenses.

Landholders benefit somewhat from increased agricultural production immediately following the installation of irrigation facilities and the construction of hydraulic structures, but significant increases in crop yields come only after a reliable supply of new inputs is available to the farmers -- at the times they need them. At present, the uncertain availability of inputs is considered to be a major constraint to increased agricultural production. The GOB is now attempting to improve the supply of all inputs; when this has been achieved, the disposable income of farmers should again be reviewed to determine their ability to repay capital costs.

Sub-project No. 6 was selected as an example for further analysis of capital cost repayment.

The construction cost of a brick-lined distribution system for this sub-project is Tk 967,000. Assuming a two-year grace period , an 18 percent interest rate, and full payment over 10 years, landholders would pay Tk 2,723 per acre per year over 10 years to repay 100 percent of the capital cost. Assuming that 50 percent of capital costs are provided through grants, landholders would have to pay Tk 1,362 per acre per year over 10 years to repay their portion of the costs.

In this example, development of the sub-project would provide enough increased disposable income to enable farmers to repay 100 percent of the capital costs on a per-acre basis by converting from dry-farming to irrigation. Because landholders are the primary beneficiaries, they should repay capital costs at some future time when their disposable income permits.

L. Distribution of Sub-Project Benefits

Development of selected sub-projects will significantly affect the economic well being of people in the area. Several strata of the population will be benefited, but to different degrees. Owners of relatively large farms will receive the most benefits, at rates shown on Table V-48.

Landless laborers will indirectly benefit from sub-project development. They will have more opportunities to work throughout the year in the cultivation of the fields and in marketing related activities, and they will provide labor for the construction of facilities and for the operation and maintenance of structures.

Rural women will also indirectly benefit from the increase in agricultural production. Bangladeshi women are active in the processing of rice and jute, the main crops of the country. Because production of these crops will increase substantially in the sub-project areas, rural women will have more work opportunities.

It is important to remember that sub-projects designed for development were selected accordingly to criteria, explained in detail in Chapter II, which guarantee the selection of sub-projects located in the poorest areas of the country and sub-projects with a high percentage of small farms (less than 1 acre) and landless people. Therefore, although within each sub-project more benefits would accrue to the relatively large farms and although the overall income distribution would remain essentially the same, development of sub-projects will reduce the degree of absolute proverty within these areas.

TABLE V-1

ECONOMIC WAGE RATES FOR MAN LABOR

District	Thana	Sub-Project Number	Man Labor (Tk/day)
Chittagong	Patiya	1	6.0
Dacca	Saturia	5	5.0
	Savar	6	5.0
Khulna	Bagerhat	13	5.0
Rajshahi	Gomostapur	19	5.0
Rangpur	Ulipur	23	3.5
Tangail	Basail	27	5.0

TABLE V-2

ECONOMIC WAGE RATES FOR ANIMAL LABOR

District	Thana	Sub-Project Number	Animal Labor (Tk/day)
Chittagong	Patiya	1	15
Dacca	Saturia	5	15
	Savar	6	20
Khulna	Bagerhat	13	20
Rajshahi	Gomostapur	19	20
Tangail	Basail	27	15

TABLE V-3

DERIVATION OF ECONOMIC PRICES FOR FERTILIZERS

Item	Urea	TSP	MP
	($/ton)	($/ton)	($/ton)
International Price [1]	203[2]	171[3]	76[4]
Ocean Freight and Insurance (FIO)[5]	48	67	61
Handling and Transport to Project Area[6]	30	30	30
Economic Cost at Project Area	281	268	167
	(Tk/md)	(Tk/md)	(Tk/md)
Economic Cost at Project Area	157	150	93

[1] IBRD Price Forecasts, May 1978. Forecast for 1985 in 1978 constant US Dollars.

[2] Bagged, FOB N.W. Europe

[3] Bulk, FOB Florida, USA

[4] Bulk, FOB Florida, USA

[5] Source: Bangladesh Shipping Corporation (BSC)

[6] Source: Bangladesh Agricultural Development Corporation (BADC)

TABLE V-4

ECONOMIC PRICE FOR SEEDS

Crop Name	Price (Tk/md)	Price (Tk/sr)
Aman	160.00	4.00
Aus	160.00	4.00
Boro	160.00	4.00
Jute	270.00	6.75
Wheat	250.00	6.25
Oilseeds	400.00	10.00

Source: Jute Research Institute and Bangladesh Agricultural Development Corporation.

TABLE V-5

ECONOMIC PRICES FOR INSECTICIDES

District	Thana	Sub-Project Number	Average Cost of Insecticides (Tk/pound)
Chittagong	Patiya	1	36
Dacca	Saturia	5	20
	Savar	6	36
Khulna	Bagerhat	13	32
Rajshahi	Gomostapur	19	32
Rangpur	Ulipur	23	30
Tangail	Basail	27	30

Source: Socio-agro-economic survey conducted by Consultant, June 1979.

TABLE V-6

DERIVATION OF ECONOMIC PRICES

FOR SELECTED AGRICULTURAL PRODUCTS

Item	Rice	Jute	Wheat	Oil Seeds
	($/ton)	($/ton)	($/ton)	($/ton)
International Price Projection[1]	410[2]	364[3]	174[4]	615[5]
Quality Differential	70[6]	100	90	100
Adjusted Price Projection	287	364	157	615
Ocean Freight and Insurance[7]	25	---	34	30
FOB/CIF Chittagong Price	312	364	191	645
Port Handling Charges[7]	15	-15	15	15
Processing, Handling and Transportation to Godowns and to Sub-project area[8 & 9]	10	-85	10	-25
Farm Gate Price	337	264	216	635
	(percent)	(percent)	(percent)	(percent)
Conversion to Paddy	65	---	---	---
Processing Adjustment	---	80	---	---
	($/ton)	($/ton)	($/ton)	($/ton)
Adjusted Farm Gate Price	219	211	216	635

(continued)

TABLE V-6

(Continued)

Item	Rice	Jute	Wheat	Oil Seeds
	(Tk/md)	(Tk/md)	(Tk/md)	(Tk/md)
Adjusted Farm Gate Price[10]	123	118	121	355

[1] International Price Projections Obtained from IBRD Price Forecasts, May 1978, in constant 1978 U.S. Dollars, projections for 1985.

[2] Thai, Milled 5% Broken, FOB Bangkok.

[3] Bangladesh Whited. FOB Chittagong/Chalna.

[4] Canadian No. 1 Western Red Spring, ex-store Thunder Bay.

[5] Mustard seed, CIF Europe.

[6] For 25-35% broken.

[7] Source: Bangladesh Shipping Corporation.

[8] Source: Bangladesh Agricultural Development Corporation.

[9] Considers Value of Sub-Products.

[10] Exchange Rate U.S. $ 1 = Tk 15.0.

TABLE V-7

ECONOMIC FARM CROP BUDGETS: PRESENT SITUATION

Crop	Human Labor (day)	Animal Labor (day)	Seeds (seer)	Fertilizer Urea (md)	Fertilizer TSP (md)	Fertilizer MP (md)	Insect-icide (pound)	Cost (Tk/ac)
Sub-project No. 1								
Irrigated area								
Boro (HYV)	65	15	15	2.20	1.80	1.00	1.70	1589
T. aman (HYV)	56	14	15	1.50	1.60	.70	1.50	1321
B. aman (L)	48	14	30	.30	.10	0	0	748
T. aus (HYV)	65	15	16	1.40	.90	.10	.50	1167
Oilseeds	55	16	4	2.00	1.20	.90	0	1306
Non-irrigated area								
Boro (L)	42	13	14	2.00	1.60	1.00	1.50	1324
B. aus (L)	40	13	32	1.60	1.90	.50	1.80	1332
T. aman (L)	50	15	14	1.50	1.10	.30	.50	1155
Oilseeds	50	14	4	1.60	1.00	.50	0	1097
Sub-project No. 5								
Irrigated area								
Boro (HYV)	72	21	12	2.00	1.50	.75	2.50	1520
T. aman (L)	54	16	14	.80	.70	0	1.00	898
Non-irrigated area								
M. aus/aman(L)	60	21	28	0	0	0	0	844
Wheat	50	17	50	1.00	.40	.20	1.00	1180
Jute	65	16	4	.50	0	0	0	738
Oilseeds	48	18	4	1.10	.80	.40	0	977

(continued)

TABLE V-7

(continued)

Crop	Human Labor (day)	Animal Labor (day)	Seeds (seer)	Fertilizer Urea (md)	TSP (md)	MP (md)	Insect-icide (pound)	Cost (Tk/ac)
Sub-project No. 6								
Irrigated area								
Boro (HYV)	57	15	13	2.10	.80	.10	2.20	1293
T. aman (HYV)	56	15	15	1.20	.50	.10	.80	1036
T. aman (L)	50	16	14	.80	.50	.10	1.00	959
Non-irrigated area								
T. aman (L)	50	16	14	.80	.50	.10	1.00	959
Wheat	43	15	48	1.25	.50	.40	0	1235
Jute	66	20	4	1.00	.60	.20	.10	1128
Oilseeds	45	22	4	1.00	.80	.10	0	945
Sub-project No. 13								
Non-irrigated area								
Boro (L)	58	14	15	.60	.10	0	.50	848
T. aman (L)	53	14	16	.50	.10	0	1.00	790
Wheat	45	15	40	.40	.20	.10	.60	909
Sub-project No. 19								
Non-irrigated area								
Boro (L)	44	15	15	0	0	0	0	638
B. aman (L)	50	16	28	0	0	0	0	750
T. aman (L)	46	14	16	0	0	0	0	631
B. aus (L)	41	14	30	0	0	0	0	666
Wheat	45	14	50	0	0	0	0	899
Oilseeds	42	12	4	0	0	0	0	539

(continued)

TABLE V-7

(continued)

Crop	Human Labor (day)	Animal Labor (day)	Seeds (seer)	Fertilizer Urea (md)	TSP (md)	MP (md)	Insect-icide (pound)	Cost (Tk/ac)
Sub-project No. 23								
Irrigated area								
Boro (HYV)	78	18	18	1.10	.70	.90	1.60	1126
T. aman (L)	62	18	22	.30	.30	.35	1.10	806
Wheat	60	14	50	.80	.30	.10	1.20	806
Jute	64	14	4	.25	.10	.20	.90	617
Non-irrigated area								
B. aus (L)	40	14	38	.35	.10	.20	.20	657
T. aus (L)	64	14	15	.40	.15	.25	1.20	699
T. aman(L)	62	18	22	.30	.30	.35	1.10	806
Wheat	60	14	50	.80	.30	.10	1.20	1043
Jute	64	14	4	.25	.10	.20	.90	617
Oilseeds	50	18	4	1.00	.60	.80	.0	887
Sub-project No. 27								
Irrigated area								
Boro (HYV)	68	22	18	2.00	.80	.20	1.10	1351
B. aman (L)	45	18	38	.80	.20	0	0	883
Non-irrigated area								
M. aus/aman(L)	64	20	35	1.20	.10	0	0	1059
Jute	62	17	5	.80	.50	.10	0	890
Wheat	52	15	50	1.00	.60	.10	1.00	1192
Oilseeds	42	20	4	1.00	.50	.10	0	870

Source: Socio-agro-economic survey conducted by Consultant, June 1979.

TABLE V-8

EXPECTED ECONOMIC GROWTH: FUTURE SITUATION WITHOUT SUB-PROJECT

District	Thana	Sub-Project Number	Future Growth (percent)
Chittagong	Patiya	1	6
Dacca	Saturia	5	6
Dacca	Savar	6	8
Khulna	Bagerhat	13	5
Rajshahi	Gomostapur	19	0
Rangpur	Ulipur	23	12
Tangail	Basail	27	5

TABLE V-9

ECONOMIC FARM CROP BUDGETS: FUTURE SITUATION

Crop	Human Labor (day)	Animal Labor (day)	Seeds (seer)	Fertilizer Urea (md)	Fertilizer TSP (md)	Fertilizer MP (md)	Insect-icide (pound)	Cost (Tk/ac)
Sub-project No. 1								
Irrigated area								
Boro (HYV)	80	22	10	2.40	1.80	1.00	2.00	1828
T. aman (HYV)	70	22	10	1.60	1.60	.80	2.00	1576
T. aus (HYV)	70	22	10	1.50	1.00	.30	1.00	1363
Wheat	58	14	50	1.50	.80	.50	1.00	1439
Oilseeds	50	22	4	1.80	1.20	.80	0	1328
Non-irrigated area								
Boro (LIV)	58	15	12	1.40	.80	.60	1.50	1178
T. aus (LIV)	56	21	12	1.00	.80	.50	1.50	1123
T. aman (LIV)	56	21	12	1.00	.80	.50	1.50	1217
M. aus & aman (LIV)	72	22	45	1.10	.90	.40	1.00	1389
Oilseeds	50	22	4	1.80	1.20	.89	0	1328
Sub-project No. 5								
Irrigated area								
Boro (HYV)	78	22	12	2.10	1.60	.90	2.50	1618
T. aman (HYV)	66	22	12	1.20	.80	.50	1.50	1202
T. aus (HYV)	66	22	12	1.00	.60	.50	1.50	1134
Wheat	55	18	50	1.20	.70	.50	2.00	1361
Jute	75	18	4	.60	.20	.40	1.00	938
Oilseeds	55	20	4	1.25	.90	.50	0	1100

(continued)

TABLE V-9

(continued)

Crop	Human Labor (day)	Animal Labor (day)	Seeds (seer)	Fertilizer Urea (md)	TSP (md)	MP (md)	Insect-icide (pound)	Cost (Tk/ac)
Sub-project No. 6								
Irrigated area								
Boro (HYV)	62	18	12	2.30	1.00	.30	3.00	1502
T. aman(HYV)	62	18	12	1.50	.80	.30	1.20	1259
T. aus (HYV)	62	18	12	1.30	.60	.30	1.20	1191
Wheat	55	15	50	2.00	.75	.50	2.00	1361
Jute	75	18	4	.60	.20	.40	1.00	938
Oilseeds	55	20	4	1.25	.90	.50	0	1100
Sub-project No. 13								
Irrigated area								
Boro (HYV)	72	22	10	2.00	1.50	.80	2.00	1669
T. aus (HYV)	68	22	10	1.50	1.00	.20	1.50	1399
M. aus & aman (LIV)	64	22	45	.60	.20	.10	1.00	1216
Wheat	60	15	50	1.50	.80	.50	2.00	1516
Oilseeds	55	22	4	1.20	.80	.60	0	1231
Non-Irrigated area								
T. aus (LIV)	54	21	12	.80	.50	.20	1.00	1088
T. aman (LIV)	54	21	12	.80	.60	.30	1.00	1115
Boro (LIV)	56	15	12	.80	.50	.20	1.50	985
M. aus & aman	64	22	45	.40	.20	.10	1.00	1164

(continued)

TABLE V-9

(Continued)

Crop	Human Labor (day)	Animal Labor (day)	Seeds (seer)	Fertilizer Urea (md)	TSP (md)	MP (md)	Insect-icide (pound)	Cost (Tk/ac)
Sub-project No. 19								
Non-irrigated area								
Boro (LIV)	56	16	14	.50	.20	.10	1.00	886
T. aus (LIV)	52	16	14	.50	.20	.10	1.00	864
T. aman (LIV)	54	16	14	.50	.20	.10	1.00	875
M. aus & aman (LIV)	64	20	45	.50	.20	.10	1.00	1155
Wheat	52	16	50	.50	.20	.10	1.00	1147
Oilseeds	50	16	4	.80	.50	.30	0	922
Sub-project No. 23								
Irrigated area								
Boro (HYV)	84	20	12	2.00	1.40	1.00	3.00	1484
T. aus (HYV)	68	18	12	1.80	1.00	.50	2.50	1221
T. aman (HYV)	68	18	12	1.90	1.00	.60	3.00	1265
Wheat	64	14	50	2.00	1.00	.50	2.50	1465
Jute	75	15	4	1.00	.60	.60	0	899
Oilseeds	50	20	4	1.25	1.50	.80	0	1029
Sub-project No. 27								
Irrigated area								
Boro (HYV)	78	22	14	2.20	1.50	.80	2.50	1645
T. aus (HYV)	75	22	14	2.00	1.50	.80	2.00	1578
M. aus & aman (LIV)	70	20	40	1.50	.50	.30	2.00	1329
T. aman (HYV)	60	20	15	1.50	1.00	.50	2.00	1267
Wheat	60	16	45	2.20	1.60	.60	3.00	1707
Jute	75	18	4	1.20	.75	.50	2.50	1204
Oilseeds	55	18	4	1.50	1.20	.40	0	1141

TABLE V-10

ESTIMATION OF ANNUAL ECONOMIC BENEFITS:

SUB-PROJECT NO. 1, PATIA THANA, CHITTAGONG DISTRICT

Crop	Area (acre)	Yield (md/ac)	Production (md)	Income (Tk)	Gross Cost (Tk)	Net Income (Tk)
Present Situation						
Irrigated area						
Boro (HYV)	60	47	2,820	346,860	94,340	
T. aman (HYV)	75	30	2,250	276,750	99,075	
B. aman (L)	85	19	1,530	188,190	63,580	
T. aus (HYV)	75	38	2,850	350,550	87,525	
Oilseeds	80	8	640	227,200	104,480	
Non-irrigated area						
Boro (L)	370	21	7,770	955,710	489,880	
B. aus (L)	200	24	4,800	590,400	266,400	
T. aman (L)	100	16	1,600	196,800	115,500	
Oilseeds	100	7	700	248,500	109,700	
Total				3,380,960	1,431,480	1,949,480
Crop intensity, irrigated area: (375/190) = 1.97						
Crop intensity, non-irrigated area: (770/570) = 1.35						
Future Situation						
Without Sub-Project (+6%)						2,066,449
Future Situation						
With Sub-Project						
Irrigated area						
Boro (HYV)	60	58	3,480	428,040	109,680	

(continued)

TABLE V-10

(continued)

Crop	Area (acre)	Yield (md/ac)	Production (md)	Income (Tk)	Gross Cost (Tk)	Net Income (Tk)
T. aman (HYV)	240	40	9,600	1,180,800	378,240	
T. aus (HYV)	165	48	7,920	974,169	224,895	
Wheat	135	24	3,240	392,040	194,265	
Oilseeds	75	11	825	292,875	99,600	
Non-irrigated area						
Boro (LIV)	160	24	2,840	472,320	188,480	
T. aus (LIV)	155	23	3,565	438,495	174,065	
T. aman (LIV)	130	20	2,600	319,80	158,210	
M. aus & aman (LIV)	100	22	2,200	270,600	138,900	
Oilseeds	140	10	1,400	497,000	185,920	
Total				5,266,139	1,852,255	3,413,884

Crop intensity, irrigated area: (675/345) = 1.96

Crop intensity, non-irrigated area: (685/415) = 1.65

TABLE V-11

ESTIMATION OF ANNUAL ECONOMIC BENEFITS:

SUB-PROJECT NO. 5, SATURIA THANA, DACCA DISTRICT

Crop	Area (acre)	Yield (md/ac)	Production (md)	Gross Income (Tk)	Total Cost (Tk)	Net Income (Tk)
Present Situation						
Irrigated area						
Boro (HYV)	60	46	2,760	339,480	91,200	
T. aman (L)	45	17	765	94,095	40,410	
Non-irrigated area						
M. aus & aman (L)	70	20	1,400	172,200	59,080	
Wheat	25	21	525	63,525	29,500	
Jute	15	15	225	26,550	11,070	
Oilseeds	25	5	225	79,875	24,425	
Total				775,725	255,685	520,040
Crop intensity, irrigated area: (105/60) = 1.75						
Crop intensity, non-irrigated area: (135/98) = 1.38						
Future Situation						
Without Sub-project (+10%)						572,044
Future Situation						
With Sub-project						
Irrigated area						
Boro (HYV)	77	54	4,158	511,434	124,586	

(continued)

TABLE V-11

(continued)

Crop	Area (acre)	Yield (md/ac)	Production (md)	Gross Income (Tk)	Total Cost (Tk)	Net Income (Tk)
T. aman						
(HYV/LIV)	119	41	4,879	600,117	143,038	
T. aus						
(HYV/LIV)	77	36	2,772	340,956	87,318	
Wheat	51	28	1,428	172,788	69,411	
Jute	20	19	380	44,840	18,760	
Oilseeds	30	12	360	127,800	33,000	
Total				1,797,935	476,113	1,321,822
Crop intensity: (374/158) = 2.36						

TABLE V-12

ESTIMATION OF ANNUAL ECONOMIC BENEFITS:

SUB-PROJECT NO. 6, SAVAR THANA, DACCA DISTRICT

Crop	Area (acre)	Yield (md/ac)	Production (md)	Gross Income (Tk)	Total Cost (Tk)	Net Income (Tk)
Present Situation						
Irrigated area						
Boro (HYV)	40	40	1,600	196,800	51,720	
T. aman (HYV)	35	31	1,085	133,455	36,260	
T. aman (L)	5	16	80	9,840	4,795	
Non-irrigated area						
T. aman (L)	70	16	1,120	137,760	67,130	
Wheat	10	24	240	29,040	12,350	
Jute	20	20	400	47,200	22,560	
Oilseeds	5	8	40	14,200	2,727	
Total				568,295	199,542	368,753
Crop intensity, irrigated area: (80/40) = 2.00						
Crop intensity, non-irrigated area: (105/70) = 1.50						
Future Situation						
Without Sub-Project (+8%)						398,253
Future Situation						
With Sub-Project						
Irrigated area						
Boro (HYV)	40	52	2,080	255,840	60,080	

(continued)

TABLE V-12

(continued)

Crop	Area (acre)	Yield (md/ac)	Production (md)	Gross Income (Tk)	Total Cost (Tk)	Net Income (Tk)
T. aman (HYV)	76	40	3,040	373,920	94,684	
T. aus (HYV)	58	38	2,204	271,092	69,078	
Wheat	65	30	1,950	235,950	102,440	
Jute	20	23	460	54,280	25,240	
Oilseeds	5	12	60	21,300	5,355	
Total				1,212,381	357,877	854,505
Crop intensity: (264/110) = 2.40						

TABLE V-13

ESTIMATION OF ANNUAL ECONOMIC BENEFITS:

SUB-PROJECT NO. 13, BAGERHAT THANA, KHULNA DISTRICT

Crop	Area (acre)	Yield (md/ac)	Production (md)	Gross Income (Tk)	Total Cost (Tk)	Net Income (Tk)
Present Situation						
Non-irrigated area						
Boro (L)	100	16	1,600	196,800	84,800	
T. aman (L)	400	14	5,600	688,800	316,000	
Wheat	140	12	1,680	203,280	127,260	
Total				1,088,880	528,060	560,820
Crop intensity: (640/640) = 1.00						
Future Situation						
Without Sub-Project (+5%)						588,861
Future Situation						
With Sub-Project						
Irrigated area						
Boro (HYV)	200	43	8,600	1,057,800	333,800	
T. aus	300	32	9,600	1,180,800	419,700	
T. aman	200	36	7,200	885,600	298,200	
M. aus & aman (LIV)	100	22	2,200	270,600	121,600	
Wheat	200	26	5,200	629,200	303,200	
Oilseeds	180	11	1,980	702,900	221,580	

(continued)

TABLE V-13

(continued)

Crop	Area (acre)	Yield (md/ac)	Production (md)	Gross Income (Tk)	Total Cost (Tk)	Net Income (Tk)
Non-irrigated area						
T. aus (LIV)	50	16	800	98,400	54,400	
T. aman (LIV)	60	18	1,080	132,840	69,300	
Boro (LIV)	70	18	1,260	154,980	68,950	
M. aus & aman (LIV)	40	16	640	78,720	46,560	
Total				5,191,840	1,937,290	3,254,552
Crop intensity, irrigated area (1180/500) = 2.36						
Crop intensity, non-irrigated area (220/140) = 1.57						

TABLE V-14

ESTIMATION OF ANNUAL ECONOMIC BENEFITS:

SUB-PROJECT NO. 18, GOMOSTAPUR THANA, RAJSHAHI DISTRICT

Crop	Area (acre)	Yield (md/ac)	Production (md)	Gross Income (Tk)	Total Cost (Tk)	Net Income (Tk)
Present Situation						
Non-irrigated area						
Boro (L)	1,000	14	14,000	1,722,000	638,000	
B. aus (L)	1,500	10	15,000	1,845,000	999,000	
B. aman (L)	1,500	11	16,500	2,029,500	1,125,000	
T. aman (L)	500	13	6,500	799,500	315,500	
Wheat	500	12	6,000	726,000	449,500	
Oilseeds	2,000	6	12,000	4,260,000	1,078,000	
Total				11,382,000	4,605,000	6,777,000
Crop intensity = (7000/5000) = 1.40						
Future Situation						
Without Sub-project (+0%)						6,777,000
Future Situation						
With Sub-project						
Non-irrigated area						
Boro (LIV)	1,300	18	23,400	2,878,200	1,151,800	
T. aus (LIV)	1,300	15	19,500	2,398,500	1,123,200	
T. aman (LIV)	900	17	15,300	1,881,900	787,500	

(continued)

TABLE V-14

(continued)

Crop	Area (acre)	Yield (md/ac)	Production (md)	Gross Income (Tk)	Total Cost (Tk)	Net Income (Tk)
M. aus & aman (LIV)	1,000	18	18,000	2,214,000	1,155,000	
Wheat	800	14	11,200	1,355,200	917,600	
Oilseeds	2,000	8	16,000	5,680,000	1,844,000	
Total				16,407,800	6,979,100	9,428,700
Crop intensity (7500/5000) = 1.46						

TABLE V-15

ESTIMATION OF ANNUAL ECONOMIC BENEFITS:

SUB-PROJECT NO. 23, ULIPUR THANA, RANGPUR DISTRICT

Crop	Area (acre)	Yield (md/ac)	Production (md)	Gross Income (Tk)	Total Cost (Tk)	Net Income (Tk)
Present Situation						
Irrigated Area						
Boro (HYV)	35	48	1,680	206,640	39,410	
T. aman (L)	15	22	330	40,590	12,090	
Wheat	34	16	544	65,824	27,404	
Jute	30	15	450	53,100	18,510	
Non-Irrigated area						
B. aus (L)	18	14	252	30,996	11,826	
T. aus (L)	18	27	486	59,778	12,582	
T. aman (L)	12	22	264	32,472	9,672	
Wheat	12	16	192	23,232	12,516	
Jute	15	15	225	26,550	9,225	
Oilseeds	12	7	84	29,820	10,644	
Total				569,002	163,879	405,123
Crop intensity, irrigated area: (114/70) = 1.63						
Crop intensity, non-irrigated area: (87/60) = 1.45						
Future Situation						
Without Sub-Project (+12%)						453,738

(continued)

TABLE V-15

(continued)

Crop	Area (acre)	Yield (md/ac)	Production (md)	Gross Income (Tk)	Total Cost (Tk)	Net Income (Tk)
Future Situation						
With Sub-Project						
Irrigated area						
Boro (HYV)	15	56	840	103,320	22,260	
T. aus (HYV)	56	36	2,016	247,968	68,376	
T. aman(HYV)	92	38	3,496	430,008	116,380	
Wheat	85	28	2,380	287,980	124,525	
Jute	20	23	460	54,280	17,980	
Oilseeds	30	11	330	117,150	30,870	
Total				1,240,706	380,391	860,315
Crop intensity = (298/130) = 2.29						

TABLE V-16

ESTIMATION OF ANNUAL ECONOMIC BENEFITS:

SUB-PROJECT NO. 27, BASAIL THANA, TANGAIL DISTRICT

Crop	Area (acre)	Yield (md/ac)	Production (md)	Gross Income (Tk)	Total Cost (Tk)	Net Income (Tk)
Present Situation						
Irrigated Area						
Boro (HYV)	60	54	3,240	398,520	81,060	
B. aman (L)	75	18	1,350	166,050	66,225	
Non-Irrigated area						
M. aus & aman (L)	35	18	630	66,490	37,065	
Jute	10	10	100	11,800	8,900	
Wheat	20	21	420	50,820	23,840	
Oilseeds	5	8	40	14,200	4,350	
Total				718,880	221,440	497,440
Crop intensity, irrigated area: (135/75) = 1.80						
Crop intensity, non-irrigated area: (70/48) = 1.46						
Future Situation Without Sub-Project (+4%)						517,338
Future Situation With Sub-Project						
Irrigated area						
Boro (HYV)	29	64	1,856	228,288	47,705	

(continued)

TABLE V-16

(continued)

Crop	Area (acre)	Yield (md/ac)	Production (md)	Gross Income (Tk)	Total Cost (Tk)	Net Income (Tk)
T. aus (HYV)	34	56	1,870	230,010	53,652	
M. aus & aman (LIV)	50	26	1,300	159,900	66,450	
T. aman(HYV)	29	42	1,218	149,814	36,743	
Wheat	64	32	2,048	247,808	109,248	
Jute	10	22	220	25,960	12,040	
Oilseeds	30	12	360	127,800	34,230	
Total				1,169,580	360,068	809,512
Crop intensity = (246/123) = 2.00						

TABLE V-17

SUMMARY OF ANNUAL ECONOMIC BENEFITS

DUE TO SUB-PROJECT DEVELOPMENT

Sub-Project Number	Present Net Income (Tk/year)	Future W/out Net Income (Tk/year)	Future With Net Income (Tk/year)	Increased Net Income (Tk/year)
1	1,949,480	2,066,449	3,413,884	1,347,435
5	520,040	572,044	1,321,822	749,778
6	368,753	398,253	854,505	456,252
13	560,820	588,861	3,254,550	2,665,689
19	6,777,000	6,777,000	9,428,700	2,651,700
23	405,123	453,738	860,315	406,577
27	497,440	517,335	809,512	292,174

TABLE V-18

CROP IRRIGATION WATER REQUIREMENTS:

SUB-PROJECT NO. 1, PATIA THANA, CHITTAGONG DISTRICT

Crop	Area (acre)	Water Requirement (inch)	Total (ac.in.)	Total (ac.ft.)
Boro, Medium Highland	45	46.5	2,092.5	
Boro, Medium Lowland	15	37.9	568.5	
Wheat	135	20.4	2,754.0	
Oilseeds	75	20.4	1,530.0	
T. aus[1]	105	11.7	1,228.5	
T. aus[2]	60	6.0	360.0	
T. aman[1]	135	2.3	310.5	
T. aman[2]	105	4.4	462.0	
Total			9,306.0	775.5

[1] Wheat-based rotation

[2] Boro-based rotation

TABLE V-19

CROP IRRIGATION WATER REQUIREMENTS:

SUB-PROJECT NO. 5, SATURIA THANA, DACCA DISTRICT

Crop	Area (acre)	Water Requirement (inch)	Total (ac.in.)	Total (ac.ft.)
Boro, Medium Highland	61	48.3	2,946.3	
Boro, Medium Lowland	16	39.7	635.2	
Wheat	51	20.7	1,055.7	
Oilseeds	30	20.7	621.0	
T. aus[1]	56	12.7	711.2	
T. aus[2]	20	6.0	120.0	
T. aman[1]	50	3.7	185.0	
T. aman[2]	69	6.9	476.1	
Total			6,750.5	562.54

[1] Wheat-based rotation

[2] Boro-based rotation

TABLE V-20

CROP IRRIGATION WATER REQUIREMENTS:

SUB-PROJECT NO. 6, SAVAR THANA, DACCA DISTRICT

Crop	Area (acre)	Water Requirement (inch)	Total (ac.in.)	Total (ac.ft.)
Boro, Lowland	18	30.2	543.6	
Boro, High Lowland	22	39.7	873.4	
Wheat	65	20.7	1,345.5	
Oilseeds	5	20.7	105.5	
T. aus[1]	50	12.7	635.0	
T. aus[2]	8	5.0	40.0	
T. aman[1]	45	3.7	166.5	
T. aman[2]	31	6.9	213.9	
Total			3,921.4	326.78

[1] Wheat-based rotation

[2] Boro-based roration

TABLE V-21

CROP IRRIGATION WATER REQUIREMENTS:

SUB-PROJECT NO. 13, BAGERHAT THANA, KHULNA DISTRICT

Crop	Area (acre)	Water Requirement (inch)	Total (ac.in.)	Total (ac.ft.)
Boro, Medium Highland	150	50.8	7,620.0	
Boro, Medium Lowland	50	42.0	2,100.0	
Wheat	200	22.9	4,580.0	
Oilseeds	200	22.9	4,580.0	
T. aus[1]	100	20.4	2,040.0	
T. aus[2]	200	8.7	1,740.0	
T. aman[1]	200	7.2	1,440.0	
Total			24,100.0	2,008.3

[1] Wheat-based rotation

[2] Boro-based roration

TABLE V-22

CROP IRRIGATION WATER REQUIREMENTS:

SUB-PROJECT NO. 23, ULIPUR THANA, RANGPUR DISTRICT

Crop	Area (acre)	Water Requirement (inch)	Total (ac.in)	Total (ac.ft.)
Boro, Highland	15	47.3	717.0	
Wheat	85	18.6	1,581.0	
Oilseeds	30	18.6	558.0	
T. aus[1]	51	15.6	795.6	
T. aus[2]	5	6.0	30.0	
T. aman[1]	60	3.9	234.0	
T. aman[2]	32	7.2	230.3	
Total			4,146.0	345.5

[1] Wheat-based rotation

[2] Boro-based roration

TABLE V-23

CROP IRRIGATION WATER REQUIREMENTS:

SUB-PROJECT NO. 27, BASAIL THANA, TANGAIL DISTRICT

Crop	Area (acre)	Water Requirement (inch)	Total (ac.in.)	Total (ac.ft.)
Boro, Lowland	29	30.2	875.8	
Wheat	69	20.7	1,428.3	
Oilseeds	25	20.7	517.5	
T. aus[1]	34	12.7	431.8	
Total			3,253.4	271.12

[1] Wheat-based rotation

TABLE V-24

SUMMARY OF COSTS FOR SUB-PROJECTS EVALUATED

Sub-Project Number	Construction Cost (Tk)	O & M Cost		New Pump Cost (Annual Equivalent) (Tk)
		Pumps (Tk)	Khals (Tk)	
1	3,974,000	57,081	4,913	25,658
5	1,524,000	33,093	0	0
6	967,000	31,513	0	0
13	6,769,000	207,016	2,385	64,145
19	6,769,000	0	3,275	0
23	1,144,000	28,819	0	0
27	1,117,000	16,910	-	0

TABLE V-25

ECONOMIC EVALUATION RESULTS: SUB-PROJECT NO. 1,

PATIA THANA, CHITTAGONG DISTRICT

Year	Sub-Project Construction (Tk)	O & M (Tk)	Sunken Cost New Pump Cost[1] (Tk)	Benefits (Tk)	Cash Flow (Tk)
1	3,974,000				-3,974,000
2		61,994	25,658	673,617	586,066
3				1,010,576	922,924
4				1,347,435	1,259,783
5					
6					
7					
8					
9					
10					
11		61,994	25,658	1,347,435	1,259,783

	(percent)
B/C at 12%	1.5
B/C at 16%	1.3
B/C at 20%	1.1
IRR	23.3%

[1] Annual Cost Basis.

Example of IRR calculation:

Discounted cash flow at 23% = 34,033

Discounted cash flow at 24% = -79,081

Interpolation for rate of return:

$$\left(\frac{34,033}{34,033 + 79,081} \right) \times 1\% + 23\% = 23.3\%$$

TABLE V-26

ECONOMIC EVALUATION RESULTS: SUB-PROJECT NO. 5,

SATURIA THANA, DACCA DISTRICT

Year	Sub-Project Construction (Tk)	O & M (Tk)	Benefits (Tk)	Cash Flow (Tk)
1	1,524,000			-1,524,000
2		33,093	374,889	341,796
3			562,334	529,241
4			749,778	716,685
5				
6				
7				
8				
9				
10				
11		33,093	749,778	716,6

	(percent)
B/C at 12%	2.2
B/C at 16%	1.9
B/C at 20%	1.6
IRR	35.9%

TABLE V-27

ECONOMIC EVALUATION RESULTS: SUB-PROJECT NO. 6,

SAVAR THANA, DACCA DISTRICT

Year	Construction (Tk)	O, M & R (Tk)	Benefits (Tk)	Cash Flow (Tk)
1	967,000			-967,000
2		31,513	228,126	196,613
3			342,189	310,676
4			456,252	424,739
5				
6				
7				
8				
9				
10				
11		31,513	456,252	424.739

	(percent)
B/C at 12%	2.0
B/C at 16%	1.7
B/C at 20%	1.5
IRR	33.3%

TABLE V-28

ECONOMIC EVALUATION RESULTS: SUB-PROJECT NO. 13,

BAGERHAT THANA, KHULNA DISTRICT

Year	Construction Cost (Tk)	O & M Cost (Tk)	New Pump Cost[1] (Tk)	Benefits (Tk)	Cash Flow (Tk)
1	6,769,000				-6,769,000
2		209,401	64,145	1,332,844	1,059,298
3				1,999,267	1,725,721
4				2,666,689	2,392,143
5					
6					
7					
8					
9					
10					
11		209,401	64,145	2,666,689	2,392,143

	(percent)
B/C at 12%	1.6
B/C at 16%	1.4
B/C at 20%	1.2
IRR	26.2%

[1] Annual Cost Basis.

TABLE V-29

ECONOMIC EVALUATION RESULTS: SUB-PROJECT NO. 19,

GOMOSTAPUR THANA, RAJSHAHI DISTRICT

Year	Construction Cost (Tk)	O & M Cost (Tk)	Benefits (Tk)	Cash Flow (Tk)
1	2,479,000			-2,479,000
2		3,275	1,325,850	1,322,575
3			1,988,775	1,985,500
4			2,651,700	2,648,425
5				
6				
7				
8				
9				
10				
11		3,275	2,651,700	2,648,425

	(percent)
B/C at 12%	5.3
B/C at 16%	4.5
B/C at 20%	3.8
IRR	76.7%

TABLE V-30

ECONOMIC EVALUATION RESULTS: SUB-PROJECT NO. 23,

ULIPUR THANA, RANGPUR DISTRICT

Year	Construction Cost (Tk)	O, M & R Cost (Tk)	Benefits (Tk)	Cash Flow (Tk)
1	1,144,000			-1,144,000
2		28,819	203,288	174,470
3			304,933	276,114
4			406,577	377,758
5				
6				
7				
8				
9				
10				
11		28,819	406,577	377,758

	(percent)
B/C at 12%	1.6
B/C at 16%	1.3
B/C at 20%	1.2
IRR	24.4%

TABLE V-31

ECONOMIC EVALUATION RESULTS: SUB-PROJECT NO. 27,

BASAIL THANA, TANGAIL DISTRICT

Year	Construction Cost (Tk)	O, M & R Cost (Tk)	Benefits (Tk)	Cash Flow (Tk)
1	1,117,000			-1,117,000
2		16,910	146,087	129,177
3			292,174	275,264
4				
5				
6				
7				
8				
9				
10				
11		16,910	292,174	275,264

	(percent)
B/C at 12%	1.3
B/C at 16%	1.1
B/C at 20%	0.9
IRR	17.9%

TABLE V-32

SUMMARY OF ECONOMIC EVALUATIONS

Sub-Project Number	B/C Ratios at 12%	B/C Ratios at 16%	B/C Ratios at 20%	Internal Rate of Return (percents)
1	1.5	1.3	1.1	23.3
5	2.2	1.9	1.6	35.9
6	2.0	1.7	1.5	33.3
13	1.6	1.4	1.2	26.2
19	5.3	4.5	3.8	76.6
23	1.6	1.3	1.2	24.4
27	1.3	1.1	0.9	17.9

TABLE V-33

MARKET WAGE RATES FOR HIRED HUMAN LABOR AND ANIMAL LABOR

District	Thana	Sub-Project Number	Hired Labor	
			Human (Tk/day)	Animal (Tk/day)
Chittagong	Patiya	1	12	15
Dacca	Saturia	5	10	15
	Savar	6	10	20
Khulna	Bagerhat	13	10	20
Rajshahi	Gomostapur	19	10	20
Rangpur	Ulipur	23	7	15
Tangail	Basail	27	10	15

Source: Socio-agro-economic survey conducted by Consultant, June 1979.

TABLE V-34

MARKET PRICE FOR SEEDS AT SUB-PROJECT AREAS

District	Thana	Sub-Project Number	Boro (HYV) (Tk/sr)	Boro (L) (Tk/sr)	Aus (Tk/sr)	Aman (Tk/sr)	Wheat (Tk/sr)	Jute (Tk/sr)	Oilse (Tk/s
Chittagong	Patiya	1	4.00	3.50	3.25	3.25	3.50	--	12.5
Dacca	Saturia	5	3.50	--	3.25	3.50	4.00	4.00	10.0
	Savar	6	3.50	--	--	3.25	3.50	4.50	8.0
Khulna	Bagerhat	13	--	3.00	--	4.00	4.00	--	--
Rajshahi	Gomostapur	19	--	4.00	3.25	3.50	5.00	--	14.0
Rangpur	Ulipur	23	4.00	--	4.25	4.25	4.50	10.00	12.0
Tangail	Basail	27	3.50	--	3.50	3.50	3.50	4.00	12.0

Source: Socio-agro-economic survey conducted by Consultant. June 1979.

TABLE V-35

MARKET PRICES FOR FERTILIZERS AND INSECTICIDES AT SUB-PROJECT AREAS

District	Thana	Sub-Project Number	Fertilizer Urea (Tk/md)	TSP (Tk/md)	MP (Tk/md)	Insecticide (Tk/pound)
Chittagong	Patia	1	70	55	50	18
Dacca	Saturia	5	70	60	50	10
	Savar	6	70	55	50	18
Khulna	Bagerhat	13	70	55	45	16
Rajshahi	Gomostapur	19	70	60	50	16
Rangpur	Ulipur	23	70	60	50	15
Tangail	Basail	27	70	60	50	14

Source: Socio-agro-economic survey conducted by Consultant. June 1979.

TABLE V-36

FINANCIAL PRICES OF FARM OUTPUT

Crop	Price (Tk/seer)
Boro	86
Aus	80
Aman	80
Wheat	86
Jute	90
Oilseeds	220

Source: Food Procurement, Bangladesh Jute Association and Bangladesh Agricultural Development Corporation.

TABLE V-37

FINANCIAL FARM CROP BUDGETS: PRESENT SITUATION

Crop	Hired Labor Human (days)	Hired Labor Animal (days)	Seed (seer)	Fertilizer Urea (md)	Fertilizer TSP (md)	Fertilizer MP (md)	Insecticide Cost (pound)	Insecticide Cost (Tk/ac)
Sub-Project No. 1								
Irrigated area								
Boro (HYV)	18	0	15	2.20	1.80	1.00	1.70	711
T. aman (HYV)	18	0	15	1.50	1.60	.70	1.50	606
B. aman (L)	20	0	30	.30	.10	0	0	424
T. aus (HYV)	18	0	16	1.40	.90	.10	.50	505
Oilseeds	18	0	4	2.00	1.20	.90	0	605
Non-irrigated area								
Boro (L)	20	0	14	2.00	1.60	1.00	1.40	684
B. aus (L)	21	0	32	1.60	1.90	.50	1.80	725
T. aman (L)	18	0	14	1.50	1.10	.30	.50	526
Oilseeds	18	0	4	1.60	1.00	.50	0	536
Sub-Project No. 5								
Irrigated area								
Boro (HYV)	25	1	12	2.00	1.50	.75	2.50	699
T. aman (L)	18	3	14	.80	.70	0	1.00	445
Non-irrigated area								
M. aus & aman (L)	15	2	38	0	0	0	0	354
Wheat	16	2	50	1.00	.40	.20	1.00	588
Jute	18	2	4	.50	0	0	0	305
Oilseeds	15	5	4	1.10	.80	.40	0	478

(continued)

TABLE V-37

(continued)

Crop	Hired Labor Human (days)	Hired Labor Animal (days)	Seed (seer)	Fertilizer Urea (md)	Fertilizer TSP (md)	Fertilizer MP (md)	Insecticide Cost (pound)	Insecticide Cost (Tk/ac)
Sub-Project No. 6								
Irrigated area								
Boro (HYV)	16	5	13	2.10	.80	.10	2.20	631
T. aman (HYV)	18	3	15	1.20	.50	.10	.80	489
T. aman (L)	18	4	14	.80	.50	.10	1.00	488
Non-irrigated area								
T. aman (L)	18	4	14	.80	.50	.10	1.00	488
Wheat	17	9	48	1.25	.50	.40	0	761
Jute	18	9	4	1.00	.60	.20	.10	574
Oilseeds	16	3	4	1.00	.80	.10	0	484
Sub-Project No. 13								
Non-irrigated area								
Boro (L)	20	0	15	.60	.10	0	1.00	343
T. aman (L)	18	1	16	.50	.10	0	.50	364
Wheat	16	-	40	.40	.20	.10	.60	394
Sub-Project No. 19								
Non-irrigated area								
Boro (L)	16	5	15	0	0	0	0	373
B. aus (L)	14	1	30	0	0	0	0	300
B. aman (L)	15	2	28	0	0	0	0	336
T. aman (L)	16	3	16	0	0	0	0	322
Wheat	18	3	50	0	0	0	0	571
Oilseeds	18	1	4	0	0	0	0	298

(continued)

TABLE V-37

(continued)

Crop	Hired Labor Human (days)	Hired Labor Animal (days)	Seed (seer)	Fertilizer Urea (md)	Fertilizer TSP (md)	Fertilizer MP (md)	Insecticide Cost (pound)	Insecticide Cost (Tk/ac)
Sub-Project No. 23								
Irrigated area								
Boro (HYV)	26	8	18	1.10	.70	.90	1.60	655
T. aman (L)	14	5	15	.30	.30	.35	1.10	356
Wheat	16	3	50	.80	.30	.10	1.20	599
Jute	18	2	4	.25	.10	.20	.90	283
Non-irrigated area								
B. aus (L)	17	2	38	.35	.10	.20	.20	391
T. aus (L)	21	5	14	.40	.15	.25	1.20	399
T. aman (L)	14	5	15	.30	.30	.35	1.10	356
Wheat	16	3	50	.80	.30	.10	1.20	599
Jute	18	2	4	.25	.10	.20	.90	283
Oilseeds	14	3	4	1.00	.60	.80	0	393
Sub-Project No. 27								
Irrigated area								
Boro (HYV)	28	3	18	2.00	.80	.20	1.10	703
B. aman (L)	12	2	38	.80	.20	0	0	409
Non-irrigated area								
M. aus & aman (L)	13	0	35	1.20	.10	0	0	399
Jute	12	1	50	1.00	.60	.10	1.00	654
Wheat	17	0	5	.80	.50	.10	0	328
Oilseeds	10	2	4	1.00	.50	.10	0	330

TABLE V-38

FINANCIAL FARM CROP BUDGETS: FUTURE SITUATION

Crop	Hired Labor Human (days)	Hired Labor Animal (days)	Seed (seer)	Fertilizer Urea (md)	Fertilizer TSP (md)	Fertilizer MP (md)	Insecticide (pound)	Cost (Tk/ac)
Sub-Project No. 1								
Irrigated area								
Boro (HYV)	24	5	10	2.40	1.80	1.00	2.00	876
T. aman (HYV)	22	4	10	1.60	1.60	.80	2.00	737
T. aus (HYV)	22	4	10	1.50	1.00	.30	1.00	641
Wheat	18	6	50	1.50	.80	.50	1.00	785
Oilseeds	18	3	4	1.80	1.20	.80	0	633
Non-irrigated area								
Boro (LIV)	18	4	12	1.40	.80	.60	1.50	603
T. aus (LIV)	16	4	12	1.00	.80	.50	1.50	533
T. aman (LIV)	16	4	12	1.00	1.00	.50	1.50	546
M. aus & aman (LIV)	18	3	4	1.80	1.20	.80	0	633
Sub-Project No. 5								
Irrigated area								
Boro (HYV)	26	2	12	2.10	1.60	.90	2.50	752
T. aman (HYV)	25	2	12	1.20	.80	.50	1.50	666
T. aus (HYV)	25	2	12	1.00	.60	.50	1.50	542
Wheat	20	3	50	1.20	.70	.50	2.00	672
Jute	25	4	4	.60	.20	.40	1.00	481
Oilseeds	18	5	4	1.25	.90	.50	0	529

(continued)

TABLE V-38

(continued)

Crop	Hired Labor Human (days)	Hired Labor Animal (days)	Seed (seer)	Fertilizer Urea (md)	Fertilizer TSP (md)	Fertilizer MP (md)	Insecticide (pound)	Cost (Tk/ac)
Sub-Project No. 6								
Irrigated area								
Boro (HYV)	26	5	12	2.30	1.00	.30	3.00	801
T. aman (HYV)	26	4	12	1.50	.80	.30	1.20	658
T. aus (HYV)	26	4	12	1.30	.60	.30	1.20	630
Wheat	20	8	50	2.00	.75	.50	2.00	906
Jute	25	8	4	1.10	.60	.50	.10	658
Oilseeds	18	4	4	1.10	.80	.25	0	496
Sub-Project No. 13								
Irrigated area								
Boro (HYV)	22	3	10	2.00	1.50	.80	2.00	717
T. aus (HYV)	20	3	10	1.50	1.00	.20	1.50	576
T. aman (HYV)	20	3	10	1.50	1.20	.60	2.00	621
M. aus & aman (LIV)	21	3	45	.60	.20	.10	1.00	611
Wheat	18	2	50	1.50	.80	.50	2.00	730
Oilseeds	18	3	4	1.20	.80	.60	0	520
Non-irrigated area								
T. aus (LIV)	18	3	12	.80	.50	.20	1.00	464
T. aman (LIV)	18	3	12	.80	.60	.30	1.00	476
Boro (LIV)	16	3	12	.80	.50	.20	1.50	449
M. aus & aman (LIV)	20	3	45	.40	.20	.10	1.00	583

(continued)

TABLE V-38

(continued)

Crop	Hired Labor Human (days)	Hired Labor Animal (days)	Seed (seer)	Fertilizer Urea (md)	Fertilizer TSP (md)	Fertilizer MP (md)	Insecticide Cost (pound)	Insecticide Cost (Tk/ac)
Sub-Project No. 19								
Non-irrigated area								
Boro (LIV)	18	5	14	.50	.20	.10	1.00	472
T. aus (LIV)	17	4	14	.50	.20	.10	1.00	429
T. aman (LIV)	17	4	14	.50	.20	.10	1.00	429
M. aus & aman (LIV)	17	4	45	.50	.20	.10	1.00	555
Wheat	20	4	50	.50	.20	.10	1.00	640
Oilseeds	18	2	4	.80	.50	.30	0	397
Sub-Project No. 23								
Irrigated area								
Boro (HYV)	35	5	12	2.00	1.40	1.00	3.00	801
T. aus (HYV)	20	4	12	1.80	1.00	.50	2.50	582
T. aman (HYV)	20	4	12	1.90	1.00	.60	3.00	605
Wheat	18	4	50	2.00	1.00	.50	2.50	785
Jute	24	4	4	1.00	.60	.60	0	471
Oilseeds	18	4	4	1.25	1.00	.80	0	491
Sub-Project No. 27								
Irrigated area								
Boro (HYV)	30	3	14	2.20	1.50	.80	2.50	834
T. aus (HYV)	25	1	14	2.00	1.50	.80	2.00	716
M. aus & aman (LIV)	22	1	40	1.50	.50	.30	2.00	647
T. aman (HYV)	15	1	15	1.50	1.00	.50	2.00	510
Wheat	15	1	45	2.20	1.60	.60	3.00	755
Jute	25	2	4	1.20	.75	.50	2.50	625
Oilseeds	10	2	4	1.50	1.20	.40	0	437

TABLE V-39

ESTIMATION OF ANNUAL FINANCIAL RETURNS:

SUB-PROJECT NO. 1, PATIA THANA, CHITTAGONG DISTRICT

Crop	Area (acre)	Yield (md/ac)	Production (md)	Gross Income (Tk)	Total Cost (Tk)	Net Income (Tk)
Present Situation						
Irrigated area						
Boro (HYV)	60	46	2,820	242,520	42,660	
T. aman (HYV)	75	30	2,250	180,000	45,450	
B. aman (L)	85	18	1,530	122,400	36,040	
T. aus (HYV)	75	38	2,850	228,000	37,875	
Oilseeds	80	8	640	140,800	48,400	
Total				913,720	210,425	1,672,365
Net income per acre = (703,295/190) = Tk 3702						
Non-irrigated area						
Boro (L)	370	21	7,770	668,220	253,080	
B. aus (L)	200	24	4,800	384,000	145,000	
T. aman(L)	100	16	1,600	128,000	52,000	
Oilseeds	100	7	700	154,000	53,600	
Total				1,334,220	504,280	829,940
Net income per acre irrigated (829,940/570) = Tk 1456						
Future situation						
Without sub-project (+6%)						
Net income per acre irrigated: (745,493/190) = Tk 3924						
Net income per acre non-irrigated: (879,736/570) = Tk 1543						

(continued)

TABLE V-39

(continued)

Crop	Area (acre)	Yield (md/ac)	Production (md)	Gross Income (Tk)	Total Cost (Tk)	Net Income (Tk)
Future situation						
With Sub-Project						
Irrigated area						
Boro (HYV)	60	58	3,480	299,280	52,560	
T. aman (HYV)	240	40	9,600	768,000	176,880	
T. aus (HYV)	165	48	7,920	633,600	105,765	
Wheat	135	24	3,240	278,640	195,975	
Oilseeds	75	11	825	181,500	47,475	
Total				2,161,020	488,650	1,672,365
Net income per acre = (1,672,365/345) = Tk 4847						
Non-irrigated area						
Boro (LIV)	160	24	3,840	320,240	96,480	
T. aus (LIV)	155	23	3,565	285,200	82,615	
T. aman (LIV)	130	20	2,600	208,000	40,980	
M. aus & aman (LIV)	100	22	2,200	176,000	53,100	
Oilseeds	140	10	1,400	308,000	88,620	
Total				1,307,440	391,795	915,645
Net income per acre = (915,645/415) = Tk 2206						

TABLE V-40

ESTIMATION OF ANNUAL FINANCIAL RETURNS:

SUB-PROJECT NO. 5, SATURIA THANA, DACCA DISTRICT

Crop	Area (acre)	Yield (md/ac)	Production (md)	Gross Income (Tk)	Total Cost (Tk)	Net Income (Tk)
Present Situation						
Irrigated area						
Boro (HYV)	60	46	2,760	237,360	41,940	
T. aman (L)	45	17	765	61,200	20,025	
Total				298,560	61,965	236,595
Net income per acre: (236,595/60) = Tk 3943						
Non-irrigated area						
M. aus & aman (L)	70	20	1,400	112,000	24,780	
Wheat	25	21	525	45,150	14,700	
Jute	15	15	225	20,250	4,575	
Oilseeds	25	9	225	49,500	11,950	
Total				226,900	56,005	170,895
Net income per acre: (170,895/98) = Tk 1744						
Future Situation						
Without Sub-Project (+10%)						
Net income per acre irrigated: (260,255/60) = Tk 4338						
Net income per acre non-irrigated: (187,985/98) = Tk 1918						

(continued)

TABLE V-40

(continued)

Crop	Area (acre)	Yield (md/ac)	Production (md)	Gross Income (Tk)	Total Cost (Tk)	Net Income (Tk)
Future Situation						
With Sub-Project						
Irrigated area						
Boro (HYV)	77	54	4,158	357,588	57,904	
T. aman (HYV)	119	41	4,879	390,320	79,254	
T. aus (HYV)	77	36	2,772	221,760	41,734	
Wheat	51	28	1,428	122,808	34,272	
Jute	20	19	380	34,200	9,620	
Oilseeds	30	12	360	79,200	15,870	
Total				1,205,876	238,654	967,222
Net income per acre = (967,222/158) = Tk 6122						

TABLE V-41

ESTIMATION OF ANNUAL FINANCIAL RETURNS:

SUB-PROJECT NO. 6, SAVAR THANA, DACCA DISTRICT

Crop	Area (acre)	Yield (md/ac)	Production (md)	Gross Income (Tk)	Total Cost (Tk)	Net Income (Tk)
Present Situation						
Irrigated area						
Boro (HYV)	40	40	1,600	137,600	25,240	
T. aman (HYV)	35	31	1,085	80,800	17,115	
T. aman (L)	5	16	80	6,400	2,440	
Total				224,800	44,795	180,005
Net income per acre: (180,005/40) = Tk 4500						
Non-irrigated area						
T. aman (L)	70	16	1,120	89,600	34,160	
Wheat	10	24	240	20,640	7,610	
Jute	20	20	400	36,000	11,480	
Oilseeds	5	8	40	8,800	2,420	
Total				155,040	55,670	99,370
Net income per acre (99,370/70) = Tk 1420						
Future Situation						
Without Sub-Project (+8%)						
Net income per acre irrigated: (194,405/40) = Tk 4860						
Net income per acre non-irrigated: (107,320/70) = Tk 1533						

(continued)

TABLE V-41

(continued)

Crop	Area (acre)	Yield (md/ac)	Production (md)	Gross Income (Tk)	Total Cost (Tk)	Net Income (Tk)
Future Situation						
With Sub-Project						
Boro (HYV)	40	52	2,080	178,880	30,080	
T. aman (HYV)	76	40	3,040	243,200	50,616	
T. aus (HYV)	58	38	2,204	176,320	31,436	
Wheat	65	30	1,950	167,700	43,680	
Jute	20	23	460	41,400	9,620	
Oilseeds	5	12	60	13,200	2,645	
Total				820,700	168,077	652,623
Net income per acre:		(652,623/110) = Tk 5933				

TABLE V-42

ESTIMATION OF ANNUAL FINANCIAL RETURNS:

SUB-PROJECT NO. 13, BAGERHAT THANA, KHULNA DISTRICT

Crop	Area (acre)	Yield (md/ac)	Production (md)	Gross Income (Tk)	Total Cost (Tk)	Net Income (Tk)
Present Situation						
Non-irrigated area						
Boro (L)	100	16	1,600	137,600	34,300	
T. aman (L)	400	14	5,600	448,000	145,600	
Wheat	140	12	1,680	144,480	55,160	
Total				730,080	235,060	495,020
Net income per acre:		(495,020/640) = Tk 7733				
Future Situation						
Without Sub-Project (+5%)						
Net income per acre:		(519,771/640) = Tk 812				
Future Situation						
With Sub-Project						
Irrigated area						
Boro (HYV)	200	43	8,600	739,600	143,400	
T. aus (HYV)	300	32	9,600	768,000	172,800	
T. aman (HYV)	200	36	7,200	576,000	124,000	
M. aus & aman (LIV)	100	22	2,200	176,000	61,100	
Wheat	200	26	5,200	447,200	146,000	
Oilseeds	180	11	1,980	633,600	104,000	
Total				3,340,400	751,500	2,588,900
Net income per acre:		(2,588,900/500) = Tk 5178				

(continued)

TABLE V-42

(continued)

Crop	Area (acre)	Yield (md/ac)	Production (md)	Gross Income (Tk)	Total Cost (Tk)	Net Income (Tk)
Non-irrigated area						
T. aus (LIV)	50	16	800	64,000	23,200	
T. aman (LIV)	60	18	1,080	86,400	28,560	
Boro (LIV)	70	18	1,260	88,200	31,430	
M. aus & aman (LIV)	40	16	640	51,200	23,320	
Total				289,800	106,510	183,290
Net income per acre: (183,290/140) = Tk 1309						

TABLE V-43

ESTIMATION OF ANNUAL FINANCIAL RETURNS:

SUB-PROJECT NO. 19, GOMOSTAPUR THANA, RAJSHAHI DISTRICT

Crop	Area (acre)	Yield (md/ac)	Production (md)	Gross Income (Tk)	Total Cost (Tk)	Net Income (Tk)
Present Situation						
Non-irrigated area						
Boro (L)	1,000	14	14,000	1,204,000	373,000	
B. aus (L)	1,500	10	15,000	1,200,000	450,000	
B. aman(L)	1,500	11	16,500	1,320,000	504,000	
T. aman (L)	500	13	6,500	520,000	161,000	
Wheat	500	12	6,000	516,000	285,500	
Oilseeds	2,000	6	12,000	2,640,000	596,000	
Total				7,400,100	2,369,500	5,030,500
Net income per acre:		(5,030,500/5000) = Tk 1006				
Future Situation						
Without Sub-project (0%)						5,030,500
Net income per acre:		(5,030,500/5000) = Tk 1006				
Future Situation						
With Sub-project						
Non-irrigated area						
Boro (LIV)	1,300	18	23,400	2,012,400	613,600	
T. aus (LIV)	1,300	15	19,500	1,560,000	557,700	
T. aman (LIV)	900	17	15,300	1,224,000	386,100	

(continued)

TABLE V-43

(continued)

Crop	Area (acre)	Yield (md/ac)	Production (md)	Gross Income (Tk)	Total Cost (Tk)	Net Income (Tk)
M. aus & aman (LIV)	1,000	18	18,000	1,440,000	555,000	
Wheat	800	14	11,200	963,200	512,000	
Oilseeds	2,000	8	16,000	3,520,000	794,000	
Total				10,719,600	3,418,200	7,301,400

Net income per acre (7,301,400/5000) = Tk 1460

TABLE V-44

ESTIMATION OF ANNUAL FINANCIAL RETURNS:

SUB-PROJECT NO. 23, ULIPUR THANA, RANGPUR DISTRICT

Crop	Area (acre)	Yield (md/ac)	Production (md)	Gross Income (Tk)	Total Cost (Tk)	Net Income (Tk)
Present Situation						
Irrigated area						
Boro (HYV)	35	48	1,680	144,480	22,925	
T. aman (L)	15	22	330	26,400	5,340	
Wheat	34	16	544	46,784	19,006	
Jute	30	15	450	40,500	8,490	
Total				258,163	55,761	202,403
Net income per acre: (202,403/70) = Tk 2891						
Non-irrigated area						
B. aus (L)	18	14	252	20,160	7,038	
T. aus (L)	18	27	486	38,880	7,182	
T. aman (L)	12	22	264	21,120	4,272	
Wheat	12	16	192	16,512	6,708	
Jute	15	15	225	20,250	4,245	
Oilseeds	12	7	84	18,480	4,716	
Total				135,402	34,161	101,241
Net income per acre: (101,241/60) = Tk 1687						
Future Situation						
Without Sub-Project (+12%)						
Net income per acre irrigated: (226,691/70) = Tk 3238						
Net income per acre non-irrigated: (113,390/60) = Tk 1890						

(continued)

TABLE V-44

(continued)

Crop	Area (acre)	Yield (md/ac)	Production (md)	Gross Income (Tk)	Total Cost (Tk)	Net Income (Tk)
Future Situation						
With Sub-Project						
Irrigated area						
Boro (HYV)	15	56	840	72,240	12,015	
T. aus (HYV)	56	36	2,016	161,280	35,592	
T. aman (HYV)	92	38	3,496	279,680	55,660	
Wheat	85	23	2,380	204,680	66,725	
Jute	20	23	460	41,400	9,420	
Oilseeds	30	11	330	72,600	14,730	
Total				831,880	191,142	640,738
Net income per acre (640,738/130) = Tk 4929						

TABLE V-45

ESTIMATION OF ANNUAL FINANCIAL RETURNS:

SUB-PROJECT NO. 27, BASAIL THANA, TANGAIL DISTRICT

Crop	Area (acre)	Yield (md/ac)	Production (md)	Gross Income (Tk)	Total Cost (Tk)	Net Income (Tk)
Present Situation						
Irrigated area						
Boro (HYV)	60	54	3,240	278,640	42,180	
B. aman (L)	75	18	1,350	108,000	30,675	
Total				386,640	72,855	313,785
Net income per acre: (303,785/75) = Tk 4184						
Non-irrigated area						
M. aus & aman (L)	35	18	630	50,400	13,965	
Jute	10	10	100	9,000	3,280	
Wheat	20	21	420	36,120	13,080	
Oilseeds	5	8	40	8,800	1,650	
Total				104,320	31,975	72,345
Net income per acre: (72,345/48) = Tk 1507						
Future situation						
Without Sub-project (+4%)						
Net income per acre irrigated: (326,336/75) = Tk 4351						
Net income per acre non-irrigated: (75,239/48) = Tk 1567						

(continued)

TABLE V-45

(continued)

Crop	Area (acre)	Yield (md/ac)	Production (md)	Gross Income (Tk)	Total Cost (Tk)	Net Income (Tk)
Future Situation						
With Sub-project						
Boro (HYV)	29	64	1,856	148,480	24,194	
T. aus (HYV)	34	56	1,870	149,600	24,341	
M. aus & aman (LIV)	50	26	1,300	104,000	32,357	
T. aman (HYV)	29	42	1,218	97,440	14,794	
Wheat	64	32	2,048	176,128	48,320	
Jute	10	20	200	18,000	6,250	
Oilseeds	30	12	360	79,200	13,110	
Total				772,848	163,366	609,482
Net income per acre: (609,482/123) = Tk 4955						

TABLE V-46

DIRECT COSTS OF IRRIGATION WATER

FOR MAJOR CROPS AT SUB-PROJECT AREAS

Sub-Project Number	Cost of Irrigation Water							
	Boro[1] (Tk/ac)	Boro[2] (Tk/ac)	Wheat (Tk/ac)	Oilseeds (Tk/ac)	T. aus[3] (Tk/ac)	T. aus[4] (Tk/ac)	T. aman[3] (Tk/ac)	T. aman[4] (Tk/ac)
1	399	326	175	175	101	52	20	38
5	415	341	178	178	109	52	32	59
6	461	351	240	240	148	58	43	80
13	436	361	197	197	175	75	62	--
19	--	--	--	--	--	--	--	--
23	547	--	215	215	181	69	45	83
27	--	354	243	243	140	--	--	--
Average	452	346	208	208	144	61	40	65

[1] Medium highland

[2] Lowland and medium lowland

[3] Wheat based rotation

[4] Boro based rotation

TABLE V-47

SUMMARY OF ANNUAL FINANCIAL RETURNS

Situation	Sub-Project Number 1 (Tk/ac)	5 (Tk/ac)	6 (Tk/ac)	13 (Tk/ac)	19 (Tk/ac)	23 (Tk/ac)	27 (Tk/ac)
Present Situation							
Irrigated	3,702	2,943	4,500	--	--	2,891	4,184
Non-irrigated	1,456	1,744	1,420	773	1,006	1,678	1,507
Future Without							
Irrigated	3,924	4,338	4,860	--	--	3,238	4,351
Non-irrigated	1,543	1,918	1,533	812	1,006	1,890	1,567
Future With							
Irrigated	4,847	6,122	5,933	5,178	--	4,929	4,955
Non-irrigated	2,206	--	--	1,309	1,460	--	--
Increment in Disposable Income							
Situation 1	923	1,784	1,073	--	--	1,691	604
Situation 2	3,304	4,204	4,400	4,366	--	3,039	3,388
Situation 3	663	--	--	497	454	--	--

CHAPTER VI

SOCIO-ECONOMIC IMPACT

Section 1: Introduction

A. Overview

> Too often in the past man's role has been restricted by the planner to that of "Homo economicus," that is, a producer and consumer of goods and services with prespecified objectives of utility and profit maximization. Today, governmental decision makers are aware of the fact that beyond these limited economic objectives the policies and programs they establish, as well as the resources they allocate, significantly affect the quality of life, and the equity of different groups of people.
> (Fitzsimmons and Salama, 1973 p.v.).

The research reported herein was initiated in the early stages of Phase II of the Rural Irrigation Works Study Project. In accordance with the contract, the fundamental objective of this portion of the study is to assess the likely socio-economic impacts associated with the development of irrigation works in a "typical sub-project area." The sub-project selected for study is the construction of the Dubail Basail Deep Tube Well Drain. This sub-project satisfies all of the screening questions used in the Survey/Evaluation Questionnaire and is one of four Tangail District sub-projects that are recommended for development. The proposed drain's prime function is to increase irrigation output flow through the curtailment of those water losses caused by seepage, thereby ensuring a more regulated supply of water to land holders in the area.

Socio-economic impacts in this chapter refer to those changes that are likely to be caused by the construction of the deep tube well drain. These changes can assume various forms and can be affected by various phenomena. Some are direct effects, whereas others are more implicit or indirect; the latter occur through interdependent, multiple-causal processes. This chapter also identifies short-term and long-term impacts with certain of the long-term types associated with the implementation of the project. Finally, differential impacts are discussed with reference to specific sub-groups within the larger affected population (e.g., poor farmers, landless laborers, and women).

The socio-economic effects of the sub-project are arrived at through a process of impact evaluation. The relative "goodness" or "badness" of the effects are weighed against the socio-cultural environment, socio-economic opportunities, and missed opportunity costs.

This chapter's five parts include this introduction, a general profile of the socio-economic environment, a discussion of the low-income farmer, landless farmer, the role of women, an assessment of pivotal impacts, and an impact evaluation with recommendations.

B. Research Design and Methods

The primary intent of this study is to assess the potential effects of the construction of a deep tube well drain. In the language of research, this constitutes the primary dependent variable, the variable(s) in need of explanation.

The inquiry was determined, in part, by the nature of the contract, which specified many of the topics to be addressed (e.g., the poor farmer, the landless laborer, the role of women). The Study's pre-development schedule fortunately does permit the construction of a data baseline so that information derived from the analysis of the data will provide insight for the future direction of the Study.

Very little socio-economic and cultural data was extant for the specific study site; consequently, the research was designed to gather basic sorts of data that to some extent would permit insight into numerous aspects of the local situation. Because the project intends to evaluate water resource development, the primary focus is on the benefits and costs of the development and the stimulants to, and constraints on, ameliorating any adverse conditions that may be associated with such development.

Data from both primary and secondary sources were used. The people from the study area, key persons from the surrounding villages, other organizational representatives, and our own personal observations provided the primary data source. A household survey, administered to a 10 percent random sample of heads of households (a total of 20 persons interviewed), gave broad coverage in a brief time. A second survey provided demographic and economic data from landless laborers. A list of sampling units was constructed from a master list of landless laborers registered with the Union Council Office. A 55 percent simple random sample was drawn, using a table of random numbers (a total of 11 persons interviewed). Finally, key people were interviewed in depth. A "snow-balling" technique was used in interviewing these key informants. Secondary data sources included records, reports, and publications dealing with the area, as well as more general manuscripts and documents that discuss rural agricultural development throughout Bangladesh.

All household surveys were conducted by native, bilingual Bangladeshi interviewers. All interviewers had previous experience, but each, prior to entering the field, rehearsed conventional interviewing procedures. An appointed field team supervisor directed the field survey operation with on-site monitoring by the senior staff. The in-depth interviewing with local key informants was carried out by senior staff personnel with the help of an interpreter. All these interviews were conducted between July 22 and 29, 1979.

Data derived from the household questionnaire were hand-tabulated and recorded for storage and analysis. Most of the coding decisions were straightforward. The range and types of responses informants made to open-ended questions empirically determined the codes.

The principal techniques of analysis were simple summary statistics, frequency distributions, and a narrative accounting system.

C. A "Typical" Sub-Project Area

The sub-project selected for study is the construction of the Dubail Basail Deep Tube Well Drain. It is located in Basail Thana, District of Tangail. The total sub-project area to be irrigated is 123 acres. Sixty acres are presently under irrigation with the remaining 73 acres having non-irrigated status.

The sub-project area and its greater environs can be identified as only generally "typical". Although the low-lying deltaic plain and the monsoon climate of Bangladesh may suggest a lack of interregional variation, differences do exist. For example, the delta area in the Dacca Division of Central Bangladesh tends to be only marginal in the north but active elsewhere. Further comparison reveals similar variations within other regions as well as between regions (e.g. within South Bangladesh and between northeast and southeast districts) (Nicholas, 1962; Bertocci, 1970; Rashid, 1967).

Interregional variation in Bangladesh is also apparent upon assessment of other ecological and cultural variables: namely, population densities and settlement patterns. It has been suggested that population density is the most "critical single ecological datum" (Bartholomew and Birdsell, 1953:488) because population density is dependent upon the physical environment, the type of subsistence technology employed, and other cultural forces. A comparison of population densities by administrative districts in Bangladesh is shown in Table VI-1.

The greatest variance in densities is between Khulna District and Dacca District, Dacca containing well over three times the number of people per square mile as Khulna. Tangail, Chittagong, and Rangpur Districts, however, more nearly approximate the population density of Bangladesh as a whole.

Whereas the settlement pattern of a culture, as well as its population density, is influenced by the physical environment and subsistence technology, other factors (such as the division of labor and house form) also determine the size and spatial distribution of local groups. The multiple determinants of settlement patterns also cause variations between regions. (See Table VI-2).

The significance of this variation is its effect on the integrative function of settlement patterns and on social interaction at the microregional level.

This brief analysis of some fundamental ecological and cultural variables has attempted to show that although Bangladesh may appear largely homogeneous in topography, climate, and social organization, some significant differences between regions do exist. Therefore, we cannot present this sub-project study as being strictly typical in all respects. Yet, the similarities that do exist between regions appear to be strong enough to generalize from this to other sub-projects in certain respects. These similarities are emphasized not because the sub-project may not be technically typical, but because neither is it atypical.

To adequately address the benefits and costs of any development plan, the planner <u>must</u> have a clear picture of what and who will be affected.

Section 2: Demographic Features

A. A Context of Growth

The demographic history of Bangladesh reveals the rather grim statistics of a country that is one of the most crowded rural areas on earth. Approximately 86 million people inhabit the delta of the Ganges, Brahmaputra, and Meghna Rivers, a 55,000 square mile area.[1] An estimated 91.2 percent of Bangladesh's residents live in rural areas, most at subsistence level. With a present annual population growth rate of approximately 2.6 percent and the existing rates of socio-economic change, the prospect of rapid improvement is not good for the years immediately ahead.

Bangladesh's recorded population in 1872 (the first census) was 23 million. Growth for the area is a recent (post-19th century) process. Up until 1920, the growth rate averaged only .76 percent yearly. After 1920, crude death rates began to recede, and by 1930, growth rates neared one percent for the decade; subsequently, these growth rates have accelerated. With intermittent alterations associated with the 1943 famine and the War of Independence, the population of Bangladesh has tripled since 1881 and doubled since 1931. In the last fifty years, crude death rates have declined from above 40 per 1000 to approximately 20 per 1000 today (Stevens, Alavi, Bertocci, 1976; Faaland and Parkinson, 1976; Arthur and McNicoll, 1978).

As Figure VI-1 illustrates, Bangladesh is in the classical state of transitional growth.

Arthur and McNicoll have identified three substantive reasons for the decline in mortality rates. Acknowledging that the three reasons may vary in weight, they suggest: (1) that improved disaster relief, transportation, and communications have resulted in fewer famine-related deaths; (2) that public health measures, however minimal, have improved; and (3) that epidemic diseases have been curtailed through medical intervention. In spite of these social, economic, and health improvements, Bangladesh still maintains mortality rates that are relatively high compared to other developing countries. (1978).

What sort of demographic future lies in store for Bangladesh? Although projections are only tentative, it is fairly safe to assume that by the year 2000, Bangladesh will have to contend with a 50 to 85 percent larger than current population; actual number estimates vary with conditions as is apparent from Table VI-3.

If mortality rates are reduced due to improved nutrition, Faaland and Parkinson point out, fertility rates still could have a short-lived increase because the biological birth rate has not yet reached its maximum (1976).

B. Population Size and Density

The most recent district- and village-level population statistics are those of the 1974 census. For that period, the Tangail District was reported to have a total resident population of 2,212,343. With annual crude birth rates as high as they are, the figure today is most assuredly greater. The village of Dubail in 1979 has a population of 3,300. Time did not permit completion of a detailed enumeration and, therefore, the figure is an estimate arrived at by multiplying the total number of reported families in the village (500) by the average family size (6.6) determined from the household survey.

The number of persons per square mile is 2,517. A population density this high seems unlikely when compared to the figure reported in the 1974 census (1593). Further assessment for the 1974 census data and subsequent reports reveal discrepancies. Because resolution of these discrepancies would require further study and greater-than-available time, the density of 2,517 is tentatively postulated as an upper-range calculation. One thing is certain: the increasing pressure of high population growth rates and bounded, village land is being felt in Dubail, as it is elsewhere in the country.

C. Age and Sex Composition

Figure VI-2 broadly depicts the age and sex structure of the study population for 1979. Due to a lack of 1974 census village-level age and sex statistics, Figure VI-2 uses a somewhat unconventional form: It includes, rather than time-depth comparative figures, figures for

both land owners (tenants and owner-tenants) and landless laborers. A comparison of the two populations for one time reveals some interesting facts.

Both groups, taken collectively, tend to have a broad base that narrows abruptly. This suggests a large proportion of children younger than 15 years and a low median age for the population. This is similar to the trend for the entire country.

Comparison of the groups shows that persons with land tend to have fewer children in the 1-14 age category than do the landless, who also have a higher proportion of persons in the older-age category from 15 to 60 years. This suggests, with some cautioned extrapolation, (1) that the ratio of dependents to landless laborers is high, (2) that the older working age [2] landless laborers in the study area must bear the burden of more dependents than must the landowner, tenant, or owner-tenant farmer; and (3) that this burden is caused largely by the number of children rather than by the number of elderly people. If it had been possible to more clearly delineate specific ages for the respondents, the structural features of the two populations would be more pronounced.

Figure VI-2 also shows the relationship of males to females for the two populations. The most significant variance is found in the case of the land-based agriculturalists for the age category 15-60 years. Here, as has been shown elsewhere for rural Bangladesh as a whole, the sex ratio (males per 100 females) favors males.

D. Family Size

Statistics for 1974 show that, of all districts, Tangail, along with Jessore, had the highest average number of persons per family (6.4). Dinajpur had the lowest average (5.4 persons per family). Dubail Basail's average family size resembled Dinajpur (5.5). This number has increased appreciably since 1974 (our survey indicates a combined (land-based farmer and landless) average family size of 6.6. Landless laborers' family size (5.6) approximates the level for that district in 1974; however, those on land (owners, tenants, owner-tenants) tend to have much larger families (average 8.3). Whether

this is a function of economic decision making or a function of mortality in the respective populations requires further study.

E. Literacy

The literacy of both sexes in Bangladesh in 1974 was reported to be 20.2 percent, approximately 4 percent higher than 1961 levels. The literacy rate in Tangail District in 1974 was equal to the national average in 1961: that is, 17.75 percent whereas the village of Dubail fared somewhat better with 18.9 percent in 1974. The Consultant's 1979 survey did not specifically address this variable; however key officials reported that only about 5 percent of the women from the village were literate. The significance of this information will be addressed at greater length in this chapter's Section 3, Part D on the role and status of women.

F. Religious Affiliation

As Figure VI-3 clearly shows, religious affiliation at district (87.5 percent) as well as at village levels is almost uniformly Muslim. The 1979 village level survey shows 100 percent of both the landless and the landed claim affiliation to Islam.

G. Mobility

This study did not directly address the two components of migration: emigration and immigration. However, a number of questions in the survey of household heads attempted to reveal migrant labor patterns. Reports from other thanas stress a growing prevalence for landowners, and others with some land base, to seek short-term employment in other than their own village areas. The reasons for this are numerous but they include: the migrant's having been flooded out; the migrant's practice of transplanting or harvesting his own crops at a time different from that of the area he migrates to; or, for some reason, the migrant's being unable to crop as intensively as those from whom he seeks employment.

For whatever its reasons, internal migration causes concern among locally-based village laborers who do not migrate because of its implications: a depression of the local wage rate, a weakening of the patron-client relationship, an increasing propensity for the landless to be less dependent on individuals but more dependent on a class of economically dominant landowners. (These landowners are said to prefer the migrant laborer to the village local because he is more dependable, less distracted--they leave their families behind, and "works harder" (Wood, 1976; 152).)

Dubail landowners reported needing help from outside of the family to sow, weed, transplant, harvest, and cultivate their crops. Seventy-five percent said they could easily obtain laborers when they needed them. The majority of these laborers are hired either on a per/day with meal basis (40 percent) or on a per/day without meal basis (40 percent). Only 10 percent were hired on a monthly basis, and only one landowner said he bargained over the rate of pay. When the landowners were asked if they preferred local workers to migrant help, an overwhelming proportion (85 percent) said local workers (mostly landless laborers) were their first choice. Although their reasons varied, the answer with the greatest frequency (45 percent) was that local people were available. Others (25 percent) said "they are known to us"; and 20 percent mentioned that they wanted to help the local poor. These responses do not correspond in every respect with those given by local laborers, as will be pointed out in later discussion.

The increasing trend towards migrant labor seems to be well under way in the project area. The extent to which this exists in other sub-project areas is unknown, but it is doubtful that Dubail is "atypical" in this respect.

Section 3: Social Organization

A. Introduction

This section addresses certain organizational and structural features of Bangladeshi social life: specifically, village organizational features, household features, household heads, and the role of household members.

B. Village Organizational Features

The gram (village) of Dubail, like other grams in Bangladesh, serves as a natural social unit composed of five geographically and socially defined paras (see Figure VI-4). The para exists as a neighborhood group composed of dispersed (within calling or visual distance) yet adjacent peasant family homesteads or households. Because the functions of paras are conditional upon lineage or upon internal social organizational (e.g., samaj) boundaries, their levels of cohesiveness vary.

The sub-project area transects a large portion of three different paras. Some respondents indicate that the paras in the sub-project area do have significant solidarity. This may well be related to the respondents' social position and family "extensiveness" beyond the local village level. To ascertain this would require further investigation.

A more cohesive, smaller social group than that of the para is the bari, traditionally a patrilineally extended family composed of chulas: that is, nuclear or joint households sharing a compound. Kinship obviously serves an important function in maintaining the strength and unity of this social grouping; daily interaction and balanced reciprocity, however, should not be discounted.

Within the project area, six baris were identified although the total number could not be determined without further genealogical work, which time did not permit. The types of chulas are predominantly joint or nuclear. They are patrilineally related and

residence is patrilocal. Limited economic exchange is present in the form of reciprocity; as one respondent said, "There is exchange of labor between two-to-three households in production, but only in families." This should not, however, be inferred to mean that baris in the project area function as economic units; this does not appear to be the case.

Village leadership arises from economically and socially dominant lineages. The village leaders, some of whom are referred to as matbars, organize, and most often, control religious and secular affairs. They hold Salish (arbitration) to decide matters over which a dispute has arisen. These disputes often are fundamental issues of great concern; they include disputes over land boundaries, cases of damage to crops by cattle and goats, and inheritance grievances, the latter of which are reported to be particularly prevalent where a son-in-law of the deceased attempts to gain equal or excessive right to the inheritance customarily held by his wife's brother. Formerly, the decisions of the matbars were binding upon the rival parties in the dispute; and when the decision offered was violated, sanctions were imposed.

The sub-project area contains two samajs. A samaj, in its ideal form, is said to be a society that over time has formulated a set of guidelines that are to be folowed by all men living in the locale. The guidelines, said to be necessary to a homogeneous existence, have become convention and are interrelated with othe idea patterns of the locale. Occasionally they outweight the written texts of law, and frequently they greatly influence matters of religion. The samajs in the sub-project area are multi-village institutions and are presided over by a council of elders.

The presence of dals (factions) is not atypical of rural village social organization in Bangladesh (Bertocci, 1970; Arthur and McNicoll, 1978). "Vertical segmentation" has often been used to describe the rivalry within village life, especially between one or more of the dominant lineages. For the less dominant or marginal residents of the village, there are economic, ceremonial, and judicial reasons for aligning oneself with a larger surplus farmer or "patron-

age group". These affiliations offer, however tenuous, a buffer in socio-economic relations at the village level. The extent to which factionalism was present in the sub-project area could not be ascertained. To gain insight into such processes would take additional time and effort at building rapport in the village. These matters are of a sensitive nature and not discussed randomly with persons outside the village wall of confidence. These alliances and dals, however, are important to development, especially for the implementation stages of a sub-project for which village participation is desired and where equity in the distribution of the sub-project's benefits is intended.

Above the level of the local village, the primary yet lowest-level governmental administrative unit is that of the Union. The Union council design has not in every respect been the success to development that its mentors had hoped it would be. Its limitations and constraints are well documented and need not be repeated here. Other models also have been tried and also have not been fully successful in "diffusing the innovations associated with agricultural development" that are so desperately needed (e.g., Comilla model)[3].

C. Household Features

Physical house structures within the study area are built up on artificially constructed mounds of earth. Although this pattern varies across Bangladesh, the flooding of fields during the rainy season causes a generally dispersed, yet small, clustering of homesteads throughout Dubail.

The house structures themselves are constructed of varying materials. For example, both corrugated metal and grass form the roof used to cover the gabled substructure. The walls are thinly sliced bamboo woven into square or diamond designs. The houses are approximately 15 to 25-feet long and 10 to 15-feet wide. Some are divided by bamboo partitions.[4]

The types of households in rural Bangladesh vary from single-family types (e.g., sub-nuclear and nuclear) to multi-family types including extended, joint, and polygynous households. Most predominant in the study area is the single-family, nuclear household composed

of the married couple and the unmarried children.

The residence pattern of the village is clearly patrilocal. When the young couple marries, "the bride regularly moves to or near the parental house of the groom."[5] The marital status and sex of household heads within this study area presents a fairly uniform picture, one that in general outline probably exists in the other sub-project areas as well. Of all landowners and landless laborers in the village of Dubail, 97 percent were married. Household heads in all instances (100 percent) were male.[6]

The institution of marriage in Bangladesh requires further analysis. This will be addressed in a subsequent discussion of the household life cycle.

D. The Role and Status of Women

Labor allocation is present in every culture. The variables of sex, age, and specialized training, however, are emphasized differently in different cultures. Within Muslim Bangladesh, the pattern has been one of male dominance. A patriarchal orientation is supported by descent that is patrilineal and by residence that is patrilocal. Household heads are male and male offspring are preferred. Positions in the social, political, judicial, and economic order at both village and national levels are nearly all held by men. The historical and, to a large extent, present role of the women, especially rural women, is one of subservience.

The perception of inequities in rural sex-roles has come largely from the indigenous urban elite and the outside Western observer; the most vocal spokespersons have been women. Much of what has been written addresses itself to two issues: the institutional constraints on women and the under-utilized resource that women represent.

Any full description of the role of Bangladeshi women in social life would require differentiating between the urban and rural segments of the population. Because the sub-projects in this study are rural, this brief description will be likewise restricted. Furthermore, as others have noted, the status of women tends to be a rather elusive construct. Cross-culturally, there appears to be no such thing

as the status of women. In the absence of such a definition, in this report we shall follow the lead of Dixon and define the status of women as "the degree of women's access to (and control over) material resources (including food, income, land, and other forms of wealth) and to social resources (including knowledge, power, and prestige) within the family, in the community, and in the society at large)" (1978:6).

Tables VI-4 and VI-5 broadly outline the role of women in the household life cycle. As is shown, numerous variables may affect the women, her role and status, and the course of events in the lifespan of a household.

As preface to discussing the household cycle, the female child's pre-puberty years should be mentioned. Young girls are taught two values: patience and virtue. She is expected to cultivate these values through her later years. The young girl also learns that differences in cultural attitudes toward the two sexes do exist. Even in food consumption, she will receive less than her brother if there is a scarcity. Her socialization entails learning to be a wife and mother. She assists, under her mother's direction, in tasks that train her for these later roles; such tasks include child rearing, food preparation, cleaning, and sewing. Her schooling also reinforces the domestic role; however, the child frequently drops out of school once the basics of reading and writing are learned. Because most husbands desire such qualities in a wife, these skills assist her in marriage. This is reported to be so for the wealthy, but often the less than wealthy receive little or no schooling (Jahan, 1974).

With the advent of puberty, the young woman is put in purdah.[7] Although the rigidity of observance varies between families, nearly all girls at this point in their development are required to adjust their relations with males and some will enter total seclusion. Respondents from the village of Dubail (specifically the project area) repeatedly said that from 90 to 95 percent of the women were in seclusion. Personal observation confirms this to be a realistic estimate.

Tables VI-4 and VI-5 are largely self explanatory; however, several features of the chart need to be emphasized. Column one (Age of Female) lists stages in the household life cycle, which begins at age 15 or 16 and concludes at age 49 or 50. The second column illustrates certain sequential events correlated with these stages. The events and their timing are subject to variations arising from the interplay of the variables listed on the chart. The role of the female is described as active or passive, active indicating her primary involvement and passive indicating her secondary involvement in controlling events. Assessment of the socio-economic/cultural stimulants and constraints indicates that the causes of existing behavior patterns are numerous and have numerous origins: some are cultural; others are social, economic, or political.

Present conditions in Bangladeshi rural social organization do not appear to harm family integration; in fact, many are risk-reducing patterns that historically have proven to be adaptive. Many of the costs of integration appear to be absorbed by women (e.g., socialization of children and strengthening family ties through marriage which indirectly relates to the observance of purdah).

Table VI-6 reveals that in their daily activities women do productive, even if not wage-earning, work. The domestic and agricultural production entries refer specifically to grain processing and storage, growing family fruits and vegetables, caring for poultry and livestock, supplementing nutrition and incomes through kitchen gardens, weaving, and other similar tasks. The daily schedule of one (not atypical) woman in the sub-project area, contained in Table VI-6, illustrates aspects of the productive role of women.

The status of women has been defined as "the degree of women's access to (and control over) material resources, and social resources." Any such definition requires some standard or baseline, either absolute or relative, to which other information can be compared. The standard in this case is male access to, and control over, material and social resources.

Table VI-5 compares some aspects of the status of women with that of men. Inequality between the sexes is deeply imbedded in a system of purdah and in early socialization of both girls and boys. The values learned during these formative years are reinforced through the household and individual life cycles by a range of legal, economic, political, and social institutions and processes (Jahan 1974).

Changes are underway. They increase as rural-urban communications increase; as the per-capita land base shrinks; and as agencies, programs, and specialized personnel provide information to the people. However, to date these changes appear to have been directed mostly toward the male role (McCarthy, Sabbah, and Akhtar, 1978).

Section 4: The Local Economy

A. Introduction

Economic choice is really a part of social organization; economic choice affects and is affected by social relations. Although land, labor, and capital comprise the basic resources of all people, resources, their use, and their allocation widely vary between and within cultures. The allocation of resources may be governed by the interaction of the market place, subsistence, and in some instances reciprocity.

The economics of various levels of Bangladeshi agricultural and non-agricultural activity have been described, but this report considers only the local village-level economy and, therefore, only the smallest units of consumption (the individual) and production (the household). Economic choice takes place at this level where variations occur because of the potential for allocating resources in different ways. Figure VI-5 provides a model of the types of alternatives that are open to a rural Bangladeshi decision-making unit. This model is based on a review of the literature and on field research.

Land, labor, and capital are productive resources. Figure VI-5 suggests the two most important allocations of resources are to the sectors of subsistence and cash. With population growth rates as high as they are and with concomitant pressures on the land, individual decision makers often diversify and mix their allocation of resources to minimize their risks. For many this strategy is essential for survival.

B. Land Ownership

Land ownership and land distribution in Dubail no doubt have fluctuated over time; however, at present the largest landholding group is the medium-sized farmer. The field survey shows this group to own 55.1 percent of the land. The surplus farmer, with 22.5 percent, and the small farmer, with 21.7 percent, share most of the remaining land.

Most landowners (85 percent) inherited their holdings from their fathers. The farmers in Dubail also reported that they have purchased land; however, the financing of land purchases varies: 69 percent said they personally financed the buying of the land; 25 percent either borrowed up to one-half of the purchase price or sold existing lands to finance the new purchases; 6 percent did not respond.

Throughout Bangladesh poorer kin tend to sell their land to richer kin. Islamic preemption laws dictate that one may not sell inherited land outside of the family network if the family can afford to purchase the land. Only 30 percent of the respondents in Dubail said they have sold land. Of these, only one-half reported sale of land to relatives. This implies (1) that preemption laws, traditionally enforced through social sanction, are losing their effect; (2) that preemption laws never were adhered to very strongly; or (3) that family members could not afford to pay for land that was available for sale.

Among the few respondent landholders who have sold land, their primary reason was their need for money for household and food expenditures (42.8 percent). Other reasons included paying off loans, buying cattle, and meeting dowry at the time of a daughter's marriage.

C. Land Use

Dubail landholders, both large and small, have alternatives for using their land resources. Each alternative has both costs and benefits, which are weighed as cultivators make decisions, such as how much of his land he will work himself and how much will be sharecropped and/or mortgaged in and out.

A large proportion (70 percent) of Dubail cultivators sharecrop from others, from relatives and non-relatives, and for varying lengths of time, ranging from one crop period to 25 years. Approximately one-half of all respondents said they were constantly looking for land to sharecrop. Personal observation and interviews with Union council members indicate that competition is intense in this activity. The amount of land sharecropped to others is limited: only 2.7 acres out of 200 acres was let for this purpose in Dubail. In these instances one land-holding respondent explained his reason: "The man has no land to cultivate, so I let him use it"; and the other respondent said, "The man is poor."

The need for food and extra cash cause a limited portion (15 percent) of Dubail cultivators to mortgage in land from others. The amounts of land involved ranged from as small as .20 of an acre to as large as .54 of an acres. A larger proportion (50 percent) said they mortgaged land out. Eighty percent of this land went to non-relatives. Arrangements for such activities are made through both relatives and neighbors who are said to have knowledge of money lenders in the area.

Several formulas exist for calculating a cultivator's operational and return holdings (BRAC, N.D.: 40-41), but as Figure VI-5 illustrates, the primary intent here is to emphasize the availability of alternatives to individual landowners, each choice with different implications. For example, if a person chooses to put his land out for sharecropping, he is assured of one-half of the gross crop returns, but he also looses control over production. Mortgaging land pays the highest benefits in cash but the farmer, especially a small

farmer, risks losing the land if future payments cannot be made (BRAC, N.D.).

Again, land is the pivotal production resource. From this resource the family derives both its subsistence and, to a large degree, the cash necessary to function in a money economy system. Land, however, is also the medium through which reciprocity operates. Although limited in intensiveness and extensiveness, it does occur between families in the village of Dubail. It further cushions the perturbations in daily and seasonal existence and must be viewed as part of the operative economic mix that villagers seek to maintain.

Land also has served as a basis for obtaining credit. Traditionally, credit has been obtained through relatives, neighbors, traders, and moneylenders. The monies obtained were used primarily for the maintenance of resources and not for the further development of agricultural production. Repayment of loans often was dependent upon the farmer's ability or opportunity to produce in any one season. Due to year-to-year changes in production levels, the ability to meet loan payments was often uncertain (Rahim 1978). Today, much of the credit farmers obtain is non-institutional and land still serves as a primary source of collateral. Only four people in the sub-project area sample were indebted. Two of these had secured loans from banks; one had borrowed from a moneylander for sharecropping; and one would not provide details as to the source, terms, or interest of his loan. The implications of demand outrunning supply are many--especially as new inputs in agriculture continue to be made.

D. Labor

Whereas the short supply of land may constrain agricultural productivity, "the supply of labor is not an important constraint to agricultural development in Bangladesh. Only during certain peak periods does the seasonal demand approach the available supply and then increased wages draw workers from other sectors to meet the temporary demands." (International Bank for Reconstruction and Development 1974:54).

Given the ample supply of labor, the individual cultivator must still decide how best to allocate his labor resources. Basically, four labor sources are at his disposal: his own labor, his family's labor, reciprocal labor, and hired labor.

The majority of Dubail cultivators, as nearly as could be determined, appear to be owner-cultivators rather than owner-managers of their land. The owner-cultivator tends to contribute his own as well as his family's work to production. (The role of the women in non-wage productive work has already been discussed.) As Cain has shown, in a Bangladesh village "Children of both sexes work long hours at early ages. Children aged 4-6 years work approximately one-fifth as long as adults. Their work time increases to one-half an adult workday by ages 7-9, to three-quarters by ages 10-12, and at age 13 and above children work on the average as long as or longer than adults." (1977:217). Although no time budget analysis was conducted, children in Dubail were observed to actively engage in work activities.

Although reciprocal labor exchange is not as prominent in rural Bangladesh as it is in some other rural peasant societies, it is part of the dynamics of alternative resource allocation at the village level. Figure VI-5 shows that this exchange may not directly involve land although in most instances it seems to. (Hired labor and migrant labor patterns are discussed in Section 2 of this chapter.) The extent to which a particular person chooses to use personal, family, reciprocal, or hired labor will vary; however, the proportion of these allocations will change in relation to the socio-economic circumstances of the family. As others have noted, the normal pattern seems to be for those having the least land to use the greatest proportion of family and reciprocal labor. The small farmer tends to hire daily labor to supplement family labor. The larger medium-sized farmers and surplus farmers also use daily labor and, in some cases, employ permanent helpers. The family contribution in each of these categories remains an important labor input (BRAC, N.D.: 47).

The household survey revealed only two persons in Dubail to be actively involved making crafts; however, because craft labor allocations may be a more important economic resource in other areas, they have been included in Figure VI-5. Their degree of significance could be determined only with additional empirical work.

Non-agricultural employment in the project area provides an additional source of cash and a means of extending a villager both economically and politically into the larger social system. Thirty percent of all landowners were engaged in one of these activities; 15 percent were involved in two or more non-agricultural employment activities. Business involvement was the most common activity and the types of activities included a retail book business, a jute business, and a cloth business. The employment mentioned most often as a second activity was that of service employment. Non-agricultural employment, besides supplementing cash and subsistence derived from the land, creates linkages with external power bases that may be drawn upon to either reinforce or expand one's socio-economic position in the village and surrounding area. (The participation by the poor farmer and landless are addressed below.)

E. The Landless and Nearly Landless

The landless and nearly landless have been defined in several ways: Faidly and Esmay define persons in this category as "those with less than one acre" (1976:132). Jannuzi and Peach are more specific and identify three levels of landlessness (1977:xxii). Janser's (1978:4) use of the term "landless" seems to conform to the first level defined by Jannuzi and Peach; that is, a "household that claims ownership of no land, either homestead or other land." (1977:xxii). The scope of this study, however, does not permit delineation of who is at subsistence and who is below subsistence. As used here, the landless are those people who claim no land other than a homestead. The landless persons interviewed all fit this definition.

As Arthur and McNicoll note, the landless agricultural population is rapidly growing. Their calculations suggest that the landless constituted 15 to 20 percent of the population in the 1960s whereas a decade later it had increased to between 30 and 35 percent (1978:36). Such a rapid growth rate has multiple and interdependent causes. A fundamental demographic reason is that mortality rates have decreased while crude birth rates have remained rather stable. This phenomenon and the Islamic system of inheritance may reduce a household having, for example, five living sons and less than five acres to landlessness in one generation. Villagers recognize this and consequently place a high demand upon acquiring additional land holdings. The wealthy farmer clearly has the advantage and not infrequently will pressure the smaller farmer into selling what he has. Strategies employed to gain additional land holdings vary. Money lending at high interest rates (ranging up to 150 or 200 percent) is one of the more manifest of these strategies (Bertocci 1976:173; Jansen 1978:4-6; Arthur and McNicoll 1978:46-51).

Subsistence remains the greatest daily need of the poor farmer and the landless. Within the study area 63.6 percent of the landless said that either they or their fathers had sold land. When asked why, they most frequently answered that they needed cash to buy food or to pay off debts.

The main source of cash for the poor is their labor; thus, most turn first to agricultural work. Survey findings show that 72.7 percent of the landless are hired on a daily basis. Just over half of the respondents said they personally must search for work; an additional 27.3 percent said the employer searches them out. Most agricultural work for the landless is on a daily rather than a seasonal basis, and the rate of pay may or may not be discussed at the time, the market for labor generally determining the rate. However, to the question, "How is the rate fixed?", 27.3 percent responded, "It is according to food grain prices."

The extent to which the poor bind themselves to their employers (e.g., patronage groups) is difficult to determine from the existing data. Only a third (36.4 percent) of the respondents said they perform additional services for employers. The majority (66.7 percent) of those interviewed also denied obtaining any loans from employers, yet 72.7 percent said they did go to their employer when they were in trouble. To clearly define the employer-employee relationship requires further study. All that can now be said is that as long as the primary struggle of the poor peasant farmer is simply to subsist, the probability is high that he will continue, when possible, to secure beneficial relations with the wealthy farmer.

In Section 2 of this chapter it was shown that land owners said they preferred local over migrant laborers. Eighty-two percent of the landless, however, said that laborers from other places come to Dubail to work. They also mentioned that this migratory labor force causes lower rates of pay and increased difficulty in finding employment. Nearly three-fourths (72.7 percent) said they increasingly must themselves seek employment outside of the immediate area.

With agricultural work proving increasingly difficult to obtain and to rely on as a source of economic security, the poor farmer and landless seek alternatives. Nearly half of the survey respondents (45.5 percent) are engaged in some form of non-agricultural employment; business activities rank first. All have entered their respective work within the last 12 years and are presently realizing a mean supplemental income of Tk. 2,700.00 (range, Tk. 1,100.00 to Tk. 5,000.00). Initial capital for starting these activities was obtained through personal savings and loans from relatives and neighbors. Reciprocity and non-cash trading provide two additional alternatives to the poor. Reciprocity, as previously mentioned, does occur in Dubail mainly among family members. Jansen also reports that non-cash trading occurs in market places but adds that this form of exchange requires further investigation (1978:14). It is apparent that, like the larger landowner, the poor farmer and the landless make choices--but from fewer alternatives. The income he realizes, both cash and in-kind, are derived primarily from one resource: namely, human labor.

F. Productive Inputs

The two foremost productive resources in Bangladesh have traditionally been land and human labor, but both of these have been somewhat limited yields; therefore, technology transfer has been viewed as a way of increasing low productivity. Most of the agriculturally related inputs to date have been associated with irrigation, water control, fertilizer, improved seeds, insecticides, and a range of support services. These inputs are interdependent and mutually modifying.

The productive inputs for Dubail are outlined in other sections of this report and need not be be repeated here. What should be noted, as Figure VI-5 illustrates, is that people with land are most directly benefitted by these inputs (e.g., deep tube wells). The larger farmer has also had access to the credit sources necessary to avail himself of the slowly improving technological availability.

Section 5: Impact Assessment

A. Introduction

Impact identification and assessment require comparison of the study area conditions both with and without the proposed development. Such a process will aid policy makers in being alerted to the possible implications of alternative development goals and strategies.

B. Without-Development Alternative

Without development, prospects for improved quality of life in Bangladesh are dismal for the immediate future. Population growth rates as high as 2.6 percent coupled with declining land holdings will cause increased rural poverty for a large segment of Bangladesh's total population of which 91.2 percent is rural.

As the population continues to grow, further attempts at accommodating the changing person-to-land ratio will cause more land to be cultivated, more people to live on farming operations already at the subsistence level, and more people to enter the marginal, near-landless, or landless categories.

Village demographics will continue to reveal a large segment of population as being less than 15 years of age. This low median age population implies a high child dependency ratio with the dependency largely being borne by the "working age" segment; this burden will probably be greatest for the landless and near-landless, both of which are predominantly Muslim and have attained only a marginal education. The propensity for landowners to seek short-term migrant labor will continue to depress local village wage labor rates. Further, patron-client relations will continue to weaken, thereby reducing a source of economic security for wage earners and making them increasingly dependent upon a class of landowners. With more employment on a day-to-day basis, the laborer's relations with the employer will become increasingly depersonalized.

Although the bari will continue to be the basic natural social unit in village organization with the nuclear family increasingly the dominant type of household, village leadership will increasingly erode as the role of local governmental officials becomes more important.

The integrated role of women in rural economic and domestic life will largely go unchanged in the decade of the 1980's. Existing programs directed at family planning, education, and changing the productive role of women may alter their role with additional time and resources. To reorder and redefine the female role, however, will require extensive efforts to further stabilize the economic base of rural society. Although such a task demands a rural development design that addresses the numerous aspects of that base (e.g., infrastructure, education, political stability, etc.), increased production is a pivotal requirement.

The economic future of Dubail wthout development is grounded on the processes portrayed in Figure VI-5. Certain changes from the past, however, appear likely. As villagers continue to exercise their risk reduction options, they will further (however slowly) diversify their time and resources into petty trading and other business-related activities. This extension into the exterior economic environment will come about largely because of shrinking landholdings, which will probably also cause more people to operate their own lands. Share-cropping by residents will remain high but demand clearly will outrun supply. Most villagers' opportunity to borrow from relatives will decrease as will the opportunity to mortgage land in. The small farmer will also continue to have problems arranging credit as long as loans are tied to land ownership.

Labor migration will accelerate although no formal organizational structure is expected to emerge to represent the interests of the migrant; if one does, its representation would probably not be broadly based. The value of the male child as a producer will persist and perhaps increase so long as the local economy remains labor-intensive and family-based. The numbers of landless laborers and nearly land-less will continue to accelerate. Islamic laws regulating inheritance and the further decline of mortality rates will increase competition for land. These projected processes will sustain food and subsistence as the prime needs of the rural household in Dubail.

These conditions will vary regionally to some extent, but only increased productive inputs into a reasonably stable political order can enable the relief of rural impoverishment and inequality.

C. With-Development Alternative

The proposed developments in the sub-project areas will affect several social groups (i.e., large, medium, and small farmers; the landless; and women) as well as the socio-cultural environment (e.g., existing institutions and practices). Table VI-7 systematically projects the impacts that may be expected with proposed developments, the direct and indirect nature of the impacts and their timing and duration (i.e., short- and long-term). Furthermore, the anticipated

likelihood of these impacts occurring is indicated as either "low" (1), "medium" (2), or "high" (3). A discussion of each of the impacts identified follows:

1. Demographics: The size, density, and age-sex composition of the population are not expected to be affected by the proposed development; however, the average family size, especially of landholders, may increase slowly over the long term because of the increased labor intensity associated with the goal of increased production and the concomitant value of male children as a source of labor.

Literacy rates among women may also be affected indirectly over the long term. Increased productive domestic labor for women will reinforce the traditional female role and so will constrain changes in the socialization of the young female child.

Increased employment opportunities, both over the short and long terms, will probably directly affect patterns of mobility. Land owners will continue to seek migrant laborers, thereby creating dependency of migrant laborers on a class of landowners and causing a depersonalization of the patron-client relationship and a long-term relative depression of local wage rates.

2. Social organization: No structural changes are projected for village social organization. However, the village elders council will undoubtedly become more active and, to some extent, will lose jurisdictional authority because of the likely new institutional roles that will be created with the construction, operation, an maintenance of the irrigation projects.

3. The role and status of women: The increased labor demands associated with increased production will directly affect women. They will be required to expend more energy on the productive tasks of processing the harvests, tasks that are not new to women but are an intensification of what they have long undertaken. Because most of these tasks take place in the domestic setting, her role there will be reinforced over the long term.

The role of women will be indirectly but further affected by the intensification and reinforcement of already established patterns. As previously mentioned, there is a "low" probability that the socialization of the young female will continue to include the importance of the domestic role. Equally likely is that purdah will continue to be emphasized as the right and most appropriate condition for a young woman to assume. This institution from the villager's perspective, is both desirable and adaptive for the family unit--if not for the individual woman. It increases her chances of marriage and for the family serves to build economic and political links within the larger community.

In the life cycle of the household, marriage is an important event. Increased production and an increased emphasis on domestic activities arising from the woman's role in production will reinforce early marriage, which marks the first of a number of steps towards a woman's security in later life. That security, however tenuous, is measured not only by her contribution to production but, perhaps more importantly, by her capacity to bear male children, for male children are both socially and economically important in the male-dominated labor-intensive Bangladesh system. Therefore, both early marriage and having male children will be reinforced by efforts to increase production, and if nothing mitigates these processes, the present inequality experienced by women may well be reinforced and fixed in the socio-economic environment of the future.

4. The local economy: The proposed developments will have direct, indirect, and long-term impacts on the land and household (see Figure VI-6). One highly probable direct impact will consist of the land's increased productivity, as is discussed in other sections of this report.

One indirect effect will be the alteration of household status. Increased crop production should also increase cash and in-kind income, which, coupled with local control over improvements, should enhance the status of at least some of the household. To ensure equitable distribution of the sub-project's

benefits will require careful design of the institutional sector of the sub-project. Both of the impacts on land and household status will occur primarily over the long term.

Without further study it is impossible to say how development will affect land ownership patterns. An increase in productivity may result in less land being sold to relatives, especially if the value of the land increases.

Land use will be directly affected by the apparently high probability of increased competition to sharecrop available lands, which, it is expected, will diminish because of the economic choices made by individual landowners. The magnitude of this impact will be felt largely over the long term.

Because credit is tied to land, it would seem that increasing land productivity would cause increased credit lending; however, other constraints in the larger credit system suggest that other developments in credit extension must precede the loosening of credit.

Like land, labor will be directly affected over both the short and long terms. Owner-cultivators will need to increase labor allocations, both during the project's construction phase and during later productive seasons. The liklihood of this is high as Table VI-7 indicates. The role of the landless and nearly landless in increased labor allocation is discussed in the following pages. (The implications of increased labor for women and children have already been discussed.)

No discernible impact is projected to affect existing patterns of reciprocity, crafts, or non-agricultural employment for the majority of persons living in the study areas. To generalize from a study of one sub-project area to all sub-projects without knowing the actual variation of participation in these activities is not possible; nonetheless, increased production will require additional labor intensity and where these activities (especially crafts and non-agricultural employment) are extensive, some decrease in activity may be realized for certain segments of the population.

Figure VI-6 shows the major economic impacts of development on labor allocation and land and implies that the interaction of these two productive resources with increased productive inputs in the form of improved irrigation works will further increase actvities in the sectors of cash and subsistence.

5. The landless and nearly landless: Agricultural labor is the main source of subsistence and cash for the landless and nearly landless. Table VI-4 shows the impact from the proposed action to be direct over both the short and long terms. Although the demand for laborers seldom exceeds the supply, during the short construction period of the proposed projects will require a sizable labor supply. It is important that initially this supply be derived from the local village. Over the long term, most sub-project areas will continue to need some laborers. Only the very small farmers will be able, through extensive family labor, to farm the land without the help of hired labor. Day labor most likely will be the type of labor in demand.

Approximately one-third of the landless have linked themselves with a patron, but a local increase in labor demand is likely to weaken relations with the patron somewhat by drawing migrant laborers form other areas to work in the sub-projects and forcing local laborers to seek employment elsewhere.

Over both the short and long terms, an increase in the number of migrant laborers visiting and working in a particular village will directly but moderately depress labor wage rates.

Non-agricultural employment and the poor's need for this source of cash and subsistence is not expected to directly affected by the development. A change in this sector of the economy would most likely occur in the capital available to start small businesses. As the numbers of landless and nearly landless continue to grow, it will be increasingly difficult to secure funds from neighbors, patrons, and relatives.

Section 6: Impact Evaluation

A. Introduction

The foregoing sections of this chapter have profiled a typical sub-project and have assessed the impacts of the proposed development. This section will evaluate the two alternatives of either improving and constructing new irrigation works in the sub-projects or of not proceeding with such development. As the following discussion shows, the determination is to proceed with the proposed action.

The criteria used for evaluation comprise (1) the degree of the community's desire for the proposed developments and (2) the Consultant's assessment of the impacts presented in the previous section; the Consultant's assessment will be based on the types, magnitude and duration of those impacts and on a knowledge of how different actions have worked in other situations.

B. Community Attitude and Public Participation

Community standards and opinions are perhaps more important in social assessment than in other environmental investigations. The underlying assumption is that for a development project to be successful, it must be compatible with the local culture and must respond to a clearly felt need. Earlier stages of this project and the study of a "typical" village, Dubail, reveal a strong desire among the rural people for development of irrigation works. In most of the sub-projects, cooperaties or other formal structures already are established for purposes of operating and maintaining improvements (e.g., water user organizations).

Public participation alone does not ensure that all persons will benefit equally from development. The goal of this evaluation is to ensure that those who benefit also pay the costs of development and to ensure the equal distrubution of costs and benefits.

C. Evaluation of Impacts

Table VI-8 projects the positive (+) and negative (-) impacts of the proposed action over both the short and long terms and estimates the likelihood of the impact. Several observations can now be made:

1. The most likely demographic effect is a increase in population mobility. This is listed as a negative impact because of its depression of local wage rates for persons seeking day labor (landless and nearly landless).

2. The short-term and long-term impacts in social organization relate to a weakening of the village elders' authority, arising from an increase in governmental and other specialized personnel entering the area. This process is well documented in other cultures, and both positive and negative interpretations are associated with it. For some, the process represents an opening up of the political and economic system; for others, the loss of village level authority is politically and economically threatening.

3. The role of women will be affected throughout the life cycle by creating increased labor for them. The effects are negative in that they reinforce traditional patterns and constrain changes in the present status of women; this evaluation may not correspond with the perceptions of women in the villages. For many women, purdah, early marriage, and bearing male children provide security in the present socio-economic environment. Attempts to mitigate these circumstances will require acknowledgement of this phenommenon if they are to be effective.

4. Table VI-8 shows the economic effects associated with the proposed action to be positive over both the short and long terms: land productivity will increase; land use will intensify; and the benefits of increased labor inputs will be significant. The positive evaluation of these processes rests on the potential increases in income to the cash and subsistence sectors.

5. The most significant positive effect of development for the landless and nearly landless will be increased employment both over the short and long terms. The negative effect, already alluded to, is the increase in a migrant labor force that will tend to drive down wage rates and increase the dependency of the day worker on a class of wealthier landowners. There will also be positive and negative effects on the patron-client relationship: positive in that the worker is relieved from the dependency of the patron but negative in the loss of some degree of political and economic security.

Section 7: Recommendations

A. General Recommendation

The Consultant recommends that, based upon socio-economic considerations, the proposed plan should be implemented because it is socially and economically sound. However, to ensure that the development yields maximum benefits, certain negative effects must be mitigated; and to maintain the derived benefits, planning must extend beyond simply increasing productive inputs. The following list of recommendations is intended to guide the mitigation process and to direct the more extensive socio-economic planning effort.

B. Specific Recommendations

The negative effects associated with the proposed plan are shown in Table VI-8. To mitigate these effects, the Consultant recommends the following actions:

1. Population mobility, especially that of the small farmer, nearly landless, and landless should be reduced. Although this process cannot be totally constrained, measures taken in design of the institutional sector can foster hiring local village laborers, which will help to reduce the flow of laborers to the urban centers of Bangladesh; it will also aid the local poor by reinforcing a competitive wage rate.

2. The condition, and in some instances the problem, of changing village leadership should be addressed by providing a well-trained worker whose primary role is that of a catalyst. Whether or not this person is based in the village is dependent upon the level of organization and the vitality of leadership already present. The goal, however, is the same: an equitable distribution of gains. The economic and political position of the poor farmer, the landless laborer, and women necessitates representation and organizaion in this sector of the rural population; efforts should be made to help in identifying, setting priorities for, and resolving their problems at the local village level.

3. The increased double work load (i.e., food production and child rearing) of women that is reinforced indirectly by the proposed plan be filtered through a process of working with women rather than deciding for them. Research shows that women in many cultures have special knowledge about certain critical areas of family socio-economic welfare, such as health care, food production, the maintenance and use of water and fuel, the production of household equipment, inter-household barter systems, and the maintenance of kin networks and ceremonies that are important during periods of food shortage. This knowledge, if developed through the participation of women in the planning process, will yield a more productive use of time and resources and will help to avoid problems of technology transfer and substitution. By working with women rather than making decisions for them, the planner may avoid inappropriate socio-economic prescriptions that could threaten the marginal security that women have managed to capture in the household life-cycle. Should this security be destroyed through poor program planning, the risk is not only to the individual female but also to the basic socio-economic unit in village life: namely, the family.

The relevance of the well-trained village worker recommended above is now more apparent. Part of this person's responsibilities should be to work with women at the village level to further develop their productive resources. If this is done, the

negative effects of increased labor intensity in food production should be appreciably mitigated. This same person may assume an important role in family planning activities.

4. The landless and nearly landless, in addition to receiving organizational assistance (see number 2 above) and having competition for local employment curtailed (see number 1 above), should receive the following types of support:

a) vocational training to upgrade their present agricultural skills;

b) research and further technical assistance;

c) additional work projects, especially in the poorer subproject areas, to ensure short-term employment during the offseasons in agriculture.

This recommendation is based not only on the needs of the rural poor but also on the implications of not investing further in rural areas. Although the task is economically troublesome in many ways, it does not pose as many problems as would projected future conditions in urban areas if it is not undertaken.

However, agricultural work probably cannot absorb all laborers, especially over the long term. Therefore, two additional types of support are needed:

a) In addition to revisions in credit extension already underway in the agricultural sector, credit is also desirable for the rural, non-agriculturally employed person. As traditional sources of credit continue to be depleted and as the number of persons dependent on non-agricultural employment increases, so the need for capital will also increase.

b) Rural, non-agricultural employment will benefit by improvements in the marketing and trading infrastructure.

REFERENCES

[1] The 1974 census of Bangladesh, upon which this figure and others to follow are based, like census data from many underdeveloped countries, are subject to considerable enumeration error. The general picture, based upon past trends, however, remains fairly apparent.

[2] It is recognized that in Bangladesh children younger than 15 years are producers.

[3] A primary limitation has been the inability of this model to successfully resolve the inequality problem that characteristically plagues rural social life.

[4] See Rashid, 1977, for a detailed account of the variation in house types throughout Bangladesh.

[5] For alternate patterns of residence, see George P. Murdock, 1949.

[6] By age, actual proportions of married, unmarried, widowed, and divorced are due to vary as will the sex of household heads, but the dominant pattern of married versus unmarried, and male versus female heads of household persists.

[7] "Purdah, literally meaning the curtain, refers to the system of seclusion of women prevalent in the Middle East and South Asia. In the strictest sense, purdah involves keeping women confined in the four walls of home and putting them in veil while moving out of the home". (Jahan 1974:1).

TABLE VI-1

POPULATION DENSITIES BY DISTRICT IN BANGLADESH, 1974

District	Population	Population per sq. mile
Dacca	76,11,807	2636
Chittagong	43,15,460	1599
Rangpur	54,46,916	1465
Khulna	35,57,460	764
Rajshahi	42,68,417	1168
Tangail	20,77,924	1593
Total for Bangladesh	1,63,98,000	70.00

Source: Statistical Yearbook of Bangladesh, 1979.

TABLE VI-2

DIVISION BY PREDOMINANT SETTLEMENT PATTERN

Divisions	Settlement Pattern
Dacca	Generally dispersed throughout; high mound building seen in parts of Mymensingh.
Rajshahi	Generally dispersed, but an observed tendency to form "line villages" along roads; more nucleation than elsewhere.
Khulna	Generally dispersed, to the extreme in South Barisal; some "line villages" along embankments and roads.
Chittagong[2]	Generally dispersed, absence of nucleation; low population in Sylhet, which is in a marginal zone.

[1] Abridged from Bertocci 1976, Table VI-1.

[2] Chittagong Hill Tracts not included.

TABLE VI-3

POPULATION PROJECTIONS

Projection		1978	1988	2000
Rapidly declining mortality and fertility				
Birth rate	(per 1,000)	45	31	20
Death rate	(per 1,000)	17	12	8
Population	(millions)	85	109	128
World Bank "probable" projection[1]				
Birth rate	(per 1,000)	46	36	30
Death rate	(per 1,000)	18	14	10
Population	(millions)	85	113	148
Continuing high mortality and fertility				
Birth rate	(per 1,000)	47	43	40
Death rate	(per 1,000)	19	18	17
Population	(millions)	85	116	159

[1] Bangladesh, Population and Nutrition Projects Department (1975, Annex 14-16); adjusted for consistency with revised 1974 census total, and with 1974 Retrospective Survey mortality estimates.

Adapted from Arthur and McNicoll, 1978.

TABLE VI-4

HOUSEHOLD CYCLE: SEQUENCE AND TIMING OF EVENTS: FEMALE ROLES; SOCIO-ECONOMIC/CULTURAL STIMULANTS AND CONSTRAINTS[1]

Age of Female	Sequence and timing of event	Female role	Socio-economic/cultural stimulants and constraints
49-50	First son leaves household	____ [2]	____
46-47	First son's first child	____	____
44-45	First son marries	Active/passive participant	____
35-36	Birth of last child	Active/passive participant	____
34-35	First daughter marries out	Active/passive participant	Purdah; family ties; economic, social, and political benefits
	Years of reproduction; mortality of household members	Active/passive participant	Population dynamics; value of male child
20-21	Establish separate household	Active domestically and in agricultural processing	Value for early household formation
17-18	Birth of first child	Active/passive participant	Value favoring male child; need for male laborers
15-16	Marriage	Passive participant	Legal basis; purdah; economic and political alliance
	Puberty and purdah	Learner/participant	Legal basis
	Socialization of female child	Learner	Legal

[1] Portions adapted from Cain, 1978, and modified to include data from surveys and other sources.

[2] Indicates "unknown."

TABLE VI-5

HOUSEHOLD CYCLE: SEQUENCE AND TIMING

OF EVENTS; IMPLICATIONS FOR FAMILY UNITS AND FOR

INDIVIDUAL FEMALES; STATUS OF WOMEN RELATIVE TO MEN[1]

Age of Female	Implications Family Unit	Implications Individual Female	± Status of Women Relative to Men[2]
49-50	"Extensiveness" in social, political, and economic realms; inheritance use rights.	Further security and protection.	± Material (e.g., dependence) - Social (e.g., power and prestige)
46-47	"Extensiveness" in social, political, and economic realms; inheritance use rights.	Further security and protection.	- Social (e.g., power and prestige)
44-45	"Extensiveness" in social, political, and economic realms; economic burden; inheritance use rights.	Decrease in labor intensity; future security.	± Material (e.g., security in future years) - Social (e.g., dependency)
35-36	Reproduction concluded.	Reproduction concluded.	± Material and social
34-35	Responsibility and status; increases interfamilial bonds; reduces economic liability and increases social, economic, and political benefits.	Increase in labor intensity.	- Material (e.g., no income)
	Ratio of births to deaths influences family size and duration; marriage duration; longevity of patriarchy; inheritance time; land fragmentation; economic status and social status of family unit.	Personal mortality risk; labor intensity in domestic and agricultural processing; marital status; present security as well as future security.	- Material (e.g., no income, less food)

(continued)

TABLE VI-5
(continued)

Age of Female	Implications Family Unit	Implications Individual Female	± Status of Women Relative to Men[2]
20-21	Increased autonomy; risk reduction against crisis.	Socialization of children; responsibility for domestic and agricultural processing; early formation increases present and future personal security.	- Material (e.g., no income) ± Social (e.g., increased power)
17-18	Respectability and status; labor source; income source in later years.	Status; security for present and future.	±Social (e.g., prestige)
15-16	Strengthen family ties; reinforces family size; respectability and status; decrease in economic liability.	Increase in security; sexual dominance; hard work; stringent seclusion.	- Material and Social (e.g., no income; power)
	Respectability and status; enhances marriage prospects.	Seclusion.	- Social (e.g. power)
	Future economic and political alliance through marriage.	Personal security through marriage.	- Social (e.g. type of knowlege)

[1] Portions adapted from Cain, 1978, and modified to include data from surveys and other sources.

[2] See text for definition of ± status of women relative to men.

TABLE VI-6

TYPICAL DAILY SCHEDULE: ONE DUBAIL WOMAN

Time	Activity
500 - 600	Arise from bed; say Fazar (morning) prayer; clean houses.
600 - 800	Supply fodder to cattle; clean cowshed; prepare breakfast; look after children.
800 - 1000	Do husking and other such works connected with husking.
1000 - 1200	Prepare meal for family members.
1200 - 1400	Look after the children; feed family; take bath.
1400 - 1600	Supply fodder to cattle; clean houses after midday.
1600 - 1800	Afternoon prayer; clean yard; look after ducks, fowl, and cattle.
1800 - 2000	Evening prayer; supply fodder to cattle; prepare evening meal and feed family.
2000 - 2200	Hold gossip sessions after evening meal; go to bed.

Source: In-depth interviews. Rural Irrigation Works Study, Summer 1979.

TABLE VI-7

PROPOSED DEVELOPMENT AND ASSOCIATED IMPACTS (RATED) [1]

Variable	Impacts			
	Direct	Indirect	Short-Term	Long-Term
Demographics				
Population size				
Population density				
Age-Sex composition				
Family size		1		1
Literacy		1		1
Religion				
Population mobility		3	3	3
Social Organization				
Village organization		2	2	2
Household features				
Women's role				
Socialization		1		1
Puberty and Purdah		1		1
Marriage patterns		2		2
Children		2		2
Labor	3			3
Local Economy				
Land and household				
Status	3	2		3
Land ownership				
Land use	3		3	2
Labor	3		3	3

(continued)

TABLE VI-7

(continued)

Variable	Impacts			
	Direct	Indirect	Short-Term	Long-Term
Reciprocity				
Crafts				
Non-agricultural employment				
Landless and near landless				
Labor	3		3	2
Patron-client relations		1	1	1
Migrant labor	2		2	2
Non-agricultural employment		1	1	1

[1] Rating Procedure:

1 = low likelihood of occurrence

2 = medium likelihood of occurrence

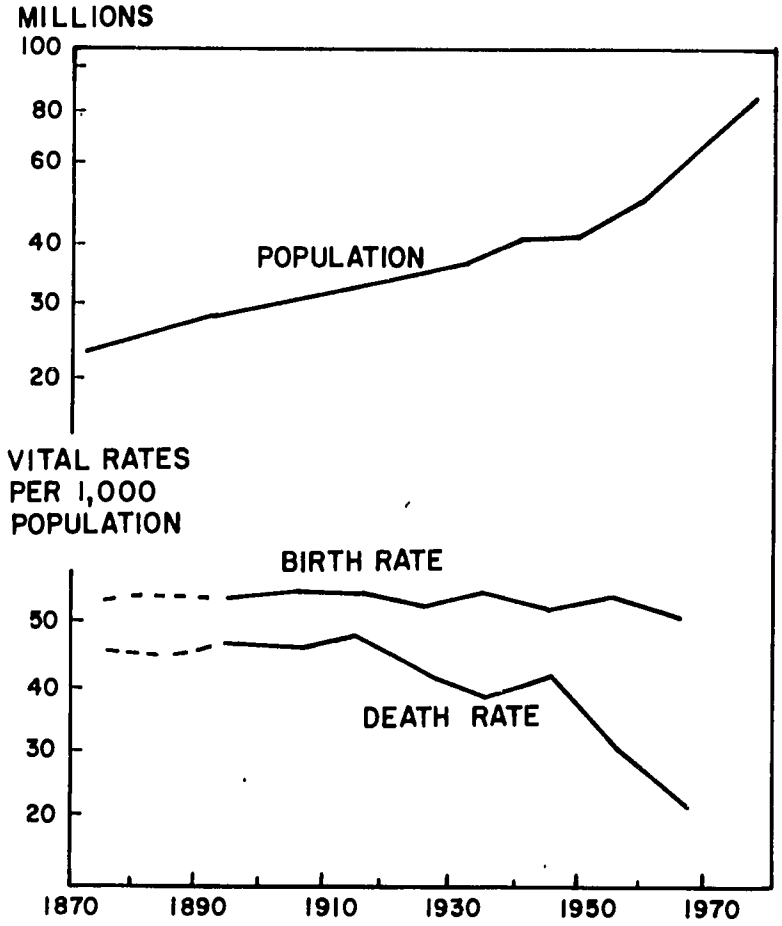
3 = high likelihood of occurrence

TABLE VI-8

POSITIVE (+) AND NEGATIVE (-) EFFECTS

OVER THE SHORT AND LONG TERMS

Variable	Impacts	
	Short-Term	Long-Term
Demographics		
Family size		1(-)
Literacy		1(-)
Population mobility	3(-)	3(-)
Social Organization		
Village organization	2(+/-)	2(+/-)
Women's Role		
Socialization		1(-)
Puberty and Purdah		1(-)
Marriage patterns		2(-)
Children		2(-)
Labor		3(-)
Local Economy		
Land and household status		3(+)
Land use	3(+)	2(+)
Labor	3(+)	3(+)
Landless and near landless		
Labor	3(+)	2(+)
Patron-client relations	1(+/-)	1(+/-)
Migrant labor	2(-)	2(-)
Non-agricultural employment	1(+/-)	1(+/-)



SOURCE: BANGLADESH BUREAU OF STATISTICS
ADOPTED FROM ARTHUR AND MC NICOLL, 1978.

FIGURE VI-1. OUTLINE OF POPULATION AND VITAL RATES.

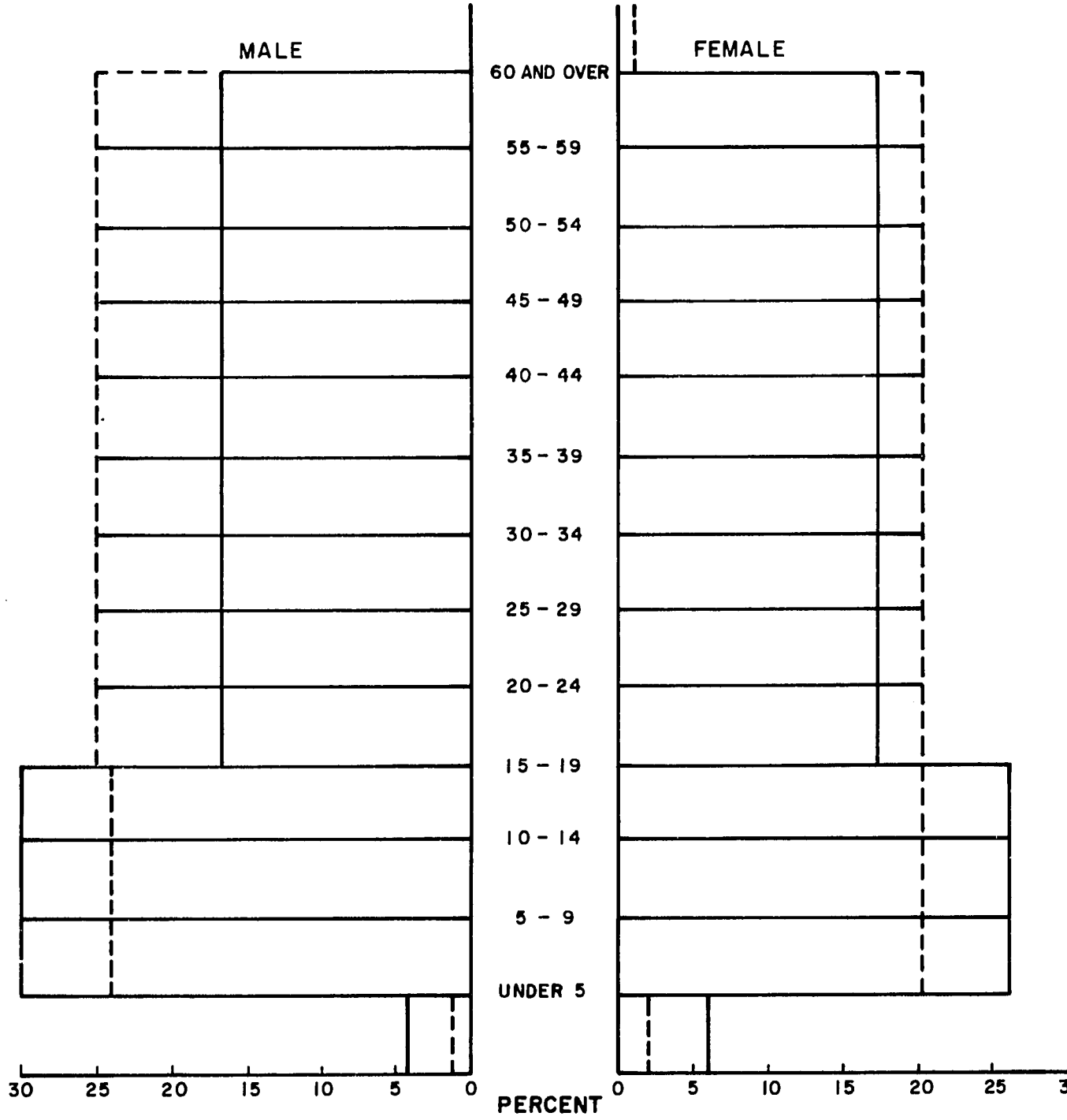
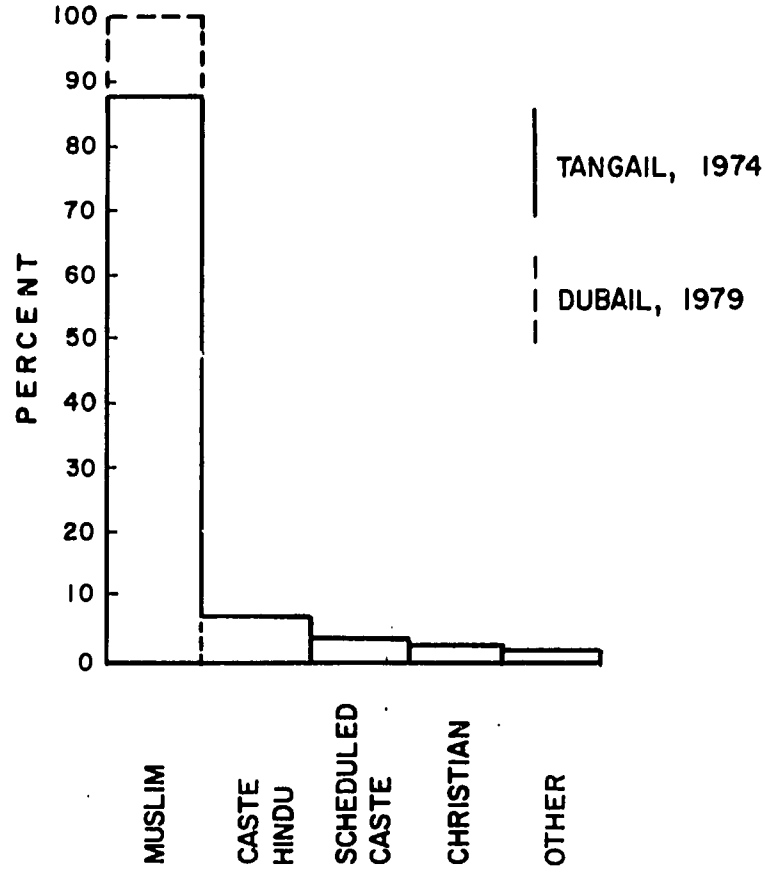
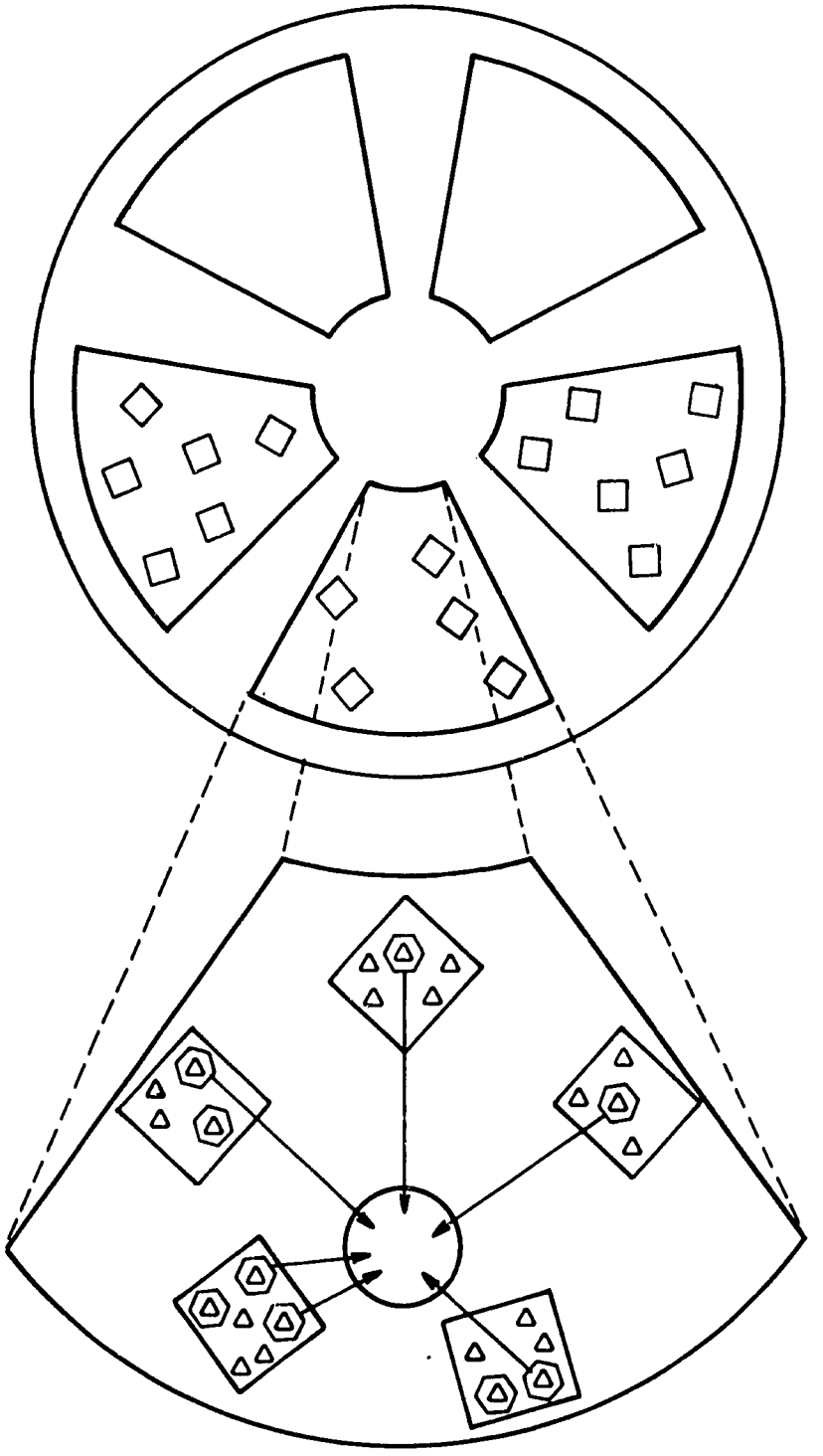


FIGURE VI-2. AGE-SEX STRUCTURE BY AGRICULTURAL ACTIVITY, RURAL WORKS SURVEY, 1979



SOURCE BBS, 1974 RURAL WORKS SURVEY.

FIGURE VI-3. RELIGIOUS AFFILIATION.



LARGE CIRCLE = GRAM
COLLAPSED RECTANGLE = PARA
SQUARE = BARI
BROKEN CIRCLE = SAMAJ COUNCIL OF ELDERS, MAY CROSS PARA BOUNDARIES.
PENTAGON = SAMAJ COUNCIL MEMBER.
TRIANGLE = CLUSTER OF HOUSEHOLDS USUALLY OF THE SAME LINEAGE BUT NOT ALWAYS.

FIGURE VI-4. FEATURES OF VILLAGE ORGANIZATION

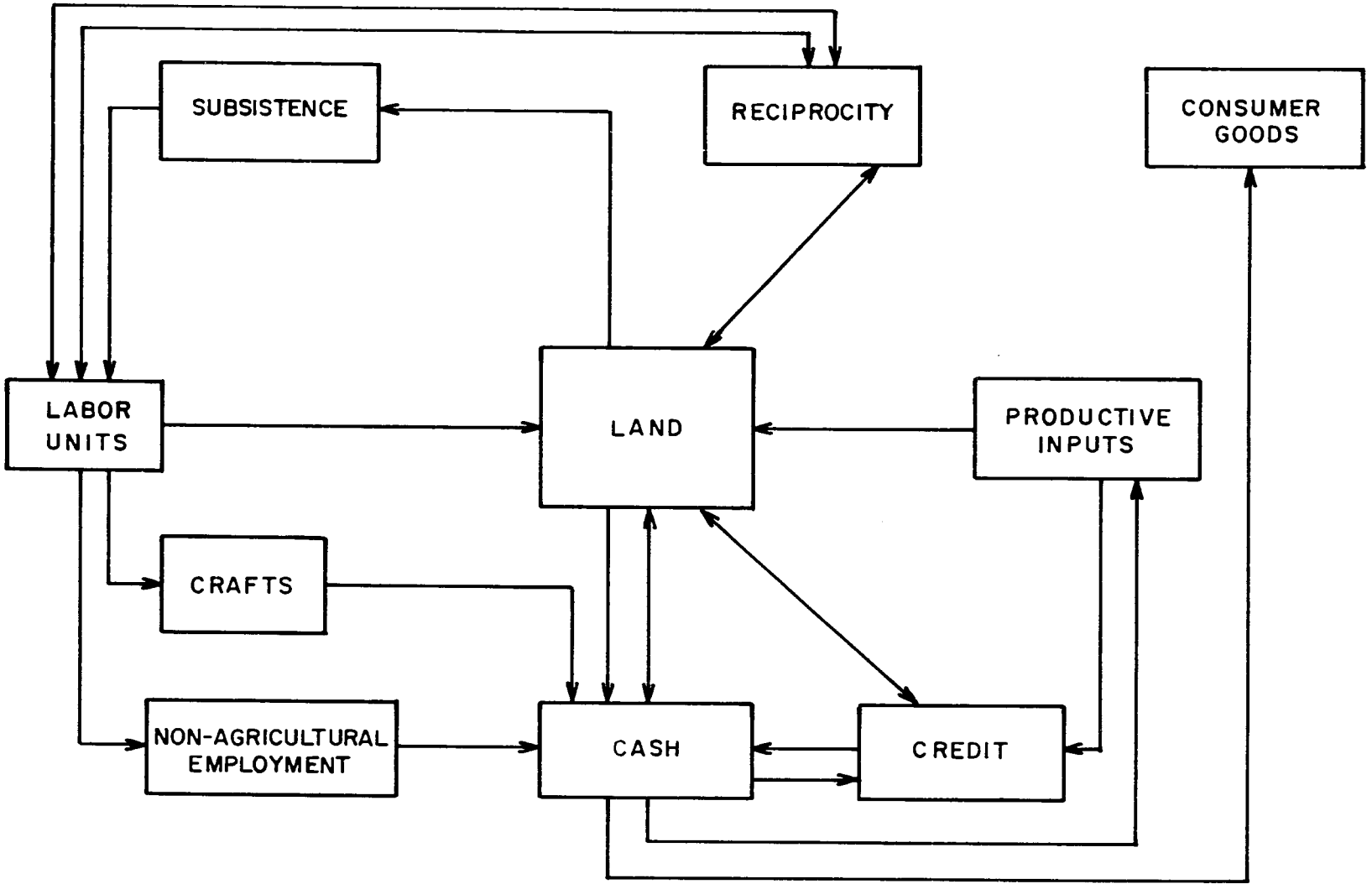


FIGURE VI-5. ALTERNATIVE RESOURCE ALLOCATIONS FOR A RURAL BANGLADESH DECISION-MAKING UNIT

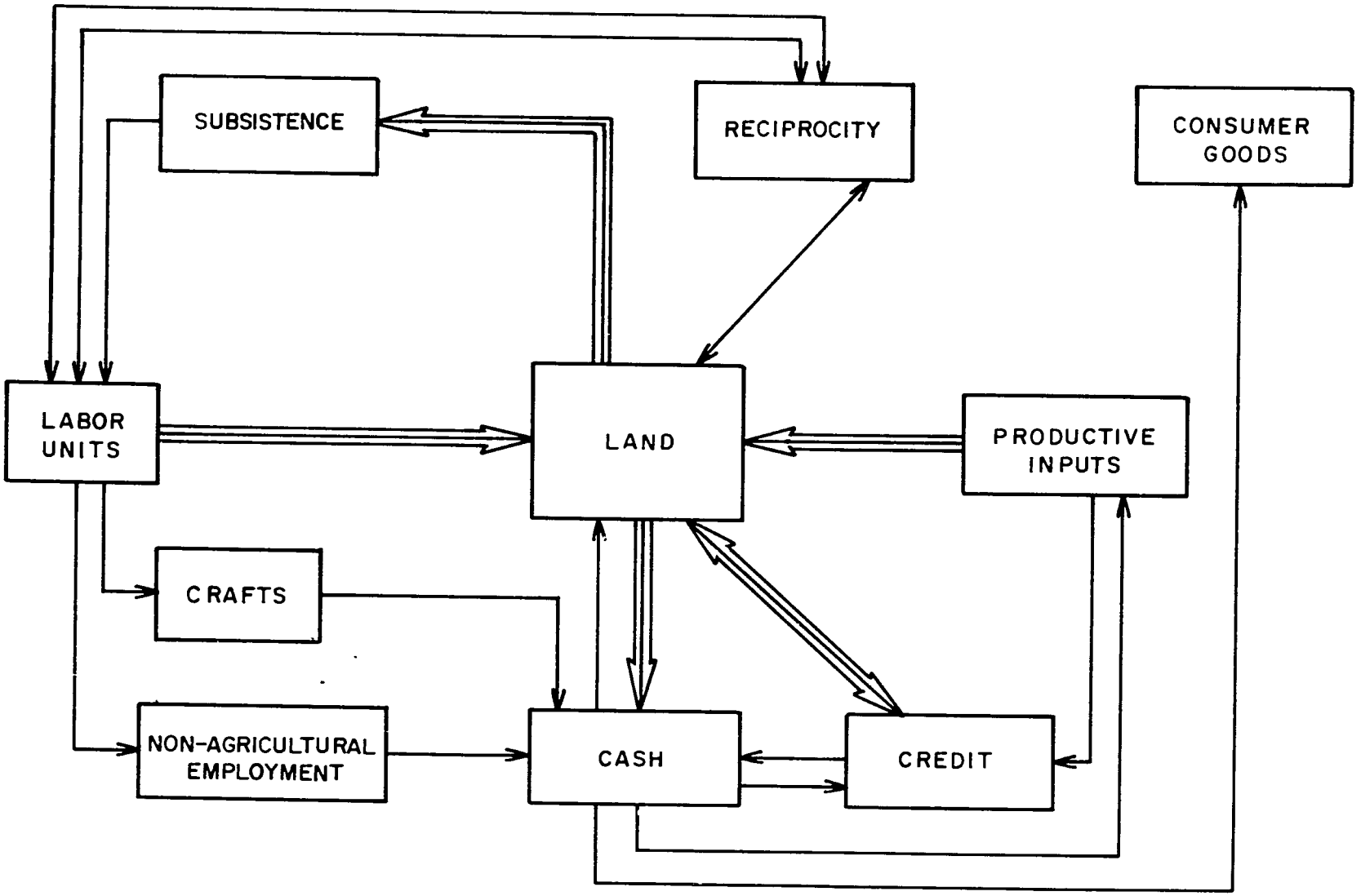


FIGURE VI-6. IMPACTS OF PROPOSED DEVELOPMENT ON THE LOCAL ECONOMY OF A RURAL BANGLADESH DECISION-MAKING UNIT.

CHAPTER VII

ENVIRONMENTAL EXAMINATION

Section 1: Introduction

A. Purpose of Environmental Examination

This initial environmental evaluation has been prepared under the Agency for International Development Guidelines for Preparation of Initial Environmental Examination (IEE) and under the direction of AID personnel in Dacca, Bangladesh. This examination intends, in the early sub-project planning and design stages, to identify any foreseeable environmental impacts, to determine the relative degree of impact, and to recommend the kind of further evaluation that may be required.

The IEE was prepared during Phase II of this project, thereby ensuring close cooperation between engineers, agronomists, and environmental scientists in developing enviromentally sound sub-project designs.

This report will also provide AID personnel with an environmental data base, with selection criteria, and with a format for the evaluation of subsequent rural irrigation projects.

B. General Information

The following paragraphs contain brief descriptions of Bangladesh's geology, soils, hydrology, flora, and fauna.

1. Geology: Most of Bangladesh forms a part of what is known as the "Bengal Basin," which is one of the most active tectonic regions of the world. Formation of the Himalayas during the Tertiary period influenced the physiography of Bangladesh. During the same time period, a movement from the east formed the

ridges of the Chittagong Hill Tracts and of the Tippera, Arkan, and Naga Hills. The effects of uplifts and foldings are clearly visible in the older claystones and shales of the Chittagong and the Chittagong Hill Tract districts. Except for the Chittagong region, the land was, and is, formed by the deposition of materials carried by ancient and modern rivers. Underlying the visible flood plains and active deltas are older, compacted sedimentary deposits of distinct reddish brown color, believed to have been formed by glacial sequences. These resistant formations may have influenced the courses of rivers although during the last 200 years, changes in the courses of the Ganges and the Brahmaputra Rivers are attributed to faulting and the resultant tilting of rocks. Although incomplete delta development, due to the shift of silt-laden rivers, may have caused some major depressions in the country (such as in the Bogra, Pabna, Faridpur, Mymensingh, and Sylhet districts), subsidence may also have contributed to the formation of depressions.

The Bengal Basin has undergone extreme changes. It is believed that 5,000 years ago, the sea reached the Rajmahal hills and the region around Sylhet was a lagoon of that sea. Some controversial evidence suggests that the Ganges probably discharged into the Arabian Sea. The Brahmaputra flowed through Mymensingh in 1785, but it now flows 40 miles westward. The Teesta at one time flowed southward through Dinajpur to join the Ganges, but it now flows southeasterly into the Brahmaputra. The great flood in the Teesta River in 1787 also caused marked changes in the alignment of the Ganges and the Brahmaputra Rivers.

2. Soils: There are two very broad groups of soil in Bangladesh, the new alluvial soil of the delta and the old alluvium of the Barind area in the northwest and in the Madhupur forests. The following sub-classes are also frequently referred to:

a) recent alluvial piedmont soils,

b) recent alluvial soils,

c) interstream alluvial soils,

d) older alluvial soils,

e) saline coastal soils,

f) swamp soils, and

g) hill soils.

The characteristics of the new alluvium vary from place to place, but generally throughout the overflow area, medium and fine sands, silts, sandy silts, and clay silts are found. For paddy, high yields are produced by soils with a high clay content, medium organic content, good but not excessive drainage, pH's of 4 to 8, and relatively high total cation exchange capacity. Sediments deposited on top of cultivated land by river overflows are often rich in humus content and greatly enhance the fertility of the soil.

3. Hydrology: Of the two major rivers, the Ganges and the Brahmaputra, the former has a length of 1600 miles and a catchment area of approximately 350,000 square miles; the latter a length of 1800 miles and a catchment area of 224,000 square miles. Of these two rivers' total catchment area of 600,000 square miles, only 7.5 percent lies in Bangladesh, although Bangladesh receives 75 percent of the total flood discharges. Theoretically, the combined peak flood flow of these two rivers could be 6.1 million cubic feet per second (if contained, enough to cover the whole of Bangladesh to a depth of 40 feet). In the Southeast, most rivers (such as the Feni, Karnafuli, Sangu, and Matamuhuri) drain directly into the sea. Most rivers are shallow and have sandy beds, gentle slopes, and oscillating channels. The river beds generally have readily recognizable forms of bed roughness. In the upper reaches, the bed in plane and offers the least resistance to flow. In the lower reaches, the bed forms have ripples and offer strong resistance to flow. The larger rivers, like many minor ones, have both meandering and braided characteristics and they are subject to both bank and bed move-

ments. Heavy erosion and scouring and the formation of channel bars, meander bars, and delta bars characterize most of the rivers. The annual sediment load carried by the river system is estimated to be approximately 2.5 million tons.

4. Flora: The following ten major families of plants are found in Bangladesh:

a) Graminae (grasses),
b) Leguminasae (pulses, ground nut, tamarind, etc.),
c) Cyperaceae (sedges),
d) Compositae (sunflower gujitil),
e) Scrophularia ceae (weeds of the rice fields),
f) Malvaceae (cotton, lady's finger, etc.),
g) Acanthaceae (hargoza, basak),
h) Euphorbiaceae (castor-oil, rubber, latkan),
i) Convolvulaceae (sweet potato, morning glory), and
j) Labiatae (minte basil and other herbs).

Also represented are Bambusae (bamboos), Palmeae (palms), Dipterocarpaceae (garjan), Cucurbitaceae (various vegetables), Aselepiadaceae (akanda), and Magnoliaceae (champs).

The mango (Mangifera indicate) is the most common tree found in the countryside and is prized for its fruit as well as its timber value. Next in occurrence and popularity is the Betelnut palm (Areca catechy). It is estimated that over 200 million of these palms grow in Bangladesh. Along waterways and water tanks, Moder (Erythrtna indica), Jiyal or Badi (Lannea grandis), and Hijol (Barringtonig acutangula) are trees commonly found. The groves are predominantly composed of Jak (Artocarpus heterophyla), Jam (Syzygium jambolana), Banana (Musa sapientum and M. Paradiplaca), and Coconut (Cocos nucifera). The Khejur palm (Phoenix sylvestris), Tal palm (Barassus flabellifer), and Rattan palm grow in thickets surrounding marshy areas. Near ditches and along the sides of groves small flowering plants and ferns such as Homalomena aromatica, Crinum amoenum, Actiniopteris flabellata, and Drymoglossum piloseloides grow profusely. Several

kinds of orchids are found in Bangladesh with the most common of the non-medical varieties being Calanthe masuca and Dendrobium pierardi.

Perennials such as Jatropha gossypifolia and Mimosa pudica inhabit open-space areas (such as fallow fields, embankments, etc.) Trees grown for shade generally consist of Banyan (Ficus bengalensis), Oshot (F. veliglosa), members of the fig family, and the rain tree (Samania saman).

Water tanks, khals, ditches, and most slow-moving waterways contain a vast variety of aquatic species of plants. The water lettuce (Pistia stratoites), duck weed (Lemna minor), Nasturtium palustra, Lepidium sativum, Vallisneria spiralis, and the water lily (Nymphea stellata) are the most prevalent. Reeds and large grasses surround the edges of waterways and swamps. They are represented by species such as Arundo donax Saccharum spontaneum and various Andropogons. A valuable sight in Bangladesh is the Benga Rose (Rosa invalucata), which is the only representative member of the genus Rosaceae. Horticulture is not very popular in Bangladesh, but various scented flowers and shrubs (such as Jasmine, Jasminium officinale and Hibiscus Mutabilis) are planted.

Forests cover 5,000 square miles, approximately 9 percent of the total area of Bangladesh. The proportion of forest to landmass, compared to other nations, is small in Bangladesh; this fact has been attributed to the increasing pressure for cultivatable land caused by population growth. The country's forest areas have been divided according to ten geographic areas: Chittagong Hill Tracts North, Chittagong, Sylhet, Dacca, Mymensingh, Tangail, Northern (Rangpur, Dinajpur and Rajshahi), and the Sundarbans. The forests are further divided into seven classes: reserved, acquired, protected, private, vested, controlled, and unclassified. Bangladesh's forests are unique in that, unlike most tropical forests, there are large pure stands of trees. Sal (Shorea robusta) stands are found in the forests of central and northern regions, and in the Sunderbans, Gewa (Excoecaria agallocha) and Sundri (Heritiera formes) grow in large stands.

The hill forests of the east are populated with stands of only Garjan (Dipterocarpus spp.). The eastern forests also contain several species of tropical oaks and chestnuts.

5. Fauna: Bangladesh's fauna is classified within the Oriental Zoological Region. There are approximately 200 species of mammals, 750 species of birds, 150 species of reptiles and batrachians, and over 200 species of marine and fresh-water fishes.

a) Primates--including monkeys, gibbons, and lemurs--are very common, especially the Rhesus Monkey (Macaca mulatta), Hoolok Gibbon (Hylodates hoolock), and the Lemur, Slow Laries (Nycticebus coucang).

b) Carnivora are well represented in Bangladesh, especially by six species of Felidae. Of these, the Royal Bengal Tiger (Panthera tigris) is the most famous and feared. Leopards (Panthera pardus), Leopard Cats (F. bengalensis), clouded Leopards (F. nebulosa), Marbled Cats (F. marmorata), and Golden Cats (F. Temmincki) are also found. Two species of the Civet and the Mongoose, Herpestes edwardsi being the most common, are well distributed.

c) Canines, including jackals (Conis aureus), wild dogs (Cyon alipnus), and Bengal foxes (Vulpes bengalensis), are found everywhere in the countryside. The Malaysian Black Bear (Ursus torguatus) and the Sloth Bear (Melursis ursinus) have been reported in the Chittagong region. Several species of Insectivora (such as hedgehogs, tree shrews, and shrews) are also found throughout the countryside.

d) Rodentia comprise twelve species of mice and rats and five species of squirrels, the Mole-rat (Nesocia bengalensis) and the Bandicoot (N. nemorisaga) being the most prevalent.

e) Elephants (Elephans maximus), found in the Chittagong Region and in northeastern Sylhet, are protected by law.

f) Cervidae are represented by the Chital (Axis axis), Barking Deer (Muntiacus muntjac), Sambar (Cervus unicolar), and Hog Deer (A. procinus). The wild boar (Sus scrofa) is common in many parts of the country.

g) Edentia is represented by the Pangolin or Bonrui (Manis pentadactyla), which is an important ingredient of village medicines.

h) Cetacea are represented by the Gangetic Dolphin (Plantanista gangetica) and the Blunt-Nosed Porpoise (Orealla brevirostris).

i) Birds are represented by more than 900 species and subspecies of birds in Bangladesh; 220 species are seasonal inhabitants. The most common resident bird populations in the cultivated and urban areas include the House Crow (Coruns splendens), House Sparrow (Passer domesticus indicus), Shalik (Acridotheres tristis), Black Drongo (Dicrurusmacrocercus albirictus), and Pariah Kite (Milvus migrans govinda). The various waterways provide habitats for fishing birds, such as the Kingfisher, Brown Fish Owl (Ketupa zeylonensis leschenaulti), and Pallas Fishing Eagle (Haliaetus leucoryphys). Winter migrants include ducks (godwal, widgeon, sheldrake, pochard, etc.), geese, and Pintail and Fantail snipes.

j) Of the Reptilia, the most numerous are the crocodiles. The major species include swamp crocodiles (Crocodilus palustrius), marine crocodiles (Crocodilus porosus), and the fish-eating crocodile (Gavialis gangetiens). There are 20 species of lizards, of which the House Geckoes or Tik-tiki (Hemidactylus spp.) are the most common. There are also several species of snakes; however, they are not very evident. The most dangerous snake species are the Cobra (Naja tripudians), King Cobra (N. bungarus), Krait (Bungarus caerules), and Rajsanp or King Snake (B. fasciatus).

k) Fisheries in Bangladesh can be divided into five classes: (1) tank; (2) bil, baor, hoar; (3) riverine; (4) estuarine; and (5) marine.

k-1) Tank fisheries are usually stocked with various species of carps or with fishes such as Magur (*Clarias batrachus*), Shing (*Heterophneustes fossilis*), Bata (*Cirrhina reba*) and Shor-Puti (*Barbus sarana*).

k-2) Bil, baor, hoar: The main fishes caught in the bils are the various carps, Magur, Jagur (*Clarias jagur*), Shing, Koi (*Anabas testudineus*), Bacha (*Eutropichthys*), Chapila (*Gadusia chapra*), Taki (*Ophiocephalus sp.*), Shole, Boal, Chital, Kajuli (*Alia coila*), and Pabda. The bils in general have better fishing than the rivers. One of the reasons for this is the nature of carp eggs. The various indigenous carp species breed during the heavy rains in the monsoon period. The free-floating eggs are carried by the currents and winds to the sea and unless they are either eaten by predators or killed by the floodwaters, they are protected and thrive.

k-3) Rivers: The fish species found in the rivers are similar to those in the bils and khals with the exception of Magur Shing and Koi. The most common fish caught is Iliish (*Hilsa ilisha*), a marine species related to the Shad that breeds in the rivers.

k-4) Estuarine: Marine species found in the estuaries include: Bhetkhi (*Lates calcifer*), Topshi (*Polynemus paradiseus*), Terabhangan (*Polynemus indicus*), and Illish. The most common freshwater species are Koi, Tengra (*Mystus vitatus*), Rangchgolash (*M. guilo*), Air (*M. aor*), Banspata (*Cynoglossus hamiltonni*), and Pangush (*Pangasius pangasius*). The estuaries also provide four-fifths of the annual catch of prawns.

k-5) Major marine species include Bhetkhi, Luckwa (Polynemus indicus), Lotia (Harpodon nherus), Chela (Chirocentrus dorab), Churmach (Trichinurus haumela), Khaibal (Cromileptes altivelis), Khar (Clupea fimbriata), Nurhilsa (Clupea toli), Khandu Magur (Pristis cuspidatus), Bhola (Scheama Semiluctuosa), and Pomfret (Stromateus sinensis).

Section 2: Environmental Evaluation Methodology

A. Introduction

Due to the short time and large number of sub-projects, it was not feasible to apply the IEE to all 30 sub-projects; instead, USAID and MRD agreed to have the Consultant examine representative sub-projects. To aid in the selection of these sub-projects, a checklist environmental questionnaire and matrix were developed and circulated for completion by individuals familiar within the sub-projects. Pertinent information was also solicited from USAID personnel, Bangladesh Government Ministries, academic institutions, other development agencies in Bangladesh, and available published literature. The 30 sub-projects were divided into three engineering sub-project scheme categories: (1) re-excavation of an existing waterway for flood control and water storage, (2) expansion and/or improvement of existing distribution systems, and (3) construction and operation of irrigation and flood-control structures. From these categories, representative engineering schemes were chosen for examination.

B. Environmental Criteria

The environmental criteria developed by the consultant for the selection of sub-projects consisted of the following considerations:

1. Environmental/Resource Linkage

   a) What will be the ecological consequences of changes in land-use patterns and possible changes in population distribution?

b) Will future resource uses be pre-empted?

c) Will undesirable crowding occur as villages expand to make way for, or take advantage of, the irrigated areas?

d) If new water resources are to be tapped, what is known of their extent and replenishment?

e) What will be the impact of the sub-project upon the biota of the water system?

f) Will the diversion of water to cultivated areas seriously degrade the capabilities of the original water system to support valuable biological species?

g) Will wildlife migration routes be permanently disrupted?

h) Will increased cultivation activities affect potable water supplies and, if so, by what means (i.e., pesticides, fertilizers)?

2. Design and Construction Activities

a) Are road patterns, land excavations, fill sites, refuse disposal activities, or other design components planned to minimize damage to the natural environment?

b) Will precautions be taken to prevent sub-project management and construction crews from introducing new diseases and/or redistributing existing diseases?

c) If ponds, canals, or other surface bodies are involved, can a fishery be established?

3. Operations

a) What steps are being taken to preserve fish and wildlife resources in the area?

b) Will run-off water contain residues (such as pesticides or fertilizers) that can contaminate downstream water users or subsurface aquifers?

c) What are the sedimentation, salinity, and erosion problems?

d) Will serious aquatic weed problems arise?

e) How does the irrigation network interact with sources of drinking water?

f) Will irrigation permit the cultivation of new crops to which exogenous posts might be attracted?

g) What provisions have been made for monitoring the effects of the development on the environment and on affected people?

4. Sociocultural Factors

a) Will the introduction of water and new crops be detrimental to important social or cultural practices?

b) Will the construction of the system or new cultivation cause the relocation of people seeking new opportunities?

c) Will the construction or operation of the system adversely affect other agricultural, economic, or commercial practices in the area?

5. Health Impacts

a) Will changes in water velocities, temperature, and depth result in a more favorable environment for insects, pests, and disease-bearing organisms?

b) Will changes in water patterns introduce disease-bearing organisms into previously unaffected areas?

c) Will food, wastes, or water cycles aggravate sanitation and disease problems?

6. Long-Term Considerations

a) What undesirable long-range changes in population or the environment may accompany the irrigation system development?

b) Will water logging and/or soil salinity become problems?

Sub-projects exhibiting multiple impacts as a result of construction and operational activities received particular emphasis in the evaluation process. Specifically, schemes having a potential impact upon fisheries, water quality, water use, land use, and public

health were favored in the selection process.

Representative engineering schemes and sub-projects identified as having potential impacts of major significance and magnitude were visually inspected. The environmental information gathered was extrapolated for other similar schemes under consideration. Eight sub-projects selected for evaluation are listed in Table VII-1.

Section 3: Probable Environmental Impacts

A. Land Use

1. Changing the Character of the Land

a) Increasing Population: Implementation of the selected sub-projects is expected to have little or no effect upon existing population patterns, distributions, or densities. The sub-projects are located in areas where existing agricultural activities are on-going and no new virgin lands are being developed. The resident farmers and tenant labor force are now large enough to cultivate the additional acreage without having to recruit supplementary labor from outside the community. For DTW and LLP sub-projects, the increase in irrigated area will be only 40 to 100 additional acres.

Construction activities in most cases will be performed by local residents, thereby eliminating the necessity of obtaining an outside labor force and associated infrastructure and cultural problems.

b) Extracting Natural Resources: No mineral resources will be extracted as a result of the proposed sub-projects.

c) Land Clearing: All lands to be affected by the proposed sub-projects have previously been cleared of natural vegetation, and they are now being used for agricultural purposes. In general, sub-project development would provide irrigation, flood control, and drainage to areas currently under

cultivation and would enable farmers to increase cropping intensities and yields. Existing rights-of-way have been established and will require no additional land clearing for construction activities.

d) Changing Soil Character: Implementation of some of the proposed sub-projects that include flood-control structures may have a direct effect upon soil fertility. The 13 LLP and DTW sub-projects will include installation of only small on-farm water distribution channels, and these will not prevent the annual floods. Increased cropping intensities and the introduction of high-yield varieties will place some further burden on the fertility of the soil, but this is considered to be minor. To replace soil nutrients that will be depleted and to ensure high yields, it will be necessary to use increasing amounts of fertilizers and pesticides.

The improper application and misuse of inputs can lead to a build-up of pesticides in the soil and to the leaching of these chemicals into waterways. The Consultant recommends that the DEM include measures in its program to prevent such significant adverse impacts.

In areas where soil salinity is high, the proposed irrigation schemes will enable leaching of the salts from the soil and thus provide positive impacts. Additional land can then be brought under cultivation during the dry season.

In summary, increased cropping intensities and the use of high-yield varieties without replenishment of fertilizers may have some effect on the long-term production of agricultural lands.

2. Altering Natural Defenses: All sub-projects will have only minor impacts upon the physical environment. Construction and operational activities will not alter the basic land forms or appreciably change the character of the areas. The flood-control structures of some sub-projects will protect agricultural land from early flooding and salt water intrusion and will reduce

flooding depths, thereby permitting more intensive use of the lands. During the construction of control structures and distribution systems and the re-excavation of the khals, there will be some temporary disruption of water courses, scarring of rights-of-way, and increased siltation and erosion. Because of these activities' short duration and the area's tropical character, it is expected that the disturbed areas would be restored quickly to their natural condition.

3. Foreclosing Important Uses: The GOB's Five-Year Plan emphasizes agricultural development with the objective of achieving food self-sufficiency in food grains, of creating employment for the rural poor in order to improve incomes and nutritional standards, and of increasing export earnings. GOB's aims are to be achieved by accelerating the use of a seed-based technology involving improved cultural practices; by increasing the use of HYV seed, fertilizers, and pesticides; by increasing use of existing facilities and expanding irrigation facilities through low-cost, short-gestation, minor irrigation and drainage schemes (e.g., low-lift pumps and tube wells, of which this study includes thirteen). The proposed sub-projects are in response to, and support of, GOB's major agricultural objective of food self-sufficiency.

4. Jeopardizing Man or His Works: The sub-project works will benefit man and his agricultural activities because some of the schemes will provide flood protection and drainage. The severity of damage caused by annual flooding to homes, crops, gardens, and livestock will be either eliminated or minimized. By providing protection from early flooding and salt water intrusion and by reducing flood depths and duration, the risks associated with agricultural activities will be greatly reduced.

5. Impact upon Surrounding Terrestrial Ecology: Construction and operation of the flood-control and drainage schemes of some of the sub-projects will disrupt the natural terrestrial habitats of indigenous wildlife forms. Because the works will either reduce the area and depths of annual floods, those species adapted to the flooded environment (i.e., waterfowl) will be forced to establish habitats in the surrounding areas. The Consultant now believes that the proposed activities will neither exert long-term detrimental stress upon wildlife forms nor upset the ecological balance. There are no known unique or endangered species at any of the project sites.

B. Water Quality

1. Physical State of Water: Physical changes in water quality will occur during construction of the irrigation and flood-control structures and during khal improvement activities. It is expected that water turbidity will increase as a result of additional silt loadings from bank and khal excavations. Construction of the control structures will be of short duration and, therefore, will only temporarily disturb downstream water use and the aquatic environment. Khal improvement activities will more significantly affect aquatic ecosystems; however, upon completion of excavation activities, disturbed habitats should return to their natural state. To ensure protection of the ecosystem, the Consultant recommends that appropriate measures (such as revegetation of khal banks) be taken as soon as feasible to prevent soil erosion.

2. Changing the Chemical or Biological State of the Water: As a result of sub-project works, more land will be placed under year-round cultivation. Associated with increased cropping intensity, new cropping patterns, and the use of high-yield varieties are the requirements for additional agrochemeicals; however, through improper application, flooding, and agricultural run-off, these chemicals ultimately find their way into the aquatic ecosystem. Little is known about their overall and long-term effects, but

some of the established linkages may be noted: Reactions have been recorded for freshwater fauna and flora, ranging from simple protozoa to complex vertebrates and from bacteria and phytoplankton to vascular plants. Most pesticides appear to have an adverse effect upon non-target as well as target organisms, including man. Toxic pesticides and herbicides can cause sudden death to aquatic organisms. Daphnia, the water flea, which is an essential component of many freshwater ecosystems, is known to readily succumb to a wide range of insecticides. Agricultural chemicals also destroy beneficial phytoplankton and, often, freshwater invertebrates. Fish kills from exposure to chemicals may be acute. Current evidence in Bangladesh sufficiently indicates that the indiscriminate application of pesticides has caused large-scale mortalities of wild fish stocks and waterfowl populations usually found grazing in flooded fields. Pesticides have different levels of persistence and are believed to persist longer in water than in soils, probably because most pesticides are readily absorbed into soil particles. Evidence also suggests that contamination of water with pesticides is more the result of direct application to water than through agricultural run-off. Subsurface waters do not appear to provide direct routes into rivers and reservoirs.

Herbicides in common use appear to break down more readily than do insecticides. However, they can alter the ecology of aquatic ecosystems sufficiently to destroy populations of animals associated with plants.

Fertilizers have a rather different and more positive impact upon plant growth. Nitrates and phosphates are the active ingredients in some fertilizer formulations, and in the surface run-off from agricultural lands, these compounds enrich the fertility of irrigation water and, combined with other elements in proportions and association that are not well understood, create entrophic conditions. The process that culminates in eutrophication involves the assimilation and fixation of carbon and nitrogen at different trophic levels. With favorabe conditions of light and temperature, aquatic organisms use the nutri-

ents and minerals to produce algal blooms and luxuriant weed growth. Typically, irrigation distribution channels, khals, bils, and other slow-moving waterways become choked with dense growth of algae and aquatic weeds (such as water hyacinths). In addition to their interfering with water flows and causing obstruction, aquatic weeds are associated with the spread of certain vectors of diseases in man and animals.

Increased agricultural activities, in conjunction with historical problems of the indiscriminate and improper use and application of agrochemicals, may lead to significant adverse effects upon aquatic ecosystems and the human environment. For example, the lack of proper application equipment and training often causes farmers to haphazardly apply liquid pesticides by splashing them on crops with bundles of sticks, leaves, or reeds. As mentioned previously, recent decreases in wild fish stocks--an important source of protein for rural farmers--have been associated with pesticide abuse. The impact is expected to be seen foremost in a reduction in the number of fish caught in rivers, khals, paddys, and ponds and secondarily in the impacts upon fishermen's incomes and upon the general health of the community.

The Consultant strongly recommends that, to preserve the natural integrity of aquatic ecosystems, intensive agricultural extension programs be conducted. These programs should educate farmers with respect to the types, dosages, application techniques, and protective measures for agrochemicals.

3. <u>Changing the Ecological Balance of the Water</u>: As discussed briefly in the preceding section, changes in the chemical and biological state of a water body can profoundly affect fish populations. Special attention should be given to the potential adverse impacts upon paddy, khal, bil, and river fisheries associated with the operation of water-control structures (i.e., sluice gates). The proposed structures are designed to have flap gates at each end (does not apply to DTWs and LLPs). During the dry season, the riverside gates will be locked in a raised position, leaving the inner gate free to conduct water to the

khals and fields when tide-induced river levels are higher than the water levels within the project. With the ebbing tide, these gates will automatically close to retain water within the project area, thereby enabling increased irrigation even though the river levels are lower. With the advent of the monsoon season, riverside gates will be lowered and interior gates will be locked in a raised position. In this manner, high river levels will close the outer gate to prevent flooding and the backing up of water into the project area. When the tide recedes and khal water levels are higher than those in the river, the gates will automatically open to drain excess interior water. However, this project concept of regulating khal flows to meet irrigation and flood-control requirements does not consider the aquatic ecosystem. For instance, several important fish species--including varieties caught by farmers in their paddy fields for their own subsistence--have specific hydrological, ecological, and migratory patterns necessary for maturation and spawning. Waterflow regulation, storage levels, and flood-control measures will prevent the natural restocking of traditional fishing areas. These types of sub-project works tend to alter fish migratory patterns, to eliminate specific nutrients from their diets, and to disturb or destroy spawning habitats.

Because many of the project areas' khals, rivers, and bils support small-scale fishing activities and provide the primary source of protein in local diets, an additional environmental study should be performed to assess the impact of sub-project development on local fisheries.

C. Atmospheric

1. Air Additives: Aerial spraying of pesticides will introduce toxic contaminants into the general site areas; however, appropriate spraying techniques can limit dispersion patterns to agricultural land.

2. Air Pollution: Construction activities will create a slight increase in particulates from fugitive dust, and because those activities will use manual labor-intensive methods rather than motorized equipment, no significant amounts of other pollutants are expected.

3. Noise Pollution: The use of manual labor rather than motorized machinery during construction should preclude noise pollution.

D. Natural Resources

1. Diversion, Storage, or Increased Use of Water: No watercourse diversions or dams are planned for any of the sub-project works. All sub-project schemes will maximize the use of existing water sources (khals, rivers, wells) for irrigation and drainage purposes. The ecological aspects of irrigation and flood-control structures and water storage are addresed in Section 3, Part B-3, of this chapter. The increased use of ground water by deep and shallow tube wells is discussed in Section 3, Part A-3, of this chapter. In general, a slight increase in the use of water from surface sources is expected, but that increase should have no significant impact upon any downstream water users.

2. Irreversible or Inefficient Commitments of Natural Resources: Because no major expansion of natural resource extraction activities is expected, few irreversible or inefficient commitments of natural resources are likely to result from the proposed action.

3. Fisheries: The potential resources for increased fishery production are great, and many opportunities for development exist. Fish, traditionally a very valued item in the Bengali diet, furnishes more than 80 percent of the people's intake of animal protein. At one time, both commercial and for-subsistence fisheries were considered sufficient to furnish the animal protein requirements of the nation. In recent years, however, a combination of factors has changed that projection radically and

now Bangladesh's average per-capita consumption of protein is among the lowest rates of all the countries in the world. These factors include: the rapid population growth; injudicious fishing practices; increased pollution from rural and urban industries; changes in agricultural practices, including increased use of agrochemicals; lack of adequate Government support for fisheries development; and the favoring, without adequate evaluation of relative benefits, of agriculture over fisheries in most resource conflicts.

In spite of the unfavorable development of fisheries in Bangladesh, the potential for substantial gains is excellent. Inland fisheries are considered not to be excelled either in area or potential by any other freshwater fisheries in the world. The main inland fishery resources are: (a) rivers, estuaries; (b) fresh and brackish water impoundments; (c) man-made lakes; (d) tanks and ponds; and (e) paddy fields. The total inland water area covers approximately 4.5 million ha, of which 2.9 million ha is paddy field that is innundated by flood waters four to six months per year. Freshwater impoundments (including khals) and low agricultural lands, that are seasonally or perennially filled from adjacent rivers or by monsoon rains are generally shallow and enriched by fresh supplies of silt brought by annual floods. Juveniles of various species--mainly carp, catfish, and feather-backs--enter with the annual floods and mature in these areas. Fishing in these impoundments provides the primary source of protein for rural farm families.

The beneficial and adverse impacts of future irrigation and flood-control projects on inland fisheries should be assessed, with emphasis on integrating aquaculture programs into irrigation sub-projects where feasible.

E. Cultural

1. Altering or Destroying Important Physical Symbols: The proposed sub-projects will not affect any known existing monuments, mosques, shrines, temples, or historic places.

2. Cultural Dilution: Because the projects are in rural areas and no major foreign technical or manpower requirements are planned, these aspects of the sub-projects should cause no cultural changes; construction activities will be performed by local labor. However, cultural changes will inevitably result from rural development in Bangladesh.

F. Socioeconomic

1. Changes in Patterns of Economic Growth and Employment: No substantial changes in economic or employment patterns are expected to result from the proposed sub-projects. Most sub-projects are of a small scale and, therefore, will not create major employment opportunities for landless laborers.

The inhabitants in the sub-project areas, however, will benefit directly from increased farm incomes and possible small increases in employment opportunities in agriculture, transportation, and marketing.

Additional information concerning the socioeconomic aspects of these projects is found in Chapters V and VI.

2. Movement, Resettlement, or Changes in Population: No changes in present population-density distribution or movement are expected. The proposed sub-projects, in fact, would help to discourage migration into the already overcrowded urban centers. Changes in socioeconomic relationships among the inhabitants of the communities resulting from the proposed actions are not expected to be significant.

3. Cultural Changes Affecting Socioeconomic Patterns: If construction activities are conducted under the Food for Work Program, limited changes in the status of women employed are expected.

G. Health

1. Altering or Destroying a Natural Environment: Increased use of agrochemicals can have undesirable effects upon areas beyond their application. As these compounds enter the food chains and accumulate in plants and fish, ultimately to be consumed by humans or domestic animals, they can cause acute or chronic illnesses. For example, high concentrations of pesticide residues have been found in locally grown food grains being sold for human consumption.

Positive benefits will accrue from the control of water storage levels and the resulting reduced breeding habitats of mosquitoes and snails, which are known hosts for transmitting tropical diseases (such as malaria, schistosomiasis, and filarasis, which are all found in Bangladesh).

2. Eliminating Ecosystem Elements: No ecosystem elements will be eliminated directly by the proposed sub-project works; however, the indiscriminate use of agrochemicals potentially could indirectly eliminate ecosystem elements.

H. General

1. Activities Having International Impact: None of the proposed activities are expected to have any significant adverse international impacts.

2. Controversial Activities: The proposed sub-projects support local and national development goals and will not affect or create controversial matters of an international nature.

3. Larger Program Impacts: The proposed actions are not part of a larger development program.

Section 4: Recommendation for Environmental Action

A. Impact Identification and Evaluation

Areas of adverse environmental impacts resulting from the proposed actions are identified on the Impact Identification and Evaluation Form (See Section 5 of this chapter) and discussed briefly in Section 3 of this chapter. As noted therein, the potential for significant adverse impacts on inland fisheries exists with the operation of some water-control structures and from the increased use of agrochemicals.

B. Environmental Assessment

Because information and knowledge concerning the impacts of existing flood-control and irrigation projects on fisheries and concerning the fisheries and water quality in the sub-project areas are inadequate, the Consultant recommends that an Environmental Assessment be prepared. This information is essential for assessing future sub-projects and for providing necessary criteria for designing sub-project schemes to mitigate any adverse effects upon fisheries that might result from the proposed actions. The Consultant also suggests that the Assessment be prepared for one representative water-control scheme and that this sub-project be monitored during the construction and operation phases. Field information gathered in this manner will serve as a data base, thus enabling engineers and planners to evaluate and incorporate mitigative measures, if required, into the early sub-project planning, evaluation, and design stages. Preliminary investigations indicate that the proposed sub-project at Gomostapur Thana (Sub-project #19) should be considered as a site for the Environmental Assessment.

In addition to the Agency's standard data requirements, the Environmental Assessment should contain inventories of fisheries and their related economic activities, including:

1. Magnitude of the fisheries of each specie in terms of numbers, weights, and value;
2. Origin of the recruitment of fish to the area and route of their migration;
3. Balance between commercial and subsistence fisheries;
4. Type and location of landing facilities;
5. Socioeconomic characteristics of fishermen (number of full-time and part-time fishermen, equipment, income, skill, etc.).

C. Recommendations

The Consultant also recommends development of a monitoring program to identify and observe environmental changes and the further study of the following topics:

1. The potential for, and feasibility of, developing fish tanks in conjunction with the operation of the DTW sub-projects;
2. The effect of the widespread use of DTW on water supplies; and
3. The feasibility of developing and implementing an agricultural extension program to educate farmers in the environmental aspects of agrochemical use.

Section 5: Impact Identification and Evaluation Form

Impact Areas and Sub-Areas	Impact Identification and Evaluation[1]
A. Land Use	
1. Changing the character of the land through:	
a) Increasing the population	L

[1]The following symbols are used:
N - No environmental impact
L - Little environmental impact
M - Moderate environmental impact
H - High environmental impact
U - Unknown environmental impact

Impact Areas and Sub-Areas	Impact Identification and Evaluation
b) Extracting natural resources	U
c) Land clearing	N
d) Changing soil character	M
2. Altering natural defenses	L
3. Foreclosing important uses	N
4. Jeopardizing man or his works	N
5. Terrestrial ecosystems	L
B. Water Quality	
1. Physical state of water	M
2. Chemical and biological states	H
3. Ecological balance	H
C. Atmospheric	
1. Air additives	L
2. Air pollution	N
3. Noise pollution	N
D. Natural Resources	
1. Diversion, altered use of water	M
2. Irreversible, inefficient commitments	N
3. Fisheries	H
E. Cultural	
1. Altering physical symbols	N
2. Dilution of cultural traditions	N
F. Socioeconomic	
1. Changes in economic/employment patterns	L
2. Changes in population	L
3. Changes in cultural patterns	L

Impact Areas and Sub-Areas	Impact Identification and Evaluation
G. Health	
1. Changing a natural environment	M
2. Eliminating an ecosystem element	M
H. General	
1. International impacts	N
2. Controversial impacts	N
3. Larger program impacts	N

TABLE VII-1

SUB-PROJECTS SELECTED FOR ENVIRONMENTAL EXAMINATION

District	Thana	Sub-project Number	Environmental Conditions
Chittagong	Patiya	1	Fisheries, Natural Resources, Public Health, Water Quality, Water Use.
	Hathazari	2	Water Resources.
	Hathazari	4	Natural Resources, Water Use, Land Use, Socio-economics, Water Quality, Construction and Operation, Terrestrial Ecosystems, Fisheries.
Dacca	Savar	6	Water Resources.
Khulna	Kalaroa	10	Water Quality, Water Resources, Land Use, Fisheries, Construction Activities, Socio-economics, Public Health.
	Bagerhat	13	Water Quality, Land Use, Operations, Fisheries, Terrestrial Ecosystems, Socio-economics, Public Health, Air Pollution, Construction Activities, Soil Salinity.
Rajshahi	Gomostapur	19	Fisheries, Socio-economics, Land Use, Water Quality.
Rangpur	Gaibanda	24	Fisheries, Socio-economics, Land Use.

CHAPTER VIII

IMPLEMENTATION PLAN

Section 1: Recommendations

Twenty-three sub-projects are recommended for implementation.

Brick-lined irrigation water distribution channels have been tried on a pilot basis in Bangladesh. Early experiences suggest that the system now be extended country-wide to provide command area development for the more than 50,000 existing LLPs and DTWs.

Implementation of the sub-projects in widely separated areas of the country can serve as prototypes or demonstrations in developing sub-projects in the balance of the country. The following 12 sub-projects involving LLPs and DTWs should be implemented on a demonstration basis:

Sub-Project Number	District	Thana	Sub-Project Name
2	Chittagong	Hathazari	Nabajugh Tebhaga Khamer DTW Pucca Drain.
5	Dacca	Saturia	Pucca Drain for Kawanara Irrigation Project.
6	Dacca	Savar	Rajghat DTW Pucca Drain.
9	Dacca	Palash	High Irrigation Pucca Drain.
11	Khulna	Sadar	Extension of Kismat Pucca Drain to Railway Line.
17	Rajshahi	Bagatipara	Low-Lift Pump Pucca Drain at Salinafar.
20	Rajshahi	Gurudaspur	Nawapara Multipurpose Society DTW Pucca Drain.

Sub-Project Number	District	Thana	Sub-Project Name
21	Rangpur	Jaldhaka	Mouza Gobral DTW Pucca Drain.
22	Rangpur	Kotwali	Uttam Deep Tube-Well Pucca Drain.
23	Rangpur	Ulipur	Hatia Deep Tube-Well Pucca Drain.
27	Tangail	Basail	Construction of Dubail-Basail DTW Drain.
29	Tangail	Nagarpur	Construction of Lowhati North DTW Pucca Drain.

Expansion of the RWP program should emphasize development of distribution systems for existing LLPs and DTWs. They are simply to design and build, and they provide immediate benefits to farmers. The tidal storage and drainage sub-projects are far more complex to design and build. Also, they are generally part of an existing large flood protection scheme or irrigation and drainage scheme already under implementation by BWDB. The following nine sub-projects are included in this category:

Sub-Project Number	District	Thana	Sub-Project Name
1	Chittagong	Patia	Re-excavation of Khan Mohana Khal.
10	Khulna	Kalaroa	Construction of Sluice Gate over Sharaskati Khal.
13	Khulna	Bagerhat	Reconstruction of Fatepur-Baitpur Embankment, Excavation of khal and construction of Two Sluice Gates.
14	Khulna	Fakirhat	Sluice Gate at Parshikhali Khal.
19	Rajshahi	Gomostapur	Sluice Gate at Pabdamari Dama.
24	Rangpur	Gaibanda	Sluice Gate at Malibari U.P.
25	Rangpur	Badarganj	Patilvasar Nala Sluice Gate.

Sub-Project Number	District	Thana	Sub-Project Name
26	Rangpur	Nageswari	Sluice Gate on Berubari Embankment at Nabulardara.
30	Tangail	Pathrail	Construction of Sluice Gate at Deojan Khal.

The following two sub-projects do not involve permanent hydraulic structures or brick-lined canals and may be implemented under the Food-for-Work Program:

Sub-Project Number	District	Thana	Sub-Project Name
15	Khulna	Sarankhola	Re-excavation of Nalburia Dhanasagar Khal.
23	Tangail	Tangail	Re-excavation of Godtala Mir Kumilli Khal.

The following six sub-projects have been reviewed by the MRD Steering Committee, U.S. AID, and the Consultant and are hereby rejected from implementation:

Sub-Project Number	District	Thana	Sub-Project Name
3	Chittagong	Satkania	Re-excavation of Faranga Sublong Khal.
4	Chittagong	Hathazari	Pucca Sluice Gate on Bepula Chara.
7	Dacca	Sreepur	Embankment of Saldah River.
8	Dacca	Shivalaya	Aricha-Ichamati Irrigation Project. Parts I, II, III and IV.
12	Khulna	Mollahat	Re-excavation of Chawdhury's Canal from Basuri to Nalua River.
18	Rajshahi	Nawabganj	Pucca Canal and Spans Aqueduct in Milky Bidirpur.

The following sub-project has been included at the special request of the MRD Steering Committee (the Consultant has no recommendation with regard to its implementation):

Sub-Project Number	District	Thana	Sub-Project Name
16	Rajshahi	Atrai	Re-excavation of Canal from Beel Katchua to Beel Pankha under Hatkalupara U.P.

When properly implemented and operated, the twelve LLP and DTW sub-projects can demonstrate, in one tract tilled by farmers under actual farm conditions, the increased production of agricultural and livestock products and other benefits. The implementation effort will provide more accurate information with regard to: (1) the rate at which new command areas may be completed; (2) the length of time required to raise average yields of principal farm crops to specified levels; and (3) the organizational build-up required to implement a future program on a nationwide basis.

More important, however, is the acceptance of, and commitment to, command area development by GOB, not only during the implementation phase but also in the period following implementation. Foreign financial assistance and the services of a future consultant play a very minor role -- that of a catalyst -- in assuring that sub-projects are built in accordance with plans and specifications and in developing the composite of programs and actions for bringing the sub-projects up to optimum agricultural production.

Implementation, therefore, is a joint effort in which the government, farmers, donor, and the Consultant closely collaborate. The Government provides leadership in setting goals, in making policy decisions, and in giving vital in-country support, primarily manpower and budget. The farmers provide the land for the brick-lined channel and numerous forms of cooperation and support. The donor and the

Consultant assist the government and the farmers in achieving the objective of increasing agricultural production.

Section 2: Background

Fundamental to the planning of the Rural Irrigation Works Study sub-projects is making greater use of available irrigation water by creating the largest possible command areas. A two-cusec flow, such as from an LLP or DTW, should readily serve 100 acres or more; in actual practice, it seldom serves over half this area, mainly because the distribution watercourses do not reach all parts of the potentially commandable area. For this and other reasons, most LLPs and DTWs throughout the country do not have maximum use.

Chapter VII of the Manual on Thana Irrigation Program (TIP) states that "One cusec should normally, except in sandy soils, be able to irrigate 50 acres in case of winter crops ... and 100 acres in karif crops ... BADC should design a suitable field channel distribution system ..." for each pump and tube-well. The Manual further states that the distribution system should be planned for "transmitting irrigation water with minimum length of field channel and minimum seepage loss with maximum command area ..." These statements make clear that "pucca" distribution systems serving a command area of 100 acres or more are in order.

Despite this seemingly clear assignment of responsibilities by the TIP Manual, in practice no technical assistance is given by BADC or any other agency to farmers either in the engineering planning and design of the water distribution systems, in the layout and construction supervision, or in water management. As a consequence, farmers in the command area are left to their own resources. This results in poorly built distribution systems with high seepage losses, small command areas serving users mainly in the vicinity of the pump, and poor water management practices. LLPs and DTWs commonly achieve only about 35 percent of their potential capacity, which reflects a significant waste of resources. Largely with the view of correcting this

deficiency, the Rural Irrigation Works Study was undertaken. The technology for on-farm command area development has long been available, but in Bangladesh there is no curriculum for supporting the multidisciplinary approach that is needed for command area development. The problem is further complicated because the numerous technical services to farmers are divided among several agencies and ministries; thus, no single agency or ministry has the authority to simultaneously focus all the necessary technical services on the problem so as to achieve significant increases in agricultural production.

Discussions at BADC revealed that they are not now staffed or equipped to undertake the work of designing on-farm water distribution systems. They are concerned primarily with the mechanical end of siting pumps, sinking wells, repairing and maintaining equipment, and distributing material inputs (except pesticides, which are distributed by DEM).

More recently it was learned that the Government is considering transferring part of BWDB's engineering staff to BADC to give BADC the technical capability to develop suitably designed distribution systems with maximum command areas for LLP and DTW user groups. This appears to be the most logical method of providing these services; because BADC is siting the pumps, BADC should also provide the engineering design of the water distribution system (as stated in the TIP Manual). Should the Government decide to enact this proposed plan, the Consultant strongly recommends that the Implementation Plan described in this Study be reviewed to determine if two Governmental agencies are needed to provide nearly identical services in planning, designing, and supervising construction of command areas for LLPs and DTWs.

Section 3: Objective

The objective of the Rural Irrigation Works Study, as stated in the contract, is two-fold: (1) to prepare plans for a number of small-scale irrigation sub-projects for implementation through the Rural Works Program (RWP), to serve as models or prototypes; and (2)

to develop the Government of Bangladesh's in-house capabilities for the design and construction of similar sub-projects in the future.

Although not stated in the contract, the implied, ultimate objective is not sub-project construction itself rather, through such construction, but bringing the sub-project areas to optimum agricultural production, thereby significantly contributing to the food needs of the people and the nation.

Section 4: Means of Implementation

The RWP of MRD will implement the proposed sub-projects assisted by an expatriate consulting company to assure the competence of final design, construction supervision, and essential training programs. Field construction will be performed by local domestic contractors.

The sub-project works contemplated stress the intensive use of labor, both skilled and unskilled, high quality workmanship, and simple construction works that use, almost exclusively, local materials. Simple hand tools and mechanical equipment will be used to the degree necessary to ensure compliance with specifications, designs, and schedules. Earthwork and its compaction will be done manually.

Simplified designs have been adopted for the command areas. The initial 23 sub-projects will initially serve as demonstrations for promoting command area development in the six districts and ultimately throughout the country. Water distribution channels are standardized to have two-cusec flows, to be lined with locally made bricks, and to have a masonry turnout for each three-to-five acre block of farm land, thereby enabling water delivery to each farm plot. Scheduling water to each block will be done by roster, will be published and updated from time to time, and will be posted at the pumphouse or another convenient location. Distribution of the water to each plot within each block will be cooperatively arranged and planned by the farmers.

One of the implementation plan's important features is its provision of an excellent training ground for a variety of "hands-on" training exercises under competent supervision for the younger, less-experienced professionals who later will be employed in the progressive development of LLP and DTW command areas in their District. This is especially important for MRD because it presently has no engineering staff that is adequately trained and experienced in irrigation project planning, design, and construction (although six engineers were associated with the Consultant during part of the Rural Irrigation Works Study). Furthermore, during the design and construction stages of the 23 sub-projects, representatives of BADC, DEM, and IRDP --specifically, professionals who will be involved in future command area development--will receive important training (See Institutional Requirements).

Full development of a command area--including design, layout, construction, O & M, extension, and other such components--to achieve optimum production, is not simple, easy, or quickly achieved. Because the number of LLPs and DTWs already installed and in use in Bangladesh is so large, such development is a monumental task. It will require extensive cooperation between government agencies, at the farm level, in a manner that is not often found. It will also take time--at least one decade, maybe two.

Making irrigation water available to farmers assures a crop. But unless the required seeds, fertilizers, pesticides, and other equipment and supplies are conveniently accessible at the proper times, very little increased agricultural production will be achieved. The farmers' demands for inputs must not be answered by telling them to be resourceful. The lack of just one of the essential inputs can cause a failure of the farmers' entire effort, regardless of how perfectly everything else is done. The government must review its policies, strengthen its system for supplying material inputs, and base its planning on the farmers' needs.

Experience in many places has demonstrated that, given reasonable incentives, a farmer will accept and use new and proven inputs, when:

1. The inputs meet a need that the farmer himself recognizes;
2. The recommended inputs work and prove to be practical and profitable under the farmer's own conditions;
3. The farmer is given the knowledge and training required to successfully use the inputs;
4. The farmer has convenient access to the materials and supplies; and
5. The farmer has confidence in the source promoting their use.

Section 5: Manpower

A. General

Drawings for each sub-project and general specifications have been prepared to accommodate labor-intensive construction or, if preferred by the contractor to permit the use of mechanical equipment.

B. Consultant Services

To assist the GOB with design, construction supervision, training, and other essential services in support of the implementation of 23 sub-projects selected by this study, the services of an expatriate consulting company are recommended.

1. Consultant Qualifications: Because the future consultant's collaboration with farmers is crucial, the total consulting services must emphasize agricultural development. Experiences in pilot projects in Bangladesh suggest that any consultant will face certain consistent problems: Coordinating the layout plan of the distribution system with the farmers in the command area and getting agreement on the canal right-of-way (for which the topography generally does not allow much flexibility) only two of the many problems for which solutions must be worked out between the water-users, the GOB, and the future consultant. Solutions require an understanding of farmers' psychology and the utmost

patience and diplomacy. Farmers are not likely to be impressed by the soundness of a design or the promise of new high yields. They will take their own time in coming to a decision; meanwhile, construction cannot begin until the new distribution system is thoroughly understood and voluntarily accepted by the farmers.

The criteria by which a consultant must be judged, are his abilities to earn farmer acceptance, concurrance, and cooperation--without coercion, not his abilities to meet the rigid dates of an implementation schedule that, at least from the farmers' viewpoint, has been rather arbitrarily prepared.

Thus, the consulting company should have experience in developing countries and capabilities in the development of irrigated agriculture projects, preferably in the rice-growing areas of Asia. Specifically, these qualifications should include the experience and capability (1) to design and construct on-farm irrigation water distribution systems and related structures, (2) to cope with the sociological and environmental aspects of on-farm development, (3) to motivate farmers to assume degrees of responsibility for construction, operation, and maintenance, (4) to plan and implement follow-up agricultural production, and (5) to co .t concentrated training of local staff (see "Suggested Training Subjects and Exercises", Section 6 of this chapter).

2. Qualifications of Team Members: Table VIII-I contains a list of the needed short-term and long-term project team members and specifies the number of manmonths each will be required. Members of the consulting teams should possess the experience and capabilities specified below.

a) The Project Manager should have experience as an agricultural extension director or agricultural experiment station director, or equivalent experience; experience in the preparation and supervision of training programs for local nationals; and experience working in developing nations. He should also be knowledgeable in rice and cereal crop production.

b) The Location and Design Engineer should be an agricultural (or civil) engineer with experience in the planning, design, and field layout of small on-farm irrigation distribution channels and related structures (such as SCS work); and, preferably, he should have experience working in developing nations. He must be compatible with farmers and rural people.

c) The Construction Engineer should have experience in construction engineering, contract administration, scheduling, monitoring, inspection of local materials, and assurance of work's compliance with plans and specifications. Preferably, he should have experience on labor-intensive projects in developing nations.

d) The Cooperative Specialist should have experience in the organization and operation of farmer cooperatives and, preferably, experience in developing nations. He should also be familiar with irrigation distribution systems.

e) The Agriculturalist should be an agronomist or general agriculturalist experienced in planning field crop production and cropping patterns, in the use of modern inputs, in working closely with farmers, and in motivating and training farmers through demonstrations and harvest days. Extensive experience in the agriculture of developing nations is essential.

f) The Operations and Maintenance Specialist should be experienced in the operation and maintenance of irrigation project works; in the scheduling of water; in the motivation of farmers to assume degrees of responsibility for the maintenance of distribution systems and for the operation and repair of pumps; and, preferably, he should have experience working in developing nations.

g) The Consulting Specialist should be a mature person with extensive on-farm irrigation development experience in developing nations. The duty of this specialist, in collaboration with farmers and farmer groups, is to establish an early pattern of development to ensure that construction of the command areas commences correctly and progresses at a satisfactory pace. To accomplish these ends, the Consulting Specialist must exercise diplomacy, patience, and flexibility in his dealings with the farmers so that he can learn their interests, problems, and constraints; can establish a rapport with them, can gain their confidence; can gain their cooperation in the determination of their responsibilities and contributions; and can convincingly assure them of the Government's commitment to provide a reliable supply of material inputs and other assistance needed to achieve optimum agricultural production.

The schedule of Consultant Services is presented in Figure VIII-2.

3. The Consultant's Scope of Work for the first 23 sub-projects in six districts (See Implementation Schedule, Figure VIII-1) will include the following activities:

a) Establish rapport with officials, water users' groups, and farmers.

b) Obtain agreement with water users concerning location of watercourses, irrigation block arrangement of three-to-five acres with turnout locations, cropping patterns, and the use of land for the distribution system.

c) Modify existing designs of the water distribution system's layout and specifications to conform to local requirements.

d) Supervise location surveys and prepare construction drawings, manpower requirements, and construction schedules.

e) Prepare tender documents and assist the GOB with the construction and award of contracts.

f) Perform the services of the "Engineer" for all work performed under contract, including: (1) testing and inspecting materials to be used or workmanship to be employed in fulfillment of the contract; and (2) supervising the contractor to ensure compliance with plans and specifications.

g) Assist with after-construction start-up operations of sub-projects; operations will include, but not be limited to,

- g-1) scheduling the delivery of water to each block,
- g-2) having all farmers in each block ready to receive water,
- g-3) managing water within each block,
- g-4) settling disputes,
- g-5) keeping records,
- g-6) repairing distribution systems, and
- g-7) assessing and collecting water charges.

h) Work with BADC and other GOB agencies in improving the logistics of providing, in a timely manner and as required, crucial inputs: production credit, fertilizer and other material inputs, fuel, lubricants, and spare parts.

i) Procure required vehicles, equipment, materials, office space, and housing.

j) Update existing manuals on sub-project design and operations and maintenance.

k) Assist in and provide support for organizing and conducting farmer motivational visits (at completed sub-projects) and farmer field days (at harvest time), including preparation and reproduction of extension literature.

l) Organize and conduct training for CAD Teams regarding preparation procedures for future sub-projects, using scaled maps and topographic data to establish command areas and watercourse layouts and to calculate costs of construction; and using soils analysis and agricultural production data to establish new cropping patterns and to estimate future agricultural benefits. (See "Suggested CAD Team Training Subjects and Exercises").

C. Government Responsibilities

The Government of Bangladesh will furnish and supply:

1. Full-time MRD Staff for training and support during construction;

2. Full-time CAD Teams for training and field work;

3. Taka revolving fund.

D. Food For Work Program

The U.S. PL 480 Title II Food for Work Program has been used in Bangladesh as a basis for payments to laborers in lieu of wages since 1975. It has provided direct relief and employment for the unemployed and landless laborers and, at the same time has provided a means of accomplishing many types of locally-initiated schemes. Achievements of the program have been evaluated at various times to improve the quality of sub-project selection and construction, to maximize secondary benefits, and to improve overall management. The program's overall objectives are consistent with the goals of U.S. AID in constructing and operating effective small-scale irrigation systems; however, the constraints of the Food for Work Program with respect to the 23 sub-projects recommended for construction of this study are as

follows:

1. The Food for Work Program is generally appropriate for projects that involve only earthwork construction.

2. It is not practical either to award a construction contract in conjunction with the Food for Work Program or to divide a sub-project so that earthwork is accomplished under the Food for Work Program and the remainder of the work is accomplished by contract.

3. Project acceptance procedures extend over one calendar year, and, if accepted, the project will be executed the following year. New construction projects are initially assigned to a low-priority category.

4. Implementation responsibilities for the Food for Work Program lie entirely in the hands of GOB officials of the central, district, sub-division, and thana levels. If the sub-projects are approved by the Ministry of Relief and Rehabilitation and accepted by CARE, the Project Implementation Committee becomes responsible for the recruitment of labor, supervision of earthwork construction, maintenance of project records, and distribution of wheat.

5. Supervision of construction is not always sufficient to ensure conformity with the plans and specifications.

6. The labor force on Food for Work Program projects rarely achieves the efficiency and production of labor employed by contractors.

7. Construction under a Food for Work Program is not conducive to either a timely or guaranteed date of completion.

8. The amount of wheat needed to accomplish the work set forth in the sub-project proposals received by CARE is several times greater than the wheat available for such projects; therefore, the probability of a sub-project being accepted, particularly within the first year, is low.

Of the 23 sub-projects recommended for construction in this study, two are limited to earthwork construction, and 21 involve both excavation and other work, such as constructing brick masonry and channel lining, compacting embankment, and constructing reinforced concrete. Furthermore, certain sub-projects will require concrete pipe, steel reinforcement bars, vertical lift gates, flap gates, and wooden stoplogs. It is not practical to divide a sub-project into earthwork construction and other construction work, unless all work can be completed by a pre-established date. To ensure the sub-projects' construction to required standards, constant supervision of construction will be required. Compaction of embankments must be carefully monitored during construction because any defects will not become evident until later when the irrigation channel is in service. The unskilled labor cost of the twelve LLP and DTW sub-projects to be implemented probably constitutes 15 percent or less of the total cost.

Because of the many disadvantages of the Food for Work Program--the restrictions on Program qualifications, the work involved in constructing the sub-projects, the materials to be furnished, the supervision necessary to ensure the work's construction in accordance with the plans and specifications, and the need for extensive training of MRD personnel in construction supervision, contract administration, and operation and maintenance--the Consultant cannot recommend the Food for Work Program as a practicable alternative to constructing the sub-projects (except for two) by awarding contracts to experienced contractors on the basis of the lowest responsible tenderer.

E. Manpower Requirements

Manpower requirements are based on labor-intensive construction methods and on the use of local personnel for engineering expertise during construction, for construction supervision, and for construction administration.

The labor requirements per unit of work that were used to determine the skilled and unskilled labor requirements for the various quantities of work are contained in Table VIII-2. Manpower requirements for the contractor's office staff and the MRD staff for engineering and construction supervision are given in the manpower plan for each district.

F. First Year Construction

Tables VIII-3, VIII-6, VIII-9, VIII-12, VIII-15, and VIII-18 present the manpower plans for the first year of construction in each of the six districts; each table covers the work to be accomplished under one contract. These tables present the estimated average quantities of work for each sub-project, the total quantity of work to be completed under the contract, the skilled and unskilled labor requirements, and the contractor's staff and the MRD staff requirements for engineering and construction supervision. The actual manpower requirements will gradually increase to a peak somewhat greater than the average, will maintain a level near the peak demand for approximately one-half the contract period, and then will gradually decrease during the latter part of the contract period.

G. Second and Third Year Construction

Tables VIII-4, VIII-7, VIII-10, VIII-13, VIII-16, and VIII-19 present the manpower plans for the second and third years of construction in each of the six districts; each table covers the work to be accomplished under one contract. Unless otherwise noted, these tables are on the same basis as the manpower plans for the first year of construction.

H. Availability of Manpower

The availability of local manpower by districts is presented by Tables VIII-5, VIII-6, VIII-11, VIII-14, VIII-17, VIII-20. The data are based on information from knowledgable sources within each district, on the experience of local contractors, on applicable records

and information of the Government, and on the advice of local consultants.

The majority of the local contractors are sufficiently experienced to adequately supervise and instruct all local manpower and, using local manpower, to construct the work in accordance with the drawings and specifications.

Probably more critical will be the availability of MRD staff required for training and supervising construction. The MRD staff now in the districts is limited in number and is fully engaged with the construction of roads, bridges, and buildings. New MRD staff should be hired and posted to sub-project construction for on-the-job training under the future consulting firm's supervision. This is an excellent opportunity to give newly hired young engineers (BSCE or equivalent) the desing and construction supervision experience they will need for future MRD expansion needs.

I. Institutional Requirements

Described below are the institutional requirements and arrangements, including organization and management, at all levels of government, that will be required by a future program for planning and expanding the command areas of LLP's and DTW's and for supervising construction.

1. Staff Experience: By tradition, the RWP has no experience in the engineering of irrigation projects, in water management, or in raising the productivity of irrigated agriculture--all disciplines essential to implementation of the 23 sub-projects selected by this study and to implementation of future sub-projects. Virtually all projects now being executed under RWP consist of roads, bridges, and buildings and their repair and maintenance. To require these professionals to suddenly assume the responsibility of irrigation project works is not realistic.

This lack of an experienced staff on which to build institutional competence in planning, designing, and constructing irrigation water distribution systems appears to be the foremost institutional constraint. To overcome this constraint, the essential technical staff first must be authorized and posted at various levels. Then it must be trained and educated in the several aspects of command area development: specifically, these aspects include sub-project proposal preparation, evaluation, and selection (approval); construction in accordance with plans and specifications; and utilization of the lands. Certainly, if financing is to be solicited either from international financing agencies or from bilateral sources, the institutional staff must be able to prepare project proposals to acceptable standards.

2. Staff Responsibilities During Project Development Process: Between the original sub-project concept and the final sub-project construction and implementation, there are a number of steps:

Step 1. The proposal is a small-scale feasibility study. It screens out undesirable sub-projects and concentrates planning efforts on one or a few of the best sub-projects. Generally, engineers and agriculturalists work together as a team to identify the sub-project area, to plan its features, and to estimate its costs and benefits. The purpose of this exercise, even for a 100-acre area served by a LLP or DTW, is to show to higher authorities in the Government and in financing agencies that the sub-project is sound and practicable and that its benefits are expected to exceed its costs. In other words, the proposal attempts to prove that the sub-project should be constructed. A team effort is required for preparing proposals and is described in more detail in "Command Area Development Concepts", Part I-3 of this section.

Step 2. The evaluation of the technical aspects of the proposal (small-scale feasibility study) verifies the proposal's accuracy and the sub-project's selection as the best choice of the available alternatives. In the evaluation process, the higher authority (in this case, the District Approving Authority) might return the proposal for more details or might approve it and forward it to MRD for review. Engineering at MRD's District level--at least in irrigation--is weak. This should be strengthened by assigning a full-time engineer exclusively to assist XEN in handling irrigation projects. The District Approving Authority should be reinforced by removing the Assistant Director for Rural Development, and the XEN should be vested with the responsibility of the implementation of irrigation projects.

Step 3. The review of sub-project proposals that have been evaluated and approved at the District level would be conducted by MRD, who would then prepare the Project Proforma (PP) for submission to the Planning Commission.

Step 4. Construction includes finalizing the proposed designs, preparing construction drawings (as needed) and bills of materials, tendering and awarding contracts, and inspecting and supervising construction to ensure that physical features are built in accordance with plans and specifications and that all the various facilities operate as planned. Construction is a complex step and requires thorough follow-up.

Step 5. Increasing Agricultural Production consists of promoting and bringing into practice new concepts of production on farmers' lands. Such practices include the HYV rice-fertilizer concept, introduction of improved wheat into the cropping patterns, and the introduction of material inputs. Not the least of the inputs is a dependable source

of water, scheduled and managed to meet crop needs. An essential part of this is a Government commitment to improve input supplies. Assistance from DEM will be necessary to ensure the effective execution of programs at the farm level.

3. The Training and Visit (T&V) System of agricultural extension has been introduced in the NW Region, including Rajshahi and Rangpur Districts. After review and evaluation, the system is expected to be extended to all districts. The T & V system includes a Training Unit with Crop Production Specialists at the Sub-Divisional level and an increase in the number of village extension agents.

4. The Command Area Development Concept: During the Rural Works Irrigation Study, six RWP Sub-Divisional Engineers (one from each of the six districts where the 23 sub-projects are located) were assigned to the Consultant for on-the-job training. These engineers should be made available for additional full-time training during the design and construction phase. This training will be valuable for supervising future sub-projects through completion. But it is expecting too much to ask that the six SDE's from RWP, on their own, will be able to prepare proposals and carry out future programs for their six districts. Additional staff will be required.

Because of the multidisciplinary nature of CAD future programs should be carried out largely through teams--initially one team in each district, made up of the SDE from RWPP: a cooperatives specialist from IRDP, an agriculturalist from DEM, and a pump specialist from BADC.

One CAD Team would be formed in each of six districts, would be headed by one of the SDE's presently undergoing training, and would be composed of competent experienced professionals (degree holders) from IRDP, BADC and DEM. The teams should be appointed in a formal government directive, possibly from MRD with the concurrence of other agencies, that would establish the teams, provide a clear assignment of responsibilities, and assure essential support facilities, equipment, and budget to carry out assignments. The first six CAD Teams would be formed during the final design and construction stages (See Figure VIII-1).

The functions of individual CAD Team members during the five-stage development process are summarized in Table VIII-21.

The main function of the CAD Team is to prepare irrigation sub-project proposals that will justify sub-project approval and construction; to ensure that sound construction practices are followed; to ensure that operation commences as planned; and to ensure that the needed agricultural inputs are provided in a timely manner. Team training during the design and construction phases of the 23 sub-projects will stress the above-mentioned subjects. As construction progresses, the team will be available to undertake preparation of new sub-projects, thus developing additional and improved competence. At the end of three years, six CAD Teams will have completed a twelve-month training program.

After the training period, each CAD Team will revert to its own district. In the RWP, the team will be assigned at the Sub-Division level. From this level the team can focus its technical expertise on the water-user groups to assist in solving their problems and to involve the Thana and Union officials in implementation of activities. The Circle Officer (Dev.), SAE, and Thana Irrigation Overseer will remain key officials in the project proposal process, but the CAD Team, having superior training and practical experience, will be able to properly direct and supervise officials in preparing the sub-project

proposal to meet required standards. The CAD Team will also have an important role during construction and the follow-up agricultural program.

Initially, only one CAD Team per district will be formed, trained, and equipped. The XEN will provide logistical and technical support to the team in topographic mapping, drafting, and clerical work and in the evaluation and technical approval of the sub-projects for construction. Funds for construction will be vested with the XEN and construction will be performed in the normal manner of the RWP. Local-initiative sub-projects will be stressed. The size of the command area should not exceed 120 acres and the source of water should primarily be LLP's and DTW's. Technical assistance planning will stress brick-lined (pucca) structures with scheduled water delivery to every farm by roster. The proper location of pumps will be coordinated within the CAD Team by its BADC member. The cost of physical features will be carefully calculated and benefits evaluated; however, a favorable benefit-cost ratio should not be the sole factor in the selection of sub-projects for implementation. Other important considerations include local cultivator participation and cooperation in project costs, construction labor, cropping management, repair and maintenance, and use of inputs. Farmers within the command area should receive preferrence in the engagement of laborers. Linking the use of local manpower to implementation should be an important feature of these sub-projects.

5. Equipment and Logistic Support: Each CAD Team will require the following equipment and logistic support to perform the services for which it was created:

a) one 4-wheel drive vehicle, preferably diesel powered;

b) one builder's level, with rod and accessories;

c) one drafting table and related equipment;

d) one calculator, Hewlett-Packard 97 or its equivalent;

e) one set of reference manuals;

f) one plane table, stadia rods and alidade;

g) one transit and its accessories;

h) two steel tapes, 100-ft. reel, with pins;

i) office space, a minimum of 400 square feet; and

j) an operating budget for fuel, oil, repairs, office supplies, etc.

6. Administrative Matters: Whatever plan is adopted, two institutional policies need early attention:

a) Administrative procedures must be made more efficient from having to spend so much time performing menial tasks.

b) The personnel management policy must be improved to encourage experienced professionals to remain in the service for which they are trained; to accomplish this, attractive lifetime career opportunities must be offered. An old axiom is worth repeating here: Most workers will produce better if they are allowed enough compensation so as to lead rational lives.

Section 6: Suggested Training Subjects and Exercises

Initially, CAD Teams (RWP) who are working through Thana and Union officials will be trained. The same CAD Teams, supported by XEN, can then train farmers. Initially, at least, CAD Teams should have one year of training. After the first year of field experience, the team should train one additional CAD Team, and so on. In this way, one CAD Team should be able to expand into about 16 teams in six years, enough to handle about 100 sub-project proposals per year.

The Consultant will prepare a detailed training program, showing dates, times, types of training (classroom, field exercise, etc.), instructors' names, and expected attendees. The Consultant will also provide general supervision for training programs. The following list includes the suggested training subjects:

1. Format of proposals--a small-scale feasibility study, by several disciplines.

2. Use of mouza maps.

3. Preparation of base maps--based on mouza maps, updated with new physical features such as bunds, buildings, roads, and ditches.

4. Derivation of field plot élevations and additions to maps (Plate table method).

5. Preparation of project proposals for LLP and DTW command areas, with attention to:

   a) Selection of channel section and slope for brick-lined channels;
   b) Irrigation blocks & turnouts;
   c) Locating channels on the map and in the field;
   d) Bills of materials;
   e) Costs of construction;
   f) Alterations to designs (as required);
   g) Channel profiles;
   h) Plans and specifications;
   i) Agricultural input requirements; and
   j) Agricultural benefits.

6. Presentation of project proposals to higher authority for authorization of construction.

7. Construction, specifically:

   a) Surveys;
   b) Earthwork & compaction;
   c) Linings;
   d) Plans and specifications; and
   e) Inspection.

8. Start-up of pumps and checking out operation of distribution system.

9. Farmers' psychology.

10. Importance of discussions with farmers.

11. Taking time to ensure farmers' understanding (without use of coercion or compulsion).

12. Dealing with obstinate farmers.

13. Getting farmers to agree to the location of channel right of way, the source embankment, and the inputs expected from them.

14. Scheduling construction.

15. Expanding and strengthening, or establishing, new water users' associations.

16. Production credit.

17. Need for new cropping patterns and the means of organizing and demonstrating patterns to farmers.

18. Block organization--cooperation on crop selection, planting dates, and water management.

19. Making full use of available water.

20. Establishing input usage--seeds, fertilizer, etc.; supply of new inputs.

21. Commitments of government agencies to the supply of inputs.

22. Repairs and maintenance--pumps and channels.

23. Scheduling irrigation water to blocks, by roster.

24. Updating water schedules.

25. Financing development costs, including assessment and collection of water charges.

TABLE VIII-1

CONSULTING TEAM COMPOSITION

Team Members	Man-Months
Long Term	
Project Manager	45
Location and Design Engineer	24
Construction Engineer	20
Short Term	
Cooperatives Specialist	9
Agriculturalist	12
Operations and Maintenance Specialist	12
Consulting Specialist	3
Total	125

TABLE VIII-2

MANPOWER REQUIREMENTS

Item of Work	Units	Man-Days Per Unit of Work	
		Skilled	Unskilled
Excavating for canals and structures, including transporting up to 100 ft., and care and handling of water.	100 cu. ft.	0	1.0
Compacting Embankments	100 cu. ft.	0	1.0
Brick Masonry	100 cu. ft.	2.5	7.0
Brick Lining	100 sq. ft.	2.0	3.0
Plastering Brick Work	100 sq. ft.	1.0	3.00
Concrete	100 cu. ft.	2.5	6.0
Laying Concrete Pipe	lin. ft.	0.5	4.0
Stop-check	each	0.5	0
Flap Gate	each	0	0
Slide Gate and Hoist	each	0	0
Stop Logs	set	0.5	0

TABLE VIII-3

MANPOWER PLAN FOR FIRST YEAR OF CONSTRUCTION: CHITTAGONG DISTRICT

Item	Unit	Estimated Quantity			Man-Days	
		#1	#2	Total	Skilled	Unskilled
Excavation	% cu. ft.	3,390	953	4,343	0	4,343
Embankment	% cu. ft.	200	659	859	0	859
Brick Masonry	% cu. ft.	140	250	390	975	2,730
Brick Lining	% cu. ft.	23	426	449	898	1,347
Plastering Brick Work	% cu. ft.	26	25	51	51	153
Concrete Class A	% cu. ft.	14	2	16	40	96
Concrete Class B	% cu. ft.	34	14	48	120	288
Concrete Class C	% cu. ft.	0	1	1	3	6
Concrete Pipe	Lin. ft.	0	60	60	30	240
Stop-check	each	0	42	42	21	0
Flap Gate	each	2		2	0	0
Stop Logs	sq. ft.	210	0	210	105	0
Total Manpower Requirement					2,243	10,062

Construction Period: October 1981 through April 1982; 7 months; 140 possible working days; 80 scheduled working days.

Contractor's Staff:

Home Office	(2 per sub-project)	4
Field Office	(10 per sub-project)	20
Skilled Labor	(2243/80)	28
Unskilled Labor	(10,062/80)	126

(Continued)

TABLE VIII-3
(Continued)

MRD Staff:		
Project Engineers	(1 BSCE for each sub-project)	2
Office Technicians	(2 for each sub-project)	4
Field Superintendent	(1 BSCE for each sub-project)	2
Deputy Field Superintendent	(1 for each sub-project)	2
Survey Crew	(one 3-man crew for each sub-project)	6
Support Staff	(4 for each sub-project)	8
Total		202

TABLE VIII-4

MANPOWER PLAN FOR SECOND AND THIRD
YEARS OF CONSTRUCTION: CHITTAGONG DISTRICT

Item	Unit	Estimated Quantity	Man-Days	
			Skilled	Unskilled
No sub-projects are scheduled for construction in second and third years.				
Contractor's Staff:				
Home Office		(2 per sub-project)		0
Field Office		(10 per sub-project)		0
Skilled Labor				0
Unskilled Labor				0
MRD Staff:				
Project Engineers		(1 BSCE per sub-project)		0
Office Technicians		(2 per sub-project)		0
Field Superintendent		(1 BSCE per sub-project)		0
Deputy Field Superintendent		(1 per sub-project)		0
Survey Crew		(one 3-man crew per sub-project)		0
Support Staff		(4 per sub-project)		0
Total				0

TABLE VIII-5

AVAILABILITY OF LOCAL MANPOWER: CHITTAGONG DISTRICT

Category of Manpower	Primary Source		Secondary Source	
	Location	Availability	Location	Availability
Labor:				
Skilled	Chittagong	Good	Noakhali	Good
Unskilled	Chittagong	Good	Noakhali	Good
Ordinary	Chittagong	Good	Noakhali	Good
Bricklayers:				
Head Mason	Chittagong	Good	Noakhali	Fair
Mason	Chittagong	Good	Noakhali	Good
Ordinary Mason	Chittagong	Good	Noakhali	Good
Concrete Workmen:				
Head Mason	Chittagong	Good	Noakhail	Fair
Mason	Chittagong	Good	Noakhali	Good
Labor	Chittagong	Good	Noakhali	Good
Carpenters:				
Head Carpenter	Chittagong	Good	Dacca	Good
Carpenter	Chittagong	Good	Dacca	Good
Pipe Layers	Chittagong	Good	Dacca	Good

TABLE VIII-6

MANPOWER PLAN FOR FIRST YEAR OF CONSTRUCTION: DACCA DISTRICT

Labor Requirements

Item	Unit	Estimated Quantity #9	Man Days Skilled	Man Days Unskilled
Excavation	% cu.ft.	1,140	0	1,140
Embankment	% cu.ft.	776	0	776
Brick Masonry	% cu.ft.	317	790	2,220
Brick Lining	% sq.ft.	500	1,000	1,500
Plastering Brick Work	% sq.ft.	26	26	78
Concrete Class A	% cu.ft.	1	3	78
Concrete Class B	% cu.ft.	14	35	6
Concrete Class C	% cu.ft.	1	3	84
Concrete Pipe	Lin.ft.	24	12	6
Stop-check	each	38	19	0
Total Manpower Requirements			1,888	5,906

Construction Period: October 1981 through April 1982; 7 months; 140 possible working days; 80 scheduled working days.

Contractor's Staff:		
Home Office	(2 per sub-project)	2
Field Office	(10 per sub-project)	10
Skilled Labor	(1,888/80)	
Unskilled Labor	(5,906/80)	
MRD Staff:		
Project Engineers	(1 BSCE per sub-project)	1
Office Technicians	(2 per sub-project)	2
Field Superintendent	(1 BSCE per sub-project)	1
Deputy Field Superintendent	(1 per sub-project)	1
Survey Crew	(one 3-man crew per sub-project)	3
Support Staff	(4 per sub-project)	4
Total		122

TABLE VIII-7

MANPOWER PLAN FOR SECOND AND THIRD
YEARS OF CONSTRUCTION: DACCA DISTRICT

Labor Requirements

Item	Unit	Estimated Quantity			Man-Days	
		#5	#6	Total	Skilled	Unskilled
Excavation	% cu.ft.	1,214	752	1,916	0	1,916
Embankment	% cu.ft.	851	532	1,383	0	1,383
Brick Masonry	% cu.ft.	330	207	537	1,343	3,759
Brick Lining	% sq.ft.	550	339	889	1,778	2,667
Plastering Brick Work	% sq.ft.	25	22	47	47	71
Concrete Class A	% cu.ft.	2	3	5	13	30
Concrete Class B	% cu.ft.	14	12	26	65	156
Concrete Class C	% cu.ft.	1	0	1	3	6
Concrete Pipe	% cu.ft.	24	0	24	12	91
Stop-check	each	38	37	75	38	0
Total Manpower Requirements					3,299	10,084

Construction Period: October 1981 through April 1982; 7 months; 140 possible working days; 80 scheduled working days.

Contractor's Staff:		
Home Office	(2 per sub-project)	4
Field Office	(10 per sub-project)	20
Skilled Labor	(3,299/80)	41
Unskilled Labor	(10,084/80)	126
MRD Staff:		
Project Engineers	(1 BSCE per sub-project)	2
Office Technicians	(2 per sub-project)	4
Field Superintendent	(1 BSCE per sub-project)	2
Deputy Field Superintendent	(1 per sub-project)	2
Survey Crew	(one 3-man crew per sub-project)	6
Support Staff	(4 per sub-project)	8
Total		215

TABLE VIII-8

AVAILABILITY OF LOCAL MANPOWER: DACCA DISTRICT

Category of Manpower	Primary Source		Secondary Source	
	Location	Availability	Location	Availability
Labor:				
Skilled	Dacca	Good	Manikgonj	Fair
Unskilled	Dacca	Good	Manikgonj	Good
Ordinary	Dacca	Good	Manikgonj	Good
Bricklayers:				
Head Mason	Dacca	Good	Manikgonj	Fair
Mason	Dacca	Good	Manikgonj	Good
Ordinary Mason	Dacca	Good	Manikgonj	Good
Concrete Workmen:				
Head Mason	Dacca	Good	Narayangonj	Good
Mason	Dacca	Good	Narayangonj	Good
Labor	Dacca	Good	Narayangonj	Good
Carpenters:				
Head Carpenter	Dacca	Good	Manikgonj	Good
Carpenter	Dacca	Good	Manikgonj	Good
Pipe Layers	Dacca	Good	Narayangonj	Good

TABLE VIII-9

MANPOWER PLAN FOR FIRST YEAR OF CONSTRUCTION: KHULNA DISTRICT

Item	Unit	Estimated Quantity #10	Estimated Quantity Total	Man-Days Skilled	Man-Days Unskilled
Excavation	% cu.ft.	67	67	0	67
Embankment	% cu.ft.	52	52	0	52
Brick Masonry	% cu.ft.	156	156	390	1,092
Brick Lining	% sq.ft.	93	93	186	279
Plastering Brick Work	% sq.ft.	44	44	44	132
Concrete Class A	% cu.ft.	18	18	45	102
Concrete Class B	% cu.ft.	42	42	105	252
Flap Gate	each	6	6	0	0
Total Manpower Requirements				770	1,976

Construction Period: October 1981 through April 1982; 7 months; 140 possible working days; 80 scheduled working days.

Contractor's Staff:		
Home Office	(2 per sub-project)	2
Field Office	(10 per sub-project)	10
Skilled Labor	(770/80)	10
Unskilled Labor	(1,976/80)	25
MRD Staff:		
Project Engineers	(1 BSCE per sub-project)	1
Office Technicians	(2 per sub-project)	2
Field Superintendent	(1 BSCE per sub-project)	2
Deputy Field Superintendent	(1 per sub-project)	1
Survey Crew	(one 3-man crew per sub-project)	3
Support Staff	(4 per sub-project)	4
Total		60

TABLE VIII-10

MANPOWER PLAN FOR SECOND AND THIRD YEARS OF CONSTRUCTION: KHULNA DISTRICT

Item	Unit	Estimated Quantity					Man-Days	
		#11	#13	#14	#15	Total	Skilled	Unskilled
Excavation	% cu.ft.	590	24,098	740	70,986	96,414	0	96,414
Embankment	% cu.ft.	408	19,644	299	0	20,351	0	20,351
Brick Masonry	% cu.ft.	152	219	96	0	467	1,168	3,269
Brick Lining	% sq.ft.	269	57	29	0	355	710	1,065
Plastering Brick Work	% sq.ft.	6	49	23	0	78	78	234
Concrete Class A	% cu.ft.	1	18	6	0	25	63	150
Concrete Class B	% cu.ft.	4	66	19	0	89	223	534
Concrete Class C	% cu.ft.	1	0	0	0	1	3	6
Concrete Pipe	Lin.ft.	120	0	0	0	120	60	480
Flap Gate	each	0	3	1	0	4	0	0
Slide Gate & Hoist	each	0	1	1	0	2	0	0
Stop Logs	sq.ft.	0	357	176	0	533	267	0
Stop-check	each	3	0	0	0	3	2	0
Total Manpower Requirement							2,574	122,503

(Continued)

TABLE VIII-10

(Continued)

Construction Period:	October 1981 through April 1982; 7 months; 140 possible working days; 80 scheduled working days.	
Contractor's Staff:		
Home Office	(2 per sub-project)	8
Field Office	(10 per sub-project)	20
Skilled Labor	(2,574/80)	32
Unskilled Labor	(122,503/80)	1,531
MRD Staff:		
Project Engineers	(1 BSCE per sub-project)	4
Office Technicians	(2 per sub-project)	8
Field Superintendent	(1 BSCE per sub-project)	4
Deputy Field Superintendent	(1 per sub-project)	4
Survey Crew	(one 3-man crew per sub-project)	12
Support Staff	(4 per sub-project)	16
Total		1,639

TABLE VIII-11

AVAILABILITY OF LOCAL MANPOWER: KHULNA DISTRICT

Category of Manpower	Primary Source		Secondary Source	
	Location	Availability	Location	Availability
Labor:				
Skilled	Khulna	Good	Faridpur	Good
Unskilled	Khulna	Good	Faridpur	Good
Ordinary	Khulna	Good	Faridpur	Good
Brick Layers:				
Head Mason	Khulna	Fair	Dacca	Good
Mason	Khulna	Good	Dacca	Good
Ordinary Mason	Khulna	Good	Dacca	Good
Concrete Workmen:				
Head Mason	Khulna	Fair	Dacca	Good
Mason	Khulna	Good	Dacca	Good
Labor	Khulna	Good	Dacca	Good
Carpenters:				
Head Carpenter	Khulna	Fair	Faridpur	Good
Carpenter	Khulna	Good	Faridpur	Good
Pipe Layers	Khulna	Fair	Dacca	Good

TABLE VIII-12

MANPOWER PLAN FOR FIRST YEAR OF CONSTRUCTION: RAJSHAHI DISTRICT

Labor Requirements

Item	Unit	Estimated Quantity			Man-Days	
		#17	#20	Total	Skilled	Unskilled
Excavation	% cu.ft.	953	785	1,738	0	1,738
Embankment	% cu.ft.	665	549	1,214	0	1,214
Brick Masonry	% cu.ft.	266	212	478	1,195	3,346
Brick Lining	% sq.ft.	426	355	781	1,562	2,343
Plastering Brick Work	% sq.ft.	23	21	44	44	132
Concrete Class A	% cu.ft.	1	1	2	5	12
Concrete Class B	% cu.ft.	12	13	25	63	150
Concrete Class C	% cu.ft.	1	0	1	3	6
Concrete Pipe	Lin.ft.	24	12	36	18	144
Stop-check	each	40	35	75	38	0
Total Manpower Requirements					2,928	9,085

Construction Period: October 1981 through April 1982; 7 months; 140 possible working days; 80 scheduled working days.

Contractor's Staff:		
Home Office	(2 per sub-project)	4
Field Office	(10 per sub-project)	20
Skilled labor	(2,928/80)	37
Unskilled Labor	(9,085/80)	114
MRD Staff:		
Project Engineer	(1 BSCE per sub-project)	2
Office Technicians	(2 per sub-project)	4
Field Superintendent	(1 BSCE per sub-project)	2
Deputy Field Superintendent	(1 per sub-project)	2
Survey Crew	(one 3-man crew per sub-project)	6
Support Staff	(4 per sub-project)	8
Total		199

TABLE VIII-13

MANPOWER PLAN FOR SECOND AND THIRD
YEARS OF CONSTRUCTION: RAJSHAHI DISTRICT

Item	Unit	Estimated Quantity		Man-Days	
		#19	Total	Skilled	Unskilled
Excavation	% cu.ft.	265	265	0	265
Embankment	% cu.ft.	461	461	0	461
Brick Masonry	% cu.ft.	574	574	1,435	4,018
Brick Lining	% sq.ft.	54	54	108	162
Plastering Brick Work	% sq.ft.	314	314	314	942
Concrete Class A	% cu.ft.	30	30	75	180
Concrete Class B	% cu.ft.	112	112	280	672
Flap Gate	each	3	3	0	0
Slide Gate & Hoist	each	3	3	0	0
Fall Board	sq.ft.	400	400	200	0
Total Manpower Requirements				2,412	6,700

Construction Period: October 1981 through April 1982; 7 months; 140 possible working days; 80 scheduled working days.

Contractor's Staff:		
Home Office	(2 per sub-project)	2
Field Office	(10 per sub-project)	10
Skilled Labor	(2,412/80)	30
Unskilled Labor	(6,700/80)	84
MRD Staff:		
Project Engineers	(1 BSCE per sub-project)	1
Office Technicians	(2 per sub-project)	2
Field Superintendent	(1 BSCE per sub-project)	1
Deputy Field Superintendent	(1 per sub-project)	2
Survey Crew	(one 3-man crew per sub-project)	3
Support Staff	(4 per sub-project)	4
Total		135

TABLE VIII-14

AVAILABILITY OF LOCAL MANPOWER: RAJSHAHI DISTRICT

Category of Manpower	Primary Source		Secondary Source	
	Location	Availability	Location	Availability
Labor:				
Skilled	Rajshahi	Good	Bogra	Good
Unskilled	Rajshahi	Good	Bogra	Good
Ordinary	Rajshahi	Good	Bogra	Good
Brick Layers:				
Head Mason	Rajshahi	Fair	Dacca	Good
Mason	Rajshahi	Good	Dacca	Good
Ordinary Mason	Rajshahi	Good	Dacca	Good
Concrete Workmen:				
Head Mason	Rajshahi	Fair	Dacca	Good
Mason	Rajshahi	Good	Dacca	Good
Labor	Rajshahi	Good	Dacca	Good
Carpenters:				
Head Carpenter	Rajshahi	Good	Dacca	Good
Carpenter	Rajshahi	Good	Dacca	Good
Pipe Layers	Rajshahi	Fair	Dacca	Good

TABLE VIII-15

MANPOWER PLAN FOR FIRST YEAR OF CONSTRUCTION: RANGPUR DISTRICT

Item	Unit	Estimated Quantity			Man-Days	
		#22	#25	Total	Skilled	Unskilled
Excavation	% cu.ft.	906	145	1,051	0	1,051
Embankment	% cu.ft.	632	1,040	1,672	0	1,672
Brick Masonry	% cu.ft.	233	172	405	1,013	2,835
Brick Lining	% sq.ft.	409	20	429	858	1,287
Plastering Brick Work	% sq.ft.	25	30	55	55	165
Concrete Class A	% cu.ft.	2	7	9	23	54
Concrete Class B	% cu.ft.	13	28	41	103	246
Concrete Class C	% cu.ft.	1	0	1	3	6
Concrete Pipe	Lin.ft.	48	0	48	24	192
Stop-check	each	36	0	36	18	0
Flap Gate	each	1	0	1	0	0
Slide Gate & Hoist	each	1	0	1	0	0
Stop Logs	sq.ft.	231	0	231	116	0
Total Manpower Requirements					2,213	7,508

Construction Period: October 1981 through April 1982; 7 months; 140 possible working days; 80 scheduled working days.

Contractor's Staff:		
Home Office	(2 per sub-project)	4
Field Office	(10 per sub-project)	20
Skilled Labor	(2,213/80)	28
Unskilled Labor	(7,508/80)	94
MRD Staff:		
Project Engineer	(1 BSCE per sub-project)	2
Office Technicians	(2 per sub-project)	4
Field Superintendent	(1 BSCE per sub-project)	2
Deputy Field Superintendent	(1 per sub-project)	1
Survey Crew	(one 3-man crew per sub-project)	6
Support Staff	(4 per sub-project)	8
Total		169

TABLE VIII-16

MANPOWER PLAN FOR SECOND AND THIRD YEARS OF CONSTRUCTION: RANGPUR DISTRICT

Labor Requirements

Item	Unit	Estimated Quantity					Man-Days	
		#21	#23	#24	#26	Total	Skilled	Unskilled
Excavation	% cu.ft.	701	857	318	966	2,842	0	2,842
Embankment	% cu.ft.	490	596	188	346	1,620	0	1,620
Brick Masonry	% cu.ft.	210	248	108	333	899	2,248	6,293
Brick Lining	% sq.ft.	316	384	7	20	727	1,454	2,181
Plastering								
Brick Work	% sq.ft.	16	24	22	41	103	103	309
Concrete Class A	% cu.ft.	2	2	16	16	37	93	222
Concrete Class B	% cu.ft.	11	15	16	80	122	305	732
Concrete Class C	% cu.ft.	0	1	0	0	1	3	6
Stop-check	each	29	37	0	0	66	33	0
Flap Gate	each	0	0	1	4	5	0	0
Slide Gate & Hoist	each	0	0	1	4	5	0	0
Stop Logs	sq.ft.	0	0	196	360	556	278	0
Total Manpower Requirement							4,517	14,205

(Continued)

TABLE VIII-16

(Continued)

Construction Period:	October 1981 through April 1982; 7 months; 140 possible working days; 80 scheduled working days.	
Contractor's Staff:		
Home Office	(2 per sub-project)	8
Field Office	(10 per sub-project)	40
Skilled Labor	(4,517/80)	56
Unskilled Labor	(14,205/80)	178
MRD Staff:		
Project Engineers	(1 BSCE per sub-project)	4
Office Technicians	(2 per sub-project)	8
Field Superintendent	(1 BSCE per sub-project)	4
Deputy Field Superintendent	(1 per sub-project)	4
Survey Crew	(one 3-man crew per sub-project)	12
Support Staff	(4 per sub-project)	16
Total		330

TABLE VIII-17

AVAILABILITY OF LOCAL MANPOWER: RANGPUR DISTRICT

Category of Manpower	Primary Source		Secondary Source	
	Location	Availability	Location	Availability
Labor:				
Skilled	Rangpur	Good	Bogra	Good
Unskilled	Rangpur	Good	Bogra	Good
Ordinary	Rangpur	Good	Bogra	Good
Brick Layers:				
Head Mason	Rangpur	Poor	Dacca	Good
Mason	Rangpur	Fair	Dacca	Good
Ordinary Mason	Rangpur	good	Dacca	Good
Concrete Workmen:				
Head Mason	Rangpur	Poor	Dacca	Good
Mason	Rangpur	Fair	Dacca	Good
Labor	Rangpur	Good	Dacca	Good
Carpenters:				
Head Carpenter	Rangpur	Fair	Dacca	Good
Carpenter	Rangpur	Fair	Dacca	Good
Pipe Layers	Rangpur	Poor	Dacca	Good

TABLE VIII-18

MANPOWER PLAN FOR FIRST YEAR OF CONSTRUCTION: TANGAIL DISTRICT

Item	Unit	Estimated Quantity	Man-Days	
			Skilled	Unskilled
No sub-projects are scheduled for construction in first year				
Contractor's Staff:				
Home Office		(2 per sub-project)		0
Field Office		(10 per sub-project)		0
Skilled Labor				0
Unskilled Labor				0
MRD Staff:				
Project Engineers		(1 BSCE per sub-project)		0
Office Technicians		(2 per sub-project)		0
Field Superintendent		(1 BSCE per sub-project)		0
Deputy Field Superintendent		(1 per sub-project)		0
Survey Crew		(one 3-man crew per sub-project)		0
Support Staff		(4 per sub-project)		0
Total				0

TABLE VIII-19

MANPOWER PLAN FOR SECOND AND THIRD YEARS OF CONSTRUCTION: TANGAIL DISTRICT

Item	Unit	Estimated Quantity					Man-Days	
		#27	#28	#29	#30	Total	Skilled	Unskilled
Excavation	% cu.ft.	902	5,103	479	1,372	7,856	0	7,856
Embankment	% cu.ft.	635	0	335	274	1,244	0	1,244
Brick Masonry	% cu.ft.	236	0	138	138	512	1,280	3,584
Brick Lining	% sq.ft.	411	0	216	29	656	1,312	1,968
Plastering								
Brick Work	% sq.ft.	19	0	3	33	55	55	165
Concrete Class A	% cu.ft.	2	0	2	32	36	90	216
Concrete Class B	% cu.ft.	12	0	7	12	31	78	186
Concrete Class C	% cu.ft.	1	0	0	0	1	3	6
Concrete Pipe	Lin.ft.	12	0	0	0	12	6	48
Stop-check	each	34	0	17	0	51	26	0
Flap Gate	each	0	0	0	1	1	0	0
Slide Gate & Hoist	each	0	0	0	1	1	0	0
Stop Logs	sq.ft.	0	0	0	217	217	109	0
Total Manpower Requirement							2,959	15,273

(Continued)

TABLE VIII-19

(Continued)

Construction Period:	October 1981 through April 1982; 7 months; 140 possible working days; 80 scheduled working days.	
Contractor's Staff:		
Home Office	(2 per sub-project)	8
Field Office	(10 per sub-project)	40
Skilled Labor	(2,950/80)	37
Unskilled Labor	(15,273/80)	191
MRD Staff:		
Project Engineers	(1 BSCE per sub-project)	4
Office Technicians	(2 per sub-project)	8
Field Superintendent	(1 BSCE per sub-project)	4
Deputy Field Superintendent	(1 per sub-project)	4
Survey Crew	(one 3-man crew per sub-project)	12
Support Staff	(4 per sub-project)	8
Total		316

TABLE VIII-20

AVAILABILITY OF LOCAL MANPOWER: TANGAIL DISTRICT

Category of Manpower	Primary Source		Secondary Source	
	Location	Availability	Location	Availability
Labor:				
Skilled	Dacca	Good	Tangail	Good
Unskilled	Dacca	Good	Tangail	Good
Ordinary	Dacca	Good	Tangail	Good
Brick Layers:				
Head Mason	Dacca	Good	Mymensingh	Good
Mason	Dacca	Good	Mymensingh	Good
Ordinary Mason	Dacca	Good	Mymensingh	Good
Concrete Workmen:				
Head Mason	Dacca	Good	Mymensingh	Fair
Mason	Dacca	Good	Mymensingh	Good
Labor	Dacca	Good	Mymensingh	Good
Carpenters:				
Head Carpenter	Dacca	Good	Mymensingh	Fair
Carpenter	Dacca	Good	Mymensingh	Good
Pipe Layers	Dacca	Good	Mymensingh	Poor

TABLE VIII-21

CAD TEAM MEMBER FUNCTIONS

Member	Functions
RWP (SDE)	Command area topography, engineering design, cost estimates, construction supervision and repair of distribution system.
IRDP	Formation (or expansion) of water users' groups and assistance with their management, credit, and other functions.
BADC	Siting of wells and pumps; installation and start up; mechanical maintenance; supply of spare parts, fuel, and agricultural inputs.
DEM	Cropping patterns, estimate of benefits, scheduling of water delivery, improved cultural practices, including on-farm water management.

FIGURE VIII-1
IMPLEMENTATION SCHEDULE

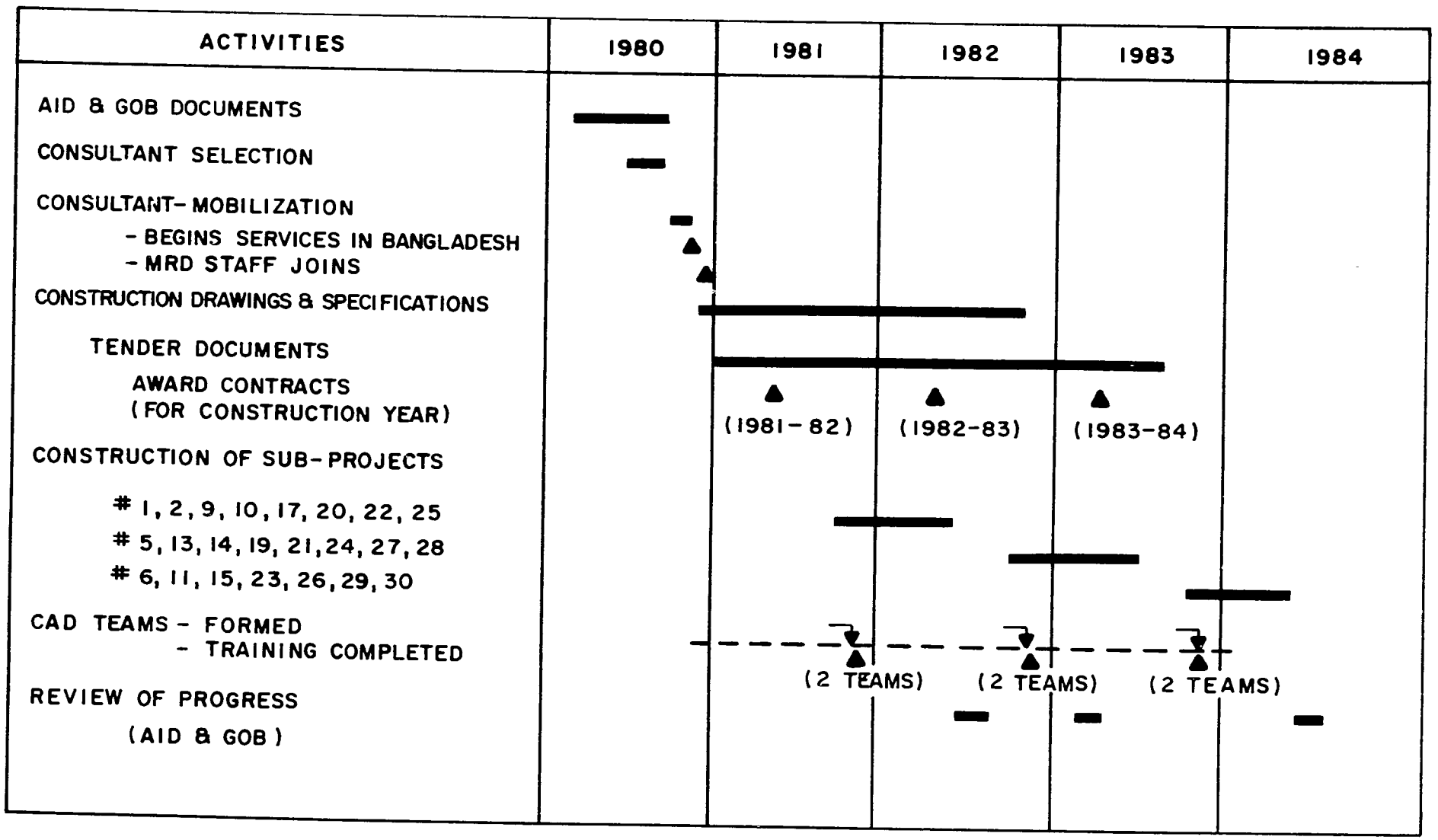


FIGURE VIII-2
SCHEDULE OF CONSULTANT SERVICES

	WM	1980	1981	1982	1983	1984
LONG TERM						
PROJECT MANAGER	45					
LOCATION & DESIGN ENGINEER	24					
CONST. ENGINEER	20					
SHORT TERM (AS NEEDED)						
COOPERATIVES SPEC.	9					
AGRICULTURALIST	12					
O & M SPECIALIST	3					
CONSULTING SPECIALIST	3					
TOTAL	125					

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