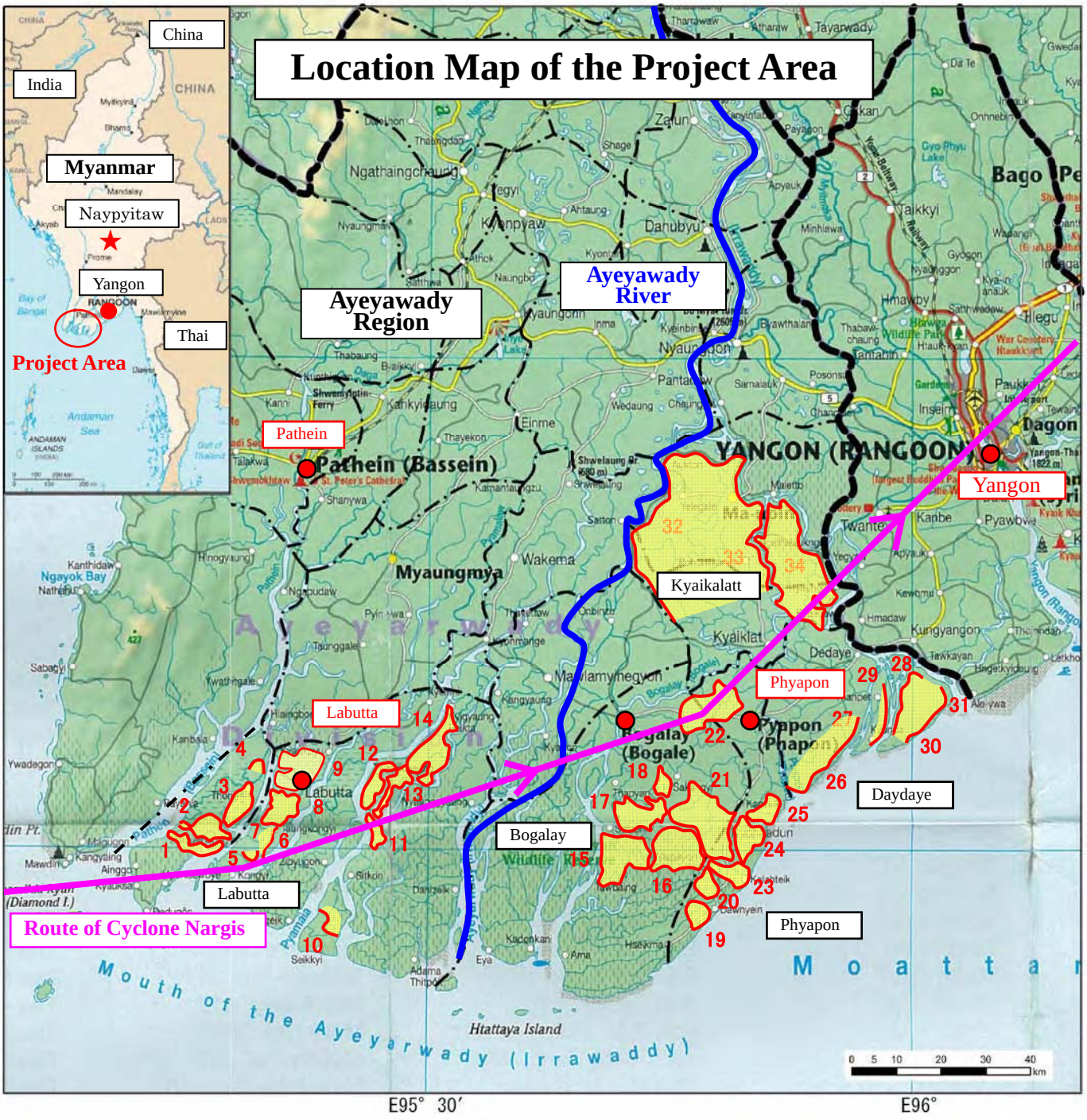
Ministry of Agriculture and Irrigation
The Republic of the Union of Myanmar

THE PROJECT
FOR
PRESERVATION OF FARMING AREA FOR URGENT REHABILITATION OF AGRICULTURAL PRODUCTION AND RURAL LIFE IN AREAS AFFECTED BY CYCLONE NARGIS
IN
THE REPUBLIC OF THE UNION OF MYANMAR

FINAL REPORT
MAIN REPORT

OCTOBER 2011

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
SANYU CONSULTANTS INC. NIPPON KOEI CO., LTD.



Polders in Project Area

【Labutta】
1.Alegyun(1)polder
2.Alegyun(2)polder
3.Alegyun(3)polder
4.Magyibinmadaukan

【Labutta】
5.Thingangyi
6.Zinywe
7.Leikkwin
8.Labutta(South)
9.Labutta(North)
10.U Gaungpu
11.Bitud Island(1)
12.Bitud Island(2)
13.Bitud Island(3)
14.Bitud Island(4)

【Bogalay】
15.Daunggyi poder
16.Daunggyi(East)
17.Daunggyi (West)
18.Daunggyi(Upper)

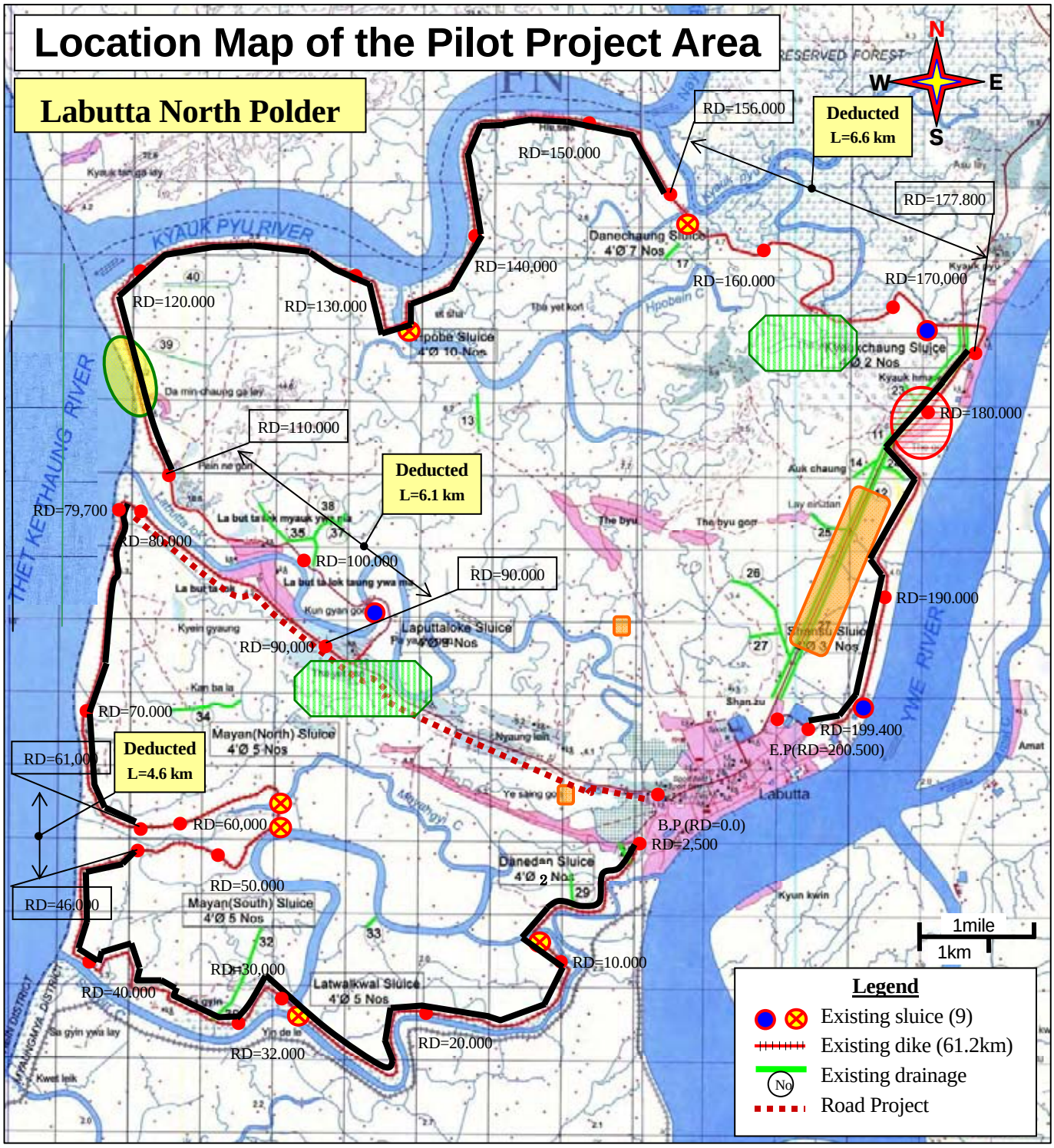
【Phyapon】
19.Dawnyein polder
20.Myokone polder
21.Kyetphamwezaung
22.Banbwezu
23.Daydalu
24.Letpanbin
25.Zinbaung

【Daydaye】
26.Myaseinkan
27.Thandi
28.Suclubbaluma
29.Hleseikchaunggyi
30.Tamatakaw
31.Kyonsoat

【Kyaiklatt】
32.Maubin Island(North)
33.Maubin Island(South)
34.Thonegwakyun

LEGEND
: Region boundary
: Major city/town
: Township boundary
: Township
: Project area
: Polders (34 places)

To Myaungmya, Yangon



Outline of Pilot Projects

Pilot Projects	Mark	Description	Implementation
1. Polder Dike Rehabilitation			
1) Polder Dike Embankment		Dike rehab section L=40 km : Test embankment site	2011/3 Completed
2) Sluice Gate Rehabilitation		Rehab - 6 sluices for 68 gates	2011/3 Completed
2. Mangrove Windbreak Rehabilitation		5 ha planting along dike L=500 m	2011/3 Completed
3. On-Site Seed Production		Paddy for 50 acres for 28 farmers	2011/4 Completed
4. Income Generation Vegetable Cultivation		2 sites for 54 landless villagers	2011/4 Completed

Pilot Projects Photos - Labutta North Polder

1. Condition before pilot project

Before Rehabilitation – Polder Dike
Common view of polder dike with farmland, mangrove and river (January 2010).

Before Rehabilitation – Polder Dike
Overtopping river water into polder during high tide near Hpobe Sluice (August 2010).

Before Rehabilitation – Sluice Gate
Broken slide gate at Danedan Sluice (January 2010).

Before Rehabilitation – Sluice Gate
Water leakage due to flap gate non-functioned (January 2010).

Farming in Labutta Land preparation for monsoon paddy June 2010

Labutta Market (June 2010)

2. Pilot Project for Polder Dike Rehabilitation

Polder Dike Rehabilitation Work
Completed with manpower embankment.

Polder Dike Rehabilitation Work
Completed by ID in March 2011.

Polder Dike Rehabilitation Work
Manpower Embankment near houses (January 2011).

Polder Dike Rehabilitation Work
Completion inspection (31 March 2011).

Polder Dike Rehabilitation Work
Under machine embankment work.

Polder Dike Rehabilitation Work
Soil borrow area is set for water pond for villagers use.

3. Pilot Project for Sluice Rehabilitation

Sluice Rehabilitation Work
Completion inspection at Hpobe Sluice (31 March 2011).

Sluice Rehabilitation Work
Completion inspection together with ID, contractor and JICA Team (31 March 2011).

Sluice Rehabilitation Work
Under final setting of slide gates at Mayan South Sluice.

Sluice Rehabilitation Work
Just after removal of existing flap gates at Hpobe Sluice.

Sluice Rehabilitation Work
Just after removal of existing slide gates at Hpobe Sluice.

Sluice Rehabilitation Work
Under chipping of existing concrete for repair of slide gates at Hpobe Sluice.

4. Pilot Project for On-site Rice Seed Production

Rice Seed Production Project
Orientation workshop with MAS, TPDC and NGOs to start the Project (April 2010).

Rice Seed Production Project
Sowing registered paddy seed obtained from MAS (June 2010).

Rice Seed Production Project
Transplanting in July 2010.

.

Rice Seed Production Project
Threshing after harvest in November 2010.

Rice Seed Production Project
Storage of paddy seed at rice mill factory in Labutta in January 2011.

Rice Seed Production Project
Extension workshop for NGOs, UN organizations, private sectors and MAS (05 April 2011).

5. Pilot Project for Income Generation – Vegetable Cultivation

Income Generation – Vegetable Project
Field training at Kyauk Hmaw village on pesticide and chmicals (February 2011).

Income Generation - Vegetable Project
Project participant is carrying water cress after harvest at Kyauk Hmaw village.

Income Generation – Vegetable Project
Harvesting cucumber by participant landless farmer at Labuttaloke South village.

Income Generation – Vegetable Project
Harvesting roselle and water cress at Labuttaloke South village.

Income Generation – Vegetable Project
Watering work for vegetables requires 3 hours a day using watering can.

Income Generation – Vegetable Project
Under watering work taking water from natural creek.

6. Pilot Project for Mangrove Windbreak Rehabilitation

Mangrove Windbreak Project
Technical training for villagers on mangrove plantation (May 2010).

Mangrove Windbreak Project
Preparation of tide protection fence using bamboo by villagers (May 2010).

Mangrove Windbreak Project
Fence making to protect from tidal wave & river flow (May 2010)

Mangrove Windbreak Project
Mangrove Management Committee set up during evaluation workshop (March 2011).

Mangrove Windbreak Project
Completed dike embankment and mangrove pilot project site (February 2011).

Mangrove Windbreak Project
Mangrove trees planted in June 2010 along polder dike (February 2011).

MAIN REPORT

CONTENTS

Location Map of the Project Area
Location Map of the Pilot Project Area
Pilot Project Photos – Labutta North Polder
Contents
List of Abbreviations and List of Acronyms

Page

CHAPTER 1 Background and Objectives of the Project 1
1.1 Authority 1
1.2 Background of the Project 1
1.3 Objectives of the Project 2
1.4 Expected Outputs of the Project 2
1.5 The Project Area 2
1.6 Implementation Organization for the Project 3

CHAPTER 2 The Project Area 4
2.1 Natural Condition 4
2.1.1 Climate and Meteorology 4
2.1.2 Rivers and Hydrology 5
2.1.3 Topography of the Project Area 7
2.1.4 Soils and Water in the Project Area 9
2.1.5 History of Cyclone in Ayeyawady Delta 12
2.2 Socio-economic Condition 16
2.2.1 Land Area and Population in the Project Area 16
2.2.2 Rural Economy and Livelihood in the Project Area 17
2.2.3 Ethnic Distribution 20
2.2.4 National and Local Government in the Project Area 20
2.2.5 Gender Issues in the Project Area 21
2.2.6 Disaster occurred by Cyclone Nargis 21
2.3 Present Condition of Agriculture in the Project Area 25
2.3.1 Agricultural Production 25
2.3.2 Paddy Cultivation 27
2.3.3 Other Crop Production and Livestock 35
2.3.4 Agricultural Supporting Service 36
2.3.5 Agricultural Damage by Cyclone Nargis 38
2.4 Present Condition of Irrigation and Drainage in the Project Area 39
2.4.1 Irrigation 39
2.4.2 Drainage 42
2.5 Present Condition of Agricultural and Rural Infrastructure in the Project Area 48
2.5.1 Polder Dikes and Sluices 48
2.5.2 Other Rural Infrastructure 51
2.6 Emergency Rehabilitation and Reconstruction implemented by the Government and Donors 52

2.6.1 Rehabilitation and Reconstruction implemented by the Government 52
2.6.2 Rehabilitation and Reconstruction implemented by Donors 53
2.6.3 Reconstruction Plans by Government and Donors 53
2.6.4 Design and Construction Standards on Civil Work 53
2.6.5 Procurement Procedure and Condition 53
2.6.6 Government Budget 54
2.7 Identification of Problems on Preservation of Farming Area for Urgent Rehabilitation of Agricultural Production and Rural Life 55
2.7.1 Problems on Agricultural and Rural Infrastructure 55
2.7.2 Problems on Farming 55
2.7.3 Problems on Livelihood and Income Sources 55
2.7.4 Problems on Mangrove Windbreak 56

CHAPTER 3 Challenges and Measures on Preservation of Farming Area for Urgent Rehabilitation of Agricultural Production and Rural Life 59
3.1 Challenges and Measures on Agricultural and Rural Infrastructure 59
3.2 Challenges and Measures on Farming 59
3.3 Challenges and Measures on Livelihood and Income Sources 60
3.4 Challenges and Measures on Mangrove Windbreak 61

CHAPTER 4 Implementation of Pilot Projects 62
4.1 Purpose and Scope of Pilot Projects 62
4.1.1 Purpose of Pilot Projects 62
4.1.2 Basic Policy of Pilot Projects 62
4.1.3 Scope of Pilot Projects 62
4.1.4 Selection of Pilot Project Area 62
4.2 Government Laws, Regulations and Institutions related to Pilot Projects 63
4.3 Implementation and Result of Pilot Projects 64
4.3.1 Dike Embankment and Sluice Rehabilitation Pilot Project 64
4.3.2 On-site Seed Production Pilot Project 73
4.3.3 Income Generation Pilot Project 85
4.3.4 Mangrove Windbreak Rehabilitation Pilot Project 92
4.4 Initial Environmental Examination (IEE) 100

CHAPTER 5 Development Plan for Preservation of Farming Area 107
5.1 Basic Policy for Formulation of Development Plan 107
5.1.1 Basic Policy for Preservation of Farming Area 107
5.1.2 Basic Concept for Formulation of Development Plan on Preservation of Farming Area 108
5.2 Scope of Development Plan 109
5.2.1 Components of Development Plan 109
5.2.2 Target Polders on Development Plan 110
5.3 Rehabilitation Plan on Agricultural and Rural Infrastructure 111
5.3.1 Basic Concept of Rehabilitation of Agricultural and Rural Infrastructure 111
5.3.2 Project Contents and Volume 111
5.3.3 Results of Hydrological Analysis 111
5.3.4 Design and Construction Plan 112
5.3.5 Implementation Method and Implementing Body 120
5.3.6 Operation and Maintenance 121
5.4 Improvement Plan on Farming 126
5.4.1 Basic Concept of Improvement of Farming 126
5.4.2 Project Contents and Volume 127

5.4.3 Implementation Method and Implementing Body 130
5.5 Income Generation Plan 134
5.5.1 Basic Concept of Income Generation 134
5.5.2 Project Contents and Volume 134
5.5.3 Implementation Method and Implementing Body 142
5.6 Rehabilitation Plan on Mangrove Windbreak 147
5.6.1 Basic Concept of Rehabilitation of Mangrove Windbreak 147
5.6.2 Project Contents and Volume 148
5.6.3 Implementation Method and Implementing Body 153
5.7 Environmental Study 155
5.7.1 Guideline on Environmental Impact Assessment 155
5.7.2 Initial Environmental Examination (IEE) 155
5.8 Implementation Plan and Schedule 160
5.8.1 Overall Implementation Plan 160
5.8.2 Selection of Priority Polders and Embankments 160
5.8.3 Implementation Schedule 163
5.9 Cost Estimates 168
5.9.1 Condition of Cost Estimates 168
5.9.2 Project Costs 168
5.9.3 Disbursement Schedule 169
5.10 Project Justification 170
5.10.1 Technical Evaluation 170
5.10.2 Financial and Economic Evaluation 171
5.10.3 Social and Natural Environmental Evaluation 183

CHAPTER 6 Technology Transfer 187
6.1 Introduction 187
6.2 Result of Technology Transfer 187
6.3 Evaluation of Technology Transfer 187

CHAPTER 7 Conclusion and Recommendations 193

LIST OF TABLES

Table 2.1-1 Probable Storm Rainfall at Yangon and Pathein (mm) 6
Table 2.1-2 Distribution of Soil Samples among the Seven Soil Material Classes 11
Table 2.1-3 Mean Mechanical and Total Chemical Compositions and Other Properties 11
Table 2.1-4 Historical Cyclones Attacked Myanmar 13
Table 2.1-5 Historical Cyclones in the North Indian Ocean Territory 13
Table 2.1-6 Characteristic of Severe Cyclonic Storms in Bay of Bengal (1965-78) 14
Table 2.2-1 Population, Area and Dike Length of 34 Polders/Embankments for the Project 16
Table 2.2-2 Administrative District and Population, Number of Village Tracts and Villages in Target Townships 17
Table 2.2-3 Land Occupancy Status and Farm Size 19
Table 2.2-4 Average 2009 Income of Tiller's Right Holders and Landless Households in 34 Polders 19
Table 2.2-5 Number of Victims by Nargis in Target Townships 22
Table 2.2-6 Source of Water before and after Cyclone in Ayeyawady Region 23

Table 2.2-7 Damage and Losses to Rice Mills in Target Townships ---------- 23
Table 2.2-8 Percentage of Loss in Fishing Gear Items by Nargis ---------- 24
Table 2.2-9 Estimated Damage and Losses to Salt Farms in the Target Townships ---------- 24
Table 2.2-10 Change of Main Income Sources before and after Nargis ---------- 25
Table 2.3-1 Sowing Area of Major Crops in Ayeyawady Region (1,000 Acre) ---------- 25
Table 2.3-2 Percentage of Farmer in 34 Polders ---------- 26
Table 2.3-3 Average Land Holding Size (2007) ---------- 26
Table 2.3-4 Type of Paddy Variety in Ayeyawady Region in Monson Season 2010 ---------- 28
Table 2.3-5 Major Paddy Variety in Ayeyawady Region in Monson Season 2010 ---------- 28
Table 2.3-6 Procurement Method of Seed ---------- 29
Table 2.3-7 Problem on Seed Quality ---------- 29
Table 2.3-8 Use of Fertilizer and Pesticide ---------- 30
Table 2.3-9 Difference of Lowest and Highest Price of Paddy ---------- 32
Table 2.3-10 Estimated Production Cost and Income of Paddy Cultivation (Monsoon Season: Local Variety) ---------- 33
Table 2.3-11 Estimated Production Cost and Income of Paddy Cultivation (Dry Season: HYV Variety) ---------- 34
Table 2.3-12 Production Amounts of Paddy Seed by Major MOAI Farms in Ayeyawady Region ---------- 37
Table 2.3-13 Farming Constraint before and after Cyclone Nargis Attack ---------- 38
Table 2.3-14 Received Support ---------- 38
Table 2.4-1 Summary of Existing Drainage Canal ---------- 43
Table 2.4-2 Summary of Drainage Condition at the 8 Sluices in Labutta North Polder ---------- 44
Table 2.4-3 Salinity (Electric Conductivity) of Soil ---------- 46
Table 2.5-1 Existing Facilities of 34 Polders in Project Area ---------- 49
Table 2.5-2 Differences in Water Level and EC Value at Labutta and Bogalay ---------- 50
Table 2.6-1 Rehabilitation of Polder Dike Embankment by ID - Accomplishment ---------- 52
Table 2.6-2 Annual Budget of Irrigation Department (Million Kyats) ---------- 54
Table 2.7-1 Current Situation of Mangrove Windbreak at 34 Polders ---------- 58
Table 4.3.1-1 Contents and Quantity for Test Embankment ---------- 64
Table 4.3.1-2 Priority Study of Dike Sections for Rehabilitation ---------- 66
Table 4.3.1-3 Implementation Schedule for Dike Embankment Pilot Project ---------- 68
Table 4.3.1-4 Criteria for Selection of Rehabilitation Method for Sluice Gate ---------- 69
Table 4.3.1-5 Quantity of Sluice Gate Rehabilitation ---------- 69
Table 4.3.1-6 Evaluation of Gate Function and Rehabilitation Method by Sluice ---------- 69
Table 4.3.1-7 Implementation Schedule for Sluice Gates Rehabilitation ---------- 71
Table 4.3.1-8 Summary of Study Tour on Dike and Sluice Rehabilitation Pilot Project ---------- 72
Table 4.3.2-1 Schedule of On-Site Seed Production Pilot Project ---------- 74
Table 4.3.2-2 Paddy Varieties used in Pilot Project ---------- 76
Table 4.3.2-3 Fertilizer Application in Pilot Project ---------- 76
Table 4.3.2-4 MAS Seed Standard for Certified Seed ---------- 78
Table 4.3.2-5 Result of Seed Quality Check, Production Amount and Cropping Yield ---------- 78
Table 4.3.2-6 Comparison of Cropping Yield ---------- 79

Table 4.3.2-7 Sales Result of Paddy Seed produced by Pilot Project as of end of April---------- 79
Table 4.3.2-8 Estimated Production Cost and Income in Pilot Project---------- 80
Table 4.3.3-1 Summary of Social Condition of Target Villages---------- 87
Table 4.3.3-2 Result of Vegetable Production in Pilot Project---------- 89
Table 4.3.3-3 Trainings and Workshops for Income Generation Pilot Project ---------- 89
Table 4.3.3-4 Estimated Annual Household Income---------- 91
Table 4.3.3-5 Estimate Income Increment in Vegetable Cultivation Pilot Project---------- 92
Table 4.3.4-1 Implementation Process of Mangrove Windbreak Rehabilitation Pilot Project--- 94
Table 4.3.4-2 Cost-Benefit Analysis of Mangrove Windbreak Pilot Project ---------- 95
Table 4.3.4-3 Villagers' Participation in Pilot Project Activity---------- 97
Table 4.3.4-4 Villagers' Response in Evaluation Workshop on Mangrove Pilot Project --------- 99
Table 4.4-1 Notification of Pilot Project to the People ---------- 102
Table 4.4-2 Situations of Resettlement ---------- 104
Table 4.4-3 Scoping Checklist for Pilot Project ---------- 105
Table 5.2-1 List of 34 Polders for Development Plan ---------- 110
Table 5.3-1 Project Volume for Rehabilitation of Dike and Sluice ---------- 111
Table 5.3-2 Relation between Design Flood Discharge and Freeboard ---------- 112
Table 5.3-3 Differences of Design Crest Level and Progress of ID Rehabilitation by Polder --- 114
Table 5.3-4 Embankment Volume Required for 34 Polders on Development Plan---------- 117
Table 5.3-5 Point Distribution in Function Evaluation Survey for Sluice Gate---------- 118
Table 5.3-6 Selection Criteria of Rehabilitation Method for Sluice Gate---------- 118
Table 5.3-7 Summary of Rehabilitation Plan for Sluice Gate at 34 Polders---------- 119
Table 5.3-8 Survey Items and Contents on Each Facility and Inspection---------- 124
Table 5.3-9 Examples of Determination Criteria for Daily Inspection on Concrete Structure--- 125
Table 5.4-1 Comparison of Net Incomes / Acre between Grain and High Quality Paddy Seed Production ---------- 127
Table 5.4-2 Increase of Farming Income by High Quality Paddy Seed Production---------- 128
Table 5.4-3 Project Volume (Target Area) for Improvement Plan on Farming---------- 129
Table 5.4-4 Selection Criteria of Farmers for Seed Production ---------- 130
Table 5.4-5 Program of Technical Seminar on High Quality Paddy Seed Production ---------- 131
Table 5.4-6 Implementation schedule for Improvement Plan on Farming---------- 132
Table 5.4-7 Implementing Body for Improvement Plan on Farming---------- 133
Table 5.5-1 Examination of existing income generation activities ---------- 135
Table 5.5-2 Project Volume of Vegetable Cultivation Sub-project---------- 138
Table 5.5-3 Crop Budget for Vegetable Cultivation Sub-project---------- 139
Table 5.5-4 Effect on Income Generation ---------- 139
Table 5.5-5 Project Volume and Project Cost of Pig Raising Sub-project ---------- 140
Table 5.5-6 Cost and Benefit of Pig Raising per Household ---------- 141
Table 5.5-7 Effect on Income Generation ---------- 141
Table 5.5-8 Implementation Procedure of Vegetable Cultivation Sub-project ---------- 142
Table 5.5-9 Role Sharing for Vegetable Cultivation Sub-project ---------- 143
Table 5.5-10 Implementation Procedure of Pig Raising Sub-project ---------- 145
Table 5.5-11 Role Sharing for Pig Raising Sub-project---------- 146

Table 5.6-1 Target Length of Mangrove Windbreak Rehabilitation by Polder ---------- 148
Table 5.6-2 Seed and Seedling Information for Three Mangrove Species ---------- 150
Table 5.6-3 Typical Schedule for Mangrove Windbreak Rehabilitation Work ---------- 151
Table 5.6-4 Unit Quantity required for Mangrove Windbreak Rehabilitation ---------- 152
Table 5.6-5 Project Volume by Polder for Mangrove Windbreak Rehabilitation ---------- 152
Table 5.7-1 Scoping Checklist for the Development Plan ---------- 157
Table 5.7-2 Proposed Monitoring Plan ---------- 159
Table 5.8-1 Grouping of 34 Polders for Construction Planning in Development Plan ---------- 161
Table 5.8-2 Priority Ranking of Polder Groups ---------- 163
Table 5.8-3 Implementation Schedule by Polder and by Component ---------- 164
Table 5.8-4 Implementation Schedule for Rehabilitation on Agricultural and Rural Infrastructure - 165
Table 5.8-5 Implementation Schedule for Improvement Plan on Farming ---------- 165
Table 5.8-6 Implementation Schedule for Vegetable Cultivation Sub-project on Income Generation ---------- 166
Table 5.8-7 Implementation Schedule for Pig Raising Sub-project on Income Generation ---------- 167
Table 5.8-8 Implementation Schedule for Rehabilitation Plan on Mangrove Windbreak -------- 168

Table 5.9-1 Summary of Total Project Costs ---------- 169
Table 5.9-2 Summary of Project Costs by Polder and by Component ---------- 169
Table 5.9-3 Disbursement Schedule of Project Costs ---------- 170
Table 5.10-1 Standard Conversion Factor (SCF) ---------- 172
Table 5.10-2 Other Conversion Factors ---------- 173
Table 5.10-3 Calculation Criteria for Human Damage ---------- 174
Table 5.10-4 Human Damage Value in Economic Terms ---------- 175
Table 5.10-5 Calculation Criteria for Crop Losses ---------- 175
Table 5.10-6 Crop Loss Value in Economic Terms ---------- 175
Table 5.10-7 Calculation Criteria for Livestock Losses ---------- 175
Table 5.10-8 Calculation Criteria for Fishery Equipment Damage ---------- 176
Table 5.10-9 Calculation Criteria for Public Facility Damage ---------- 176
Table 5.10-10 Calculation Criteria for Water Shortage Volume ---------- 176
Table 5.10-11 Summary of Financial and Economic Viability Indicators ---------- 177
Table 5.10-12 Summary of Sensitivity Analysis ---------- 177
Table 5.10-13 Annual Per Acre Supporting Cost for MAS ---------- 178
Table 5.10-14 Calculation Criteria for Quality Paddy Seed Production ---------- 178
Table 5.10-15 Farm Economy Analysis ---------- 178
Table 5.10-16 Agricultural Production Loan ---------- 179
Table 5.10-17 Annual Supporting Costs for MAS and LBVD ---------- 179
Table 5.10-18 Calculation Criteria for Vegetable Production per 0.025 Acre ---------- 180
Table 5.10-19 Calculation Criteria for Pig Breeding/Fattening Activities ---------- 180
Table 5.10-20 Farm Economy Analysis ---------- 180
Table 5.10-21 Agricultural Production Loan ---------- 181
Table 5.10-22 Breakdown of Project Cost for 1 km-long Windbreak Mangroves ---------- 181

Table 5.10-23 Breakdown of Project Benefit for 1 km-long Windbreak Mangroves ---------- 182
Table 5.10-24 Farm Economy Analysis (1 km-long windbreak mangroves) ---------- 182
Table 5.10-25 Summary of Financial and Economic Viability Indicators ---------- 182
Table 5.10-26 Summary of Sensitivity Analysis ---------- 183
Table 5.10-27 Anticipated Disaster Prevention Value (Financial Terms) ---------- 185
Table 5.10-28 Anticipated Disaster Prevention Value (Economic Terms) ---------- 186
Table 6.2-1 Results of Technology Transfer conducted in the Project ---------- 188
Table 6.2-2 Participants in Workshops, Seminars, Trainings and Study Tours ---------- 191
Table 6.3-1 Evaluation of Technology Transfer ---------- 192

LIST OF FIGURES

Figure 1.2-1 Route of Cyclone Nargis ---------- 2
Figure 1.6-1 Organization Chart for the Implementation of the Study ---------- 3
Figure 2.1-1 Monthly Pattern of Rainfall and Mean Temperature at Pathein ---------- 4
Figure 2.1-2 River Systems of Ayeyawady Delta ---------- 6
Figure 2.1-3 Astronomical Tide at Diamond Island and Elephant Point ---------- 7
Figure 2.1-4 Topography ---------- 8
Figure 2.1-5 Project Area ---------- 8
Figure 2.1-6 Soil Map of Delta ---------- 10
Figure 2.1-7 Soil Samples from Ayeyawady Delta ---------- 11
Figure 2.1-8 Critical Saline Front at the End of March ---------- 12
Figure 2.1-9 Tracks of Cyclones since 1965 ---------- 15
Figure 2.3-1 Paddy Sowing Area of Myanmar and Ayeyawady Region ---------- 25
Figure 2.3-2 General Cropping Pattern of Paddy ---------- 27
Figure 2.3-3 Average Cropping Yield in 34 Polders (2007-2009 Wet Seasons) ---------- 28
Figure 2.3-4 Fluctuation of Paddy Price in Pathein Market (Kyat /basket) ---------- 33
Figure 2.4-1 EC at Danedan Sluice ---------- 39
Figure 2.4-2 EC of Canal Water for Irrigation of Vegetable ---------- 40
Figure 2.4-3 Drainage Condition of Labuttaloke Sluice ---------- 45
Figure 2.5-1 Polder Dike Schematic Section ---------- 48
Figure 2.5-2 Function Condition of Flap and Sluice Gate at Sluice ---------- 51
Figure 2.6-1 Organization Chart of Ministry of Agriculture and Irrigation (MOAI) ---------- 54
Figure 2.7-1 Changes of Mangrove Forest Areas in Ayeyawady Delta ---------- 57
Figure 4.3.1-1 Corrosion Test for 5 Years ---------- 70
Figure 4.3.2-1 High Quality Seed Production Flow prepared for Pilot Project ---------- 74
Figure 4.3.2-2 Organization for Implementation of On-site Seed Production Pilot Project ---------- 75
Figure 4.3.2-3 Result of Farmer Satisfaction Survey in Pilot Project ---------- 85
Figure 4.3.4-1 Implementation Structure of Mangrove Pilot Project ---------- 93
Figure 4.3.4-2 Site Arrangement of Mangrove Windbreak Rehabilitation Pilot Project ---------- 93
Figure 4.3.4-3 Mangrove Height Monitoring after Planting ---------- 98
Figure 4.4-1 Cross Sections of Construction Method to Minimize Resettlement ---------- 101
Figure 4.4-2 Prior Explanation about Land Acquisition to affected Farmers ---------- 103

Figure 4.4-3 Farmers Attitude on Embankment Work and Land Acquisition ---------- 104
Figure 5.3-1 Iso-lines of Design High Water Level ---------- 112
Figure 5.3-2 Wave Gradient Carve ---------- 113
Figure 5.3-3 Improved Supposition Slope ---------- 113
Figure 5.3-4 Improved Supposition Slope and Wave Run-up Height Ratio ---------- 113
Figure 5.3-5 Proposed Typical Cross Section of Dike Embankment ---------- 114
Figure 5.3-6 Additional Embankment Method (Case-1) ---------- 115
Figure 5.3-7 Additional Embankment Method (Case-2) ---------- 116
Figure 5.3-8 Case of Bank Expansion to River Side ---------- 116
Figure 5.3-9 Case of Bank Expansion to Land Side ---------- 116
Figure 5.3-10 Concepts for Management of Embankment ---------- 120
Figure 5.3-11 Implementation Structure for Rehabilitation of Polder Dike and Sluice ---------- 121
Figure 5.3-12 Concept of Preventive Maintenance Measures ---------- 122
Figure 5.3-13 Scheme for Preventive Maintenance Measures ---------- 123
Figure 5.3-14 Procedural Flow of Function Evaluation ---------- 126
Figure 5.4-1 Implementing Flow for Improvement Plan on Farming ---------- 132
Figure 5.4-2 Implementation Structure for Improvement Plan on Farming ---------- 133
Figure 5.5-1 Implementation Structure for Vegetable Cultivation Sub-project ---------- 144
Figure 5.5-2 Implementation Structure for Pig Raising Sub-project ---------- 147
Figure 5.6-1 Cross Section of Typical Planting Site ---------- 150
Figure 5.6-2 Typical Design for Mangrove Plantation ---------- 150
Figure 5.6-3 Dimension of Bamboo Fence ---------- 151
Figure 5.6-4 Implementation Structure for Mangrove Windbreak Rehabilitation Project --------- 153
Figure 5.6-5 Implementation Process of Mangrove Windbreak Rehabilitation ---------- 154

APPENDICES

Appendix 1 **Team Members, C/Ps, Government Officials and NGOs contacted**
Appendix 2 **Scope of Work and Minutes of Meeting**
Appendix 3 **Estimation of External High Water Level for Embankment Design**
Appendix 4 **Results of Present Condition Survey**
Appendix 5 **Irrigation and Drainage**
Appendix 6 **Agricultural and Rural Infrastructure**
Appendix 7 **Farm Management**
Appendix 8 **Income Generation**
Appendix 9 **Mangrove Windbreak**
Appendix 10 **Environmental Examination**
Appendix 11 **Cost Estimates**
Appendix 12 **Project Evaluation**
Appendix 13 **List of Collected Data**
Appendix 14 **Result of Route Survey for Three Polders**

List of Abbreviations and Acronyms

ACL	Authorized Crest Level
ADPC	Asian Disaster Preparedness Centre
AE	Assistant engineer
AES	Assistant engineering surveyor
AMD	Agricultural Mechanization Department
ASEAN	Association of Southeast Asian Nations
B/C	Benefit/cost
CDN	Consortium of Dutch NGO's
CF	Conversion factor
CIF	Cost, insurance and freight
C/Ps	Counterpart(s)
CS	Certified seed
DAP	Department of Agricultural Planning
DAR	Department of Agriculture Research
DG	Director general
DMH	Department of Meteorology and Hydrology
DOF	Department of Fisheries
D/P	Development Plan
DPDC	District Pease and Development Council
DS	Dry season
DYDG	Deputy director general
EC	Electric conductivity
ECL	Existing crest level
EIA	Environmental Impact Assessment
EIRR	Economic internal rate of return
ES	Engineering surveyor
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FD	Forest Department
FIRR	Financial internal rate of return
FOB	Free on board
FW	Future with project
FW/O	Future without project
GL	Ground level
GoJ	Government of Japan
GoUM	Government of the Republic of the Union of Myanmar
HHs	Household(s)
HWL	High water level
HYV	High yielding variety
IBM	Irrigation benchmark
ID	Irrigation Department
IDE	International Development Enterprise
IEE	Initial environmental examination

IndOOS	Indian Ocean Observation System
INGOs	International non-governmental organisation(s)
IRR	Internal rate of return
ITC	Irrigation Technology Center
JICA	Japan International Cooperation Agency
LBVD	Livestock Breeding and Veterinary Department
LNGOs	Local non-governmental organisation(s)
MADB	Myanma Agricultural Development Bank
MAS	Myanma Agriculture Service
MIMU	Myanmar Information Management Unit
M/M	Minutes of meeting
MMC	Mangrove management committee
MOAI	Ministry of Agriculture and Irrigation
MOD	Ministry of Defense
MOF	Ministry of Forestry
MOHA	Ministry of Home Affairs
MOLF	Ministry of Livestock and Fisheries
MONP	Ministry of National Planning
MRRC	Myanma Rice Research Centre
NCEA	National Commission for Environmental Affairs
NGOs	Non-governmental organization(s)
NPOs	Non-profitable organization(s)
NPV	Net present value
OJT	On-the-job training
O&M	Operation and maintenance
PDC	Pease and Development Council
pH	Potential of hydrogen
PMU	Project Management Unit
PONJA	Post-Nargis Joint Assessment
PR	Periodic Review
ROW	Right of way
RS	Registered seed
SAE	Sub-assistant engineer
S/C	Steering committee
SCF	Standard conversion factor
SD	Survey Department
SLRD	Settlement and Land Records Department
SPDC	State Pease and Development Council
SUS	Stainless steel
S/W	Scope of work
SWOT	Strengths, Weaknesses, Opportunities and Threats
TBM	Temporary bench mark
TCG	Tripartite Core Group

TPDC	Township Pease and Development Council
Tsp	Township
USAID	United States Agency for International Development
UN	United Nations
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
VFRDC	Vegetable and Fruits Research Development Centre
VPDC	Village Pease and Development Council
VTs	Village-tract(s)
WS	Wet season
YAU	Yezin Agriculture University

List of Unit Conversions

1 basket (Paddy)	=	20.88 kg	=	46 pounds
1 basket (Groundnuts)	=	11.4 kg		
1 basket (Soybeans)	=	32.7 kg		

1 inch (in.)	=	2.54 cm	=	1/12 feet		
1 foot (ft.)	=	30.48 cm	=	1/3 yard	=	12 inches
1 yard (yd.)	=	0.9144 m	=	3 feet	=	36 inches
1 meter (m)	=	3.28 feet	=	1.09 yard		
1 mile	=	1.61 km				
1 kilometer (km)	=	0.62 miles				
1 square-foot (sq-f)	=	929 sq-cm	=	0.093 sq-m		
1 acre (ac)	=	0.405 ha	=	4048 sq-m		
1 hectare (ha)	=	2.47 acres				
1 acre-foot	=	1233.4 cum				
1 gallon (gal. UK)	=	8 pints	=	4.546 litter (UK)		
1 sud	=	2.83 cum	=	100 cu-feet		

1 mS/cm (milli-Siemens per centimeter)= 1 dS/m (deci-Siemens per meter)
= 1000 μ S/cm (micro-Siemens per centimeter)
(e.g. EC = 0.1 – 0.3 mS/cm = 100 – 300 μ S/cm for normal tap water)

Currency Equivalents as of March 2011

1 US$	=	869.00 Myanmar Kyats (TTB)
1 US$	=	81.73 Japanese Yens (TTB)
1 Kyats	=	0.094 yens

Myanmar Fiscal Year

1st April to 31st March

CHAPTER 1 BACKGROUND AND OBJECTIVES OF THE PROJECT

1.1 Authority

This Final Report is prepared in accordance with the Scope of Work (S/W) and the Minutes of Meeting (M/M) for the Study on "The Preservation of Farming Area for Urgent Rehabilitation of Agricultural Production and Rural Life in Areas Affected by Cyclone Nargis in the Union of Myanmar" (the Project) agreed upon between the Ministry of Agriculture and Irrigation (MOAI) of the Union of Myanmar and the the Japan International Cooperation Agency (JICA) dated on October 6th 2009. This Final Report describes the findings and analysis obtained from a series of field surveys and pilot projects carried out by the Project Team in the Union of Myanmar from December 2009 to September 2011 and Development Plan (D/P) as well as conclusion and recommendations.

The Final Report is composed of the following:

1) Main Report
2) Summary Report
3) Appendices

Appendix 1	Team Members, C/Ps, Government Officials and NGOs contacted
Appendix 2	Scope of Work and Minutes of Meeting
Appendix 3	Estimation of External High Water Level for Embankment Design
Appendix 4	Result of Present Condition Survey
Appendix 5	Irrigation and Drainage
Appendix 6	Agricultural and Rural Infrastructure
Appendix 7	Farm Management
Appendix 8	Income Generation
Appendix 9	Mangrove Windbreak
Appendix 10	Environmental Examination
Appendix 11	Cost Estimates
Appendix 12	Project Evaluation
Appendix 13	List of Collected Data
Appendix 14	Result of Route Survey for Three Polders

1.2 Background of the Project

On May 2-3, 2008, a huge cyclone named 'Nargis' which originated in the Bengal Bay directly hit the southwestern part of the Ayeyawady Delta, affecting 2.4 million people that included 140 thousand dead and missing persons. The Ayeyawady Delta is the major rice producing areas in Myanmar so that the cyclone damaged about 770,000 ha of paddy field through salt water intrusion and flooding and also seriously affecting the living conditions in the polders. Under these circumstances, the "Government of the Union of Myanmar" (GoUM) requested the "Government of Japan" (GoJ) to conduct the D/P Study for the preservation of farming area to restore agricultural production and the rural life through rehabilitation of polder dikes.

Storms with heavy rains and strong winds normally occur in Myanmar in monsoon season and cyclones are generated from the development of atmospheric depression. Normally, most of cyclones generated in the Bengal Bay proceed to the north and hit Bangladesh and the east of India located in the west of Arakan mountain range. However, some cyclones occasionally proceed to the east and hit the Ayeyawady Delta. The Cyclone Nargis was one of the largest

cyclones that hit the area. According to the 5-scale classification defined by Japan Meteorological Agency, the Cyclone Nargis has the largest grade. The Cyclone Nargis passed right above the Ayeyawady Delta from the west to the east affecting unexpected huge damages in the Delta area.

The emergency rehabilitation work of polder dike embankment was commenced by the government of the Union of Myanmar but the work accomplished has not been considered sufficient in terms of quality and quantity, because of lack of both technology and budget. Under these circumstances, the GoUM requested the GoJ to conduct the D/P study for the preservation of farming area to restore agricultural production and the rural life through rehabilitation of polder dike. In response to the request, the GoJ dispatched the missions to conduct the preliminary surveys in the year 2008 and 2009 and the S/W was signed on 6th Oct 2009 to implement the project. In the project, the D/P study to rehabilitate the damage areas affected by the Cyclone Nargis clarifying the methodology for restoring the polder dikes and the gates and through the implementation of the pilot project, the capacity of counterparts for project implementation and technical skills will be developed as well as the agricultural production and rural life in target areas will be rehabilitated.

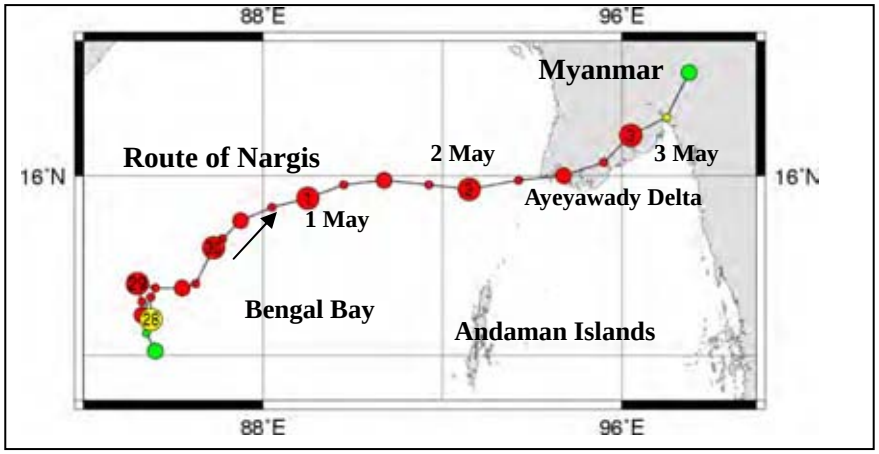


Figure 1.2-1 Route of Cyclone Nargis

1.3 Objectives of the Project

The objectives of the Project are as follows:

1) To formulate the Development Plan (D/P) for the preservation of farming area for urgent rehabilitation of agricultural production and rural life in areas affected by Cyclone Nargis.
2) To develop the capacity of counterparts for project implementation and technical skills as well as to rehabilitate agricultural production and rural life in pilot project area.

1.4 Expected Outputs of the Project

The expected outputs of the Project are as follows:

1) The D/P for preservation of farming area to restore agricultural production and rural life will be formulated.
2) Agricultural production and rural life will be rehabilitated in Labutta North polder through preservation of farming area by pilot projects such as rehabilitation of polder dike.
3) Capacity of counterparts for project implementation and technical skills will be developed.

1.5 The Project Area

The project area covers 34 polder/embankment areas in Ayeyawady Region that were seriously affected by the Cyclone Nargis in the Ayeyawady Delta. The total area is 1,342 km^2 (134,200 ha) and the total length of the polder dike is 942 km. Population in the area is estimated at 248,000 and average population per polder is estimated at 7,300 people.

1.6 Implementation Organization for the Project

In implementing the Project, JICA sent the Project Team consisting of Sanyu Consultants Inc. and Nippon Koei Co. Ltd to the Union of Myanmar. The Project Team carried out the Project in collaboration with counterparts assigned by the Ministry of Agriculture and Irrigation (MOAI).

Also, the Department of Agricultural Planning (DAP) of the MOAI took initiatives to establish a steering committee and working groups to discuss issues and analysis as well as to coordinate among agencies concerned in Myanmar side during the Project. The following structure shows organizational relationship among agencies involved in the Project.

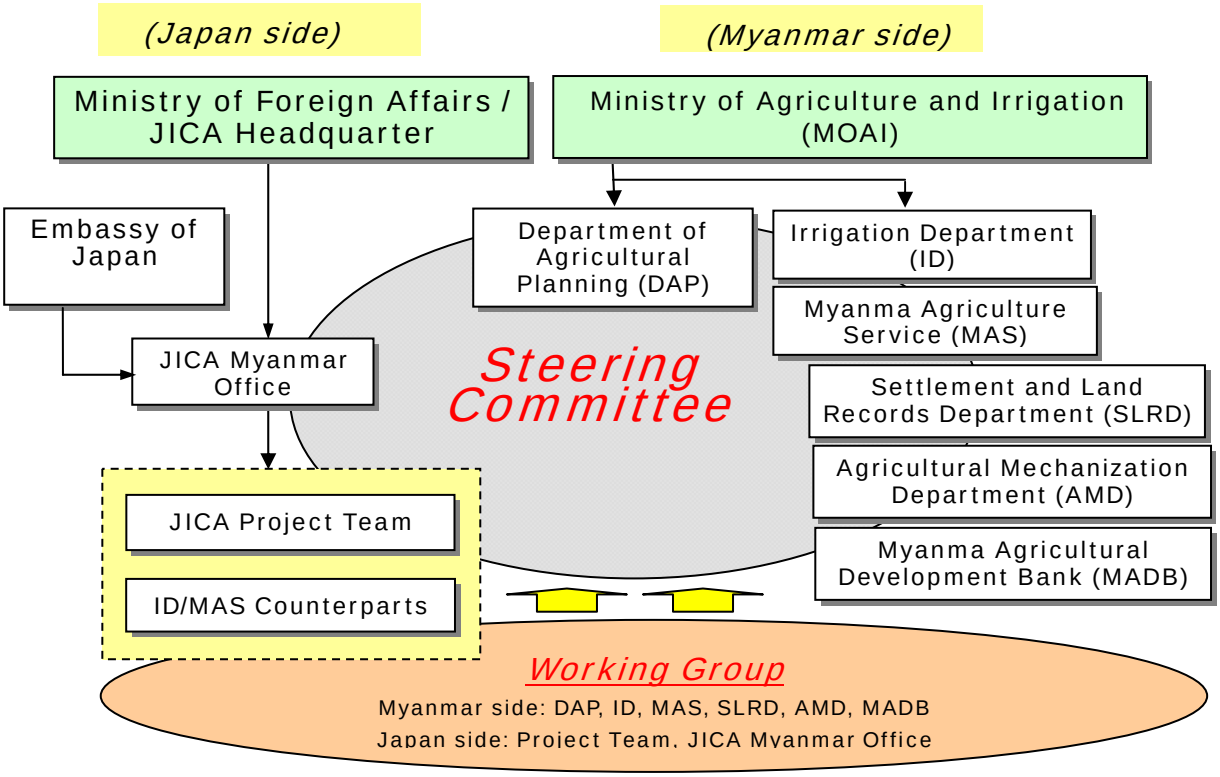


Figure 1.6-1 Organization Chart for the Implementation of the Study

CHAPTER 2 THE PROJECT AREA

2.1 Natural Condition

2.1.1 Climate and Meteorology

The Ayeyawady Delta has tropical and monsoon climate with four definite seasons distinguished as;

- Cool Season from December to March during which the north-eastern cool and dry air current from China brings about 1% of annual rainfall. Monthly mean temperatures vary from 25.0 to 28.8℃.
- Pre-monsoon Hot Season of April and May which is a transitional period with convective heating of the unsettled air mass bringing 13% of the annual rainfall mostly as thunderstorms. Some cyclones tend to re-curve on the Bay of Bengal across the Myanmar coastal area. The 2008 'Nargis' and 1975 severe cyclone landed in the country in May. Monthly mean temperatures are between 29.2 and 30.5℃.
- Monsoon Season from June to September during which the south-western monsoon brings about 77% of the annual rainfall. Monthly mean temperatures vary from 26.8 to 27.5℃.
- Post-monsoon Season of October and November during which some weaker cyclonic storms accompanied by the withdrawal of the south-western monsoon bring 9% of the annual rainfall, mostly in October. Monthly mean temperatures vary from 27.6 to 28.2℃.

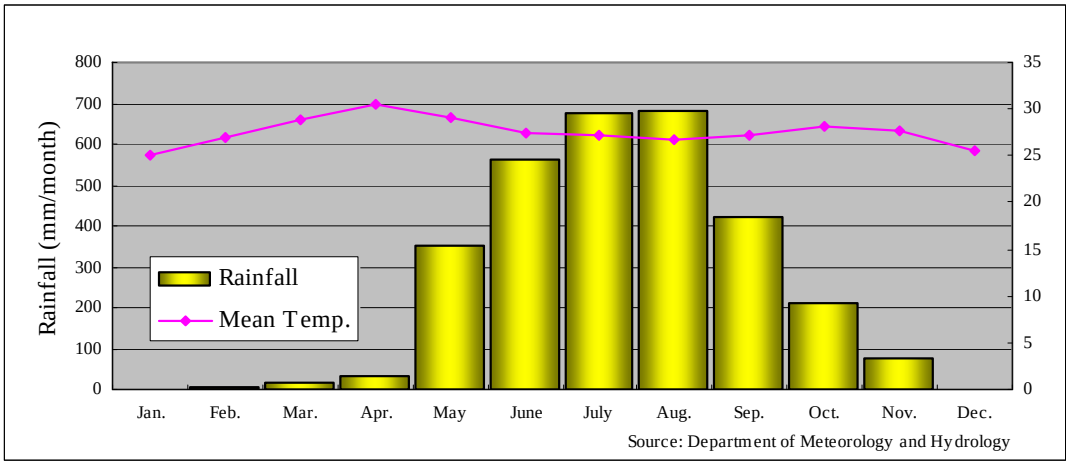


Figure 2.1-1 Monthly Pattern of Rainfall and Mean Temperature at Pathein

These figures relate to Pathein (Bassein) with an annual rainfall of 3,040 mm per year, as an average for the period 1998-2007. In the Ayeyawady delta, there is a trend from about 2,000 mm in the north to 2,500 mm in the southeast and 3,500 mm in the southwest, with a higher variability in the north. Over 90% of the rain falls between mid May and mid November. During the monsoon season, the maximum and minimum temperatures in the delta coastal zone are about 37℃ and 22℃, respectively. The seas may be very rough, and there are often strong winds from the south and southwest. It is also reported that the average annual rainfall exceed 5,000 mm in Diamond Island located about 10 km off the Ayeyawady coast opposite the mouth of the Bassein River,.

According to the report "the Global Climatic Risk Index", Myanmar is one of the countries that is

most affected by extreme weather resulting from climatic change for the last two decades from 1990 to 2008. The report also ranked Myanmar as the worst-hit country in the world in 2008 due to the impact of Cyclone Nargis, which devastated the Ayeyawady Delta in early May killing tens of thousands of people. The report was presented to the United Nations Climate Change Conference held in Copenhagen in 2009. In Myanmar it is observed by environmental researchers that widespread deforestation in the country has affected environment negatively. Despite of the Forest Law enacted in 1992, deforestation in the country is still ongoing. Agricultural expansion, infrastructure projects including dam construction and excessive consumption of firewood are also challenges for sustainable forest management.

2.1.2 Rivers and Hydrology

Originating from the confluence of the Mai Kha and Mali Kha rivers in Kachin State, the Ayeyawady River flows relatively straight north to south direction before emptying via the nine-armed Ayeyawady Delta in the Andaman Sea. Its drainage area of about 413,000 km² covers a large part of the country.

The apex of Ayeyawady delta is situated near Seiktha, about 93 km above Henzada and about 290 km from its outlet at the Andaman Sea. The mean annual flow of Ayeyawady River is reported at about 400,000 million m^3/year. The flow of Ayeyawady River is at its lowest in February and March with a succeeding sharp rise in level in April-May as a result of melting snow in the upper catchment, and a further steep rise in May-June with the onset of the monsoon. The maximum flow occurs in July or August. Most waterways are natural water courses, and there is no extensive system of dredged canals, except the only major canal, Twante Canal, being operated linking Yangon with the western part of the delta.

Due to monsoonal rains, which occur between mid-May and mid-October, the flow volume of Ayeyawady River and its tributaries varies greatly throughout a year. In summer the melting of the snow and glaciers in Northern part of the country add to the volume. The average discharge near the head of the delta is between a high of 32,600 m^3/sec and a low of 2,300 m^3/sec. Over a year, the discharge averages 13,000 m^3/sec. Variation between high and low water levels is also great. Because of the monsoonal character of the rain, the highest point is recorded in August, the lowest in February.

At the Seiktha, the maximum and minimum discharges of 63,900 m^3/sec and 1,306 m^3/sec were recorded in the year 1877.

In relation to storm rainfall, probable values of one day maximum, 2 to 7 day consecutive storm rainfalls are analyzed by the Hydrology Branch of Irrigation Department. Some figures adapted from their study are presented in **Table 2.1-1**.

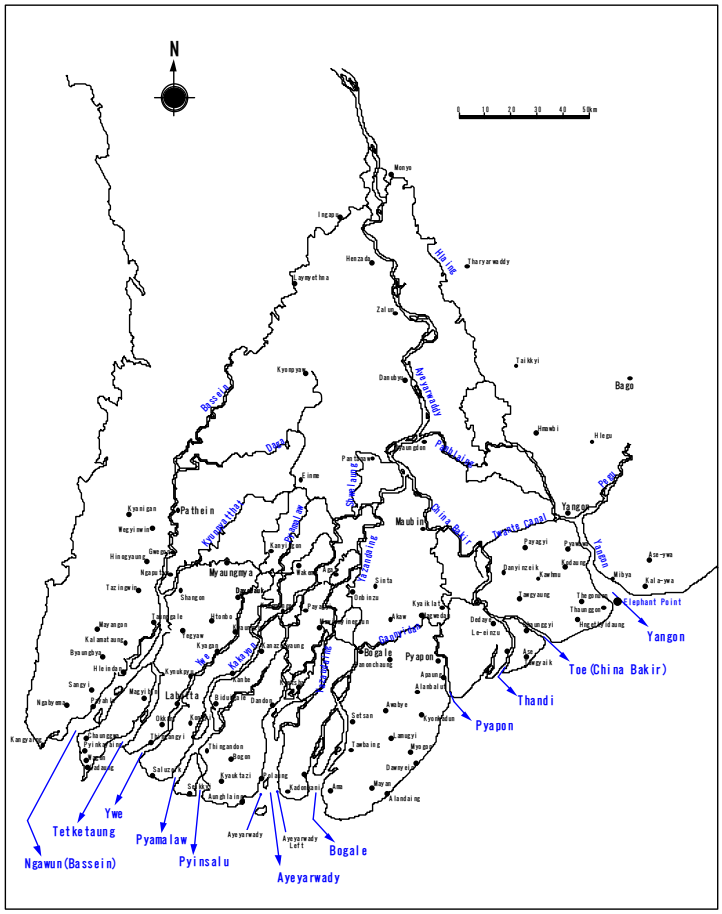


Figure 2.1-2 River Systems of Ayeyawady Delta

Table 2.1-1 Probable Storm Rainfall at Yangon and Pathein (mm)

Station	Yangon			Pathein		
Return Period (years)	One Day Maximum	2 Day Consecutive	3 day Consecutive	One Day Maximum	2 Day Consecutive	3 day Consecutive
5	147.3	203.7	236.0	161.3	242.3	308.4
10	169.9	233.9	266.7	183.4	278.1	352.6
20	191.8	262.9	295.9	204.7	312.4	394.7
25	198.6	272.0	305.3	211.6	323.3	408.2
50	219.7	300.2	334.0	232.4	357.1	449.6
100	240.8	328.4	362.5	253.2	390.4	490.7
200	261.6	356.4	390.9	273.8	423.7	531.6

The westernmost flow of the delta is the Bassein River, while the easternmost stream is the Yangon River, on the left bank of which stands Myanmar's capital city, Yangon. Drainage of Ayeyawady Delta is made directly into the Bay of Bengal through nine major river mouths, the Bassein, Thetkethaung, Ywe, Pyanmalaw, Ayeyawady Bogalay, Phyapon, China Bakir and Yangon, as shown in **Figure 2.1-2**. These rivers carry heavy silt deposit, and their waters are very turbid. In the delta, the soils consist of fine silt, which is replenished continuously by fertile alluvium carried downstream by the river. As a result of heavy rainfall sometimes exceeding 3,000 mm a year in the delta, and the motion and sediment load of the river, the delta surface extends into the Andaman Sea at a rate of about 50 m per

year.

The tidal regime along the coast of the delta is mainly semi-diurnal in character, but with significant diurnal variations. In total, 12 ocean outfalls of the delta are spread along about 250 km of coastline. The spring tide range varies from a minimum of 1.5m at the Phyapon River entrance to a maximum of 5m at the entrance to the Yangon River (Elephant Point). The phase of the main M2 tidal constituent at the mouth of the Yangon River is about 6 hours later than that at the Bassein River entrance. Astronomical tides calculated at both Diamond Island, some 10 km off the Bassein River entrance, and Elephant Point is given in **Figure 2.1-3**.

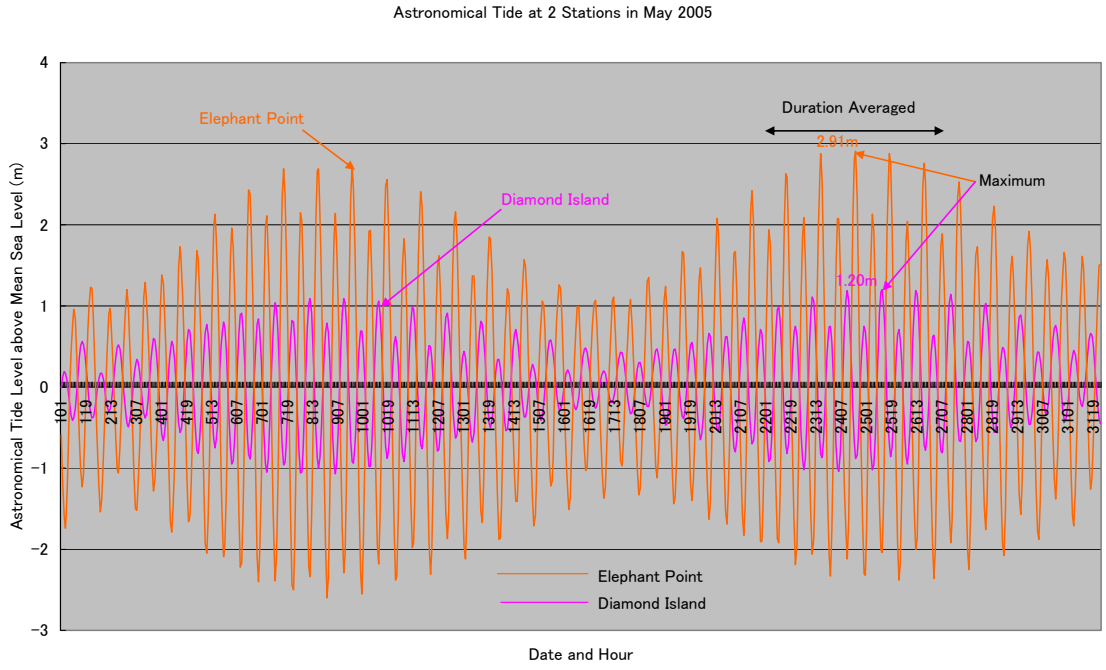


Figure 2.1-3 Astronomical Tide at Diamond Island and Elephant Point

2.1.3 Topography of the Project Area

Myanmar has four distinct topographic regions, the western Rakhine and Chin and Kachin Northern Hills, the Eastern Shan plateau, the Central Belt and Tanintharyi Coastal regions. The Central Belt is further divided into the Central Myanmar basin and the Ayeyawady Delta region. The delta system of the Ayeyawady River extends in a great alluvial fan from the limit of tidal influence near Myanaung (18-15'N) to the Andaman Sea, 290 km to the south. This alluvial plain is bounded to the west by the southern Arakan Yoma range and to the east by the Bago Yoma. The city of Yangon, situated on the southernmost spur of the Bago Yoma, lies at the South-eastern edge of the delta.

There are many distributaries, of which the upper reaches of the Bassein and Hlaing Rivers are only connected to the Ayeyawady River during flood season. As discharge increases, so does overspill into the distributaries. It is estimated that a maximum of 12% of the Ayeyawady discharge enter the Bassein and 24% the Hlaing. This presents an important reduction in the flow entering the middle part of delta areas. Except for a few scattered hills and terraces the total area of flood plain of the delta covering about 31,000 km^2 is less than about 15m above mean sea level. About 5,200 km^2 are below high spring tide level. The network of channels divides the delta into a large number of fertile islands. There is often a shallow depression in the center of the islands, which is flooded by local rainfall early in the wet season and flood remains throughout dry season in some cases. Natural levees and narrow strips of alluvial deposits have formed around the perimeters of most of the islands. The level of these levees and the mean level of the flooded plains increase towards the apex of the delta. Drainage paths

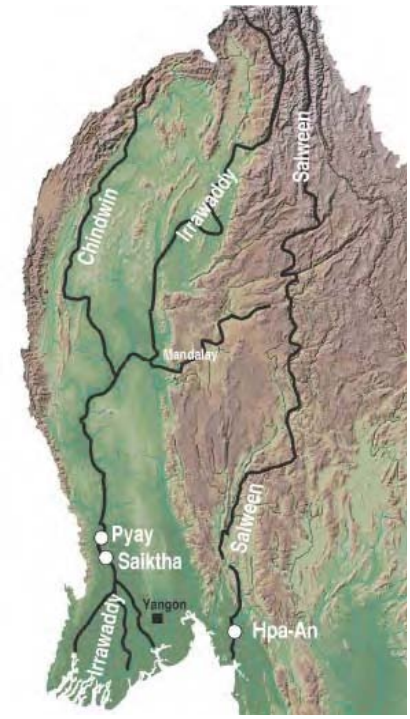


Figure 2.1-4 Topography

tend to be directed towards the most seaward points of the islands. There are large areas of saline mangrove swamps and forests in the south-west part of the delta. These drain via branched systems of tidal tributaries, which feed into the main tidal channels. There are about 2,600 km of channel divided into about 140 reaches connected at about 75 junctions. The system has 12 ocean outfalls and one main fluvial input.

The upper and central portions of the delta are almost entirely under cultivation, principally for rice. Until about 1850, much of this region comprised a complex of permanent and seasonal lakes, swamps and marshes, and vast areas of seasonally inundated plains and swamp forest. However, following the rush of settlers from upper to lower Myanmar in the late 19th Century, the construction of embankments and reclamation of land for agriculture has kept pace with the increase in population. Dike building was initiated by the Government as early as 1861, and many embankments were constructed around 1880 and 1920. In the year 1909, the Burma Embankment Act was enacted, and the Manual on Care and Maintenance of Embankment was released at the same time. At present, there are some 1,300 km of major embankments in the delta, protecting over 600,000 ha of rice paddy. The heights of embankment are designed to protect a flood of 20 years recurrence period only.

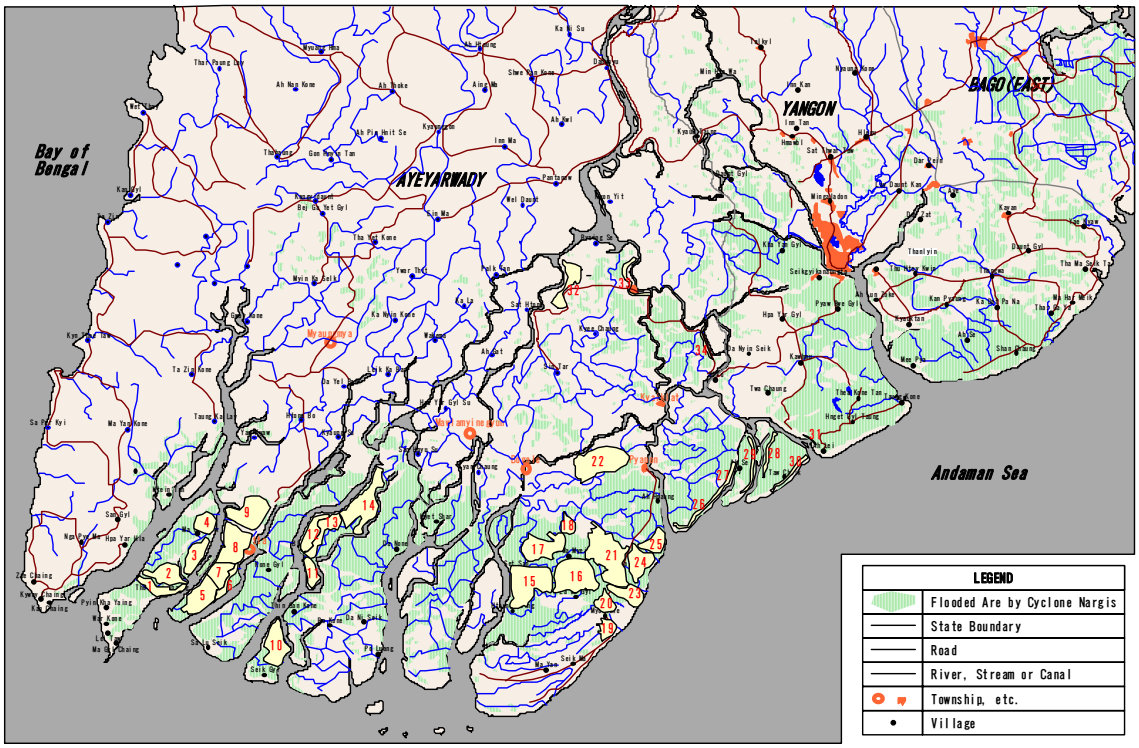


Figure 2.1-5 Project Area

The system of embankments provides a unique example of partial flood protection. The major dikes form horseshoes around the protected areas situated between the main rivers, with the downstream ends left open. In the event of extreme flooding, the lower parts act as flood basins, thus slightly reducing the flood peak. The old embankments have been maintained, and projects are contemplated to extend the system even further. Despite these reclamation schemes, there still remain large tracts of land that are deeply flooded during the monsoon and retain water even during the dry season. In addition, there are numerous permanent oxbow lakes and associated marshes, particularly along the Ayeyawady River between Myanaung and Henzada, along the Myitmaka, and along the upper Bassein and Daga rivers.

The lower, seaward third of the delta, stretching 130 km from east to west, is completely flat with no local relief. About 520,000 ha of land are below high spring tide level and subject to tidal inundation. Much of this area is covered by mangrove forest, and cultivation is limited to the higher patches of ground. Sandy ridges, such as old beaches and sand banks, provide refuges for wildlife during the highest tides. Although the mangrove vegetation has been exploited for a very long time, there are some relatively intact stands remaining. The area is dissected into a number of islands and peninsulas by a series of large, southerly flowing rivers and a complex of smaller, interconnecting water courses, all of which are at least intermittently saline due to tidal intrusion.

The projected area under the study covers the extent that involves 34 polder dikes as shown in **Figure 2.1-5.**

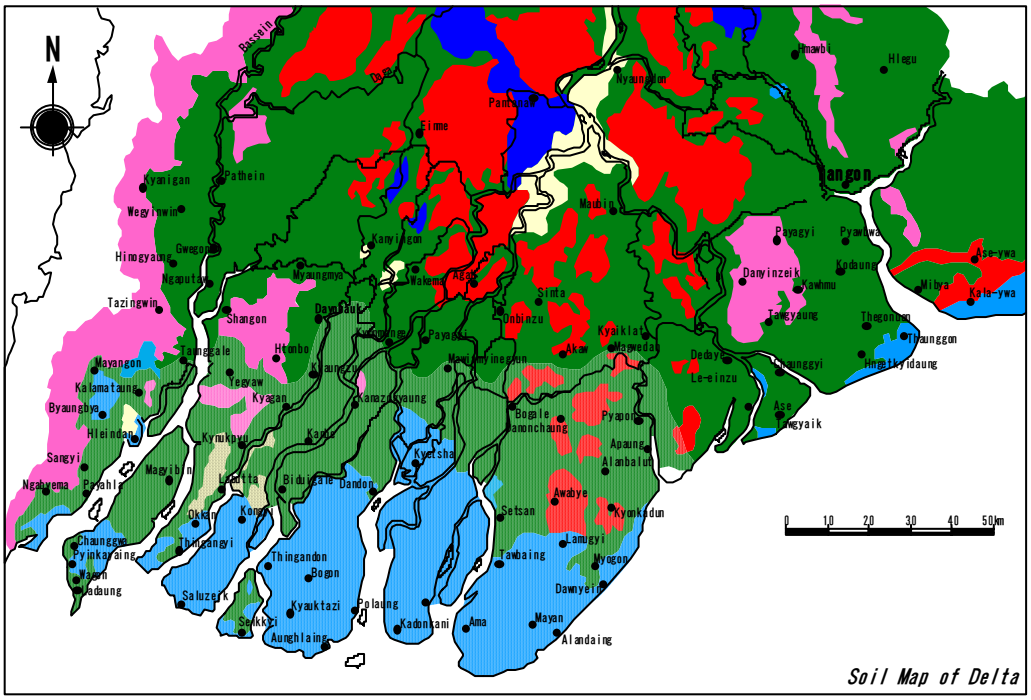
2.1.4 Soils and Water in the Project Area

The entire area is overlain by a thick layer of recent alluvium brought down by the Ayeyawady River. Three main types of soil have been developed, namely meadow gleyey clay soils, meadow swampy soils and saline gleyey soils. There is a general uniformity to the soils of the whole delta. With certain exceptions the soils are essentially fine textured predominantly clays and silty clays at depth and variably textured but often lighter at the surface. The only major variation in profile morphology is in the degree of soil gleying and this appears to have formed the main basis for the classification and mapping of soils. Variations in soil texture and the degree of soil gleying are closely related to physiographic position, and ten units in a soil map shown below are, according to “Irrawaddy Delta Hydrological Investigations and Delta Survey, Sir William Halcrow & Partners, August 1981”, described briefly as follows.

The General Delta Plain (Unit 1) is characterized by fine textured soils, mottled in the upper horizons and becoming increasingly strongly gleyed with depth. The Broad Depressions within the Alluvial Plain (Unit 2) have soils which are almost uniformly very fine textured throughout – silt clays to heavy clays. The soils are strongly gleyed from the surface. Slight elevations associated with somewhat lighter textured and less gleyed soils can occur throughout the delta alluvial plain but in the north east of the plain is an area characterized by extensive elevated terraces designated Unit 3. Within this the soils are a mixture of medium and heavy textured soils with a predominance of lighter textured surface horizons. The delta alluvial plain extends below the limit of the saline front penetration and soils therefore occur with all the general characteristics ascribed to Unit 1 and 2 above, but with salt affected profiles. Such soils are assigned to Unit 4 and 5. The young coastal plain, designated Unit 6, is characterized by soils showing little or no profile development. Soils are fairly uniformly fine textured, moderately or strongly saline throughout and generally support a mangrove forest. The soils of the current river flood plains, Unit 7, differ from the main delta plain in being predominantly light and medium textured. They show very little soil profile development and are generally characterized by depositional stratification of layers of contrasting texture. Where these soils occur below the limit of saline intrusion, Unit 8, their general characteristics are the same as in Unit 7 above but profiles are likely to be moderately saline, the degree of salinity varying according to the balance between salt and fresh water flooding. The meandering belts, Unit 9, are complex physiographic areas with clearly defined ridges and depressions. The elongated low ridges present old levees on which the soils are

generally medium textured – loams or silt loams overlying silty clay loams or clay loams – but area of homogeneous sandy soils may occur. Surrounding the delta are the hills and foothills, Unit 10, with soils markedly different from those of the delta. Textures are predominantly light and profiles show clear pedogenetic development which may include horizons of clay accumulation. Most soils overlie weathering parent materials or unhardened layers of iron enrichment.

Having suitable soil for paddy cultivation, an attempt to classify tropical Asian paddy soil with respect to their material characteristics has been made and presented in "A New Soil Material Classification for Tropical Asian Paddy Soils, L. E. Domingo and K. Kyuma, Southeast Asian Studies, Vol.22, No.3, December 1984". The study was made based on data including those of various total trace element status. Data pertaining to contents of both macro and microelements and mechanical composition for 482 samples were processed. By factor analysis, six factors were extracted, each of which appears to represent a different aspect of soil material characteristics. The scores of the six factors were computed and used for numerical classification by means of numerical taxonomy.



	Delta Alluvial Plain	Predominantly fine textured soils, gleyed and mottled: some surface horizons may be lighter textured particularly on slight elevations
	Depression in delta alluvial plain	Very fine textured soils, strongly gleyed throughout
	Elevated alluvial plain	Medium and heavy textured, soils with gleying only in the lower subsoil
	Delta alluvial plain	Predominantly fine textured soils: gleyed and mottled, with moderately saline subsoil
	Depression in delta alluvial plain	Very fine textured soils, strongly gleyed throughout with moderately saline subsoils
	Coastal plain	Fine textured soils with little or no profile development, moderately or strongly saline, usually supporting mangrove forest
	River flood plain	Predominantly medium and light textured, moderately saline soils with relatively little profile development and some stratification, usually course textured at depth
	River flood plain	Predominantly medium and light textured, moderately saline soils with relatively little profile development
	Meandering belt	Mixture of soils, with medium textured ungleyed soils at higher points and heavy clay strongly gleyed soils in the depression
	Hills and foot-hills	Predominantly lighter textured soils overlaying weathering parent material or plinthite; some shallow stoney soils

Figure 2.1-6 Soil Map of Delta

Based on the dendrogram, seven classes, I-VII, were set up. Of these, two classes (I and III), containing 188 samples, were evaluated to have low capabilities as soil material; two other classes (II and IV), containing 138 samples, to be intermediate; and the remaining three classes (V, VI and VII), accounting for 156 samples, to have high capabilities. In Myanmar, 60 soil samples were collected from the Ayeyawady delta, as shown in **Figure 2.1-7**. Of this, 55 samples out of 60 (92%) are categorized under the class VII, showing extreme uniformity of soil materials suited for paddy cultivation. Distribution of soil samples from Ayeyawady Delta among the seven soil material classes is shown in **Table 2.1-2**. The mean mechanical and total macro and microelement compositions for the samples in each class are given in **Table 2.1-3**, together with the means of such chemical and mineralogical characters related to soil materials as pH, percent base saturation (PBS), cation exchange capacity (CEC), and clay mineralogical compositions.

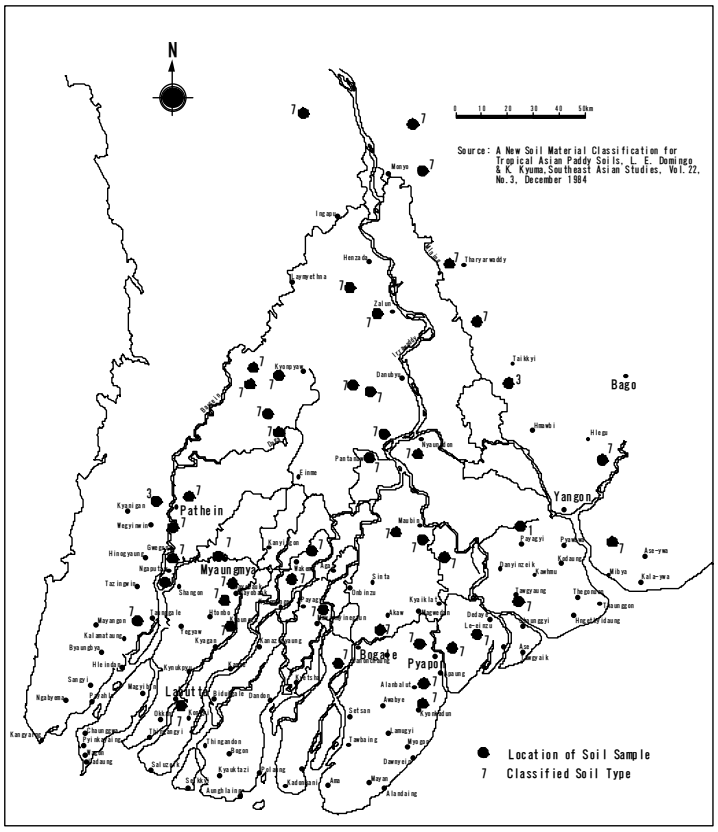


Figure 2.1-7 Soil Samples from Ayeyawady Delta

Table 2.1-2 Distribution of Soil Samples among the Seven Soil Material Classes

Soil Material Class	I	II	III	IV	V	VI	VII	Total
Number of Sample	1	0	4	0	0	0	55	60

Table 2.1-3 Mean Mechanical and Total Chemical Compositions and Other Properties

Class	Unit	I	III	VII
Sand	%	10.06	49.40	17.13
Silt	%	33.78	25.53	41.14
Clay	%	55.16	25.08	41.75
SiO_2	%	68.91	85.57	68.19
Fe_2O_3	%	4.94	2.84	6.92
Al_2O_3	%	21.54	8.86	19.13
CaO	%	0.29	0.34	0.66
MgO	%	0.82	0.27	1.72
MnO_2	%	0.04	0.05	0.09
TiO_2	%	1.23	1.91	1.10
K_2O	%	2.13	1.20	2.09
P_2O_5	%	0.12	0.07	0.08
pH		4.59	5.32	5.10
PBS	%	62.66	59.25	84.42
CEC	Me/100g	22.29	10.00	20.82

In the Ayeyawady delta areas, rainwater or water from ponds and lakes is major water source for local people for daily use. In places where households depend on rainwater only for domestic uses, containers are utilized to store water for future use when rains are not sufficient or dry season. Once the onset of monsoon is late during early monsoon season, the ponds and lakes become totally dry, hence the, local people have to fetch water from neighboring villages or places where fresh water is available. After the Nargis storm hit, most lakes and ponds were filled with salty water from the sea and dead bodies of people and animals. Villagers have removed the corpses from rivulets and drained out salty water from ponds. However, the water is still polluted. The people in the area will have to wait for the rains to come so that the present pond water will be replaced by the rainwater.

The river water is affected by saline water intrusion especially at the end of dry season, or just before onset of pre-monsoon season. Saline water sometimes reaches as far as more than 100 km from the ocean outfalls. Predicted and actually observed saline penetrations are shown in **Figure 2.1-8**.

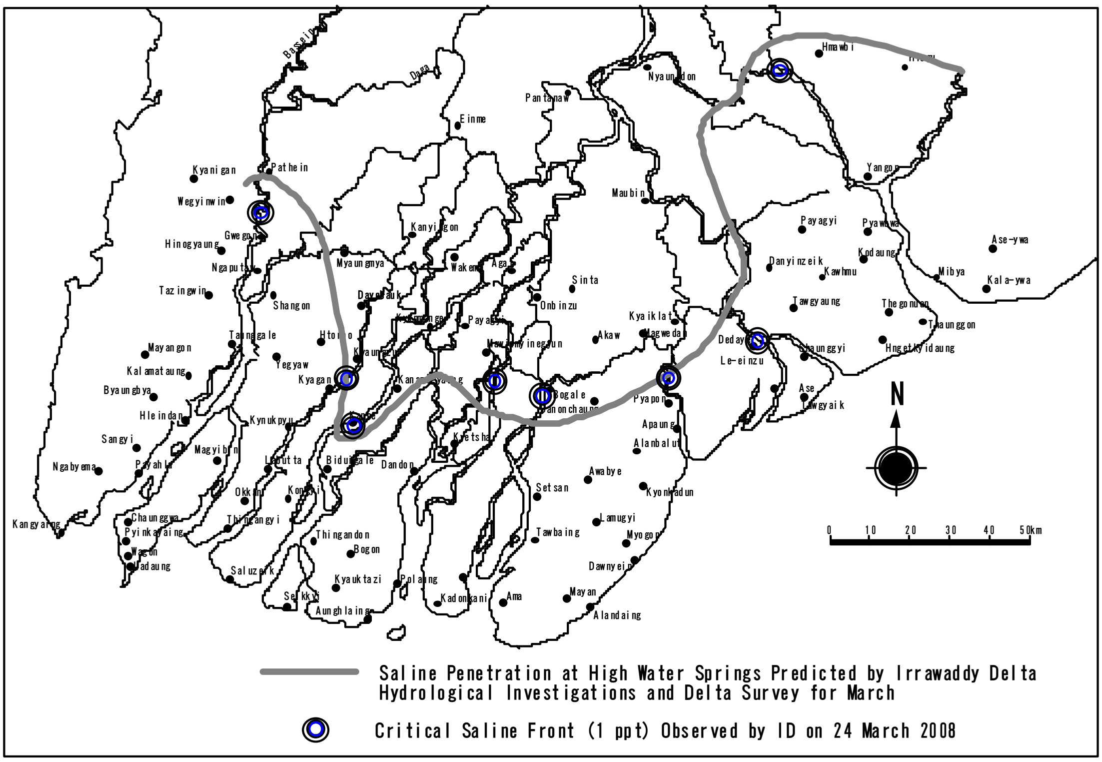


Figure 2.1-8 Critical Saline Front at the End of March

2.1.5 History of Cyclone in Ayeyawady Delta

The Bay of Bengal is frequently subject to severe cyclonic storms, some of which cross the Arakan coast of Myanmar, and very rarely the delta coast. When this happens, however, the surge induced leads to widespread flooding, which could be amplified by extensive polder construction. The Cyclone “Nargis” was generated at the north of Indian Ocean and crossed the Ayeyawady Delta on 2nd May, 2008. The wind speed in the landing became more than 50 m/sec and the scale of cyclone was considered to be at Category 4. A large number of people and houses were severely devastated by the storm surge, high wave and strong wind. The basic data of the cyclone “Nargis” and its damage are reported as follows (OCHA).

- Maximum wind velocity: 54 m/sec

- Maximum wind velocity in 1 min: 66 m/sec
- Central pressure: 962 hPa
- Moving speed: 19 km/h
- Dead person: 78,000
- Missing person: 56,000
- Injured person: 20,000
- Affected population: 2,400,000
- Economic loss: about 100 million US$

Severe cyclones that hit the country are listed in **Table 2.1-4** together with those recorded in the Northern Indian Ocean territory with the death toll exceeding 20,0000 as given in **Table 2.1-5**.

Table 2.1-4 Historical Cyclones Attacked Myanmar

Cyclone	Date of Occurrence	Death Toll[*1,*2]	Sufferers[*1]
-	May 19, 1926	2,700	Unknown
Cyclone 196510	Oct 23, 1965	100	500,000
Cyclone 196702	May 16, 1967	100	130,200
Cyclone 196712	Oct 23, 1967	178	Unknown
Cyclone 196801	May 10, 1968	1,070	90,000
Nargis	May 2, 2008	133,000	1,200,000 – 1,900,000

Notes: *1 Government of Myanmar
*2 Include missing people

Table 2.1-5 Historical Cyclones in the North Indian Ocean Territory

Year	Cyclone	Country	Death Toll
1584	Cyclone Backerganji	Bangladesh	200,000
1699		Bangladesh	50,000
1737	Cyclone Calcutta	Bangladesh	350,000
1767	Cyclone Backerganji	Bangladesh	30,000
1789	Cyclone Indian	India	20,000
1822		Bangladesh	50,000
1831		Bangladesh	22,000
1839	Cyclone Coringa	India	300,000
1864	Cyclone Calcutta	India	60,000
1876	Greater Backganji	Bangkadesh	200,000
1897	Cyclone Chittagong	Bangladesh	175,000
1942	Cyclone Bengal	India	40,000
1970	Cyclone Bhola	Bangladesh	550,000
1977	Andhla Pradesh	India	20,000
1991	Cyclone 02B	Bangladesh	143,000
2008	Cyclone Nargis	Myanmar	133,000

The most recent maximum cyclone that devastated the area was “Bhola” in Bangladesh in 1970 and caused 550,000 casualties. Damage of the cyclone “Nargis” is rank 8th in the above table and therefore ranked as one of the most severe disaster in South-Asia. Cyclones of similar intensity hit Myanmar in May 1982 and April 2006. In both instances the landfall fortunately hit the northern part of the most densely populated parts of the country.

Generally, in the months of April and May, there is an appreciable increase in the frequency of storms.

Most of the storms originate between 10°N and 15°N, move initially in a northwesterly and northerly direction and then re-curve towards the northeast. The Arakan coast of the country is liable to incidence of storms in these months. A number of these storms are of severe intensity. In the months of October and November, storms originate between 8°N and 14°N and move initially in a west-northwesterly direction and then re-curve and move towards northwest. These storms rarely approach the Myanmar coast.

Data on storm occurrences are not readily available. No storm data are recorded since the year 1979 due to the malfunctioning of the automatic gauging facilities installed in the area. Hence, the period from 1979 up to the recent times and prior to the study, the resultant sea water levels (astronomical tide + storm surge) at ocean outfalls (river mouths) have neither been recorded nor documented within the whole regions of the Ayeyawady Delta. Recently the Department of Meteorology and Hydrology (DMH) under the Ministry of Transportation decided to start again observation of the sea water level after the Great Sumatra Earthquake of 2004. The DMH installed 2 tide gauges, which were donated by the Asian Disaster Preparedness Center (ADPC), in the Myanmar coastal areas of Mawlamyine and Sittwe in June 2006.

Information on cyclones generated mostly in Indian Ocean and crossed or approached the country since 1965 were collected from various sources as shown in **Figure 2.1-9**. Physical data including high water levels and surge amplitudes are not available after 1979. Old data of storm surge utilized in various investigations are listed in **Table 2.1-6**.

Table 2.1-6 Characteristic of Severe Cyclonic Storms in Bay of Bengal (1965-78)

Date	Surge Produced at Elephant Point (m)	Date	Surge Produced at Elephant Point (m)
21 Oct 1965	0.54	15 Nov 1972	0.34
8 Dec 1965	0.58	26 Nov 1972	0.42
26 Sep 1966	0.94	1 Dec 1972	0.24
9 Dec 1966	0.58	2 May 1973	0.82
16 May 1967	0.80	4 Nov 1973	0.86
20 Oct 1967	0.85	14 Nov 1973	0.63
7 May 1968	0.91	6 Dec 1973	0.66
22 Oct 1968	0.38	22 May 1974	0.76
10 Nov 1968	0.74	26 Sep 1974	1.52
9 Oct 1969	0.50	22 Nov 1974	0.74
3 Nov 1969	0.77	5 May 1975	1.41
4 May 1970	0.55	3 June 1975	0.59
18 Oct 1970	0.85	25 Nov 1975	0.59
8 Nov 1970	0.90	29 Apr 1976	0.49
27 Oct 1971	0.58	1 Jan 1977	0.49
4 Nov 1971	0.52		
7 Sep 1972	0.71		

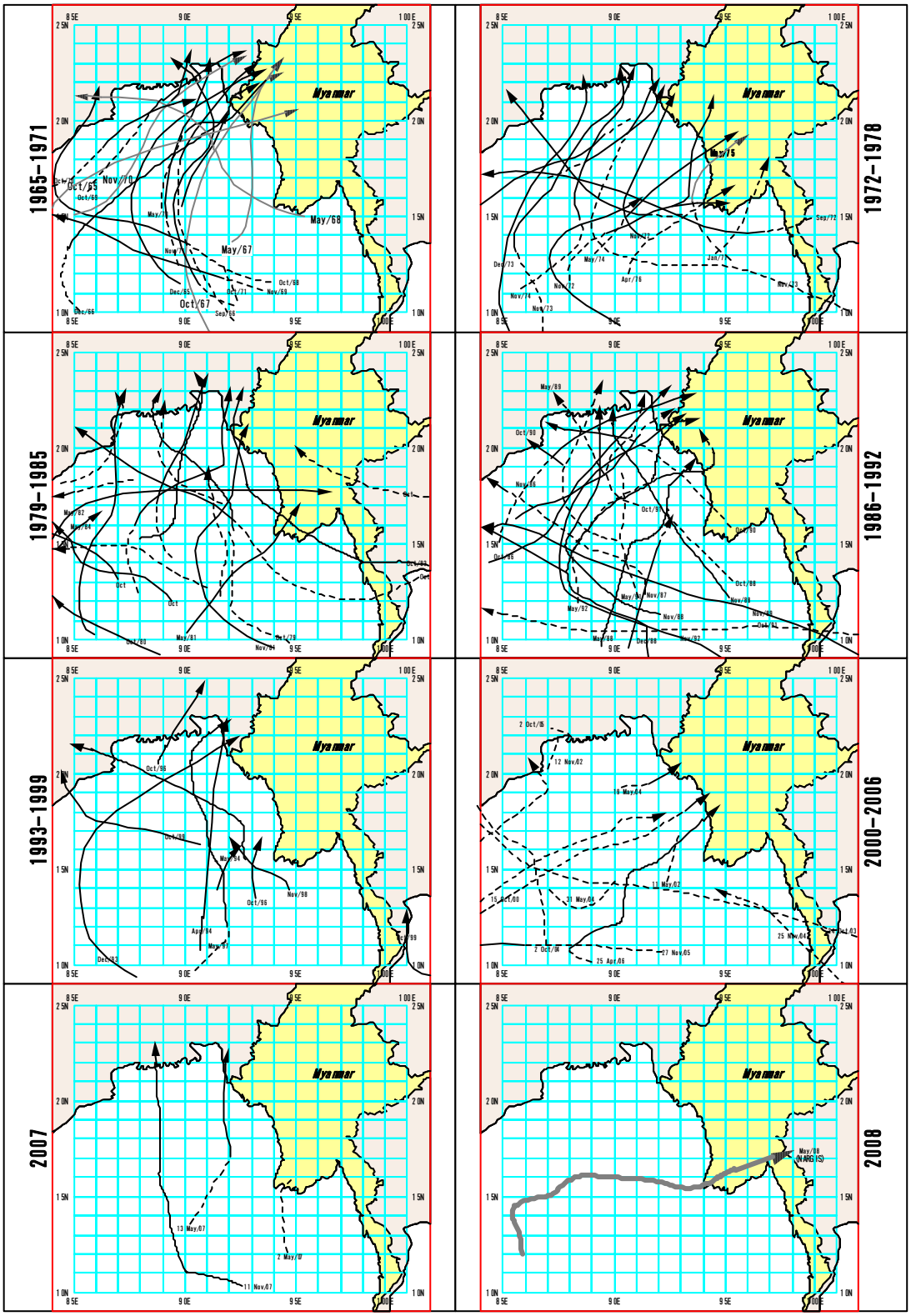


Figure 2.1-9 Tracks of Cyclones since 1965

2.2 Socio-economic Condition

2.2.1 Land Area and Population in the Project Area

The Project Area consists of 34 polders/embankments in the Ayeyawady Region, with protected area of 1,342 km^2 and a total population of 248,001 as shown below. It covers 2 districts, namely, Labutta and Phyapon Districts. Polder area is not exactly matching with administrative boundary of township and village-tract (VT). Therefore, some polders stretch over plural VTs. Labutta Township was originally under the Myaungmya District; however it became Labutta District in August 2008 after reorganization as it was combined with Mawlamyinegyum Township which was also under the Myaungmya District.

Table 2.2-1 Population, Area and Dike Length of 34 Polders/Embankments under the Project

District	Township	Sr. No.	Name of polder	Population	Household	Protected area (km^2)	Length of dike	
							(mile)	(km)
Labutta	Labutta	1	Alegyun (1)	3,947	1,019	16.7	13.40	21.6
		2	Alegyun (2)	6,139	1,515	36.1	22.70	36.5
		3	Alegyun (3)	2,967	813	36.5	17.65	28.4
		4	Magybinmadaukkan	1,601	379	5.5	3.40	5.5
		5	Thingangyi	474	155	7.0	6.30	10.1
		6	Zinywe	633	159	6.2	6.00	9.7
		7	Leikkwin	392	98	3.8	3.75	6.0
		8	Labutta (South)	4,166	1,051	28.7	20.20	32.5
		9	Labutta (North)	15,547	3,662	78.3	38.00	61.2
		10	U Gaungpu	205	50	3.7	5.20	8.4
		11	Bitud Island (1)	1,191	332	19.0	14.02	22.6
		12	Bitud Island (2)	7,315	1,777	27.8	18.60	29.9
		13	Bitud Island (3)	3,743	968	32.2	28.00	45.1
		14	Bitud Island (4)	14,169	2,916	76.4	40.53	65.3
			Sub-total	**62,489**	**14,894**	**377.8**	**237.75**	**382.8**
Phyapon	Bogalay	15	Daunggyi	15,935	2,944	98.9	37.00	59.6
		16	Daunggyi (East)	8,433	1,406	89.3	33.90	54.6
		17	Daunggyi (West)	12,921	4,004	69.4	31.60	50.9
		18	Daunggyi (Upper)	4,066	639	13.8	10.50	16.9
			Sub-total	**41,355**	**8,993**	**271.4**	**113.00**	**181.9**
	Phyapon	19	Daw Nyein	5,850	1,295	12.0	14.00	22.5
		20	Myokone	4,019	962	22.8	17.00	27.4
		21	Kyetphamwezaung	25,687	5,044	125.7	46.00	74.1
		22	Banbwezu	9,604	2,173	53.3	26.00	41.9
		23	Daydalu	4,072	859	17.2	13.00	20.9
		24	Letpanbin	4,195	840	34.6	20.00	32.2
		25	Zinbaung	3,992	875	26.7	15.00	24.2
			Sub-total	**57,419**	**12,048**	**292.3**	**151.00**	**243.1**
	Daydaye	26	Myaseinkan	9,866	2,335	54.7	13.50	21.7
		27	Thandi	1,651	372	13.9	4.25	6.8
		28	Suclubbaluma	4,935	1,225	29.5	7.40	11.9
		29	Hleseikchaunggyi	2,026	492	9.1	7.40	11.9
		30	Tamatakaw	10,459	2,589	53.5	7.00	11.3
		31	Kyonsoat	316	72	2.4	5.00	8.1
			Sub-total	**29,253**	**7,085**	**163.0**	**44.55**	**71.7**
	Kyaiklatt	32	Maubin Island (North)	27,386	5,764	110.0	12.40	20.0
		33	Maubin Island (South)	9,248	1,990	46.1	4.40	7.1
		34	Thonegwakyun	20,851	4,601	81.2	22.25	35.8
			Sub-total	**57,485**	**12,355**	**237.3**	**39.05**	**62.9**
			G-total	**248,001**	**55,375**	**1,341.7**	**585.4**	**942.4**

Notes: (1) Polders No. 1 to No. 4 are in located in Haigyinkyun sub-township within the Labutta Township (they were formerly located in the Ngaputaw Township at the time of Nargis) while polders No. 5 to No. 14 are located in the Labutta sub-township.
(2) Three village-tracts of No. 21 Kyetphamwezaung polder are located in Bogalay Township.
(3) All figures are based on 2010 January to April estimates.
Source: Township Peace and Development Councils (TPDC) and Township Irrigation Department.

2.2.2 Rural Economy and Livelihood in the Project Area

(1) Situations by Township[1]

The Project Area is located in five townships as shown below. Total population of the five townships is 1,470,296 as of December 2008. The project target population accounts about 17% of the total population of these townships. Conditions in these townships are described as follows.

Table 2.2-2 Administrative District and Population, Number of Village Tracts and Villages in Target Townships

District	Township		Total Population	Project Area Population	Number of Village Tracts	Number of Villages
Labutta	Labutta	Labutta sub-township	287,671	14,654	61	408
		Haigyikyun sub-township	109,512	47,835	22	112
Phyapon	Bogalay		349,427	41,355	71	589
	Phyapon		310,321	57,419	52	211
	Daydaye		216,959	29.253	90+3	390
	Kyaiklatt		196,406	57,485	87	438
Total			**1,470,296**	**248,001**	**383+3**	**2,148**

Source: Year 2009 General Administration Office Data for Labutta District and Post-Nargis Periodic Review II (TCG, July 2009) for Phyapon District.

1) Labutta Township

Farming, especially rice production is the most important livelihood in the northern part of this township. Residents residing in the coastal areas are engaged in the fishery sector. During agricultural off-season, many farmers work in the fishery sector. This township is famous for salt production and that some salt farms are also available. Other activities are small livestock/poultry rearing, transport, retail trade, cottage industry and so on. It has high percentage of landless people.

2) Daydaye Township

Local residents employ traditional agriculture, fishery, trading and salt refining in Daydaye Township. Casual labors generally work in agricultural sector. Apart from these industries, bamdayboo-ware trading is done as a main income resource.

3) Phyapon Township

Main income sources are agriculture, fisheries, small livestock rearing (pig, duck and chicken), casual labors and commerce. More than one third of total area, especially southern part of the township is covered with mangrove vegetation. Villages and agricultural lands are concentrated in the upper part of the township.

4) Bogalay Township

Only a few people own most of the lands as 68% own more than 10 acres in spite of high percentage of landless people. Main crop is paddy in the agricultural area. In addition, 37% of people work in fishery sector and 80% of households raise livestock.

[1] This part mainly refers to Myanmar Information Management Unit (MIMU), March 2009, "Township Profile"

5) Kyaiklatt Township

Main stream of the Ayeyawady River traverses the township north and south. Most of people make a living by farming rice and some vegetables. Moreover, other crops planted are coconut, betel nut and banana. The residents of the area also engaged livestock rearing (pig and duck), casual labor and commerce.

(2) Main Industries

The Project Area is located in Ayeyawady Region. Although this Region occupies only 5% of whole national land in the Union, it is known as the rice bowl of the country as it produces most of rice requirements of the country. . Annual rice production of Ayeyawady Region which is about 6 million tons accounts for 30% of total production in Myanmar of which about 22 million tons annually (FAO, 2001/2002, Agricultural Atlas of the Union of Myanmar). This situation is mainly due to increase of farmland area, especially, 25% increase between 1990 and 1994. In addition to rice farming, aquaculture, poultry and pig farms are being operated. Especially, the area of fishpond in the Region is more than half of the country's area, thus it is worth to note that Ayeyawady Region is the fish and prawn production center in Myanmar. Therefore, it can be said that the Region is very important to Myanmar in terms of food supply. Moreover, Labutta area is famous for salt production. On the other hand, since the development of the delta has been launched only from early 20th century, other industries apart from farming and fishery are not actively done.

According to the result of the Present Condition Survey carried out in 34 villages[2] from January to February 2010 by the JICA Study Team, where one village was selected from each polder as sample village, agriculture is observed as the main source of income in all sample villages except Akeichaungwa village, representative sample of Myaseinkan polder in Daydaye Township, where fishery is the main income source. Priority sources of income stated in the sample villages before Nargis are unchanged even after Nargis.

Paddy is widely grown in rainy season in all sample villages while summer paddy is grown to some extent within all three polders in Kyaiklatt Township, Banbwezu polder in Phyapon Township, and few area of summer paddy in Bitud Island-2, Labutta Township depending on the availability of irrigation water. Some vegetables are grown for home consumption and the surplus as other source of income. Rice is followed by black gram as winter crops in all the polders (Bitud 1, 2, 3 & 4) of Labutta Township, and Maubin Island (North) and Maubin Island (South), Kyaiklatt Township.

Fishery stands as the second important source of income after farming in all survey villages located in survey areas of six townships. Fishing and processing of fishery products provide an opportunity for landless people to earn income for their livelihood. Based on information from the key informants' survey, prawn is the most important source of income in the aqua industry in the villages and given first priority for earning income particularly in former Ngaputaw (actually Haigyinkyun sub–township of Labutta district) and Labutta Townships. Dry prawn, fried fish and prawn paste making industries are performed in most of the surveyed villages. All stock of fishery products was damaged by Nargis but informants of the sample villages said that rural fish product industries recovered to normal condition at present except in Nalinkyaw village, Thingangyi polder in Labutta Township.

(3) High Percentage of Landless People

The average farm size per household in Ayeyawady Delta is 11.2 acre (= 4.536 ha) according to UNDP (June, 2007)[3], which is ranked at 1st among the Union in terms of farmland size per household. It is probably because the process of settling of immigrants in the delta has only been around 100 years so

[2] One village in each polder was pointed by the TPDC chairman in consideration of the criteria "most affected village" and "accessibility". The list of sample villages is shown in **Appendix 1.**

[3] UNDP/UNOPS/ Ministry of National Planning and Economic Development, June 2007 "Poverty Profile, Integrated Household Living Conditions Survey in Myanmar"

that it was not difficult for people to expand their lands. However, due to the high rate of population increase[4], the ratio of landless farmers in the delta reaches to not-negligible level. Some people lost their land tiller's right to cover school expense or medical payment. Severely affected townships by Nargis are characterized by their high percentage of landless people, for instance, 62% and 71% of people in Bogalay and Labutta is landless, respectively, according to "Post-Nargis Joint Assessment Report"[5] (hereinafter, PONJA, July 2008). On the other hand, there is a case of one person holds 60 acre farmland.

Result of Present Condition Survey shows that ratio of households who have the tiller's right on farm land at the survey period falls between 39.7% of villages in Kyaiklatt TS and 22.6% of villages in Bogalay TS (70% at the maximum and 9.9% at the minimum at village level). Majority of household are landless farm workers, accounting over 50% except in Labutta and Bogalay townships on average. At the village level, the maximum ratio is 86.3% in the village of Bitud Island-3 polder, Labutta Township, and the minimum is 14.8% in the village of Kyetphamwezaung polder, Phyapon Township.

Average farm sizes of land holders who have tiller's right in the sample villages are more than 15 acre per farm household except in Kyaiklatownship. The range of farm size is large in some polders indicating maximum holding area of 200 acres and minimum area of 1.7 acres.

Table 2.2-3 Land Occupancy Status and Farm Size

Sr. No.	Township	Land occupancy status				Average farm size (acre/farm household)
		Land Holder (%)	Tenant (%)	Farm worker (Landless) %	Non-farm %	
1	Labutta (14 Polders)	26.1%	1.1%	65.2%	7.6%	18.5
2	Bogalay (4 Polders)	22.6%	1.4%	53.1%	22.9%	21.9
3	Phyapon (7 Polders)	31.2%	1.0%	28.3%	39.5%	25.6
4	Daydaye (6 Polders)	30.7%	0.8%	34.6%	33.9%	16.2
5	Kyaiklatt (3 Polders)	39.7%	0.0%	44.6%	15.7%	8.5

Source: Present Condition Survey, JICA Study Team, 2010

There is a big difference between land right holders and landless households in terms of household income. Average household income of the land right holders is more than double than landless households. Average income of all polders for landholders and land less households are presented d in **Table 2.2-4**.

Table 2.2-4 Average 2009 Income of Tiller's Right Holders and Landless Households in 34 Polders

Township	Landholder (Kyat/hh/year)	Landless households (Kyat/hh/year)
Labutta	4,353,986	1,804,961
Former Labutta	*2,386,598*	*1,219,861*
Former Ngaputaw	*1,967,388*	*585,100*
Bogalay	3,705,438	1,893,917
Phyapon	6,643,200	1,931,857
Daydaye	4,342,898	2,414,917
Kyaiklatt	2,206,367	1,354,333
All townships	3,541,981	1,566,664

Source: Present Condition Survey JICA Study Team, Jan. 2010

In La Put Ta Loke North Village Tract (VT) in Labutta North polder, there are 150 landless households

[4] According to an interview to Kyein Chaung Village (La Put Ta Loke North Village Tract), current population is around 1,000 while that was about 500 around 15 years before.

[5] This report is prepared by Tripartite Core Group (TCG), which consists of ASEAN, Government of Myanmar and UNDP.

whose annual incomes are about 1,200,000 Kyats, while 15 rich households receive about 5,000,000 Kyats annually (JICA study team, Jan. 2010). If people do not own farmland nor fishing tools, their job opportunity is limited mainly to daily labor, which means that their income tends to be unstable. Furthermore, nowadays, it is becoming more difficult to get land tiller's right due to more demand of farmland. In addition, very poor people face difficulty to find out a piece of land area even to construct their houses. Sometimes, they have no choice but to stay in prohibited area for residence even though they know it is illegal

2.2.3 Ethnic Distribution

Majority of the residents in the Project Area are Burmese, composed mainly of minority groups such as the Kayin, Rakhine and so on. Rakhine people reside mostly in the west coast of the Ayeyawady Delta, which was not severely affected by Nargis. The Bamar are distributed in the whole Delta while the Kayin people reside in southern coastal area. Both Bamar and Rakhine is Buddhist, while the Kayin people are either Christian or Buddhist. These minority groups are mostly engaged in fishery activities. They have established each community and sometimes they combined with other people to organize villages. The relationships among these groups in a village are relatively good in spite of some cultural differences.

Each community in the Delta Region shows relatively strong solidarity, as people know their neighborhood's living status, farmlands location and so on very well. If they face some difficulties, they try to solve the challenges collaboratively even between different ethnicity and religion, livelihood type groups. They have tradition to help each other, for instance, rich person lend money to the poor without interest in difficult situations. However, there are some cases reported where assistance are only provided to a particular group which affected solidarity in the villages[6].

2.2.4 National and Local Government in the Project Area

The PDC chairman at township/district level is assigned by the Ministry of Home Affairs and had important tasks. All departments' staff such as ID, MAS, and FD was supposed to report their information acquired by their daily works to the PDC chairman at each level. Therefore, the PDC chairmen are familiar with current situations in all sectors and it is also called as General Administration Council. PDC chairmen reported all the collected information to higher level of PDC. On the other hand, all department staff has close relationship among different levels, namely, township, district, Region and state level. They hold regular meeting at various levels to share current status concerning each sector.

The direct administrative organization for people is a township office. Every department at township level regularly implements site inspection to collect basic information and disseminate the technical knowledge for rural communities to improve their socio-economic status. Technical staffs such as ID officers are not members of Township level PDC (hereinafter called as "TPDC"). However, they regularly communicate with TPDC to share information among various departments. TPDC offices acknowledged the selected village leader and assign one clerk as a VPDC member to each village. A VPDC chairman provides information on new projects as informed by township officers and is also delegated to inform the villagers and sometimes gives necessary instruction to the people. TPDC consists of chairman, project officer and township police officer.

A township office has detail information about land use right distribution of responsible villages. Since the land use right is renewed every year, township officers revise the distribution map based on the site survey in collaboration with Settlement and Land Record Department (SLRD). If they find out that private construction for settlement is being constructed in prohibited area they warn the illegal occupiers through the village headman. If a private company wants to acquire farmland for development, township offices intervene between the land holders and the private developer and fix

[6] TCG, January 2009, "Post-Nargis Social Impacts Monitoring: November 2008"

the rate for land acquisition. Payment is also under the control of township officers, not directly paid from the private company to the individuals.

The minimum administrative unit is VT with an average of about 6 villages under a VT in the target area. Each village tract has an organization so called Village Peace and Development Council (VPDC), which consists of chairman, secretary, clerk and so on. VPDC is the lowest Peace and Development Council (PDC) in the country. People select their leaders at three stages, namely, one leader per 10 households, another leader per 100 households and a VT head. The VT head is also the VPDC chairman and with a responsibility (generally village leader is male) to inform coming events or projects implemented by the government to villagers through his frequent contact with township office staff. The clerk is assigned by the responsible townships office.

According to the Notification No. 8/2011 issued by the State Peace and Development Council (SPDC) on 30th March 2011, PDCs of the district, township, ward/village tract were dissolved and all their duties and function were handed over to the following personnel as shown below:

a) District PDC → Deputy Commissioner of District General Administration Department
b) Township PDC → Administrator of Township General Administration Department
c) Ward or Village-tract PDC → Head of Ward or Head of Village-tract

2.2.5 Gender Issues in the Project Area

Seven (7) States/Regions in Union, literacy rates of male and female in Ayeyawady Region are 91.6% and 88.2%, respectively, while that of the whole union are 88.2% and 82.0%, respectively.. Therefore, it can be said that educational level in Ayeyawady Region is relatively high, with as little gender difference as compared to the national average rates. Generally, women in Myanmar society have equal position to men and wives keep and manage the house income even though husbands have a duty to earn to make living. According to the interview done by the Project Team in January 2010, women can make decision on how to spend money to some extent, such as their accessories and their clothes; however, for big amount of money, couples decide it based on discussion.

Women's main tasks are housekeeping, taking care children and water fetching and so on. If husbands own land tiller's right, wives assist in farming their lands. Women join in farming activities such as transplanting and harvesting, however, land preparation is regarded as men's job. The cash income that women can get is relatively limited, since wage of female is less than men's, sometimes almost half. For instance, female can earn Kyats 2,000/day for road construction work while male can get daily wage at Kyats 4,000 according to the interview by the Project Team near Labutta North Polder. The reason cited was that men generally do harder work than women. It means that conditions are very tough for households headed by female to survive. However, retail selling is regarded as women's job, where some women are actively involved. Women can attend official meeting and sometimes express their opinions, however, they are not very active in these situations and generally only men are supposed to fill seat of public position such as village head.

Basically, women can inherit fortune from their parents as well as men do and children have equal right to do that. However, there is tendency/custom that parents distribute bigger part of their property to the poorest child and smaller part to the richest one. In addition, there is another case that son/daughter who takes care of his/her parents inherits more than his/her brothers and sisters. The way of property inheritance depends on each condition. Still, it is common that women sign over their land tiller's right to their husbands after marriage since farming is generally men's job even though wives assist their husbands. In such cases, husbands become official land users and women cannot transfer the land tiller's right to others without permission from their husbands.

2.2.6 Disaster occurred by Cyclone Nargis

(1) Victims of Cyclone Nargis

The scale of damage by Nargis was unprecedented and many human lives were lost in the Project Area. According to TCG (July 2008), the numbers of dead and missing in the six townships (including Ngaputaw) in Ayeyawady Region were 77,647 and 51,701, respectively, with a total number of 129,348, as shown the following table. The grand total number of dead and missing due to cyclone Nargis including casualties in Yangon Region and other townships in Ayeyawady Region was 138,373. Labutta Township was the most severely damaged area by cyclone Nargis with a population decrease of about 20% due to deaths.

Table 2.2-5 Number of Victims by Nargis in Target Townships

Township	Population before Nargis	Number of Dead	Number of Missing	Missed Houses
Ngaputaw[7]	330,058	4,178	10	13,021
Labutta	394,553	33,344	48,464	9,297
Bogalay	285,909	34,744	3,198	No Data
Phyapon	240,091	1,258	10	-
Daydaye	211,353	4,111	19	8,593
Kyaiklatt	177,339	12	-	-
Total	**1,639,303**	**77,647**	**51,701**	**30,911**

Source: TCG, July 2008, "Post-Nargis Joint Assessment", for number of dead and missing, and MIMU, "Township Profile", March 2009 for population before Nargis and number of missed houses

(2) Damages to Infrastructures

1) Housing

There are two types of housing structures, namely, traditional type and modern type in the affected area. The materials of the former is a mixture of wooden and bamboo. Before cyclone Nargis, around half of houses were constructed by using bamboo and wooden; about 35% of structures were all wooden and 15% were made of brick or concrete. Many houses were vulnerable to storms, which led to the significant damage by cyclone Nargis. It is estimated that around 450,000 houses were totally destroyed and 350,000 houses were lightly damaged in the whole affected area. The total damage and losses in both Ayeyawady Region and Yangon Region is estimated as around 686 billion Kyats (TCG, 2008, PONJA).

2) Schools

Present Condition Survey revealed that educational level in most of the villages are satisfactory for rural people before Nargis since local communities established self reliant schools in most of the sample villages for their children. Though almost all educational facilities were damaged by Nargis, reconstruction and repairing of these infrastructures had been urgently undertaken by the government agencies and NGOs, cooperating with the local organizations and communities. School attendance and educational activities are functioning as usual at present.

3) Water Supply

The most common water source in Ayeyawady Region is the pond. Other sources of domestic water use are the river and open well. During rainy season, most houses collect water by using roof-rainwater system. Only handful people can access to piped water supply system before and after Nargis. Communal ponds were affected by Nargis significantly as 43% of communal ponds were damaged in Ayeyawady Region according to PONJA. Many households were enforced to shift water sources from pond to rain water tanks due to high salinity of pond water as shown below.

[7] The administrative Region is that of the time of Nargis.

Table 2.2-6 Source of Water before and after Cyclone in Ayeyawady Region

Water Sources	Before Nargis	After Nargis
Hand Pump	2%	2%
Tube Well	4%	4%
Pond	42%	24%
Rain Water Tank	16%	30%
Water Truck	1%	2%
River	21%	19%
Open Dug Well	21%	19%
Others	8%	0%

Source: TCG, July 2008, "Post-Nargis Joint Assessment (PONJA)"

During Nargis, all water resources existing in 34 sample villages were damaged due to in flow of salt water, debris in the ponds and wells, and rising up of salt water table. Immediate measures were provided by various agencies by providing drinking water and water saving tanks to save the rain water. Renovation and cleaning of the ponds were carried out during the short period of time before monsoon in order to restore the rain water in the ponds. In the sample villages, water quality is still salty, impure and insufficient in most places (in 23 villages out of 34) during the survey period. There is still a need to improve and upgrade the basic infrastructures to become functional for rural household.

4) Transport and Communications

The damage[8] to the transport and communication sector covering road, rail, water and air transport is estimated at over 120 billion Kyats and total losses is estimated at nearly 63 billion Kyats in the whole area affected by the cyclone. Most affected facilities were the water transport, the damage and losses of each was about 100 billion and 31 billion Kyats, respectively.

5) Other facilities

Public building such as outreach health stations, village libraries, administrative offices and religious facilities were damaged by Nargis. Some of the infrastructures have been reconstructed and some are still under construction in order of priority and urgency.

(3) Damages to Industries

The detailed damages to agricultural sector is mentioned in Section 2.3.5, therefore, hereinafter damages in other sectors such as processing industry, fishery and so on by Nargis is described.

1) Rice Mill Factories

Around two-thirds of small scale rice mills and more than 80% of medium-large mills in the 6 target townships were damaged by the cyclone as shown in the table below. The sector suffered from significant losses due to suspension of their business, destruction of paddy stocks, lower expected yields and deterioration of quality of the next paddy crop.

Table 2.2-7 Damage and Losses to Rice Mills in Target Townships

Township	Small Scale		Medium to Large Scale		Damage	Losses
	Total	Damaged	Total	Damaged	(Million Kyat)	(Million Kyat)
Ngaputaw[9]	271	200 (74%)	8	6 (75%)	2,561	19,712
Labutta	149	100 (67%)	22	22 (100%)	3,008	18,260

[8] In PONJA, "damage" is defined as the estimated replacement value of totally or partially destroyed physical assets and "losses" are estimated changes in the flow of the economy that arise from the temporary absence of the damaged assets; they include losses in production and higher cost in goods and services.

[9] The administrative Region is that of the time of Nargis.

Bogalay	254	170 (67%)	31	31 (100%)	4,532	28,211
Phyapon	222	148 (67%)	25	20 (80%)	3,310	21,469
Daydaye	259	159 (61%)	30	21 (70%)	3,512	22,849
Kyaiklatt	323	142 (44%)	28	20 (71%)	3,250	20,957
Total	**1,478**	**919 (62%)**	**144**	**120 (83%)**	**20,173**	**131,458**

Source: TCG, July 2009, Post-Nargis Periodic Review II, the number in parentheses is percentage to the total one

2) Fishery

Fishery is the second important income source in this area, for instance, 32.9% of households in Labutta Township had fishing gear items before Nargis. However, many fishery gears were lost by the cyclone and the worst record is 28.4% loss in Labutta as shown below, which led to the serious impact on the fishery sector.

Table 2.2-8 Percentage of Loss in Fishing Gear Items by Nargis

Township[10]	Lost Fishing Gear Items
Ngaputaw	18.2%
Labutta	28.4%
Bogalay	10.3%
Phyapon	10.2%
Daydaye	6.0%
Kyaiklatt	24.6%

Source: TCG, July 2009, Post-Nargis Periodic Review II

3) Salt Farms

Most of salt production farms are located in the coastal area, and these areas were severely affected by Nargis. Around 80% of salt farm area was destroyed by Nargis and many workforces of this industry and their families passed away. After Nargis, salt price increased from 200 Kyats before Nargis to 1,300 Kyats at peak time due to shortage of salt. This situation caused problem to the food processing industry e.g. salt fish, fish paste and fish sauce.

Table 2.2-9 Estimated Damage and Losses to Salt Farms in the Target Townships

Township[11]	Total Area (acres)	Affected Area (acres)	Damage (Million Kyat)	Loss (Million Kyat)
Ngaputaw	19,855	15,781 (79%)	22,882	9,863
Labutta	9,011	7,162 (79%)	10,385	4,476
Phyapon	1,794	1,425 (79%)	2,066	891
Total	**30,660**	**24,368 (79%)**	**35,333**	**15,230**

Source: TCG, July 2009, Post-Nargis Periodic Review II, the number in parentheses is ratio to the total one

(4) Change of Main Income Source

According to the survey by FAO in February 2009, main income sources distribution was changed by Nargis. Percentages of farming and fishery sectors decreased, while the rate of daily labors increased into the 2nd main income source instead (see the table below). The reasons for the change may be thought to be the result of damages to farmland by salt intrusion, loss on fishery tools and so on.

[10] The administrative Region is that of the time of Nargis.
[11] The administrative Region is that of the time of Nargis.

Table 2.2-10 Change of Main Income Sources before and after Nargis

	Before Nargis (%)	After Nargis (%)	Balance (%)
Farming	43.3	38.7	-4.6
Fishery	21.8	9.0	-12.8
Livestock	4.6	3.8	-0.8
Casual labor	16.4	30.3	+13.9
Others	13.9	18.2	+4.3
Total	**100.0**	**100.0**	**0.0**

2.3 Present Condition of Agriculture in the Project Area

2.3.1 Agricultural Production

(1) Character of Agriculture in Ayeyawady Area

Agriculture in Ayeyawady Region (Project Area) is characterized particularly by paddy cultivation in polder dikes. **Table 2.3-1** gives sowing area of major crops in Ayeyawady Region.

Table 2.3-1 Sowing Area of Major Crops in Ayeyawady Region (1,000 Acre)

Crops	1985-86	1990-91	1995-96	2000-01	2005-06	2007-08	Increase % 1985-2007	Increase % 2000-2007
Paddy	3,243	3,241	4,892	4,988	4,801	4,956	53%	-1%
Maize	40	20	18	48	31	16	-60%	-67%
Sesame	166	29	26	21	27	30	-82%	47%
Major Pulses	329	407	916	1,202	1,632	1,920	483%	60%
Sesame	166	29	26	21	27	30	-82%	47%
Sunflower	229	82	132	n.a	n.a	n.a	-	-
Chili	27	20	24	44	84	87	222%	98%

Source: Agricultural Statistics 1985-86 to 1995-96, Ministry of Agriculture and Irrigation, Statistical Yearbook 2008, Central Statistic Organization

Remark: Major Pulses (Ground Nuts, Black Gram, Green Gram, Garden Pea, Pigeon Pea, Chick Pea, Soybean, Cow Pea)

As shown in **Table 2.3-1**, paddy area in the Region is significant as compared to other major crops. Paddy production area in 2007-08 cropping season is 4.9 million acres equivalent to 24.8% of total production area in Myanmar. Drastic increase of paddy production area in Ayeyawady Region has not been observed since 1995-96 cropping season while the areas in other region have strongly increased. As a result, the share of Ayeyawady Region has been decreased. Ayeyawady Region, however, is still the most important rice production area in Myanmar keeping its position as the largest rice production area.

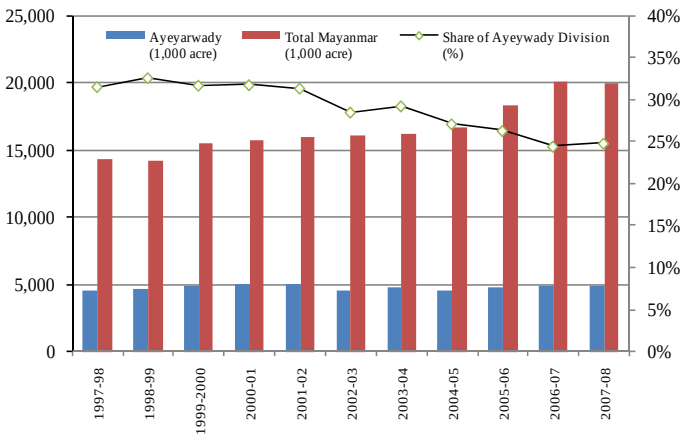


Figure 2.3-1 Paddy Sowing Area of Myanmar and Ayeyawady Region

Source: Statistical Year Book 2004, 2008 Central Statistical

A large part of Ayeyawady Region is located in the delta brackish water area. The delta was isolated area lapped in Mangrove trees. In 1974, a large-scale agricultural development of the delta area was commenced by Ayeyawady Development Project with United Kingdom's technical assistance.

The Project developed included the reclaiming of farming land for the construction of polder dikes,

gates and drains for controlling water flow between the land and rivers.

Rain-fed paddy cultivation in wet season is popular in the polder area. Irrigated paddy cultivation in dry season is practiced mainly in upstream of delta where is not affected by inflow of saline water. Since change of government policy on crop production, farmers can select cultivation crops by themselves. However, crop diversification has not progressed except pulses in dry season. The following are possible reasons of farmer's high preference of paddy cultivation.

1) Unsuitable soil and water conditions in reclaimed land for cultivation of other crops
2) High importance of paddy as food for self consumption

(2) Farming Purpose

Farming is most important activity for both land owners and landless farmers to secure food especially rice and, to earn income in Ayeyawady Region. Land owing farmers usually get income selling surplus of harvested crop after keeping food for home consumption. Landless farmers earn income working as casual labor for agriculture.

Estimated average yearly consumption of rice / capita in Myanmar ranges between 140 - 200 kg. 200 kg / capita can be considered as paddy weight according to result of interview with farmers (200 kg of paddy * 55-65% of milling recovery rate = 110-130 kg of milled rice). Therefore, average annual consumption of rice / capita may be estimated to be around 110-130 kg. Rice production in Ayeyawady Region has important role to sustain such high consumption (demand) of rice.

Table 2.3-2 gives percentage of farmer population in 34 polders. The percentage is very high indicating 49% at the minimum in Phyapon Township and 93% at the maximum in Labutta Township. As the percentage implies, agriculture is most important economic sector in the polders sustaining livelihood of the people.

Table 2.3-2 Percentage of Farmer in 34 Polders

(%)

No	Township	Land Holder	Tenant	Farm worker (Landless)	Non-farm	Total	Farmer
1	Bogalay	20	1	58	21	100	79
2	Daydaye	23	1	41	35	100	65
3	Kyaiklatt	36	-	45	19	100	81
4	Labutta	28	1	64	7	100	93
5	Ngaputaw (Labutta-New)	27	1	64	8	100	92
6	Phyapon	28	1	20	51	100	49

Source: Present Condition Survey by JICA Project Team, March 2010

(3) Land Holding

All of the farming land belongs to nation in Myanmar. Farmers cultivate the land under tiller's right and are not subjected to land sale or release. According to FAO report and the Present Condition Survey by the Project Team at 34 polders, percentage of landless farmers in the area is 64-80%. As shown in **Table 2.3-3**, estimated average land holding size of farmers with cultivation right (land holding farmer) is 25 acres. Its' rental cost ranges from 33,000 to 50,000 Kyats/acre in Labutta North Polder.

Table 2.3-3 Average Land Holding Size (2007)

Township	No. of Sample Landowner (Nos.)	Landholding Size (Acres)	Average Landholding Size (Acres)
Bogalay	20	527	26
Daydaye	32	777	24
Kyaiklatt	15	105	7
Labutta	46	1,158	25
Ngaputaw	27	545	20
Phyapon	32	1,144	36
Total	172	4,256	25

Source : Present Condition Survey by JICA Project Team, March 2010

(4) Natural Condition and Cropping Pattern

Climate of Ayeyawady Region is typical tropical monsoon. Annual rainfall is around 3,000 mm and, is concentrated in monsoon season from April to October. Maximum and minimum temperature ranges between 15-25 and 30-35, respectively. Such climate condition and existence of agricultural infrastructure dominate cropping pattern and selection of crop in Ayeyawady Region. Usual cropping pattern is shown in **Figure 2.3-2**.

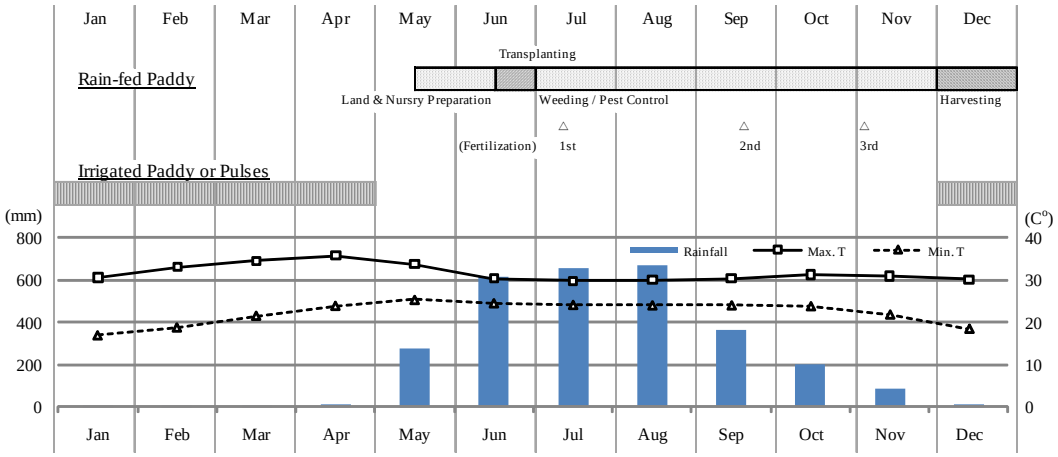


Figure 2.3-2 General Cropping Pattern of Paddy

Source: Agricultural Atlas of the Union Myanmar 2001-2002, World Meteorological Organization (WMO), Estimated by JICA Project Team based on result of interview to farmers

Cropping pattern depends on natural condition especially rainfall. Farmers start wet season cultivation at the beginning of rainy season (May to June) and, harvest at the beginning of dry season (November to December) after drying paddy at the field.

Subject : Soil at Polder
Location : Labutta North Polder
Date : 20 January 2010

Subject : Soil at Polder
Location : Labutta North Polder
Date : 20 January 2010

Irrigated Paddy Field in Ayeyawady Region

Farmers in irrigated area practice dry season paddy between December and April. And, the farmers who have farming land with high moisture contents usually cultivate beans such as black gram, green gram, ground nuts, etc.

Soil is acid sulfate soil which is widely exists in delta region of Southeast Asia. Acid sulfate soil has character of strong acidic and high absorbability of phosphoric acid. Such characters affect growth of crops. Normally, Lime and phosphoric acid are applied for improvement of acid sulfate soil. However, farmers who apply such materials are very few in Ayeyawady Region due to mainly lack of farming budget etc.

2.3.2 Paddy Cultivation

(1) Cropping Yield and Quality of Rice

Cropping yield of paddy in Ayeyawady Region is still low. According to Agricultural Census 1985-86 to 1995-96, average cropping yield of paddy in Ayeyawady Region is 1,315 kg/acre or 63 baskets/acre. However, cropping yield on 34 polders in 2007-2009 monsoon seasons surveyed by JICA Project Team in March 2010 is 30-42 baskets/acre, lower than the average as shown in figure below. Cropping

yield of 2008 monsoon season was drastically decreased due to the damage by Cyclone Nargis.

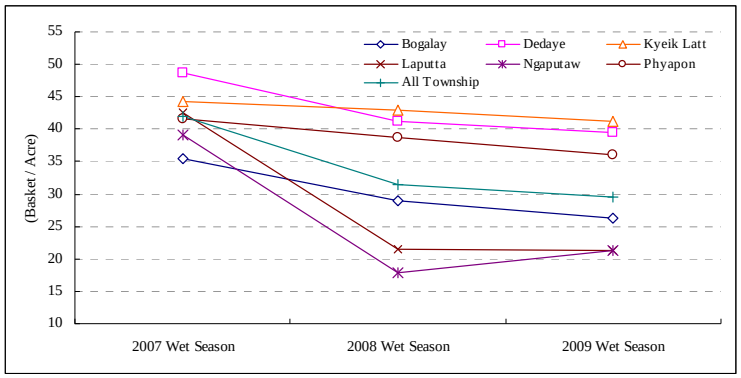


Figure 2.3-3 Average Cropping Yield in 34 Polders (2007-2009 Wet Seasons)

Source : Present Condition Survey by JICA Project Team, March 2010

Potential cropping yield of local variety is originally low because of low response to fertilizer etc. In case of Pawsanyin (local variety) which is widely cultivated in Ayeyawady Region, potential cropping yield is 60 baskets. Therefore, HYV is necessary, if drastic increase of paddy production is required. For applying HYV, constraints like a) high investment cost, b) Unstable paddy price, c) Unverified appropriateness and cropping technology of HYV in field, should be solved to reduce farmer's risk.

In addition, quality of rice is also low. Many broken and cracked rice were observed at small scale rice mill located in the villages of Labutta North Polder.

Under the abovementioned situation, improvement on both production amount and quality is indispensable to secure stable supply of high quality rice for the country and to grow paddy as an export crop.

(2) Variety and Seed

Local and High Yielding Variety (HYV) is widely cultivated in Ayeyawady Region. Major paddy variety cultivated in Ayeyawady Region is summarized in **Table 2.3-4 and Table 2.3-5**.

Table 2.3-4 Type of Paddy Variety in Ayeyawady Region in Monson Season 2010

District	Total	HYV / Improved Variety		Local Variety	
Pathein	793,262	584,070	73.6%	209,192	26.4%
Hinthada	526,207	381,118	72.4%	145,089	27.6%
Myaungmya	490,791	274,822	56.0%	215,969	44.0%
Labutta	667,177	253,239	38.0%	413,938	62.0%
Maubin	398,888	251,428	63.0%	147,460	37.0%
Pyapon	834,440	332,107	39.8%	502,333	60.2%
Total	3,710,765	2,076,784	56.0%	1,633,981	44.0%

Data Source : MAS Pathein Office

Table 2.3-5 Major Paddy Variety in Ayeyawady Region in Monson Season 2010

No.	Variety	Type	Acres	Share against total paddy sowing area in Ayeyawady Region (%)
1	Manawthukha	HYV	847,030	22.9%
2	Hnan Gar	Local	573,599	15.5%
3	Sin Thwe Lat	HYV	447,767	12.1%
4	TheeHtatyin	HYV	321,697	8.7%
5	Paw San Yin	Local	241,157	6.5%
6	Mee done	Local (High Eating Quality)	173,442	4.7%
7	Aye yar min	Local (High Eating Quality)	152,210	4.1%
8	Sin Thu Kha	HYV	127,176	3.4%
9	Nga sein	Local	103,481	2.8%
10	Kyaw Zay Ya	HYV	103,321	2.8%

No.	Variety	Type	Acres	Share against total paddy sowing area in Ayeyawady Region (%)
	Total		3,090,880	83.4%

Source: MAS Pathein Office

As shown in **Tables 2.3-5**, in Ayeyawady Region, local variety such as Hnan Gar, Paw San Yin still have high share. Especially, the share of local variety in Phyapon and Labutta Districts located in downstream of the delta where many polders are located is very high (more than 60%).

There are many reasons of cultivation of local variety such as high quality of milled rice (test and flavor) and high price, low agricultural input requirement as compared to with HYV and, high appropriateness to natural condition. Among these reasons, "appropriateness to natural condition" will be the most important reason. Based on the result of interview to farmers carried out by the JICA Project Team in selected 10 polders, 70.5% (62 farmers out of 88 farmers) answered that natural condition related aspects such as rainfall and drainage is main reason (criteria) for variety selection. High share of local variety in Phyapon and Labutta Districts (downstream of the delta) where problems of salt water and flood are relatively serious also implies the importance of natural condition for variety selection.

Table 2.3-6 shows procurement method of seed. Usually, farmers use previous harvesting paddy (seed) for next cropping without selection and disinfection. About 80.4% of farmers apply previous harvesting paddy as seed. On the other hand, farmers who apply purchased seed and department seed is only 23.8% and 0.5%, respectively.

Table 2.3-6 Procurement Method of Seed

Township	No. of Sample Farmer	Previous Harvesting Paddy	Purchase Seed	MAS Seed	Donation Seed
Bogalay	20	16	6		
Daydaye	33	33	1		
Kyaiklatt	15	15			
Labutta	54	30	31	1	11
Ngaputaw	29	23	4		3
Phyapon	38	35	3		
Total	189	152	45	1	14
%	100.0	80.4	23.8	0.5	7.4

Source: Present Condition Survey by JICA Project Team, March 2010

Remark: Multiple selections / answers

Quality of seed (previous harvested paddy) is very possibly low genetically and physically. In fact, some of farmers use 3-4 baskets of seed for 1.0 acre. That is 2.0-3.0 times higher than the standard (less than 1.5 baskets/acre).

Table 2.3-7 gives result of question on problems of seed where 47.8% and 35.4% of farmers have problems of mixture of red rice or other variety.

Result of seed quality check carried out for 18 participant farmers in the on-site seed production pilot project in March 2010 (refer to Chapter 4) also shows problem of the mixture with red rice or other variety. Out of the 18 sample seeds checked only one (1) sample passed the seed quality standard of MAS. Main problem of farmers' seed is high contents rate of "red rice".

Table 2.3-7 Problem on Seed Quality

Problem	Total	
Mixture with Red Rice	77	47.8%
Mixture with Other Variety	57	35.4%
Low Germination Rate	11	6.8%
Bad Growth of Seedling	9	5.6%
Others	7	4.3%
Total	161	100.0%

Source :Farmer interview at 10 polders, JICA Project Team, 2011

Remark : Multiple Answer

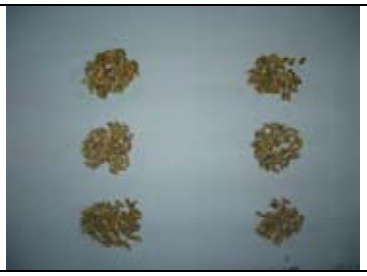
According to the farmers in Labutta North Polder, mixture level of other variety or red rice is very important factor to set up selling price of harvested paddy. Moreover, in recent years, paddy brokers

check quality not only of paddy but also cooked rice to set up the price. As abovementioned, realization of the importance of quality of seed is increasing.

(3) Land Preparation and Seedling

Land preparation (plow) is very hard work for the farmer due to very hard soil dried up by strong sunshine in dry season. Usually, water buffalo is used for plowing at beginning of monsoon season. Use of hand tractor is limited because of its' low availability in the village area, financial deficit and also low quality of machinery (or low durability against hard soil).

Subject : Farmers Seed
Location : Labutta North Polder
Date : 27 January 2010



Subject : Farmers Seed Quality (left : Good, Right : Poor)
Location : Labutta North Polder
Date : 23 January 2010

Farmer's Rice Seed

Many water buffalos died during the Cyclone Nargis. As a result, many farmers rented out water buffalo (4,000 Kyats/acre, 40,000 Kyats/season) for farming. Hydro tiller is used mainly in irrigated paddy field (rental cost is 15,000 Kyats/acre) as well.

Nursery at paddy field is popular seedling method in the upstream area of delta Ayeyawady Region. Farmers prepare nursery on May-June after plow and hallowing (for rain-fed). Transplanting is done after 25-30 days of Seedling period. Planting density of transplanting or seedling is relatively high due to low quality of seedling and lack of technology (regular transplanting is not popular).

Especially in deep water and flood areas, broadcasting is still practiced. In addition, according to MAS staff, many farmers shifted to broadcasting from transplanting after Nargis attack to reduce production cost.

(4) Fertilization and Pest Control

Table 2.3-8 shows percentage of farmers who apply fertilizer and pesticide. 84% of surveyed farmers use Nitrogen fertilizer (Urea: N46%) which is most common fertilizer for the farmers. Percentage of farmers who apply phosphoric (T-Super: P46%) and potash fertilizers is one 41% and the other only 4%. Reason of low application of potash fertilizer may a) high price and, b) low understanding about its' importance.

Table 2.3-8 Use of Fertilizer and Pesticide

Township	No. of Sample Farmer	N : Urea		P : T-Super		K : MOP		Compound Fertilizer		Organic		Pesticide	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Ngaputaw	29	28	97%	0	0%	0	0%	0	0%	0	0%	22	76%
Labutta	54	41	76%	18	33%	4	7%	1	2%	8	15%	16	30%
Bogalay	20	10	50%	3	15%	0	0%	5	25%	2	10%	2	10%
Phyapon	38	36	95%	27	71%	3	8%	3	8%	0	0%	15	39%
Daydaye	33	29	88%	20	61%	0	0%	7	21%	2	6%	28	85%
Kyaiklatt	15	15	100%	10	67%	1	7%	0	0%	0	0%	10	67%
Total	189	159	84%	78	41%	8	4%	16	8%	12	6%	93	49%

Source: Present Condition Survey by JICA Project Team, March 2010

Farmers who own large farming land applied 1-3 bags (50-150 kg) of Urea for 1.0 acre before Nargis attack. According to interview to participant farmers of On-site Seed Production Pilot Project (refer to Chapter 4), they usually apply 0.5 bags (25 kg) of Urea and 0.5 bags (25 kg) of T-Super for a acre.

Most of farmers emphasize only color of leaf to decide timing of fertilization. In addition, they do not recognize exact size of farming area. Such situation causes excess and/or insufficient use of agricultural fertilizer and other inputs. As a result, the effectiveness of fertilization and other inputs may be low.

(5) Harvesting and Post-Harvest

Harvesting period of paddy is from November to December for monsoon season paddy, March to April for dry season irrigated paddy. Harvesting is done manually by hand remaining 30-50 cm of straw on original ground. Straw is usually used as animal feed.

Subject : Harvest (30cm height of paddy straw is remained)
Location : Labutta North Polder
Date : 31 December 2009

Subject : Paddy Drying
Location : Labutta North Polder
Date : 31 December 2009

Subject : Paddy straw for animal feed
Location : Irrigated paddy field near Myaungmya City
Date : 21 January 2010

Harvest of Paddy

Water buffalo or wooden roller at ground threshing floor is common threshing method. Farmers mainly in irrigated paddy area use portable rice thresher. Milled rice contains many broken and cracked rice due to lack of paddy quality and post-harvest technology.

Main problem of harvesting and post harvesting are: a) Un-uniform growth of paddy plant due to lack of leveling, mixture with other variety b) Lack of labor force for harvest and post harvesting, 3) Lack of storage facility and, 4) Sudden rain in some area or year etc.

Usually, farmers sell harvested paddy immediately to rice miller or broker after harvest for repayment of agricultural loan (refer to Section 2.3.4 (3) Agricultural Finance). There are many small-medium scale rice mill factories in the village. In case of Labutta North Polder, one large scale rice mill factory with milling capacity of 1,000 baskets/day and many small-medium scale rice mill factories with capacity of less than 500 baskets /day exists. According to large scale rice miller, trading volume of paddy is decreasing after Nargis attack.

Subject : Removable Threshing Machine
Location : Irrigated paddy field near Myaungmya City
Date : 29 January 2010

Subject : Paddy threshing yard of village (threshing by buffalo)
Location : Labutta North Polder
Date : 27 January 2010

Subject : Paddy drying
Location : Irrigated paddy field near Myaungmya City
Date : 29 January 2010

Post Harvest Process (1)

Subject : Paddy Transportation
Location : Irrigated paddy field near Myaungmya City
Date : 29 January 2010

Subject : Price of Paddy at Small Scale Rice Mill Factory
Location : Labutta North Polder
Date 20 January 2010

Subject : Rice Mill Machine at Small Scale Rice Mill Factory
Location : Labutta North Polder
Date 20 January 2010

Post Harvest Process (2)

Subject : Quality of milled rice
Location : Labutta North Polder
Date : 20 January 2010

Subject : Storage at Large Scale Rice Mill Factory
Location : Labutta North Polder
Date : 28 January 2010

Subject : Rice in Market
Location : Labutta City
Date : 27 January 2010

Post Harvest Process (3)

(6) Price of Paddy

Figure 2.3-4 shows fluctuation of paddy price between January 2005 and February 2011 in Pathein Market, Ayeyawady Region. As shown in the figure, Price of Paddy in Myanmar is characterized by strong yearly fluctuation.

The price is usually at its lowest price during the harvest season of monsoon season paddy and highest price after 6-7 months after harvest. As shown **Table 2.3-9**, the difference between the lowest and highest prices is 26.5% to 147.6% in past 5 years. Therefore, it is ideal for farmers to sell paddy several months after harvest to get high profit. However, such sales method is not realistic due to lack of farmers' storage capacity and for repayment of agricultural loan.

Table 2.3-9 Difference of Lowest and Highest Price of Paddy

		2005-2006 Season	2006-2007 Season	2007-2008 Season	2008-2009 Season	2009-2010 Season
Paw San Yin (Local Variety)						
Lowest Price during Harvesting Period of Monsoon Paddy (Kyat / 100 Baskets)	a)	254,400	410,000	475,200	392,094	414,438
Highest Price after Harvesting Period of Monsoon Paddy (Kyat / 100 Baskets)	b)	630,000	640,000	N.A	566,875	670,000
Increase (%)	c)=b)/a)-1	147.6%	56.1%	N.A	44.6%	61.7%
Manautuka (HYV)						
Lowest Price during Harvesting Period of Monsoon Paddy (Kyat / 100 Baskets)	d)	193,750	280,000	350,000	238,050	362,250
Highest Price after Harvesting Period of Monsoon Paddy (Kyat / 100 Baskets)	e)	374,200	475,000	N.A	393,300	458,160
Increase (%)	f)=e)/d)-1	93.1%	69.6%	N.A	65.2%	26.5%

Source: Paddy Price at Pathein Market. Market Information Service Project, Department of Planning, MOAI

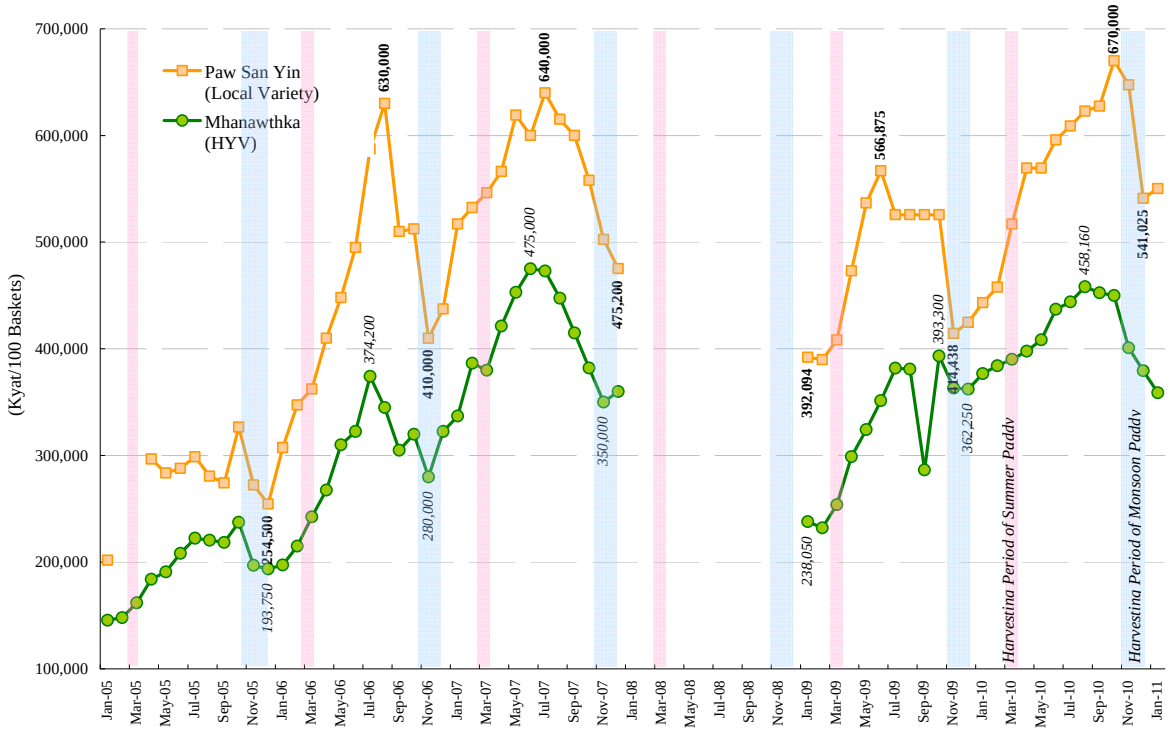


Figure 2.3-4 Fluctuation of Paddy Price in Pathein Market (Kyat /basket)

Source: Paddy Price at Pathein Market. Market Information Service Project, Department of Planning, MOAI

(7) Production Cost and Income of Paddy Cultivation

Paddy cultivation cost in 2010 monsoon seasons was estimated based on result of interview with participant farmers of On-site Seed Production Pilot Project and other concerned information. Estimated paddy production cost and income of local and HYV is shown in **Table 2.3-10** and **Table 2.3-11.**

Table 2.3-10 Estimated Production Cost and Income of Paddy Cultivation

(Monsoon Season: Local Variety) (Kyat/acre)

Items	Unit Cost *2		Quantity *2	Total
Production Cost				
Material Cost				
Seed	6,000	/Basket	2.0	12,000
Registered Seed	8,000	/Basket	0.0	0
Fertilizer (Urea:N46%)	22,000	/Bag (50kg)	0.5	11,000
Fertilizer (T-Super:P16%)	12,000	/Bag (50kg)	0.0	0
Fertilizer (T-Super:P46%)	22,000	/Bag (50kg)	0.5	11,000
Fertilizer (Potash：K50%)	35,000	/Bag (50kg)	0.0	0
Agricultural Chemical etc.	3,000	/Season	1.0	3,000
Sub-Total				37,000
Labor / Animal Cost				
Plow / Harrow (Labor and Animal Power)	5,000	/man-day	7.0	35,000
Broadcasting	1,000	/man-day	1.0	1,000
Nursery Preparation	2,000	/man-day	0.0	0

Items	Unit Cost *2		Quantity *2	Total
Seedling Preparation	3,500	/man-day	0.0	0
Transplanting	30,000	/Acre	0.0	0
Weeding	1,500	/man-day	0.0	0
Rouging	1,500	/man-day	0.0	0
Harvesting	12,000	/Acre	1.0	12,000
Threshing / Dry	3,000	/man-day	5.0	15,000
Transportation	4,000	/Time	1.0	4,000
Sub-Total				67,000
Total			0.0	104,000
Contingency (5% of Total)			0.0	5,200
Grand Total			0.0	109,200
Gross Income				
Cropping Yield (Baskets / Acre)				42
Price (Kyat / Basket) *1				5,956
Gross Income (Kyat)				250,152
Net Income				
Net Income (Kyat)				140,952

Source: *1: On Site Seed Production Pilot Project,
*2: Average Price of Pawsanyin (Local Variety) in Pathein Market Mar 2010- Feb 2011

Price	Cropping Yield (Baskets / Acre)						
(Kyat / Basket)	30	35	40	45	50	55	60
5,000	40,800	65,800	90,800	115,800	140,800	165,800	190,800
5,500	55,800	83,300	110,800	138,300	165,800	193,300	220,800
6,000	70,800	100,800	130,800	160,800	190,800	220,800	250,800
7,000	100,800	135,800	170,800	205,800	240,800	275,800	310,800
7,500	115,800	153,300	190,800	228,300	265,800	303,300	340,800

Table 2.3-11 Estimated Production Cost and Income of Paddy Cultivation (Dry Season: HYV Variety)

(Kyat/acre)

Items	Unit Cost *2		Quantity *2	Total
Production Cost				
Material Cost				
Seed	4,000	/Basket	2.0	8,000
Registered Seed	6,000	/Basket	0.0	0
Fertilizer (Urea:N46%)	22,000	/Bag (50kg)	0.5	11,000
Fertilizer (T-Super:P16%)	12,000	/Bag (50kg)	0.0	0
Fertilizer (T-Super:P46%)	22,000	/Bag (50kg)	0.5	11,000
Fertilizer (Potash：K50%)	35,000	/Bag (50kg)	0.0	0
Agricultural Chemical etc.	3,000	/Season	1.0	3,000
Sub-Total				33,000
Labor / Animal Cost				
Plow / Harrow (Labor and Animal Power)	5,000	/man-day	7.0	35,000
Broadcasting	1,000	/man-day	1.0	1,000
Nursery Preparation	2,000	/man-day	0.0	0
Seedling Preparation	3,500	/man-day	0.0	0

Items	Unit Cost *2		Quantity *2	Total
Production Cost				
Transplanting	30,000	/Acre	0.0	0
Weeding	1,500	/man-day	0.0	0
Rouging	1,500	/man-day	0.0	0
Harvesting	12,000	/Acre	1.0	12,000
Threshing / Dry	3,000	/man-day	5.0	15,000
Transportation	4,000	/Time	1.0	4,000
Sub-Total				67,000
Total				100,000
Contingency (5% of Total)				5,000
Grand Total				105,000
Gross Income				
Cropping Yield (Baskets / Acre)				54
Price (Kyat / Basket)				4,131
Gross Income (Kyat)				223,074
Net Income				
Net Income (Kyat)				118,074

Source: *1: On Site Seed Production Pilot Project,
*2: Average Price of Manhawthka (HYV) in Pathein Market Mar 2010- Feb 2011

Price (Kyat / Basket)	Cropping Yield (Baskets / Acre)						
	40	50	60	70	80	90	100
3,000	15,000	45,000	75,000	105,000	135,000	165,000	195,000
3,500	35,000	70,000	105,000	140,000	175,000	210,000	245,000
4,000	55,000	95,000	135,000	175,000	215,000	255,000	295,000
4,500	75,000	120,000	165,000	210,000	255,000	300,000	345,000
5,000	95,000	145,000	195,000	245,000	295,000	345,000	395,000

Estimated production cost of monsoon season paddy is 109,200 Kyats/acre for local variety and 105,000 Kyats/acre for HYV variety. Around 60% of the production cost is spent for labor and animal power. Most of farmers use agricultural loan more or less. Therefore, net income decreased depending on interest rate of the loan.

2.3.3 Other Crop Production and Livestock

Apart from paddy, maize, beans, chili, sesame are widely cultivated in Ayeyawady Region. Particularly, production of beans, which are viable in dry condition, has been increasing. The production has increased more than 400% in 22 years between 1985 and 2007 while increase of paddy production in the same period was only 53%.

Cash crop production like vegetables is important income source mainly for landless farmer. Some farmers in Labutta North Polder cultivate cauliflower, cucumber, water melon, pumpkin, leaf on small scale farm land. According to the farmers, profit of vegetable production is higher than paddy production. The farmer gained 50,000 Kyats with 150,000 Kyats of investment in 2009 dry season (cultivated area is unclear). Constraints of vegetable production are 1) Limited cropping is depending on high quality water distribution and / or soil moisture contents, 2) Low storage stability and limited demand in rural area, 3) High investment cost etc.

Livestock is important asset and work force for farmers. Most of farmers own water buffalo, pig and/or poultry. It is reported that actually, many village in Ayeyawady Region have inadequate work force due to lost of huge number of water buffalo caused Cyclone Nargis. The price of water buffalo in the rural area is 260,000 Kyats for purchase and 35,000 - 40,000 Kyats for seasonal rental.

Subject : Small Scale Cucumber Cropping using natural pond
Location : Labutta North Polder
Date : 27 January 2010

Subject : Vegetables in Market
Location : Labutta City
Date : 27 January 2010

Subject : Poultry breeding at farmers house
Location : Labutta North Polder
Date : 28 January 2010

Cash Crop Cultivation and Livestock

2.3.4 Agricultural Supporting Service

(1) Extension Work

Myanma Agricultural Service (MAS) under the Ministry of Agriculture and Irrigation is the agency responsible for extension work. The MAS Extension Division assigns a manager and an assistant manager in district, village extension manager in township and village.

Subject : Sunflower and Green Gram Cultivation at MAS demonstration farm
Location : Labutta North Polder
Date : 27 January 2010

Subject : Extension Material prepared by MAS staff trained by JICA project
Location : Labutta North Polder
Date : 27 January 2010

Extension Work of MAS Labutta

Recently, the number of MAS including extension worker was reduced drastically. Number of MAS staff as of March 2007 is 7,538 staff, equivalent to -57% as compared with 17,870 staff before reduction.

Number of Labutta North Township MAS office also was reduced to 15 staff from 50 staff. In addition, transportations such as motor cycle for extension work are not available. Therefore, MAS office provides extension work to farmers mainly through demonstration (0.5 acre) and pamphlet distribution. These limited activities are not also viable due to insufficient resources (equipment and tools). According to the Present Condition Survey carried out by the Project Team in 33 polders, percentage of farmers who received at least one time of extension service is only 6.7% for 2007 and 30.2% for 2009.

(2) Seed Production

The MOAI is the agency responsible for the production of all classes of seeds which are needed for seed multiplication.

The Department of Agricultural Research (DAR) is responsible for the production of Breeder Seed (BS), the Seed Division of the MAS responsible for the production of foundation seeds (FS), and registered seeds (RS) while the Extension Division of the MAS has the responsibility to distribute certified seeds (CS: Seed used for paddy grain production) to farmers and also technical support to farmers for CS production. According to Hmawby Rice Research Station and DAR Myaungmya Agricultural Research Station, common price of registered and certified seed is 6,000 Kyats/basket for HYV and 8,000 Kyats/basket for local variety.

Out of abovementioned four classes of the seed, production of certified seed is open for private sector by Seed Law established in January 2011. Private sectors are allowed for seed production and seed quality check (e.g. operation of seed quality check laboratory) under license controlled by the government. However, seed production by individual farmers, is excluded from the Law.

There are 5 main MOAI farms for paddy seed production in Ayeyawady Region. **Table 2.3-12** shows production amount of seed by the five (5) main farms.

Table 2.3-12 Production Amounts of Paddy Seed by Major MOAI Farms in Ayeyawady Region

(Baskets)

	Seed Farm	Total Area (Acre)	Production (Baskets)											
			2008				2009				2010			
			BS	FS	RS	CS	BS	FS	RS	CS	BS	FS	RS	CS
1	Tagontaing	98	0	0	2,293	165	0	0	701	0	0	397	3,279	0
2	Shwelaung Kyun 1	500	0	20	0	4,258	0	0	0	400	0	4,065	135	1,800
3	Shwelaung Kyun 2	67	0	0	0	750	0	0	0	300	0	1,470	50	0
4	Thayaung Chaung	125	13	161	2,505	0	0	75	2,922	0	0	201	4,166	0
5	Aukkwingyi	72	0	0	2,726	0	250	2,317	0	0	0	105	2,945	0
6	Myaungmya Agricultural Research Station	50					15	170	1,530	0	15	170	1,530	0
	Total	912	13	181	7,524	5,173	265	2,562	5,153	700	15	6,407	12,105	1,800

Source: MAS Pathein Office

Remark: BS (Breeders Seed), FS (Foundation Seed), RS (Registered Seed), CS (Certified Seed)

Potential production amount of certified seed (CS) in 2010 can be estimated at 403,500 baskets or for 269,000 acres as follows.

Assumption
- Production Amount of RS in 2010 (a) : 12,105 Baskets
- Amount of RS for CS Production / Acre (b) : 1.5 baskets
- Estimated Cropping Yield of CS / Acre (c) : 50 baskets
- Amount of CS for Paddy Production / Acre (d) : 1.5 Baskets

Estimated Potential Production Amount of CS

12,105 (a) / 1.5 (b) * 50 (c) = 403,500 Baskets of CS / 1.5 (d) = 269,000 Acres

This amount covers only 5.4% of total paddy sowing area of wet and dry seasons in Ayeyawady Region (5,020,779 acres 2009 - 2010). Covering rate can be increased to 16.0% based on assumption "seed renovation per 4 years". Therefore, it is assumed that there is still a high potential demand of CS in Ayeyawady Region.

Subject	:	Seed Production Paddy Field	Subject	:	Seed Selector introduced by UNDP
Location	:	Hmawby Rice Research Station	Location	:	Agricultural Research Station, Myaungmya
Date		25 January 2010	Date	:	25 November 2010

Seed Production at Hmawby Rice Research Station and Myaungmya Agricultural Research Station

(3) Agricultural Finance

There are government and private agricultural finance support in the rural areas. Government agricultural finance is provided by Myanma Agricultural Development Bank (MADB) and private agricultural finance.

Many farmers utilize MADB's farming loan with interest rate of 17% per year. However, amount of

MADB Loan is limited to 20,000 Kyats/acre for paddy (10,000/Kyats/acre for other crops) equivalent to only 10-20% of total production cost. Therefore, many farmers borrow the money (farming budget) from private agricultural finance even though the interest rate is very high (5-15%/month). Private agricultural finance has more flexibility than MADB loan. Loan condition like interest rate and amount is fixed depending on negotiation between borrower and leaser. This difference of flexibility between the loans is one of the reasons to accelerate use of private agricultural finance.

For some farmers, access to private agricultural finance has been difficult due to delay of repayment due to the reduction of production caused by Nargis attack in 2008.

2.3.5 Agricultural Damage by Cyclone Nargis

(1) Damage in Agriculture

Inflow of saline water into paddy field by Nargis attack decreased agricultural production. According to farmers in Labutta North Polder, cropping yield of paddy of immediate crop after Nargis attack was decreased to 10 - 20 baskets/acre equivalent to minus 50 -75% from 40-50 baskets of cropping yield before Nargis (local variety). However, cropping yield of 2009 cropping season has recovered with a yield of 40-50 baskets/acre.

Table 2.3-13 shows farming constraint before and after Cyclone Nargis attack in 34 polders.

Table 2.3-13 Farming Constraint before and after Cyclone Nargis Attack

Constraint	No. of Sample Farmer	Before Nargis		After Nargis		Difference
a)	b)	c)	d)	e)	f)	g)=f)-d)
Lack of Labor	189	16	8%	29	15%	+7%
Lack of Farming Tech.	189	13	7%	18	10%	+3%
Pest & Disaster	189	35	19%	63	33%	+15%
Lack of Water	189	18	10%	25	13%	+4%
Flooding	189	43	23%	72	38%	+15%
Salt Injury	**189**	**23**	**12%**	**75**	**40%**	**+28%**
Lack of OM of Polder (Muddy)	189	1	1%	9	5%	+4%
Lack of Extension	189	14	7%	25	13%	+6%
Lack of Access to Finance	**189**	**43**	**23%**	**109**	**58%**	**+35%**
Lack of Market	189	6	3%	12	6%	+3%
Low Price of Product	189	9	5%	20	11%	+6%
Lack of Farming Tool	**189**	**20**	**11%**	**57**	**30%**	**+20%**
Lack of Draft Animal	**189**	**7**	**4%**	**74**	**39%**	**+35%**
Low Quality Seed	**189**	**9**	**5%**	**42**	**22%**	**+17%**
Lack of Fertilizer	189	28	15%	82	43%	+29%
Others	189	3	2%	29	15%	+14%

Source: Present Condition Survey by JICA Project Team, March 2010

Main farming constraint is lack of input such as farming tool, draft animal, fertilizer and access to agricultural finance. These constraints became worse after Cyclone Nargis attack. Especially, number of farmers without draft animal was increased from 4% to 35%.

Table 2.3-14 shows situation of support for farmers after Nargis attack. Many agricultural inputs mainly seed; fertilizer and farming machinery were provided to farmers even at present time. According to the results of interview of farmers, demand of support for

Table 2.3-14 Received Support

Assistance	Total	
Seed	69	39%
Fertilizer	40	22%
Farming Machinery	36	20%
Others	26	15%
Farming Tool	4	2%
Animal Power (Cattle)	2	1%
Farming Budget / Agri. Loan	2	1%
Total	179	100%

Source: Farmer interview at 10 polders, JICA Project Team,
Remark: Multiple Answer

agricultural inputs and agricultural loan is still high.

Agricultural inputs (seed, fertilizer and loan) are required for every cropping season and for all rural areas of Myanmar. Therefore, fundamental measure which is not limited to Nargis damage may be necessary.

2.4 Present Condition of Irrigation and Drainage in the Project Area

2.4.1 Irrigation

(1) General Situation

As the average annual rainfall is more than 3,000 mm and concentrated in the rainy season from May to October, no irrigation is practiced for rainy season paddy cultivation in the area.

The irrigation is practiced in the limited paddy fields located nearby the large drainage canal by pumping the water from drainage canal in the dry season from November to April. Diesel pumps are used and lifted water is conveyed through small ditches or in plot to plot method. The slide gates of the sluice regulators are usually opened on 15 May and are kept open until mid-September when the rainy season is terminating and the water inside the drainage canal keeps the stable level. The fresh rainwater is stored in the drainage canal for irrigation, livestock and miscellaneous purposes for the dry season.

Small scale pump irrigation

There are several special polder areas where irrigation water is conveyed from the intake of the upstream reach of the tidal river where the water is fresh and free from salt water contamination. In Labutta North polder, the irrigation water in the dry season from October to April is conveyed from the sluice gate intake located 16 miles (26 km) from the north boundary polder dike in the upstream of Ywe River. The irrigation water is conveyed through the feeder canal and it is filled in the drainage canals. Then the irrigation water is to be supplied to the field along the drainage canal by pumping. The project was completed in the year 2000, and it is said the beneficial area is 2,500 acre (1,000 ha). However, it seems that the project did not accomplish the initially proposed target of the irrigation area and paddy production.

(2) Water Quality

Because the annual rainfall of more than 3,000 mm is concentrated in the rainy season from May to October, irrigation is not required in the rainy season. On the other hand, the rainfall amount in the dry season is not sufficient for growing of any kind of crops and therefore irrigation is necessary for dry season crop cultivation. Generally the dry season irrigation is practiced by using the water pumped up by portable pumps from the drainage canal in which water was stored in the last stage of the rainy season. Therefore, the irrigation areas are limited to the land along on the drainage canals or the adjacent areas. The quantity of available water

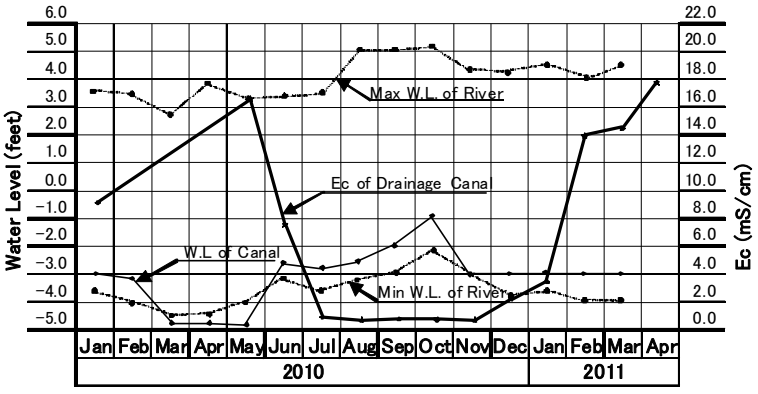


Figure 2.4-1 Ec at Danedan Sluice

is limited to the stored water in the drainage canal in the end of the preceding rainy season.

The periodic changes of water quality in term of salinity have been measured since January 2009 inside and outside of the eight (8) sluices. As a typical example of the monthly changes of Ec values, the Ec values at Danedan Sluice are illustrated with the water levels of the drainage canals inside the polders in **Figure 2.4-1**. It is clear from the figure, that the Ec values of the dry season are as high as more than 10 mS/cm. In the dry season, the water level of the drainage canal is lower than the high tide of the river side and the gates do not work properly, the leakage of salty water from the river side occur and the Ec values in the drainage canal go up. When the rainy season starts in June, the water level of the drainage canal is still lower than the high tide of the river side; saline water in the drainage canal is diluted by the fresh rain water and the discharged water from the paddy field. The average water levels of the drainage canal goes up continuously and in July, although the water level of the drainage canal may be lower than the high tide of the river side and leakage of saline water may take place during high tide but the during the low tide saline water may be extruded out from the drainage canal. Eventually salinity of the drainage canal goes down until the water level of the drainage canal goes down to allow the saline water leakage from the river side in December. The increase of the salinity of the drainage canal is affected only in that part of the drainage canal within the short range from the sluice. The salinity of the drainage canal is not affected in that part of the drainage canals that is several hundreds meters far from the sluices.

The pilot project of high quality paddy seed production and the pilot project of vegetable cultivation for income generation have been implemented. The paddy seed production was implemented during the wet season and no direct irrigation water supply was expected from drainage canals, however, vegetable cultivation was expected to produce vegetable during the dry season, and naturally the water from the drainage canal was the vital source for irrigation to the vegetable cultivation. EC values were obtained from the drainage canals where the pilot project of vegetable cultivation was implemented. These drainage canals are located several hundreds meters away from the sluices and the obtained EC values are less than 3 mS/cm excepting one measurement in June before starting the vegetable cultivation. The EC values obtained in the periodic measurements are less than 2 mS/cm and it was judged adequate to be used for irrigation water for vegetable cultivation.

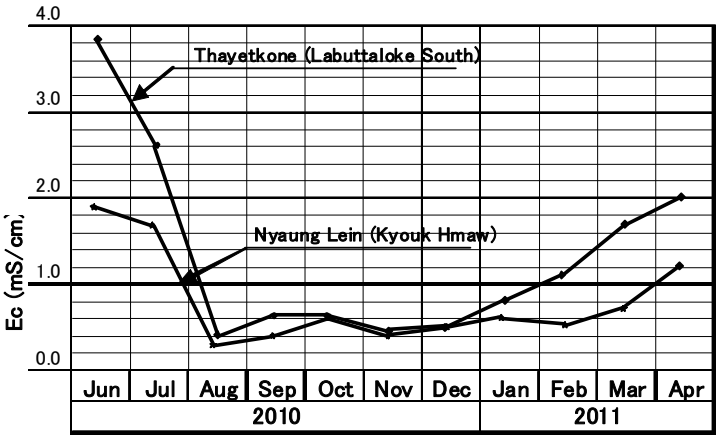


Figure 2.4-2 Ec of Canal Water for Irrigation of Vegetable

The measurement shall be continued at the interval of preferably once a month. The monitoring of EC values is important for the implementation of the vegetable cultivation pilot project. A number of sluice gates are going to be rehabilitated by the pilot project. Therefore, the improvement of the salinity is one of the important factors and the monitoring of EC should be continued for evaluation of the benefit and effect of the Pilot Project of Dike Embankment and Sluice Rehabilitation.

(3) Treadle Pump

At present, small scale vegetable cultivation is practiced during dry season in the project area. The irrigation water is carried and sprinkled by a pair of sprinkling cans with capacity of 4-5 gallons (16-20 liters) each. Very limited numbers of farmers use engine pumps or treadle pumps. However, when the sluices are rehabilitated and salt water intrusion from the river is prevented and naturally the water quality of the drainage canal is improved, irrigated crop cultivation would be prevailed in the

area. Here we will discuss the future possibility of introduction of treadle pumps for dry season cultivation.

a) Characteristics

The treadle pump is a portable, simple, low-cost, manpower operated water pump suitable for drawing water from shallow wells, streams, canals or ponds where the water surface is less than 5 meters below the ground surface of the pump installation.

The pump comprises two cylinders and pistons positioned side by side and a wire, which passes over a pulley and joins the two pistons together so that when one piston is being pushed down, the other is coming up. Each piston is connected to a treadle. The operator stands upright on the treadles and presses them down alternately in a steady motion, similar to pressing the pedals of a bicycle.

It can be operated usually by one person. However, if two people can stand on the treadles, that will increase the output of the pump and the operators will not tire as quickly and can operate the pump for longer time.

The pump is usually provided with 50 mm diameter rigid suction hose with length suitable to reach the water source and 50 mm diameter flexible “layflat” delivery hose. The suction hose connects the pump to the water source and the mouth of the suction hose must placed deep in the water to avoid the air entrainment. The delivery hose is laid out to convey the water direct to the plot of irrigation application or the suitable place from where the flow is channeled by gravity to the plot of irrigation.

b) Capacity

The pump works by creating a vacuum in the cylinder of the piston that is raised. This sucks water into pump through the intake pipe. On the down stroke of the piston, the water is discharged through the discharge pipe.

The amount of water pumped per unit time will depend on:

- the strength, weight and stamina of the operator
- the vertical distance of the water surface below the pump intake
- the height of water raised from the pump to the end of delivery pipe

The numbers will differ in each situation. However the average pump that could be acquired in Myanmar has discharge capacity 1.25 liter per stroke and it will deliver about 1 liter/second (l/s) when operated by a single adult. The volume of water pumped will then depend on the length of time the pumps is operating. An operator cannot pump continuously all day. Rather, the operator may pump for 20 or 30 minutes, rest, and then pump again.

If the total actual daily pumping time is 5 hours except time for setting and resetting the pump and pipes and time for the rest and the average rate of flow is 4,800 liters/hour, the volume of water pumped in one day for irrigation will approximately be 24 m3 (24,000 liters).

c) Store dealing in and price

Swiss NGO ESDAE (Ecological Systems by Development Aid, and Education) has introduced the treadle pumps several years before and the pumps were applied to some projects. This organization has already retreated from Myanmar. No equipment or information is available at present.

Irrigation Department suggested that another organization IDE (International Development Enterprise) has the information and deals in treadle pumps. IDE is the leading organization established in Myanmar in 2004 and distributed 67,000 sets of treadle pumps all over the Myanmar country. However, very limited numbers of treadle pumps have been distributed in the project area because irrigation water availability in dry season has been limited. The price of the treadle pump ranges from 15,000 Kyats to 43,000 Kyats depending on the specifications of the pump.

The information was also collected from one back-street workshop manufacturing treadle pumps. According to the owner of the workshop only several sets of pumps has been sold up to now. The price of one set of treadle pump including a suction pipe and a delivery pipe costs about 50,000 Kyats.

d) Possibility of treadle pump application to the project

Taking into consideration all the situations, the introduction of treadle pumps to the irrigation of dry season crop cultivation would be recommended from the engineering point of view on the condition that the dry season crop cultivation is prevailing and irrigation from the drainage canal is commonly practiced.

2.4.2 Drainage

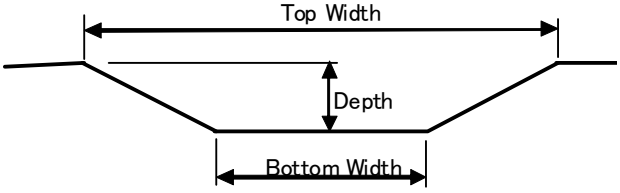
(1) General Situation

As the average annual rainfall is more than 3,000 mm, the role of drainage canal is very important. There is no need to store abundant rainwater during rainy season. The slide gates of the sluice are kept open from 15 May to mid-September and the drainage is controlled by the frap gates of the sluice to keep the water level of the drainage canals as low as possible. The old river courses are functioning as major drainage channels and small artificial drainage canals are connected as required in the areas with embankment. Whereas in the areas surrounded by polder dikes, artificial drainage canals are predominant.

In the final stage of the rainy season the slide gates of the sluice located end points of the drainage canal are closed to store the fresh rainwater in the drainage canals. However, the salt water intrusions are occasionally found through the degraded slide gates and also frap gates; hence the water impounded in the drainage canal is contaminated with salty water.

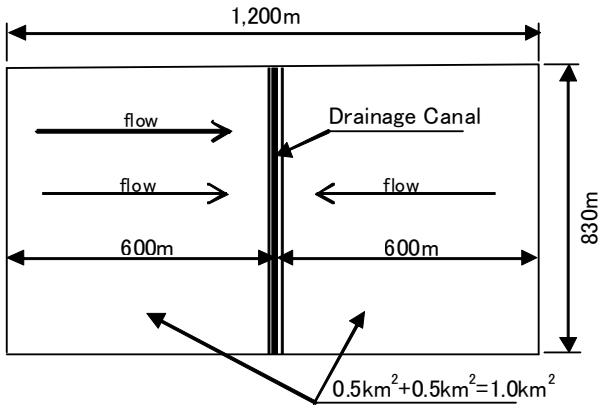
The summary of the existing drainage canals in 34 polders are shown in **Table 2.4-1**. The dimension of the cross sections of the drainage canals range as follows;

According to Hydrology Division, the capacities of the drainage facilities are usually so decided as to drain the 5 days consecutive rain water of 5 years return period within 10 days. At the peak of the rainy season, inundations on the paddy fields are sometimes found in the low-lying area or area with insufficient drainage canal allocation. The drainage condition of the area with insufficient drainage canal would be improved by providing new drainage canal. However improvement of drainage condition in the low-lying area could not be achieved by the gravity drainage. The complete drainage systems could be achieved by introducing the pumping-up drainage. However, the pumping-up drainage systems cannot be proposed in this stage from the view point of cost and effect (benefit) consideration.



Top width	10ft (3.0m) - 350ft (105.0m)
Bottom width	4ft (1.2m) - 150ft (45.0m)
Depth	1.5ft (0.45m) - 18ft (5.4m)

The length of the drainage canals varies from 0.03 mile to 13.0 mile. The total length of the drainage canals in the project area of 1,342 km2 in 34 polders is 1,109 km. The average density of the drainage canals is calculated at 0.83 km/km2. That means 830 m of drainage canal is provided in each 1 km2 of drainage area which is equal to 830 m x 1,200 m of area as illustrated below;



It is easily understood that the average drainage

Table 2.4-1 Summary of Existing Drainage Canal

Township	No.	Polder	Drainage Area (km2)	No. of Sluice	No. of Drainage Canal	Length of Drainage Canal		Density of Drainage Canal (km/km3)	Remarks
						(mile)	(km)		
Ngaputaw	1	Alegyun(1)polder	16.7	3	9	16.62	26.7	1.60	
	2	Alegyun(2)polder	36.1	4	26	26.04	41.9	1.16	
	3	Alegyun(3)polder	36.4	4	14	19.87	32.0	0.88	
	4	Magyibinmadaukan	5.5				0.0	0.00	Embankment
		Sub-total	94.7	11	49	62.53	100.6	1.06	
Labutta	5	Thingangyi	7.0	2			0.0	0.00	Embankment
	6	Zinywe	6.2				0.0	0.00	Embankment
	7	Leikkwin	3.8				0.0	0.00	Embankment
	8	Labutta South	28.6	3	13	20.35	32.7	1.14	
	9	Labutta North	78.3	10	40	57.43	92.4	1.18	
	10	U Gaungpu	3.7	3			0.0	0.00	
	11	Bitud Island (1)	19.0	2	12	14.69	23.6	1.24	
	12	Bitud Island (2)	27.8	4	33	37.59	60.5	2.18	
	13	Bitud Island (3)	32.1	4	26	28.80	46.3	1.44	
	14	Bitud Island (4)	76.4	6	45	80.57	129.6	1.70	
		Sub-total	282.9	34	169	239.42	385.2	1.36	
Bogalay	15	Daunggyi polder	98.9	6	32	51.66	83.1	0.84	
	16	Daunggyi East	89.3	3	9	27.40	44.1	0.49	
	17	Daunggyi West	69.4	4	20	31.90	51.3	0.74	
	18	Daunggyi Upper	13.8	1	2	4.36	7.0	0.51	
		Sub-total	271.4	14	63	115.32	185.5	0.68	
Pyapon	19	Dawnyein polder	12.0	1	10	14.00	22.5	1.88	
	20	Myokone polder	22.8	1	16	17.00	27.4	1.20	
	21	Kyetphamwezaung	125.7	7	50	66.25	106.6	0.85	
	22	Banbwezu	53.3	7	36	33.00	53.1	1.00	
	23	Daydalu	17.2	1	5	7.00	11.3	0.65	
	24	Letpanbin	34.6	4	11	14.00	22.5	0.65	
	25	Zinbaung	26.7	4	14	13.00	20.9	0.78	
		Sub-total	292.3	25	142	164.25	264.3	0.90	
Daydaye	26	Myaseinkan	54.7				0.0	0.00	Embankment
	27	Thandi	13.9		7	43.00	69.2	4.98	Embankment
	28	Suclubbaluma	29.5				0.0	0.00	Embankment
	29	Hleseikchaunggyi	9.1				0.0	0.00	Embankment
	30	Tamatakaw	53.5				0.0	0.00	Embankment
	31	Kyonsoat	2.4				0.0	0.00	Embankment
		Sub-total	163.1	0	7	43.00	69.2	0.42	
Kyaiklatt	32	Maubin Island North	81.2		3	20.27	32.6	0.40	
	33	Maubin Island South	110.0		4	19.58	31.5	0.29	
	34	Thonegwakyun	46.1		7	24.55	39.5	0.86	
		Sub-total	237.3	0	14	64.40	103.6	0.44	
		Total	1,341.7	84	444	688.92	1,108.5	0.83	
	Source: List of Drainage Canal in the Polder Area Ayeyarwady Division Department of Irrigation								

path to the drainage canal on the surface of the land is estimated at 600 m. This figure is fairly large. It is generally considered that the adequate drainage path to the drainage canal should be 300m-400m in

the flat topography like the project area. (For example if rainwater runs surface of the land with the gradient of 1/2,000, 30 cm water level difference is required between runoff starting point and the edge of the drainage canal.) It is reported that the low lying parts of the project area sometimes encounter the drainage problems damaging paddy cultivation and is considered as one of the reason that the production of paddy does not increase to the level of the paddy production in the upper area within Ayeyawady Region.

(2) Behavior of Water Level of Drainage Canal

The water level of the drainage canal fluctuates according to the rainfall discharges, riverside water level and the gates operation. According to the engineer of the Irrigation Department, the gates in the polders in the Ayeyawady Delta are operated by the simple operation rule. That is "open the slide gates on 15th May and close the slide gates in the last half month of September. Of course, the flap gates are operated arbitrarily by difference of water level without any human control.

The water levels of river sides and canal sides are measured and recorded 3 times a day at 6:00, 12:00 and 18:00 together with the maximum and the minimum water levels and occurrence times by the gate men employed by the Irrigation Department. The records are reported to the Township Irrigation Department Office monthly and compiled in the office.

The water level records from October 2008 to March 2011 of 8 sluices in Labutta North Polder were collected. Within this observation period, September 2009 became the critical month, because this month had more than 40 inches of rainfall after the preceding big amount of rainfall, soils are completely saturated and water was impounded deep on the paddy fields. The water levels of the drainage canals and the maximum and. minimum. River water levels in said eight (8) sluices are shown in **Appendix 5-2**. It is understood from the figure that credibility of the data on Latwalkwal Sluice is doubtful because water level fluctuation cannot be explained theoretically. The water level of the drainage canal went down even the lowest level of the river water level although the big amount of rainfall continued and drained water came out from the paddy fields.

The summary of drainage condition of highest drainage canal water levels in the year 2009 and 2010 and number of days of water levels above the average lowest paddy fields at eight (8) sluices are shown in **Table 2.4-2**.

Table 2.4-2 Summary of Darinage Condition at the 8 Sluices in Labutta North Polder

No.	Sluice Name	R.D. (feet)	River Name	Lowest Paddy Field Level (feet)	Year	Max. Water Level of Drainage Canal			
						Water Leve (feet)	Date	Water depth (feet)	above Paddy Field (Days)
1	Danedan	9,220	Sa Gyin	2.5	2009	3.8	9.9.2009	1.3	6
					2010	0.5	5.8.2010	no	0
2	Latwalkwal	28,800	Sa Gyin	2.0	2009	4.1	7.9.2009	2.1	10
					2010	2.5	5.8.2010	0.5	2
3	Mayan	57,600	Thet Ke Thaung	2.0	2009	3.8	8.9.2009	1.8	7
					2010	2.3	9.8.2010	0.3	1
4	Laputttaloke	94,700	Thet Ke Thaung	5.0	2009	5.6	7.9.2009	0.6	2
					2010	3.1	5.8.2010	no	0
5	Hpobe	135,200	Kyauk Pyu	2.5	2009	3.8	9.9.2009	1.3	11
					2010	3.0	21.7.2010	0.5	10
6	Danechaung	156,400	Kyauk Pyu	2.0	2009	3.8	9.9.2009	1.8	50
					2010	2.0	15.7.2010	no	0
7	Kyaukchaung	173,700	Kyaukchaung Yae Kyaw	2.6	2009	3.8	10.9.2009	1.2	7
					2010	2.2	24.8.2010	no	0
8	Shansu	195,500	Ywe	3.2	2009	4.5	7.9.2009	1.3	3
					2010	2.7	5.8.2010	no	0

For the discussion of the drainage capacity, the typical sample of the behavior of water levels of the drainage canal side and the river side in September 2009 is shown in **Figure 2.4-3.** As seen from the Figure, heavy rainfall is concentrated in the beginning of September. The water levels of both the drainage canal side and river side went up by the discharge caused by the large amount of rainfall. The water level of the drainage canal side exceeded the level of the average lowest paddy field surface for five days with the maximum water depth above the paddy field 0.6 feet and the water level fluctuations have little correlation with the daily water level fluctuations in the riversides but have close correlation with the rainfall discharges. The peak water level in the drainage canals went down slowly for several weeks. The drainage capacity of both canals and sluices seems to be insufficient. However for the monsoon paddy cultivation, the capacity deficiency would not bring vital damage.

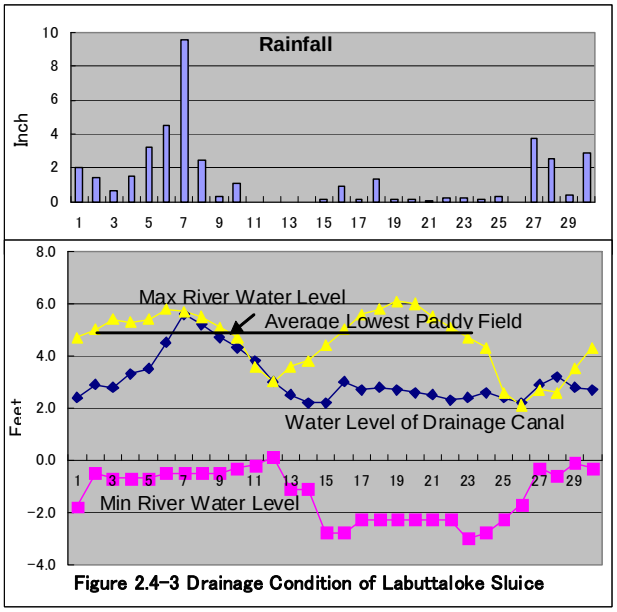


Figure 2.4-3 Drainage Condition of Labuttaloke Sluice

(3) Salinity of Soil

Salinity is a negative factor for growing agricultural crop that affects seriously crop production.

Cyclone Nargis has brought salt to the agriculture land inside polder dikes by the result of damage of polder dikes or overtopping over the crest of the dikes by the high tides or the waves generated by the strong wind and low atmospheric pressure of cyclone Nargis. The cyclone struck the Ayeyawady Delta on 2-3 May 2008, which was just before the wet season paddy cultivation started. It is considered that there was no agricultural crop plant growing on the surface of the paddy land, however the surface soil was almost saturated by the considerable amount of rainfall (say 60 mm that took place in the preceding one week, but the water levels of the drainage canals were low. The intruded salt water remained on the surface of the paddy field for relatively short periods (2 to 3 days), and during occupation period of the salt water, the salt water did not go deep down into soils which were already almost saturated with rain water. The remaining salt water flowed out as the water level of the river or the sea went down.

The wet season paddy cultivation has started in the year 2008 in the condition described above. The rainfall water in the wet season infiltrated into the soil and some leaching effects were accomplished. However the salt content was still high and the proper growing of the wet season paddy was discouraged. The yield of the paddy in the year 2008 was counted at only 10 baskets/acre (0.57 ton/ha).

Because the rainfall water was impounded for several months on the surface of the paddy field for the wet season paddy cultivation, the leaching was accelerated and the salt concentration has remarkably reduced. The growing of the wet season paddy cultivation in the year 2009 was much better than the in 2008 with a yield that has reached 40 baskets/acre (2.28 ton/ha). Judging from the amounts of yield, it can be considered that the salt in the plow layer (about 20 cm depth from the surface) has almost been leached.

The soil EC value in Labutta North has been obtained from practical field measurement by our agronomist (refer to section 2.3.5 Agricultural Damage by Cyclone Nargis). According to the result of

the field test, EC value of eight 8 samples shows less than 3 mS/cm. Judging from the results of the tests, it seems that salt has already leached out. The survey on the soil salinity was sub-contracted to the local consulting firm "Golden Plain Agricultural Products Cooperative Society Ltd.". The soil samples were collected from the paddy fields of the selected plots in each polder from 28th January to 14 February 2010. Soil profiles from two different depths, 15 cm depth as surface soil samples and 50 cm depth. In one sample plot, five places were dug and the samples from the same depth were mixed for the test sample. Judging from the result of the test, there is no significant diversity between the samples from the different depths. Therefore, the discussion hereafter will be made based on the result of the salinity tests of the samples from the 15 cm depth.

The results of the soil salinity tests are given in **Table 2.4-3**. Polders are categorized according to the value of the EC(e). The ranking of the EC(e) value is categorized as follows;

However, these EC(e) values were obtained from the soil samples taken in mid-dry season from the end of January to beginning of February. The soils where drainage conditions are poor and water remains after the harvesting of paddy, the salinity of soil will be increased by the condensation of stagnant water. Incomplete drainage condition of sub-surface water (water logging) also causes the increase of the salinity of the soil by the evaporation from the surface of the soil during the dry season.

Table 2.4-3 Salinity (Electric Conductivity) of Soil

Township	No.	Polder	Sample Village	Ece ms/cm	Rank
Labutta	1	Alegyun(1)polder	Hponyokone	9.49	B
	2	Alegyun(2)polder	Hpobagankone	10.36	C
	3	Alegyun(3)polder	Ingaday	10.87	C
	4	Magyibinmadaukan	Madaukan	18.69	C
	5	Thingangyi	Nalinkyaw	22.34	C
	6	Zinywe	Koebo	22.46	C
	7	Leikkwin	Leikkwin	5.01	B
	8	Labutta South	Kyarnkan	3.42	B
	9	Labutta North	Daminchaunglay	2.67	A
	10	U Gaungpu	Kangyidaunt	14.27	C
	11	Bitud Island (1)	Zeebyu	3.80	B
	12	Bitud Island (2)	Lay-ein tan	2.94	A
	13	Bitud Island (3)	Kabarkwin	2.82	A
	14	Bitud Island (4)	Leik-i	4.01	B
Bogalay	15	Daunggyi polder	Daunggyi	3.28	B
	16	Daunggyi East	Hpoe-nyo	4.92	B
	17	Daunggyi West	Paung De	6.70	B
	18	Daunggyi Upper	Kamarkula	8.40	B
Pyapon	19	Dawnyein polder	Dawnyein	42.88	D
	20	Myokone polder	Hpa-yar-kone	11.86	C
	21	Kyetphamwezaung	Okkapar	3.45	B
	22	Banbwezu	Koe-ein tan	2.65	A
	23	Daydalu	Ngoat ta htaung	4.57	B
	24	Letpanbin	Letpanbin	3.99	B
	25	Zinbaung	Tinpalwair	3.42	B
Daydaye	26	Myaseinkan	Akeichaungwa	12.46	C
	27	Thandi	Baygyi	3.39	B
	28	Suclubbaluma	Hnarkhaungchaun	4.80	B
	29	Hleseikchaunggyi	Lay	3.52	B
	30	Tamatakaw	Toe	4.52	B
	31	Kyonsoat	Kawet	10.64	C
Kyaiklatt	32	Maubin Island North	Hlaingtar	1.54	A
	33	Maubin Island South	Tharyawel	3.02	B
	34	Thonegwakyun	Tamatpyay	2.39	A

Source: Water Quality and Soil Quality Survey by Golden Plain Cooperative Society Ltd.

FAO Field Guide gives the leaching water requirement for the each salinity level as follows;

Initial EC(e) value (mS/cm)	Required water (mm)
10	315
15	430
20	540
25	650
30	765

Judging from the above table, leaching water requirement for each salinity rank is estimated as follows;

Rank	EC(e) (mS/cm)	Required Water (mm)	No. of Polders
A	Less than 3	Non	6
B	3<EC(e)<10	300	18
C	10<EC(e)<25	600	9
D	Greater than 25	900	1

Judging from the pattern of distribution of rainfall which usually starts mid-May, the required period of rainfall is roughly estimated as follows;

- Rank A has no special restriction for growing paddy from the salinity point.

- Rank B needs leaching by flooding with rain water in the plots about one month duration with frequent drainage.

- Rank C needs leaching by flooding with rain water in the plots about one and half month duration with frequent drainage.

- Rank D is special case and the data has lack of creditability. If this data is true, more than two month duration of leaching would be necessary.

The project area is blessed with affluent rainfall in wet season. Therefore, before transplanting paddy in the beginning of wet season, it is practically possible to wait one or two months until the paddy fields are leached by flooding of the rain water. It is the most applicable method for reducing the salinity of the soil.

According to the FAO Field Guide, if the EC(e) is less than 3 mS/cm there will be practically no harm to the crop and no yield loss will be incurred. If the EC(e) is greater than 3 mS/cm the yield loss is given as follows;

- If the EC(e) is less than 4, the yield loss will be less than 10%
- If the EC(e) is more than 4, the yield loss will be 10 – 20%
- If the EC(e) is more than 6, the yield loss will be 20 – 50%
- If the EC(e) is more than 10, the yield loss will be more than 50%

However, the leaching effect on the plow sole and the consolidated clay or silt layer would have been limited, and it is considered to take longer time to leach the salt completely from these layers. Taking longer time for leaching means that the quantity of salt to be leached in one cropping season is small and the salt contents could be regulated to the harmless level for the crops, and it is anticipated that the ill effects of salt on crops would become minor.

As there is more than 3,000 mm of rainfall every year, the area already passed two rainy seasons and the leaching process has been accelerated rapidly. It is expected that one or two more rainy seasons will bring the solution on the salt concentration problems. However, in the restricted low lying areas where thick consolidated clayey soil is prevailing or the areas where the distance to the drainage canal is too far or the depth of the drainage canal is too shallow, there is a need to deepen by dredging the existing drainage canal or to provide new on-farm drainage canals along the farm plots. But these components will not be included in the project except rehabilitation of dredging deposited or collapsed soil nearby the sluices. The only problems that remain are those located in the low lying area adjacent to the swampy saline soils which face difficulties with drainage and reclamation will require huge earth works and project cost.

The Labutta North polder was selected for the pilot project area. By the overall EC values of polder wide measurement shows Labutta North is classified as Rank A which means safe for vegetable cultivation. At the commencement of the On-site Seed Production Pilot Project, EC measurements at the pin point sites have been carried out. The results are shown below:

Sr No.	**Farmer's Name**	**Village Name**	**EC (1:5) Soil: Water ms/cm**	**ECe (1:5) Soil: Water ms/cm**
1	Daw Khin Yi	Kyaut Hmaw	0.19	1.20
2	U Zaw Oo	Kyaut Hmaw	0.12	0.75
3	U Hla Ngwe	Myo Ma (9)	0.08	0.48
4	U Myint Lwin	Myo Ma (9)	0.07	0.44

The results show there is no concentration of salinity in the soils and impounding of rain water in the paddy fields before planting seedlings of paddy would not be required.

EC measurements were also conducted in the fields of Pilot project of Income Generation Vegetable Cultivation. There is no EC problem on the soil together with irrigation water to be applied.

2.5 Present Condition of Agricultural and Rural Infrastructure in the Project Area

2.5.1 Polder Dikes and Sluices

The relation between river water level and rainfall inside the polder is as follows. During wet season, rainwater is accumulated inside the polder then water is drained to the river outside of the polder through the sluice gate. During dry season, on the other hand, canal water level inside the polder becomes lower than the river water level at high tide, thus sluice gates need to have a function not to flow salty river water into the polder. Consequently, sluice structure need to have both functions, namely to drain excess rainwater inside the polder to the outside as well as to stop river water flowing into the polder. From this reason, two types of gates are installed at the sluice, one is flap gates at the river side to stop river water not flowing into the polder, and the other is slide gates at the polder side to drain and control excess fresh water to the outside. Both the quality and quantity of the drainage canal water inside the polder are controlled by using these two types of gates (refer to the illustration below).

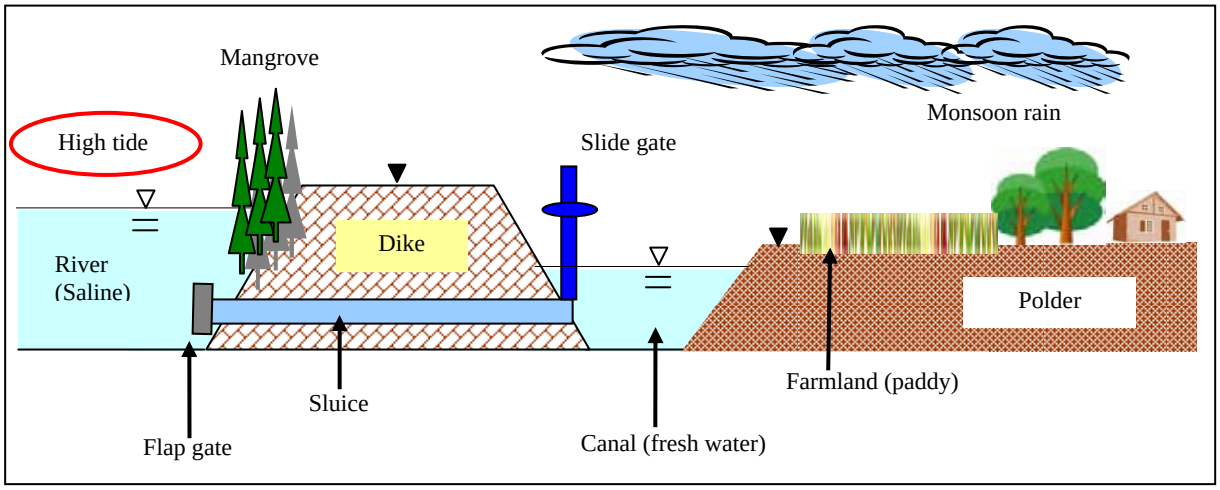


Figure 2.5-1 Polder Dike Schematic Section

Present condition and existing facilities of 34 polders in the Project Area are as follows;

Present Condition of Existing Dike: Small & Low
(January 2010, at the time of high tide)

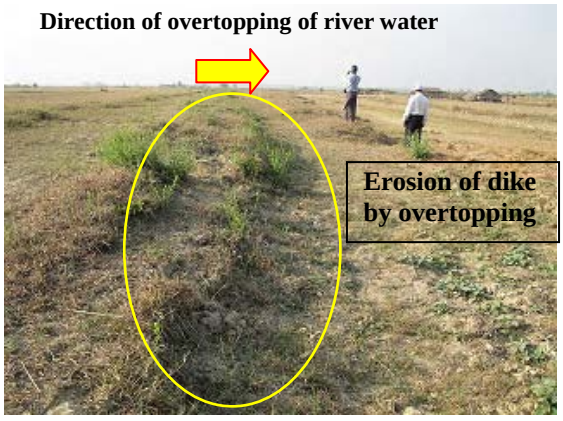
Present Condition of Existing Sluice: Slide Gate Side
(January 2010)

Table 2.5-1 Existing Facilities of 34 Polders in Project Area

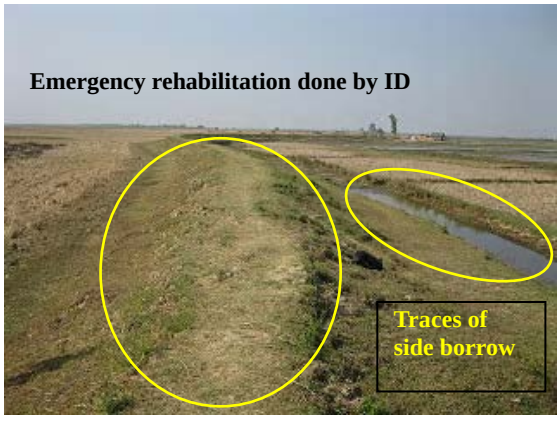
Township	No.	Name of Polder	Protected Area (km^2)	Dike Length (km)	Sluice (nos.)	Township	No.	Name of Polder	Protected Area (km^2)	Dike Length (km)	Sluice (nos.)
Labutta	1	Alegyun (1)	16.7	21.6	3	Phyapon	19	Daw Nyein	12.0	22.5	1
	2	Alegyun (2)	36.1	36.5	4		20	Myokone	22.8	27.4	2
	3	Alegyun (3)	36.5	28.4	4		21	Kyetphamwezaung	125.7	74.1	7
	4	Magybinmadaukkan	5.5	5.5	0		22	Banbwezu	53.3	41.9	7
	5	Thingangyi	7.0	10.1	0		23	Daydalu	17.2	20.9	1
	6	Zinywe	6.2	9.7	0		24	Lepanbin	34.6	32.2	4
	7	Leikkwin	3.8	6.0	1		25	Zinbaung	26.7	24.2	4
	8	Labutta (South)	28.7	32.5	3			Sub Total	292.3	243.1	26
	9	Labutta (North)	78.3	61.2	9	Daydaye	26	Myaseinkan	54.7	21.7	0
	10	U Gaungpu	3.7	8.4	0		27	Thandi	13.9	6.8	0
	11	Bitud Island (1)	19.0	22.6	2		28	Suclubbaluma	29.5	11.9	0
	12	Bitud Island (2)	27.8	29.9	4		29	Hleseikchaunggyi	9.1	11.9	0
	13	Bitud Island (3)	32.2	45.1	4		30	Tamatakaw	53.5	11.3	0
	14	Bitud Island (4)	76.4	65.3	6		31	Kyonsoat	2.4	8.1	0
		Sub Total	377.8	382.8	40			Sub Total	163.0	71.7	0
Bogalay	15	Daunggyi	98.9	59.6	6	Kyaiklatt	32	Maubin Island (North)	110.0	20.0	0
	16	Daunggyi (East)	89.3	54.6	3		33	Maubin Island (South)	46.1	7.1	3
	17	Daunggyi (West)	69.4	50.9	4		34	Thonegwakyun	81.2	35.8	6
	18	Daunggyi (Upper)	13.8	16.9	1			Sub Total	237.3	62.9	9
		Sub Total	271.4	181.9	14			Grand Total	1,341.7	942.4	89

The alignment of polder dike depends on the topographic condition. One is shown as full ring-shape in case of lower elevation on whole polder and the other shown as half ring-shape of river side in case of higher elevation on inland.

It is judged from the field inspection that the crest elevation of polder dikes had already lowered considerably by about 0.9 - 0.6m (4.0 - 3.0 ft) on the average before the cyclone Nargis, from their original heights when constructed by Lower Burma Paddy Land Development Project, Phase I & II in 1980's, due to settlement of embankment, erosion by rainfall, wind-drift and others. Under those conditions, high tides and high waves of the river induced by the Nargis had overflowed the polder dikes and caused a great deal of damage to the inside of the polder. After cyclone Nargis, emergency restoration works for all damaged polder dikes have been implemented to recover the original height of the embankment by ID.

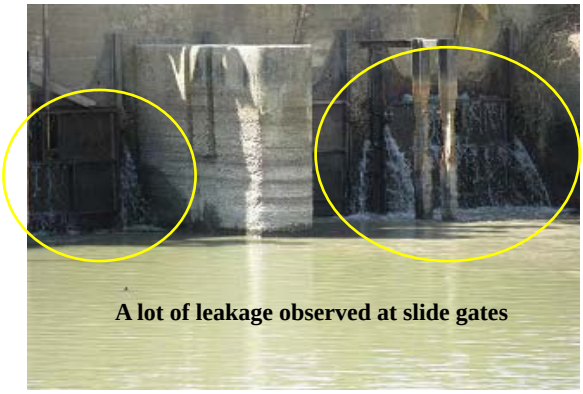


East Side in Labutta (North) Polder



South West Side in Labutta (North) Polder

At the sluice facilities, leakage is observed through flap gates as well as slide gates. At some sluices, entire gates have disappeared or gates are not operational due to broken gate hoist including damages of concrete base.

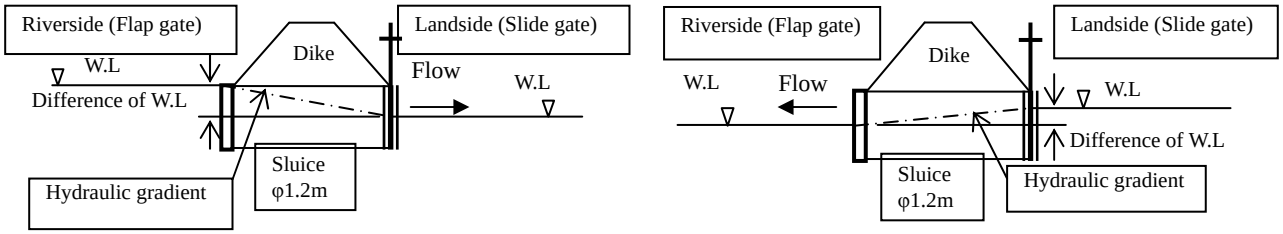


Function of gates has been assessed by evaluating the differences in water level (WL) and electric conductivity (EC) between both sides of flap & slide gate. When such differences become big, the functional condition of gates are judged as adequate and satisfactory. **Table 2.5-2** shows the differences in water levels and electric conductivities measured at sluices in the Labutta North and Daunggyi polders. From the said table, it is evaluated that good condition is only when the EC value of the external river exceeds more than twice as large as it internal water. From this point of view, about one third of sluices in the Labutta North polder are evaluated to be functioning well, and on the contrary all sluices in Daunggyi polder are evaluated as not functioning well.

Table 2.5-2 Differences in Water Level and EC Value at Labutta and Bogalay

No.	Sluice Name (Survey Side)	Date/Time of EC survey	EC (mS/m)	Difference of EC (River - Landside)	Date/Time of WL survey	WL (ft)	Difference of WL (ft)
Labutta North Polder in Labutta Township							
1	Danetan (Riverside)	30/01/2010	15.57	6.57	20/01/2010	-4.0	0.5
	Danetan (Landrside)	1:00 p.m.	9.00		8:10 a.m.	-3.5	
2	Latwalkwal (R)	30/01/2010	12.77	3.50	20/01/2010	-4.0	1.7
	Latwalkwal (L)	1:30 p.m.	9.27		8:45 a.m.	-2.3	
3	Mayan-S (R)	30/01/2010	5.20	1.40	20/01/2010	-0.5	2.7
	Mayan-S (L)	2:30 p.m.	2.80		10:20 a.m.	-3.2	
4	Mayan-N (R)	30/01/2010	7.73	(good) 4.56	20/01/2010	-0.5	2.7
	Mayan-N (L)	3:00 p.m.	3.17		10:20 a.m.	-3.2	
5	Labuttaloke (R)	30/01/2010	12.37	(good) 9.87	19/01/2010	2.0	3.0
	Labuttaloke (L)	3:30 p.m.	2.50		1:00 p.m.	-1.0	
6	Shansu (R)	30/01/2010	15.07	(good) 9.07	19/01/2010	-3.1	2.6
	Shansu (L)	4:45 p.m.	4.00		8:15 a.m.	-0.5	
7	Kyaukchaung (R)	31/01/2010	11.10	1.10	11/01/2010	-1.5	1.0
	Kyaukchaung (L)	8:00 a.m.	10.00		2:00 p.m.	-0.5	
8	Danechaung (R)	31/01/2010	10.93	0.23	19/01/2010	-0.8	0.2
	Danechaung (L)	10:00 a.m.	10.70		10:15 a.m.	-1.0	
9	Hpobe (R)	31/01/2010	3.20	0.60	19/01/2010	1.0	1.0
	Hpobe (L)	11:00 a.m.	2.60		11:00 a.m.	0.0	
Daunggyi Polder in Bogalay Township							
1	Kathapaung (R)	02/02/2010	5.67	0.27	02/02/2010	1.5	1.0
	Kathapaung (L)	10:00 a.m.	5.40		1:00 p.m.	0.5	
2	Kyonekaw (R)	02/02/2010	5.80	1.67	02/02/2010	-3.0	2.0
	Kyonekaw (L)	11:00 a.m.	4.13		11:00 a.m.	-1.0	

3	Ahseelay (R)	02/02/2010	11.67	2.37			
	Ahsselay (L)	11:30 a.m.	9.30				
4	Thalchaung (R)	02/02/2010	8.63	0.20			
	Thalchaung (L)	12:00 p.m.	8.43				
5	Myitkyo (R)	02/02/2010	13.80	0.00			
	Myitkyo (L)	2:30 p.m.	13.80				
6	Kalagyichaung (R)	02/02/2010	9.60	1.67			
	Kalagyichaung (L)	3:00 p.m.	7.93				



Case in suitable condition of Flap Gate **Case in suitable condition of Slide Gate**

Figure 2.5-2 Functional Condition of Flap and Sluice Gate at Sluice

Furthermore, variation of yearly expenses for ordinary operation & Maintenance (O/M) by ID is shown in the right table for these 5 years on Labutta North Polder.

Year	Personnel Expenses (Kyat/Year)	Material Expenses (Kyat/Year)	Total O/M Expenses (Kyat/Year)
2006/7	9,300,000	17,682,000	26,982,000
2007/8	9,300,000	34,336,000	43,636,000
2008/9	9,300,000	6,092,000	15,392,000
2009/10	9,780,000	6,409,000	16,189,000
2010/11	21,228,000	108,372,000	129,600,000

Personnel expenses increased in 2010 according to revision of base salary. On the other hand, material expenses is divided into regular O/M and special repair, and expenses of special repair depends on the conditions of facilities needed repairing. In addition, material expenses became bigger due to the inclusion of rehabilitation of the sluice surrounding together with JICA pilot project.

As mentioned above, operation and maintenance efforts have been undertaken to maintain in good conditions the r facilities under a very limited expenses.

2.5.2 Other Rural Infrastructure

(1) Rural Roads

The Yangon-Pathein road is fairly good. However, this road runs in the north out of the project area. The major roads which connect the project area with the Yangon-Pathein road or the roads connecting between townships are poor. Tar paved sections are limited. Most of the sections are paved with small cobble or gravel and the paving is under progress. However these gravel paving is carried out without machinery. Most of the gravel paved sections are left without compaction and grading. The roads are very much bumpy and only four wheel drive vehicles and large buses and trucks can drive through the roads. The widths of the roads are narrow. The total width of the roads including shoulders is approximately 15 ft - 20 ft (4.5 - 6.0 m). It means that two large vehicles cannot pass smoothly without one of two vehicles slowing down to provide space to the other to pass through.

The roads within the polders are also poor in condition. Even four wheel drive vehicles cannot traverse on some parts of the roads. Most of the crests of the polder dikes are used as road; however some part of these roads cannot be traverse by vehicles.

The roads in the towns are paved with tar or concrete and they are free from muddy trails of vehicles in rainy season and also free from dust winding up by driving in dry season.

(2) Water Ponds for Drinking Water

The dominant source of drinking water prior to the cyclone Nargis was rainwater harvested by households in large earthen pots (used during rainy season) or in large community ponds (used more in dry season). People are now drinking and using unsafe surface water, due to house damage that collapsed roof-rainwater harvesting systems. In addition, up to 40% of the ponds have turned saline or turbid due to flooding by the cyclone. The ponds are square shaped (30mx30m - 50mx50m) with bottoms excavated to 5 feet deep and surrounding bank of 5 feet high. After Nargis, the water of most of the ponds has once been drained and new fresh rainwater is stored and the water is used for drinking and domestic purposes.

A pond for drinking water in Labutta

People are using different water treatment methods for drinking purpose. The most common water treatment method in the affected area was straining the water through a cloth, 39%, followed by boiling, 29%, and letting the water stand and settle, 22%. (Post-Nargis Periodic Review II)

Most villages have ponds for domestic water use. Villagers store water in these ponds in the wet season for use during the dry season. However, the water quality in some ponds is not necessarily good. Although two rainy seasons have already passed, saline water is sometimes found. As villagers do not use saline pond water for domestic use nor they do not remove saline water due to lack of proper ditch or drainage canal, the pond water remain saline.

Lack of sanitation facilities in camps and transition shelters presented an increase risk of diarrhea disease due to the potential for contamination of surface water source. Latrines that existed prior to the cyclone collapsed or were unsafe for use due to flooding. However, these sanitation facilities are now completed or under rehabilitation and people are expecting to get water from safe water source.

2.6 Emergency Rehabilitation and Reconstruction implemented by the Government and Donors

2.6.1 Rehabilitation and Reconstruction implemented by the Government

As previously stated in Section 2.5.1, emergency rehabilitation works to restore the crest elevation of the dike to its original height before the Nargis have been completed already by the Government. It is, however, considered that the crest elevations are not safe enough, and reconstruction of dikes with necessary height to protect the service area from river flooding has been implemented by ID. At present, 13 polders have already been completed while 9 polders are under construction, as shown in **Table 2.6-1**

Table 2.6-1 Rehabilitation of Polder Dike Embankment by ID - Accomplishment

Completed 100% as of end of March in 2011			Progress (%) Under Construction as of end of March in 2011			
Township	Name of Polder	Dike Length (mile)	Township	Name of Polder	Dike Length (mile)	Progress (%)
Labutta	No.3 Alegyun (3)	17.65	Labutta	No.5 Thingangyi	6.30	68
	No.4 Mgyibinmadaukan	3.40		No.11 Bitud Island (1)	14.02	23
	No.6 Zinywe	6.00		No.12 Bitud Island (2)	18.60	7
	No.14 Bitud Island (4)	40.53		No.13 Bitud Island (3)	28.00	54

Bogalay	No.17 Daungggyi (West)	31.60	Bogalay	No.15 Daungggyi	37.00	17
Phyapon	No.19 Dawnyein	14.00		No.16 Daungggyi (East)	33.90	36
	No.20 Myokone	17.00	Phyapon	No.21 Kyetphamwezaun	46.00	6
	No.23 Daydalu	13.00		No.25 Zinbaung	15.00	18
	No.24 Letpanbin	20.00	Daydaye	No.26 Myaseinkan	13.50	72
Daydaye	No.27 Thandi	4.25				
	No.28 Suclubbaluma	7.40				
	No.30 Tamatakaw	7.00				
	No.31 Kyonsoat	5.00				
Total	13 Nos.	186.83	Total	9 Nos.	212.32	

2.6.2 Rehabilitation and Reconstruction implemented by Donors

It is reported that some donors have expressed their intent to participate in the rehabilitation and reconstruction works of polders. However, to this day, the Consortium of Dutch NGO's (CDN) has only participated in the rehabilitation of the whole sluice gates and a part of polder dike in Bitud Island (1). Other plans and programs for rehabilitation works are still not clear at this time.

2.6.3 Reconstruction Plans by Government and Donors

Reconstruction works of polder dikes have been already undertaken by ID as mentioned above, and consecutive program for remaining 12 polders will be implemented by ID after 2011/2012 dry season.

2.6.4 Design and Construction Standards on Civil Work

Technical standards as to polder dike and sluice have not been established yet by the Irrigation Department (ID). At present however, design criteria for three civil engineering fields, namely 'fill dam', 'head works' and 'canal works', were prepared in 1997 as edited by ITC under ID from the land improvement project in JAPAN with technical cooperation by JICA. For the technical fields other than the above three, design and construction have been made based on standards of donor countries or experience of engineers.

2.6.5 Procurement Procedure and Condition

Government projects in relation to polder dike are normally undertaken by force account work by ID and contracted work by private contractors. Private contractors are usually procured through either international tender or domestic tender depending on project nature. The following are the general procurement procedure on government project for international and domestic tenders;

< Procurement procedure for international tender >

- Invitation of tender
- Opening international competitive bidding
- Various evaluations by technical and financial evaluation committee
- Decision by central procurement committee
- Approval of state trade council

< Procurement procedure for domestic tender >

- Invitation of tender
- Opening competitive bidding
- Various evaluations by technical and financial evaluation committee
- Negotiation and decision by the committee
- Approval of respective ministry

As to procurement conditions in Myanmar, basic plate and steel section of special steel (stainless steel) are imported from China and Thailand while high quality cement is imported from Thailand. But normal cement is mostly produced in Myanmar.

The ID has made many contracted works with private contractors since 1996 on condition that contractors have necessary number of construction equipment as well as qualified and experienced engineers. Therefore, many engineers retired from ID have been employed by private contractors and made use of their experience in the design and implementation of the project. However, private contractors with sufficient number of backhoes and bulldozers are only few. For instance, contractors with more than 20 numbers of backhoes and bulldozers were only 3 out of 7 contractors who were requested to submit quotation in the pilot project phase-1.

2.6.6 Government Budget

Figure 2.6-1 shows the organization of the Ministry of Agriculture and Irrigation (MOAI).

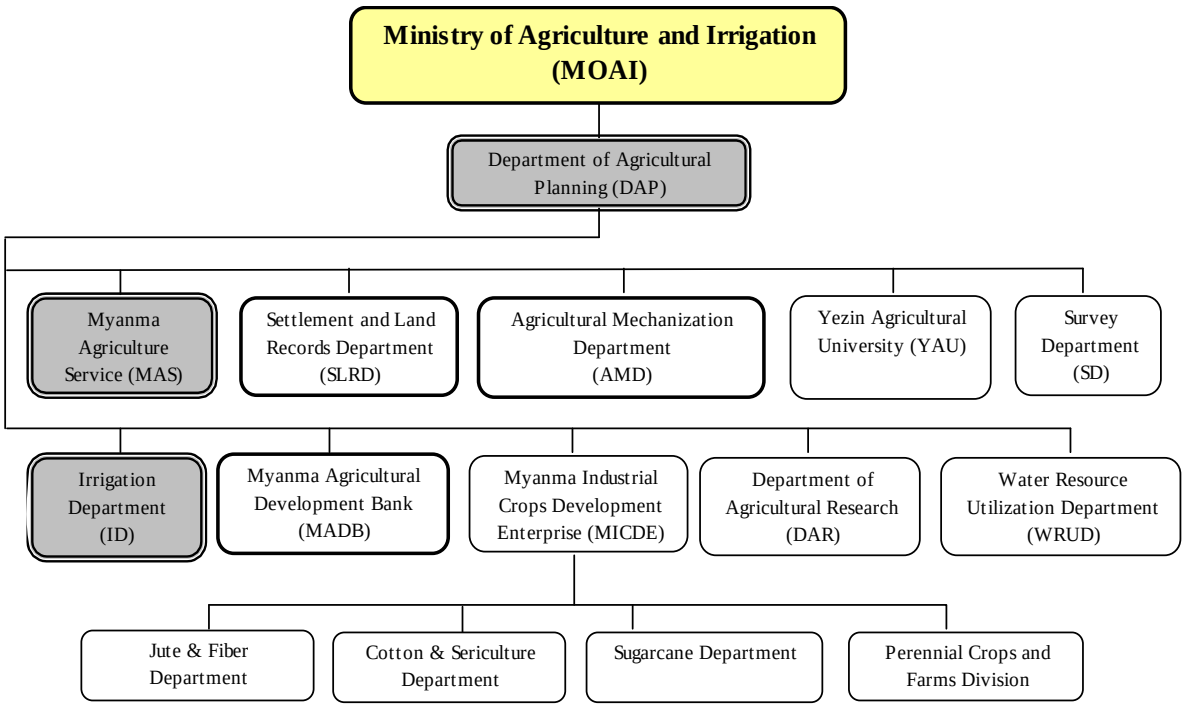


Figure 2.6-1 Organization Chart of Ministry of Agriculture and Irrigation (MOAI)

The Government allocates annual budget in two categories, namely current and capital. The current budget is used for O&M of existing facilities, staff salary and other services. The capital budget is for new project (i.e. construction project), extensions and renovations. The total budget of ID was 110,811 million Kyats in the year 2010 – 2011.

Table 2.6-2 Annual Budget of Irrigation Department (Million Kyats)

Year	Current	Capital	Total
2001 – 2002	4,111.55	17,201.11	21,312.66
2002 – 2003	4,639.42	21,394.71	26,034.13
2003 – 2004	7,995.54	27,919.69	35,915.23
2004 – 2005	9,977.17	27,495.93	37,473.10
2005 – 2006	11,642.11	43,755.57	55,397.68
2006 – 2007	20,259.28	48,862.95	69,122.23
2007 – 2008	24,796.41	70,560.54	95,356.95
2008 – 2009	27,186.94	126,043.13	153,230.07
2009 – 2010	32,635.77	88,134.43	120,770.20
2010 – 2011	37,112.88	73,698.86	110,811.74

2.7 Identification of Problems on Preservation of Farming Area for Urgent Rehabilitation of Agricultural Production and Rural Life

2.7.1 Problems on Agricultural and Rural Infrastructure

As briefly mentioned in the previous paragraph 2.5, problems on agriculture and rural infrastructure are shown as follows;

1) Low height of polder dike: Emergency rehabilitation work to restore the crest elevation of the dike to its original height before the Nargis has been completed already by the Government (ID). It is, however, considered that the crest elevations are not safe enough, because at the original design and construction in the early 1980s, the heights of embankment are designed to protect a flood of 20 years recurrence period only. Intrusion of saline water occurred several times in the past causing considerable damages to the farming of the empoldered area. It seems that an occurrence similar to Nargis will greatly affect the delta area again.

2) Poor water tightness of sluice gates: In accordance with non-rehabilitation of damage and leakage on most of sluice gates, salt concentration of water in the drainage are kept high due to saline water intrusion through damaged sluice, making difficult to improve farming activities in the served areas. In addition, inundation on farm occurs due to poor drainage caused by uncontrolled sluice gate in wet season. The said condition makes it difficult to improve the preservation of farming area and farming activities in the served areas. These problems are usually caused by astronomical tide through wet/dry season at present.

2.7.2 Problems on Farming

Based on the present condition of agriculture in the project area as explained in the previous section 2.3, major problems on farming in the project area can be summarized as follows:

1) Poor farming technique: Since natural condition of polder areas in terms of mainly soil have been deteriorated, adequate farm management is essential to reduce such risk. Most of farmers in polder areas have practiced traditional farming such as “use of ordinary (low quality) seed”, “inadequate use of fertilizer”, “non-regular row transplanting method”, etc. which have kept their productivity low. Such situation can decrease productivity of farming.

2) Lack of support on farming technique: Extension work has important role for improving farming technique of farmers. However, the number of staff of MAS which is the responsible agency to provide extension services to farmers was drastically decreased during the past 10 years. Consequently it has resulted to the slowing of agricultural developments.

3) Lack of farming inputs: Lack of farming input is one of the major problems in the project area for a longtime. Among problems, lack of seed, fertilizer, animal-power and agricultural finance have become serious especially after Nargis. Inputs such as seed and fertilizer are required at every cropping season on permanent basis. Therefore, supply of these inputs should be secured to realize agricultural recovery and further development in the polder area on medium and long term basis.

Lack of adequate agricultural loan is also serious issue and farmers have to go to the private agricultural loan, which requires very high interest rate. Thus, most of farmers have practiced unstable agricultural production in terms of financial condition. Farmers are forced to sell their paddy immediately after harvest to repay their loan even at lower price.

2.7.3 Problems on Livelihood and Income Sources

Inhabitants of this area (or almost all rural areas in Myanmar) are divided into tiller’s right holders and landless people. Almost all of tiller’s right holders are into paddy cultivation by employing farm workers except those who own tiller’s right of smaller areas. Landless households account for more

than 40% of the people in Myanmar[12] but it increase to more than three-fourths in Labutta North Polder[13] and 73% in all 34 polders[14] after the cyclone. The income generation plan will target these landless households.

Problems of landless households in the target area are identified as follows.

1) Low level of income: The main problem of landless households is low income and lack of income generation opportunities. Present Condition Survey revealed that the average annual income in 2007 for farmer household is 5,381,009 Kyats while that of landless household is 1,743,234 Kyats; in 2009 it was 3,866,402 Kyats for land right holders and 1,422,448 Kyats for landless household. If the annual income of landless household is divided by five (average household size), per capita annual income was 348,647 Kyats in 2007 and 284,490 Kyats in 2009 or $269 in 2007 and $261 respectively15. This income is below poverty threshold of 'one dollar for one day", the target of objective of the United Nation Millennium Development Goal.
2) Little opportunity of increasing income: Opportunity of increasing income for landless households is limited in the project area. Many of landless people are paddy workers and casual labour who do wage work or fishery as fishery worker, while very few landless households get income as tenant of paddy cultivation. Especially in the former case, income of landless households coming from farmers is rather low due to low productivity of rice production. Also, a number of landless people go to the southern part of the Ayeyawady Delta as temporary fishery worker. There are very few cottage industries like salt production and traditional manufacture in the target area. However, opportunity of wage labour increases in some areas such as New District Centre of Labutta District and construction of roads inside and connecting polders
3) Lack of skills for production: Landless households have very limited skills. They have low capability to generate income themselves due to low education level and little opportunity for learning modern technology/technique for generating new income. This means they have little knowledge and experience of income generation activities. Also, they have no means of production (land, boat) except to do manual labour. A few full-time fishermen have fishery license and own fishery boats and fishing nets but they are rare exception (generally these people are rich and out of the scope for income generation).
4) Lack of outside support: Systematical supports from outside for enhancing their capacity is not generally available though there were many direct supports (in-kind, projects) in the years within the areas affected by Cyclone Nargis. Market information has not been collected in the target area and it may cause discrepancy of production/harvest volume and amount of income.
5) Limited usable natural resources: Natural resources are limited for landless households. Land is largely used for paddy production and other land use is not common. Water inside polders is actually saline but it will be fresh after dike embankments and sluices are rehabilitated. This is only one positive condition for landless households.

2.7.4 Problems on Mangrove Windbreak

Regarding degradation of mangrove forest in the Ayeyawady Delta, the UNEP report, "Learning from Cyclone Nargis", describes detailed situation. According to this report, in the last 80 years, nearly 75% of mangrove trees in the Ayeyawady Delta have been lost, mainly due to the result of human activities. **Figure 2.7-1** shows that from a peak of about 260,000 ha (625,222 acres) in 1924, mangrove forests decreased to 67,000 ha (160,930 acres) in 2007. Nearly half of losses of mangroves were observed in the last 15 years, especially after 2001.

[12] Source: Agricultural Sector Review and Investment Strategy, UNDP/FAO, 2004
[13] Source: Interview to village tract chairmen
[14] Source: Present condition survey
[15] Exchange rate was 1 USD = 1,296 Kyat in 2007 and 1,090 Kyat in 2009 according to the World Fact Book (CIA).

The main reason for mangrove deforestation is the harvesting of timber for firewood and charcoal for home consumption as well as income generation. Other driving factors include conversion to paddy fields, salt farms, shrimp ponds and settlement areas. Mangrove deforestation has taken place in communal lands and land leased by individuals from the government, as well as in reserved and protected forests.

The loss and damage of mangrove forest as a result of Nargis is particularly critical, which affected about 16,800 ha (41,514 acres) of natural forest and 21,000 ha (51,892 acres) of forest plantation. Survey by Mr. Maung Maung Than, director of FD, indicated significant destruction of mangrove in the direct path of the cyclone and in adjacent areas. Defoliation and damage to branches ranged from 38.9 to 55.6% and damage to crown was between 12.8 to 19.8%. Uprooting of trees was notably higher in the direct path of the storm (56.7%) than elsewhere (4.2%).

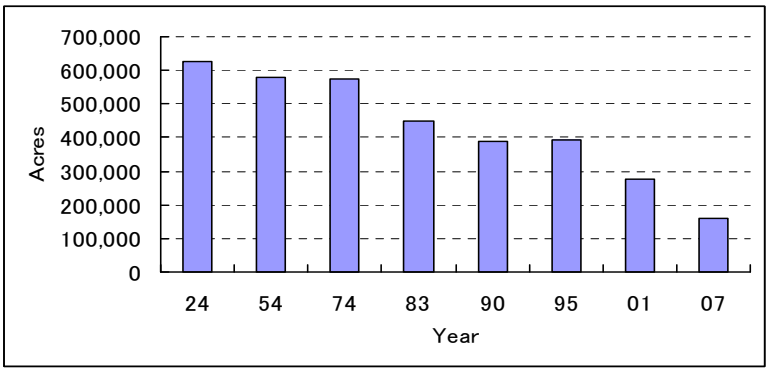


Figure 2.7-1 Changes of Mangrove Forest Areas in Ayeyawady Delta

On the other hand, the case that the mangrove defended a lot of resident against the damage of Cyclone Nargis was reported. The report of rapid survey for damage by Cyclone Nargis which was implemented by JICA project team for mangrove integrated management through participatory approach in Ayeyawady Delta introduced some case. According to the report, a lot of residents who received big damage by Cyclone Nargis were rescued by mangrove forest. The residents run into the mangrove forest and they held tightly to branch of mangrove tree during the Nargis attack. Such case shows that mangrove forest is useful for the residents when a natural disaster comes.

On March 2011, Study team conducted the survey for the remaining situation of mangrove windbreak at 34 polders in the study area. The survey result is shown in **Table 2.7-1.**

According to this investigation, 66% of the polder dike had been covered with mangrove before Nargis, but it was reduced to 50% just after Nargis. It passed almost 3 years since Nargis, but natural regeneration of mangrove has not been observed. Moreover, activities for the restoration of mangrove windbreak have not been carried out yet except No. 8, No. 9 and No. 15 polders which have been carried by some organisations. It means that both governmental and non-governmental support systems on restoration of mangrove along polder dike are almost lacking. From above situation, problems of mangrove windbreak trees along polder dike in the project area are summarized as follows;

1) Slow natural recovery of mangrove trees: Mangrove windbreak trees which are located along polder dike suffered huge damage from Nargis and it is observed that natural recovery of mangrove in such area is seen at very slow speed.
2) Lack of implementing organization for restoration of mangrove: It is necessary to replant for the restoration of mangrove windbreak, however there are only a few organizations which are working for the restoration of mangrove. Consequently recovery / rehabilitation of mangrove windbreak along polder dike have not made progress.

Table 2.7-1 Current Situation of Mangrove Windbreak at 34 Polders

	Polder name	Length of dike		Length of mangrove windbreak			Target for rehabilitation (miles)	Implementation organization
		km	mile	Before Nargis(%)	After Nargis(%)	Present situation (mile)		
1	Alegyun (1) polder	22.5	13.4	92%	80%	13.3	0.1	None
2	Alegyun (2) polder	38.6	22.7	90%	80%	20.2	2.5	None
3	Alegyun (3) polder	29	17.65	50%	30%	8	10	None
4	Magybinmadaukkan	5.8	3.4	60%	30%	2	1.4	None
5	Thingangyi	10.8	6.3	0	0	0	0	None
6	Zinywe	9.4	3.75	0	0	0	0	None
7	Leikkwin	6	6	100%	100%	6	0	None
8	Labutta (South)	33	20.5	96%	60%	19.75	0.75	FD
9	Labutta (North)	62.2	38	90%	80%	36.5	1.5	JICA
10	U Gaungpu	2.9	1.4	100%	100%	1.4	0	None
11	Bitud Island (1)	24.1	14.2	79%	60%	11.2	3	None
12	Bitud Island (2)	25.7	18.6	57%	30%	8	8	None
13	Bitud Island (3)	48.3	28	70%	50%	18	10	None
14	Bitud Island (4)	64.4	40.53	37%	20%	15	25.5	None
15	Daunggyi	59.5	37			30	7	Myitta Foundation
16	Daunggyi (East)	54.5	33.9			33.9	0	None
17	Daunggyi (West)	50.8	31.6			31.6	0	None
18	Daunggyi (Upper)	16.9	10.5			10.3	0.2	None
19	Daw Nyein polder	22.5	14			14	0	None
20	Myokone polder	27.4	17			17	0	None
21	Kyetphamwezaung	74	46			39	17	None
22	Banbwezu	45.1	26			26	0	None
23	Daydalu	20.9	13			13	0	None
24	Letpanbin	32.2	20			20	0	None
25	Zinbaung	24.1	15			15	0	None
26	Myaseinkan	21.7	13.5			12	1.5	None
27	Thandi	6.8	4.25			2.75	1.5	None
28	Suclubbaluma	11.9	7.4			6.4	1	None
29	Hleseik chaunggyi	11.9	7.4			4.4	3	None
30	Tamatakaw	11.3	7			0	7	None
31	Kyonsoat	8.1	5			2.6	2.4	None
32	Maubin Island (North)	20	12.4			2.4	10	None
33	Maubin Island (South)	7.1	4.4			0.4	4	None
34	Thonegwakyun	35.8	22.25			10.25	12	None

CHAPTER 3 CHALLENGES AND MEASURES ON PRESERVATION OF FARMING AREA FOR URGENT REHABILITATION OF AGRICULTURAL PRODUCTION AND RURAL LIFE

3.1 Challenges and Measures on Agricultural and Rural Infrastructure

The following challenges and measures for agricultural and rural infrastructure are considered based on the problems mentioned in Section 2.7.1.

(1) Challenges

For the purpose of prevention from saline water intrusion, reconstruction of polder dike with the required dike height and further replacement/repair of sluice gates are considered as urgent needs to recover and/or improve the preservation of farming area in the polder. The ID, however, has already completed emergency restoration works to recover the original height of dike embankment.

(2) Measures

Measures to resolve such challenges are to immediately implement reconstruction of polder dike and sluice.

For the formulating of the D/P of reconstruction of polder dike and sluice, it is very important to comprehensively study the safety (quality), cost and construction schedule of rehabilitation plan and recommend the most suitable and viable design and construction plan based on the technical standard and construction technology in Myanmar.

Therefore, various aspects such as technical standards in design and construction, implementation procedures, implementing body, administrative arrangement, environmental soundness, and so on will be studied and verified through the implementation of pilot project for dike embankment and sluice rehabilitation.

3.2 Challenges and Measures on Farming

The present situation and problems of agricultural farming in the Project Area are explained in Sections 5.2 and 2.7.2. Challenges and measures to solve problems would be considered as follows:

(1) Challenges

Lack of Farming Technique and MAS Technical Support; Improvement of faming technique is essential to increase crop productivity, and MAS support is primarily required to improve farmers' current farming techniques. However, most of farmers still practice traditional farming technique. In addition, the total number of MAS extension staff was reduced drastically in the recent years. The need for extension services by MAS is considered now as very necessary to enable the fast and efficient reaching out to farmers and to lessen delays in project implementation due to limited or non-presence of extension support services. Therefore, the establishment of effective supporting system by MAS to improve and update farming technique and skills is very important challenge.

Lack of Autonomous Agricultural Supply System in Rural Area; After the occurrence of the cyclone (Nargis), many support and assistance were provided and extended by the government, international organizations, NGOs, etc. for the urgent recovery of the area in terms of farming input supply such as seed, fertilizer, farm machinery, draft animals, etc. The problem on farm input supply after the disaster was gradually reduced. However, three years after Nargis, external support and assistance has diminished. Therefore, it is necessary to consider strengthening of

input supply system in the rural areas to realize long term recovery.

(2) Measures

Strengthening of MAS technical support in farming technique; Strengthening of demonstration activities is necessary utilizing MAS demo-farms and advanced farmers in order to provide effective extension work with limited number of MAS staff. Especially, development of advance farmer who have very important role in extension work in other country is needed.

Strengthening of production of agricultural input; Among agricultural inputs, seed is considered as the most basic and important input that can also be produced in the rural area by farmers. In line with this, the Myanmar Government has established the Seed Law in January 2011 to enhance the production of high quality seed through the private sector. However, there is a need to clarify the mechanism and viability of seed produced by farmers, and a pilot project for rice seed production is planned for this purpose.

3.3 Challenges and Measures on Livelihood and Income Sources

(1) Challenges

To improve actual livelihood conditions examined in Section 2.7.3, especially core problem of low income, the following challenges are considered to be tackled.

Poverty of landless households comes from lack of income generation opportunities and production means. Limited knowledge, skills and experience also worsen this situation. There is therefore a need to find solutions to improve this problem of creating livelihood opportunities. Based on these livelihood conditions, the following challenges are set for the D/P for income generation of landless households.

Opportunities for income generation must consider activities other than paddy cultivation. Though increase in paddy yield will activate rural economy and increase farm budget and make an impact on the economy of agricultural workers, there is still a need to consider other ways and means of assisting the landless people to become self-reliant.

The challenges and basis of planning of income generation must consider income opportunities that would require lower investment cost and something that will require low or limited technology so that these landless people who have not much income and skills and experience will be able to access and avail of these projects without problem. The natural conditions of the area, the easy access to production factors especially land must also be considered in the determination and planning of income generation opportunities. The support of the Government of Myanmar including the local government units will also be needed for this project so that the target priority areas and people will be able to access the project.

(2) Measures

To respond to these challenges, the following five (5) activities implemented in the target area at a small scale by landless households were examined as possible sources of income generation project. As a result, two (2) activities, vegetable cultivation and pig raising were identified to be feasible in the framework of the D/P. Details and feasibility assessment are described in Section 5.5.2.

1) Vegetable cultivation using fresh creek water at the borrowed paddy field during dry season
2) Fruit tree plantation: one banana and one mango tree in the house compound
3) Technical improvement of primary processing of small fish and prawn: increase income through grading up processing quality (drying) of small fish and prawn
4) Pig raising for breeding and fattening
5) Processing of farm produce as creation of special products of the village using planted

vegetables, fruits and processed fish (result of above mentioned activities).

3.4 Challenges and Measures on Mangrove Windbreak

It was realized by the people of the Ayeyawady Delta based on the Nargis experience, that mangrove windbreak could prevent human life disaster or death from tidal surge which is caused by cyclones and storms. From current situation and problems of mangrove windbreak as described in previous Section 2.7.4, challenges and measures to solve problems would be considered as follows:

(1) Challenges

It is strongly challenged to accelerate restoration of mangrove, through planting mangrove trees in order to contribute to the preservation of the farming area through the protection of polder dike from tidal surge and storms. Recovery of the mangrove will be very slow if no restoration will be done.

(2) Measures

Measures to solve such challenge are to plant mangrove trees at Nargis affected area for acceleration of mangrove recovery.

In the formulation of the D/P for the rehabilitation of mangrove windbreak, it is important to conduct integrated study from technical, financial, institutional and social viewpoints, from which the most appropriate rehabilitation plan can be established. For this purpose, mangrove planting is tested at one polder as a pilot project. Through the pilot project, materials and equipment required, technical input, operation and maintenance system, etc. will be verified including appropriate technology to be employed in the plan. Based on the results of the pilot project area, viable and implementable measures will be finally formulated for the whole area