NATIONAL WORKSHOP ON FISHERIES RESOURCES DEVELOPMENT AND MANAGEMENT IN BANGLADESH

DHAKA, BANGLADESH
29 OCTOBER - 1 NOVEMBER, 1995

ORGANIZED BY
MINISTRY OF FISHERIES AND LIVESTOCK, BANGLADESH, IN COLLABORATION WITH BOBP/FAO & ODA

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BAY OF BENGAL PROGRAMME BOBP/REP/74
FOR FISHERIES MANAGEMENT

REPORT OF THE NATIONAL WORKSHOP ON FISHERIES RESOURCES DEVELOPMENT AND MANAGEMENT IN BANGLADESH

29 October - 1 November, 1995
Dhaka, Bangladesh

BAY OF BENGAL PROGRAMME
Madras, India
1997

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This document records the proceedings of the National Workshop on Fisheries Resources Development and Management, held in Dhaka, Bangladesh, from 29 October to 1 November, 1995. Some 125 delegates — representatives from the government, NGOs, the private sector, donor and technical assistance agencies, research and university personnel, besides fishers and fish farmers — attended the Workshop.

Organized by the Ministry of Fisheries and Livestock, Bangladesh, the Workshop was sponsored by the FAO and ODA (UK). FAO funds for the Workshop were made available through the Japan Trust Fund GCP/RAS/138/JPN. Nine papers that addressed circumstances, needs and concerns in fisheries resources development and management were presented at the Workshop.

This report describes the background to the Workshop and lists its recommendations. It also reproduces the papers by invited resource persons and four project proposals for technical assistance presented at the Workshop.

The Bay of Bengal Programme (BOBP) is a multi-agency regional fisheries programme that covers seven countries around the Bay of Bengal — Bangladesh, India, Indonesia, Malaysia, Maldives, Sri Lanka and Thailand. The Programme plays a catalytic and consultative role in developing coastal fisheries management in the Bay of Bengal to help improve the conditions of small-scale fisherfolk communities in member-countries.

The BOBP is sponsored by the governments of Denmark, Japan, the Netherlands, the United Kingdom, the United States of America and the International Maritime Organization of the UN. The executing agency is the FAO (Food and Agriculture Organization of the United Nations).

January 1997

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FOREWORD

This is a weighty report of formidable bulk and understandably so. Rarely has a Workshop in Bangladesh or anywhere else been so comprehensive in mandate or assembled such an array of fisheries expertise.

Why was the workshop held? Quite simply, to give effect to Bangladesh's vision of fisheries development and management, set forth in its Perspective Development Plan for 1995-2010. That plan seeks to increase production of fish, manage and conserve fisheries resources for present and future generations, encourage private enterprise, increase overall economic growth, and generate employment and incomes, particularly for the rural poor and unemployed youth.

These are comprehensive goals, and call for clear guidelines and strategies to address the problems and concerns of fisheries. The National Workshop on Fisheries Resources Development and Management, in Bangladesh, held 29 October-l November, 1995, in Dhaka, sought to evolve such guidelines and strategies.

The Workshop's recommendations are wide-ranging. They relate to the management of inland fisheries, brackishwater and marine fisheries resources: the management needs of freshwater, marine and brackishwater aquaculture; integrated management of land and water; financing of all these sectors; the legal framework for fishing community development and management; the marketing of fish and fish products.

In sum, the Workshop (sponsored jointly by the FAO through BOBP, and the ODA) left nothing uncovered or untouched. The report of this Workshop should therefore be a valuable document — for research and reference, and for the needs of everyone who is concerned with fisheries development and management in Bangladesh.

It is significant that the nine papers presented at the Workshop were all by experts from Bangladesh. The editorial board that finalized this report also consists entirely of Bangladesh nationals. The Workshop and the resulting report are therefore examples of national effort, fully reflecting the spirit of national execution during the BOBP's Third Phase.

Kee-Chai CHONG
Programme Coordinator,
Bay of Bengal Programme

ABBREVIATIONS AND ACRONYMS

ADAB	Association for Development Agencies, Bangladesh
ADB	Asian Development Bank
AFO	Assistant Fisheries Officer
BADC	Bangladesh Agriculture Development Corporation
BAFRU	Bangladesh Aquaculture and Fisheries Resources Uni:
BARC	Bangladesh Agricultural Research Council
BARD	Bangladesh Academy for Rural Development
BCAS	Bangladesh Centre of Advanced Studies
BCSIR	Bangladesh Council of Scientific and Industrial Research
BELA	Bangladesh Environmental Lawyers' Association
BFDC	Bangladesh Fisheries Development Corporation
BFFEA	Bangladesh Frozen Foods Exporters Association
BFRSS	Bangladesh Fisheries Resources Survey Systems
BJMSS	Bangladesh Jatiya Matshyajibi Samabaya Samity (Bangladesh National Fishermen's Co-operative Societies)
BLL	Bottom longline
BOBP	Bay of Bengal Programme
BRAC	Bangladesh Rural Advancement Committee
BRDB	Bangladesh Rural Development Board
BSKB	Bangladesh Samabaya Krishi Bank
BSS	Bangladesh Sangabad Sangstha
BUET	Bangladesh University of Engineering and Technology
BWDB	Bangladesh Water Development Board
CARE	Co-operative for Assistance and Relief Everywhere
CB	Commercial Bank
CFEO	Chief Fisheries Extension Officer
CFHO	Chief Fish Health Officer
CFSO	Chief Fish Seed Officer
CIDA	Canadian International Development Agency
CIRDAP	Centre for Integrated Rural Development in Asia & the Pacific
CPUA	Catch per unit area
CPUE	Catch per unit effort
DANIDA	Danish International Development Agency
DC	Deputy Commissioner
DFO	District Fisheries Officer

DOF	Department of Fisheries
EEZ	Exclusive Economic Zone
EPB	Export Promotion Bureau
ERD	Economic Relations Division, Ministry of Finance
ESBN	Estuarine Set Bagnet
FAP	Flood Action Plan
FBCCI	Federation of Bangladesh Chambers of Commerce and Industry
FCD	Flood Control and Drainage
FCDI	Flood Control, Drainage and Irrigation
FIQC	Fish Inspection & Quality Control Service
FPCO	Flood Plan Coordination Organization
FRI	Fisheries Research Institute
FRSS	Fisheries Resources Survey Systems
GIS	Geographic Information Systems
GDP	Gross Domestic Product
HACCP	Hazard Analysis and Critical Control Point
ICLARM	International Center for Living Aquatic Resources Management
ICUN	International Union for the Conservation of Nature
IDRC	International Development Research Center (Canada)
IFAD	International Fund for Agricultural Development
IPQC	In-plant Quality Control
JICA	Japan International Co-operation Agency
KSS	Krishak Samabaya Samity
LLP	Low-Lift Pump
LMD	Large-Mesh Driftnet
MB	Mechanized Boat
MC	Ministry of Commerce
MCS	Monitoring, Control and Surveillance
MEY	Maximum Economic Yield
MF	Ministry of Finance
MFA	Ministry of Foreign Affairs
MFA	Marine Fisheries Association
MFE	Ministry of Forests & Environment
MFO	Marine Fisheries Ordinance
MIWDFC	Ministry of Irrigation, Water Development and Flood Control
ML	Ministry of Law

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MMD	Mercantile Marine Department
MOA	Ministry of Agriculture
MOFL	Ministry of Fisheries and Livestock
MPO	Master Plan Organization
MSBN	Marine Set Bagnet
MSFCP	Marginal and Small Farmers Systems Crop Intensification Project
MSS	Matshyajibi Samabaya Samity
MSY	Maximum Sustainable Yield
MTA	Management Technical Assistance
NACA	Network of Aquaculture Centres in Asia
NDRC	National Development Research Cell
NGO	Non-Government Organization
NMB	Non-Mechanized Boat
NFMP	New Fisheries Management Policy
NORAD	Norwegian Aid for Development
NWP	National Water Plan
ODA	Overseas Development Administration
PSO	Principal Scientific Officer
QC	Quality Control
RSS	Rural Social Service
RDRS	Rangpur Dinajpur Rural Service
RRA	Rapid Rural Appraisal
SABINCO	Saudi Bangladesh Investment Company
SADP	Second Aquaculture Development Project
SBN	Set Bagnet
SFEO	Senior Fisheries Extension Officer
SIDA	Swedish International Development Authority
SMD	Small-Mesh Driftnet
SPARRSO	Space Research and Remote Sensing Organization
TCCA	Thana Central Co-operative Association
TFO	Thana Fishery Officer
TFP	Third Fisheries Project
TNO	Thana Nirbahi Officer
TSS	Technical Support Services
TW	Tubewells
UNDP	United Nations Development Program

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RESEARCH AND INFORMATION NEEDS FOR FISHERIES DEVELOPMENT AND MANAGEMENT **157**

by M.A. Mazid, Director, Fisheries Research Institute, Mymensingh, Bangladesh, and M.V. Gupta, Senior Aquaculture Specialist, International Center for Living Aquatic Resources Management, Makati. Metro Manila, Philippines.

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PROSPECTUS

1. BACKGROUND AND JUSTIFICATION

Fisheries in Bangladesh play a vital role in the national economy, providing as they do nutrition, employment and export. An estimated 70-80 per cent of the animal protein supply in the country is of fish origin. Over 1.2 million people are engaged full-time in fishing, but most of the rural families are involved in part-time fishing during certain months of the year. In 1994-95, fisheries products earned Tk. 13,000 million worth of foreign exchange, of which about 85 per cent was the contribution of shrimp alone.

Estimated fish production in 1993-94 was a little over one million metric tonnes of which 552,000 mt (51 per cent) came from inland openwaters, 275,000 mt (25 per cent) from culture and 260,000 mt (24 per cent) from marine waters. The floodplains and rivers together are the largest sources of fish supply in the country, but these sources are, unfortunately, the most affected by the adverse changes in nature that are man-made and man-induced. Riverine fisheries has declined from 0.21 million mt in 1984-85 to 0.13 million mt in 1993-94, accounting for a 38 per cent fall. The Government has taken up massive programmes for stock enhancement and management in the openwaters.

Various types of interventions, including open water stock enhancement programmes or Flood Action Plan mitigation or compensatory measures, being taken by the Government, may halt or even reverse the declining trend in open water fish production. But will the benefits of the public sector efforts adequately flow to the target beneficiaries, i.e. the fishing community? It might also be wondered if the public sector, all by itself, can sustain the open water fisheries resource management efforts. It may also be asked if the resource users i.e. the fishermen, should share the fisheries management responsibilities and functions with the Government through a co-management or participatory community-based fisheries management system. If so, what should be the framework of such a management system?

The Government wishes to protect all categories of fisheries resources and develop them at their maximum sustainable levels to accelerate the country’s economic growth and social benefits.

The Government has drawn up a draft perspective development plan for the period 1995-2010.

The Workshop will provide an opportunity for direct interactions amongst the national and international fisheries experts, fishermen’s and fish farmers’ associations, entrepreneurs, financiers, various Government, non-Government, international and bilateral organizations, and others, on fisheries development and management matters in Bangladesh. The technical papers and the free and frank discussions on them may lead to valuable recommendations which may be useful for the formulation of strategies for future development.

2. PURPOSE

a) To create further awareness and understanding, among the policy-makers, planners, fishery administrators, researchers, fishermen, fish farmers, entrepreneurs and financiers, of the fisheries resources, potentials, constraints and prospects.

b) To promote new ideas, approaches, strategies, etc. for further development of resources on a sustainable basis.

c) To identify new project ideas and initiate preparation of specific project proposals with indications of fund requirements and sources.

3. WORKSHOP PAPERS

Nine papers will be presented in the Workshop. The papers are:

1. Potentials, constraints and development strategies for conservation and management of inland openwater fisheries in Bangladesh.
2. Potentials, constraints and strategies for conservation and management of open brackishwater and marine fishery resources.
3. Freshwater aquaculture: Potential, constraints and management needs for sustainable development.
4. Brackish and marine water aquaculture: Potential, constraints and management needs for sustainable development.
5. Strategy for integrated management of land and water in FCDI projects with focus on fisheries development.
6. Research and information needs for fisheries development and management.
7. Financing of aquaculture, capture, processing and marketing of fish, shrimp and other aquatic resources in Bangladesh.
8. Legal, regulatory and institutional framework for fisheries and fishing community development and management.
9. Quality control and marketing of fish products: Need for infrastructure and legal support.

4. PARTICIPANTS

The participants of the Workshop will be fishery policy-makers, planners, fishery managers, extension officers from government agencies, and representatives from research institutes, universities, banking institutions, fishermen's organizations, NGOs, the private sector, donors and development agencies.

5. EXPECTED OUTPUTS

a) Nine technical papers covering different aspects of fisheries development and recommendations.

b) Improved awareness and understanding amongst the policy-makers, planners, fishery managers and fishermen of the problems, constraints and impacts of fisheries management measures.

c) A list of broad project ideas, each or a few of which combined together could lead to a specific development project.

d) Proceedings of the workshop in printed form.

6. NATIONAL INSTITUTIONS AND DONORS TO BE ZNVOLVED

Apart from the Ministry of Fisheries and Livestock, FAO and ODA, representatives from all the relevant national Government and non-Government organizations, fishermen's and fishfarmers' associations and international and bilateral donors will be invited to the Workshop for participation.

NATIONAL WORKSHOP ON
FISHERIES RESOURCES DEVELOPMENT AND
MANAGEMENT IN BANGLADESH, DHAKA

29 Oct. – 01 Nov. 1995

PROGRAMME

INAUGURAL SESSION
Day-l: 29 October 1995

0900 hrs	Registration
0930 hrs	Guests are seated
0945 hrs	Arrival of the Chief Guest, the Hon'ble Minister of Fisheries and Livestock, Government of Bangladesh, Mr. Abdullah Al-Noman
1000 hrs	Recitation from the Holy Quran
1005 hrs	Welcome address by Mr B A Khan, Joint Secretary, Ministry of Fisheries and Livestock
1015 hrs	Address by FAO Representative, Bangladesh, Dhaka
1025 hrs	Address by ODA Representative, Bangladesh, Dhaka
1035 hrs	Address by the Chairman, the Secretary, Ministry of Fisheries and Livestock
1045 hrs	Address and inauguration of the workshop by the Chief Guest, the Hon'ble Minister of Fisheries and Livestock
1055 hrs	Vote of thanks by the Director-General, Department of Fisheries, Bangladesh
11 00 hrs	Tea

Day 1: 29 October 1995
Session 1(1115 - 1700 hrs)

Theme		**OPENWATER FISHERIES MANAGEMENT**
Chairman	:	Mr Mohammad Abu Hena Member (Programming), Planning Commission
Rapporteurs	:	Mr M Ali Patwari, Sr Assistant Secretary, Ministry of Fisheries & Livestock; Dr Anwar Hossain, Assistant Director, Directorate of Fisheries
1115-1200	:	**Paper 1:Potentials, Constraints and Strategies for Conservation and Management of Inland Open Freshwater Fisheries Resources.**

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		by: 1. Mr Md Liaquat Ali, Director-General, DoF 2. Mr Jim Scullion, Team Leader, FAP- 17 (ODA)
1200-1220	:	Selective discussion
		by: 1. Mr Keith Fisher, MTA-Team Leader, Third Fisheries (ODA) 2. Mr Nasiruddin Ahmed, Project Director, DoF 3. Dr M Youssouf Ali, Ex-Secretary, MoFL
1220- 1330		Open discussion and Chairman's remarks
1330-1400		Lunch
1400-144s	:	**Paper 2:Potentials, Constraints and Strategies for Conservation and Management of Open Brackishwater and Marine Fisheries**
14451505		Selective discussion
		by: 1. Mr Ghyasuddin Khan, Project Director, Marine Fisheries, DoF 2. Dr M A Latif. Chief Scientific Officer, FRI
1445-1505	:	Selective discussion
		by: 1. Mr Masudur Rahman, Director (Marine), DoF 2. Admiral (Retd.) M H Khan, President, Marine Fisheries Association 3. Dr Abul Hossain, Chief Scientific Officer (Marine), FRI
1505-1700	:	Open discussion and Chairman's remarks.

Day 2: 30 October 1995

Session 11: (0900 - 1400 hrs)

Theme		**AQUACULTURE**
Chairman	:	Mr A Z M Nasiruddin, Managing Director, Motsho Foundation, Grameen Bank
Rapporteur	:	Mr Rafiqul Islam, Joint Director, SADP, DoF Mr Kanon Kumar Purakayestho, Senior Assistant Secretary, MoFL
0900-0940	**:**	**Paper 3:Freshwater Aquaculture: Potentials, Constraints and Management Needs for Sustainable Development**
		by: 1. Mr S N Chowdhury, Deputy Director, DoF 2. Dr Aminullah Bhuiyan, Carp Culture Consultant, ADB/DoF
0940- 1000	**:**	Selective discussion

NATIONAL WORKSHOP ON FISHERIES RESOURCES DEVELOPMENT AND MANAGEMENT IN BANGLADESH, DHAKA

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1055 hrs	Vote of thanks by the Director-General, Department of Fisheries, Bangladesh
11 00 hrs	Tea

Day I : 29 October 1995
<u>**Session 1(1115 - 1700 hrs)**</u>

Theme		**OPENWATER FISHERIES MANAGEMENT**
Chairman	:	Mr Mohammad Abu Hena Member (Programming), Planning Commission
Rapporteurs	:	Mr M Ali Patwari, Sr Assistant Secretary, Ministry of Fisheries & Livestock; Dr Anwar Hossain, Assistant Director, Directorate of Fisheries
1115-1200	:	**Paper 1:Potentials, Constraints and Strategies for Conservation and Management of Inland Open Freshwater Fisheries Resources.**

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by:
1. Major (Retd.) Aktaruzzaman, M P, Gachiahata Fisheries Project
2. Prof Dr Fazlul Awal Mollah, Fisheries Faculty, BAU
3. Begum Anwara Shelly, Fisheries Expert, CARITAS
4. DANIDA Representative

1000-1030	:	Tea
1030-1130	:	Open discussion and Chairman's remarks
1130-1210	:	**Paper 4:Brackish and Marine Water Aquaculture: Potentials, Constraints and Management Needs for Sustainable Development**

by:
1. Dr Mahmudul Karim, DoF/ADB Consultant
2. Dr Aftabuzzaman, Chairman, Bangladesh Frozen Food Exporters' Association

1210-1230 : Selective discussion

by:
1. Prof ATA Ahmed, Department of Zoology, Dhaka University
2. Mr Khandaker Shafiq Ahmed, Grameen Bank
3. Mr Nizamuddin M Selim, Managing Director, Pioneer Hatchery

1230-1330	:	Open discussion and Chairman's remarks
1330-1400	:	Lunch

Working Session III: 1400 - 1525 hrs

Theme		**LAND AND WATER RESOURCES UTILIZATION**
Chairman	:	Secretary, Ministry of Water Resources
Rapporteur	:	Mr Jahirul Islam, Deputy Director, DoF Mr K U M Shahidur Rahman, Deputy Director, DoF
1400-1430	:	**Paper 5:Strategy for Integrated Management of Land and Water in FCDI Projects with focus on Fisheries Development**

by: Prof Ainun Nishat, Department of Water Resource Engineering, BUET, Dhaka

1430-1440 : Selective discussion

by:
1. Mr Mashrurul Huq Siddiqui, Chief Engineer, FPCO
2. Joint Secretary, Ministry of Land
3. Mr Majedul Islam, Chairman, BWDB

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1440-1510	:	Open discussion and Chairman's remark
1510-1525	:	Tea

Working Session IV: 15251730 hrs

Theme		**FISHERIES RESEARCH**
Chairman	:	Dr M S U Chowdhury, Executive Vice Chairman, BARC
Rapporteurs	:	1. Mr Mahmudul Haq, Assistant Chief, DoF 2. Dr Jahangir Alam, FRI
1530-1600	:	**Paper 6: Research & Information Needs for Fisheries Development and Management** by: 1. Dr. M.A. Majid. Director, FRI 2. Dr. M.V. Gupta, Sr. Aquaculture Specialist, ICLARM/FRI
1600-1630	:	Selective discussion by: 1. Professor A K M Aminul Haque, Ex-Vice Chancellor, BAU 2. Professor Yousuf Sharif Khan, Institute of Marine Science, Chittagong University 3. Dr A K M Nuruzzaman, Member-Director (Fisheries), BARC
1630- 1720	:	Open discussion and Chairman's remarks
1715-1730	:	Tea

Day 3: 3 1 October 1995

Working Session V

Theme		**FISHERIES CREDIT**
Chairman	:	Dr A T M Shamsul Huda, Secretary, Banking Division, Ministry of Finance
Rapporteurs	:	Mr. Syed Ataur Rahman, Assistant Secretary, Ministry of Fisheries and Livestock Mr Khandakar Rashid Hasan, Manager (Marketing), Bangladesh Fisheries Development Corporation
0900-0920	:	**Paper 7:Financing of Aquaculture, Capture, Processing and Marketing of Fish, Shrimp and other Aquatic Resources in Bangladesh** by: 1. Mr. A.B.M. Mahbubul Amin Khan, Dy. Governor, Bangladesh Bank

0920-0935	Selective discussion	
	by:	1. Mr. Mesbahuddin Ahmed, Dy. Director, DOF 2. Mr Kutubuddin, General Manager, SABINCO 3. Mr. M.A. Salam, Agri. Credit Project Deptt., Bangladesh Bank 4. Agrani Bank representative 5. Proshika representative
09351015	Open discussion and Chairman's remarks	
1015-1030	Tea	

Working Session VI: 1030-1330 hrs

Theme:	**INSTITUTIONAL FRAMEWORK FOR FISHERIES DEVELOPMENT AND ADMINISTRATION**	
Chairman	Mr A K Ataur Rahman, Director-General (Retd.), Directorate of Fisheries	
Rapporteurs	1. Dr Momtaz, Project Director, DoF 2. Mr Mohsin, Assistant Secretary, MoFL	
1030-1115	**Paper 8: Legal, Regulatory and Institutional Framework for Fisheries and Fishing Community Development and Management**	
	by:	1. Mr A Q Chowdhury, Ex-Director of Fishery and BAFRU Consultant 2. Dr Kee Chai Chong, Team Leader, BOBP, Madras, India
1115-1130	Selective discussion	
	by:	1. Mr Badre Alam Khan, Joint Secretary, MoFL 2. Mr.Mohammed Mozharul Islam, Joint Secretary (Law), Ministry of Land 3. Mr Mohiuddin Farooq, Bangladesh Environment Lawyers Association, Dhaka
1130-1230	Open discussion	
1230-1330	Lunch	
1330-1400	**Paper 9:Quality Control and Marketing of Fish and Fish Products: Needs for Infrastructure and Legal Support**	
	by:	1. Mr Alhaj M M Hossain, Chairman, BFDC 2. Mr Md Helal Uddin Ahmed, Deputy Director (Quality Control), DoF
1400-1415	Selective discussion	
	by:	1. Major (Retd.) Manzoor Ahmed

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		2.	Dr Moslemuddin, BCSIR
		3.	Prof Nazrul Islam, Department of Fisheries Technology, Fisheries Faculty, BAU
		4.	JICA Representative

1415-1500 Open disucssion

1500-1515 Tea

Session VII: 15151700

Theme **NEW PROJECT IDEAS**

Chairman : Dr Shah Mohammad Farid, Member (Agri), Planning Commission

Rapporteurs : 1. Mr Mokammel Hossain, Deputy Director, DoF
2. Ms Monwara Begum, Deputy Chief, MoFL

1515-1600 : **New Project Proposals for Sustainable Development and Management of Fisheries in Bangladesh in Future**

by: Dr M Hotta, Senior Fishery Planning Officer, FIDP, FAO, Rome

1600- 1625 Selective discussion

1. WB representative
2. ADB representative
3. MoFL representative
4. Planning Commission representative
5. IMED representative

1625 1700 : Open discussion and Chairman's remarks

Day 4: 1 Nov. 1995

Concluding Session (VIII): 1000-1200 hrs

Theme **SUMMARY, CONCLUSIONS AND RECOMMENDATIONS**

Chairman : Mr A H Mofazzal Karim, Secretary, Ministry of Fisheries and Livestock

Rapporteurs : 1. Mr M A Wahab, Deputy Secretary, MoFL
2. Mr Nazrul Islam, Chief Fisheries Extension Officer, DoF

1000-1020 : **Draft recommendations**

by: Mr Loqueman Ahmed. Joint Chief, MoFL

1020-1035 : Tea

1035-1 135 : Open discussion

1135-1200 : Concluding remarks by the Chairman and adoption of the recommendations.

LIST OF PARTICIPANTS

OFFICE OF THE MINISTER

01. Mr. Abdullah-Al-Noman
    Honb'le Minister for Fisheries and Livestock
02. Mr. Nazimuddin Ahmed Chowdhury
    P.S. to Minister
03. Mr. Syed Alamgir Hossain
    APS to Minister
04. Mr. Mostofa Kamal
    Public Relation Officer

MEMBERS OF PARLIAMENTARY STANDING COMMITTEE

05. Mrs. Farida Rahman, MP
06. Mr. Md. Abdul Gani, MP
07. Alhaj Dr. Abdul Latif Bhuiyan, MP
08. Mr. Sirajul Islam, MP
09. Mr. Kazi Golam Morshed, MP

OFFICE OF THE SECRETARY, MOFL

10. Mr. A.H. Mofazzal Karim
    Secretary
11. Mr. Azizul Haque
    PS. to Secretary
12. Mr. B.A. Khan
    Joint Secretary
13. Mr. Azizul Huq
    Joint Secretary
14. Mr. Luqeman Ahmed
    Joint Chief
15. Deputy Secretary
    (Fisheries)
16. Mr. Abdul Wahab
    Deputy Secretary
17. Mrs. Monowara Begum
    Deputy Chief
18. Mr. R.R. Khan
    Deputy Secretary (Admn)
19. Mr. Abdul Hye
    Deputy Secretary
20. Syed Atuar Rahman
    Sr. Asstt. Secretary
21. Mr. Moniruzzaman
    Senior Asstt. Secretary
22. Mr. Hasinur Hassan
    Asstt. Chief
23. Mr. Abdur Razzaque
    Asstt. Chief
24. Mr. Mashiur Rahman
    Research Officer
25. Mr. Shajahan
    Research Officer

DEPARTMENT OF FISHERIES

26. Mr. Liaquat Ali
    Director General
27. Mr. Abdul Matin
    Principal Scientific Officer
28. Mr. Masudur Rahman
    Director (Marine)
29. Mr. Mizanur Rahman
    Principal Scientific Officer
30. Mr. Nasiruddin Ahmed
    Project Director, SADP
31. Mr. Rafiqul Islam
    Joint Director, SADP
32. Mr. S.N. Chowdhury
    Deputy Director
33. Mr. S.I. Khan
    Deputy Director, Comilla
34. Mr. RI. Chowdhury
    Deputy Director, Khulna
35. Mr. Golam Rasul
    Deputy Director, Dhaka
36. Mr. Siddiqur Rahman
    Deputy Director, Rajshahi
37. Mr. T. Rahman
    PD, Beel Baor Project
38. Mr. Mokammel Hossain
    Deputy Director, TFP
39. Mr. Jahirul Islam
    Deputy Director, TFP
40. Mr. K.U.M. Shahidur Rahman
    Deputy Director, FCDI
41. Mrs. Ferdous Parveen
    Deputy Chief
42. Dr. Momtazuddin Ahmed
    Project Director, MEP

43. Mr. Ali Akbar
Principal, FTI, Chandpur
44. Mr. Anwar Iqbal
PSO, Raipur
45. Mr. Meshbauddin Ahmed
Deputy Chief
46. Md. Helaluddin Ahmed
Deputy Director (Q.C), Khulna
47. Mr. Mahmudul Haq
Asstt. Chief
48. Md. Shafiqul Islam
Project Director, FCDI
49. Dr. Anwar Hossain
Asstt. Director
50. Mr. Giasuddin Khan
Project Director, Marine Fisheries
51. Mrs. Momtaz Begum
Deputy Chief
52. Mr. Momtaz Hossain Miah
Deputy Director
53. Mr. Mazharul Islam
Deputy Director
54. Mr. Akter Ali
Deputy Director (QC), Chittagong
55. Mr. Bazlur Rahman
Deputy Director (QC), Dhaka
56. Mr. Harunur Rashid
Deputy Director, Marine
57. Mr. A.K. Ataur Rahman
Ex-DG
58. Mr. A.Q. Chowdhury
Ex-Director
59. Mr. Ahsanullah
Ex. Director
60. Mr. Ali Azam
Deputy Director
61. Mr. Md. Mohsin
Ex Addl. Director

PLANNING COMMISSION

62. Mr. Md. Abu Hena
Member Planning (Programming)
63. Mr. S.M. Shajahan
Divisional Chief
64. Mr. A.K.M. Abdus Sattar
Joint Chief
65. Mr. Rahul Amin
Deputy Chief

IMED (Implementation, Monitoring & Evaluation Division, Planning Commission)

66. Mr. Momdel Hossain
Director General
67. Mr. Jahirul Haque
Deputy Director

MINISTRY OF LAND

68. Mr. Mohammed Mozharul Islam
Joint Secretary
69. Mr. S. Kumar Sarkar
Sr. Asstt. Secretary

MINISTRY OF AGRICULTURE

70. Secretary/Representative

MINISTRY OF IRRIGATION, FLOOD CONTROL AND WATER RESOURCES

71. Mr. Mohammad Nazrul Islam
Secretary
72. Mr. Dulal Abdul Hafiz
Deputy Secretary

MINISTRY OF LOCAL GOVT. RURAL DEVELOPMENT & COOPERATIVES

73. Mr. Aminul Islam
Representative Sr. Asstt Secretary

MINISTRY OF PLANNING

74. Dr. Shah Mohammad Farid
Secretary & Member (Agri.)
Planning Division
75. Representative

MINISTRY OF FINANCE

76. Dr. A.T.M. Shamsul Huda
Secretary, Banking Division

ERD (Economic Relations Division, Ministry of Finance)

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ENVIRONMENT & GZS SYSTEM

195, Mr. Derrel Deppert
196. Syed Farid Uddin
Food Technologist

PRESS

197. Representative, *The Bangladesh Observer*
198. Representative, *The Bangladesh Times*
199. Representative, *The Independent*
200. Representative, *The Daily Star*
201. Representative, *The Daily Ittefaq*
202. Representative, *The Danik* Bangla
203. Representative, *The Daily Inquilab*
204. Representative, *The Daily Janakanta*
205. Representative, *The Banglar Bani*

RECOMMENDATIONS

1. BACKGROUND INFORMATION

Fisheries plays an important role in the social and economic life of Bangladesh. It contributes 4.7 per cent to the GDP of the country while providing full-time employment to approximately 1.2 million people. In addition, a very large number of people are engaged in subsistence fishing and in activities related to the fisheries sector. Fish provides 80 per cent of the animal protein intake of the people of Bangladesh. It is also a major earner of foreign exchange, contributing about 10 per cent of the total export earnings, ranking third in terms of importance after the garment and leather sectors.

The fisheries sector in Bangladesh is faced with a peculiar dilemma. On the one hand, fisheries is seen. as an opportunity, a way to provide the people of Bangladesh protein at a reasonable price, to generate employment and enterprise which, in turn, will alleviate poverty, to increase earnings of much-needed foreign exchange and contribute to the economy. On the other hand, the fisheries sector faces a crisis. Several fisheries, particularly in the inshore marine, estuarine and inland open water sectors, are under stress because of overfishing, environmental and habitat degradation, and un-coordinated, multiple use of water bodies. Inland, freshwater aquaculture and coastal brackishwater aquaculture are facing infrastructural, environmental and socio-economic hurdles that constrain increased production. The key issue confronting the sector is how to simultaneously increase production and manage fisheries and aquaculture to ensure sustainability and profitability.

The Government of Bangladesh, concerned about the welfare of its people and of the resources that sustain them, has committed itself to protect and conserve the aquatic resources of the country and the environments in which they live, while seeking sustainable ways of exploiting the resources to maximally benefit the population. To this end, the Government has drawn up a draft Perspective Development Plan for the period 19952010 to give direction to the fisheries sector and its development.

The goal of the fisheries development strategy set forth in the perspective plan is "to increase production of fish, manage and conserve fisheries resources to sustain benefits to present and future generations, to encourage private enterprises, increase overall economic growth, and generate employment and incomes, particularly for the rural poor and unemployed youth of Bangladesh".

The Government of Bangladesh recognize, the importance of the fisheries sector to the national economy and the need for a well-articulated national strategy to achieve the goal it has set for itself. The main objectives of this strategic plan are to develop and strengthen fisheries research, development, management, coordination and extension activities to:

-- Increase fish production and improve the nutrition of the people.

-- Generate employment opportunities in fisheries and ancillary industries.

-- Improve the socio-economic conditions of fishers, fish farmers and others engaged in the fisheries sector.

-- Increase exports and contribution to the GDP.

-- Improve environmental conditions and public health.

-- Improve the biological and institutional management mechanisms for judicious use of fisheries resources.

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-- Ensure sustainable development of fisheries resources.

-- Ensure the quality of fish and fish products.

The Government of Bangladesh, committed to the development of the fisheries sector and to the conservation and sustainability of the fisheries resources, hopes to address these tasks through a multi-pronged strategy:

-- Reorganizing and restructuring the Department of Fisheries (DOF), the Fisheries Research Institute (FRI) and other related government agencies to rationalize, improve and amplify their performance.

-- Strengthening government organizations concerned with fisheries.

-- Focussing limited manpower and resources on tasks and responsibilities that have to be done by government; and encouraging the private sector, fishers, fish farmers and other governmental and non-governmental organizations to take responsibility for and participate in the development and management of the sector.

-- Encouraging participation of fishers, fish farmers and all other stakeholders in the management of fisheries and aquaculture, thus giving them ownership in the task and also reducing costs to the government by transferring the costs of enforcement to the concerned stakeholders.

-- Strengthening planning at all levels to give direction to fisheries development and management.

-- Co-ordinating, within and among government and non-governmental agencies concerned with fisheries development and management, to reduce duplication of effort and to overcome hurdles posed by complex multi-user, multi-jurisdiction situations.

-- Strengthening conservation and management of resources by developing sustainable technologies, tapping untapped and under-utilized resources, reducing post-harvest waste, and adding value to fish and fish products.

In 1994, the UNDP and FAO, at the request of the Government of Bangladesh, developed a proposal for development of the fisheries sector. This study. which learned from the situation prevailing in the sector and from similar exercises undertaken by the World Bank, proposed several investment and technical assistance projects to develop the sector.

The Government of Bangladesh, in order to prioritize the proposals of the UNDP/FAO effort and to develop clear guidelines and strategies to address the problems and concerns of the sector, decided to bring together at a national workshop representatives of the government, non-government, private sector, research, university personnel, fishers and fish farmers, donor and technical assistance agencies. The workshop, organized by the Ministry of Fisheries and Livestock, was sponsored by the FAO and the ODA (UK). The workshop was organized around nine invited papers which addressed the situations, needs and concerns of the various aspects of the fisheries sector. The workshop, held at the Sonargaon Hotel, Dhaka, from 29-October - 1 November, 1995, brought together 125 participants. The meeting was inaugurated by Mr Abdullah-al-Noman, Minister of Fisheries and Livestock, Government of Bangladesh.

After thorough discussion, the workshop recommended the following guidelines, priorities and actions for the consideration of agencies concerned with the fisheries sector.

2. RECOMMENDATIONS

2.1 Potentials, constraints and strategies for conservation and management of inland openwater fisheries in Bangladesh

- In view of the positive results achieved in terms of production increases from the stock enhancement programme during the last few years, continue and strengthen the programme to ensure distribution of accrued benefits to the target group i.e., the fishermen.
- Reclaim and rehabilitate silted and/or derelict aquatic habitats, including *haors,* baors, *beds,* dead rivers, canals and ponds, etc.
- Protect and manage fishery resources, including fry and fingerlings, by application of fish conservation regulations through participatory community-based management systems.
- Establish permanent sanctuaries for broodstock and fry in openwater habitats.
- Control aquatic pollution and conserve and protect the fisheries environment.
- Implement management measures to sustain the Hilsa fishery.

2.2 Potentials, constraints and strategies for conservation and management of open brackishwater and marine fishery resources

- Withdraw the estuarine set bagnet (ESBN), in phases, and rehabilitate the affected fishermen by expanding the operations of trammelnet, bottom longline and marine set bagnet (MSBN) fisheries and by providing them other gainful employment.

  Stop, in phases, operation of large mesh drift gillnets in shallow waters and beach seines in estuaries.

  Expand trammelnet, bottom longline and marine set bagnet fisheries to ensure utilization of the untapped marine resources through artisanal fishermen.

  Take measures to explore and exploit pelagic fisheries like tuna, mackerel, sardines and cephalopods.
- Protect the critical marine resources around St. Martin's Island and set up a marine park there with marine research facilities.

2.3 Freshwater aquaculture: Potentials, constraints and management needs for sustainable development

Bring all unconventional water bodies, such as FCD/FCDI area, burrowpits and road-side canals under aquaculture, with particular emphasis on community involvement.

Integrate fish culture with paddy cultivation and livestock farming.

- Bring all ponds under improved aquaculture by the year 2000.
- Encourage establishment of open-system and closed-system galda hatcheries and networks of nurseries in the farming areas.

  Establish, in potential unions, facilities for production of fingerlings of various suitable species in order to ensure availability of large-size fingerlings close to the farm and obviate the risk of mortality and stress resulting from long- distance transportation.

- Ensure quality of broodstock and seed in hatcheries through motivation and regulations.
- Undertake an inventory of union-wise culturable water bodies. their development needs and prevalent culture techniques.

2.4 Brackishwater and marinewater acquaculture: Potentials, constrains and management needs for sustainable development

- Formulate coastal land-use policy, classify and demarcate lands into various zones (based on their tidal inundation, soil qualities and water salinities), into various zones and assign these zones for one or more most suitable uses, in order to avoid inter-sectoral and social conflicts.
- Promote diversified. improved extensive culture systems to suit various environmental conditions and farmers' backgrounds, with production upto 1000 kg/ha/yr of tiger shrimp. taking into account environmental preservation and the need for crop rotation.
- Establish marine shrimp hatcheries under a crash programme with arrangements to ensure broodstock collection from the sea and development of broodstock farms.
- Formulate and create polder-specific development plans with appropriate water supply and drainage networks.
- Stress demonstration and extension of galda and bagda shrimp corresponding to various environmental zones.
- Reduce wastage of wild fry of bagda shrimp through better handling and transportation.
- Ensure unhindered seaward breeding mitigation of pre-adult bagda shrimp from estuarine rivers.
- Protect galda and bagda shrimp breeding grounds and ban trawling in those grounds during the peak breeding season.
- Ban destruction of mangroves and encourage mangrove plantation on the strip of land between the pond dykes and the river.
- Establish shrimp health laboratories at field levels.
- Exempt tax on imported aquaculture equipment. feed ingredients, chemicals and other relevant items.

2.5 Strategy for integrated management of land and water in FCDI Project with focus on fisheries development

- Ensure fisheries mitigational measures in all FCD/FCDI projects.
- Modify or adjust water control structure projects and other larger enclosed areas to facilitate natural recruitment of fish and shellfish.
- Maintain a sill level of 1-1.5m above the driest beel water sill level in the drainage channels of perennial beels in water management projects, to facilitate the timely spawning of beel-resident fish species.

2.6 Research and information needs for fisheries development and management

- Develop GIS and eco-region specific aquaculture practices.

- Develop low-cost balanced feeds for various fish and shrimp.
- Develop breeding and culture techniques for endangered species.
- Undertake genetic research for improvement of fish and shrimp stocks.
- Develop appropriate techniques for seed production and culture of marine finfish, shellfish and seaweeds.
- Develop appropriate techniques for nursery management, handling and transportation of fingerlings.
- Assess and conserve aquatic biodiversity.
- Undertake stock assessment of demersal and pelagic fish.
- Undertake studies on oceanography and marine productivity.
- Establish fisheries research laboratories in all divisional headquarters.
- Undertake socioeconomic studies of fishing/farming communities.
- Study migratory behaviour of fish and shellfish in inland waters.
- Undertake studies on environmental impact of shrimp culture.
- Conduct culture research on diversified shrimp species.

2.7 Financing of culture and capture fisheries, processing and marketing of fish, shrimp and other aquatic resources in Bangladesh

- Strengthen capacity of banks and NGOs through technical assistance, training and guarantee arrangements to provide credit to fisheries sector in a demand-oriented and financially viable manner.
- Consider introduction of special credit lines for diversification of fishing efforts to trammelnet fishing and shrimp-cum-fish trawling.
- Consider introduction of special credit lines for upgrading fish processing plants for value-added fisheries products and for shrimp hatcheries.
- Strengthen credit schemes for alternative livelihood programmes for fisherfolk outside the fisheries sector.
- Promote supervised and non-collateral-based credit programmes for artisanal, traditional fisherfolk supported by extension services and technology inputs.
- Actively involve NGOs in credit programmes for poor fisherfolk, especially rural women. in aquaculture activities.
- Link credit programmes with insurance converage for fisheries activities. particularly aquaculture.
- Ensure availability of supervised credit, without collateral, along with technology.

2.8 Legal, regulatory and institutional framework for fisheries and fishing community development und management

- Reorganize and strengthen DOF, FRI, Bangladesh Fisheries Development Corporation (BFDC) and other fisheries agencies to improve their institutional performance and the quality of their services to people.

-- Delegate appropriate administrative and financial functions and responsibilities to field officers, where such decentralization of responsibility can improve the administrative efficiency of the DOF.

-- Depute a Magistrate for fisheries matters to enforce fisheries acts, ordinances and management measures.

-- Transfer management responsibility of all government-owned waterbodies. including *khas* lands suitable for aquaculture, to the DOE Evolve legislation/regulations to transfer aquatic resources ownership/user-rights to appropriate community decision units, to empower stakeholders to participate in management processes.

-- Safeguard the interests of poor fishing communities by widely implementing the New Fisheries Management Policy.

-- Expand the jurisdiction mandate and coverage of the 1983 Fisheries Ordinance to include fisheries within the 50 m depth, that is, inshore or nearshore fisheries.

-- Promote more participatory law enforcement.

-- Strengthen fisheries extension services of the DOF to facilitate and enable the promotion of aquaculture in a sustainable and equitable manner as well as participatory fisheries management by involving all the stakeholders.

- Establish within the Department of Fisheries, a Human Resources Development /Training Section to undertake manpower planning and training and provide support to enhance the capacity of the staff to better carry out the mandate of the Department.

Strengthen collaboration and coordination between government and all other agencies, including universities, NGOs, research and development agencies and the private sector.

Strengthen training programmes for farmers, scientists, extension officers, planners and administrators.

2.9 Quality assurance and marketing of fish and fish products: Needs for infrastructure and legal support

-- Establish modern fish landing centres/shrimp service centres with preservation and distribution facilities in fish/shrimp landing zones to reduce post-harvest losses.

-- Introduce cold-chains all along the fish marketing system, from catching to export/final consumption, to ensure the quality of the products.

-- Standardize and upgrade fishing fleets to improve the quality of the harvested fish and shrimp.

-- Strengthen the organizational set-up of the FIQC wing of DOF, to meet international requirements and standards, and modernize the existing Quality Control Laboratories on a priority basis.

-- Introduce HACCP/FDA system in all phases, from harvesting to exporting of shrimp and fish, on a priority basis.

-- Provide HACCP training to extension workers, farmers, fishers, depot operators, processing plant workers, factory managers and quality assurance staff.

-- Invite international assistance in the establishment of a stringent sanitary and hygienic system for primary fish landing, handling and processing to meet the new HACCP system requirements, which are expected to come into force in 1996.

- Amend rules of the Fish and Fish Product Ordinance to reflect present and future quality requirements and introduce appropriate fish landing and marketing regulations.

2.10 Technical Assistance Project Proposals

Four technical assistance project proposals were presented and discussed. These four, based on government priorities, were selected out of the 12 sectoral TA proposals and nine investment proposals of the TSS-1 National Fisheries Development Programme. Another follow-up workshop will be convened as soon as possible to finalize the proposals of the entire fisheries sector as contained in the national 15-year perspective plan.

The four proposals are:

- Strengthen the marine fisheries management system in Bangladesh.
- Establish fish sanctuaries and impose a ban on fishing juvenile fish (Hilsa/jatka).
- Strengthen commercial and specialized financial institutions and NGOs in Bangladesh to enable easier provision of credit to the fisheries sector.
- Strengthen the Fisheries Extension Service of the Department of Fisheries.

The FRI has already carried out extensive research on the Hilsa fishery, such as behaviour and migratory patterns, breeding and spawning ground and life history. As such, the FRI should be actively involved in conducting research in the proposal *hilsa* fishery programme.

2.11 General areas

- Establish a national fisheries data-base and arrange easy dissemination of information to all concerned.

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PAPER I

POTENTIAL CONSTRAINTS AND STRATEGIES FOR CONSERVATION AND MANAGEMENT OF INLAND OPEN WATER FISHERIES IN BANGLADESH

by

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SUMMARY

This paper describes the resource status, the constraints, the policy implications of management regimes and access arrangements in the open water fishery of Bangladesh. To discern the impact of any strategy on resource values, whether by compensation (stocking) or by mitigation, one must consider the prevailing rural power structure, the socio-economic conditions, the real possibilities of communal/community management and the effect on the sustainability of the fisheries resource.

The paper also discusses the use of a strategy of stock enhancement to **compensate** for losses in floodplain fish production. Two examples and approaches are considered. The lessons learnt from a technical viewpoint are identified. The results of fisheries studies undertaken as part of the Flood Action Plan (FAP) are also considered. The FAP 17 study examined the impact of Flood Control, Drainage and Irrigation Projects (FCDI) on fisheries and fishing communities. One of the constraints on open water fisheries is the continued expansion of FCD/I schemes. The FAP 17 follow-up project is concerned with **mitigation (management and conservation) measures.**

The experience gained under these projects shows:

-- Production monitoring indicates that stock enhancement can produce economically efficient increases in production. However, the socioeconomic impact results are mixed in the sense that the distribution of the benefits is not equal across the different strata and level of society and community.

-- Data are required on the cost-benefit of mitigation measures and the distributive efficiency of such measures.

-- Resource economics are crucial and over-fishing pressures become greater with environmental interventions, and where the value of the resource is increased by stocking or by mitigation measures.

-- Conservation strategies are required to be integrated with management strategies.

-- Resource management needs govern the degree of success that can be achieved in terms of equity and poverty alleviation.

-- A clear policy and institutional framework is required for effective management of open water fisheries.

-- Community-based approaches are more relevant than target group approaches.

In conclusion, this paper has focused mainly on the floodplain fishery of Bangladesh. The FAP 17 study also examined the riverine fisheries in the Jamuna and Padma River systems,

1. INTRODUCTION

Bangladesh is very rich in inland capture fish production. It has a large number of rivers with extensive floodplains. The total area available for inland fisheries is 4.307,974 hectares, with culture fisheries comprising 260,658 ha (DOF, 1986). The inland capture fishery covers an area of 4,047,3 16 ha, comprising rivers and estuaries(excluding the Sundarbans) 1,03 1.563 ha, heels 114,16 1 ha, Kaptai Lake 68,800 ha and floodplains 2,832,792 ha.

It is estimated that the annual production of fish was about 1,090,610 tonnes in 1993/94 (DOE 1994) of which inland capture contributed 51 per cent (compared to 60 per cent in 1983-84). Fish production has increased at a rate of 3.4 per cent per year over the period 1983-84 through 1993-94. Growth in the period from 1990-91 to 1993-94 has been estimated at an average of 6.5 per cent per annum by the FRSS (DoF) methodology. However, the increase in fish production is mainly attributable to the rise in production from inland culture fisheries, particularly from pond aquaculture and shrimp farms, and catch from the artisanal marine fishery. On the other hand, the area and production from inland capture fisheries has declined over time. The most recently published production statistics are shown as Table 1.

Table 1: Species group-wise catch in open water fisheries by sector (1993-94)

(Unit: Metric Ton)

Species	*River*	*Sundarbans*	*Beel*	*Subsistence*	*Kaptai Lake*	*Total*	*% of Weight*
Major Carp	1,875		13,203	25,169	103	40,350	7.04
Other Carp	1,410		5,198		181	6,789	1.18
Exotic Carp	–		–		61	61	0.01
Cat Fish	5,347		16,066	5,337	315	27,065	4.72
Snake Head	247		2,891	52,972	62	56,172	9.80
Live Fish	392		1,640	58,272	–	60,304	10.52
Other Inland Fish	41,094	6,234	14,843	193,785	5,913	261,869	45.67
Hilisa/illish	70,938	432			–	71,370	12.45
Big Shrimp & Prawn	738	274		2,005	–	3,897	0.68
Small Shrimp & Prawn	21,384	la7	1,751	22,177	–	45,499	7.94
TOTAL	143,425	7,127	55,592	360,597	6,635	573,376	100

The contribution of fisheries to the economy of Bangladesh is substantial, particularly with reference to food consumption. nutrition. employment and export. It is estimated that the fisheries sector contributes 4.7 per cent of the country's GDP (BBS, l994), although this figure may not fully reflect fisheries-related activities such as processing, transportation and marketing. The average annual growth rate of the fisheries sectoral GDP was about 6.6 per cent over the period 1984-85 to 1992-93 (BBS, 1994), while growth in agricultural GDP as a whole was only 1.9 per cent during the same period. The fisheries sector also accounts for about 10 per cent of export earnings (EPB, 1994) and employs about 1.3 million people (DOF's own estimates). FAO estimates that there are up to 11 million subsistence fishermen. A significant number of households live on trade and transportation of fish and on manufacturing nets and equipment.

In 198X-89, fish ranked third in terms of expenditure and accounted for nearly 9 per cent of food expenditure in Bangladesh. Fish is extremely important in the local diet and a significant proportion of non-cereal per capita daily average calories intake is contributed by fish in Bangladesh. The real significance of fish consumption lies in its importance as a source of protein in the local diet. The contribution of fish to animal protein intake is 70-80 per cent, and to total protein intake is 12 per cent (BBS, 1994).

In the light of the importance of fish to Bangladesh, any decline in the catch from capture fisheries is cause for serious concern. There is a national need to look at how this decline can be halted or even reversed, considering not only the importance of maintaining fish yields but also the need to provide employment and maintain the incomes of vulnerable social groups.

2. THE INLAND OPEN WATER FZSHERZES OF BANGLADESH

Situated in the deltaic plain of the three river systems -- the Ganges, the Brahmaputra **and the** Meghna -- Bangladesh has vast inland open waters, rich in fisheries resources. The inland open water is inhabited **by** 260 species of fish and 25 species of shrimp. Species/group wise catch composition is furnished in Table 1. Historically, inland open waters were the major source of fish production of the country. The inland open water fishery resources contributed about 90 per cent of the country's fish production in the 1960s (DOF's own estimate), but due to man-made causes, such as overfishing in the absence of fisheries management and conservation measures, implementation of flood control and drainage projects. fish production in the inland open water, particularly in the rivers and floodplains, has declined significantly during the last three decades.

The area of floodplains was estimated at 5.5 million ha by MPO for 1958 (MPO, 1985) but the DOF estimates of fish production area in the open water fishery is close to only 3 million ha. The downward trend in the late 1970s saw a 20-25 per cent decrease in the contribution to production from inland open water **sources.** This contribution to the country's fish production has continued to drop and is about 51 per cent at present (DOE 1994). Source-wise fish production over the period is shown in Table I (DOF, 1994).

This decline has been comparatively high in the case of important and valued fish like major carp (Rui, Catla, Mrigal, etc.). The major carp, which earlier contributed about 30 per cent of the fish production, has now dropped to 5-6 per cent (Tsai and Ali, 1987). The species composition in open water has been out of balance because of the disturbance to natural reproduction of the fish by overfishing and other causes.

In the open water production system, floodplains play an important role in fish production. Floodplains are the low-lying areas which are flooded by rivers and rainwater congestion. About one-third of the total area of Bangladesh is flooded every year and remains under water for 4-6 months. The floodplains, naturally rich in nutrients and fish food, are the feeding and grazing grounds of almost all inland fish. and the breeding grounds of many of the aquatic species. During the flood seasons (June-November), fish and shellfish grow in the floodplains and are harvested by the rural people. When the water recedes, fish accumulate in the deeper part of the floodplains. called beels, or they migrate to rivers which retain water throughout the year. Due to the decline of fish population in inland open water and obstruction in the migration route, recruitment of fish in the floodplains has declined and resources in the floodplains are not fully utilized.

The riverine fish catch was considered by FAP 17 and various management regimes for riverine *jalmahals* were undertaken by the DoF/ICLARM/Ford Foundation ENIMOF Project. Similarly, FRI has undertaken research activities on the Hilsa fishery.

3. FISHERIES POLICY AND MANAGEMENT

The inland open waters, except seasonal floodlands, are owned by Government. Seasonal tloodlands comprise large privately owned areas devoted to crop (rice) production. The Government water bodies. particularly the rivers, are divided for management convenience into segments known as *jalmohals* (fishery/fishing ground). Individual *beels* (depressions) are also known as *jalmohals.* There are about 13,000 *jalmohals* (Land Ministry, 19--), including closed water bodies like ponds and *baors* (oxbow-lakes), owned by Government.

Traditionally. the management system of *jalmohals* has been mostly revenue-oriented, ignoring the biological aspects of fisheries management and the fishing rights of the fisherfolk. Because of this, the fishery has been over-exploited, leading to stock depletion and catch reduction. The fishermen are exploited by leaseholders and moneylenders and do not get their share of benefits from the fishery. In order to ensure the biological management of the fishery and to protect the interest of the poor fishing community from these exploitative influences, the New Fisheries Management Policy (NFMP) was introduced on an experimental basis in 1986 to cover ten *jalmohals.* Under the NFMP system. the leasing system was abolished **and** fishing rights were directly licensed to fishermen. Subsequently, 257 *jalmohals* were brought under this system. NFMP has generated some tangible benefits, but problems in organisation. management and logistics remain. Community development is also required.

The historical perspective of fisheries management has been concerned only with the *jalmohals.* The *jalmohals* were originally operated by landlords (zamindars). The management of the *jalmohals* was taken up by the Government after the abolition of the zamindari system in 1951. This responsibility was transferred to the Department of Fisheries during the early 1980s. but reverted back to the Ministry of Land soon after.

The auction system. which sells off annual use-rights for fishing grounds. is a major component of fisheries management in Bangladesh. It was largely the responsibility of the Ministry of Land, which is seen as consistent with the revenue collection function of that Ministry. Current leasing policy requires that Fishermen's Associations or Cooperatives should receive priority in the allocation of use-rights at auctions. However, the intention of this instruction founders on two grounds. First, Fishermen's Associations are often fake — little more than a list of names provided by a powerful individual. Second, the recent changes in the system, from open bids to sealed bids. makes the monitoring of prioritisation of Fishermen's Associations impossible.

The NFMP was perceived as a way to:

— Prevent the exploitation of genuine fishermen by leaseholders:

-- Provide the ability to manage the resource more effectively;

-- Provide for more control on degradation of the fishery;

— Provide for improvement of the socioeconomic status of genuine fishermen:

— Provide access to institutional credit for genuine fishermen: and

— Provide secure property rights for genuine fishermen.

Shortcomings in the NFMP remain, but, in many cases. the following are problems that also exist in the leasing system:

— The need to provide accurate lists of genuine fishermen;

— The need to provide fisheries surveillance:

- The need for accurate information on fish catches;
- The need to control effort and apply fish conservation measures:
- The lack of DoF resources to undertake fee collection;
- The problems of securing institutional credit and access to markets; and
- The conferring of secure property rights on one group which could lead to displacement of other fishermen and conflicts.

A recent development in the leasing system has been a decision by the government to extend the current l-3 year period to 7-8 years. The reasoning behind this is that it will encourage the lessees to conserve the fish stock and invest in improvements. The longer leases will only be given to lessees who have had their development plans approved by the Department of Fisheries.

Pursuant to the announcement by the Prime Minister during the 1995 Fish Fortnight that the lease system for open waters had been withdrawn, the Ministry of Land issued an order. This order does not address the implications for fisheries management and ignores the NFMP. The sustainable management of the fishery is concerned with rational exploitation and the control of the number of fishing units/effort. The order does not recognise this.

The Department of Fisheries is responsible for the fishing restriction policy. The stocking is mainly of carp. There are a number of fishing restrictions in force, based on the Fish Act 1950 (Amendment 1985):

- Mesh size restriction. Gillnets made of monofilament twine of 4.5 cm or less (stretched diagonal) are prohibited.
- Fish size restrictions on capture : Major carp/Hilsa less than 23 cm long cannot be caught. Nor can catfish of less than 30 cm.
- Fishing by dewatering of land is prohibited.
- Fishing by using explosives and fixed engines is prohibited.

These regulations are seldom fully enforced, partly because of a lack of resources and partly because of opposition from local people. The enforcement of the gillnet ban early in the season has been increased recently, stimulated by a wish to protect the stocked carp.

Inland fisheries management is also under-resourced in relation to the scale of the management task which the Department of Fisheries sets itself. Too few staff are expected to carry out too many tasks.

Inland capture fisheries can he of considerable importance for a variety of reasons, not least being the value of their product and their economic value to the population dependent upon their exploitation. Over the last decade, recognition of this has led governments to reconsider their **policies** towards inland fisheries and to experiment with **management regimes.**

Policy can be defined as the collection of decisions which sets out the general aims and objectives of the governing body with respect to inland fisheries. It provides a context within which more detailed decisions about organisation, resource allocation. procedures. etc. should be made.

Management regime is the set of arrangements and procedures which are established to govern the fishery. so that policy objectives may be secured.

The main conflict between the concepts is confused by such management objectives as:

Maximum Sustainable Yield (MSY) - the maximum quantity of fish which could be theoretically extracted from a given biomass indefinitely;

Maximum Economic Yield (MEY) - the volume of landings which could produce the highest value added of the sector in the long term; and

Maximum Social Yield (MScY) - the production level which would maximize the social value of factors like income distribution, employment, etc.

The double objectives of maximizing production and poverty alleviation with equity should be examined against this framework. The purpose of fishing could be described by fishermen as the need to make as decent a living as possible. The objective of the Government is to manage the resource efficiently in order to provide the highest level of well-being, including that which must be set aside for economic growth (enhancement of well-being in the future). Examples that illustrate the categorization of different policy goals are:

Social/Economic Policy	**Biological Management**
Maximum contribution to national economic growth	Increase the physical productivity of the fishery
Maximize employment in the fishery	Make fishery biologically sustainable
Increase government revenues (through licenses or leasing)	Change the composition of species (to improve quality of the fishery)
Increase the incomes of fishing households	Conserve particular species
Assist fishing households	Improve the quality of existing species
Promote community development	Maintain biodiversity

The two categories of policy are linked. Action taken in pursuit of a goal under one policy can have an effect on the ability to achieve goals under the other policy. Therefore, it is possible for policy to set objectives under each heading which are incompatible.

3.1 Assessment of fisheries policy

Fisheries policy consists of both social and biological dimensions, so a comprehensive assessment of policy and management options requires inputs from both the social and biological sciences.

3.2 Decline in fish catch

Changes in the annual catch in a fishery may be random, due to specific circumstances, or systematic, because of progressive, long-term changes in the fishery. Without catch data over a period of at least ten years, it is difficult to determine the cause.

There are two general reasons why yields might be falling:

— Environmental degradation; and

— Over-fishing.

Common forms of environmental change which have an impact on a fishery include:

— Pollution	from agriculture, or from industrial or residential areas, which affects water quality.
— The extraction of water	for agricultural, domestic, or industrial use.
— Flood control measures	where infrastructure may decrease flooded areas and disrupt fish migration patterns.
— Siltation	where reduced water flows allow the build-up of silt.

3.3 Over-fishing

A high amount of fishing effort in an inland fishery can cause 'biological over-fishing'. However, while fisheries officers are trained to consider biological over-fishing as the main obstacle to the development of tropical inland fisheries, the ability to identify effective policy depends upon a more detailed understanding of the nature of biological over-fishing in these fisheries. The conventional wisdom is that there is a relationship between the effort and catch in a fishery, which serves to define a maximum sustainable yield (biological).

3.4 Economic effciency

If the intention of policy is to increase the contribution of the fishery to national economic growth. then it is important to assess whether the fishery is being exploited efficiently. In this analysis the biology of the fishery and economics can be brought together, by considering the relationship between catch-effort data and cost and price data. Economic efficiency needs to be examined in terms of static. dynamic and distributional aspects.

4. POLICY CONFLICTS

Inland capture fisheries policy in Bangladesh is the subject of considerable debate, reflecting the great importance of these fisheries. There are three concerns that can be identified.

Over-fishing. The fisheries are seen to be at risk from over-fishing. This is a natural inference from the reduction in total catches when there is no sign of reduced fishing effort. In addition, there is particular concern that the stock of large fish has been depleted. The Department of Fisheries has two approaches (stocking and conservation) and these two approaches are interrelated; the stocking of carp increases arguments to reduce early season fishing, in order to let more of the carp grow to a reasonable size before capture.

Environmental degradation. The major environmental threat to the capture fisheries is thought to be the river defenses that are part of flood control efforts. These defenses can interfere with the movement of migratory fish, and may prevent them reaching their breeding grounds. The loss of fish habitat due to siltation is common and is a natural threat to the open water fishery in Bangladesh. An additional impact of siltation is to increase the conversion of land to agricultural use.

Poverty and employment effects. Many of the policy issues in Bangladesh are concerned with distributional efficiency. Both the Department of Fisheries and non-governmental organisations (NGOs) indicate that they want to increase the share of the catch that goes to real fishermen. They see this as complementing their conservation efforts, as they regard poverty as a major cause of over-fishing. They see the leasing system as contributing to the poverty of fishermen and favour the elimination of middlemen in the leasing system. It is this that underlies their support for the NFMP, which limits licensing of water bodies to groups of "genuine fishermen".

5. STRATEGIES FOR INLAND FISHERIES DEVELOPMENT AND MANAGEMENT

The response to the continuous decline in the catch in open water fisheries has resulted in a number of development strategies.

There are three main strategies:

- Stock enhancement schemes.
- Improvement of fish habitats, fish migration routes in FCDI schemes and re-excavation of siltation.
- Biological management, including the enforcement of conservation measures, establishment of fish sanctuaries, and rational exploitation.

6. STOCK ENHANCEMENT SCHEMES - COMPENSATION MEASURES

6.1 Approaches *and methodology*

The objective of the stocking programmes is to develop a long-term strategy for enhancement of floodplain fisheries through adoption and application of a culture-based stocking scheme. The technical basis of the programme rests on proper utilization of the under-utilized nutrients and fish food produced in the floodplains during the flood season. Nutrient-rich river water, which spreads across the deltaic plains. is further enhanced by the soil fertility of the plains, optimal temperatures and intensive light radiation. and produces areas of water with a high level of biological productivity. Floodplains are, therefore, most suitable for breeding, nurturing and growing the fish which migrate into and out of the plain with rising and falling floods. A planned and systematic programme of stocking with suitable fish species in an appropriate balance, in order to utilize the underutilized nutrient and food in the floodplains during the flood season (June-November) would also enhance catches in rivers and other permanent waterbodies. This intervention, if properly applied, is expected to result in an incremental yield of 300kg/ha in the major floodplains and 700 kg/ha in minor floodplains against the present low level of productions of 70-100 kg/ha.

Two important assumptions are that:

- There are ecological niches that are under-exploited; and
- Stock enhancement will not adversely affect biodiversity.

Based on this rationale, the Government has taken up a programme of floodplain stocking under donor funded projects (the Third Fisheries Project -IDA/UNDP/ODA and the Second Aquaculture Project of ADB) as well as using Government resources.

6.1.1. Stocking Programmes under the Third Fisheries Project

The project focussed on Western Bangladesh and proposed the stocking of floodplains in Khulna Division, Rajshahi Division and greater Faridpur (Dhaka Division). The programme planned to stock 100,000 ha by 1996. The major depression in Khulna-Narail, Gopalganj-Madaripur and Chalan Beel of Rajshahi-Pabna regions would be stocked in phases with 6-16 cm fingerling of major carps at a stocking density of 20-30 kg/ha, starting with 29,000 ha in 1992. With the stocking of the 100,000 ha floodplain a total incremental production of 30,000 m ton fish would be obtained at 300 kg/ha, it was intended.

A pilot stocking programme was initiated in 1991 in two minor floodplains, Garalia Beel in Jessore district and Hilna Beel in Naogaon District. The encouraging results of this programme provided guidelines in respect of species composition for the major stocking programme to be started in 1992. In 1992, three major floodplains, the BSKB Beel (a poldered area of 13,000 ha, of which effective stocking area is 6,000 ha) in the Khulna Narail-region, Chanda Beel (an open system of 6000 ha) in Gopalganj and Halti Beel (a semi-closed area of 10,000 ha) in the Rajshahi-Natore region were stocked with carp fingerlings. The 1992 stocking results provided valuable technical information for improved stocking of the floodplains in 1993. Figure 1 shows the location of the project floodplains.

6.1.2 Technical assumptions

* The project initially stocked a number of floodplains that were earmarked during appraisal for stock-enhancement. These floodplains were found to be significantly different in their hydrological, biological and physical characteristics. The BSKB 'floodplain' was within a totally empoldered Flood Control Drainage and Irrigation Project (FCD/I). Halti Beel was partly empoldered. And Chanda Beel was an open floodplain that most nearly equated to the traditional terrain.

* The species mix was based on the stocking composition found to be most effective under the Baor Project. However, this concept was markedly different from TFP; the baors are relatively small, totally enclosed areas of water that are likely to respond to an aquaculturally-based re-stocking programme. The physical, biological and hydrological characteristics are significantly different.

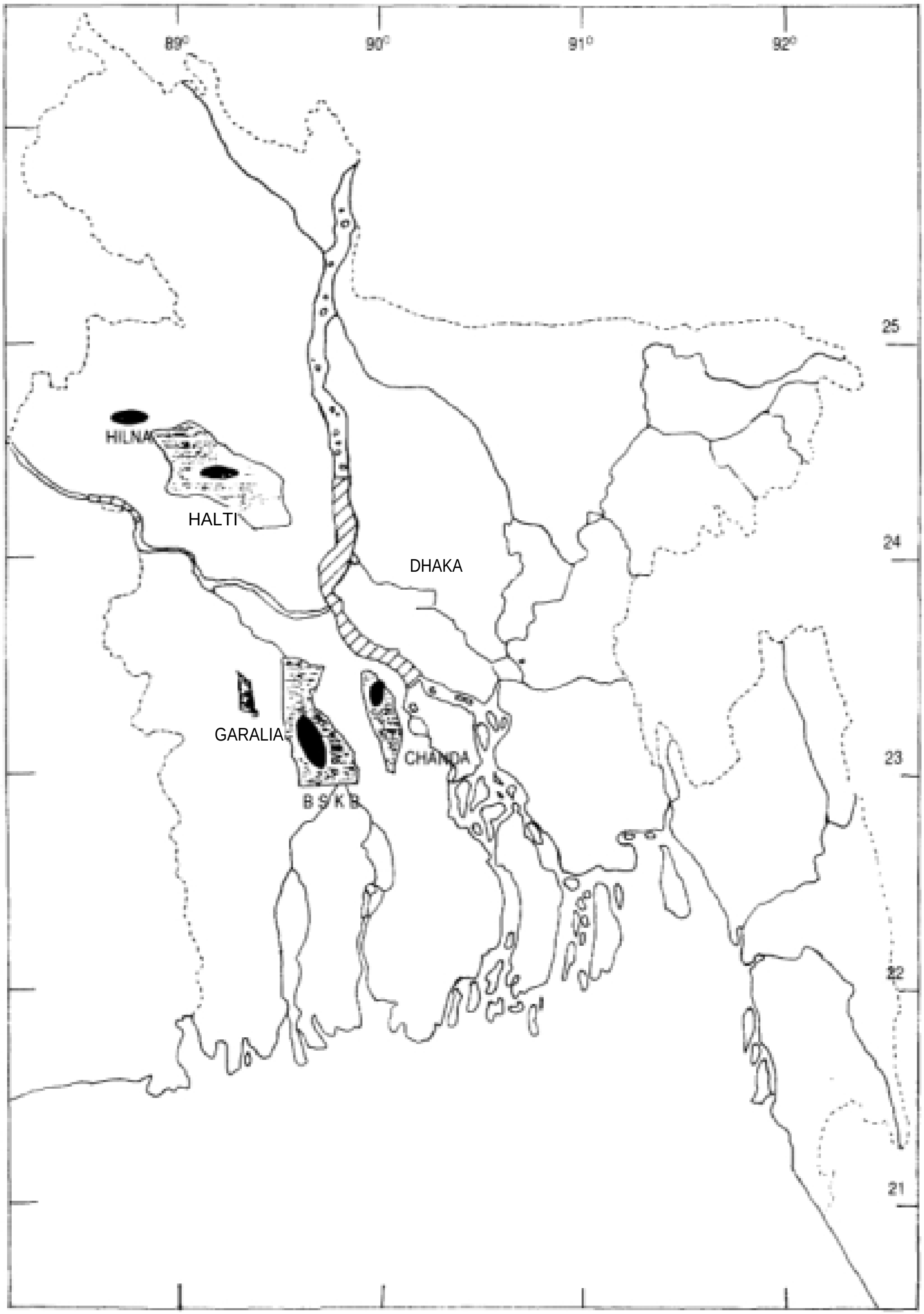
* The lack of detailed observations on the floodplains led to an assumption on the areas of inundation that would prevail. In fact, rainfall levels impact significantly on the areas of inundations for the open and semi-open system. This in turn leads to the concept of the area inundated that is suitable for the growth of stocked species.

* Production estimates were based on a 12 per cent retrieval rate and an overall incremental yield of 300 kg/ha.

* No impact on bio-diversity

  The assumption being that ecological niches exist in the floodplains. caused by various interventions and activities. The technical process of stock enhancement would lead to increased incomes for fishermen. Changes in fishery ecology would induce changes in income distribution and assist in poverty alleviation. Restocking will compensate for a reduction of fish habitats and the decrease of fish habitats will not affect the rate of growth of stocked species. The assumption of declining catches of Indian major carp in floodplains is reflected in the work of Tsai and Ali (1985). They examined catch composition data from 1967 to 1984 in beels in the Sylhet-Mymensingh basin and found that the contribution of major Carps declined from 67 per cent (1967) to SO per cent(1973) to 4 per cent (1984).

Figure 1. Beels stocked in Third Fisheries Pro}ect



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* Baseline data on gear selectivity and fish food availability/limnology would be generated by a research component operated by the Fisheries Research Institute (FRI).

* Fingerlings would escape from the floodplains.

6.1.3 Socio-Economic Assumptions

* Stock enhancement would improve the incomes of fishermen in the floodplain area.

* The project would support poverty alleviation and achieve equity objectives in the floodplain community.

* The floodplain stocking component would allow genuine fishermen greater access.

6.1.4 Institutional assumptions

* The system of leasing would be gradually replaced by a licensing system under the NFMP.

* The private sector nursery operators would provide incremental production of fingerlings.

* The private sector contractors, with administrative and financial skills, would organize nursery operators.

* In the formative years, the DoF would require assistance in certifying of fish delivered. Ultimately, the DoF would have a capability to manage a large-scale stocking programme.

* The Fish Act would be applied to control the early catching of stocked fingerlings.

6.1.5 Research

A research programme was conducted on water quality, fish food, gear selectivity and disease in the three major floodplains (BSKB, Chanda and Halti) to suggest appropriate species composition, stocking density and suitable gear for harvesting the fish.

The limnological and biological parameters studied in the three major floodplains were temperature, pH, DO, and plankton. For study on gear selectivity and growth of stocked carp, length-weight data and species-wise, catch along with particulars of different gears were collected. Occurrence of fish disease in different ***beels*** was recorded and diseases were identified.

6.1.6 Monitoring and impact assessment

In order to assess the impact of the stocking programme on fish production, biodiversity, and socio-economic condition of the fishing community, an intensive fish production monitoring programme and socio-economic study were undertaken in three major floodplains by engaging a local consulting firm, BCAS. In the minor floodplains. the monitoring programme was undertaken by DoF personnel.

The production monitoring programme required a frame and benchmark survey before stocking and a continuous collection of catch data based on statistical sampling technique for estimating of fish production by species and gear and by month. A socio-economic study was undertaken before stocking in 1991 to obtain benchmark information. The study was repeated in March-June 94.

Table 2: Quantity of fish stocked (kg) and harvested in TFP project

		BSKB				CHANDI				HALTI			HIL NA				GARALIA		
Species		1991	1992	1993	1994	1991	7992	1993	1994	1991	1992	1993	1991	1992	1993	1994	1991	1993	1994
Rul	Stocked		34,018	36,333	30,041		20,134	27,234	29,702		26,970	29,183	8,285	3,421	6,741	9,664	7,881	9,100	9,600
	Harvested	21,741	66,809	392,518	8,530	26,422	61,689	187,971	80,481	30,395	15,338	105,952			79,114	14,159		129,746	82,014
Cotla	Stocked		21,110	24,180	25,001		12,242	18,957	27,555		17,852	52,362	4,673	4,290	8,457	11,503	4,000	6,100	7,487
	Harvested	12,002	43,761	148,517	5,720	10,425	34,647	81,650	56,120	10,970	19,330	174,443			107,757	44,209		35,047	42,000
Silver	Stocked		66,402	18,400	7,272		30,327	5,170			51,840	30,539	15,055	5,081	5,367		18,704	4,479	1,500
	Harvested	19,838	20,030	28,120	2,657		2,387	7,693	2,956	34,307	50,009	5,883			8,912	83		6,200	21,000
Mrigal	Stocked		17,851	18,136	13,437		11,306	14,415	10,568	21,122	27,998	4,587	5,191	5,367	1,898	3,937	4,600	4,500	
	Harvested	1,476	17,036	94,883	998		33,954	32,301	7,700	9,888	10,977	59,861			88,737	3,873		100,989	59,076
Common	Stocked		7,475	14,802	17,744		5,142	5,770	15,080		54,474	27,082	1,801	276	1,809	91,098	3,517	3,420	4,497
	Harvested	0	10,824	138,481	14,350	33	80,153	413,451	399,861	2,119	19,421	232,285			46,046	89,416		94,398	54,534
Sarputi	Stocked	0	0	5,389	6,465	0	0	694	5,711			2,437	0	291	1,487	3,305	0	1,429	2,416
	Harvested	0	0	11,932	0	0	0	3,806	20,807			19,176	0	0	17,593	27,250		3,074	10,872
Karbau	Stocked	0	0	0	0	0	0	0	718	0	0	0	0	0	0	0	0	0	0
	Harvested	0	0	2,745	5,137	0	0	1,395	26,381	1,256	0	0	0	0	1,754	1,907	0	0	0
Bighead	Stocked	0	3,970	0	0	0	0	4,250	0	0	0	6,396	0	0	0	0	0	0	0
	Harvested	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	Stocked		150,832	117,299	99,900	0	83,401	72,246	80,333	21,122	185,530	146,196	35,005	18,726	25,818	119.807	38,702	29,029	25,500
	Harvested	55,747	159,110	817,196	37,404	36,880	214,225	753,256	569,181	87,688	115,375	597,600	0	0	349,913	180,897	0	369,460	270,852

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6.1.7 Protection and conservation of the stocked fingerlings

The most important issue after stocking is to protect the fingerlings from being harvested before they attain legal size for capture. According to the Fish Protection and Conservation Act 1950, catching of major carp below 23 cm (9”) is prohibited and punishable. Enforcement of the Fish Act is very difficult in circumstances where there is great demand for fish and the fishing community is very poor. There are also limitations of manpower and logistics in enforcing the law properly. However, special attention was paid to protect the fingerlings stocked under this programme. NGOs were engaged in a section of BSKB and Halti *beel* to organize the fishermen and motivate them on conserving the stocked fish. This experimental NGO intervention proved to be successful in restraining the fishing community from catching undersized carp.

6.1.8 Results

In 1992, the production was insignificant because of a severe drought and late flooding (Tables 2 and 3). Such droughts occur once in twenty years. In 1993-94, the production improved in all the stocking areas. In 1993, incremental production of stocked species was 150 kg/ha in Chanda, 118 kg/ha in BSKB, 57 kg/ha in Halti, 243 kg/ha in Garalia and 150 kg/ha in Hilna. The escape of fingerlings from the *beel* has not been considered in estimating the production. In other words, production (catch) of stocked species varied in different *beels* from 3 to 12 times the stocked quantity.

Table 3: Species composition (%) of fingerlings stocked in different bee/s in different years

Species	Year																		
	92	93	94	92	93	94	92	93	91	92	93	94	91	92	93	94	94	94	94
Rui	20	30	30	20	28	30	20	20	20		30	32	20	20	20	25	25	30	20
Catla	15	20	25	15	30	30	15	30	10		20	25	10	33	30	30	30	30	30
Mrigal	10	15	12	10	15	11	10	15	10		15	15	10	15	15	5	9	10	10
S.CARP	40	15	5	40	5	0	40	15	50		15	5	50	15	15	0	30	5	5
C.CARP	10	15	20	10	20	20	10	15	10		15	15	10	15	15	30	5	20	25
Sarputi		5	8			8		5			5	8		3	5	10		5	10
Karbau					2	1													
Bighead	5			5			5												

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The stocking programme has been found economically viable in all *beels* except Halti, with Economic Rates of Return varying from 12 per cent to 70 per cent. Project Performance Indicators show a 10-11 fold increase in production of stocked species and a 12 per cent retrieval rate by numbers of fish captured to fish stocked. This would give an initial incremental production of 220 kg/ha. Stocking densities are planned to rise to reach the final target of incremental production, 300 kg/ha.

The summary results for 1993-94 are:

Beel	*Stocked Quantity (t)*	*Production of Stocked Species (t)*
BSKB'	119	713
Halti	177	570
Chanda	77	741
Garalia	29.7	365 (to December 1993)
		309 (to Jan/Feb.1994)
Number (Dec. 1993)	*xIncrease*	*Retrieval %*
BSKB	X 6	13.4
Halti	X 3	9
Chanda	X 9.6	7.5
Garalia	X 12.3	NA (33.5 1991-92)
Hilna	X 10	21 (to Jan./Feb. 1994)

'BSKB : Barnal Salimpur Kola Basukhali

In general, the only species to achieve the target weight at capture has been the common carp, with the next best performing species being catla.

6.2 Case study of Chanda Beel

Chanda Beel, in terms of conventional economic appraisal, has achieved an economic rate of return of 29 per cent.

The breakdown of fishermen categories is:

Full-time fishermen:	8 per cent of total population
Occasional/Subsistence fishermen:	16 per cent of total population
'Non-fishing':	76 per cent of total population
Total population :	- 32,000
Total households :	6,846

The costs of leases have varied as follows:

1991-92	Tk 114,900
1992-93	Tk 365,200
1993-94	Tk 172,544
1994-95	Tk 446,377

The term 'non-fishing' household is not applicable under stock enhancement, for every household has a potential for involvement in fishing on an occasional basis.

The share of stocked fish being taken by gear or type of fishermen has been dynamic. The dynamics of the situation, with stocking likely to influence changes in categories, and gear ownership not reflecting strict categorisation (e.g., part-time and full time fishermen may operate cast nets) act against simple classification.

The DOF applied strict conservation measures in 1992-93 in Chanda Beel, although there appeared to be a far greater impact on the intensity of fishing by full- and part-time fishermen. In terms of changes, pre- and post-stocking in CPUE by individual gear in Chanda Beel, the only gear with a reduced CPUE for all species are bamboo traps. In terms of fishing intensity, the only reduction is for gill-nets.

6.2.1 Socio-economic indicators

FISH CONSUMPTION STUDIES

Per capita consumption of fish has increased in the post-intervention period compared to before the intervention (DOF, 1995). In Chanda Bee1 the increase hqs been 191 per cent, from 5.36 g to 15.61 g. Adequate data was not collected of stocked species, but the general trend was increases of between 300 and 165 per cent in consumption of the indigenous species sampled (Koi, *Taki, Magur).* One species, *Singi,* showed a decline (20 per cent).

Before stocking, the mean fish consumption in fishing households was 0.268 kg/h hold/day. This increased to 0.440 kg/HH/day after stocking (+27 per cent). In non-fishing households, pre-stocking consumption was 0. 1.30 kg/HH/day; post-stocking was reduced by approximately 8 per cent, to 0.120 kg/HH/day. Household fish consumption was maximum in December for fishing households both in the pre-and post-stocking periods. The maximum period of consumption by non-fishing households shifted from August (pre-stocking) to December (post-stocking). Fish consumption was at a minimum for all households in April.

In addition, the harvesting of *kuas* also influences the period. A period of maximum fish consumption in Chanda in February (post-stocking) may be consistent with this.

The general trend would appear to be:

— Increased fish consumption, comparing pre- and post- project intervention.

— The fishing households appear to have gained in fish consumption terms.

— The minimum quantity of fish available has increased with stocking; levels of fish consumption have increased in the post-project period and for a longer period *i.e.* increased fish consumption for a longer period.

Table 4: Per cent Distribution by Annual Income from Fishing by Fishing Strata Professional (PF) and Non-professional (NPF) in Chanda

Pfe-Intervention		
Income Band [Tk)	*PF (%)*	*NPF (%)*
0 - 2000	10	21
2001 - 10,000	20	56
10,001+	70	23
post-Intervention		
0 - 2000	18	22
2001 - 10,000	27	58
10,001+	55	20

Table 5: Investment in Land Assets by Fishing Strata (per cent Distribution by land values) in Chanda.

fin Taka)	Before intervention			After intervention		
	PF N=11	NPF N=295	NF N=90	PF N=11	NPF N=295	NF N=90
o-10,000	18.2	13.8	17.7	9.1	11.4	9.18
10,001-20,0000	9.1	13.9	16.7	18.2	13.2	16.7
20,001-30,000	18.2	13.9	12.2	9.1	13.9	12.2
30,001-50,000	18.2	23.7	18.9	18.2	23.4	18.9
50,001-75,000	-	15.6	8.9	--	15.9	7.8
75,001+	36.4	19.3	25.6	45.5	21.7	25.6
Total	100.0	100.0	100.0	100.0	100.0	100.0

NF=Non-fishermen

In Chanda, the trend for professional fishermen would appear to be upwards. The trend for non-professional and non-fishing households would appear to be more ambiguous.

Table 6: Per cent distribution of fishing equipment (owned by fishing strata) in Chanda

fin Taka)	Before intervention			After intervention		
	PF N=11	NPF N=295	NF N=90	PF N=11	NPF N=295	NF N=90
0-500	9.2	23.8	51.1	-	25.8	50.0
501-2000	35.4	0.2	31.1	36.4	43.1	30.0
2001-5000	18.2	19.7	13.3	27.3	25.1	13.3
5001+	36.4	6.4	4.4	36.4	6.1	6.7
Total	100.0	100.0	100.0	100.0	100.0	100.0

6.2.2 Impact of stocking programme

The data presented represents the socio-economic and production monitoring. The results seem to provide conflicting signals. The general indication is that fishermen incomes, fish consumption and asset ownership have increased. However, the distributive efficiency cannot be fully identified.

6.3 Stocking programme under the second aquaculture development project

Under the Second Aquaculture Development Project, the depression and floodplains in the Northeast Region (Sylhet-Mymensingh Basin) of Bangladesh would be stocked with hatchery-spawned fry in April-May. Three-to-five-day-old hatchery-produced carp fry would be stocked at 500,000 per ha in a low-dyked nursery pond. The pond is prepared in the heels for raising 3”-4”-sized fingerling, by using toxicants to remove the predators. The dykes around the beel/pond nursery are so constructed that the fry are raised to the desired size before they are inundated during the rainy seasons and the fingerlings automatically dispersed in the open water of the floodplains. Starting with the development of a 200 ha nursery area in the first year, a 1600 ha heel nursery would be developed by the fifth year of the project. It has been expected that at least 5 per cent of the hatchling stocked would survive to an average harvestable size of 330 g. Thus, by stocking 880 million hatchlings in the fifth year of the project, an incremental yield of 13,000 t fish would be produced.

This programme was initiated during 1991-92 when a 277 ha nursery was stocked with 89 million carp hatchlings *(rui, catla, mrigal,* silver carp, grass carp, common carp).

Subsequently. 79 ha and 578 ha *beel* nurseries were stocked with 27.6 million and 237 million hatchlings during 1992-93 and 1993-94. The fingerling raising system is the same as practised in pond nurseries. Survival rate of fry in the nursery before dispersal (or when attaining 4-8”-size), as estimated by sampling, varied heel-wise from 20 to 30 per cent of the stocked hatchling. The per ha production of fingerling was estimated by sampling to be 95,000.

In addition to the *heel* nursing concept of stocking under the project, a programme of stocking in the light of Third Fisheries stocking concept was also undertaken in Hail Haor (8000 ha) and Kao Dighi (60 ha) in Moulavibazar District and Kuri *beel* (80 ha) in Sunamgonj District during 1991-94.

6.4. Impact of floodplain stocking

The stocking programme is an efficient and appropriate approach to managing fisheries resources for increasing production when the stock is overfished and the aquatic niche is underutilized. But it is a very difficult and costly approach. In the context of the present fisheries situation in Bangladesh, this approach to resources management may be suitable. However, the biological management of the natural stock in inland open water should be given due consideration along with increasing fish production.

Carp hatchlings harvested from natural sources are less now due to sufficient production of carp fry in hatcheries. The volume of fry production from natural sources is most probably not enough to sustain the natural stocking of carp to such an extent as to give the maximum sustainable yield. However. to supplement aquaculture and to maintain a good brood stock for induced spawning of major carp, hatchlings from natural water are necessary. The survival rate of fry in nature is also much lower compared to when they are collected and reared in nursery ponds. The collection of carp hatchlings from natural water should, therefore, be discouraged, except for the purpose of maintaining a brood stock for induced spawning.

Two different open-water stocking approaches are adopted in Bangladesh. First, under the Third Fisheries Project, fingerlings reared in nursery ponds are transported to stocking sites and stocked in the open water. Second, under the Second Aquaculture Development Project, 4-5-day old hatchery-produced hatchlings are stocked in a low dyked nursery prepared in *heels* (after removing predators by using toxicants) and are allowed to grow to fingerling size when they automatically get dispersed in the open water during inundation of the nursery. Both approaches are very difficult but may be effective. However, the approach adopted under the Third Fisheries Project is costlier, lengthy and management-oriented. However, it creates more employment for the rural people. On the other hand. the approach adopted under the Second Aquaculture Development Project is less expensive but it involves more risk, because of the possibility of sudden flash floods. Besides, it might have a negative impact on the biodiversity to some extent.

The lessons learnt from TFP are:

— The questions of access and participation in the fishery are crucial

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— Effort control, privatization or establishment of secure property rights may not automatically result in effective conservation.

— There are initial indicators of significant overfishing pressure.

— Community intervention/management may not be universally applicable. Informal management tends towards formal management as soon as the value of the resource is recognised.

— An experimental programme on the technical success of stocking is required to be supported by various attempts at social intervention to achieve equity.

— The institutional/policy framework is crucial to questions of equity and sustainability.

— Motivational control of gear usage and closed seasons do not work in large project impact areas. Regulation is required. The shifting of the period of high fishing intensity for a few months creates short-term problems for fishermen incomes. but the longer term rewards are evident in terms of improved catches later.

— Management of the programme is easier in smaller floodplains from the point of view of biological production monitoring and the prospects for community management.

— It is by no means certain that poverty alleviation and equity objectives can be achieved without institutional/cultural change.

— The unplanned response has been an increase in groups of fishermen who want to undertake private stocking of small floodplains.

— Where equity does not inherently exist. it is difficult to impose it. The overall tendency is for fishermen's groups to seek to achieve a monopoly.

— The theory that the enhanced fishery is valued and cost recovery is built into the system is related to scale. The private sector will stock smaller floodplains (see above), if they can secure, enforce and exclude others from the fishery. Cost recovery becomes credit recovery for these fishermen groups.

There is a need to develop an understanding of the following aspects:

— A sound knowledge base of the social interactions in the fishing community.

— Sensitive management approaches to possible community management initiatives.

— The institutional constraints.

— The fishery — in terms of current fishing levels, recruitment, species and gear interactions, gear ownership and usage patterns within the community.

— The implications of any control of effort and whether they are manageable.

The concept of mutual co-existence under any scheme that increases the value of the resource may be misguided.

The impact of stocking open water through the beel nursery concept under the Second Aquaculture Development Project could not be directly assessed, as monitoring of production was not initiated early in the project. However, an overall increase in carp production in the area was a trend observed. Stocking of carp fingerlings in Hail Haor has, of course, shown a positive impact on the carp production in the *haor* itself. The positive impact in production terms has been identified through market surveys.

7. MITIGATION MEASURES

All FAP regional studies included an examination of the impact on fisheries in existing or proposed FCD/I schemes. These studies suggested various measures to either compensate for or mitigate fisheries losses. Compensation measures included stock enhancement and the promotion of pond aquaculture. Several schemes proposed the adoption of fish-'friendly' sluice gates and fish passes.

7. I The FAP 17 Phase 1 study

The Fisheries Studies and Pilot Project (FAP 17) was the only FAP project designed solely to address inland fisheries issues, Phase I, the Fisheries Studies, was a biological and socio-economic research project which aimed to assess the impact of different types of FCD/I projects on fish resources and the fishing communities dependent to varying degrees on these resources. Phase II, the Pilot Project, was designed to demonstrate feasible strategies to mitigate harmful impacts of FCD/I projects on capture fisheries, through the integration of fisheries into water management, Phase I commenced in December 1991 and ended in June 1994. Phase II is under consideration by the GOB and the ODA.

To assess the impact of flood control on fisheries it was necessary to undertake quantitative investigations of fish production (catch), diversity and movements in floodplains, canals and rivers inside and outside FCD/I projects and to examine both quantitatively and qualitatively social and economic factors. Eight FCD/I projects were selected in four FAP regions. The Southeast Region was not studied. Fisheries and socioeconomic surveys started between August 1992 and February 1993 and ended in February 1994, providing a 13-19-month sampling period, depending on the region.

7.2 Objectives of flood control

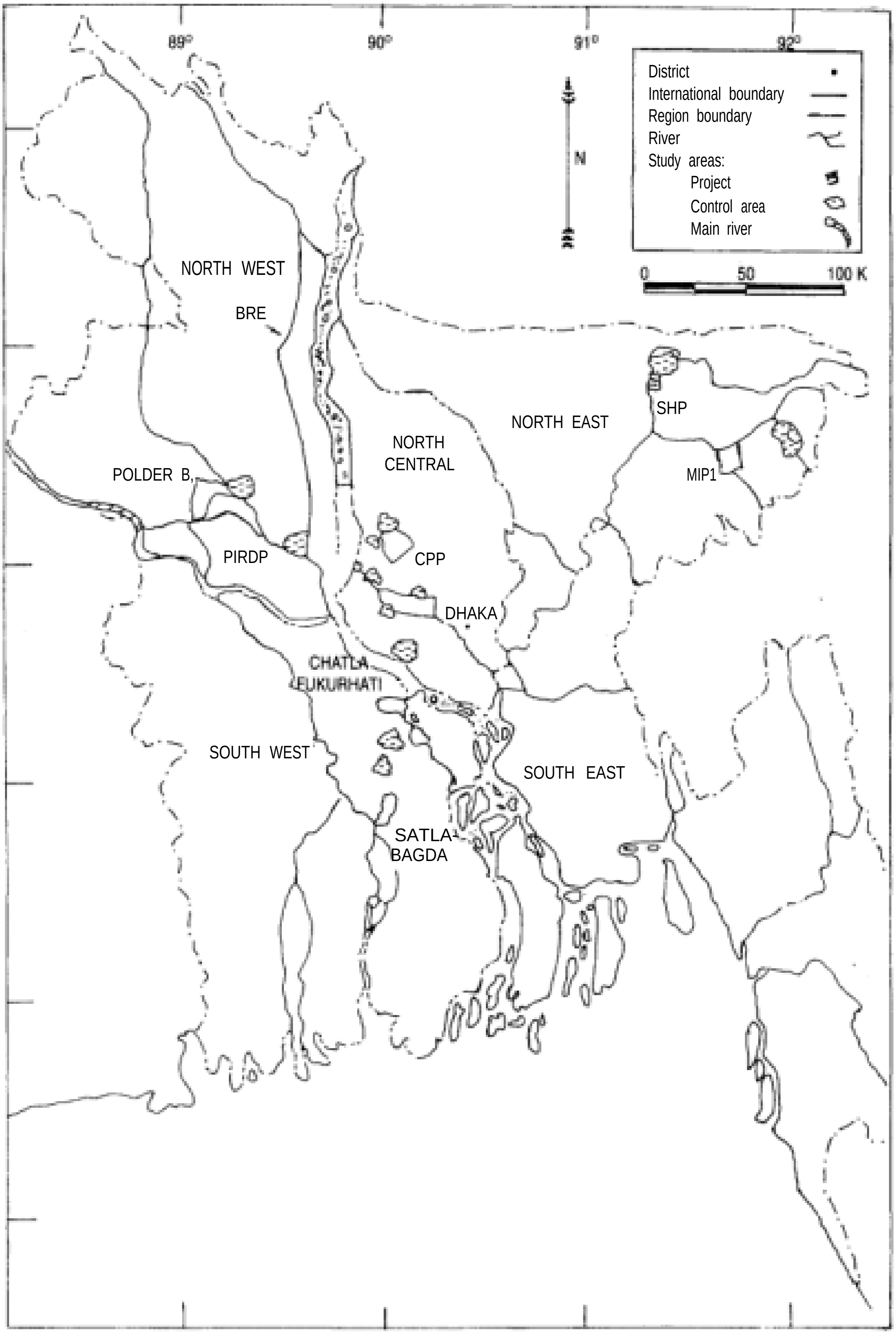
The principal aim of all FCD/I projects studied was how to increase rice production. Outside the Northeast Region, this was to be achieved by the exclusion of external river flooding from protected areas and the conversion of seasonal wetland into drier land where HYV t. *aman* could replace deepwater rice (h. aman). Several other minor shifts in agricultural patterns were anticipated but the main economic benefit of flood control was to be from the predicted increase in production through the suggested HYV t. aman, a crop which tolerates only shallow flooding during the monsoon.

In the Northeast Region this is the basic rationale of most flood control projects covering inland low-lying floodplains. In the North East, two types of FCD/I projects were studied. The first, a partial flood control project using submersible embankments, and the second, a full flood control project with pumped drainage and irrigation facilities. The aim of all partial flood control projects in this region is to increase winter rice production by reducing damage caused by early or pre-monsoon river floods. These projects are not designed to alter flooding patterns during the monsoon. The FCD/I project. on the other hand, aimed to increase winter rice production and anticipated increases during the monsoon season through increased HYV *t. aman* production at the expense of b. *aman.*

7.2.1 Impacts on flooding

Eight flood control projects were selected in four FAP regions (Table 7 and Fig.2). The projects were selected to cover different types of flood control representative of current developments in Bangladesh. The distribution of projects between regions was rather uneven; three in the Northwest and one in the Northcentral Region but this reflected differences in the extent of flood control development between these regions.

Figure 2. FAP 17 Study Areas



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Type of flood control	***Name of project***	***Type of project***	***Performance***
Full Flood Control	Brahmaputra Right Enhancement (BRE) (NW	Full river embankment	Successful full flood control embankment. in area and year studied. In several other locations the embankment was repeatedly breeched by erosion by the Jamuna.
Controlled Flooding	Pabna Irrigation and Rural Development Project (PIRDP) (NW)	FCDI	Structurally secure project designed for full flood control but in which external river waters were allowed entry for the production of deepwater aman. This produced controlled deep flooding. Pumped drainage not fully functional up to 1994.
	Chalan Beel Polder B (SBP) (SW)	FCD	Structurally secure project designed for full flood control but in which external river waters were allowed entry for the production of deepwater aman. This produced controlled deep flooding.
	Satla-Bagda Project Polder (SBP) (SW)	FCD	Structurally secure project designed for full flood control but in which external canal waters were allowed entry for the production of deepwater rice. This produced controlled deep flooding.
Partial Flood Control	Shaghai Haor Project (SHP) (NE)	FCD - with submersible embankment	Structurally secure partial flood control project using submersible embankments to prevent river until May after which floodwaters overspilled. Monsoon flooding unaffected.
	Manu Irrigation Project (MIP) (NE)	FCD	Full flood control project in which embankments were cut when outside river levels were high resulting in flooding of the project. Pumped drainage and winter gravity-fed irrigation and fully functional.
	Chatla-Fukurhati Project (CFP) (SW)	FCD	Full flood control and drainage project in which external river flooding occurred due to non-functioning regulations and damaged embankments.
	Compartmentalization Pilot Project (CPP) in Tagail (NC)	FCD	Flood control and drainage project which did not prevent river flooding due to poor design of original, project (Silimpur-Karatin) and non-completion of current design (CPP).

7.2.2 Impacts on fish

7.2.2. I POTENTIAL IMPACTS

The potential impacts of flood control on capture fisheries were based on the general perception that full flood control projects were functional and that natural flooding patterns on floodplains had been radically altered. Outside the Northeast Region, the principal objective of full flood control was to increase rice production by replacing deepwater b. ***aman*** with HYV t. ***aman.*** In this scenario, some of the possible adverse impacts on fisheries are:

- Loss of flooded habitat during the monsoon, resulting in a loss of fish production.
- Blockage of the movements of fish (adults, juveniles and hatchlings) between external rivers and floodplains.
- Reduced diversity of fish due to the prevention of migratory species entering the floodplains.
- Increased fishing pressure on smaller areas of water during the monsoon. resulting in damage to the long-term sustainability of the fisheries.
- Reduced dry season habitat resulting in higher fishing pressure and increased catchability of overwintering fish broodstock. The increasing use of water from beels to irrigate surrounding rice fields is of particular concern.
- Reduced groundwater recharge, resulting in a lower water table in the dry season which, in turn, could lead to a reduction in the area of perennial heels. Dry season rice production dependent on tubewell irrigation is also thought to be at risk from lowered groundwater levels, which also increase the problems with drinking water supplies.
- Loss of high value migratory species such as major carps and catfish, by preventing migrations between rivers and floodplains, and, thereby, interfering with their life cycles.
- Increased fish disease through the creation of adverse environmental conditions, such as stagnation of standing waters, which could trigger disease outbreaks in already stressed and modified fish communities.

7.2.2.2 IDENTIFIED IMPACTS

The impacts of flood control on fisheries which were identified by the FAP 17 study are summarized below:

- Loss of catch through loss of habitat.
- Reduction in catch per unit area (CPUA).
- Reduced fish density/abundance.
- Increased fishing effort.
- Reduced biodiversity.
- Reduction in the numbers of migratory fish and the number of fish migrations.
- Disruption of fish community structure.
- Increased capture at regulators.
- Reduced opportunity for mitigation measures.
- Reduced potential for stock enhancement.

7.2.3 **Impacts on people**

The project which provided the highest degree of flood control, the BRE, was not covered by socio-economic surveys and, therefore, the greatest social and economic impacts of flood control were probably not recorded. This also partly explains why it was not possible to identify quantitatively impacts solely caused by flood control, since in all projects studied there were substantial monsoon floods. The FAP 17 social and economic surveys did, however, provide quantitative descriptions of rural communities and their varying levels of economic dependence on capture fisheries. These are summarized briefly below:

- The incomes of households in fishing communities are highly dependent on the fisheries resource — across all regions, those households show between 50 per cent and 90 per cent dependence on activities related to fishing.
- In the Northwest and Southwest regions, small and landless farmers in agricultural communities are significantly dependent on fisheries. In those areas, between 9 and 15 per cent of these farmers' incomes are generated from fisheries.
- In all areas except the Northeast, fisheries accounted for significant portions of the incomes of the landless during the flood season. Between 10 and 25 per cent of landless farmers' incomes in these areas are from fisheries during the flood season.
- In agricultural communities in all regions, there are high levels of participation in fishing even by those groups which report low-levels of dependence on fishing for their income. In the Northcentral, Northeast and Southwest areas, over 60 per cent of all categories of farmers reported some participation in fishing.

From the results of social and economic studies it was then possible to identify several potential impacts of flood control, namely:

- Whenever full flood control effectively reduces the magnitude, extent and duration of flooding, resulting in a decrease in fish production, all groups dependent on the fishery will lose income, a cheap source of animal protein and employment opportunities. The adverse impacts will affect subsistence, seasonal and professional fishermen, as well as leaseholders and fish traders.
- Under controlled flooding for deepwater *aman,* professional fishermen may lose income through a reduction in the extent of public water bodies which they traditionally fished and through increased competition from agricultural communities.
- Under controlled flooding for deepwater *aman,* subsistence and seasonal fishermen can gain through increased fishing opportunity so long as they have access to waters.
- Where flood control allows greater control of drainage, fisheries leaseholders may make short-term gains through increased catches when heels and *khals* are drained almost completely by sluice gates or when sluice gates are closed temporarily to trap fish and make them easier to capture. In the longer term, however, these practices may be very damaging to the sustainability of fisheries.

8. RECOMMENDATIONS

8.1 Recommendations - stock enhancement schemes

There is further need to develop an understanding of the open water fisheries in Bangladesh. There is need to build on the information base and experience of various projects. The issue of the potential for community approaches is concerned with resource economics. The experience of stocking programmes indicates that where resource values are increased, the distribution of benefits on an equitable basis is not guaranteed. The issue of privatization of stocking or the establishment of community management of open water resources is faced with the problem of establishing the costs of resource use. Without clearly defined property rights that are enforceable, manageable and have the principle of exclusion, the degradation/overfishing of the resource will continue. The management and conservation of the resource must be viewed against this background.

The results of stock enhancement, both in terms of production and socio-economic impact, contribute to this policy debate. Similarly, the results of mitigation measures — heel sanctuaries, improving fish migration by re-excavation of *khals* — may also generate significant improvement in production. The policy debate will then focus on the most appropriate response for each situation. Similarly, the improvement of local capacity in environmental monitoring will enhance the technical knowledge of the resource.

This paper recommends that existing knowledge be institutionalized within Bangladesh and the gaps in knowledge be addressed (e.g. the effects of pesticide use on fish populations). The largest information gaps appear to be concerned with resource management issues. This issue has been approached from an efficiency of production viewpoint and also the socio-economic aspects, but the policy gap remains. The issue of conservation has been relegated to issues that are more concerned with rights of access. This has led to problems in establishing property rights for fishermen perceived as poor. NGOs have invariably tried to establish fishing rights for their groups (without an adequate knowledge of the group's poverty status), at the expense of other groups. The principle of exclusion has been applied by this target group approach rather than by a community-based approach.

An open water stocking programme may be a successful management tool for fisheries if properly and systematically planned and managed. This would include, *inter alia,* the following:

- Selection of suitable water bodies on the basis of the physio-chemical and biological parameters as well as on social considerations.
- Selection of suitable species of appropriate composition, size and stocking density with due consideration to biodiversity and the ecological condition of the water bodies.
- Protection of the fries/fingerlings stocked, so that they are not caught before attaining desirable/ legal size. For a multiple species fishery, gear selectivity may play an important role in harvesting non-stocked species when fishing of stocked fishes (undersized) are prohibited.
- Continuous monitoring of survival, growth and production of fish in the water bodies.
- Raising of fingerlings, by species, to the desired size in the proper time and avoiding stocking of hybrid, inbred and diseased fingerlings.
- Ensuring an improved fingerling transportation system to reduce mortality and stress on fingerlings, and to avoid further mortality after stocking.
- Proper planning and management of the stocking programme, including procurement of fingerlings and management of the stocking operation.
- Creating social awareness of the programme to ensure post-stocking management of the fishery and to promote equal distribution of benefit and social justice.
- Development of a well-planned strategy for sustainability of the stocking programme.

8.2 Recommended mitigation measures

A clear distinction is drawn between compensation and mitigation strategies. Compensation measures rely on aquaculture and culture-based techniques to increase fish production and, thereby, compensate, to varying degrees. for the tonnage of fish lost due to flood control. In contrast, the following mitigation measures are designed to reduce or avoid losses in capture fisheries:

- Production of deepwater *aman.*
- Habitat rehabilitation and protection.

— Increased fish migration across flood control structures.
— Fisheries conservation: ***Beel*** management.
— Fisheries conservation: Prohibited fishing zones at regulators.
— Fisheries conservation: Protection of river (duar) fisheries.
— Fisheries conservation: Etablishment of fish sanctuaries
— Conversion of full flood control to partial control.
— Provision of flood pathways in extensive areas protected by submersible embankments.
— Increased fish migration across rural roads.
— Strengthening of technical assessment and planning capabilities of BWDB/WARPO.
— Establishment of national database on FCD/I projects.
— Improvement of data collection by BWDB.
— Establishment of water-user groups.
— Taining within BWDB.
— Development of flood modelling techniques.

8.3 Future research requirements

Quantitative catch assessment surveys to obtain estimates of fish densities and yield per unit area of floodplain.

* Stock assessment using length frequency analysis and ageing techniques to obtain information on the population dynamics of selected species of fish and prawns dominating floodplain catches.
* Investigation of the biology and ecology of selected fish and prawn species dominating floodplain catches inside and outside FCD areas.
* Assessment of the impact of FCD projects on the diversity of fish and prawns. Standardized systematic, intensive sampling is required to record not only the more common species but also the numerous rarer species which may be more vulnerable to adverse impacts of flood control.
* A national capability to provide systematic quantitative information on geographical variations in the diversity of the aquatic resources of Bangladesh should be established. This would improve the basic knowledge of the diversity of fish, shrimp and prawns and identify environmental problems, including flood control, linked with reductions in biodiversity.
* Investigation of the movements of fish and prawns between rivers and floodplains which are free-flooding and others on which flooding is controlled.
* Investigation of movements by passive downstream drift of fish and prawn hatchlings between rivers and floodplains in relation to seasonal changes in river discharge. This study is essential on the BRE where the Jamuna River provides an annual supply of hatchlings of major carps and many other species of fish.
* Investigation of the impact of water regulators on the survival and movement by passive downstream drift of fish and prawn larvae in relation to seasonal changes in river discharge.
* Determination of water velocities from a range of different types of structures operating under varying head differences and gate openings.
* Determination of swimming speeds of selected fish species.
* Integration of biological information derived from research studies (listed above) and flood modelling techniques, to improve the predictive capability of impact assessments.

* Identification of possible spawning grounds of major carps in the Brahmaputra and Padma rivers in Bangladesh and investigation of upstream breeding migrations in these rivers.
* Investigation of the migration of fish in the rivers of the Northcentral Region to identify possible environmental factors which might explain the general scarcity of riverine and migratory species in them compared in some other regions of Bangladesh.

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PAPER 2

POTENTIALS, CONSTRAINTS AND STRATEGIES FOR CONSERVATION AND MANAGEMENT OF OPEN BRACKISHWATER AND MARINE FISHERY RESOURCES

by

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I. INTRODUCTION

The fisheries sector provides about 80 per cent of the animal protein consumed in Bangladesh. But despite continuous increase in fish production, it has not been able to cope with the fast-growing population. In 1975-76 the country's fish production from all sources was 640,000t. In 1993-94, this production rose to 1,087,000 t, whereas the per capita fish consumption went down from 33.4 g to 21 g. This has happened simply because fish production increased at an arithmetical rate whereas the human population increased in geometrical proportion.

The freshwater area is getting reduced and the overall ecology of fish habitats and the routes of migration have altered due to various water resources development activities. So, it is difficult to fulfil the minimum protein requirement of the teeming millions from the freshwater subsector alone. But the highest priority has always been accorded to the freshwater fisheries, as reflected in the number of fisheries development projects implemented since liberation, in spite of the fact that the marine fisheries sector has the lion's share of foreign exchange earnings and contributes to the development budget in that proportion. If similar level of management and development attention was paid to the marine sector, it would be possible to give substantially increased production.

The marine fisheries sector at present contributes only 25 per cent of the country's total production, despite a sizeable marine and brackishwater area under the EEZ. The development potential of this sector has not been properly exploited.Rather, because of unplanned and irrational increase in fishing effort, many of the marine fish and shrimp stocks have already declined. As a result, coastal fishing has become non-remunerative and fisherfolk are getting poorer, thus putting more and more damaging pressure on the resource, a fruitless endeavor for survival. This may give the impression that marine resources exploitation has become saturated, but the story is different: in fact, we are killing a resource with great potential.

The valuable penaeid shrimp stocks in particular have been under pressure from three different sides, leading to a complete risk of annihilation. Superseding the long term development objectives with various quick-money strategies is a common practice in the tropical developing countries, which has led many fisheries throughout Asia and the Pacific to total annihilation. This must be taken as a lesson and we must choose the long term and not the short-term strategies for management, before we reach a point of no return. As fisheries resources are renewable, a diversified and judicial exploitation plan may give a production many times higher than the present from the same stock.

2. RESOURCES POTENTIAL IN MARINE AND BRACKZSHWATER BODIES

Three recent surveys involving Dr.Fridtjof Nansen (FAO/NORAD/BGD 197980) and Annusandhani (BGD 1983, and FAO/BGD 1984-86) gave estimates of demersal standing stock very close to each other, between 150,000 and 160,000 t. within the exploited 10-100 meter shelf area (Saetre 1981. Khan 1983. Lamboeuf 1987). An additional 100,000 mt of fish stock is available within the 24,000 sq.km open brackishwater area between the shore line and 10m depth (Saetre 1981). The penaeid shrimp stock has been reported as being 2,000-4,000 t. by various authors (Penn, 1983: White & Khan, 1985a: Mustafa et.al., 1985). On the basis of biological information, the penaeid shrimp MSY was estimated at 7,000-8,000 t. annually (Khan *et al. 1989).*

A detailed pelagic survey is yet to take place to provide a reliable estimate of the standing stock. Acoustic survey by Dr.Fridtjof Nansen, however, gave an estimate of 60,000-1,20,000 mt, which is an underestimate (Saetre, 1981). The other potential resources, eg. Cephalopods, lobster, flatfish etc., have not been studied in detail. Some indications are however, available from the casual data of the

Anusandhani that encourage the belief that a potential yield is available for harvesting. A detailed study would. however, be necessary.

The total production from all sources of marine and brackishwater fisheries has been estimated to be 264.000 mt (Khan, 1994). The drift gillnet fishery and the estuarine set bagnet fishery account for the bulk of the production, followed by the marine set bagnet fishery, and trawl fishery accounting for 136,000 t., 73,000 t., 26,000t and 17,000 t respectively.

3. THE PHYSICAL CHARACTERISTICS OF THE MARINE AND BRACKISHWATER ENVIRONMENT

3.1 The causal oceanographic features

The principal feature of the brackishwater estuarine hydrology is the presence of a prolonged low-saline regime, generally during the monsoon and post-monsoon seasons. A semi-diurnal tide is typical of Bangladesh's coastal waters which range upto three metres. Salinity increases with strong tidal effect catalyzed by ebb-tide, and turbidity increases due to the sub- monsoon effect (FAO,1968). The reversal currents influence the circulation and, thus, productivity of the water, their ecology and the biogeography. Oxygen deficit is prominent in the subsurface layer of the outer shelf area.

The distribution of depths in the Bay of Bengal has many irregularities, due to the presence of submarine canyons, ridges and other topographic features. This restricts fishing operations greatly. A huge discharge of freshwater runoff from many great rivers is a dominant feature that influences dynamics of the coastal and marine environment seasonally. The Bangladesh continental shelf serves as the reception basin of a great amount of sediment brought down from the Himalayas; this amounts to 13 million t/day during the rainy season (Eysink, 1983).

3.2 The effect of environmental alteration on resource degradation

Water resources development activities, destruction of mangrove forests, water pollution and overfishing have been recognized as major factors for the alternation of the natural environment and the degradation of coastal and marine resources.

3.2.1 Water resources development activities

About 3.36 million ha of inundatable floodplain have been protected through the construction of 7,024 m. of hydraulic embankments, 3,888 bridges and culverts, and 1,064 minor closures up to June 1990 (MPO, 1990) as part of the implementation of various water development projects, such as river closures, water abstraction, FCD and FCDI. These projects, though achieving the target objective, produce inimical effects on the aquatic systems and affect aquatic productivity adversely (Ah, 1991) by inhibiting fish movements and migration for breeding and feeding and reducing production area and nursery grounds openwater systems.

About 814.000 ha of floodplains have been removed from the openwater fishery production system till 1985. This has caused a considerably smaller fish harvest in the area, which includes valuable brackishwater and marine euryhaline species such as mullet, hilsa and macrobrachium. Thus, it is estimated that, by the year 2000, 110,000 t. of fish harvest would be lost every year (MPO, 1987).

River closures, barrages and sluice gates obstruct the siltation flow process, which is supposed to wash down to the Bay of Bengal, and, as a result, the rivers and estuaries are silted up. The closure of the Kumar river, under the Ganges-Kobadak Project, has for example cut off the Hilsa migration route and. as a consequence, the Hilsa fishery in the Kumar river is no more evident. The *Hilsa* fishery in the Ganges has declined both in India (99 per cent) and Bangladesh due to the Farakka Barrage (Jhingran, 1983; MPO, 1986).

3.2.2 Destruction of mangrove forests

Mangroves serve as buffer zones against cyclones and tidal surges. The Bangladesh coast supports about 587,400 ha of natural mangroves (Mahmood 1986) and a further 100,000 ha of planted mangroves. This vast network supports the habitat of several species, particularly the younger stages of shellfish and finfish (Mahmood et al, 1994).

Because of severe destruction, ecological changes caused by biotic factors, and salinity increase due to reduced rainflows, caused by the construction of dams, barrages, embankments etc, an estimated 40-45% of the two major mangrove species of the Khulna Sundarbans reserve forest have declined between 1959 and 1983. The worst destruction has been going on in Chakaria, Cox's Bazar, due to the irrational expansion of coastal shrimp farming. The Kewra forest of Jaliardwip, in the Naf river, has been cleared for conversion into shrimp ponds (Mahmood, 1995).

Many authors have tried to establish the relationship of fish and shrimp (post larvae and juvenile) shelter with the mangroves and have stated that rich fishing grounds in the shelf areas are usually found off dense mangrove forests. The degradation of these mangrove ecosystem has resulted in the depletion of fish and shrimp stock and affected the nursery grounds of the post larvae and juveniles. As a consequence the *P.monodon* PL are now less abundant in brackishwater areas.

3.2.3 Pollution of the marine and brackishwater environment

The Bangladesh marine and brackishwater ecosystem is threatened by different types of pollutants dumped directly in them or washed down through the large number of rivers and tributaries which crisscross the entire country before emptying into the Bay of Bengal.

Indutrial wastes: More than 900 polluting industries, directly or indirectly, discharge their untreated liquid and solid wastes into brackish waterbodies. The Karnaphuli and the Rupsa-Bhrab rivers, which receive effluents from 309 industries in Chittagong and Khulna, are major carriers of such industrial contaminants as Ammonia, Chromium, Mercury, Phenols and DDT. Reports are available of direct fish kills and the toxic effect on the mortality of post- larvae and juveniles in the nursery grounds. Some pollution control measures have recently been introduced for effluent treatment (Mahmood et al, 1994).

Municipal wastes: Coastal cities and towns do not have any domestic waste treatment facilities. As a result huge quantities of untreated municipal wastes find their way directly or indirectly into the rivers and, thereafter to the Bay of Bengal, thus adding to the degradation of the marine and estuaries habitat.

Agrochemicul wastes: Since 1977, the use of agrochemicals, both fertilizers and pesticides, has increased by about 40070. It has been estimated that, at present about 1800 t/ year (Mahmood *et al.* 1994) of pesticide residues are added to the coastal waters through runoff.

Oil pollution: Localized oil pollution in the vicinity of Chittagong and Mongla port is said to be heavy. Increased shipping activities in the ports, crude and refined oil transportation, oil slicking from mechanized vessels, refinery and workshop spillage and accidental or wilful oil spillage by tankers are the major sources of pollution threatening the aquatic lives in the upper Bay of Bengal.

Owing to a lack of waste-reception and treatment facilities in the ports, and a lack of effective legislation and surveillance, foreign and domestic ships and trawlers discharge their oily waste in the sea unhindered. Ship-breaking operations around Chittagong and Khulna also discharge oily wastes and other noxious materials.

4. BIOLOGICAL CHARACTERISTICS OF THE BRACKISHWATER AND MARINE ECOSYSTEMS

Brackishwater estuaries are the meeting point of the fauna from three different ecosystems. Brackishwater species, *e.g. Acetes indicus, Raconda russeliana,etc.* live, grow and spawn in the same environment, while the marine and freshwater fauna use the brackishwater low-saline, nutrient-rich area as nursery grounds and visit only for a short time.

4.1 Life cycle pattern of penaeid shrimps

Penaeid shrimp live and spawn in offshore waters beyond the 40-metre depth zone. The larvae enter the estuarine habitat with the tidal currents. There they find an environment suitable for feeding and living at that age. As they grow bigger, their physical and biological demands change gradually and, so, they move back towards the sea. When they reach the parent stock they have grown to adulthood and have matured to participate in the spawning process, thus completing the life cycle.

During the different phases of their life cycle, the penaeid shrimp population encounter a variety of fishing gear in different areas and depths of the sea (Fig 1) starting with shrimp fry collecting gear at the PL stage, followed by the estuarine set bagnet (ESBN) and beach seine in the open brackish waters and estuaries, when they are at the juvenile stage. The survivors are then captured by the marine set bagnet (MSBN) at post-juvenile and pre-adult stages, by the trammelnets at adult size and, finally, the residual population is caught by the shrimp trawlers in the marine environment. Thus, members of a single stock are exposed to a multigear fisheries exploitation system.

4.2 Artisanal fisheries restricting offshore recruitment

The artisanal fishing gear operated in the open brackishwater environment - the ESBN, the pushnet and the beach seine - catches only the post-larvae and juveniles of the marine fauna in huge numbers, thereby restricting their recruitment in the open sea at an adult stage. The degree of such restriction by size and number would be evident from Figure 2 (after Khan‘et al, 1994) which shows *P.monodon* (Tiger shrimp) harvested by different interactive fishing gear. These gear, in this fashion cause imbalance in the food chain and in the overall ecology of marine habitat.

4.3 Industrial fishery reducing recruitment and killing spawners

The trawler fleet, although not permitted by rules and ordinance to fish at depths shallower than 40m, normally fish upto 30 m and even upto 20m depth. As their gear is non-selective, they too harvest sizes of fish and shrimp which fall under the post-juvenile and pre-adult categories (Figure 2), thereby restricting adult recruitment of a part of the population.

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Figure 1. Life cycle pattern of penaeid shrimp

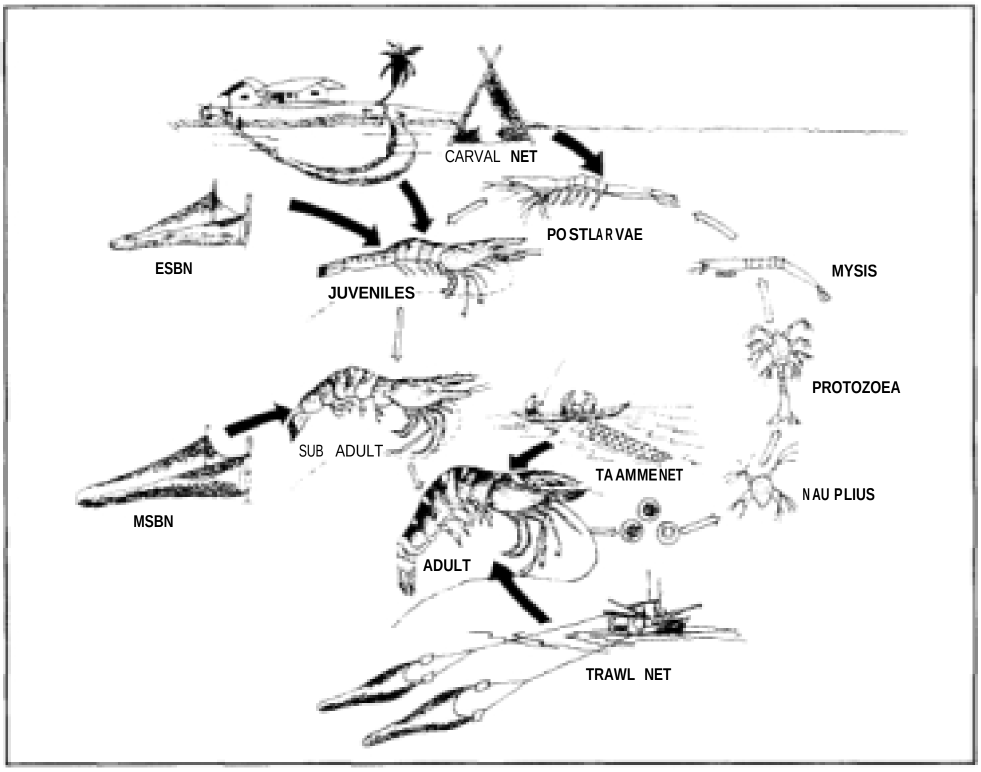
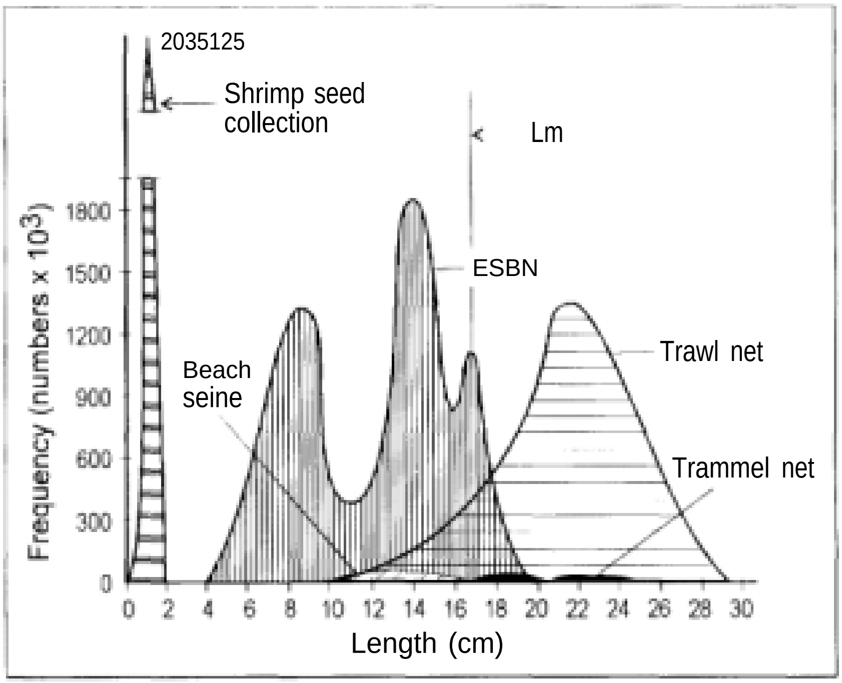


Figure 2. Annual catch (numbers) of Tiger shrimp *(P monodon)* by length, exploited by different gears



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Penaeid shrimp spawn throughout the year, with two peak seasons (January-Feb and July-August) when more than 90 per cent of the population in the spawning ground show the signs of full ripeness. To ensure a larval population for the next generation, the brooders need to be saved from fishing mortality during there periods. But the trawler fleet randomly harvests the brood shrimp during the peak spawning season. Thus, the larval population is getting reduced year after year.

5. EXPLOITATION PATTERN AS AGAINST MSY OF VARIOUS STOCKS

Analysis of the catch effort as well as the biological data for the growth and mortality during the last decade (under DOF) provides information on the pattern of exploitation of various fish and shrimp stocks by different fishing gear. Some gear were found to be totally destructive, while the others were either partially harmful or proved to be biologically sustainable.

5.1 Exploitation by industrial (trawl) fishery

The effort in the trawl fishery during the last decade and a half has been around 5000-6000 standard fishing days (Table 1), to produce 3,500-6,000 t. of shrimp. The MSY of penaeid shrimp is 7,000 t. and the optimum effort for producing this amount is 7,000-8000 standard days. In some years it was around the level of MSY. Some effort was lost due to a major cyclone in April 1991. Thereafter, till date (1995) shrimp production has been much below the MSY level. At present there are 53 trawlers (41 shrimp and 12 finfish) which gave a total annual effort of about 5,000 standard days. This is at least 1000 days less than the optimum, mainly because ten of the trawlers are too old and their present average effort is 62 days/year/trawler (250 days standard) (Khan and Paul, 1993; Rahman and Khan, 1995). If these old trawlers are made effective, the total effort would reach the optimum level.

Whitefish landed by the trawler fleet is in the range of 8,000-12,000 t, which is only 20 per cent of the actual catch,; while 80 per cent, equivalent to 35-45,000 t (White and Khan, 1985), is discarded dead in the sea. Even if the discarded amount is considered as production, the MSY is not being achieved. The MSY is 85,000 mt (Lambeouf, 1987). Although the trawl fishery is below the optimum effort, tiger shrimp, the targeted species, has been over-exploited as the gear is non-selective (Table 2). On the other hand, the brown shrimp, ***M.monoceros,*** shows an upward trend.

5.2 Exploitation by semi-industrial fisheries

Introduction of engine and nylon twine prior to and after liberation have made it possible to exploit even more the unexploited resources. One such development is the small mesh drift gillnetting for ***Hilsa.*** Production was raised by at least 1 ,00,000 t over-night. Till date (1995), no report on overfishing of ***Hilsa*** is available.

Then there are the bottom long-lining and marine set bagnet fishing operations with motorized boats. These fisheries do not provide sufficient indication of overfishing, but capture of ***Hilsa*** spawn and jatka is a concern for management. Over-fishing, however, is noticed in the brooder exploitation of Indian salmon and long Jewfish ***(Lakha*** and ***Lambu)*** with large mesh driftnet (LMD).

Table 1: Total catch for the last decade by commercial trawlers

Years	Standard effort [days) of shrimp trawl	Actual effort (days) of shrimp trawl	No. of shrimp trawlers in operation	Shrimp catch (ml)	Catch/Day/ Trawler (kg)	Shrimp catch by fish trawler (mt)	Total shrimp catch lmt)	Fish trawler effort converted to shrimp trawler effort	Total effort (Standard shrimp days)
1981-82	2987	2396	13	1340	449	357	1697	795	3782
1982-83	4510	2395	18	2004	444	1116	3120	2514	7024
1983-84	8087	2866	19	3441	565	2020	5461	3575	9662
1984-85	8287	5014	29	4239	676	1279	5518	1892	8159
1985-88	5941	5990	31	3716	626	318	4034	502	6444
1988-87	6449	6629	31	4178	648	310	4488	479	6928
1987-88	8239	6429	33	3339	535	180	3523	344	6583
1988-89	6615	6763	35	4661	705	232	4893	330	6945
1989-90	5460	6093	36	3086	565	48	3134	86	5546
1990-91'	4437	4845	36	3384	763	47	3431	62	4499

'Due to cyclone, fishing was interrupted for two months.

Table 2: Population dynamics of some species exploited by the trawl fishery

Species of fish/shrimp	L(cm)	K	Z	M	F	E	L_c
Penaeus monodon (M)	30.5	1.14	6.83	1.94	4.89	.71	17.5
Penaeus monodon (F)	31.5	1.35	5.72	2.14	3.58	.62	15.7
Metapenaeus monoceros (M)	15.7	1.6	5.89	2.91	2.98	.50	8.9
Metapenaeus monoceros (F)	18.5	1.65	4.52	2.84	1.68	0.37	9.5
Pampus argenteus	30.67	1.66	5.25	2.35	2.90	0.55	-
Upenaeus sulphureus	22.0	1.1	10.59	2.96	7.63	0.72	-
Nemipterus japonicus	24.96	1.06	3.75	1.94	1.81	0.48	-
Saurida tumbil	39.0	0.97	2.54	1.66	0.88	0.35	-
Pomadasys hasta	56.9	0.38	1.61	0.81	0.79	0.51	-
Lepturacanthus savala	105	0.85	2.06	1.33	0.73	0.65	-
Harpadon nehereus	38.3	0.42	1.54	0.94	0.6	0.38	-
Lutjanus johni	64.72	0.28	2.70	0.59	2.11	0.78	-
Ariomma indica	22.0	1.12	5.53	2.10	3.43	0.62	-

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5.3 Exploitation by artisanal fisheries

5.3.1 **The estuarine set bagnet (ESBN) fishery**

Detailed catch assessment and biological information on the pattern of exploitation by this fishery is available (with DOF). It is evident that this fishery is the most destructive fishery of the natural resource (Islam et al., 1993, Khan *et* al., 1994). Table 3 shows the natural mortality, fishing mortality and exploitation pattern of the 19 most significantly occurring species of this fishery, covering three different ecosystems.

Table 3: Population parameters of some important species exploited by the ESBN fishery

Species	L_∞	*K*	*M*	*F*	L_c	*E*
P. monodon	31.36	0.72	1.423	8.377	13.792	.855
P. indicus	22.83	0.55	1.303	3.70	5.919	.74
M. monoceros	19.77	0.437	1.167	3.652	5.86	.758
M. brevicornis	15.57	0.31	0.997	4.235	4.809	.809
M. spinulatus	20.06	0.39	1.079	5.90	5.292	.845
P. scuplitis	16.90	0.76	1.752	4.15	15.30	.703
P. styli/era	14.37	1.665	3.062	3.00	2.80	.495
Acetes indicus	4.97	0.73	2.401	1.10	2.036	.314
M. rosenbergii	35.54	0.34	0.841	1.96	7.341	.70
P styliferus	15.37	0.63	1.591	3.20	3.736	.67
R. russeliana	23.62	0.43	1.099	2.10	2.931	.657
S. taty	21.27	0.53	1.284	0.80	15.796	.281
S. tri	16.83	0.652	1.586	9.00	3.351	.85
H. nehereus	34.90	0.38	0.909	3.75	6.273	.805
L. savala	93.00	0.29	0.579	2.62	22.60	.819
E. tetradactylum	38.08	0.18	0.850	3.50	5.30	.866
P. paradiseus	21.63	0.52	1.276	4.724	2.699	.787
S. domina	43.26	0.38	0.856	2.70	10.057	.759
S. sihama	27.36	0.392	0.993	3.00	5.10	.751

It can be seen that the species of brackishwater origin, i.e. *Acetes* indicus (the sergestid shrimp), *Raconda russeliana* and *Setipinna taty* are not over-harvested, rather they are underfished to some extent, while almost all species of marine and freshwater origin which visit the brackishwater area for nursery and breeding purpose are seriously overfished (growth overfishing). It can be seen in Figure 2 that all the shrimp are caught by this gear before the adult stage and are thus not permitted to join in the spawning process.

53.2 **The pushnet fishery (for Bagda PL)**

More than 2035 million *Bagda* post-larvae are collected annually, which is only a little over one per cent of the total catch of the fishery. The rest of the catch equivalent to about 200 billion PL of the shrimp/fish and zoo plankton. is thrown on the sand to die. This is serious growth overfishing.

5.3.3 **The trammel net fishery**

The trammel net is at present operated only on a limited scale along the Teknaf coast. Since this gear is operated with country boats, the fishing is on artisanal scale, but the technique is modern. This is a selective gear and biological studies show that the exploitation pattern is below the optimum level, though the size at first capture is definitely above the optimum.

6. FUTURE STRATEGIES FOR CONSERVATION, MANAGEMENT AND DEVELOPMENT

The present management is largely concentrated on the industrial trawl fishery. The brackishwater and marine fisheries are not managed very much.

6.1 The complexity of multigear and multispecies fisheries management

Bangladesh has the problem of not only tropical multispecies fisheries but also multigear fisheries. Any single fishing operation catches a number of species at different sizes and ages on the one hand. On the other hand, members of the population of one species belonging to a single stock become available to different interactive fishing gear, in a sequential order. So each of them need to be accounted, as it is not possible to carry out an assessment on the basis of a single fishery alone. For instance, a large increase in artisanal fishing pressure significantly lowers the number of shrimp reaching the industrial trawling grounds and results in lower overall catches in the industrial fleet. This is unrelated to change in industrial fleet size. A situation like this preceded a temporary collapse of the shrimp stocks in the gulf (Vanzalinge, 1986).

The situation in the Bangladesh coastal shrimp fishery is similar and the penaeid shrimp stock is under pressure from all sides. It can be seen that (Fig 2) the ESBN, pushnets and beach seine harvest the members of the same population at sizes much lower than the size at first maturity and, as a result. about 99 per cent of the population do not get a chance to participate in the spawning process. It was estimated that out of the total penaeid shrimp harvested, ESBN comprises 55.87 per cent, the trawler fleet 29.70 per cent. MSBN 14.30 per cent beach seine 0.09 per cent and the pushnet only 0.04 per cent by weight. The same production if converted into number shows a reversed situation i.e. the trawler fleet takes only 1 per cent, ESBN 3.4 per cent and the pushnetters alone take 94.6 per cent (Khan, 1994). Thus it is evident that the enhanced production in the trawl fishery largely depends not on the trawl fishery alone but on the management of the three artisanal fisheries.

6.2 Reduction of fishing effort in the ESBN fishery

As a regulatory approach, a 30 mm codend mesh size regulation was introduced in the ordinance (not enforced) for ESBN, assuming that the juveniles would escape. But with the availability of valid scientific information now, it is evident that this gear targeted the juveniles and that increased mesh size virtually results in no catch (Hansen and Mustafa, 1992). So there is no alternative to complete withdrawal of this gear from the estuarine environment.

6.2.1 Rehabilitation of ESBN fisherfolk

Overnight withdrawal of this gear would not be possible, as it would force 50,000 fisherfolk, who live below the poverty line, into starvation. So, alternate employment, to ensure their livelihood, needs

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be identified inside or outside the fisheries sector. New fisheries development and expansion of the presently sustainable fisheries with the direct participation of ESBN fisherfolk would be necessary.

6.2.2 Area and seasonal closure in ESBN operation

Gradual withdrawal of effort in the fishery needs to be pursued. As a first step, closure of fishing during the peak recruitment periods, i.e. July to September and February to April in the Cox's Bazar area would substantially reduce the juvenile mortality, since the Cox's Bazar district alone accounts for 46 per cent of the total destruction (Khan *et* al, 1994) of juvenile penaeid shrimp.

6.3 Banning of particular fishing gear

Large mesh driftnets (LMD) have been operated in the Cox's Bazar region for the last two decades, targeting the Indian Salmon *(Lakhua)* and Long Jewfish (Lambu). These species have been fished so much that they are nearly extinct now. So, use of this gear needs to be stopped for a few years and the situation monitored. Beach seine in estuaries should be banned.

6.4 Diversification of fishing method and reduction of mortality in shrimp PL fishery

Since the valuable coastal shrimp culture industry is dependent on wild seed, in the absence of hatcheries, and since this industry earns more foreign exchange than the capture fishery at present, it may not be possible at this stage to stop this fishery. So, with a view to catalyze reduced collection from Nature, some management measures which can be undertaken are discussed below:

6.4.1 Selective collection of tiger shrimp PL

The by-catch in the Tiger shrimp PL fishery is about 200 billion plankton. These are destroyed, with no benefitters, and result in reduced standing stock in the sea year after year. An alternate method of collection must be tried,targetting only tiger shrimp PL. For example, a water hyacinth type of method may be experimented within which particular shrimp larvae will stick to a flora introduced. This will save much of the bycatch.

6.4.2 Reduction of induced mortality of PL

Upto 60 per cent of the PL collected from Nature die during sorting, transporting and stocking, forcing harvests of PL from Nature. If this mortality could be reduced substantially, 50 per cent of the PL could be left behind in the sea to give enhanced production. Strong extension and motivation campaigns are necessary for this.

PL's are overstocked in ponds for no substantial gain. So fishing for PL in the months other than the peak stocking season should be restricted.

6.4.3 Rapid development of *Bagda* hatcheries

At present, now 98 per cent of the shrimp culture industry is dependent on natural seed. Only two private hatcheries are in production. Many more hatcheries are needed to support the rapidly expanding culture industry. Transition to semi-intensive farming should not be permitted without the direct support of hatcheries. Otherwise both the goose and the golden eggs will undoubtedly disappear.

6.5 Expansion and extension of fisheries sustainability at present

Some fisheries are at present biologically sustainable, but their distribution and the effort in them is limited. Expansion of these fisheries may give enhanced and sustainable production as well as create room for rehabilitation of the ESBN fisherfolk.

6.5.1 Expansion and extension of the trammel net fishery

The trammel net fishery has proved to be the biologically most sustainable fishery. At present this fishery is in operation at Teknaf coast only. Feasibility and technical demonstration of this gear in the western part of the coast may help expand this fishery in the other areas to produce more fish and would enhance economic as well as socio-economic benefits.

This gear is presently operated with traditional country boats and hence cannot go far. There is need to extend this fishery vertically upto 40 m depth of water and there is room for such expansion. But it would need study on the biological and economic feasibility and hopefully would add to the sustainable increase in production and would create an alternate source of income for the ESBN fisherfolk. Technological improvement may also be required.

6.5.2 The Bottom Longline (BLL) fishery

Bottom long lining for croaker off the Cox's Bazar coast has created a good employment opportunity for the fisherfolk in that area. This is an export oriented venture and very feasible (Huq et *al.* 1993). This fishery needs to be expanded in the other areas of the coast as a substitute employment for the ESBN fishermen, as well as to produce more fish.

6.5.3 Expansion of the marine behundi (MSBN) fishery

The marine behundi fishery is a seasonal activity and localized in Sonadia (Cox's Bazar), Dubla (Khulna) and Sonarchar (Patuakhali). This fishery catches a good percentage of pre-adult shrimps, but its target species is ribbonfish and Bombay Duck which are harvested mainly in the adult phase. Some of the larger ESBN may be encouraged to operate in deeper waters from other island bases (eg. St. Martin Island) with mechanized boats in order to reduce effort in the ESBN fishery.

This fishery has recently turned export-oriented and new-comers are joining in every year. It would be necessary to take immediate steps to stop new entry and utilize the space for partial rehabilitation of the ESBN fishery.

6.6 Management of the industrial trawl fishery

Optimum fishing effort for MSY is more than 7000 standard days, but the effort at present is at least 1000 days less than that. If the ten inefficient trawlers are made efficient, effort will be at optimum level or else new effort would need be added. One shrimp trawler is equivalent to 3.5 fish trawlers in terms of shrimp catch efficiency. So 1000 standard days is equivalent to four shrimp trawlers or 14 fish trawlers. If all the trawler effort is converted to finfish trawlers, it is estimated that the total production of both finfish and shrimp would be at MSY level. The benefit would be mainly in the assurance of landing all whitefish caught, because fish trawlers hardly make any discards. As a result, an additional amount of at least 50,000 t, of fish would be landed.

The present rule for season closure must be implemented to ensure breeding in the peak season and the 40 m depth zone restriction should be enforced strictly to facilitate post-juveniles being recruited as adults.

6.7 Prospect for development of new resources

Competition has increased over the years for investment in the demersal and artisanal fisheries sectors, both of which are already overburdened, while the pelagic resources, e.g. the Tuna and Tunalike fish resources have remained untapped. *Hilsa* is the only pelagic species categorized are present in the fish catch statistics of Bangladesh. Eight species of Tuna and Skipjack (Khan, 1983, 1995) and a number of potential species of Mackerels, Shark, Ray, Sardines, Anchovies, Shad and several species of cephalopods, Soles and flat-fish, lobster etc. are available in Bangladesh waters (Rahman et al., 1995). Development of these resources will open a new era for the Bangladesh fisheries sector, to boosting production sustainably. But a detailed survey and assessment of stock and MSY would be necessary, along with feasibility and technological demonstration, for transfer to the private sector.

7. ECONOMIC ANALYSIS PERTAINING TO SUSTAINABLE DEVELOPMENT

Being encouraged by the positive indication of the yield as well as the belief revenue per recruit in the trammel and trawl fisheries that in the ESBN fisheries, a 'long-term prediction' analysis was done with a view to find the comparative economic gain from various fisheries if only one is allowed to operate and all the other fisheries are suppressed, or if only the ESBN is suppressed and the others allowed to operate as they are.

The analysis indicated that if the trawl fishery is kept and all other interactive fisheries (but not pushnet) are suppressed, there would be substantial gain in weight and about 300 per cent gain in value of the catch, while there would be 250 per cent gain in value of the catch. There would be 250 per cent gain in value of the catch if only ESBN fishery is not in operation.

On the other hand, trammelnet showed an extremely high gain (about ten times) in revenue when all fisheries (including trawlers, but not the pushnet fishery) are suppressed, but a smaller gain in yield and a large gain in revenue (300%) if only the ESBN is suppressed.

So, from different magnitude analyses, it is evident that withdrawal of the ESBN fishery would not only maintain a healthier stock but would give a substantial difference in economic return. The pushnet (larval) fishery was kept out of this analysis because data necessary for such analysis were not available. But since about 95 per cent of the exploited population is taken by the larval fishery alone, suppression of this fishery would definitely give a manifold higher economic return. This perception would definitely lead fishery managers/planners to avail of the opportunity to achieve manifold higher economic returns from the same stock by only changing the traditional fishing attitudes.

8. LEGAL AND INSTITUTIONAL FRAMEWORK

8.1 Marine Fisheries Ordinance 1983 and the present situation

In 1983, the Government of the Peoples Republic of Bangladesh enacted the Marine Fisheries Rules, 1983, in accordance with the provisions of the Marine Fisheries Ordinance, 1983. Under the provisions of the Ordinance. the Marine Fisheries Wing of the DOF is authorized to deal with matters relating to marine fisheries exploitation, including licensing and monitoring of operations of fishing vessels. The Marine Fisheries Rules amended in 1993 provide for licensing and monitoring of artisanal mechanized fishing boats as well. Under the Ordinance, the officers of the Marine Wing of the DOF have been empowered to check, seize or take appropriate action required for surveillance and enforcement of the rules of the ordinance. These activities are performed from the Marine Fisheries checkpost established under the DOF Marine Wing at Patenga bay front, Chittagong.

The Ministry of Industry is currently authorized to accord permission in consultation with the MOFL, for the acquisition of fishing trawlers. The mechanized fishing vessels are registered with the Mercantile Marine Department (MMD). To patrol the EEZ, the DOF has procured two modern gunboats and placed them under the operational control of the Bangladesh Navy. Besides the MOFL, other ministries directly involved are the Ministry of Land, Ministry of Industries, LGRD and MOEF.

8.2. The agencies and institutions involved in development and management of the marine fisheries resources

Fisheries administration and management primarily remain under the control of the MOFL, headed by a cabinet minister. The Department of Fisheries (DOF) is the key organization responsible for development and management of fisheries. The Bangladesh Fisheries Development Corporation (BFDC) was established in 1964 with a view to promoting the fishing industry and developing landing, preservation and processing facilities, particularly in the marine sector. A part of the survey and exploratory work was once included in the mandate of the BFDC, but is now carried out by the Marine Fishery Survey Project, DOF.

The Fisheries Research Institute (FRT) was established in 1984, as an autonomous body under the administrative control of the MOFL. Research stations and ancillary facilities of the DOF were, subsequently, transferred to the FRI by an administrative order of the Government. The mandate of the FRI is to plan and undertake adaptive research programmes to develop suitable technology for fish farmers and fishery managers (Rahman, 1993). But survey work producing information on resource monitoring and management remains with the DOF for practical reasons. This work is at present done by a permanent set up of the DOF, called the Marine Fishery Resources Management and Monitoring unit. The unit is based in Chittagong and has two marine and brackishwater research vessels and other equipments.

Several NGOs and fishermen’s cooperatives are involved in marine fisheries development activities in the country. The Bangladesh Jatiyo Matshyajibi Samabay Samity (BJMSS), for example, had direct involvement in marine fisheries development, but is now ineffective. Among the NGOs, Codec, Caritas, and Proshika-MUK are directly involved in the development of the coastal fisher-folk community.

8.3 Infrastructure and service facilities

Infrastructural and service facilities are inadequate. In the absence of proper landing centres artisanal fishermen land their catches at scattered places which do not have processing, marketing or fast transportation facilities. Only the industrial trawler fleet (public and private) lands at defined places. Some of the mechanized boats catching Hilsa land at a few landing centres of the BFDC. The other private landing places do not have adequate ice, freshwater, berthing bunkering facilities. The BFDC operates four landing centres, in Cox’s Bazar, Khulna, Barisal and Patuakhali. It has modern landing, preservation, ice, water, berthing and bunkering facilities at Chittagong when it uses it for its own fleet. It also extends services to private operators. Such landing centres need be developed in every coastal district and in other important landing areas.

8.4 Institutional strength for fisheries development, management and research

The DOF Marine Wing has two establishments. One is for survey and monitoring and to provide management information. But its few scientific staff are hardly enough to carry out the task of operating two research vessels as well as do land-based work for routine collection and processing of industrial, semi-industrial and artisanal, statistical and biological data. The other establishment is the law enforcement and legislative unit. This too does not have adequate manpower or training to undertake its task along the entire coastline, particularly in respect of the marine artisanal fishing operations. The BFDC's activities have been reduced over the last decade and it now maintains only the previously established facilities, which provide hardly any opportunities for further development. The FRI has two stations for marine and brackishwater research, one in Cox's Bazar and the other in Paikgacha, Khulna. The scientific staff is limited, and inadequate training and exposure limit proper programmes for marine and brackishwater research.

9. REVIEW OF THE RULES OF MARINE FISHERIES ORDINANCE AND RELATED ISSUES

9. I Need for revision of the rules of the Marine Fisheries Ordinance 1983

The Marine Fisheries Ordinance and subsequent rules were prepared more than a decade ago. Since then, more knowledge about the exploitation dynamics of marine fishery resources has been gathered. In the light of this knowledge and the changes in fishing pressure, as discussed in the text, certain amendments in the rules are called for.

— The provision exists (although not enforced) for a 30 mm codend mesh size limit for ESBN. At present, 8-12 mm mesh is used. Results of recent experimentation and investigation reveal that, the 30 mm codend would bring in no catch, as they target the juvenile. Further it will be non-remunerative for the fisher-folk and will also involve further cash investment for change with no benefit to, the fishers. So mesh size increase or improvement of gear design would not be helpful for management (Hansen and Mustafa, 1992). This is why the complete withdrawal of this gear from the estuarine habitat is necessary. This needs be included in the Marine Fisheries Rules.

— As an immediate measure for reduction of effort, ESBN operations in the Cox's Bazar district should be stopped during the July-September, and February-April period.

— Operation of LMD in shallow waters should be banned until further orders.

— The marine set bagnet should use 45mm codend mesh size.

— Net making/mending factories should produce nets not below 45mm mesh and they should be encouraged to make nets suitable for trammelnetting.

— Limitations should be imposed on the boatbuilding yards not to build boats (mechanized) for fisheries without the permission of the Government.

— Aging shrimp trawlers should not be replaced with shrimp trawlers, but with fish trawlers, in the light of the discussions in the text. (It was also a recommendation of the FAO/BOBP Seminar at Cox's Bazar, 1992).

— Rule 7, Clause h: (landing of 30 per cent of the total catch) is rather a vague term and also a very small figure. It needs to be replaced as "50 per cent of the fish catch, equivalent to five times of the shrimp catch", because a shrimp trawler's finfish by-catch is 8-10 times its shrimp catch.

— Rule 6 prescribes the licence fee for fishing vessels. Fees for resource monitoring and management (including operation of research vessels) should also be included, as this is now a routine and continuing programme under the revenue budget. Some recompense should now come from the beneficiaries.

9.2 Other related matters which interfere with resource management and surveillance work

Other management and legislative measures which are not under the direct control of the DOF/MOFL need interministerial and interdepartmental decisions and arrangements. Some of these measures which deserve special attention are discussed here.

- There are waterbodies under the control and ownership of the ministries other than fisheries. Some of these waterbodies/areas are directly ‘managed’ by administrative units such as the Ministry of Land, Department of Forests, and MOEF. These are revenue oriented managements which collect produce or lease the water areas. But since fisheries resources are a living renewable resource, biological management, based on research findings and scientific information, would be necessary, irrespective of which agency/organization owns the land, water or the fish. The Department of Fisheries must be entrusted with the responsibility for such management because it also has the capability to handle fisheries-oriented duties.

  As discussed earlier. various water development activities have altered much of the ecological habitat concerning fisheries, so any development or management activity (non-biological) in such waterbodies. for purposes other than fisheries, should be done only in close consultation with the MOFL/DOF to ensure a healthy environment for the growth of the fish population. A high power steering committee for **Integrated Coastal Zone Management,** with a respected position for MoFL/DOE, needs to be established.

- To minimize the degradation of the coastal environment by industrial, agrochemical, oil and other pollution, integrated research -- to qualify and quantify the toxic effect on fish -- needs be undertaken immediately, Such research should identify the pesticides which are not water soluble or do not have a toxic effect on aquatic life and limit the other brands of fertilizer and pesticides. Waste treatment facilities need be established in the coastal districts and rules need be reformulated to take care of aquatic life. Legislation must be improved. Co-ordination is necessary between the MoFL and MOEF.

- Mangrove afforestration programmes should be undertaken jointly by the DOF and DOF (Forest) to save the environment from further degradation.

- In the Marine Fisheries Ordinance subsequent rules have been made for licensing of artisanal fishing boats by the DOF. The Mercantile Marine Department (MMD) deals with the registration. But it is evident that all boats are not registered and there is no enforcement to make them comply The MMD also looks after the safety of life at sea and issues vessel health certificates after checking the safety equipment. Fishermen, it is reported, are not interested in observing formalities of registration and licensing with two similar departments. The DOF has the capability to check craft health and safety equipment. The two functions need to be put under the DOF for easy monitoring and enforcement.

- There are gear and area conflicts between artisanal and industrial fishermen. There are reports of sea piracy and resource use conflicts. The Coast Guard is required to solve these problems.

10. NEED FOR INSTITUTIONAL STRENGTHENING AND INFRASTRUCTURAL DEVELOPMENT

Resources survey, research, monitoring, surveillance and management in the area of marine fishries is a very big task, involving activities not only within the sector but also with other sectors. So the capabilities of the organizations under the MOFL, particularly in respect of marine and brackishwater fisheries, need to be strengthened greatly.

10.1 Department of Fisheries (DOF)

The DOF performs two main functions in respect of marine fisheries viz:

- It does resource assessment, monitoring of the fishing dynamics and stock assessment for sustainable gear development and expansion. The findings of this routine work enables the DOF to offer continuous advice to fisheries planners on the options and strategies for management available to them.
- The DOF implements and enforces the rules under the Marine Fisheries Ordinance 1983. To do this, the DOF has two units, but these are managed by a limited scientific and enforcement staff. which is inadequate for the present task, leave alone any expansion in the future.

The Marine Fisheries Resources, Monitoring and Management Centre has recently decided to established a permanent set-up. The proposal document identifies some urgent programmes for facilities and manpower that will enable the entire coastline, as well as the EEZ to be covered. Implementation of the proposal will help strengthen the resource assessment and management capacity of this centre. At present the DD(M) is given the task of licensing mechanized boats, but its manpower is inadequate for the job. To date, only 1000 boats have been licensed, licences for the rest are delayed due to shortage of manpower. A separate directorate of marine fisheries would be needed to enhance the expansion and comprehensive planning of the marine fisheries sector. The FAO proposal for marine wing strengthening may be reviewed and considered. The proposal identifies the manpower and facilities required to strengthen the marine wing of the DOF.

10.2 Bangladesh Fisheries Development Corporation (BFDC)

Once, the BFDC was a very capable and active organization. It was virtually the major contributor to the development, modernization and industrialization of marine fisheries. Over the years. however, its activities have been reduced. But the recent construction by BFDC of a most modern mechanized boat landing centre in Chittagong (Manoharkhali) with landing, marketing, bunkering and berthing facilities, is considered an important contribution to marine fisheries. Two more landing centres of this type, one at Khulna and the other at Barisal are necessary. In addition to BFDC’s four landing centres in Cox’s Bazar, Khulna, Barisal and Patuakhali, landing centres with facilities for berthing, bunkering, ice, water and preservation, should be established in each coastal district. These landing centres can house a unit of the DOF Marine Wing for catch monitoring and data collection and to serve as a checkpost. After such development, all mechanized boats should be asked to land their catches at designated landing centres. If such centre facilities are available the boats would be happy to follow the rules imposed. In this regard, Government should consider extending help for the modernization of some of the busier private landing centres particularly those under the BJMSS. It should also establish checkposts at these landing centres.

The only industrial fisheries landing centre is the BFDC's and it is known as the Chittagong fish harbour. It was started with the most modern facilities for its own fleet as well as for private trawlers. But the basin is now silted up. and. as a result, easy movement of vessels has become a problem. It needs thorough dredging every year to keep it workable. Major excavation and modification is required for free water movement to lower the siltation rate. This basin should be reconstructed for multipurpose functions, such as to serve as a beaching yard for seized foreign trawlers and as a cyclone shelter for public as well as private trawlers, in addition to its primary objectives. The Chittagong fish harbour has good facilities for a marine workshop and slipway for docking trawlers and other vessels. These facilities are at present being utilized on a reduced scale. They too need strengthening and modernization.

10.3 Fisheries Research Institute (FRI)

The FRI Brackishwater Station, Paikgacha, Khulna, and the Marine Fisheries Research Station at Cox's Bazar were established to undertake brackishwater and marine fisheries research, respectively, with a view to generating basic scientific information to feed back to the stock assessment programme and enable management and development of the two fisheries. But due to inadequacy of scientific staff and lack of training in these fields the research programmes have greatly suffered, and the institute, particularly the Marine Fisheries Station, has not been able to launch an openwater research programme to fulfil the objectives desired.

Initially (as per the Project Proposal - PP of FRI) the marine fisheries research establishment of the DOF at Chittagong and Cox's Bazar were supposed to be transferred to the FRT Marine Fisheries Technological Station, Cox's Bazar, with all manpower and facilities. This was only partly implemented, i.e. the Cox's Bazar campus including the laboratory and functional building of DOF, was transferred to the FRI. It should be mentioned that the DOF has no laboratory and functional building of its own in Chittagong. There probably remained a gap in the PP about the need for all establishments of the DOF marine survey and research, including the research vessels, equipment and manpower, to be transferred to the FRI, whereas the need for the DOF for a unit for marine resources survey and stock monitoring for instant management advice. was not felt during the preparation of the PP and. hence, the execution suffered. Thus the FRI was put into a difficult situation. for it could neither avail of the DOF's research vessel and trained manpower nor could it provide in the PP for its own set of research vessels, equipment and facilities. So the whole programme suffered badly.

IO.4 Need for marine and brackishwater fishery research and coordination

The basic and adaptive research pertaining to generating information for fishery management is the mandate of the FRI. while the stock monitoring survey. the catch assessment survey, diversified development support experimentation, and extension work lie with the DOF. Considering that the DOF would need the scientific staff and the research vessels and equipment for the stock monitoring survey and to generate routine advice as a continuous process for management dynamics, the FRI would need to establish a substation of its marine station in Chittagong, and procure oceanographic research vessels and equipment. A few DOF marine fishery biologists could be transferred to FRI on deputation for a limited period to initiate the openwater research programme.

It is necessary to identify the right work of both organizations to avoid the duplication observed an present. Oceanographic work and correlation with fishery abundance and biodiversity should be considered as an important task of the FRI.

The FRI needs to undertake studies on fisheries biology, fish distribution, migration and fish behaviour. Research on the selective collection of bagda fry and the causes and rate of fry mortality are essential.

Hatcheries are suffering from broodstock supply even though at present, broodstock is protected during the spawning season by rule. The point is the demand for brood is going to be very high. Research should be launched to produce broodstock under captive conditions, pollution and toxicity studies should be started and a socioeconomic survey of the fisherfolk community should be undertaken and the means of uplifting their socioeconomic condition through biologically and environmentally sustainable processes identified. NGOs could be involved in this work. The results of the study should be communicated to the DOF for extension work and for transfer of the technology to the private sector and to the fishermen.

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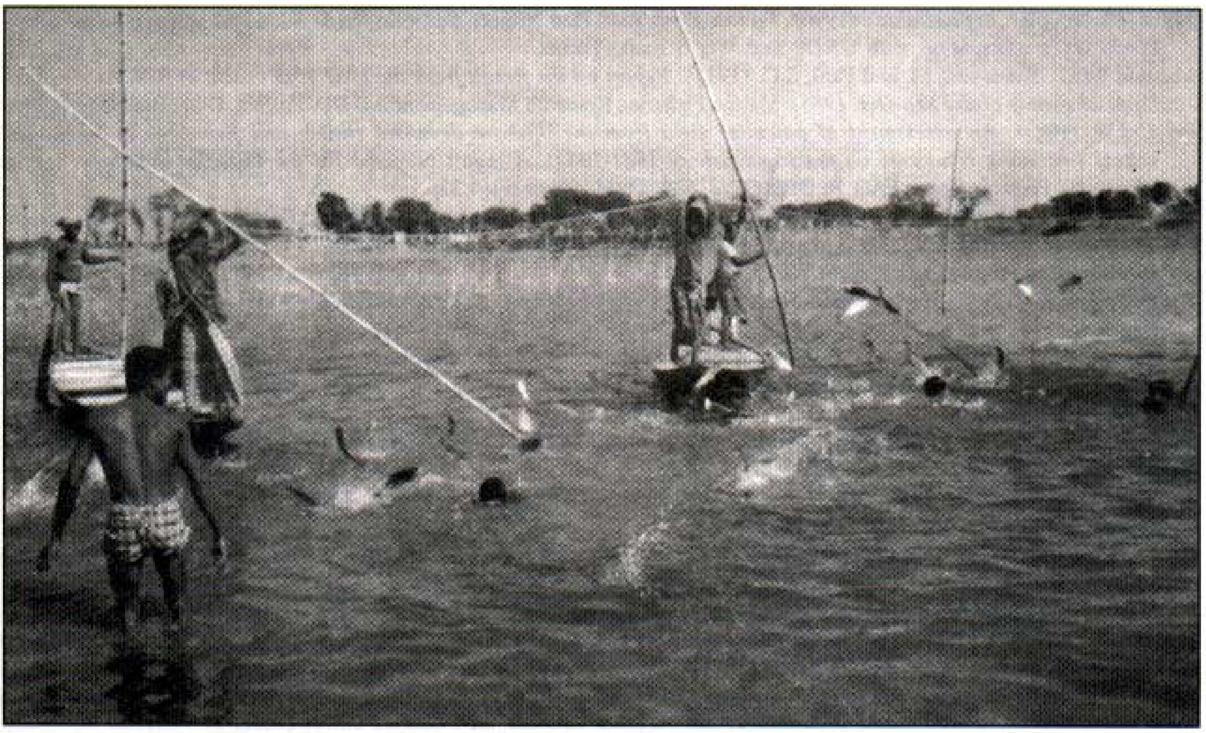

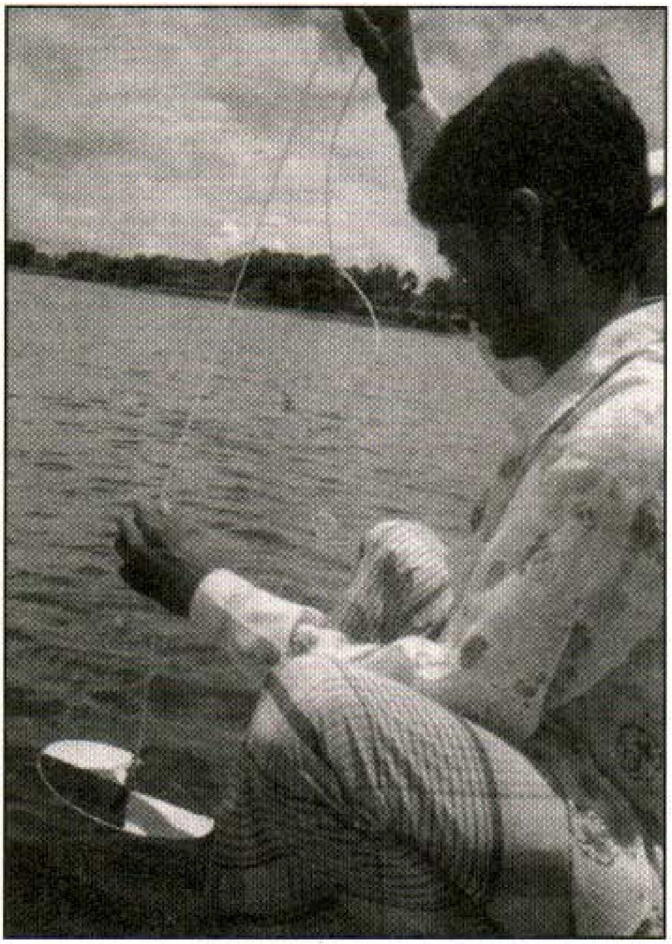

PAPER 3

FRESHWATER AQUACULTURE: POTENTIALS, CONSTRAINTS AND MANAGEMENT NEEDS FOR SUSTAINABLE DEVELOPMENT

by

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LIST OF ABBREVIATIONS AND ACRONYMS

ADB	=	Asian Development Bank
BFDC	=	Bangladesh Fisheries Development Corporation
CARE	=	Cooperative for Assistance and Relief Everywhere
CIDA	=	Canadian International Development Agency
CIRDAP	=	Centre for the Integrated Rural Development for Asia and the Pacific
DANIDA	=	The Danish International Development Agency
DOF	=	Department of Fisheries
FAO	=	Food and Agriculture Organization of the United Nations
FCD	=	Flood Control and Drainage
FCDI	=	Flood Control, Drainage and Irrigation
FRI	=	Fisheries Research Institute
GOB	=	Government of Bangladesh
ICLARM	=	International Centre for Living Aquatic Resources Management
IDRC	=	International Development Research Centre
MOA	=	Ministry of Agriculture
NACA	=	Network for Aquaculture Centres in Asia-Pacific
NGO	=	Non-Governmental Organization
ODA	=	Overseas Development Administration

SUMMARY

For a sustainable aquaculture development the three inter-related aspects are:

— Production technology;

— Socioeconomic factors; and

— Environmental factors.

Sustainable aquaculture in Bangladesh has the potential to serve as a strong economic tool for rural development, ensuring social justice.

The detailed study of the various factors involved in freshwater aquaculture development reveals that the fish culture potential in Bangladesh is very high. The climate is generally favourable and the water area is extensive. There is always a market demand for fresh fish, enticing pond owners towards aquaculture venture. There is scope for increasing aquacultural production through semi-intensive or intensive culture technologies. Better lake management is now possible for ox-bow lakes. There are educational institutes to produce senior, trained, manpower. There are Governmental and non-Governmental organizations for effective transfer of technologies. Funds for aquaculture credit are also available.

Ponds and *baors* have mainly been included in this paper, as waterbodies which are aquaculturable for freshwater fish. Only occasional references have been made to waterbodies in the FCD/FCDI areas.

Despite the fact that the country has good freshwater aquaculture potential, this potential could not be fully utilized for various reasons. It has not been possible to bring many under aquaculture. The production rate is still far below than what it is in China and other South-East Asian countries. Similarly the majority of the ox-bow lakes could not be brought under improved management systems for various reasons. An effective management system is yet to be developed for the FCD/FCDI areas and burrow pits. To some people the main problem is biological or technological, to others it is socio-political or legal. After a detailed study, it appeared to the authors that in almost all the factors of development. there is ample scope for improvement. These are: natural resources; aquaculture technology and technology transfer; processing and marketing; fry and fingerling production; environment and disease; feeds and ferlilizers; credit; human resources development; administrative needs of the organizations involved, etc.

Since the development process is an interplay between objectives, resources and measures, a careful analysis of the present situation in the country in all these has resulted in pointing out some management and other measures required to be taken.

To understand the management needs a bottom-up approach has been made : farmer’s needs (technology, training and credit) are at the top and at the bottom are the universities which produce the required senior manpower. In between these two are the major activities that unite them in the overall aquaculture development process. Expected responsibilities to be carried out by different concerned organizations have been discussed and discrepancies pointed out.

The following recommendations are made:

a. Strategic: Besides some pertinent policy issues, it has been suggested that the freshwater aquaculture development process should adopt a phase-wise planning and implementation strategy. In the first

phase (1996-2000) the target for the total production, from ponds and *baors,* has been set at 3.7 million tons (the 1993 production figure is slightly over 2.0 million tons). The same has been set at about 5.5 million tons at the end of the second phase (2001-2005). Average national productivity rate in ponds in these two phases is expected to rise to 2500 kg/ha/yr and 3700 kg/ha/yr, respectively, from the 1993 productivity rate of 1367 kg.

b. Imolementational: Recommendations have been made in order to achieve the above stated targets in the specific fields of human resources development, research, transfer of technology, credit, fry and fingerlings, feed, fertilizer, better use of natural resources, and management needs.

Regarding management needs, two recommendations have been made, which are :

i) The expected role of different organizations involved in aquaculture development should be clearly defined and followed (detailed discussion, and suggestions are made in Chapter-4)

ii) The Department of Fisheries should play a stronger role in the aquaculture development sector and reorganize/rebuild its management wings (detailed discussion, and suggestions are made in Chapter-4)

c. The concluding recommendation seeks:

A national workshop to be convened as soon as possible, as a follow-up action to the present seminar, to work out details of the following to meet the impending challenge of phase-wise planning and implementation (Phase- 1: 1996-2000):

— Immediate short-term research and management needs.

— All kinds of inputs/assistance needed, including fingerlings and credit, and the measures to be followed to make these available.

— Training needs.

1. INTRODUCTION

Sustainable aquaculture systems should be viewed in terms of three interrelated aspects:

— production technology;

— socioeconomic factors; and

— environmental factors, as depicted in Figure 1 below (after Anon 1987).

Figure 1. Interrelationship among various aspects of sustainable aquaculture system.

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The contribution which aquaculture already makes to the total fish production of Bangladesh is not insignificant, 237,743 tons or 23.29% of total production (DOF 1993), but as vast possibilities are as yet not fully utilized, it is the authors' contention that when properly planned, coordinated and integrated, expansions and improvements in the field of aquaculture will assist greatly in achieving the aims of rural development.

2. POTENTIALS OF FRESHWATER AQUACULTURE

2.1 Resource potential

2.1.1 Natural resources

Bangladesh, located as it is in the delta of three mighty rivers : the Ganges, the Brahmaputra and the Meghna, has vast inland water resources in the forms of ponds, heels and haors (natural depressions), baors (ox-bow lakes), canals, rivers, flood plains, reservoirs and impounded brackishwater. The inland water resources of Bangladesh can be divided into the following categories:

1. OPEN INLAND WATERS

— Rivers, streams and canals, including estuaries,

— *Beels* and haors

— Lake Kaptai

2. CLOSED WATERS

— Ponds

— Ox-bow lakes, or baors

— FCD/FCDI areas and burrow pits
— Coastal aquaculture (brackishwater)

3. SEASONAL WATERS

— Flood plains
— Inundated paddy fields

Open inland and seasonal waters consist mainly of capture fishery and closed waters, mainly of culture fishery. The present paper deals with closed waters only, excluding coastal aquaculture. The extent of each of the different types of closed waters is detailed below:

Ponds

Bangladesh has got a large number of ponds scattered all over the country . The total area of freshwater ponds is about 0.15 million ha, representing 3.53 per cent of total inland water resources excluding FCD/FCDI and burrow pits. The size of the individual ponds varies between 0.02 ha and 20 ha. The total area of ponds by region are presented in Table 1. The DANIDA experience in the Mymensingh region, however, suggests that the actual number of ponds could be well over 1.6 million instead of about 1.3 million ponds as is presently known. SPARRSO (1984) estimated the area of derelict, cultivable and under-cultivation ponds to be about 43 per cent, 30 per cent and 27 per cent respectively. After about ten years, these percentages have tilted considerably towards under-cultivation ponds, now being 17per cent, 31per cent, and 52 per cent respectively (DOF 1993).

Table 1: Total area of ponds in different regions of Bangladesh

Region	Area (ha)	per cent of total area
Barisal	11,765	8.01
Bogra	5,677	3.86
Chittagong	14,306	9.74
Comilla	13,551	9.22
Dhaka	6,862	4.67
Dinajpur	9,589	6.54
Faridpur	6,322	4.30
Jamalpur	1,435	0.98
Jessore	7,152	4.87
Khulna	5,384	3.67
Kushtia	1,532	1.04
Mymensingh	8,839	6.02
Noakhali	11,211	7.63
Pabna	7,405	5.04
Patuakhali	6,601	4.49
Rajshahi	14,798	10.07
Rangpur	3,933	2.68
Sylhet	9,077	6.18
Tangail	1,485	0.99
Total	146,897	100.00

Source : DOF 1993.

Baors or Ox-bow Lakes

In the southwest region of the country, some of the meandering rivers, becoming old, changed their courses and, in the process, left ox-bow bends, which got cut-off from the main river courses and became isolated, forming baors or ox-bow lakes.

There are 37 large ox-bow lakes, covering an area of about 4000 ha, and 50 smaller ones in Jessore. Kushtia, Faridpur and Khulna. Most of the larger ox-bow lakes are located in the Jessore region. The distribution of ox-bow lakes in different regions are given in Table 2. Ox-bow lakes range in size from about 25 ha to a maximum of 500 ha (Hasan 1990).

Table 2: Distribution of ox-bow lakes in different regions

Region	*Area (ha)*	*Per cent of total area*
Faridpur	965	17.58
Khulna	331	6.03
Kushtia	1,458	26.57
Jessore	2,734	49.62
Total	5,488	100.00

Source : DOF 1993

FCD/FCDI areas and **burrow** pits

The total area under this component is estimated to be 0.7 million ha, of which 7000 ha area is now under being developed under different projects for integrated aquaculture. Data regarding the area of waterbodies under burrow pits could not be obtained. (Details of FCD/FCDI areas may be found in the paper by Ayenunnishat (?)).

2.1.2 Aquacultural technologies

A total of 257 species of fish have so far been recorded in the freshwaters of Bangladesh (Rahman 1974). It is estimated that about 200 of these species are truly freshwater forms (Islam 1989) and the rest are estuarine and marine forms that enter rivers and other freshwater areas during certain periods of their lives. With the exception of a few, most of the 257 species are available in the impounded waterbodies. However, at present, only major Indian carps, such as Catla (Carla catla), Rohu (Labeo rohita,) Mrigala *(Cirrhinus mrigala)* and Kalbashu (Labeo calbasu), along with exotic carps such as Silver carp *(Hypophthulmichthys molitrix),* Grass carp *(Ctenophuryngodon idellus)* and Common carp *(Cyprinus carpio),* are commonly cultured in a polyculture system in ponds. The other two Chinese carps, Bighead carp *(Aristichthys nobilis)* and Black carp *(Mylopharyngodon piceus),* are also cultivated, but to a lesser extent. Very recently, African catfish *(magur),* and freshwater prawn *(Macrobrachium rosenbergii)* have received considerable response from aquafarmers. There are some other species, too, which are occasionally cultured.

Tilapia *(Oreochromis niloticus)* and Silver barb (Puntius *gonionotus)* are cultured in small waterbodies, **such as** ditches, and shallow ponds and burrow pits.

Indian major carps, Chinese carps, catfish and small indigenous fish are grown in ox-bow lake aquaculture.

The species cultured in Bangladesh freshwaters are summarized in Table 3.

Table 3: Species cultured In Bangladesh and their culture systems

Species	*Common name*	*Culture system*	*Intensity*
Freshwater Fish			
Catla catla	Catla	Pond/Baor culture	Ext/Semi/Int
Cirrhinus mrigala	Mrigala	Pond/Baor culture	Ext/Semi/Int
Labeo calbasu	Kafbashu	Pond/Baor culture	Ext
Labeo rohita	Rohu	Pond/Baor culture	Ext/Semi/Int
Ompok pabda	Butter catfish	Pond culture	Semi
Pangasius pangasius	Pangas, catfish	Pond culture	Semi
Pangasius sutchi	Pangas, catfish	Pond culture	Semi
Clarias batrachus	Asian catfish	Pond/Baor culture	Ext/Semi/Int
Clarias gariepinus	African catfish	Pond culture	Int
Heteropneustes fossilis	Shingi catfish	Pond culture	Ext
Hypophthalmichthys nobilis	Bighead carp	Pond/Baor culture	Semi/Int
Ctenopharyngodon idellus	Grass carp	Pond/Baor culture	Semi/Int
Cyprinus carpio var. Comminus	Common carp	Pond/Baor culture	Semi/Int
Cyprinus carpio var. *Specularis*	Mirror carp	Pond/Baor culture	Semi/Int
Hypophthalmichthys molitrix	Silver carp	Pond /Ricefield	Semi/Int
Mylopharnygodon piceus	Black carp	Pond/Baor culture	Semi/Int
Puntius gonionotus	Minnows	Pond/Baor culture	Semi/Int
Oreochromis niloticus	Nile tilapia	Pond Rice-field/cage	Semi/Int
O.mossambicus	Red talapia	Pond/Rice-field/Cage	Semi/Int
Amblypharyngodon mola	Mola	Pond culture	Semi/Int
Freshwater Shellfish			
Macrobrachium rosenbergii	Giant f.w. prawn	Pond/Ricefield	Ext
Macrobrachium matcolmsoni	Monsoon river-prawn	Pond/Ricefield	Ext
Lamellidens marginalis	Freshwater clam	Pond culture	Int

Several aquaculture systems have been successfully operated in Bangladesh, although not all of them of equal intensity. The systems include :

1. Carp (both Indian and Chinese) polyculture without galda *(Macrobrachium rosenbergii)*
2. Carp (both Indian and Chinese) polyculture with galda
3. Integrated fish (fish-cum-duck/chicken) farming

4. Rice-cum-fish farming

5. Artificial breeding and culture of African catfish (Clarias gariepinus)

6. Culture and seed production of galda in ponds

7. Culture of nilotica and red tilapia

8. Culture of *magur (Clurius butruchus), pubdu (Ompok pubdu),* gulsha *(Mystus cuvusius)*

9. Culture of *raj punti (Puntius* sp)

10. Artificial breeding and culture of *pungas (Pungusius sutchi)* in ponds (mono and mixed culture)

11. Cage and pen culture

12. Mono and mixed culture in seasonal ponds

13. Culture of *molu (Amblyphuryngodou mola)* and *dhelu (Danio rerio)* with carp

14. Artificial propagation of *Macrobrachium rosenbergii* in backyard hatcheries

15. Induced breeding of major carps

16. Feed development

17. Nursery operations for glada, major carps, catfish (local and exotic)

18. Genetic considerations in hatchery stocks

19. Rice-cum-shrimp farming

20. Improved *buor* management, etc.

2.1.3 Processing and marketing

In Bangladesh's freshwater culture fishery, the main processing activities involve drying and icing, both as a means of prolonging shelflife of the harvested fish, although people predominantly favour fresh fish or unprocessed fish. The process of drying also adds a piquant flavour. which is again liked by a good number of consumers. Icing is practised on a very limited scale.

Maintaining the quality of harvested cultured freshwater fish has, so far, not proved to be a problem. The quality control mechanism for exported marine and coastal products, including shrimp, is well-established in the country, but for domestic marketing of fish there is no such system. Surveillance of fish markets by government officials is only sporadic. This is mainly because of the scattered locations of the ponds and their closest markets, where the harvest is, generally, consumed.

2.1.4 Spawn/fry and fingerlings

Effective technologies are now available for commercial production of carp and catfish. Breeding technologies for major carps and catfish, specially African *magur,* have now been fully accepted at the field level. Breeding technology of galda is known and, besides Government effort, some private entrepreneurs are going in for this business although the commercial viability is yet to be achieved.

Data on production of African magur fry could not be obtained. The other major source of aquaculture, and by far the largest one, the carp spawn/fry, is the most important factor in determining the success of freshwater culture. Millions of eggs and spawns are collected from the rivers during the monsoon (April-August). They are mostly found in the Padma - Brahmaputra river system (i.e., Padma, Jamuna, Aria1 Khan, Kumar and old Brahmaputra rivers) and the Halda river in Chittagong. Carp spawn/fry are collected from the Padma-Brahmaputra river system, whereas fertilized eggs are collected from the Halda river.

In 1993, the spawn collection in Bangladesh was estimated to be 3439.93 kg from the Padma-Brahmaputra river system, 1629.12 kg from the Halda river and 48,964.22 kg from all hatcheries; they contributed respectively 6.37 per cent, 3.01 per cent, and 90.62 per cent of the total spawn supply (54,033.27kg) for aquaculture in the country (Table 4).

Table 4: Production of carp hatchlings in Bangladesh (1993)

Production sources		*Quantity of hatchling produced (Kg)*	% total production
A. Natural sources		5069.05	9.38
B. Artificial sources		48,964.22	90.62
(i) Govt. hatcheries	*2583.00*		
(ii) Fisheries Research Institute	*680.22*		
(iii) Private hatcheries	*45,701 .00*		
TOTAL	48,964.22	*54,033.27*	*100.00*

Source : DOF 1993

Although modem techniques of fish seed transportation — in polyethylene bag filled with oxygen and in fish hauling tanks with agitator and oxygen supply — are practised in large hatcheries and fish seed multiplication farms, the major quantity of fish seed are transported by indigenous methods.

Together with the growth of carp hatcheries, there has been a major expansion of private nursery operations in different parts of the country. Hatchlings, collected from natural sources or produced by induced breeding, are reared for one to three months in earthen rearing ponds to a size of about 6-12 cm before being sold. Apart from private nursery operators, fingerlings are also being produced in different Government Fish Seed Multiplication Farms.

2.1.5 Human resources

2.1 5. 1 TRADITIONAL VALUES

The Bangla proverb *Mache bhate hangalee, i.e.,* a Bengali thrives on fish and rice, amply demonstrates the tremendous social value of fish in Bangladesh. Unlike many developed and developing countries of the world, the demand for fish is always there. There is no need for advocacy for fish consumtion, as a sizeable and permanent market is there. An overwhelming majority of the people in Bangladesh like almost all the culturable freshwater fish species.

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2.1 5.2 HUMAN RESOURCE DEVELOPMENT

A good number of institutes in Bangladesh are engaged in imparting aquacultural education and training to the intended persons as summarised in Table 5.

Table 5: Fisheries education and training programmes in Bangladesh

Institution	*Course title*	*Duration*	*Course details*
Certificate, diploma and training programmes			
Fisheries Training Institute, Chandpur, DOF	In-service training Certificate	Variable l-3 months	In-service training on fish culture management and administration for Fisheries Officers
Fish Hatchery and Training Centre, Raipur, DOF	Certificate	—	Fish culture and hatchery technology
Fisheries Training Centre, Faridpur, DOF	Certificate	—	Fish culture and fisheries management
Agricultural Extension Training Institute: 12 centres at different places in Bangladesh. MOA	Certificate	1-3 months	Training on fish culture as one of the components of Agriculture for farmers and Agricultural Officers
Marine Fisheries Academy, Chittagong, BFDC	Diploma/ Certificate	1-2 years	Training on marine fisheries, including navigation, marine engineering, electrical engineering, refrigeration engineering, radio and operation, trawl operation, fish processing and as boatswain.
Vocational Youth Training Centres	Diploma/ Certificate	—	Aquaculture
Undergraduate and postgraduate degree programme			
Faculty of Fisheries, Bangladesh Agricultural University	BSc. Fisheries (Honours)	4 years	A professional degree course covering all aspects of fisheries
Faculty of Fisheries, Bangladesh Agriculturral University	MSc. (Fisheries) in Fisheries Biology & Limnology, Aquaculture & Management, Fisheries Technology	1 year	Postgraduate degree programme by course work and research
Institute of Marine Science, University of Chittagong	M.Sc. (Marine Biology)	2 years	Postgraduate degree programme by course work and research
Department of Zoology, Universities of Dhaka, Rajshahi and Jahangirnager	M.Sc. (Zoology) in fish group	1 year	Postgraduate degree programme by course work and research or only by course work

2.1 5.3 ORGANIZATIONS INVOLVED IN AQUACULTURAL RESEARCH

There are three major types of research for the promotion of aquaculture, and they may be viewed in sequential stages in an essentially farming systems framework. They are:

— Situation appraisal

- The development of appropriate technology, and
- The dissemination of technology to farmers.

Research of all three types is required to develop sustainable aquaculture systems. The main task of conducting such research and development activities has been bestowed upon the Fisheries Research Institute. The Institute is an autonomous research organization linked administratively with the Ministry of Fisheries and Livestock of the Government of Bangladesh. Of its four research stations and two substations, the Freshwater Station located in Mymensingh is mainly concerned with freshwater aquacultural research.

Besides the FRI, universities, specially the Bangladesh Agricultural University, are involved in fisheries research, but on a limited scale. At BAU, the Faculty of Fisheries, as expected, is mainly concerned with fisheries research, but the Faculty of Agricultural Economics and Rural Sociology and the Department of Agricultural Extension (Faculty of Agriculture) are also conducting some important fisheries research, dealing mainly with the aspects of socioeconomics and transfer of technology. The Departments of Zoology in Dhaka, Rajshahi and Jahangimager Universities and the Institute of Marine Science, University of Chittagong also are involved in such research work. And Khulna University has become involved in fisheries research and education recently.

The Bangladesh Agricultural Research Council is the national body for co-ordination, monitoring, and evaluation of all aquaculture research, its fisheries wing in particular being charged with the responsibility.

In addition to these national bodies, some international organizations such as CIRDAP, FAO, ODA, DANIDA, World Bank, NACA, CIDA, TDRC and ICLARM are, to some extent, involved in action-oriented research programmes in the form of studies of different development aspects of aquaculture.

2.1.6 Environment

The climate of Bangladesh, in general, is very favourable for freshwater aquaculture. Except for the drought situation in the northwestern region of the country, mainly due to low rainfall and the negative impact of the Farakka barrage, and overflooding in some other parts, the country enjoys a congenial environment throughout the year to support aquaculture.

On the other hand, most types of freshwater aquaculture, it is felt, are not harmful to the environment. The impact of the production of phytoplankton, through all the aquacultural systems practised in Bangladesh, is enormously beneficial to the environment. The potentially negative environmental impacts of freshwater aquaculture consist essentially of its contribution to aquatic pollution.

Adequate information on the impact of environment on aquaculture and vice-versa is not available. Nevertheless, it is satisfying to note that the situation is changing very fast. Everybody related to the development of aquaculture is, nowadays, becoming more and more concerned and is trying to do something about it. Although how far we can balance our environment is the key question asked by all, the fact that the importance of understanding the environment is not being felt by all concerned is, undoubtedly a positive factor towards ensuring sustainable aquaculture development.

2.1.7 Organizations involved in aquaculture development

Several organizations in the country are involved in different degrees, in the various activities related to aquaculture. Universities head the list because they are responsible for producing senior trained

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manpower (teachers, researchers, planners, managers, trainers and. occasionally, farmers) through their formal educational degree programmes. Universities also conduct research and are also involved, to a lesser extent, in training, planning for aquaculture development, and extension. Vocational training centres, such as the Youth Development Training Centre under the Ministry of Youth, mainly produce farmers. They engage in training programmes and are, in this way, involved in extension. The Department of Fisheries (DOF) has responsibilities in planning. extension, and in providing in-service training. NGOs are generally involved in training. extension, and to a much lesser extent, in research. In recent years, NGOs in Bangladesh have been becoming a strong and effective medium for successful transfer of technologies and for providing credit for aquaculture. They have nine different types of fisheries programmes (Shah 1995). Pond fisheries is the most common. A considerable number of NGOs (29 per cent of those studied) have initiated hatchery/nursery components in their activities. The range of various fisheries activities has been found to be the widest amongst the international NGOs (e.g., CARE and CARITAS). Local NGOs are not able to cover more then two activites. Various international organizations sometimes act as funding sources, but in many cases, they are directly/indirectly involved in the aquaculture development and extension activities, too. Table 6 provides a list of the major organizations now involved in aquaculture development, in various ways in Bangladesh:

Table 6: List of major organizations and the nature of their involvement in freshwater aquaculture development in Bangladesh

	Organization	*Activities*
A.	**Government**	
1.	Department of Fisheries (DOF)	Development, management and extension
2.	Bangladesh Fisheries Development Corporation (BFDC)	Production (Kaptai lake) and marketing
3.	Bangladesh Agricultural Research Council (BARC)	Coordination, monitoring, and evaluation of aquaculture research
4.	Fisheries Research Institute (FRI)	Research,training and coordination
5.	Bangladesh Rural Development Board (BRDB)	Fisheries component of integrated rural development
6.	Bangladesh Academy for Rural Development (BARD)	Fisheries component of integrated rural development
7.	Land Administration and Land Reform Division	Leasing of public waterbodies
8.	Bangladesh Water Development Board (BWDP)	Leasing of reservoirs, irrigation canals and burrow pits
9.	Export Promotion Bureau	Export
10.	Bangladesh Sugar and Food Industries Corporation (BSFIC)	Processing
11.	Universities	Higher fisheries education
12.	Economic Relations Division	Administration of external aid for aquaculture development
13.	Commercial banks	Credit for fish culture
B.	**Non-Government**	Aquaculture extension and development (with or without supervised credit programmes)
1.	Bangladesh Rural Advanced Committee (BRAC)	
2.	Grameen Bank	
3.	CARITAS	
4.	Mennonite Central Committee (MCC)	
5.	Proshika Monobik Unnayan Sangstha	
6.	Association for Social Advancement	

7.	Gono Unnayan Prochesta	
8.	Uttaran	
9.	Jagorori Chakra	
10.	Thengamara Mohila Sobuj Sangha (TMSS)	
11.	Rangpur Dinajpur Rural Services (RDRS)	
12.	Gandhi Ashram Trust	
13.	Centre for Alleviation of Rural Poverty (CARP)	
14.	CARE, etc.	
C.	**International**	Mainly aquaculture extension, development, and information dissemination. To a lesser extent, training and research
1.	DANIDA	
2.	FAO	
3.	ODA	
4.	NACA	
5.	ICLARM	
6.	World Bank	
7.	ADB	
8.	WFP, etc.	

2.1.8 Credit facilities

In all agricultural activities, credit plays an important role and, therefore, has become an integral component of the overall scheme to accelerate rural development in Bangladesh. Increasing credit is one of the policy instruments considered necessary to facilitate technology transfer, stimulate productivity, generate employment, and increase income.

In Bangladesh almost the entire institutional credit for the aquaculture sector is provided by:

(1) Government owned agricultural banks

— Bangladesh Krishi Bank, and

— Rajshahi Krishi Unnayan Bank

(2) Commercial banks

— Sonali Bank

— Janata Bank

— Agrani Bank, and

— Rupali Bank;

(3) Cooperative bank

— Bangladesh Samabaya Bank Ltd;

(4) NGOs

- Grameen Bank
- CARITAS
- CARE
- Proshika
- Gono Unnayan Prochesta
- BRAC, etc.

(5) Development projects

- IDA-financed shrimp culture project
- ADB-financed Second Aquaculture Development Project
- DANIDA-supported Aquaculture Development Projects
- ODA-supported NWFP, and other projects.

Government-owned agricultural banks and commercial banks operate with the usual collateral/mortgage system. NGOs, however, do not depend on collateral or mortgage for ensuring repayment of an extended loan; they rely on an intensive supervisory system. On the other hand, the development project-funded schemes operate with or without any interest under an extensive supervisory system involving both selected NGOs and government staff.

The Government of Bangladesh is well aware of the credit need. In its Fourth Five-Year Plan (1990-95), it has paid special attention to increasing the flow of fisheries credit to the fisheries sector and particularly to the underprivileged groups.

2.2 Production potential

PONDS

Country production figures show that 202,167 tons of fish were produced in ponds in Bangladesh during 1992-1993, about 19.8 per cent of the total country production (DOF 1993). The same source reports an average annual catch of about 1,376 kg/ha from ponds. It is the contention of the authors. based on field observations, that the current production rate in ponds may exceed 1500 kg/ha. (Statistics are not available to indicate the amount of pond water area under different aquaculture practices.)

About 80 per cent of the pond production is major carps and catfish (mainly magur). Proven aquaculture technologies now available for major carps and catfish can produce 3-tons (even more) of fish easily. *Nilotica, rajpunti,* pangas, etc., the other preferred culturable species. can also be grown at the same range of production rate. These species account for about 90 per cent of total freshwater aquaculture production in Bangladesh.

On the assumption that 80 per cent of pond water area will be brought under aquaculture with these species and an easily achievable target of at least 3 tons/ha, Bangladesh production would then rise to 352,536 tons. The remaining 20 per cent of pond water area could, with miscellaneous culturable species and a modest target of 1.5 ton/ha, produce another 44,067 tons. making the total country production from ponds alone 396,603, say 400,000 mt, annually. This means that appropriate technology

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is available at present to double pond production. With better management, average production rates of both major and miscellaneous species could in the near future be raised to ,on an average, 4 tons and 2 tons respectively. This would mean a country production from ponds of nearly 530,000 mt annually.

BAORS

Baor production in 1992-93 was reported to be 1,803 tons with an annual production rate of 329 kg/ha. It has been reported that the yield in one ***baor*** (Baluhar ***baor:*** 28 1 ha) was raised from 118 kg/ha to over 900 kg/ha between 1981-82 and 1984-85 by stocking 13cm carp fingerlings (FAO/UNDP 1986). The same report felt that, under proper management, an enduring average yield in the range of 600-800 kg/ha should be obtainable from the ox-bow lakes of Bangladesh. With a total area of 5488 ha and a 600 kg/ha annual production rate, a total production from ***baors*** of about 3300 mt, almost a two-fold increase from the 1992-93 production, is achievable.

PADDYFIELDS

It has been estimated that Bangladesh's paddyfields cover an area of about 8 million hectare. Fish production in inundated paddyfields is at present, mainly a subsistence capture fishery and, generally, no culture measures are taken. However, paddy-cum-fish culture is now considered an ideal method of land-use. Fish culture in paddyfields has enormous potential in Bangladesh and the present low yield could be increased to 250kg/ha/crop by adopting scientific management practices. Even if just 5 per cent of the total paddyfields were brought under paddy-cum-fish culture (especially in places where the fields become inundated or are irrigated), the total annual production obtainable from this scource alone could be 200,000 mt of fish.

3. CONSTRAINTS

The detailed study of aquaculture potential made in Section 2 reveals that the fish culture potential in Bangladesh is very high and several factors favour the realisation of this potential. But for various reasons, freshwater aquaculture potential is not being fully realized.

Bangladesh has not been able to bring a large number of ponds under aquaculture. The production rate is still far below than what it is in China and in the Southeast Asian countries. It has not been possible to bring all the ox-bow lakes under proper aquaculture management. An effective management system is yet to be developed for the FCD/FCDI areas and burrow pits. To some people the main problem is biological or technological, to others sociopolitical or legal, yet to others, all these have their place in the overall problem. In order to achieve maximum results. the various factors governing production and their interplay must be studied and appropriate steps taken for their integration. Development through production increase is an interplay between objectives, resources and measures. Let us examine these separately.

3.1 Objectives of aquaculture development

As aquaculture production can be increased to a considerable extent. properly planned and managed development of it should be able to contribute considerably to an increase in protein food supplies at affordable prices. By improving the physical well-being and quality of life of the rural poor through fisheries production, their productivity level and ability to contribute to the national economy can be increased. As Bangladesh is predominantly a rural country and aquaculturable water bodies are overwhelmingly situated in the rural areas, the development of aquaculture can become synonymous to rural development provided it is seen in the perspective of integrated rural development.

In Bangladesh, freshwater aquaculture is still being treated largely as a separate or isolated entity. The various conflicts -- social, technological, or resource-related -- are, therefore, hindering the process of sustainable development of aquaculture.

3.2 Resources available for freshwater aquaculture development

3.2.1 Natural resources

Not all ponds are equally suitable for all kinds of aquaculture systems. As far as a pond as a natural resource is concerned, soil type, local climate, geographical location, size, depth and water-holding capacity; water availability and localized environmental impact are some of the major determinants for consideration of suitability of the water body for a particular aquaculture technology.

In many of the ox-bow lakes, introduction of better management practices involving external planned stocking of fingerlings of allowable fish species may be the only option. In some other lakes, it may be possible and profitable to introduce pen or cage culture systems side by side with the general stocking practice. In these circumstances, introduction of a particular aquaculture technology without looking into the physical condition of the pond or lake is bound to fail or result in less profit.

It is, therefore, necessary for the extension person concerned to be well acquainted with the physical characteristics (and the chemical characteristics of the soil and water) of the ponds and lakes under his domain before he recommends a particular technology.

3.2.2 Technological developments

3.2.2.1 AQUACULTURE TECHNOLOGY AND ITS TRANSFER TO INTENDED FARMERS

Aquaculture technology may be conveniently divided into three main aspects:

— Cultured species;
— Culture facility, and
— Husbandry.

Culture species determines the facility, and the facility chosen limits the species choice. Species and facility together determine husbandry practice. The interaction among the three aspects determines the selection of a technology to ensure sustainable profitability of the practice through increased productivity.

For the same aquaculture system, there may be more than one technology available. For example, the carp polyculture system has at least six different models. Which one should be recommended ? This type of situation may create confusion and even frustration among extension personnel. Therefore, it is desirable that the number of technology models for a particular kind of activity should be as few as possible. However, this does not, and should not, mean that there should be only one model; after all, the different models have been developed to adapt to different situations, such as the socioeconomic condition of a particular farmer, water quality and geographical location of the pond.

Available models or technologies should, therefore, be tested by a single authorized body and a short list prepared for the use of different organizations. The type of water or nature of region best suited for a particular model should also be recommended by this body. All extension personnel involved in the development of aquaculture should be able to fully comprehend the underlying philosophy of all the recommended models.

A technology to be generally transferable to intended farmers should have some flexible and universal characteristics which will enable it to be adapted to variable situations. Situations that hinder the transfer, generally. are:

— Multiple ownerships;

— Size of the pond;

— Other uses of the pond water;

— Inability to closely supervise pond activities;

— Age of owners;

— Main occupation of the owners;

— Lack of finance:

— The educational level of the owner;

— Efficiency of the extension agent;

— Effectiveness of the extension system;

— Availability of various inputs.

A participatory approach, whereby local fishermen can effectively play a role both in the decision-making and implementation processes concerned with ox-bow lake management, can help overcome the problems that may arise during introduction of a better management system.

3.2.2.2 PROCESSING AND MARKETING

Freshwater aquacultural products are largely consumed as fresh fish through the local market. However, a significant portion of these products need to be’processed, either through icing or, to a lesser extent, drying. Icing facilities are not available equally throughout the country, thereby compelling a farmer to sell his products in the local markets, as he cannot take his produce to distant wholesale markets where he could make a greater profit. Sale of freshwater aquaculture products is still a problem in remote areas where communication is poor and local demand limited.

Selling prices of the produce have a decisive influence on the economics of aquaculture. Principally, there are two ways of improving the profitability of the industry: either on increasing the sale prices: or by the culturist getting a greater share of the final sale price. These, however, are not always realistic alternatives, for, in most cases there are many small farmers and considerable competition, and the individual fish farmer consequently has very limited possibilities of influencing the final market price. Then again, as pond-reared fish are often the same species as fished in inland or coastal waters, the consumer can easily substitute other types of fish products for pond fish. And the marketing of carp is particularly difficult during October and November when these fish are also caught in floodplains all over the country.

3.2.2.3 FRY AND FINGERLING PRODUCTION

Almost all the ponds in Bangladesh are rain-fed, have greater fluctuations of water depth, and there

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is practically no facility of water manipulation in the ponds. These factors limit the scope of intensive aquaculture in Bangladesh. However, these ponds are better suited for semi-intensive and extensive aquaculture. To introduce semi-intensive freshwater aquaculture with a production target of a minimum of 3 ton/ha/yr, from a pond , the stocking density for the ponds would have to be about 10,000 fingerlings per hectare water area. Simplifying the problem, if we consider the entire 146,890 ha of pond water area, the requirement of 4-5 inch fingerlings of different species, but mainly carp, would be 1468 million annually. If we consider the loss of fingerlings due to rough handling during transportation and release in ponds, at least another 20 per cent is required to be added, making an annual requirement of about 1800 million fingerlings for pond aquaculture alone.

In addition to this, we need fingerlings for baors. floodplain fisheries, FCD/FCDI fisheries, and other miscellaneous fisheries. The total requirement is yet to be determined based on the type of water body, its location and quality. and the aquaculture systems to be followed. But if necessary steps are not taken to increase fry/fingerling production, it is likely that smallscale aquaculture will suffer at the cost of other fisheries specially the floodplain fisheries.

Another problem is fingerling production. Both the size of the fingerlings to be produced and the number required are yet to be firmly established. It has been observed that carp fingerlings of 2 inch size are being sold to farmers from even government seed centres, inspite of the fact that there is strong advocacy for the use of 4-5 inch fingerlings for aquaculture purposes. It is also observed that in many areas, farmers stock l-inch fingerlings in their ponds. If fingerlings are to be restricted to a minimum of 4-inch size, a planned fingerling development strategy has to be developed throughout the country, by which quality fish fingerling can be supplied largely from local sources. Nevertheless, it has been observed that regions like Jessore, Bogra and Comilla are producing fry/fingerlings in quantities more than the local demand. Fry/fingerling handling during transportation to other places and their subsequent release, however, need to be significantly improved. At an estimated production of 150,000 4-inch fingerlings per hectare and two cycles of production a year, 6,000 ha of suitable waterbodies would be required for the production of 1800 million fingerlings.

Production of carp fry through induced breeding has made real progress in Bangladesh. But in the absence of policy guidelines, production of fry is not based on any local need assessment. While large- and medium-sized government hatcheries may be used to produce fry for fingerling stocking in open waters exclusively, besides offering some to private farmers, private hatcheries, medium- and small-sized, can cater for local requirements. *Thana-wise* need assessment studies are required to be made, taking into consideration the type and nature of waterbodies and the culture technologies suitable for the ponds in the particular *thana.* Big hatcheries can, and should, modernize their fry handling and transport systems in order to reduce the mortality to an acceptable range. On the other hand, mainly due to the prevailing socioeconomic condition, the indigenous method of transportation in rural and remote areas are expected to continue for a considerable period of time. While extension efforts should be aimed at making the hatchery/nursery operators aware of the bad effect of indigenous methods, an alternative solution to the problem should simultaneously be found. One solution would, perhaps, be, not to allow more than one medium- or small-sized hatchery to be built in one *thana.* If demand is high, a single hatchery can cater to the needs of the particular *thana* alone in which it is situated, or it can reach out to the farmer/nursery operators of adjacent *thanas.* Either way the transportation problem will be significantly reduced. An adequate number of nurseries should therefore be encouraged in each union to reduce the need for long hauls of fingerlings.

3.2.3 Environment and disease

The environment exerts a major influence on aquaculture. Interaction between aquaculture and changes in the environment induced by human activities is becoming increasingly important in Bangladesh.

Examples of the impact of the environment on aquaculture are the various types of pollution from urbanization, industrialization, and intensification in aquaculture which cause stress in fish beeding, reduced growth, disease, mortality and contamination of surviving stock. The situation in Dhanmondi Lake in Dhaka city is a typical example of pollution due to urbanization. Aquaculture in Bangladesh faces high risks as the country suffers perennially from floods and droughts. It is, thus, important to offer pond preparation and production models which are well adapted to flooding and dry season risks.

Acidic soil in certain areas and sandy soils in other areas of the country are also a constraint to aquaculture development. The use of pesticides and fertilizers in ricefields is increasing daily in Bangladesh, where 4000-5000 tons and 242 different types of pesticides are used annually. The use of pesticides is important for crop production, but improper doses or unapproved chemicals are harmful to fish and other aquatic fauna. In a survey conducted in Bangladesh, it was revealed that the killing of fish with pesticides occurs mainly as a result of;

- The use of pesticides in improper doses;
- The use of banned chemicals; and
- Aerial spraying of chemicals for mosquito control (FAO/NACA 1995).

On the other hand, aquaculture may exert a diverse range of impacts on the environment. For example:

- Eutrophication of water and sediments from discharge of aquaculture farm effluents, particularly from intensive aquaculture systems (e.g., integrated fish-cum-duck/chicken farming);
- Misuse of chemicals in disease treatment, with potentially adverse effects on fish production. product residues and farm worker health;
- Reduction of biodiversity due to introduction of exotic species and use of toxicants to kill the predators or so-called wild fish; and
- The production of potentially toxic blue-green algal toxins in eutrophic ponds.

Social conflicts due to water becoming unusable for various other purposes because of the use of manures and fertilizers, and non-availability of pond water for other purposes, such as agriculture, are also increasing.

There is a need to gather quantitative and qualitative information on both the impact of the environment on aquaculture and the impact of aquaculture on the environment. Any Environmental Impact Assessment (EIA) study in the country should henceforth consider major freshwater aquaculture development programmes.

Disease in freshwater aquaculture mainly results from two causes:

- Degradation of natural balance of the environment; and
- Intensification.

Practising good husbandry is the best way to keep away most diseases experienced in the field of aquaculture. However, once disease strikes, it has been observed that it becomes very hard to find a suitable ‘doctor’. The mechanism of developing disease experts and proper diagnosis systems is yet to be effectively developed. With the growing inclination of all concerned towards greater intensification of aquaculture systems, both frequency and intensity of disease occurrence are bound to considerably increase. Therefore, it is important to take necessary administrative measures to strengthen the field of combating disease.

3.2.4 Inputs supply

Besides fish seed, the two most important inputs required for more intensified aquaculture are feed and fertilizer.

In Bangladesh the typical freshwater culture systems are extensive or semi-intensive polyculture systems with some supplementary feeding and fertilization. The goal is to bring all the ponds under aquaculture, preferably semi-intensive aquaculture.

Semi-intensive aquaculture practices could differ from each other in:

— The degree of management;

— Provision of feed (supply of direct feed, or through plankton production);

— The stocking density; and

— Yields.

A national body could define, periodically, the intensity level to be followed by all the extension personnel.

Feed ingredients that are predominantly used in Bangladesh are rice bran, wheat bran, mustard oilcake and seasame oilcake, although as many as 83 different types of ingredients, of both plant and animal origin, could be listed as potential feed ingredients in Bangladesh (Bhuiyan et *al. 1989).*

Inorganic fertilizer use mainly follows the N-P-K regime, for which Urea, TSP and MP are used. Cowdung and, to a lesser extent, poultry manure are used as organic fertilizers.

Without understanding the intricate role of supplementary feeds in the nutrition of the cultured organism in a particular pond or culture system, and the differences in the requirements of all these inputs, which, again, are bound to differ, depending on the geographical location of the water body, it is hard to quantify, to an acceptable level, the annual requirements of each of the feed and fertilizer ingredients. Feed and fertilizers are both required to intensify the system in order to increase profitability. If available manure alone can supplement inorganic fertilizers, that will be an added benefit. However, since manure has other important uses in the country, a balanced use of both organic and inorganic fertilizers, along with supplementary feed, seems to be the best option.

It is, therefore, necessary to first select the technologies to be used in a particular thana eco-system, based on which'the requirement of different feed fertilizer ingredients may be determined. Compilation of thanawise requirements can provide practical information regarding the country's requirement. This information is an indispensable tool for planners.

Farmers need to be trained in the preparation of farmer-made aquafeeds, as the use of commercial feeds will be uneconomical for freshwater aquaculture farmers. They need to be made aware of locally available ingredients and simple but effective feed preparation processes.

Another recent problem is that of the presence of SSP (single super phosphate) in the market. Either the import of SSP should be banned or farmers, especially aquaculture farmers, should be educated about the negative impacts of using SSP in place of TSP.

3.2.5 Human resources development

Figure 2. Activities in freshwater aquaculture development, and the professionals involved.

PRODUCTION		CONSUMPTION
1. Manpower Development by teachers/trainers 2. R&D activities by researchers 3. Resource Survey and Management by field personnel, management personnel, planners, etc. 4. Transfer of technology by extension personnel 5. Fish culture by farmers, entrepreneurs 6. Marketing by fish traders	⟷	CONSUMERS CREATE DEMAND

As seen in the Figure 2, universities are mainly responsible for producing senior trained manpower (teachers, researchers, planners, managers, trainers, etc.) through formal education programmes. It is felt by many that the curriculum development process in the universities should involve a more participatory approach. in the absence of which their graduates become unable to handle field situations at an acceptable level. The situation/demand in the field also changes rapidly and it is often seen that inflexibility of the curriculum development process of the universities results in not keeping pace **with** the ever-changing field demand. Once a university is committed to educational development. a team of technical specialists, specialized in field situations, should collaborate with the university in defining and meeting the university's curriculum development needs through a problem-posing and -solving approach.

The DOF is, by far, the single largest employer and, as such, it is the biggest training institution in the country. On reviewing the performance of the field level officers, it is felt that they should be further trained in a purpose-oriented and coordinated manner. The Fisheries Training Academy, which is under implementation, can play a vital role in conducting exclusive training to acquaint officers with the new/ emerging technologies. All the aquacultural development projects/programmes should, in fact, have their own training programmes, with or without the help of the FTA, to familiarize the implementing officers with the technological as well as management philosophies of the projects.

Transfer of technology is another important activity in acquaculture development. This process depends on two factors : the inherent usefulness and adaptability of the technology itself, and the efficiency of the extension officers/workers in preparing the recipients, i.e., the prospective fish farmers, so that they can fully assimilate the technology and effectively utilize it. Farmer development is again dependent on trained manpower, which is produced hy the universities. Appropriate technologies which can be transferred are the product of good researchers who are the products of universities.

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3.2.6 Credit

As capital is often scarce in rural areas, problems over finance and the need for credit schemes often arise. Institutional credit is an essential prerequisite for every phase of the aquaculture industry. It has been observed in Bangladesh that, so far, large farmers have been the main beneficiaries. Most small farmers have limited or no access to institutional credit, most of which is short term credit.

Providing security is always a problem with small fish-farmers and some kind of arrangement has to be made to guarantee loans to them for investment and working capital. It should also be accepted that credit administration costs are relatively higher for smaller loans. Recent experience suggests that supervised credit is at present the only alternative now available to replace the traditional ways of providing security, namely collateral or mortgage.

The productivity of the fish-farmer will be considerably enhanced if he is provided with a comprehensive package of advice and assistance (‘technology package’), of which supervised credit should be a part. Commercial banks (CBs) will have to introduce supervised credit systems. They need to develop their fisheries manpower to fully comprehend the biotechno- and socioeconomic background of a particular credit package programme, and to effectively work with field officers of different aquaculture development agencies.

The development projects, on the other hand, should have a clear stand on credit availability. These projects are intended to develop technology packages containing both technical advice and institutional credit on reasonable terms for investment as well as operational purposes. While the technological advice in such packages should be exclusively provided by the DOF itself, the credit should be channelled through CBs having adequate and competent manpower, or through proven NGOs. A joint team of DOF and NGOs, or DOF and CBs, should work in the transfer of technology packages. As long as the CBs are not capable of becoming flexible and competent enough to work in field situations, a DOF and NGO team should be the preferred partner in the transfer of a technology package.

3.2.7 Administrative needs of the organizations involved in freshwater aquaculture development

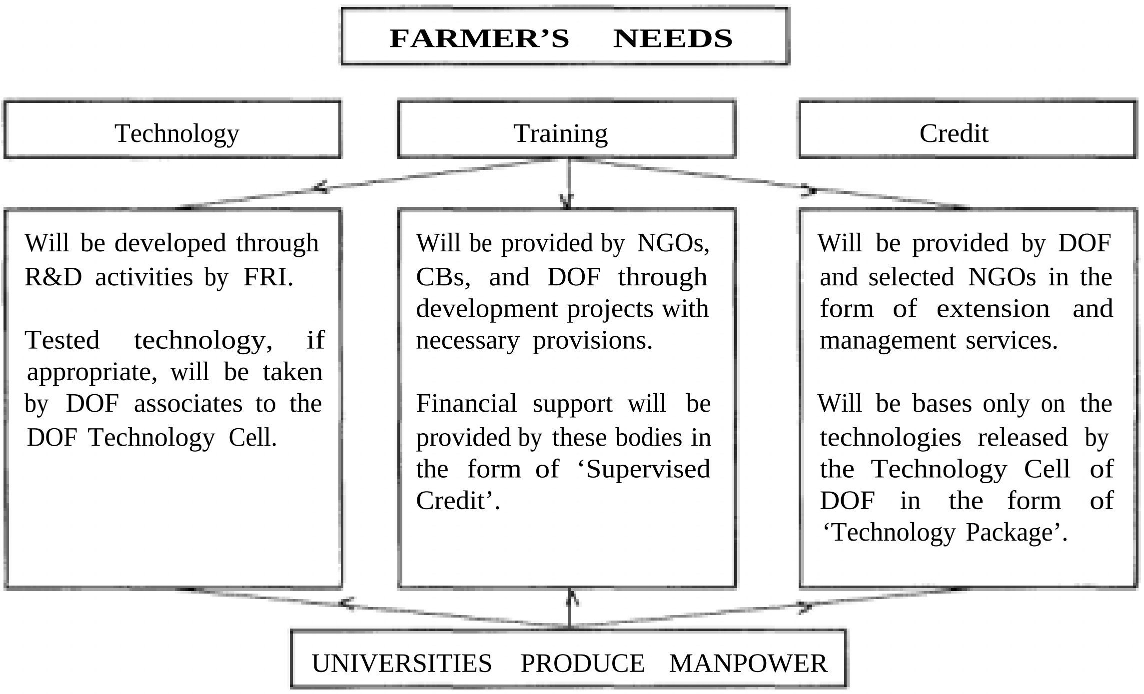
Apart from the universities, the other organizations playing a major role in freshwater aquaculture development in Bangladesh are the Fisheries Research Institute (FRI), the Department of Fisheries (DOF), the universities and NGOs. The FRI is involved directly in research and development activities, whereas the DOF’s involvement is in the transfer of technology through extension and management services. NGOs, as a whole, are becoming more involved in the transfer of technology than in the development process. They are doing this either independently or in association with the FRI (mainly in on-farm testing of an evolved or developed technology) or the DOF (mainly as the local extension agents). International organizations are also involved in the process, but not independently; they work under the provisions of the Government or NGOs.

Although all these organizations are administratively independent of each other, the common field of their activity (freshwater aquaculture development) has made them interrelated and, to some extent, interdependent. An absence of effective coordination among these bodies, which is an oft-alleged problem is, therefore, bound to result in failure to harness the maximum benefit achievable from aquaculture development. The aspects of effective coordination, and some improvement needs of individual organizations, therefore, are the principal basis for the following suggestions on aquaculture management schemes.

4. *MANAGEMENT NEEDS : A BOTTOM-UP APPROACH*

4. 1 Responsibilities

Figure 3. Major responsibilities to be carried out by different organizations in order to meet the aqua-farmer's needs.



4.2 Notes on responsibilities

Universities

- The curriculum development process should be more dynamic, field oriented and should be based on a participatory approach involving outside experts in the team. Management aspects of *haor, baor,* FCDIFCDI areas and burrow pits - should be adequately reflected in the course curriculum.

  Should conduct research work, mainly, during postgraduate studies, and joint-studies with other organizations, but, in principle, should not be involved in field level extension works.
- Should participate in the Advisory Board of the DOF (discussed later), the FRI research management body and the SSC/HSC (fisheries) curriculum development processes.

Research Organizations

- The FRI's responsibility should be only to conduct R&D activities. On-farm testing should be considered a part of the overall research programme.
- The FRI should participate in the Advisory Board of the DOF and the Universities' curriculum development process.

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- BARC (Fisheries Wing) activities need to be further geared for better coordination, monitoring and evaluation of all the fisheries research work being carried out in the country.
- BARC shold participate in the Universities' curriculum development process and the DOF advisory board.

Department of Fisheries

- The DOF should form a decision making advisory board with the participation of all concerned, such as the FRI, BARC, universities, CBs, NGOs and BFDC. The advisory board will fully depend on its proposed 'Monitoring and Evaluation Wing' for taking decisions.
- It should further strengthen extension personnel training programmes by giving the Chief Fisheries Extension Officer's office a strong institutional shape. AFOs and FAs should be properly utilized in extension activities.
- Fish seed production, and fish health and disease are two neglected fields in the DOF, which need to be developed.
- The DOF should participate in the universities' and SSC/HSC (fisheries) curriculum development processes and in the FRI research management body.

Non-Governmental Organizations

- They should, for maximum benefit, use technologies recommended by the DOF (through the Technology Cell).
- They should be represented in the DOF advisory board and FRI research management body.
- If required, they should participate in the on-farm testing of the technologies evolved/appropriated by the FRI.
- They should utilize their administrative flexibility to organize demonstration/ extension farmers to disseminate technology and to realize loans.
- They should consider extending credit support.

Commercial banks

- The CBs should follow a supervised credit system. Such a system would be expected to remove many of the problems arising from the field of aquaculture due to the prevailing socioeconomic conditions of prospective aquafarmers.
- Accordingly, they should strengthen the manpower needed to look after aquaculture ventures.
- They should participate in the DOF advisory board.

4.3 *Coordination and strengthening of DOF activities related to national aquaculture development*[1]

DOF ADVISORY BOARD[2]

MONITORING AND EVALUATION WING

- Natural and Development Resources Cell (NDRC) (to maintain detailed up-to-date information about these resources.)
- Technology Cell (TC) (to select and recommend various technologies.)
- Credit Cell (CC) (to assess credit needs, suggest measures for supervised credit and monitor utilization and recovery.)
- Human Resource Cell (HRC) (to assess training needs, monitor related activities and evaluate performance of trained personnel.)
- Office of the Chief Fish Seed Officer (CFSO).
- Project/Programme Cell (PC) (to assess the need for new projects/ programmes; evaluate the progress of under-implementation projects/ programmes; keep a record of projects/programmes of others e.g. NGOs and their performances.
- Environment Cell (EC) (to do all that is necessary to carry out EIA studies, and look into other environmental issues.)
- Production and Marketing Cell (PMC) (to deal with all kinds of production and marketing information/statistics; exercise quality control of fish and fishery products; collect export statistics of fish and fishery products; assess import needs of aquaculture-related inputs and harvesting gear.)
- Socioeconomic Cell (SC) (to conduct studies on the impact implementation of projects/ programmes have had on farmers and fishing communities.)

EXECUTION WING

- (DOF may have other offices, but the following offices are proposed, either to be newly created or further strengthened.)
- Office of the Chief, Fisheries Extension Offices (CFEO).
- Office of the Chief Fish Health Officer (CFHO).

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[1]Other activities, in addition to aquaculture development, will also be served by such schemes.

[2]To be headed by DG, DOF, and have representation from FRI, BARC, Universities, NGOs, MOFL, Planning Ministry, BFDC, CBs, etc.

Notes on Monitoring and Evaluation Wing

1. This wing will be headed by a Director.
2. Each individual cell will be headed by a Deputy Director.
3. Each of the cells will maintain close contact with the related organizations and may ultimately team together formally to secure all the required information.
4. All the cells will build strong databases of their own.

Notes on Execution Wing

1. <u>Office of the Chief Fisheries Extension Officer (CFEO)</u>

This office is not new **but** needs to be strengthened in the following ways:

CFEO (one for the country)	Will be of the rank of a Deputy Director and stationed at H.Q., DOF Will coordinate, monitor and evaluate nationwide extension activities and report periodically to the Advisory Board
SFEO (Senior Fisheries Extension Officer; one for each division)	Will be of the rank of a DFO, preferably a senior one, and stationed at the divisional H.Q. Will coordinate, monitor and **evaluate** extension activities in the division, in association with the concerned DFOs, and report periodically to the CFEO
FEO (Fisheries Extension Officer; one for each of the selected thanas)	Entry level officer stationed at the DFO office -- and in selected cases in the TFO office, too. Will assist the DFO in implementation, monitoring and evaluation activities of the district and report periodically to the SFEO

(The *thana* will be the centre of all extension activities. The TFO, along with his deputies *i.e.,* AFO and FA, will perform his duties under the guidance of the DFO. In some *thanas,* where the situation demands extra hands, a FEO may be posted to assist him.)

2. <u>Office of the Chief Fish Health Officer (CFHO)</u>

This is a new proposal to meet the field demand for quality service in the field of fish health and disease, and may be developed gradually in the following ways:

CFHO	--	Will be of the rank of a Deputy Director, stationed at HQ, DOE
(One for the country)	--	Will supervise and coordinate activities of all the divisional offices.
	--	Periodically report to the advisory board.

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SFHO (Senior Fish Health Officer, one or two for each division)	--	Will be of the rank of a DFO, and stationed at the DD Office.
	--	Those of the present senior officers of DOF who have best exposure to fish health/diseases will be hand-picked.
	--	Later, as demand grows in Chittagong and Khulna divisions, there may be two SFHOs, one for finfish and the other for shellfish.)
FHO (Fish Health Officer, one for each district)	–	Entry level officer, to be stationed at the DFO office, who has better exposure to fish disease problems, having a related academic background and/or in-service training in fish disease and good husbandry practices.)

– Only the divisional offices, for the time being, will develop small but useful laboratories for the diagnosis of diseases and to help with health-related activities.

3. <u>Office of the Chief Fish Seed Officer</u>

This is a new proposal to meet the growing field demand for greater quantities of quality fish seeds of cultured species as culture practices intensify ‘seeds, includes both fry and fingerlings.

In future, all fish seed farms, including hatcheries, may be brought under the administrative authority of this office

CFSO (One for the country)	-	Will be of the rank of a Deputy Director, stationed at HQ, DOF.
	-	One of the most senior officers in DOF, with wide-ranging experience in hatchery and nursery operations.
	-	Will coordinate nationwide activities with regard to fish seed production and distribution.
SFSO (Senior Fish Seed Officer: one or two for each division)	-	Will be of the rank of a DFO, and stationed at the DD Office. Will look after related needs for the division. Will be selected from among the present senior officers of the DOF who have the best exposure in hatchery/nursery operations. Later, as demand increases in the Chittagong and Khulna divisions, there may two SFSOs, one for finfish and the other for shellfish.
FHO (Fish Seed Officer, one for each district)		Entry level officer, stationed at the DFO office Will do everything required to meet the district requirement for fish seed.

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5 RECOMMENDATIONS

5.1 Strategical

1. An integrated approach, that takes into account both the technical aspects of aquaculture development and the socioeconomic needs of the farmers and fishing communities, to be followed to ensure sustainable integrated rural development. Technical aspects to include, inter alia, environmental considerations.

2. The role of the various organizations in the development of freshwater aquaculture to be clearly defined.

3. Detailed and up-to-date information on all aspects of aquaculture development, and effective coordination among the organizations involved, to be the basis for proper management of resources and administration of activities.

4. Consideration to be given in aquaculture plans, to the lifestyle and social and vocational needs of local people in villages/towns, to avoid conflicts.

5. Environment Impact Assessment (EIA) and Environmental Monitoring Plan (EMP) to be insisted upon for larger units and self assessment/monitoring for smaller units, subject to verification at inspection.

6. NGO participation in aquaculture development activities as complementary to Government efforts, to be encouraged.

7. Besides ponds and ***bums,*** the management aspects of unconventional waterbodies in FCD/FCDI areas, such as burrow pits, paddyfields and haors, should get immeditate attention. These should be seen as potential waterbodies for significant increase in production. A participatory approach should be the guiding principle in introducing better management practices in these waterbodies.

8. To bring all the ponds and baors (and related waterbodies) under effective aquaculture systems, a fiveyear phased plan should be adopted.

5.2 Implementational

5.2.1 PHASEWISE TARGET

5.2.1.1 PHASE-l: 1996-2000

5.2.1.1.1 Ponds

The areas under 'under cultivation', 'culturable' and 'derelict' to shift from 52 per cent, 31 per cent and 17 per cent to 70 per cent, 25 per cent and 5 per cent, respectively.

- Average production rate (per hectare, annually) to be 3.0 tonnes in under-cultivation ponds (semi-intensive), 1.5 tonnes in culturable ponds (extensive), and 0.5 tonnes in derelict ponds (natural/ extensive).
- Total country nroduction from ponds to rise from 202,167 tonnes to 367,225 tonnes, following an increase in country average nroduction rate of 2500 kg in place of 1367 kg.

5.2.1.1.2 *Baors*

— 'The average production rate to increase from 329 kg to 600 kg per hectare annually.

— The concomitant total production to increase from 1803 tons to 3293 tons annually.

5.2. 1.2 PHASE-2: 200 I-2005

5.2.1.2.1 Ponds

— The areas under 'under-cultivation'. 'culturable' and 'derelict' to shift from 52 per cent, 3 I per cent and 17 per cent to 85 per cent. 14 per cent and 1 per cent, respectively.

— Average production rate (per hectare, annually) to be 4.0 tonnes in under-cultivation ponds (semi-intensive): 2 tonnes in culturable ponds (extensive/semi-intensive); and 0.6 tonnes in derelict ponds (natural -- extensive).

— Total country production from ponds to increase from 202. 176 tonnes to 541, 436 tonnes following an increase in production rate from 1376 to 3700 kg/ha/yr.

5.2. 1.2.2 Baors

— The average production rate (per hectare. annually) to increase from 329 kg to 900 kg.

— The resultant total production from baors to rise to 4939 tonnes from 1803 tonnes.

5.2.2 Specific recommendations

5.2.2.1 HUMAN RESOURCES DEVELOPMENT

— Universities' curriculum development process should be participatory in nature and more dynamic in implementation.

— Institutionalization of training for aquaculture and industry.

— Training of scientists in specific disciplines and specialization. as well as interdisciplinary training.

— Training of planners, developers and managers.

— Training of teachers in specialized fields.

— Imparting training skills in trainers.

— On-site training of farmers.

— All such training to give equal emphasis to technical as well as human aspects of a total training programme.

5.2.2.2 RESEARCH

— Research programmes for developing acquaculture should be given a high priority and should comprise of both bio-, techno-, and socioeconomic problems.

— Aquaculture system research on a holistic basis,

— Comparative economics with environmental audit of different culture systems/ technologies/models.

- Research on need for, and judicious application of, drugs and chemicals where necessary; the residual effects; withdrawal time; safe environment; and safe products.
- Research on feed technology vis-a-vis environmental health, giving importance to farm-made aquafeed development.
- Genetic and biotechnology interventions for stock and production improvement which might relieve pressure on environmental impact.
- Research on disease-free and disease-resistant stock, and fish disease itself.
- Research on need for and judicious application of fertilizers, lime, etc.
- Assessment of need to use MP fertilizer and its appropriate required dosage.

5.2.2.3 TRANSFER OF TECHNOLOGY

- Technologies to be followed should be selective. These technologies will get Government support.
- Technologies to be transferred should be in a package form, to be named ‘Technology Package’, and will include technology, training and credit support.
- NCO participation complementary to Government efforts, particularly in this activity, should be encouraged.

5.2.2.4 CREDIT

- Provision of credit should be considered a natural part of the Technology Package.
- Financial support should be in supervised credit form.
- NCO participation complementary to GOB/CB effort should be encouraged

5.2.2.5 FRY AND FINGERLINGS

- Policy on fry and fingerling production and distribution should be based on local (union) need assessment study.
- All concerned should engage themselves, on a priority basis, in making farmers aware of the importance of stocking 4-5 inch carp fingerlings in their waterbodies.
- If the heel nursery programme is to continue, then the required fry should be exclusively supplied from the Government’s large hatcheries. Small Government and private hatcheries should cater mainly to local needs.

5.2.2.6 FEED

- Instead of commercial feeds, the use of farm-made aquafeeds. using locally available ingredients, should be encouraged. Farmers should be trained to use this. In this training, the importance of quality feed ingredients and proper storage of ingredients/feed should be adequately highlighted.

5.2.2.7 FERTILIZER

- If adequately available organic manure should be preferred to inorganic fertilizers.
- Farmers should be made aware of the negative impact of using SSP in place of TSP.

5.2.2.8 NATURAL RESOURCES

— Detailed survey on pond, *baor* and related waterbodies' culture needs to be updated with regard to, inter *dia.* number, area. status of use, uses of water, socioeconomic condition of pond-owners/ farmers and fishermen, water retention, water sources, productivity, suitability of particular aquaculture systems/ technology, and local environmental issues.

— Regionally (that is, districtwise) gathered information on the above points, particularly with respect to natural resources, should be compiled.

— Physical development of waterbodies should be a part of the management strategy.

5.2.2.9 MANAGEMENT NEEDS

— The expected role of different organizations involved in aquaculture development should be clearly defined and followed (detailed discussion, and suggestions are made in Section - 4).

-- The Department of Fisheries should play a stronger role in this sector and reorganize/rebuild its management wings (detailed discussion, and suggestions, made in Section - 4).

5.3 Concluding recommendation

A national workshop to be convened early, as a follow-up of the 1995 seminar, to work out details of the following:

— Immediate short-term research and management needs;

— Inputs/assistance needed, including fingerlings, credit. and measures to be taken to ensure their availability;

— Training needs.

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PAPER 4

BRACKISH AND MARINE WATER AQUACULTURE : POTENTIAL, CONSTRAINTS AND MANAGEMENT NEEDS FOR SUSTAINABLE DEVELOPMENT

by

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SUMMARY

Brackishwater aquaculture. also known as coastal aquaculture, is a rapidly expanding farming activity and plays an important role in the overall fisheries development effort in Bangladesh. Marine and estuarine shrimp, fish and crabs are the farm products. Bagda shrimp (black tiger shrimp. *penaeus* monodon) is the primary target culture species. while fish, heterogeneous shrimp and crabs are the by-products. Amongst the coastal districts, brackishwater aquaculture activities are most visible in Satkhira, Khulna, Bagerhat, Cox's Bazar and Chittagong. Because of the turbulent nature of the Bay of Bengal. the wide fluctuations of tide and salinity, and the absence of any sheltered places. e.g. lagoons or backwaters adjoining the sea, mariculture (culture of marine organisms in marine environment) has not so far developed in Bangladesh.

Brackishwater aquaculture has been a definite economic activity since the early Seventies when Bangladesh started exporting shrimp. Currently (1993-94) brackishwater aquaculture covers an approximate area of 125,000 ha, or 43 per cent of the total aquaculture area, and nearly equals 75 per cent of the area under freshwater aquaculture. Brackishwater aquaculture products are largely export-oriented and account for 52 per cent by volume and 64 per cent by value of the total fisheries export. However, out of the aquaculture products exported, brackishwater products contributed 86 per cent by volume and 84 per cent by value, far outrivalling the freshwater products in 1993/94.

Well over 200,000 people are directly employed in brackishwater aquafarming which has also led to the establishment of various rural-based cottage industries, e.g.making of bamboo screens, cages, traps, baskets, mats, nets, wooden sluices, rickshaw vans, boats, etc.

The farming technology followed by most farmers is rather primitive and inefficient. Production level is, very low, possibly around 300 kg/ha, of which Bagda and miscellaneous species of shrimp make up 204 kg/ha. It is difficult to effectively apply any improved culture technology in the existing terms because most of the ponds are unmanageably large in size, shallow in depth and irregular in shape. Water supply and drainage systems are inadequate. Farm remodelling, with reduction of pond size and improved water supply and drainage systems, is emphasized in this paper.

A policy for the best economic utilization of land in the brackishwater belt is urgently required to remove land-use conflicts and create opportunities for small farmers to derive due benefits from shrimp culture.

Criteria for a culture technology appropriate for general use in Bangladesh have been proposed. An improved extensive type of culture, with various management options, has been recommended to suit different types of topographic and hydrological environments and farmers of varied backgrounds. Brackishwater aquafarming alternating with paddy in low saline areas and with salt in high saline areas has been recommended as a general farming policy. In perennially saline areas, double crops of Bagda have been suggested. The intensity of semi-intensive culture has been defined for Bangladesh. Expansion efforts for semi-intensive culture would not be wise before solving the fry and feed problems.

Considerable efforts are necessary for optimum utilization and hetter management of culturable shrimp fry resources. The need for establishing hatcheries. feed mills, the reestablishment of mangrove covers, and problem-oriented research has been stressed.

1. INTRODUCTION

The role of fisheries in Bangladesh in supplying animal protein, in providing employment, in earning foreign exchange and in supporting multifarious ancillary industries at the rural levels is well-known. The fishery-based economy will, no doubt, gain even greater importance in the future. Because of the limitations of capture fisheries and the vast potential for the development of culture fisheries, most of the additional fish production, necessary for domestic consumption or for export will have to come from aquaculture. It is also felt that a large part of the surplus labour could be productively absorbed through the development of aquaculture.

In Bangladesh, both freshwater and brackishwater aquaculture are practiced. Culture of marine organisms in the marine environment is, however, yet to be introduced. The Bay of Bengal and the associated river mouths are characterized by strong waves, wide tidal and salinity fluctuations, frequent cyclones and tidal bores. The open beaches are strongly surf-bitten. The lack of lagoons, backwaters or other sheltered marine environments is apparently why mariculture has not taken off. Extensive areas in the coastal belt are, however, under brackishwater aquaculture, which is entirely shrimp-based.

Shrimp was once much cheaper locally than fish and was not considered an attractive food item. In the early Seventies, however, Bangladesh entered the world export market for shrimp and since then this crustacea has suddenly become a very high-priced commodity. Simultaneous with the public sector efforts to harvest marine shrimp by trawling, some farsighted entrepreneurs began to look at brackishwater aquafarming. Before long, aquaculture efforts proved more rewarding than marine capture. More and more areas were brought under brackishwater aquaculture and more and more people engaged themselves in shrimp farming. The increasing demand and steadily rising price of shrimp in the international market caused a silent revolution in brackishwater aquafarming development. Once a casual activity of little economic significance, brackishwater aquafarming soon emerged as a multi-million taka farming industry in a few years.

All these developments took place in the private sector with very little inputs from Government. It is only since 1980, the starting year of the Second Five-Year Plan, that the contribution of brackishwater aquafarming has been officially recognized. With favourable environmental conditions for brackishwater aquaculture and the existence of large areas with good potential for aquaculture, the Government has given high priority to brackishwater aqua farming because of the urgent needs of export and rural employment.

2. CONTRIBUTIONS

2.1 Culture area

The total area currently under aquaculture is 292,378 ha of which 48 per cent, or 125,000 has, is under brackishwater aquaculture.

2.2 Aquaculture production and value

In 1993-94, the total fisheries production was 1.087 million t, of which 24.2 per cent, or 264,190 t, was of aquaculture origin. According to DOF statistics, brackishwater farms produced 39,477 t of shrimp and fish, of which shrimp accounted for about 25,000 mt (204 kg/ha) and fish about 14,000 mt.

In the total aquaculture production, brackishwater farms contributed 15 per cent by weight and an estimated 38.5 per cent by value. The total cultured shrimp, brackishwater products accounted for 86 per cent by volume and 84 per cent by value. In all shrimp taken together (100,538 t), brackishwater farm-raised shrimp accounted for 25 per cent by weight and 50 per cent by value.

2.3 Fisheries export

In the total fisheries export of 31,835 t (valued at Tk. 9,210 million) in 1993-94, the shrimp component of the culture fisheries contributed approximately 52 per cent by volume and 64 per cent by value. Brackishwater aquaculture products contributed 86 per cent by volume and 84 per cent by value of the export originating from culture fisheries.

2.4 Employment

Estimates of employment in various farm-related activities are presented in Table 1.

Table 1: Estimated employment in brackishwater aquaculture

Activity	*Number of people engaged (in thousands)*		
	Men	*Women*	*Total*
Fry collection	99,000	55,000	154,000
Fry trading & transportation	1,500		1,500
Farming	50,000		50,000
Shrimp depot workers	400	1,100	1,500
Shrimp van/ boat operators	1,500		1,500
Processing factory workers	400	1,100	1,500
TOTAL (appx.)	152,000	57,000	210,000

Source: Field data

3. GEOGRAPHICAL DISTRIBUTION OF FARMS

3.1 Culture waters

Brackishwater aquaculture is mostly practised in low-lying tidal flats within Bangladesh Water Development Board (BWDB) polders. The polders were originally constructed to prevent the land from brackishwater inundation and to enable the reclaimed land to be used for agriculture. In many places, the farmers themselves have constructed dykes along the river banks for the dual purposes of agriculture and aquaculture.

Brackishwater aquaculture is practised mostly where the land is low and tidally inundated. Excavation of relatively high land to make its level lower and allow tidal inundation for aquaculture purposes is not common. Use of a pump to supply water from the surface or from underground layers to initially fill the ponds and subsequently replenish them is seen in exceptional areas in Kaliganj and Shyamnagar thanas and Satkhira district. These farms are completely pump-fed and are small. ranging from a fraction of a hectare to a few hectares in size.

In Pirojpur, Patuakhali, Paikgacha and Rampur areas, many small domestic ponds are connected with tidal creeks. These ponds, originally meant for household washing, have, of late, begun to be used for brackishwater aquaculture of various degrees of intensity.

3.2 Pond area

A survey conducted by the Department of Fisheries revealed that in 1982-83 there were 51,835 ha of brackishwater ponds in Bangladesh. In 1984-85, the brackishwater farming area was estimated at 70,331 ha (Aquatic Farms Ltd, Hawaii USA, engaged by the Asian Development Bank). The brackishwater aquaculture area thereafter further expanded and reached 108,280 ha in 1988 (DOF estimated). The Department of Fisheries have been using this figure until 1994-95. But the first author (M Karim) of this paper made an estimate of the culture area in 1993 through DOF field officers and arrived at a figure of 125,235 ha (see Table 2).

Table 2: Districtwise brackishwater aquaculture areas

District	*1982-83*		*1984-85*		*1988-89*	*1993-94*	
	Ha	*% of total*	*Ha*	*% of total*		*Ha*	*% of total*
Cox's Bazar & Chittagong	19,539	37.7	24,468	30.5	27,453	27,385	21.8
Bagerhat	11,013	21.2	22,158	31.5	79,728	40,740	32.5
Khulna	12,817	24.7	13,465	19.1		30,187	24.1
Satkhira	8,001	15.4	13,240	18.8		23,924	19.1
Others	465	0.9	-		1,099	3,000	2.4
TOTAL	51,835	100.00	70,331	100.00	108,280	125,236	100.00

The DOF recently estimated the total shrimp culture area in 1993-94 as 138,000 ha. The figure does not separately indicate the brackishwater farming area. The Galda farming areas excluded, the brackishwater farming area would possibly be around 125,000 ha.

4. CULTURE PONDS

Brackishwater aquaculture in Bangladesh is generally carried out in large tidal ponds each of which actually consist of a large number of contiguous private plots owned by several people. An entrepreneur farmer can lease the land for various lengths of time but normally does not take it for more than three years at a time. The entrepreneurs then separate the leased areas by erecting a high boundary dyke enclosing the land. A pond thus created has its own water inlet and outlet, mostly of wood. Masonry sluices or reinforced cement concrete (RCC) pipes are also used. The water control structures are usually imperfectly constructed. No engineering devices, such as cut-out walls, are adopted to effectively prevent water leakage. The wooden sluices are usually made with unseasoned and untreated wood and, consequently, get deformed and leaky quickly. The dykes are normally low and often have holes in them that allow easy entry of pests animals into the pond. The ponds are shallow, generally not maintaining the required water depth of around 1 m. The pond bottoms are uneven, thereby hampering easy harvest of the cultured shrimp or removal of the pest animals.

5. GENERAL CULTURE SYSTEM

Brackishwater aquaculture in Bangladesh is primarily shrimp-oriented. The target for culture is *Bagda* (black tiger shrimp), *Penaeus monodon.* The culture system is still rather unsophisticated.

5.1 Culture system during the '70s

In the Seventies, when brackishwater aquaculture started as an important economic activity, the culture system was quite primitive. The ponds were large and ill-defined. Pre-stocking pond preparation techniques were not known. Farming almost entirely depended on the autostocking principle rather than on selective stocking with target species. Supplementary stocking with target species was the exception. Initial eradication and subsequent control of pest or competitor animals by poisoning or screening were not practised. Ponds were shallow and often infested with aquatic vegetation. Liming and fertilization techniques were not pursued. The need for stocking healthy fry and pre-stocking acclimatization of fry with pond water was not appreciated. The principles of water management to enhance and sustain the pond's natural productivity were not known. The farming system was not based on science and production depended more on luck than on scientific principles.

5.2 Culture improvement effort during the '80s and '90s

From the early Eighties, the Government of Bangladesh has been endeavouring to improve on the traditional culture practices. The FAO/SIDA Bay of Bengal Programme, the First Aquaculture Development Project (ADB), the Shrimp Culture Project (IDA), the Second Aquaculture Development Project (ADB) and the Third Fisheries Project (World Bank) have all contributed to the national effort in improving on the traditional shrimp culture technology. Techniques that all these projects have tried to transfer to the farmer during the last several years include:

- Nursery rearing of post-larvae;
- Pre-stocking pond preparation by drying,pest eradication, liming and fertilization to stimulate production of natural food organisms in the pond;
- Screening of the pond sluices with a fine-meshed synthetic screen to prevent or reduce intrusion of pest animals through incoming tides;
- Selective stocking with *Bagda* (tiger shrimp) post-larvae;
- Maintenance of around lm depth of water;
- Selection of healthy post-larvae and their acclimatization to the growout pond water **before** stocking;
- Water management, to sustain adequate natural food production in the pond and to maintain appropriate levels of oxygen, pH temperature and salinity;
- Regular sampling of water quality;
- Recording of input supply information, shrimp growth data; production and sale proceeds **data;**

— Post-harvest care; and

— Analysis of data for future improvements of culture operations.

The demonstration, extension and training activities under the projects have created interest and awareness about improved technology and management amongst the farmers. However, applications of improved techniques are still haphazard, imperfect or incomplete in most farms and not suitably adapted to the specific farm conditions. As a result, farm production levels have not improved much. The farmer's incapability as well as the farm's structural inadequacies both contribute to the, low production.

6. VARIOUS CULTURE PRACTICES IN USE

6.1 Based on species mix

6.1.1 Mixed culture of Bagda with heterogeneous species

Screens are not used or are used only occasionally. In this type of culture, entry of non-predatory fish, e.g., mullets and such species of exportable shrimp as Penaeus indicus (white shrimp) and Metapenaeus ***monoceros*** (brown shrimp), is desired, but heterogeneous species of highly predatory fish and crabs also enter the pond freely. Bagda fry is stocked separately.

6.1.2 Monoculture of *Bagda*

In this type of family, culture of ***Bagda*** alone is intended. But a pure monoculture seldom exists because of the inevitable intrusion of pest animals because of imperfect screening. As a result. most monoculture farms are degraded and become mixed culture farms.

4.2 Based on alternation of crops

6.2.1 ***Bagda*** alternating with paddy

February-mid-August: ***Bagda*** (normally with heterogeneous shrimp and fish, which are either deliberately allowed entry or are intruders)

Mid-August-December: Transplanted ***aman***

Rotation of aquaculture with agriculture is the most commonly practiced farming system in the brackishwater belt of the southwestern zone which covers the Bagerhat, Khulna and Satkhira Districts. During the high salinity period (February-July), marine and brackishwater shrimp and fish are cultured. During freshwater or the low salinity period (August-December) cultivation of a slat-resistant transplanted ***aman*** paddy is done in the elevated parts of the field. Simultaneous with the paddy, the leftover undergrown euryhaline shrimp and fish may continue to grow in the ditches of low-lying parts of the farm. Some farmers even combine freshwater shrimp (Macrobrachium rosenbergii) and fish, e.g., tilapia, carp, Thai sharpunti, etc., with the euryhaline species.

Seasonal shrimp culture in rotation with paddy in the same field is an excellent example of integrated farming practice in which aquaculture and agriculture support each other rather than compete against each other. The shrimp excreta, cast-off shells, leftover feed and the residual fertilizers all add to the fertility of the soil and improve paddy production. On the other hand, stumps of harvested paddy and the ploughing of the soil help increase productivity of the water and, hence, production of shrimp. However, prolonging the brackishwater aquaculture process and occupying land beyond the optimum period for paddy transplantation often creates serious conflicts between the aquafarmers and agricultural farmers. Such conflicts are unfortunate, but certainly avoidable. Crop rotation is not only good for both crops. but also helps sustain productivity of the soil.

6.2.2 *Bagda* alternating with salt

December-April: Salt
May-November: Bagda (normally with intruder species)

In the eastern zone, where the salinity level in general is much higher than in the western zone, shrimp culture and salt production in rotation is the usual practice. Shrimp is cultured during the wet season, mid-May to mid-October, while salt is produced during the dry and high saline period of December April.

6.3 Based on seasonality of brackishwater

6.3.1 Seasonal culture

Fehruary-mid-August:	Most areas in the Khulna region and many places in Cox's Bazar region.
May-November:	In salt production areas in Chakoria, Maheshkhali and Teknaf.

6.3.2 Perennial culture

In a few areas, where river salinity is suitably high the year round, shrimp is cultured almost perennially. Such farms are found in Syamnagar, Koira and Assuni *thanas* in the southwestern zone and Taknaf, Maheshkhali and Cox's Bazar *thanas* in the southeastern zone.

6.4 Based on the fry stocking and harvesting system

6.4.1 Continuous stocking and continuous harvesting

Be it seasonal culture or be it perennial culture, this involves one-time pond preparation in the beginning and one-time complete harvesting at the end. During the whole culture period, multiple stocking and harvesting are done. This is the usual practice amongst the farmers.

6.4.2 One-time stocking and periodic harvesting

In this case, there is one-time stocking in the beginning, periodic harvesting during the culture season and complete harvesting at the end of culture. A new culture cycle is restarted every 4-5 months after pond drying, liming and fertilization in double crop areas where suitable salinity is available for at least eight months. This type of culture is ideal, but most farmers do not practise it.

6.5 Based on water source

6.5.1 Completely tide-dependent

This is by far the most common culture practice. However, tidal inundation in the greater part of the farming area in February, which marks the beginning of culture season, is quite inadequate. The land is relatively high compared to the tidal height. Most of the farming areas in Bagerhat District, nearly three-fourths of the area in Cox's Bazar District, and more than 50 per cent of the area in the Khulna and Satkhira Districts cannot be tidally inundated under even 50 cm of water at the beginning of the culture season. Yet, the farms depend upon tide alone. Chakoria and Rampal are the two *thanas* which have the largest areas of *Bagda* farms, but they are amongst the worst from the point of view of tidal inundation. Supplemental pumping could significantly increase productivity here, but it is not used.

6.52 Completely pump-dependent

Several hundred ponds in the Kaliganj and Shyamnagar *thanas* of Satkhira District are located at rather high levels and are not inundated by tide at all. These farms depend completely on pumped water, mostly low-lift but some are shallow.

6.6 Based on the fry stocking rate and the degree of management

Three basic types of culture systems seem to exist:

i) The extensive type;
ii) The improved extensive type; and
iii) The semi-intensive/intensive type.

The salient features of the three types of culture are summarized in Table 3.

Table 3: Selected features of three existing culture types

Culture type	*Artifical stock of Bagda per m^2*	*Liming and fertilization*	*Artificial feeding*	*Screening*	*Aerator*	*Pumping*	*Shrimp production kg/ha/year*
Extensive	I-I.5	No	No	No or very imperfect	No	No, tide-fed	150-200
Imperfectly Improved extensive	1.5-3.0	Yes	No/Yes	Yes, but not perfect	No	No, or completely pump-fed	250-750
Semi-intensive/ Intensive	20-40	Yes	Yes	Yes and much better than in improved extensive	Yes	Partly tide-fed and partly pump-fed	3000-6000

6.6.1 Extensive type

This is the predominant culture type currently in practice. An estimated 75 per cent, or over 93,000 ha, of the brackishwater culture area (125,000 ha) is under extensive culture. The average production of shrimp is possibly 175 kg/ha.

6.6.2 Imperfectly improved extensive type

An approximate 25 per cent or 28,000 ha, of the culture area is under what can be called 'imperfectly improved extensive type of culture' or is in a transitional state between extensive and improved extensive type. The shrimp production possibly averages 300 kg/ha.

6.6.3 Semi-intensive/intensive culture

'Semi-intensive shrimp culture' is a term for which an internationally, regionally or locally acceptable definition is not available. In Bangladesh, the term is very loosely used, assigning no upper limit to the stocking rate. The culture system as it is being practised at present, consists basically of high stocking rates (25-60 m^2), heavy artificial feeding, pumping of water and using aerators. The SO-called semi-intensive culture (which is actually intensive) sporadically demonstrated impressive production results exceeding 5t/ha in 4-5 months in 1993. The high production rates, although achieved only in a few farms for one season, generated a great deal of enthusiasm amongst the entrepreneurs and many financial institutions. In 1994, 36 farms, covering an estimated are of 700 ha in the Cox's Bazar District, started semi-intensive shrimp culture. But the shrimp in most of the farms suffered mass mortality due to diseases. A similar disaster recurred in 1995 also.

That unplanned and uncontrolled high intensity shrimp culture practices, as started by many private farmers in 1993, could lead to outbreak of shrimp diseases, mass mortality and environmental pollution had been earlier predicted by some local experts. The Ministry of Fisheries and Livestock, referring to the expert opinions and to the experience of Taiwan, the Philippines, China, Thailand and some other countries, cautioned all concerned against the possible hazards of high-intensity shrimp culture.

7. CRITERIA FOR APPROPRIATE FARMING TECHNOLOGY

In view of the country's depressed socioeconomic status, low technological base, private ownership of most of the suitable land, short-term leasing systems, lack of infrastructure, diversified environment in terms of land elevation, tidal inundation and hydrological characteristics, a production technology can be called appropriate only if it satisfies all or most of the following criteria:

— Requires low capital;

— Can be applied to land taken on short- and medium-term lease;

— General farmers can easily adopt with short-term training;

— Can be applied in existing farms without substantial topographic changes;

— Production is much higher with relatively low financial risk, compared to the traditional methods;

— Little or no dependence on imported machinery and raw materials;

— Little or no dependence on machinery that require electricity supply (which is not available in most of the coastal areas or, where available, is seldom stable and dependable);

— Can create new employment opportunities;

— Can benefit all or most of the farmers in an ecological area for which the technology is intended:

— Does not pollute, upset or degrade the ecosystem or cause diseases (Bangladesh shrimp is still disease-free and of pollution free origin. The shrimp is raised completely on natural food rather than artificial products and no antibiotics or any prophylactic chemicals are used in the farms. As a result, the Bangladeshi shrimp enjoys an advantage in the international market.);

— The farming system can be sustained on a profitable basis year after year: and

— Keep production cost low, thus allowing easy survival of the product in the competitive international market. (Bangladesh can more effectively attract a foreign market by offering a lower price than by attractive presentation of its products).

A culture technology, should not be recommended, however high its production potential is, if it cannot be sustained on a long-term economic basis and if it creates a clearly adverse impact on the environment.

8. RECOMMENDED FARMING SYSTEMS

Having considered the criteria given above to determine culture technologies appropriate for Bangladesh. the authors recommend the following diversified culture technologies for marine shrimp, for farms of different environmental qualities and farmers of different financial and technical backgrounds.

8.1 *Monocrop* Bagda *area:* Bagda *alternated with paddy*

Within the suitable shrimp culture area, land in which soil and water salinities remain below 3 ppt continuously for at least four months, thereby allowing paddy production, should be utilized for improved extensive culture of tiger shrimp' alternating with salt-resistant transplanted aman, the latter could be simultaneously grown with euryhaline fish, *galda, tilapia, carp sharpunti,* etc.

Tiger shrimp:	February-end July/mid August
Paddy:	August-December

The culture techniques for Bagda shrimp are summarized below:

MONO ***CROP*** BAGDA ***AREA: Shrimp alternated with paddy***
ALL IMPROVED EXTENSIVE, NO SEMI-INTENSIVE CULTURE

i) Ponds having adequate tidal inundation, manuring and fertilization

No feed	250-400 kg/ha
Suppl. feed	400-600 kg/ha
Supp.feed + pump as needed :	500-800 kg/ha

ii) Ponds with inadequate tidal inundation, tide + pump, manuring and fertilization

No feed	300-500 kg/ha
Suppl. feed	500-800 kg/ha

iii) Ponds not tidally inundated at all, completely pump-fed. manuring and fertilization

Suppl.feed	600-800 kg/ha

'NOTE: For tiger shrimp culture, only those areas where river water or underground water salinity remains at or above 8 ppt continuously for at least four months are considered suitable.

8.2 Monocrop Bagda *area:* Bagda *alternated with salt*

In many parts of the Cox's Bazar area, salinity of water is too high (above 25 ppt.) to permit ***Bagda*** culture or the tidal height is too low to adequately inundate the pond during the dry season (December-April). In these places, salt should be produced during the dry season and ***Bagda*** during the wet season (May-November).

Tiger shrimp :	May-November
Salt	December-April

The culture techniques for ***Bagda*** shrimp are summarized below.

MONO CROP **BAGDA** ***AREA: Shrimp alternated with salt***
ALL IMPROVED EXTENSIVE, NO SEMI-INTENSIVE CULTURE

i) Ponds having adequate tidal inundation, manuring and fertilization

No feed	**250-400** kg/ha
Suppl. feed	**400-600** kg/ha
Supp.feed + pump as needed :	5004300 kg/ha

ii) Ponds with inadequate tidal inundation tide + pump, manuring and fertilization

No feed	**300-500** kg/ha
Suppl. feed	**500-800** kg/ha

8.3. Double crop area: Two Bagda *crops*

Within suitable shrimp culture areas, land where paddy cultivation is not feasible even in the wet season, because of prohibitive levels of soil salinity (above 3 ppt.) and water salinity remaining at or above 8 ppt for eight months or longer, the following culture modules for two crops of ***Bagda*** could be demonstrated and introduced. Improved extensive type would be the general farming system, but the semi-intensive system on a limited scale could also be tried in selected areas when sufficient fry and sufficient suitable feed could be locally produced in hatcheries and feed mills to meet the additional demand.

DOUBLE CROP *BAGDA* AREA: *Two Bagda* crops
IMPRO VED EXTENSIVE

Ponds having adequate tidal inundation, ponds completely tide-fed, manuring and fertilization

No feed	450-550 kg/ha (250-300 kg) + (250)
Suppl. feed	500-800 kg/ha (250-500) + (250-300)
Suppl. feed + pump as need :	600- 1000 kg/ha (350-600)+(250-400)

Tide + pump, manuring and fertilization

No Feed	450-650 kg/ha (250-400)+(200-250)
Suppl .Feed	500-900 kg/ha (250+600)+(250+300)

SEMI-INTENSIVE

Tide + pump + aerators

Feed	Stocking 7-15/m2
Production	2,300-4,500 kg/ha (1300-2500)+(1000-2000)

9. *SOME SELECTED ISSUES AND RECOMMENDATIONS*

9.1 Low production rates, reasons and recommendations

9.1.1 Reasons

Much of the extension efforts for improving on the traditional culture system has been wasted because the recommended culture techniques could not be appropriately applied in most of the existing farms. The reasons for this are:

— Ponds are generally unmanageably large and have irregular shapes, uneven bottoms, shallow depths, inadequate and leaky sluices and inadequate water supply and drainage networks.

— Ponds are mostly in land taken on short-term (l-3 years in most cases) lease; the lessees are, therefore, not permitted by the owners to excavate the land for construction of canals for water distribution, or build higher peripheral dykes, to hold the appropriate depth of water, and partition dykes, to reduce pond size into easily manageable units. Now the ponds are, therefore, exceedingly large and have shallow water depths, hardly exceeding 45 cm as against the required lm depth.

— Because of their very large sizes and shallow depths, enhancement of productivity of such ponds by pest control, fertilization, feeding, water exchange or any other improved management techniques is very difficult.

9.1.2 Recommendations

Culture infrastructure development

One or the other of the following options could be adopted:

i) The land owners of each area should form one or more association (s) and develop the ponds as an integrated complex with **common** water supply and drainage canals. Each pond owner, however, should undertake shrimp culture in his pond.

ii) Alternatively, the land owners may decide to sell their land to other farmers or lease it out on a long-term basis, with permission to the lessees to bring about the structural changes required to undertake semi-intensive shrimp culture. In this case also, an integrated development approach will be required to ensure appropriate utilization of the entire area.

iii) As a third alternative Government should provide polder-specific total development plans and create a basic supply and drainage network (gravity flow or pump lifting) on either side of selected rivers. This will encourage farmers to undertake further development and improvements on their own. For example:

- — Construction of a large number of suitably designed ponds with improved water supply and drainage systems.
- — Reduction of large ponds into easily manageable small units. For improved extensive type of farming. l-5 ha unit should be suitable. The size should not exceed 10 ha.
- — Utilization of a much greater proportion of the land located in areas suitable for shrimp culture.

iv) As a fourth alternative, the Government may do the necessary development work either on khas land or acquired land and allot the ponds to interested individual farmers or their associations on appropriate terms, more or less on the principle adopted by RAJUK or private housing estates for house construction.

9.2 Land-use conflicts, and policy

9.2.1 Need for policy

Conflicts on the use of coastal land for paddy, shrimp, salt and mangrove plantation, cattle grazing, etc. exist and often lead to social and technical problems. Most of the problems could be avoided if there were a policy for land use.

9.2.2 **Policy recommendations**

Land classification

Based on land topography, tidal inundation, water salinity, soil quality and other environmental factors and relative economic return, a land utilization policy should be urgently formulated. Land should be classified and assigned to one or a few specific uses, for which the land is technically most suitable and economically most profitable.

Earmarking land for brackishwater and freshwater shrimp

- The coastal area where river water salinity remains at or above 8 ppt. for at least four months of the year should be declared as brackishwater aquaculture area.
- Land within the declared brackishwater aquaculture area, where river salinity remains at or above 8 ppt. for at least 8-9 months of the year, should be primarily utilized for brackishwater aquaculture, with shrimp as the major culture species. Other farming activities, if any will have to be adjusted to shrimp farming.
- Land where soil and river water salinity remain below 3 ppt. for four months or more, can be utilized for both paddy and shrimp in rotation: paddy during the low saline months and shrimp during the high saline period. The land must be freed for paddy production by August 30th.
- Land where soil salinity is always over 3 ppt. and river water salinity over 25 ppt. for a few months during the dry months could be used for brackishwater aquaculture alternated with salt production: salt during dry months and aquaculture during wet months.
- Monsoon-flooded or tidally-flooded low-lying freshwater or slightly brackishwater upto 7 ppt. areas close to a natural source of wild seed or to a hatchery should be considered on a priority basis for M. *rosenbergii* and fish polyculture. Suitable culture areas located far from seed sources may be taken up later as hatchery techniques develop on a commercial basis.

9.2.2.2 EARMARKING GOAT AND CATTLE GRAZING LAND

Within both high and low saline areas. some high land should be specifically earmarked for growing green fodder for livestock. The owners of the land should be appropriately compensated by the shrimp farms.

9.2.2.3 EARMARKING LAND FOR MANGROVE PLANTATIONS

9.2.2.4 SELF-FARMING OR LAND LEASING

Formulation of policy for private shrimp land utilization is needed to encourage landowners to culture shrimp directly, either individually or in groups, or lease out their land on a long-term basis and allow the lease-holders to suitably alter topography of the land, by way of raising dykes, excavating canals etc., to enable adoption of improved culture technology. The and should not be allowed to keep any culturable land unutilized or underutilized.

9.3 Dearth of culturable shrimp fry

The most frequently encountered complaint from the shrimp farmers is the dearth of Bagda fry.

9.3.1 Present status

Both Bagda shrimp fry and Galda shrimp fry prices shot up 50-100 per cent in 1994 compared to 1993. In 1995 Bagda fry price went further up, exceeding Tk 3000 per thousand in the Khulna region. Both price hikes and the abnormal scarcity of Bugda fry adversely affected shrimp culture in 1994 and 1995.

Taking advantage of scarcity and the resultant high price of shrimp fry, some people imported millions of fry from Thailand, Taiwan and Indonesia where shrimp diseases and mass mortalities of cultured shrimp have been a recurrent feature for the last several years. The situation has given rise to strong criticism and deep concern amongst shrimp farmers and environmentalists. Large-scale disease and mass mortality of shrimp in the intensive and semi-intensive farms in Cox's Bazar have aggravated the concern.

Despite the scarcity and high prices, there are colossal wastage of the fry. A close analysis of the issue indicates the following :

— The existing Bagda farms(125,000-135,000 ha) stock an estimated 2,600 million post-larvae (at 20,000/ha).

— The farm-raised Bagda shrimp production (17,500 t) represents an estimated 20 per cent survival (525 million shrimp of average weight 30 g) of the stocked post-larvae, revealing huge post-stocking wastage.

— The stocked quantity of post-larvae represents a possible two-thirds of the quantity of *P.* monodon fry actually caught from Nature; the other third (1.3 billion) die due to handling and transportation mortality.

— The cultured Bagda accounts for an estimated 13.5 per cent of the total Bagda fry caught (3,900 million).

— Nearly 200 Bagda hatcheries would be required to produce the number of fry that are caught from the wild.

As of now, Bangladesh depends almost entirely on Nature for culturable shrimp seed supply. The country's most efficient operational tiger shrimp hatchery at Cox's Bazar produces about 20 million post-larvae. Some sites have been earmarked by the Government for establishing tiger shrimp hatcheries, but they are all in the southeastern zone. The southwestern belt, where 75 per cent of the marine shrimp farms are located, does not have suitable environmental conditions for tiger shrimp hatcheries. There are a few Macrobrachium hatcheries which produce only a few million post-larvae.

9.3.2 Recommendations

Stop wastage of wild fry resources

In view of the environmental limitations affecting marine shrimp hatcheries, appropriate measures should be immediately taken to stop wastage of the valuable natural resources which Bangladesh is getting absolutely free from Nature. The following measures are recommended:

- Organized surveys of the Bagda post-larvae in the lower reaches of all the southern rivers, to assess the true magnitude of natural fry resources.
- Scientific collection of Bagda fry from the lower reaches of the southern rivers and from the sea surf avoiding, or substantially reducing, wastage of non-target aquatic organisms.
- Transportation of the fry from the catching areas to the fry-marketing and farming areas using modem technologies.
- Pre-stocking acclimatization of the fry with the culture pond water.
- Stocking of fry in the pest-free and well-prepared ponds.

Promote establishment of *Bagda* shrimp hatcheries in the private sector.

Five areas have been identified in Cox's Bazar District for the establishment Bagda shrimp hatcheries all in the western part of Teknaf and Ukhiya thanas bordering the Bay of Bengal. The five areas are located along a 40 km stretch and have an approximate total area of 105 ha and a combined sea frontage of 9 km. However, final selection of the site is subject to availability of adequate freshwater and consideration of its secured elevation above tidal bores. The recommended areas are in addition to an already declared hatchery zone in Kalatoli. The site should be further investigated and what is judged suitable land should be allocated to genuinely deserving candidates at the earliest. The Government would have to establish essential common infrastructure facilities in the areas. Investigations should also be made on the feasibility of establishing floating hatcheries or closed system hatcheries for Bagda shrimp in the Khulna region.

Promote various feasible modules of *Macrobrachium* hatcheries.

These should include:

- An open water system using surface water or underground water. A survey of suitable underground saline water should be undertaken expeditiously.
- A closed (recycling) system using brine water transported from salt beds.
- Open and closed systems combined, in areas where river water salinity remains suitable for only a few months.

Establish a modern system for fry transportation from the hatcheries to the farming areas and/or to the nursery areas.

Develop large-scale nursery systems to hold *Bagda* shrimp and *Galda* fry through the winter months (September to January) for stocking in growout ponds in early February. This should be done in order:

- to utilize the off-season cheap fry of Bagda and Galda,
- to start Galda culture as early as February, rather than in July, in ponds having a perennial water source, and
- to raise a full crop of tiger shrimp before the onset of the monsoon, which sometimes starts as early as May. A drastic drop in river salinity, due to heavy freshwater run-off, is rather common in the Chakoria area.

Conserve shrimp broodstocks

- Ban use of behundi nets in the entire stretches of the selected rivers from the estuarine zone down to the sea in order to encourage unhindered seaward breeding migration of the pre-adult shrimp during June-August. The would-be brood shrimp are most undesirably removed by hundreds of *behundi* nets set in the estuarine rivers.
- Ban off-shore shrimping for a month during the peak tiger shrimp breeding season.

Conserve and propagate mangrove cover

Any further destruction of mangrove forests or bushes, either natural or planted, for expansion of shrimp farming or for any other purpose, should be completely banned with immediate effect in order to:

- Conserve the primary sources of nutrients for all the aquatic organisms in the estuarine environment;
- Conserve the nursery and shelter grounds for the multitudes of shrimp and fish fry, including those of the tiger shrimp; and
- Reduce erosion of the river banks and keep the silt load low in the rivers.

The Sundarbans forests, already degraded or depleted by human interferences or otherwise, must be appropriately replenished and improved at the earliest.

All the estuarine river banks, outside the shrimp farms, **must** be compulsorily afforested by the farm owners with appropriate mangrove species. The Forest Department should supply the seedlings against payment and also provide technical advice to the shrimp farm owners on mangrove plantation and maintenance, Wherever feasible, suitable trees (e.g., Eucalyptus, *ipil ipil,* coconut, casuarina, acacia, etc.) should be planted on the dykes.

9.4 Artificially formulated feed

9.4.1 Present status

In order to intensify shrimp culture beyond 400-500 kg/ha/crop, artificial feeding may be necessary, There exists only one operational feed mill -- at Valuka, Mymensingh. Apart from its products, a few other feeds of local origin and under various brand names are available.

Some of the essential feed ingredients, e.g., fishmeal, vitamin-mineral pre-mix, binder, etc., are in short supply. Some people import finished feed from Thailand and Taiwan. Storage facilities for feed at the field level are very poor. Shelf-life of feed even under good storage condition is about three months only. The farmers often offer rancid feed to the farm, creating health problems for the farm animals.

9.4.2 Recommendations

Formulated shrimp feed of various pellet sizes should be manufactured within the country. Feed adequate for 25,000 ha of improved extensive farming of Bagda shrimp **(1000** kg/ha) and 500 ha of semi-intensive farming (3000 kg/ha) and 10,000 ha of *Galda* farming (1000 kg/ha) should be locally produced on a priority basis. The feed must be of international quality.

- Local feed ingredients should be utilized as far as possible;
- Export of ricebran, wheatbran, oil cake should be banned in view of the fact that these are essential components of cattle, poultry, fish and shrimp feed;
- Any shortfall in fishmeal and vitamin-mineral pre-mixes, food-binder, etc, should be imported;
- The feed manufacturers will have to ensure appropriate storage arrangements at the field level;
- Regular quality monitoring of the feed stored at various levels should be introduced;
- Heavy import duties should be levied on imported finished feed, while imports of essential raw materials not available locally should be duty- and tax-exempted in order to encourage establishment of local industries.

9.5 Other recommendations

9.5.1 Cautious approach to semi-intensive shrimp culture

Defining intensity of 'semi-intensive shrimp culture'

The Ministry of Fisheries and Livestock has restricted the stocking rate at 7-15/m^2 for semi-intensive culture. We support the rate and strongly remind farmers not to exceed the upper limit. At this stocking rate, the production could be 1400-2300 kg/ha/crop: this is high enough.

Careful site selection

Semi-intensive shrimp culture would be justified only in carefully selected, perennially saline areas where two *Bagda* crops could be raised and the risk of environmental pollution is minimal. *Report on the Site Selection* of Bagda *Shrimp Hatchery Zones and Semi-intensive* Bagda *Shrimp Farming Areas,* released by the Ministry of Fisheries and Livestock in August, 1994, is a useful guide for selecting suitable sites for semi-intensive marine shrimp culture.

Appropriate time for expansion

Bangladesh is not immediately prepared for semi-intensive shrimp culture on any appreciable scale, even at the recommended lower stocking rates. Semi-intensive culture efforts should not be taken up in isolation without first ensuring steady supplies of seed and feed of local origin, trained manpower and infrastructure.

Engineering design

The existing semi-intensive farm should have an adequate reservoir to stabilize the supply water quality before the water is introduced into the culture ponds. The farm should also have built-in facilities for treatment, disinfection and dumping pond sludge. Pond sludge must not be thrown into the river. Water from a diseased pond should be appropriately treated in a treatment pond before being released into the open water system.

Experimental-cum-demonstration

Two experimental model farm complexes, each of about 25 ha, could be established, one in Teknaf and one in Shyamnagar, as joint ventures of the public sector and carefully selected private farmers.

9.5.2 Pilot-scale operation before commercial operation

Large-scale application of any engineering design or new farming technology must be preceded by careful testing on a pilot scale of the proposed development model. Appropriately adjusted or improved as needed, the model can later be replicated on a large-scale with confidence.

9.5.3 Extension units

The farming area should be divided into several representative extension units, based on tidal inundation, water salinity, type of water supply (tide-fed or pump-fed), soil quality, farm type, etc. At a convenient point of each unit, a private farm should be used for a few consecutive years to demonstrate improved culture techniques, suitable under the local environmental conditions. Each unit should have at least one of such demonstration farm, which must play an effective role in extending improved cultural practices to the neighbouring farms.

9.5.4 Research support

The FRI's brackishwater aquaculture research programme must be chalked out in close collaboration with the shrimp culture demonstration unit officers and the farmers. The technical problems already identified by DOF field officers and the farmers themselves must be addressed with utmost priority.

In the case of M. rosenbergii, the hatchery operator can handle broodstock collection/development and nursery rearing along with hatchery operation because of the simplicity of techniques involved in the various activities.

9.5.5 Infrastructure in shrimp farming areas

Government should urgently establish essential infrastructure facilities, e.g., roads and waterways, power supply and telephone connections in the shrimp farming areas.

Improved transportation systems will help maintain the shrimp quality, besides ensuring construction materials and production inputs, et.g., seed, feed, fertilizer, pumps, etc. can be transported quickly. Power supply will encourage private entrepreneurs to establish much-needed ice plants in remote areas and inspire farmers to use pumps. Electricity will also contribute to the security of the farm property and shrimp stocks.

9.5.6 Incentives

To farmers:

- Shrimp farming should be considered as an export-oriented industry and producers should receive various investment incentives, similar to shrimp trawler operators and shrimp processors and exporters.

- Any perennial shrimp farm producing at least 1000 kg of *P. monodon* or other marine shrimp of not less than 30 g average size per hectare per year should be given special financial concessions and a certificate of honour. Any seasonal shrimp farm producing 500 kg/ha/yr of *P. monodon* or other penaeid shrimp of the above mentioned counts should also enjoy the above privileges.
- Duty-free import of farm equipment, feed and other materials should be allowed and Government should ensure that the benefits of these concessions reach the general farmers.

To extension officers:

The DOF officer directly associated with the best demonstration and extension results or activity under each district should be awarded a Certificate of Merit and a cash incentive for meritorious work each year. The Government should have a system of annually selecting the officers directly connected with the best demonstration and extension work in each shrimp district.

10. PLACE OF SMALL-SCALE SHRIMP FARMERS

In Bangladesh, influential and rich farmers take on lease a large number of plots from landowners, many of whom are small farmers. The small farmers are often forced to lease out their lands to the big farmers. Data available from the Department of Fisheries suggest that the average size of existing farms is 15 ha, but farms well over 200 ha also exist. The ponds are exceedingly large compared to those common in Thailand, Indonesia, Taiwan, etc., where ponds over 5 ha are rare.

Although the big farmers deserve appreciation for developing a new export-oriented industry and bringing it to the present scale, the current ownership pattern should not go unchecked in the greater interest of society. Increased poverty, landlessness and the likely social unrest warrant changes in the farming system. The socioeconomic factors inhibiting direct participation of the small and marginal landowners in profitable shrimp farming practices should be immediately looked into and a practical solution to the problem aimed at.

Can small or marginal landowners pursue shrimp farming individually? Developing individual farms by erecting earthen dykes around a large number of small and scattered individual plots may not be technically feasible in most cases as the structures are likely to undesirably interfere with the water circulation within the gher. This leads us to wonder whether small landowners and big landowners can jointly farm in a cohesive group or as a cooperative and share the costs and profits of farming.

The big landowners (lease-holders) are unlikely to take the initiative in this regard, but even if they do, the small landowners generally will not feel confident of establishing joint venture with a much more powerful counterpart. The Thana Shrimp Culture Regulation Committee is authorized by the Government to help and assist the marginal and small landowners to form co-operatives to undertake shrimp farming by them. But, to date, a genuine co-operative farm has not been reported as surviving for long.

Whatever be the reasons of failure for not developing a co-operative/group farming system in the past, a concerned society cannot remain a silent observer to such a social issue. If something concrete is not done soon, many of the small or marginal landowners will soon degenerate into landless people with no definite source of income or employment. Group farming or co-operative farming, despite its past failures, is very likely the best approach to try afresh with new strategies. With Government backing, through adequate bank loans, legal rights, technical and management training, and State patronage, a viable group/co-operative farming system may gradually develop. An attempt could be made along these lines in a few selected *ghers.*

Apart from the above institutional approach, a new technology could possibly be tried to benefit the small landowners. Penculture appears to be a prospective technology, allowing farming in a gher on an individual as well as group basis. An individual small farmer could enclose his plot with suitable netting material without interfering with water circulation in the *gher.* The holders of a number of contiguous plots could instal their pens side by side so that costs on common walls could be obviated. Instead of very small individual pens, several neighbouring farmers could jointly put up a large pen enclosing their plots, this could be a further cost-saving.

However, penculture in a *gher* is only a concept; it has not been tried anywhere so far. Before demonstrating its techno-socioeconomic viability on experimental pilot scale, the technology should not be recommended for general use.

Promotion of small-scale farming to benefit the small and marginal farmers is, ironically, a very big task, a task which the society cannot and should not evade any longer in its own interest. ‘Small is beautiful’. Let our efforts be to establish it.

PAPER 5

STRATEGY FOR INTEGRATED MANAGEMENT OF LAND AND WATER IN FCDI PROJECTS WITH FOCUS ON FISHERIES DEVELOPMENT

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SUMMARY

The present trend of land and water development, with the single objective of increasing agricultural production, mainly paddy, has led to neglect to other water sectors, such as fisheries, navigation, environment management and industrial water supply. The main casualty of the present development process has been the fisheries sector. It is now recognized that great opportunities exist for utilization of the land and water resources of the country in an integrated, balanced and comprehensive manner that will not only lead to growth both in the agriculture and fisheries sectors but also resolve many environmental problems.

In the past, the water development included interventions aimed at i) flood protection with polders in order to enhance agricultural productivity, ii) drain wetlands for making them available for crop production, and iii) provide irrigation by pumping either groundwater or surface water. These have led to loss of habitat and prevented the movement and migration of fish from rivers and waterbodies to flood plains and vice versa. This has contributed to a rapid decline in openwater fisheries. However, flood protection improved conditions for expanding and intensifying pond fish culture.

To mitigate the adverse affects of flood embankment and regulators in flood control drainage and irrigation projects (FCDI) the introduction of fish passes has been proposed under the Flood Action Plan and, at present, pilot level projects are being implemented.

While mitigatory measures are being evolved, there exist many opportunities for integration of fisheries development components in already completed FCDI projects. These include i) fish stocking and fish cultivation in burrow-pits; ii) aquaculture in ponds/tanks; iv) aquaculture in dead channel/rivers; v) integrated fish farming; vi) fish culture in paddy fields; vii) pen culture of fish; and viii) shrimp culture in the coastal polders.

Finally, the paper recommends proper integration of fisheries management requirements in all future water development projects.

1. INTRODUCTION

There is a distinct pattern in the annual water cycle which dominates life in Bangladesh: excessive water during the monsoon, causing flood, and insufficient water during the dry season, creating a drought-like situation. These two extremes have influenced the planning strategy for the development of land and water in Bangladesh requiring effective measures for flood mitigation, irrigation and drainage. Water resources development, including flood management, has till now been considered the key factor in the economic development of Bangladesh. In fact, developments in irrigation together with flood mitigation and drainage infrastructure, in areas where they have already been completed, have created a regime wherein other agricultural inputs may be effectively utilized to enhance the yield rate of rice crops. However, this trend in land and water development with the single objective of increasing production in agriculture (mainly paddy), has led to neglect to other water sectors such as fisheries, navigation, salinity control in the coastal area and domestic and industrial water supply. Concerns are being expressed about the various adverse aspects of water development projects and questions are being raised about the present strategy of land and water management in the country. It is being recognized that great opportunities exists for utilization of the land and water resources of the country in an integrated, balanced and comprehensive manner that will not only lead to growth, specially in the agricultural and fisheries sectors, but also resolve many environmental problems (Nishat 1986. UNDP 1989, and MPO 1986, The World Bank 1989). The main casualty in the present development process has been the fisheries sector.

A predominantly agrarian society dependent on climate and weather. evolved in Bangladesh over the years. Excepting for the farmers themselves lifting water from ponds and streams to provide supplementary irrigation by indigenous methods, there were no major efforts in water development. Agriculture was mainly rain-fed and the traditional rice varieties, aus and aman, were the main crops. There was no conflict with growth of fish in the wetlands. food plain and rivers.

But with the rapid increase in population, it soon became a fact of life that Bangaldesh suffered from a chronic shortage of foodgrain. It became clear that increased production of foodgrain had to come from intensified use of available land as well as by increasing the yield from the crops grown, as there was' virtually no additional land to be brought under cultivation. The situation was reviewed in 1957 by a UNDP-sponsored mission and it was concluded that water development was essential for higher agricultural production and that the control of floods was the central issue (Siddiqui & Nishat 1986).

In 1959, the present Bangladesh Water Development Board (BWDB) was established and was assigned responsibility for water development, i.e. to plan. design. construct, operate and maintain such development schemes. A Master Plan was prepared in 1964, the broad strategy of which was to reduce damage to crops, first, by providing flood protection, and then, boosting crop production through use of modern agricultural techniques, e.g. chemical fertilizers. Irrigation was to be introduced at a later stage. Such a strategy essentially required large flood-protection schemes and most of the major projects of BWDB have been developed by following this strategy. In the meanwhile, the present Bangladesh Agriculture Development Corporation (BADC) had been created in 1961 and entrusted with the task of procurement and distribution of inputs and equipment for modern agriculture, such as tractors. low lift pumps (LLPs), tubewells (TWs), seeds, fertilizers and pesticides: and they became the instrument for implementation of small, quick maturing irrigation projects, i.e. installation of LLPs and TWs.

In 1972, the Land and Water development strategy was reformulated with assistance from IBRD and high priority was attached to small schemes that emphasized the use of agricultural inputs, winter irrigation and quick drainage of low-lying areas for cultivation of winter boro paddy. This strategy constituted a major ingredient in the programme of the BWDB and BADC, and was reflected in all the Five-Year Plans of the country formulated so far. These activities succeeded in giving a boost to foodgrain production.

To respond to the need for development of an integrated land and water development strategy, the National Water Plan (NWP) project was initiated in 1983. The project was given the task to formulate a perspective water development plan for the period 19852005 based on a comprehensive assessment of all natural, human and financial resources. The plan was to allocate a fair share of the scarce water resources to various sectors and to formulate water development strategy and plans so as to ensure harmonious growth in different water use sectors. Phase-I of the NWP study was completed in 1986. In Phase-II, completed in 1991, the Phase-I report was updated. Unfortunately, agricultural production remained the target of the NWP and the incorporation of the requirements of the fisheries sector continued to remain unattended.

In 1987 and 1988, Bangladesh experienced two of the most severe floods on record. Widespread damage was caused to crops, roads railroads, cities and towns, and more than 3000 people lost their lives (World Bank 1989). Floods cause a major setback to the country's economy, in part because of the heavy expenditures incurred by the Government in its relief efforts and in part by the disruption of economic activities. The flood of 1988 stimulated the Government to undertake a comprehensive review of the planning approach of ongoing activities and work began on a flood policy study and a flood preparedness study (UNDP 1989). Studies were also carried out by professionals from Japan, France. U.S.A and China (Nishat 1992). All these studies were reviewed and an integrated approach for flood mitigation based on the concept of 'controlled flooding was recommended (UNDP 1989). The Flood Action Plan (FAP) was formulated and study of different components under FAP is going on (World Bank 1989). In fact, it was envisaged that the studies to be undertaken under the FAP umbrella would pay full attention to the needs of the fisheries sector while preparing land and water development plans. But though some attention to the fisheries sector has been given in the FAP's regional studies, the focus still remains concentrated on the agriculture sector. However, one special study was commissioned, known as FAP-17, which was to recommend how fisheries development could be integrated in land and water development projects. The FAP process is expected to be reviewed by the end of 1995, in order to set out the future course of action. As such this National Seminar is being held at a very opportune moment and its recommendations would provide concepts and strategies for integrating the fisheries sector in the management of the country's land and water resources.

2. IMPACT ON FLOOD CONTROL DRAINAGE AND IRRIGATION PROJECTS ON FISHERIES

Impacts on fisheries due to the present Flood Control, Drainage and Irrigation (FCDI) projects have been evaluated in a number for studies (e.g., Ahmed 1987). The FAP has contributed significantly to the literature. Notable among them are the Fisheries Study (FAP-17), the FCDI Agricultural Study (FAP-12) and the Northeast Regional Study (FAP-6). Growing awareness of the cumulative negative impact on inland capture fisheries of the progression of flood control embankment and polder type projects throughout Bangladesh. and of the general lack of basic information with which to assess the scale of the problem, led to the inclusion of a fisheries component in the terms of reference for FAP- 12. wherein 17 projects were evaluated through the Rapid Rural Appraisal (RRA) technique. Five of these projects underwent further in-depth study through Project Impact Evaluation (PIE) methodology (FPCO 1992a). This section summarises the findings of FAP-12 on the impacts the FCDI projects have had on fisheries.

The RRA surveys were carried out from late April until mid-July 199 I. during the first half of the

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monsoon flood season when fish production is lowest, whilst the PIE's took place in the second half of the monsoon, from July to October. The latter period includes the peak time for subsistence floodplain fishing and the time when the heel and river fisheries are revived and move towards their peaks around November to January. The timing of these studies was dictated by circumstances rather than by choice, but from the fisheries side. it was advantageous to see conditions during the flood season, despite the difficulty of contacting fish pond owners and fishermen.

The overall conclusion of FAP-I 2 was that there were two main areas of fisheries impact: firstly, relating to pond fish culture, which benefited from FCD, and secondly, inland capture fishing, which almost invariably suffered severe damage. The pond culture benefits accrued mainly to land owners and farmers, whose land-holdings already benefited from positive agricultural impacts, whereas the impact on capture fishing adversely affected large numbers of landless fishermen. The net impact was negative in the majority of cases.

2. I Impact on the capture fisheries

Indications from the RRA surveys were that virtually all the projects contributed to the decline in fish stocks targeted by inland capture fisheries by obstructing fish mitigation routes, thereby reducing the riverine spawning stocks and preventing the return distribution of fish fry to the floodplain. Land reclamation by drainage works has greatly reduced the areas of permanent water bodies and. especially within FCDI projects, many once perennial beefs have been rendered seasonal if not permanently dry. The spawning and rearing areas for a number of non-migratory, resident floodplain and *beel* fish species have, thereby, also been reduced, with similar effects on the stocks of such fish. Catch rates have also declined, with fishermen in several of the projects, studied claiming reduction of upto to 75 percent which they blamed in large part on the FCD project concerned. RRA findings with regard to submersible embankments. which only protect against early monsoon flood, were that they cause less damage to fish stocks because they only delay fish migrations to and from the rivers rather than prevent them.

Other significant findings pertaining to the capture fisheries were:

- All the projects. except for the submersible embankments have greatly reduced the right of free common access to catch fish for subsistence needs during the flood season.
- Virtually all the projects. except for the submersible embankments have resulted in many former full-time fishermen having to seek other work, at least on a part-time basis. At the same time, there has been an influx of other landless people into part-time fishing for the first time.
- All the projects, except for the submersible embankments facilitate the development of enhanced commercial fishing, based on regular restocking of water bodies with hatchery-produced fingerling. Fishermen and traders confirm that this is happening. but they have doubts whether the strangle-hold of the local elite and wealthy on such fisheries can be broken in favour of the fishermen.
- The existing designs for FCD sluices and regulators cannot he operated to enable fish to pass in either direction, and conventional fish ladders are not suited to the needs of local fish species.

An important PIE finding on capture fisheries was that the daily catch, per fisherman, now averages around 2.5 kg., compared with 4.6 kg before the FCDI projects. Current and pre-project control area averages are both lower than these, partly because fishermen on the affected areas have a better chance to make up some of their open water losses by catching pond fish for pond owners who lack the means to harvest their own fish. As expected, the great majority of fishermen reported decreases of 25 percent or more in catches of all the major species groups, namely the major carps, Hilsa, catfish. live fish (shing, *Magur* and Koi) and the Snakeheads, showing that riverine and floodplain species were equally vulnerable.

2.2 Impacts on culture fisheries

RRA findings were that all the projects, except for the submersible embankments, created improved conditions for expanding and intensifying pond fish culture and culture-based fisheries in some other permanent waterbodies. However, it was also found that the anticipated benefits did not occur in parts of some of the projects which were subject to rainwater congestion caused by inadequate drainage provision or where there were frequent breaches of the embankments. Even in areas where flood protection could be maintained, the RRAs concluded that the response by pond owners frequently fell far short of expectation because there was repeatedly a general lack of credit to finance pond re-excavation and rehabilitation as well as problems stemming from multiple ownership of many ponds and the inability of aquaculture extension staff to meet the needs of prospective fish farmers.

Pond owners' views on the reasons for improved performance in the impacted areas included flood protection, higher fish prices, improved availability of good quality fish seed and improved technology, all leading to increased profitability., However, many problems still remain, notably the high risk of fish being affected by the current epidemic of ulcerative syndrome fish disease. The supply of fisherlings still presents difficulty in some parts of the country, and the risk of over-flooding is still unacceptably high.

The findings on the impact of FCDI projects on fisheries are summarized in Table I.

The principal conclusions arising from FAP 12 are:

— There has been a very substantial decline in the freshwater capture fisheries resources and catches concurrently with the implementation of major parts of the FCD and FCD/I programme.

— Despite the general lack of reliable data, the study has established that fish stocks and production overall have fallen by more that 25 percent in recent years and that in some places the loss may be upto 75 percent as reported by many of the fishermen concerned. A major cause of the decline is the blockage of fish migration routes by FCD structures.

— Consequent on these declining catch rates. there has also been a drop of up to 50 percent in the number of full-time professional fishermen coupled with an influx of at least a similar number of new part-time fishermen according to RRA report. These changes are not recorded, but the pattern suggests that the total effort may not have greatly increased since the late 1980s.

— Given the reduction in fish stock size, even an unchanged level of fishing effort will cause overfishing and the present widespread use of illegal small mesh nets only makes matters worse. FCD and illegal overfishing are both implicated in the decline to date, but unless changed or checked both have the potential to inflict even greater damage in future.

— Among the recommendations for future mitigatory and remedial action, it is proposed that all future FCD projects give particular consideration to fisheries impacts, make appropriate adjustments to structural design and include specific mitigatory provisions to assist the fishing communities whose livelihood will unavoidably be adversely affected. The DOF must be fully involved and assisted where necessary. To marshal the resources needed, publicly-owned waterbodies in project areas should be protected and managed to optimize fish production instead of being drained. Riverine fish breeding stocks should be rebuilt by all possible means and, in particular, all existing fisheries regulations governing fish protection must be vigorously enforced.

Table 1: FCD/I Project Impacts on Fisheries (Source: FPCO 1993 a)

Project	Type	Capture Fishery Production			Culture Fishery Production		fishermen's employment	Fishermen's earnings	Overall	Remarks
		Avers	Beels	Flood plain	Fish ponds	Lager bodies				
Chalan Beel "D"	P	-2	-2	-2	t l	t l	-2	-2	-2	The loss 'leader'
Kurigram South	P	-1	-2	-2	+2	t l	-2	-1	-2	Fish culture OK, otherwise negative
Meghna Dhonagoda	P	-2	-2	-2	t 2	t l	-2	-2	-2	Fish culture OK, otherwise negative
Zilkar Haor	S	-1	-1	-1	0	t l	-1	-1	-1	Less damaging to fish stocks
Kolabashukhali	P(T)	-2	-2	-2	t l	+1	-2	-2	-2	Good potential for fish culture
Protappur	P	0	0	0	t l		0	0	t l	A neutral project
Nagor River	P	-1	0	0	t l		0	0	-1	Without cuts would be -2
Sonamukhi	D	0	-1	0	t 2	t l	-1	-1	0	Could improve
Sakunia Beel	P	-2	-2	-1	t l	0	-2	-2	-2	Good potential for aquaculture
Silimpur	E	-1	-2	-2	t l		-1	-1	-1	Sandy soil inhibits aquaculture
Katakhali Khal	E	-2	-2	-2	t l	+1	-2	-2	-2	Area no longer a surplus fishery
Halir Haor	S	-1	-1	-1	0	0	0	-1	-1	Less damaging to fish stocks
Kahua-Muhuri	P	-2	-2	-1	t l	t l	-1	-2	-2	Could be improved
Konapara	E	-2	-2	-2	t 2	0	-1	-2	-2	Major restocking effort in beels needed
Polder 1712	`P(T)	-2	-2	-1	t l	-1 (*)	-2	-2	-2	Shrimp farming needs controlling
BRE-Kamarajan	E	-1	-2	-2	-1	-1	-2	-2	-2	Drainage congestion floods ponds
BRE-Kazipur	E	-1	-2	-1	-2	-1	-2	-2	-2	Erosion of BRE main problem

Source: PLEs and RRAs

Prqect Type: P=Polder; P(T)=Tidal polder; S=Submersible embankments; E=Single Embankment, D=Drainage only.

Fisheries Impact- 0=No change, +1 = Increased by some extent; +2 = increased substantially: 1 = d

(*) The area of shrimp farms has reduced since Polder 1712 were completed. so could be rated -2 but the remaining area seems stable, and with proper control could be expanded for benefit of local small farmers

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3. MITIGATION OF ADVERSE IMPACTS OF FCDZ PROJECTS

A major concern when embankments are used to protect areas from extreme floods in Bangladesh is the perceived detrimental effect on the important floodplain fisheries (FPCO 1992a, FPCO 1992b). There may be several reasons for this and one that has been put forward is that the gated structures (regulators) used to control the flow into the embanked areas, inhibit fish movement or damage fish in passage. It is possible to mitigate the negative impacts due to restriction of river bank overspill, through structural additions and/or modifications to flood schemes. Fish passes can be installed to assist both upstream migration and to facilitate downstream movement of adults and passive drift of hatchlings (FPCO 1992b).

Migrating adult fish, under normal flood levels, are most likely able to pass through existing structures, but the distribution of fish fry being carried downstream from the spawning grounds to the floodplains is limited and hatchlings are possibly damaged when passing through the regulators. The possible problems when fish fry negotiate regulators are :

- total obstruction to fish passage:
- physical damage to the fish through contact with the structure.
- damage to the swim bladder through rapid changes in pressure: and
- damage arising from turbulence downstream of the structure.

A regulator of normal design using vertical life gates. will not completely exclude fish fry, but it may delay them if the gates are undershot and the gate opening is small. Damage to fish by contact with the structure would most commonly occur because the velocities are high. Culverts using impact energy dissipators are unsuitable for fish passage but this type of dissipator is used where tail-water depth is low and fish movement is not likely to be high. Culvert regulators could be improved to some extent for the passage of fish by increasing the size to minimize velocities and by streamlining the entry.

Damage to the swim bladders of fish could be a serious problem and is most likely to occur with undershot gates operating at small openings. Free surface flow, as occurs with overshot gates or fully open gates, will minimize this problem. Turbulence downstream of a regulator is not yet a proven cause of damage to fish fry in passage, but clearly it is preferable if the exposure of fish fry to the often violent downstream fluctuations can be minimized.

In order to evaluate the various options availabe to minimize the negative impacts of flood control infrastructure on fish production. it could be useful to discuss some basic issues with respect to the life cycle of fish and their migratory characteristics. This section has been based on FAP-17 (FPCO 1992b).

3.1 Life cycles of fish

A great range of niches are available within the river floodplain complex which contribute towards the characteristics. great diversity and the high biomass of the fish present. Fish of tropical flood river systems tend to show rapid growth and short life cycles compared to lake fish or temperate species.

The life cycles and behavioral patterns of fish which inhabit river and floodplains that have well defined seasonal flood regimes are closely related to changing water levels and river discharge. Large annual fluctuations in volumes of river-and flood water cause seasonal shifts between predominantly aquatic and terrestrial environments. The fish and ecology are strongly influenced by the flood regime and the alteration between aquatic and terrestrial phases. Extreme oscillations. in conditions and in the distribution and availability of resources, exert a profound effort on the productivity, community dynamics, biology and behaviour of the fish. Life cycle patterns of behaviour that have evolved are synchronized with the cyclical nature of the flood regime that determines environmental capacity and food availability. The seasonal changes in the hydrology of the river and floodplain environment are probably the most important stimuli of changes in feeding and breeding activities. dispersal and movements of fish which,. in turn, determine, sexual activity. rates of growth. specific associations and oxygen requirements.

During the wet season, the over-bank spillage of floodwater from the main river channels through secondary rivers, onto the flood plain, provides important pathways for fish to enter and migrate into the floodplain area. The flooded floor plain presents a dramatic increase in environmental capacity (living space) and resources. As the floodwaters recede and the supply of resources upon the floodplain diminish, large numbers of fish retreat to the river channels and drainage systems (khals) and to the residual permanent waterbodies (beels). Growth is rapid in both juveniles and adults in the flood season, but slow or even negative during the dry season. Floodplains are the major food resource for the fish inhabiting tropical river systems.

The flood cycle is an essential element in the life history of most of the fish in the rivers. The inundation of the floodplain provides the spawning grounds, nursery areas and the major feeding opportunities for many of the 256 species which have been recorded as found in Bangladesh (Rahman 1989). Many of these species migrate considerable distances upstream, under the stimulus of the rising waters, to reach the spawning areas, and also move out over the floodplain as the waters spread. These fish depend upon the flood cycle to provide feeding grounds, space for reproduction and the environmental triggers that synchronize their life cycles with the flood cycle of the rivers. The movements of fish populations for spawning and feeding must be co-ordinated and it is the information derived from the changing water conditions during the flood cycle which provides the basis for such co-ordination.

3.2 Migration characteristics

Few flood river fish are confined to one habitat. The species that reside on the flood plain and beels at the height of the dry season tend to be those that have adapted to withstand limiting conditions (such as-desiccation, isolation and deoxygenation) in the dry season pools. Of these. some are restricted to a small geographical area and make only short migrations (20-30 km). Others, however, migrate substantial distances, upto several thousand kilometres. between very different habitats.

For fish inhabiting seasonal floodplain river systems, the extreme spatial and temporal differences in the distribution of resources mean that the optimum habitat for feeding rarely coincides with that for breeding. The two sites may be isolated and separated and migrations between the two will have to be undertaken to optimize available resources. With breeding grounds upstream of the feeding grounds (floodplains), the relatively immobile eggs and hatchlings drift downstream towards the feeding grounds in the first stages of their development. The developing fish are then transported and dispersed by the floods through the secondary river systems and by the time they reach the floodplains they are at a stage in their development when they are able to exploit the rich food resources.

Fish migration is most commonly associated with a behavioral response to currents. The nature of this response can, however. change during the life cycle of the species. the fundamental distinction of response is between active upstream migrations, usually of adults to their spawning grounds, and

Figure 1. The seasonal cycle of events in a floodplain river (Source: FPCO 1992 b)

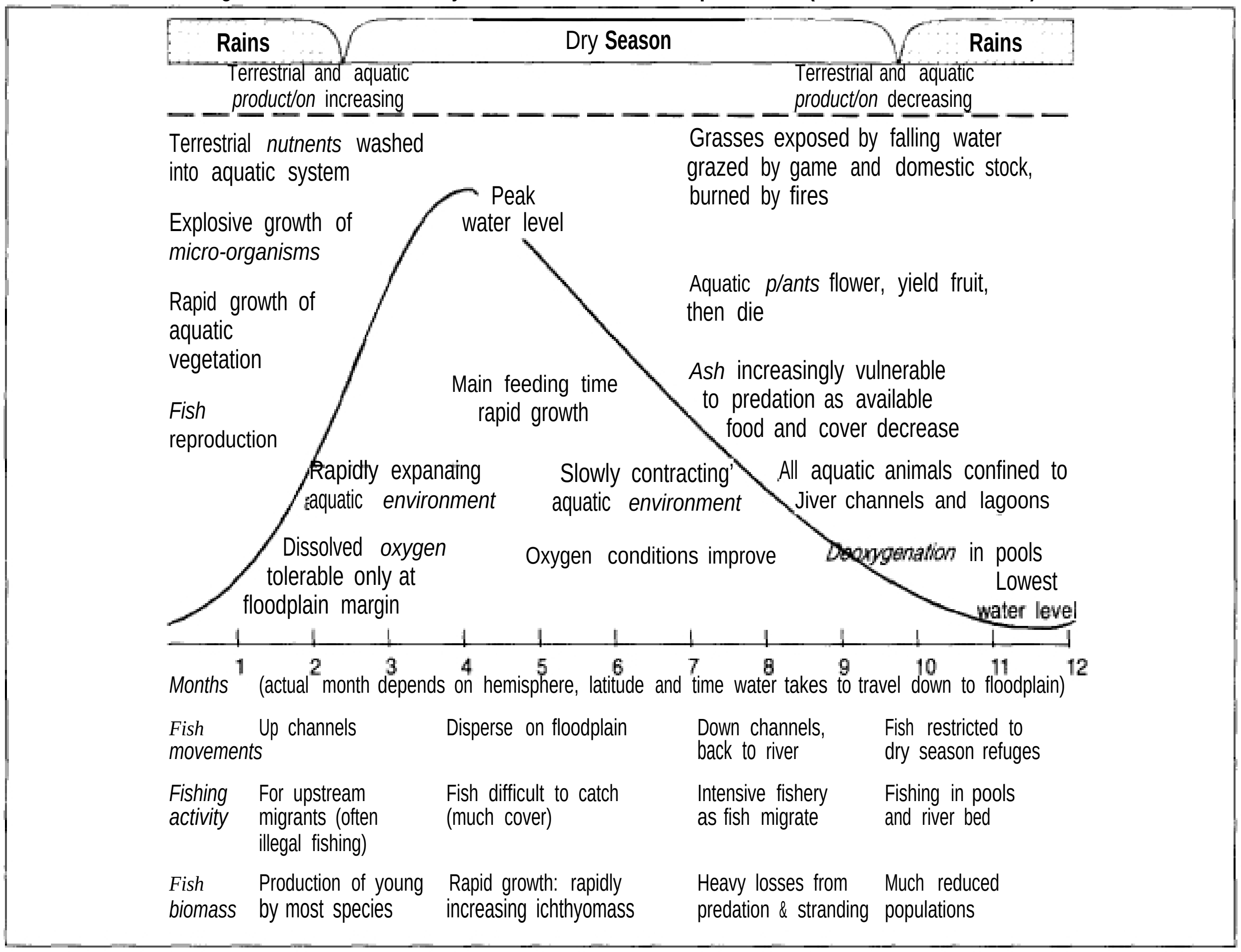
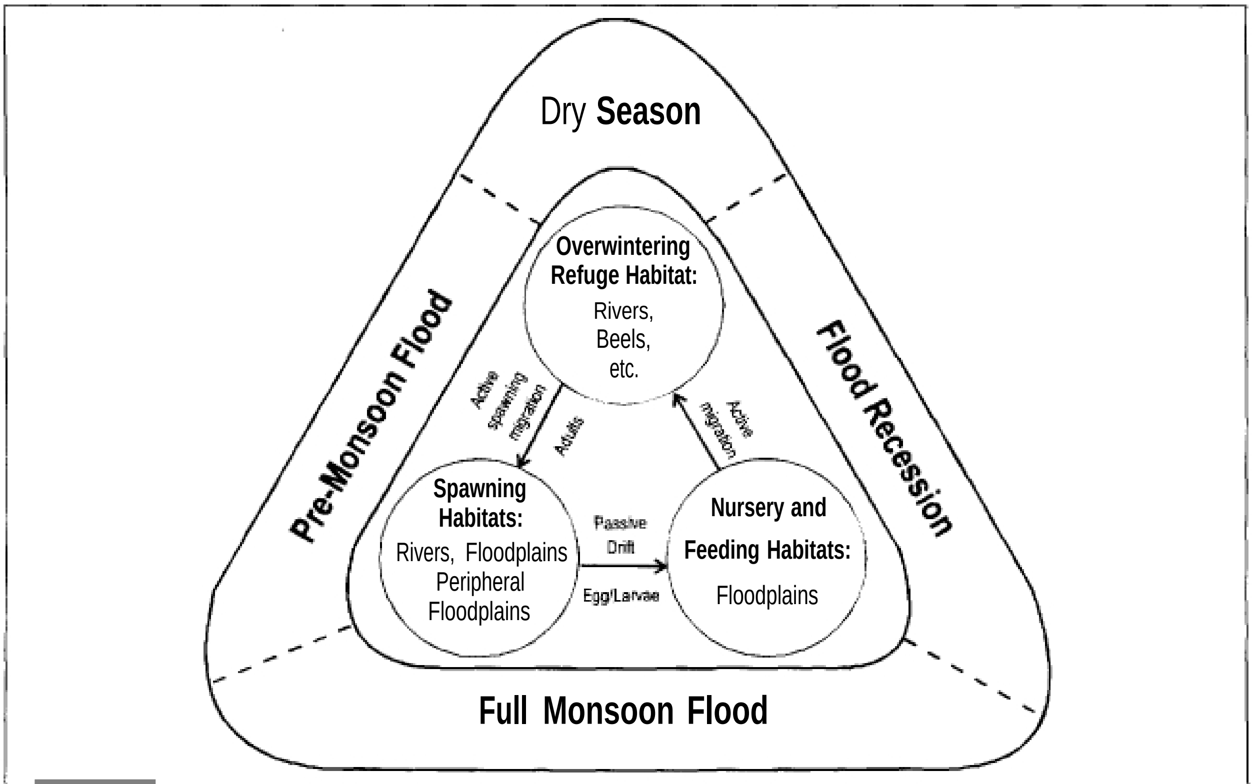


Figure 2. Basic pattern of migration between feeding, spawning and nursery habitats



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the passive combined active/passive downstream migrations of juveniles. For the population to be maintained in the river, both phases need to be considered (Fig 2).

Whilst this is the basic pattern, different species of fish differ in the extent of the various responses. With regard to migratory response, the fish communities of southern Asia are divided into 'black fish' which are essentially resident on the floodplain and 'white fish' which show some distinct migratory movement within the river system. usually associated with spawning.

The 'black fish' community are those which would normally retreat into heels or other residual water after the floods have receded. They are predominantly those species which are commonest in the kua or fish pits, which trap the last remnants of the floodplain waters. As the resident water is used ever more intensively, the dry season habitat and refuges for these species diminish.

The 'white fish' community can be divided into three categories, depending on the extent of migration:

- those with considerable longitudinal migrations, which may be followed by lateral migration onto the floodplain;
- those with limited longitudinal migrating followed by latitudinal migrations onto the floodplain; and
- those which are truly anadromous, moving from the sea and into freshwater.

There are few direct observations on the migration of fish in the rivers of Bangladesh. It is necessary, therefore, to infer the most probable pattern of events from observations elsewhere in the Gangetic or Brahmaputra systems or from other regions with hydrological conditions which are essentially tropical. It would appear that by far the greatest number of migratory species in Bangladesh exhibit Category (ii) type migrations (FPCO 1992b). However, it has been suggested that the major carps migrate long distances even beyond the borders of Bangladesh, to spawn (Tsai and Ali 1983, but evidence of fry catches along the banks of the Padma suggest local spawning grounds given that there is little possibility for upstream migration because of the Farrakah Barrage just over the border in India. It is probable that the spawn is locally produced, as in the Kaptai River (Tsai and Ali 1985). The position of catfish in Bangladesh is least clear. The common catfish has been mentioned as migrating onto the floodplain and show movements of the Category (ii) type. The diafromous Hilsa shows large scale movements from the estuary into the river during the monsoon season, such as typical of Category (iii) migration.

3.3 Impacts of water control structures

Table 2 identifies the possible impacts of FCDI schemes on the fisheries production as a matrix of the alteration of the hydrology of the floodplain against the consequences of various environmental characteristics, fish behavior and fisheries production.

Reduction of flood extent will decrease the extent of the feeding grounds for the fish. with a consequent fall in production of the fisheries.

Reduction of flood depth may increase productivity of the aquatic environment and increase the availability of nestin g sites for 'black fish' species; the effect of this on overall fisheries production in uncertain, but could well increase the productive potential of the residential 'black fish' species.

Restriction of river bank overspill will delay the inundation of the flood, which will disrupt the

Table 2: FAP Fisheries Production impact Matrix (Source: FPCO 1992 b)

Characteristics of existing situation	*Possible Impacts of Engineered Flood Control Mechanisms Affecting Fisheries Production*				
	Reduction of Flood extent	*Reduction of flood depth*	*Restriction of river bank overspills*	*Reduction of wafer throughput*	*Drainage 'congestion*
Environmental capacity	Reduction of flood-plain environment		Delay of inundation of flood-plain		Uncertain
Water quality				Increased risk of pollution eutrophication and deoxygenation	Possible stagnation
Ecosystem production	Decrease in aquatic productivity. Loss of nutrient input for terrestrial production.	Increase in aquatic productivity.		Reduction of environmental production.	Uncertain
Land use	Increase in cereal production. Increase in aquaculture opportunities.	Increase in crop security	Increase in crop security	Degradation of land and water resources	Waterlogging. Loss of agriculture
Biodiversity	Loss of aquatic and terrestrial biodiversity		Loss of fish biodiversity; depletion of migratory species.	Loss of biodiversity	Uncertain
Fish migration			Loss of migration routes and decrease in distribution of fish hatchlings over the flood-plains.	Degraded environment	
Fish reproduction		Possible increase for nesting sites.	Disruption of breeding cycles.	Increase in natural mortality.	
Fish growth	Decrease in feeding grounds for fish	Uncertain	Loss of access to flood-plains; reduced feeding opportunities.	Degraded environment, loss of feeding opportunities,	
Fish production	Loss in production	Increased production potential for "black" fish. Outcome for fisheries production uncertain.	Increased susceptibility to capture due to restricted entry to the flood-plains through regulators and channels. Long-term reduction of fisheries production.	Reduction in fisheries production	Uncertain
Environmental stability	Short-term increase in stability				
Environmental sustainability	Possible loss in sustainability				
Fisheries resource sustainability	Loss in sustainability		Increased susceptibility to overfishing	Increased susceptibility to overfishing	Uncertain

breeding cycles of 'white fish' species and decrease the distribution of 'white fish' hatchlings over the floodplain. This would have a major impact on the biodiversity of the fishery and an unknown effect on the productive potential of the fishery. In addition, restricted access to the floodplain through channels and regulators would allow application of more efficient fishing techniques, leaving the fishery more susceptible to overfishing and a consequent fall in long-term production.

Reduction of water flow through the flood control scheme will increase the risk of pollution and a consequent degradation of land and water resources, leading to a fall in production.

Finally, increased drainage congestion will increase the aquatic habitat, but the effect on environmental capacity will be uncertain, given the possible impact on water quality; the effect on fisheries production would therefore be uncertain.

3.4 Fish passes

It is possible to partially mitigate the negative impacts due to restriction of river bank overspill through structural addition and/or modification of flood control engineering. A number of structures, which might collectively be called fish passes or fish ladders, have been devised to circumvent engineering structures that obstruct fish movement. Normally, these are found in association with structures that are essentially dams which cut across the main flow of the river. Where barrages are planned that require a fish ladder for fish migrating upstream, the methodology for their design has already been developed. What is required is detailed knowledge of the physiology of the local fish involved and the design parameters of the structure. A fish pass design can then be tailored to a specific structure.

Dams and barrages are designed to maintain differences in heads of water far greater than the meter or so head deferential that may result from the flood control embankment engineering in Bangladesh. There are no main river structures intended to maintain water levels above the nature level. The concept of fish ladders to enable fish migrating against the current to surmount large permanent variations in water level is, therefore, generally not applicable in Bangladesh. Nevertheless. the principles used in the design of such structures are essentially the same as for the design of structures that allow the movement of fish onto the floodplain.

There is no experience of fish passes in Bangladesh and very little information on the swimming characteristics of the fish species involved. Those characteristics and the likely response to various types of fish passes will have to be extrapolated from information gathered in other parts of the world. Before the design and operational characteristics of a fish pass can be decided upon, those species of the migratory response which are being catered for need to be identified.

River discharge provides the essential directional clues to physiologically prepared fish to move upstream whilst also offering increased resistance to progress. Fish migrate normally at some intermediate cruising speed and only rarely at maximum speed. If current velocity in the main river channel exceeds their swimming ability. the fish will move closer to the bank where velocities are generally slower. The presence of turbulence or whirlpools tends to disorient the fish.

3.5 Applications in Bangladesh

The concept for fish ladders, to enable fish migrating against current to Surmount permanent large variations in water level, is generally not applicable in Bangladesh, as there are no main river structures intended to maintain water levels above the natural level. the common regulatory structures used in Bangladesh are the regulators with vertical gates controlling both the inflow of water into an area and the outflow drainage from it. There are normally situated across secondary rivers and drainage systems that traverse embanked flood control schemes.

Most often, the inflow of water is controlled by large undershot sluices, the gates of which can be opened between compartments and the rising river to allow controlled volumes of water into the cultivated area. The drainage sluices can be of the same type (undershot), but can also take the form of a large steel gate which opens automatically as the pressure builds up behind it. Simpler overshot gates can be used for the same purpose. The drainage sluices allow the evacuation of rainwater flooding from the compartment during the rains and allow the water level in the compartment to be finely controlled in relation to the inflow channels to facilitate rice cultivation.

These regulators and sluices can be modified to improve their 'fish friendliness', prevent fish kills, minimize physical harm to fish, and avert detrimental changes in their behavior.

4. OPTIONS FOR INTEGRATION OF FISHERIES DEVELOPMENT COMPONENTS IN ALREADY COMPLETED FCDZ PROJECTS

In order to harvest the potential of aquaculture within FCDl projects, both FPCO and Ministry of Fisheries and Livestock (MOFL) have worked out various options for integration of fisheries development in FCDI projects. An innovative proposal suggesting fish culture in rice fields has also been proposed. This section is based on the proposals of MOFL (1993).

4.1 Fish stocking and fish cultivation in burrow-pits

Burrow-pits, after implementation of irrigation, drainage and embankment projects, usually lie unused. Some fish which grow naturally in some of these pits are caught by poor people. These pits could be turned into nursery ponds and could be used for growing of quick-yielding species. Up to 1.25 million fingerlings per hectare can be produced by modifying the size and depth of these pits besides about 1.5 of high-yielding fish, like *Sarpunti* and *Tilapia.* The required rehabilitation includes earth excavation work and water control structures.

4.2 Aquaculture programme in ponds/tanks

Before the flood control and irrigation projects were implemented, production of fish in ponds in flood-prone areas was very low. Aquaculture was risky because there was the possibility of inundation. Once flood control infrastructure was built, this risk greatly diminished. According to present experiences, about two tons of fish per hectare can be easily produced in ponds.

4.3 Aquaculture in canals

Aquaculture in the canals of the FCDI project is possible by maintaining suitable water levels, and providing some basic facilities without disturbing the irrigation programme. This would require setting up iron-nets or meshes at certain distances and establishing fishing management units. About 700 kg of fish per hectare can be produced in these canals.

4.4 Aquaculture in dead rivers/channels

Due to the construction of flood control structures. some rivers became closed or semi-closed waterbodies — for example, Dakatia River in the Chandpur Irrigation Project, the Ichamati River in the Panda Irrigation Project and the Kumar River in the Ganges-Kobadah Project. Polders of coastal embankment projects have turned hundreds of rivers into closed lagoons, like the baors of Jessore. Therefore, such methods of fisheries development as followed in ox-bow lakes may well be implemented in these dead rivers. About 500 kg of fish per hectare can be produced in such rivers.

4.5 Integrated fish-farming

Although integrated fish-farming is relatively new in Bangladesh, the concept and practice of integrated fish production with other rural and agricultural activities is not new outside Bangladesh. Integrated fish-farming has been practised for centuries in China. Integrated fish-cum-poultry is also much practised in Thailand and Indonesia. In Bangladesh. fish-farming can quite easily be integrated with other farm activities such as poultry-rearing, cattle-fattening and growing crops. The system could be highly profitable and economical if an appropriate technology and farm management system is established.

4.6 Fish culture in paddy fields

Growing fish in paddy fields is very popular in Indonesia and Thailand. About 23,000t and 90,000t of fish are raised by this process in Thailand and Indonesia respectively, This method of rearing fish is widely practices in Indonesia, where water is provided through canals to rice fields, ponds and pits. In Thailand the method is similar, although not as widespread.

During the rainy season, sufficient water is available in the paddy fields for about four to six months. During this time. the fish grow in a natural way Suitable and quick-yielding species are cultured. These fish are netted from adjacent canals or lowlands where they move as water recedes at the end of the rainly season. About 300 kg of fish can be produced per hectare in this way.

In Bangladesh. there is a very good opportunity of rearing fish in paddyfields, particularly in paddyficlds under irrigation schemes such as those of the Water Development Board. this method does not require feeding the fish. *Punti, Nilotica* and common carps arc not suitable for such culture. It is gathered from Indonesian farmers that fish raised by this method fetch much more profit than the rice grown in the same field.

4.7 Pen culture of fish

Although pen culture technology is used in the Philippines on a subsistence or commercial basis, its application in Bangladesh is still on an experimental basis. Results from such trials have shown that pen culture is not only technically feasible but also economically viable under Bangladesh conditions. The advantages of using pens to grow fish in that the initial capital cost is low. The pens could be built by using locally-available materials like bamboo. rattan and wood. The expected yield is about 500 kg/ha/yr.

5. CONCLUSIONS

Water development in Bangladesh has arrived at a phase where it has to proceed progressively from easy-to-develop single purpose schemes to more complex inter-related projects. This implies the necessary plan for major infrastructure projects, that would unlock the hitherto untapped water resources of major rivers, as they would require longer development periods. Such a strategy, in no way precludes the continued development of easy-to-draw water schemes wherever feasible. The choice will have to be made among alternative technologies, competing and conflicting usage and allocation. This step, however, requires careful monitoring of the land and water sector so as to mitigate adverse environmental consequences from such development.

It is now recognized that the traditional FCDI projects are highly detrimental to the fisheries sector. Flood control embankments. over-drainage, and over-harvesting have been the main causes of decline in open fisheries. However, the potential of closed water fisheries are still to be harnessed.

The hydraulic structures used in FCDI projects should be modified to make them fish-friendly and fish passes should be introduced for easy movement of adults as well as juveniles. Inside already completed FCDI projects, extensive programmes of aquaculture may be undertaken. Fish culture in paddyfields would open up new opportunities in the fisheries sector.

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REPORT OF THE NATIONAL WORKSHOP ON FISHERIES RESOURCES DEVELOPMENT AND MANAGEMENT IN BANGLADESH

PAPER 6

RESEARCH AND INFORMATION NEEDS FOR FISHERIES DEVELOPMENT AND MANAGEMENT

by

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SUMMARY

In the agrobased economy of Bangladesh, the fisheries sector makes a significant contribution to nutrition. employment and foreign exchange earning. The vast water resources, covering some 4.3 m ha of inland waters and 480 km coastline, a subtropical climate and suitable soil and water conditions offer a very high potential for fisheries and aquaculture development. In spite of this, fish production was very low and quite static till 1985. The few development programmes, implemented at that time did not produce the desired results due to lack of research support. As a result. production targets as set for the Second and Third Five-Year Plans could not be achieved. On the other hand, establishment of the FRI in 1984 and subsequent generation of improved aquaculture and management practices have made a positive contribution to almost achieving the production target of 1.2 m tons in 1994-9.5, the final year of the Fourth Five Year Plan.

The review of the country's perspective plan which is now under preparation, identifies the poor socioeconomic conditions of the fishing and farming communities and the lack of integrated resource management research as lapses. Taking into consideration the aquaculture/fisheries potential and the constraints for development. priority research areas have been identified in freshwater. brackishwater and marine aquaculture, and in the management aspects of inland openwater and, marine fisheries. Aquaculture research has boosted this sector and shown an average annual growth of about 17 per cent in the last ten years, now contributing 25 per cent of the total fish production. Considering the enormous potential, research fields identified in freshwater aquaculture include:

— Integrated farming systems;
— Development of GIS and ecoregion specific culture practices;
— Fish feed development;
— Nutritional studies of commercially important fish;
— Development of breeding and culture practices for indigenous and endangered species;
— Pen and cage culture;
— Hatchery and culture system for Golda (giant freshwater prawn);
— Genetic improvement of cultured species; and
— Aquaculture development in FCDI areas and floodplains.

The suggested areas for brackishwater aquaculture research are:
— Hatchery technology for Golda and Bagda (P. *monodon)* shrimp;
— Improved shrimp production systems;
— Polyculture of shrimp and fish;
— Culture of non-traditional species like mud crab and environmental; and
— Socioeconomic aspects of shrimp culture.

In mariculture, research on culture and breeding of mullets, sea bass, grouper, oysters, clams and cockles, green mussel, pearl culture, seaweed culture, etc. is needed to be undertaken. This needs information to be collected on the extent and nature of:
— Inter-tidal waters;

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— Climatic. hydrological and oceanographic conditions;
— Water quality;
— Existing stocks and distribution pattern of selected culturable species;
— Pollution etc.

Greater emphasis on fish and shrimp disease research is of obvious importance **because** of increased risk consequential to intensive aquaculture.

Inland openwater fisheries generating from the vast river systems and floodplains contribute about 5 1 per cent of the total production, that are facing a difficult situation due to over-exploitation and habitat degradation. It is necessary to undertake research on

— Fish stock assessment;
— Population dynamics of major river systems and floodplains;
— Biodiversity;
— Stocking strategies for openwater bodies:
— Community participation and management strategies for the important riverine fishery like hilsa, ***pangasius*** and shrimp etc.

in order to formulate appropriate management policy for conservation and sustainable production.

Marine fisheries production has significantly increased and more or less stabilized to a level at around 24 per cent of the total production. Management of the multispecies and multigear artisanal fisheries is rather complicated and information on the resources needed for the development of management measures necessary to obtain maximum sustainable yields are absent. The immediate research needs for marine fisheries development are:

— Stock assessment of pelagic and demersal resources;
— Evolving appropriate catch monitoring systems;
— Development of a model for multigear/multispecies fisheries and to forecast the fish resources in time and space;
— Diversification of fishing methods for untapped and underexploited species:
— Identification of overexploited species and their management for conservation;
— Oceanography:
— Utilization of bycatch and low-value fish;
— Quality control; and
- - Socio-economic conditions of fishing communities.

A strong database, effective inter-agency coordination and dissemination of information through electronic media are very much needed.

1. INTRODUCTION

The three major intertwined challenges facing the world today are alleviation of poverty, meeting current and future food needs, and managing natural resources to assure sustainability. Poverty, combined with population pressures, land constraints and lack of appropriate production technologies for intensification, are a major source of environmental degradation in low-income developing countries (Pinstrup-Anderson and Pandya-Larch, 1994). Aquatic resources have been identified as being important for food security and economic development in many developing countries. Internationally, fisheries and aquaculture products are highly traded goods and the trade grew from 32 per cent in 1980 to 38 per cent of world production in 1990. By comparison, only 4 per cent of rice and 22 per cent of wheat are traded (FAO, 1993).

In the agrobased economy of Bangladesh, fish and fisheries play an important role, contributing 73 per cent of total animal protein intake, providing fulltime employment to 1.4 million people and part time work to 11 million, and contributing some 10 per cent to the total export earnings. An estimated 73 per cent of rural households are involved in subsistence fishing. During the last two decades, emphasis has been on developing the crop sector, with the result that cereal production has increased from 10.26 million tonnes in 1972-‘73 to 19.52 million tonnes in 1992-‘93 and per capita grain production has increased from 137.6 to 167.8 kg. NARS research efforts have played a crucial role in the successful increase in production (BARC, 1995). While the country is reaching self-sufficiency in cereal production, it has lagged behind in the fisheries and livestock sectors. It is only in recent years, when fish production has not been able to keep pace with increasing population and fishing pressures, that the awakening has come. It has been realized that fish stocks are not inexhaustible and that, to improve the situation and keep the fish stocks at sustainable levels, management has to be undertaken on a scientific basis. As production from natural resources declines, the world has been expecting aquaculture production to help bridge the gap between supply and demand. In these circumstances, the fisheries sector has become a major target in the country’s development plans, and is being geared to meet the demand of increasing population through optimum utilization and development of aquatic resources on a sustainable basis.

2. FISHERIES RESOURCES AND PRODUCTION

Bangladesh has been bestowed with vast water resources in the form of rivers, estuaries, floodplains, ox-bow lakes, reservoirs, inundated paddy fields and ponds, covering a total area of some 4.3 million ha. It also has a coastline of 480 km. In spite of these resources, fish production in the past has been low, being 0.774-0.856 million tonnes per annum in the period 1984-85 to ‘89-90, with an annual growth of only 1.47-2.64 per cent . In recent years, however, there has been a substantial estimated increase in production, from 0.856 million tonnes in ‘89-90 to 1.08 million tonnes in 1993-‘94, at an annual growth rate of 4.67-7.25 per cent (DOF, 1994). This has been due to the implementation of various research and development programmes. Nevertheless, production is far from satisfactory. A good part of the inland and coastal waters are either unused or underutilized. The dominant role of the fisheries and livestock subsectors in the agricultural scenario may be seen from the table below.

Table 1: Growth rate(%) in the agriculture sector (1990-1995)

	1990-91	1991-92	f 992-93	f 993-94	1994-95
Agriculture	1.6	2.2	1.8	1.8	0.2
Subsectors					
a) Crops	1.2	1.7	0.8	0.5	- 2.0
b) Forestry	2.1	2.4	3.0	3.0	4.5
c) Livestock	2.2	3.6	6.2	6.2	9.0
d) Fisheries	5.8	6.5	6.6	8.7	8.5

Source: Director General, Department of Agricultural Extension, as published in the *Bangladesh Observer* on 16.10.95.

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A review of previous plans indicate that fish production target, which was set at 1.0 million tonnes during the First Five-Year Plan (1973-‘78), could not be achieved even at the end of the Third Five-Year Plan (1985’90). The target was then set at 1.2 million tonnes by the end of Fourth Five-Year Plan (1994-‘95), in order to increase per capita fish consumption from 20.5 to 25.0g/day. Against this target, a production of an estimated 1.17 million tonnes was achieved during 1994-‘95.

If we look at why the targets set during the first three five-year plans could not be reached, it becomes evident that no major investment or effort was made to develop appropriate technologies and management practices for the development of aquaculture and fisheries. Only in the latter part of the Third Five-Year Plan and during the Fourth Five- Year Plan has the Governrnent made investments in research, and these have started yielding results. It is a well-known fact that the national and international research initiated in the 1960s to increase yields of wheat and rice resulted in the Green Revolution that removed the threat of mass starvation that faced parts of Asia. Investment in research and technological improvements is imperative as they are the only options to assure sufficient production to meet future demands. and alleviate poverty, without irreversible degradation of the natural resource base.

3. PERSPECTZVEPZAN

The Bangladesh Government in its Perspective Plan (1995), has set fish production targets of 1.502. I .824 and 2. I80 million tonnes to be achieved by the years 1999-2000, 2004-2005 and 2009-20 10. when the country’s population is expected to be 136.3, 146.4 and 153.9 million, respectively, to provide per capita fish consumption of 28.38. Il.32 and 33.46 g/day. If these targets are to be achieved. the resource base for fish production must be kept in a healthy functioning state by protecting the regenerative potential of natural stocks, maintaining high quality, high diversity options for the genetic resource base for culture, and protecting the integrity of ecosystem functions in production systems.

However, the combined effect of crop intensification, flood protection measures and siltation are not only contributing to degradation but also to progressive physical alteration and shrinkage of natural water bodies. This is very unfortunate, because fisheries is more profitable, is a major source of animal protein for the rural poor. provides livelihood for a large population group and helps purification and improvement of the environment. Therefore, steps need to be taken to stop/control activities which result in loss of waterbodies. What is a waterbody today should not be allowed to be converted into a cropfield tomorrow. Rather, silted up or degraded natural waterbodies, must be rehabilitated and reconverted as aquaculture facilities.

The Perspective Plan has identified a number of areas where long- and short-term research needs to be undertaken to support development efforts. The identified long-term research areas were:

- Productivity management and maintenance of soil and water quality in ponds;
- Population dynamics and stock assessment of commercially important riverine fish;
- Stock improvement of commercially important fish;
- Man-made changes in inland openwaters and their effects on fish reproduction biology, fish genetic resources and biodiversity;
- Coastal ecology, biodiversity and monitoring,of manmade changes in the coastal environment;
- Mariculture of fin fish, oysters, seaweeds, crabs, molluscs, etc.;

- Productivity and stock assessments and migratory behaviour of the important marine fish; and
- Pearl culture development in the coastal and freshwater areas.

One area of research that does not seem to have been covered much in the proposed perspective plan for the development of culture and capture fisheries is the people involved, i.e., the fish farmers and the fishers.

The failure of technologies and management practices are often due to their mismatch with the social and economic conditions of the target beneficiaries of research. Very little attention was paid in the past to studying and improving the socioeconomic conditions of the farming/fishing communities and they were often identified as the causative factor for over exploitation and depletion of stocks. It is poverty that forces people to use natural resources in an unsustainable way, for their survival. Hence, it is important that adequate attention is paid in the future to studies on socioeconomic conditions of farming/fishing communities and to identify causative factors that are deterring their economic upliftment.

Another strategic area of research in the aquaculture sector is integrated resource management. As farmers are resource-poor, aquaculture should not be looked at in isolation, but as an integral part of their farming systems. With farming systems changing over time, integrated resource management research should be an integral part of the long-term research plans.

Taking into consideration the aquaculture/fisheries potential, the constraints for development and a detailed review of the proposed Perspective Plan, the areas where research needs to be undertaken, to improve productivity in closed waters and develop conservation and management strategies for openwaters, have been identified and are detailed in the following sections.

4. POTENTIAL FOR DEVELOPMENT AND RESEARCH TO BE UNDERTAKEN

4. I Aquaculture

Throughout the world, aquaculture is being looked upon as a panacea for meeting the increasing demand for fish as catches from openwaters decline due to over-exploitation and degradation of fish habitats. Bangladesh is no different. Advantageously. it has 146.890 ha of ponds, 5,488 ha of ox-bow lakes and 140,000 ha of brackishwater areas, where aquaculture can be undertaken. There are also large number of beels (natural depressions) where there had once been abundant fish. These beels, however, have silted up and, being used for growing paddy, are now fishless due to water shortfall and the use of pesticides in shallow water. Upgrading and maintaining the resource base properly will enable aquaculture both in heels and *hors.* In addition, there are some 8 million ha of paddyfields. where aquaculture can be integrated with rice farming.

These water resources offer excellent opportunities for culture of various species: carps, Tilapia, Catfish, various species of prawn and shrimp, etc. Though aquaculture is still in its infancy, it has shown an average annual growth of 16.8 per cent in the last ten years and contributed 36.7 per cent to the inland fish production and 25.30 per cent to the total fish production during 1993-‘94. Production obtained from these aquaculture resources is still below optimum levels, being on an average 1700 kg/ha in the case of carp culture in freshwater ponds (1992-‘93) and 250 kg/ha in the case of shrimp in brackishwater ghers (enclosures). To optimise production on a sustainable basis, research should be strengthened to develop improved aquaculture techniques/ management practices and address the constraints facing the sector.

The Fisheries Research Institute (FRI) has, in the meantime, developed a number of improved aquaculture and management technologies which include:

- Culture and breeding of short-cycled fish like Tilapia and Sharpunti (silver barb).
- Breeding and culture of endangered species like ***Pangas, Pabda, Gulsha*** (Catfish), ***Mahseer*** etc.
- Polyculture of carps.
- Integrated poultry/duck-fish farming.
- Integrated rice-fish farming.
- Development and culture of hybrid Magur (Catfish).
- Development of cost-effective fish-feed.
- Nursery development.
- Breeding and culture of ***Golda*** shrimp.
- Hilsa fishery management.

4.1.1 Freshwater aquaculture

4.1.1.1 DEVELOPMENT OF INTEGRATED FARMING SYSTEMS

Research undertaken in Bangladesh and elsewhere has shown that fish production of over 10 t/ha could be obtained through intensive feeding and fertilization of ponds. However, under the existing socioeconomic conditions in rural Bangladesh, intensive aquaculture is neither feasible nor environmentally compatible. Also, inputs needed for intensive culture systems, such as high-protein supplementary feeds, are not only expensive and beyond the means of rural farmers but are also in short supply. Research undertaken in recent years by the FRI has shown the feasibility of increasing fish productions to over 6 t/ha through polyculture of various species of carps, using agricultural wastes and by-products as feeds and fertilizers.

A key to sustainable aquaculture expansion is its potential to raise total farm productivity and profitability, particularly among resource-poor farm households. This will require rational management of natural resources, care for the environment, conservation of biodiversity, and equitable distribution of benefits among producers and consumers (ICLARM, 1993). Hence, it is necessary to develop fish production systems that easily integrate with the farming systems of different ecosystems and ecoregions. Integrated agriculture-aquaculture, which is an environmentally sound farming system, holds high potential for over 8 million ha of rice farms in the country. Research undertaken in recent years has shown the feasibility of integrating fish culture with rice farming and studies need to be undertaken to develop integrated farming practices for different rice ecosystems, such as medium lowlands. lowlands and deeply flooded lands. Besides, the technology developed for poultry/duck-cum-fish culture needs a coordinated effort (FRI, BLRI) for large scale multilocation research trials.

4.1.2 Development of GIS and ecoregion-specific aquaculture practices

Though the country is small in terms of area, there is wide diversity in soil, water and climatic conditions and agriculture scientists have identified 30 major agroecological regions. Unlike in agriculture, where soils and soil fertility have been mapped upto thana/union levels, information with regard to aquaculture resource characteristics is not available. Hence it is necessary to develop Geographical Information System (GIS) for aquaculture and develop ecoregion-specific aquaculture technologies/ management practices.

4.1.3 Fish feed and nutrition

To increase fish production beyond the natural productivity of cultured waters, supplementary feeding is a must. A balanced feed, in terms of protein, fat, carbohydrates, vitamins and minerals. with optimum energy levels is essential for maturation and reproduction, besides growth.

The nutritional requirements vary from species to species and at different stages of their life history. In many countries, formulated feeds are developed for specific species, depending on their nutritional requirements. Fish-feeding practices in Bangladesh are quite arbitrary and do not conform with the actual or specific nutritional requirements of the species being cultured. This obviously hampers production. Therefore, the knowledge of the exact requirements of fish. both in terms of major and trace elements, is much needed in order, to be able to develop quality feeds not only to maximize production but also to ensure the quality of aquaculture production.

At present, farmers in Bangladesh use rice bran and oil cakes (mustard, peanut, soybean, etc.) as supplementary feed in carp culture, while fish meal is used additionally in prawn and catfish culture. Fish meal is in short supply and not easily available to farmers. Hence, a substitute for fish meal needs to be identified. Surveys undertaken by the FRI have revealed a number of indigenous ingredients of plant and animal origin which could be used in formulating fish feeds (Bhuiyan et al, 1989).

The production of agricultural by-products and wastes, which have been traditionally used as the major sources of fish feed, is being reduced day by day due to country's chronic problems of flood and drought. On the other hand, the demand for supplemental fish feed is increasing with the expansion of aquaculture. Therefore, to meet the increasing needs of the developing aquaculture industry, research needs to be undertaken to develop of nutritionally balanced feeds for Carp. Catfish, prawn and shrimp nursery, growout and broodstock ponds using conventional and unconventional feed resources. As feed plays a role in maturity of fish, feeds for fish species which do not easily mature in captivity should be developed. It is essential to establish a fish feed mill which will allow production of commercial as well as experimental fish diets.

In order to make aquaculture more successful and profitable. it is of utmost importance also to undertake research to determine the optimum level of requirements of different individual nutrients for fish of high commercial value. This will need the establishment of a modern fish nutrition laboratory with sophisticated equipment for biochemical analysis of fish and feed ingredients.

4.1.4 Breeding and culture techniques for indigenous, endangered species

Habitat destruction, as a result of siltation, pollution and changes in hydrology of the rivers due to human interventions. has resulted in certain species of fish becoming extinct or endangered, threatening the aquatic biodiversity. It is necessary to develop breeding and culture techniques for these endangered species, in order to save them from extinction. The FRI has already done some work with regard to the breeding of some of the endangered species such as *Pabda (Ompok pabda), Gulsha (Mystus cavasius), Mohashoal (Tor putitora)* and *Pangasius* spp. This research needs to be continued to develop techniques for other threatened species and to develop culture practices. Seed production and culture technologies also need to be developed for such non-conventional fish as Snakehead *(shoal* and taki). Climbing Perch (koi), Catfish *(Boal, Air, Rita)* and Eel *(Baim).*

4.1.5 Improved nursery management practices

Nursery operation is a very promising occupation, particularly for resource-poor farmers on account of its high assurance of quick return. Rapid expansion of aquaculture and the stocking of floodplains and other openwaters have resulted in increased demand for quality fingerlings of specific species and sizes, at specific times. This necessitates nursery management practices that could ensure large-size fingerlings for stocking in openwaters at the beginning of the season. Floodplain stocking programmes experience high mortalities of fingerlings due to transport over long distances and poor handling. Hence, it is necessary to identify suitable areas near floodplains, including heels and seasonal waterbodies, for nurseries and develop appropriate management practices.

4.1.6 Pen and cage culture

There are thousands of hectares of irrigation and roadside canals and burrow pits in flood control and drainage development areas and deeply flooded lowlands which are, at present. lying fallow. They could be utilized for fish culture by constructing pens. Cage culture of fish could also be taken up in these water resources by landless farmers, especially women.

While ‘cage culture is a form of intensive aquaculture in developed and some of the developing countries, it has to be an extensive culture under Bangladesh conditions, as supplementary feeds needed for cage culture are in short supply and expensive. Hence, low-input, low-cost cage culture techniques, using species which could grow well on agriculture by-products and wastes, need to be developed. While pen culture technology has been developed for irrigation canals, techniques need to be developed for other ecosystems.

4.1.7 Development of hatchery and culture techniques for giant freshwater Golda shrimp *(Macrobrachium rosenbergii)*

Catches of Golda shrimp (M. rosenbergii), which used to be a lucrative fishery in some of the rivers in the past. have declined. The species commands a high price in the domestic market and has high export potential. About one fifth of the total export of shrimp is contributed by M. *rosenbergii.* A large number of farmers are evincing interest in its culture. One of the constraints for its culture is the shortage of seed. While a few hatcheries have been established in the private sector in the last couple of years, the technology has not been perfected and the hatcheries are still facing problems in respect of breeding and larval rearing. Hence there is urgent need to develop techniques for the establishment of small-scale viable hatcheries, as has been done in Thailand.

The vast inland freshwater area offers tremendous potential for commercial culture of Golda shrimp. which has a high export potential. At present. culture of this shrimp. either in monoculture or in polyculture with Carps in ponds and ghers, is expanding fast. especially in the Bagerhat, Khulna and Satkhira Districts. As it has considerable scope to spread all over the country and as the production obtained at present is very low using the traditional systems, culture techniques need to be improved through appropriate research.

4.1.8 Genetic improvement of cultured species

Significant gains attained in agriculture have been attributed to genetic research and breeding programmes. Though fish-farming has been in vogue for hundreds of years, the aquaculture sector has not been touched by advances in applied breeding technology. A few studies undertaken in recent years for genetic improvement of Salmon and Tilapia have indicated that the potential for achieving rapid genetic gains is generally very high. The freshwater aquaculture industry is at present dependent on hatchery bred stocks. Due to the unconscious negative selection from finite populations of brood in hatcheries, inbreeding is taking place. This is resulting in reduced growth and deformities, drastically affecting aquaculture production. It is an established fact that in genetically closed systems. potential selective pressures exerted on finite and, often, small culture populations by various farm management practices result in indirect selection of important life history traits, inbreeding and genetic drift (Doyle, 1983). As these hatchery-produced seed are being stocked in floodplains and rivers, wild populations of Carp could also be affected if care is not taken. Hence, it is necessary to take up selective breeding programmes to develop better strains of cultured carps. To meet the tremendous need for carp fingerlings, and knowing that private hatcheries are their major source, proper broodstock care and management, selective breeding and improved nursery techniques need to be perfected and disseminated to the hatchery owners to ensure quality fingerling production.

4.1.9 Ecological characterization of waterbodies

Aquatic ecosystems, their flora and fauna, and the dynamics of bio-physicochemical phenomena are highly diverse in Bangladesh. This is mainly because of its subtropical climate, its natural features, climatic conditions. its flood-and cyclone-prone nature, and its mainly alluvial soils which have their' origin in deltaic plainland crisscrossed with over 250 rivers.

The large area of floodplain, once estimated to be about 6.3 m ha, has reportedly been reduced by about 0.8 1 m ha by flood protection measures (MPO, 1987). Inside the floodplains, there used to be a large number of beels (natural depressions) which were perennial in nature. Heavy siltation, due to erosion and the construction of a large number of FCD and FCDI structures, has progressively increased sedimentation in waterbodies, turbidity, temperature, salinity and fluctuations in oxygen and other limnological parameters. Approximately 2 billion tonnes of silt are carried to the rivers and sea from upstream.

All these result in loss and degradation of habitat, alteration of ecology, impediment to population recruitment, loss of primary productivity and biodiversity etc. However, the dynamics of changes in soil and water quality, flood and drought, habitat topography, temperature, salinity and primary productivity are not well known. It is necessary to know more about them to make long-term predictions on the type of changes going to take place over time and space. This information is needed for long-term planning and development of ecoregion specific aquaculture and fisheries management practices for sustainable development. Therefore, research on dynamics of changes and the characterization of all waterbodies (both lotic and lentic) need to be carried out for the zonalization of the huge waterbodies of the country.

4.2 Brackishwater aquaculture

Brackishwater aquaculture, particularly of shrimp, is fast expanding in Bangladesh due to the high demand for its products in the world market. The most commercially important brackishwater shrimp are *Bagda* (Penaeus monodon) and the white shrimp (P.indicus). Shrimp culture area has expanded from 20,000 ha in 1980 to over 140.000 ha in 1994 and production has increased from 2,220 t in 1982-83 to 57.000 t in 1994-95. While gross production has increased, production per unit area is very low, being 1 00- 150 kg/ha in traditional extensive systems and about 250-350 kg/ha in improved extensive systems. Semi-intensive culture, through higher stocking, supplementary feeding, aeration and water exchange has indicated productions of 2.500 kg/ha.

Indiscriminate horizontal expansion of the industry has resulted in a shortage of seed, disease leading to mass mortality of culture stocks, and environmental and social problems. Unless these constraints are addressed through solutions to problems, the sector cannot progress. The areas where research needs to be undertaken. for development of environmentally compatible management practices, are discussed below.

4.2.1 Development of hatchery technologies

Seed is the main input for any aquaculture operation. At present. a major portion of the seed of Bagda shrimp (P. monodon) is collected from natural resources. But the availability of seed from Nature is erratic, unreliable and is on the decline due to various reasons. Mortality of seed collected from Nature is high, due to the crude methods used in collection and transportation. It is estimated that over 50 per cent of the seed collected dies before reaching the shrimp farms.

It has been estimated that over three billion *P.monodon* seed are annually collected from natural sources. Along with the desired *P.monodon* post-larvae, fry of a number of other finfish and shellfish are caught, but are destroyed. as they are discarded on the shore. Studies undertaken by the FRI indicate that for every single *P.monodon* post-larva collected, 40 other shrimp and 10 finfish seed are destroyed (Mazid, 1994).

With the expansion of shrimp culture area and also intensification. the demand for shrimp seed has increased, but the collection from Nature is not able to meet the demand. Only in recent years have a few hatcheries been established in Bangladesh. but their production is very low. These hatcheries are also facing several problems. With the result, to meet the demand, seed is being imported from neighbouring countries, and these are bringing in additional problems, such as disease.

If the growing shrimp culture industry is to be sustained, it is imperative that research is undertaken to develop simple, low-cost hatcheries. The FRI in recent years has made some strides in the development of a prototype backyard hatchery for *Golda (M. rosenbergii).* These research efforts need to be strengthened. At the same time, surveys need to be taken up for charting shrimp breeding grounds and assessing fry resources over time and space.

Another constraint faced by the hatcheries in many countries is non-availability of brood of *Bagda,* P. *monodon.* Though this is not yet a problem in Bangladesh, due to the very low requirement of broodstock for the limited number of hatcheries, it will become a major constraint in the near future if the expected increase in the number of hatcheries materialises. Hence. it is imperative that studies be undertaken on the maturation of shrimp in captivity through eye ablation and other techniques. Also, research should be undertaken to develop appropriate gear for secured and safe collection of *Bagda* brood by the artisanal fishermen.

4.2.2 Improved shrimp production systems

As has been mentioned earlier, shrimp production from extensive systems has been very low, while semi-intensive systems have led to disease resulting in crop losses. The information available in Bangladesh and elsewhere indicates that semi-intensive and intensive systems are fraught with uncertainties and might not be suitable under Bangladesh conditions. Therefore, the objective in Bangladesh should be to increase sustainable production with minimum cost. In view of this, it is necessary to develop improved extensive systems by proper pond preparation, soil and water quality management, low stocking densities and feeding, but at the same time ensuring higher productions.

4.2.3 Polyculture of shrimp and finfish

There are excellent brackishwater finfish species. such as Mullets and Catfish, that could be cultured either in mono- or polyculture along with shrimp. This would involve less risk, be less capital intensive and would also demand less shrimp seed. While these fish are cultured in other countries of the region and have high demand, there is no experience with them in Bangladesh. This necessitates taking up research to develop breeding and culture techniques for these finfish. Polyculture of fish and shrimp as well as the culture of fish and shrimp in rotation reportedly reduce the risk of shrimp disease. Such cultural practices needs to be examined through research.

4.2.4 Culture techniques for non-traditional species

Besides shrimp and finfish, there are other species, such as mud crab (*Scylla serrata*), which have high export potential and could be cultured in mangrove swamps, mud flats, creeks etc. High export potential has resulted in their being caught in large numbers, resulting in declining populations in the wild. The seed of mud crab is available in abundance in the Khulna region. However. techniques for its culture are not known and need to be developed.

4.2.5 Environmental and socioeconomic impacts of shrimp culture

Haphazard expansion of shrimp culture has led to environmental degradation in terms of destruction of mangroves. pollution of tidal rivers and inshore waters, salinisation of soils. loss of grazing grounds for livestock, loss of freshwater sources, etc. Shrimp culture expansion has also led to social conflicts over land tenure and use rights, leading to marginalisation of small rice farmers who have been forced to lease their lands to large shrimp farmers. Unless these problems are addressed and redressed at this stage, it might lead to irreparable damage to the environment and the socio-cultural ethos of the shrimp culture areas.

To save the environment from degradation, it is necessary to undertake surveys to identify and demarcate areas for shrimp culture. Unplanned expansion of shrimp culture and unregulated discharge of shrimp farm enffluents not only threaten the shrimp farms. by way of their intake of polluted water. but also other aquatic flora and fauna present in the ecosystem. Therefore. the negative impact of shrimp farming on the aquatic environment needs to be studied in order to develop mitigating measures against these impacts.

4.3 Mariculture

Great strides have been made in mariculture/coastal aquaculture of commercially important species, such as Grouper. Snapper and Sea Bass, in neighbouring countries. This has proved to be an attractive venture for small-scale farmers/fishers. But very little is known of the potential for culture of marine species (other than shrimp) in Bangladesh. Mullet (Mugil spp.), Sea Bass (Lates *calcarifer)* and Grouper (Epinepheius spp.) are of commercial importance in the domestic market as well as for export. Hence, studies should be undertaken to assess the availability of seed of these species in the wild and seed production and culture techniques for these species should be developed.

Culture of edible oysters, clams and cockles is practised extensively throughout the world and there has been increasing interest in such culture in the tropics to meet the demands of domestic consumption and export. Preliminary surveys have identified a number of species of edible oysters *(Crasostrea* spp.. *Saccostrea* spp.), windowpane oysters *(Placuna placenta).* pearl oysters *(Pinctada* sp.), clams and cockles *(Anadra* spp., *Maritrix* spp.) and green mussel (Perna *viridis),* which are suitable for commercial culture (Pagcatipunan. 1982). At present, the meat of shellfish is consumed only by low-income groups and is also used as feed in shrimp culture. The shells are crushed and used as lime. Feasibility studies need to be undertaken for their commercial culture and marketing of shellfish. Efforts also need to be made to develop techniques for the culture of pearls.

Seaweed is cultured in large quantities in many coastal areas of Asia. Nearly 90 per cent of the world production is from the Asia-Pacific region. Demand for seaweed is growing, as it is used as human food, as a component of animal feed and as a raw material in industry. Several species of seaweed have been identified in Bangladesh (Islam, 1876). Studies need to be undertaken to assess the feasibility of culturing them on a commercial scale.

Accurate information on coastal areas of Bangladesh is needed in order to take decisions on the use and management of its coastal resources, as very little information is available at present. It is imperative that information be collected on:

— The extent and nature of inter-tidal waters.
— Climatic/ hydrological/oceanographic conditions.
— Water quality.
— Existing stocks and distribution of selected culture species.
— Access and pollution.

5. FISH AND SHRIMP HEALTH

Intensification of aquaculture, which necessitates greater use of fertilizers and supplementary feeds, increases the risk of disease outbreak in cultured waters, leading to mass mortalities and economic losses. **One** such example in the case of freshwater finfish is the recent large-scale outbreak of the epizootic ulcerative syndrome (EUS). Also, losses of fish seed have been reported in recent years from hatcheries and nurseries.

Disease to shrimp has become a major problem in recent years and has led to great losses to shrimp producers. Very little is understood of the aetiology of shrimp disease, with the result that any suggestion made to shrimp growers is only on the basis of empirical knowledge. Hence, it is necessary to understand, through research, the environmental parameters that trigger disease, identify the causative pathogens (bacteria, virus, fungus) and formulate measures to control disease.

Well-equipped fish health laboratories and skilled manpower are needed for research. At the national workshop held in 1994 in Cox’s Bazar and Khulna, a strong recommendation was made to establish two modern fish health research laboratories at the Marine and Brackishwater Stations of the FRI at Cox’s Bazar and Khulna in order to render services to the shrimp farmers of those two important shrimp culture areas. Substantial investment is needed for the establishment of these two laboratories.

6. INLAND CAPTURE FISHERIES

The major river systems of Bangladesh have a total length of 22,000 km and provide a base for artisanal and subsistence fisheries, which contribute over 51 per cent to the total fish production. These fisheries provide employment to a large section of the population who are involved in fishing and ancillary industries. Production from inland capture fisheries has been on the decline in recent years, due to over-exploitation and habitat degradation. While it is difficult, if not impossible, to regenerate and improve openwater fisheries, even small improvements in average yield would significantly increase national fish production, because of the large extent of openwater resources. Hence, it is necessary to undertake appropriate conservation and management measures to improve and sustain production.

Being situated in the delta of three major rivers, Bangladesh has one of the largest floodplains in the world. Some 2.X million ha retain water for periods ranging from four to seven months and contribute substantially to fish production. These floodlands are repositories for mineral and organic matter washed down by seasonal flooding, resulting in high primary productivity. They play a major role in providing breeding, nursing and grazing grounds for commercially important species. They also play a role in repopulating the openwater fishery system, including rivers and estuaries. In recent years, implementation of various irrigation and flood control projects has resulted in reduction of habitat, inhibition of breeding and feeding migrations of fish. reduction in productivity and decline in fish production. Composition of species has changed in favour of sedentary species which are of less economic value (Tsai and Ali, 1988). All these changes have resulted in a decline in annual fish production from the floodplains of 2.4-2.9 per cent . This has also resulted in declining recruitment to the riverine fisheries. which is evident from the declining trend in riverine catches.

In recent years, the Government has taken up programmes to stock the floodplains, with a view to increase fish production. For these programmes to be successful and sustainable, it is necessary to understand the dynamics of the floodplain ecosystem.

6. I Fish stock assessment and stocking strategies for floodplains

Openwater stocking of fish is an important tool for stock replenishment. However, stocking of floodplains in Bangladesh is being undertaken on an ad hoc basis, without a full understanding of the productivity and carrying capacities of these water resources. the population dynamics of the existing fish stocks and the socioeconomic conditions of the fishing communities dependent on these wetlands. For the regeneration of the fish populations in the floodplains and the sustainable management of the resources, it is necessary to undertake studies on the biological characteristics of these floodplains and develop stocking strategies.

6.2 Community participation in inland openwater fisheries management

The economic conditions of fishing communities are deteriorating due to the decline in openwater fish catches as a result of the degradation of fishery resources and fish habitats as well as due to lack of access to common property waterbodies. Government policies in the past were not conducive to benefitting the fishers, whose livelihoods are linked with fishing in these waterbodies, nor to the ecological sustainability of these water resources. In recent years, the Government has introduced a New Fisheries Management Policy in a few public waterbodies. Under this policy, short-term leasing has been replaced with licensing of genuine fishermen. Even with these waterhodies, there have been problems in benefitting the genuine fishers. who have to depend on moneylenders for equipment (boats and nets) and operating capital, and the subsistence fishers, who were excluded from the programme. Also. in the absence of any assessment of the exploitable biomass. adjustment of fishing pressure and long-term planning could not be undertaken. Hence, it is necessary to undertake studies to develop a system by which the fishing community can participate in the management of the openwaters.

6.3 Hilsa *fisher! management*

Hilsa is the largest single species fishery in Bangladesh, contributing nearly 25 per cent of the total fish production. There is also thriving fishery for the young of *Hilsa,* generally known as Jatka. It has been estimated that some 4,000 tonnes of *Jatka* are annually caught from a section of the Meghna River. Some estimates suggest that a 10-20 per cent conservation of *Jatka* would be equivalent to an additional 40,000- 100.000 tonnes of *Hilsa.*

Studies undertaken by the FRI in recent years have resulted in the identification of some of the spawning and nursery grounds of *Hilsa* an anadromus fish. In view of the importance of this fishery, it is imperative that it is protected and managed at optimum levels. For this it would be necessary to study the population dynamics of the *Hilsa* make an assessment of the stocks. identify different sub-populations. identify and protect spawning and nursery grounds and undertake steps to conserve its young. the Jatka.

6.4 Population dynamics and stock assessment of carps and prawns in the major river systems

Populations of carps and prawns are on the decline. There is considerable overfishing of broodstock, mainly major carps, during the spawning and dry seasons when the floodplains dry up and fish congregate in the beels. This results in a negative impact on recruitment, leading to a decline in overall fish production in the floodplains and rivers. Hence, the population dynamics of these commercially important species need to be studied. to enable formulation of appropriate management measures.

6.5 Aquatic biodiversity

Biodiversity, the genetic library maintained by natural ecosystems (Ehrlich and Wilson, 1991). is the basic biotic resource that sustains all human life-support systems (Kim. 1993). Fish are the fifth largest agricultural resource and are the primary source of protein to over one billion people. Yet. aquatic biodiversity remains a neglected issue. Recent estimates suggest that, worldwide, 20 per cent of all freshwater species are either extinct. endangered or vulnerable (Maclean and Jones, 1995). The major causative factors for decline in aquatic biodiversity are: degradation and loss of habitat, over exploitation, spread of exotics, pollution. and climate change. Conservation of biodiversity rests on resource management, that is, sustainable management of stocks and preservation of the habitat.

The biodiversity of Bangladesh's water resources, especially in the tloodplains. is one of the richest in the world. However, it is under threat due to overexploitation. loss of habitat. water pollution. etc. Surveys need to be undertaken to assess the fauna in these water resources, identify the species extinct or endangered. identify causative factors, and suggest remedial measures for conservation of threatened species and biodiversity.

7. MARINE FISHERIES

Marine fisheries has shown a steady growth over the years and landings have increased from 10.6 per cent of total fish production in 1970 to 24 per cent in 1993-94 and has more or less stabilized. Of this, the artisanal fishery. comprising of some 17.000 boats of different sizes, of which 6.000 are mechanized, contributes 95 per cent of the catch. The artisanal fishery, especially the set bagnets, exploit the juveniles and post-juveniles of different species. In recent years, there has been a substantial increase in fishing effort, leading to overexploitation of coastal stocks, with a resultant decrease in catch per unit effort.

The offshore industrial trawl fishery is. relatively, a new development and at present 53 trawlers are in operation, of which 40 are engaged in shrimp trawling. Overall shrimp catches have dropped in recent years. The problem is further compounded by the increasing exploitation of shrimp seed from inshore and estuarine waters. to meet the demand of expanding shrimp culture activities.

While the inshore fish and shrimp stocks are under heavy fishing pressure, exploitation of pelagic resources, like tuna, mackerel, sardines and anchovies, and demersal stocks beyond 40 m depth, is constrained by a lack of knowledge of the resource as well as of the means to exploit it. Surveys undertaken of demersal and pelagic stocks in the past have come up with different estimates (Khan, 1994: Mazid, 1994). Very little effort has been made in the past to assess the size of stocks of different species of finfish and shellfish and implement management measures to obtain maximum sustainable yields. Information on oceanographic parameters, i.e. temperature, salinity, turbidity, water current, mixing and upwelling, organic productivity and its potential of fish yields as well as their relationship with the standing stock and resulting landing is also absent. In the absence of a database on standing stocks, catch statistics, gear selectivity, fish behaviour, etc. of both inshore and offshore stocks, and oceanographic parameters, it would not be possible to come up with any management solutions for conservation of depleting stocks and increased exploitation of underexploited stocks. In view of this, research in the following areas is suggested.

7.1 Productivity and stock assessment of demersal and pelagic fish resources

It is high time that research is initiated for the assessment of stocks of commercially important species of fish, especially *Hilsa* which contributes about 46 per cent to the total marine landings (and 13 per cent of inland catch), and shrimp exploited by the artisanal fishery, with a view to understanding the fishing effort at which maximum sustainable yields could be obtained and to develop management measures for rational exploitation. Along with this, an assessment of the stocks in pelagic fisheries (Tuna, Mckerel. Sardines, Anchovies etc.) that are at present unexploited or underexploited needs to be undertaken and fishing grounds charted. There is at present intense fishing upto 40 m depth by the artisanal fishery and 100 m depth by the industrial fishery whereas both pelagic and demersal resources beyond that remain unidentified and untapped. Research studies need to be undertaken to identify and determine the stock size in the deep sea and should include:

- Development of a suitable model for multigear/multispecies fisheries and to forecast the fish resources in time/space;
- Development of diversified fishing methods to tap underutilized species, particularly pelagic ones;
- Development of gear on the basis of fish behavioral studies;
- Identification of overexploited species and their management for conservation, particularly of *Hilsa* and shrimp:
- Development of different models of community-level participation in conservation management;
- Understanding the marine ecology of the area, and assessment of the primary and secondary productivity of the EEZ of Bangladesh;
- Relating marine fish stock assessment with marine productivity and marine fish landings;
- Development of various methodology to monitor the catches and fishing efforts of Bangladesh's marine fisheries; and
- Development of suitable catch monitoring systems to assess the status and trends of resources in catch.

7.2 Utilization of by-catch

With the introduction of trawling for shrimp, a considerable amount of by-catch of low-economic value is being discarded at sea by trawlers. The amount of by-catch discarded at sea has been estimated at around 50,000 tonnes a year. In a country where there is shortage of fish, the nation cannot afford to discard this low-cost animal protein which can benefit low-income population and which can also be used as fish meal. In view of this, it is necessary to develop techniques to process by-catch and small pelagic fish as surimi and other value-added products.

The 93 processing plants in the country are at present working at nearly 13 per cent of their capacity. If appropriate methods are developed for the processing of by-catch and small pelagics, these processing plants would be able to utilize their unutilized capacity without additional investment. The important areas of research are as follows:

— Development of techniques for the processing of by-catch and small pelagic fish to make improved quality surimi and other value-added products; and

— Developments of techniques to screen protein concentrates, both qualitatively and quantitativelyfrom by-catch and small pelagic fish.

7.3 Studies on the socioeconomic conditions of fishing communities

It is estimated that over 500,000 full-time fishers at present depend on marine fisheries for their livelihoods. The number of marine fishers has increased by 50 per cent from the period 197940 to 1988439, putting pressure on fisheries and resulting in overexploitation of stocks and decline of household incomes. Any effort made to enforce laws or control fishing effort with a view to sustaining the fishery will be futile, unless the fisher communities cooperate and become partners in government efforts aimed at rational exploitation of stocks. To achieve their cooperation and participation, it is important to understand and improve the socioeconomic conditions of these fisher communities and create awareness among them of the need for conservation and management of resources. Hence, demographic surveys of fishing villages need to be undertaken to assess their economic condition and social problems, and come up with measures for improving their living standards, which, in turn, could lead to better implementation of measures aimed at the sustainable exploitation of fisheries resources.

7.4 Quality control of fish and fish products

Fish and shrimp being important tradeable commodities in the international market, their quality has to conform to international standards. This is particularly important in case of shrimp, which in the case of Bangladesh is 100 per cent exported. Buyers from the USA, Japan and EEC are greatly concerned with poor hygiene and sanitary conditions in processing plants and suggest quality control through Hazard Analysis Critical Control Point (HACCP).

As domestic demand for fish exceeds supply, traders are not concerned with improving the quality of transport, processing and marketing. Post-harvest care in handling, transporting, washing, icing, packing etc. have a direct bearing on the quality of the product. Good sanitation at ice plants and freezing and processing plants are extremely important for quality control. Research support is needed for ensuring the quality of fish and fish products (dried and salted fish) for both the domestic and export markets. The immediate areas of research should be to:

— Survey quality control systems in different processing plants and the transport system and the loss of quality at these stages;

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- Deterioration of organoleptic quality of Hilsa and shrimp under varying conditions;
- Biochemical changes occurring in fish, particularly *Hilsa* and shrimp, during different stages of handling, transport, processing and preservation, affecting their quality;
- The bacteriology of *Hilsa* and shrimp preservation; and
- Development of standard methods of quality control, quality protection and quality assurance.

8. INFORMATION NEEDS

Development of technologies or management practices by itself is not enough to reach the goal of increasing production. Available information indicates that there is a large gap in productivity between what has been achieved in research organizations and the farmers' field or by the fishers. This is because research results do not easily percolate to the beneficiaries or to the implementers of management measures. This is because of weakness in the system of technology transfer and information dissemination.

A large number of government and non-government organizations are involved in the dissemination of modem techniques/management tools to fish farmers/fishers. Regular coordination meetings between these organizations on the one hand and between these organizations and the farmers/fishers on the other hand could help in speedier dissemination of research results and, at the same time, provide feedback to the research. Since the majority of rural farmers/fishers are illiterate, the electronic media could be an economical way of reaching information to this section of the population. Also, good coordination between researchers and planners/administrators is needed for policy support to the planning and implementation of development programmes and also for the conservation of resources.

9. CONCLUSIONS

While the resources for fish production in Bangladesh are vast, there are many constraints, biological, social and economical, which need research to be undertaken in order to harness the full potential. Studies undertaken in different countries, to assess the impact of agriculture research, have concluded that research did increase production from a given resource and has been very cost-effective. Fisheries research in Bangladesh is in its early stages; investments made in it in the past were negligible. To conserve and manage fishery resources for the benefit of the present and future generations, the resources need to be managed and exploited on a sustainable basis. This needs continuous information-support through research. The research areas identified in this paper are comprehensive enough to assist the authorities in formulating appropriate management plans for conservation of the resources and optimization of production, in consonance with ecology, economics and equity. To achieve this goal, Government has to commit long-term funding for research backed by qualified manpower. The organizational structure of FRI has to be strengthened by upgrading the position of the Director to Director-General like other similar organizations. There is also a great need to improve research facilities and establish Fisheries Research Laboratories at the 19 greater district head quarters.

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PAPER 7

FINANCING OF AQUACULTURE, CAPTURE, PROCESSING AND MARKETING OF FISH, SHRIMP AND OTHER AQUATIC RESOURCES IN BANGLADESH

by

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CONTENTS

SUMMARY

Bangladesh, as one of the world's largest deltaic regions, has great potential for development of its aquatic resources, both inland and marine. Fish and shrimp have been captured by non-mechanized and mechanized boats and trawlers for decades. But pond culture of fish and shrimp for commercial purposes started in an organized manner only from 1980.

Fish production, gradually increasing. reached 1.2 million tonnes in 1994-95. Export earnings have also recorded considerable increase, standing at US $ 325.11 million in 1994-95 and representing 9.38 % of the total exports of the country.

Due to depletion of fish and shrimp in both inland waters and the Bay of Bengal, mainly on account of overfishing, there is urgent need to prohibit fishing during the breeding periods and the catching of juveniles. Re-stocking of the inland waters by released artificially bred fish fingerlings, the establishment of hatcheries, including those for shrimp, the establishment of fish sanctuaries, enforcement of environment pollution control regulations and for launching a well-coordinated drive for organized, intensive/semi-intensive culture of fish and shrimp are other initiatives crucial for increasing the catch.

While the owners of boats in inland waters and owners of artisanal boats and trawlers can easily access credit from institutional sources, being able to provide the necessary collateral, the poor and illiterate fishing communities continue to remain impoverished due to control of the capturing and marketing systems by the moneylender-cum-boat-owners and the middlemen who play an exploitative role.

Banks are not in a position to reach the poor fishermen communities, as **they need supervised credit** together with a package of socioeconomic services. These can be effectively provided only by NGOs.

The Grameen Bank and the Bangladesh Rural Development Board have successfully organized assetless poor people, mostly women, who were not members of the fishing community, to culture fish and shrimp in ponds . The NGO activities, however, remain very limited among the real fishermen communities who generally live in remote and inaccessible areas on the river banks and in the coastal regions.

The Bangladesh Bank continues to encourage the banks extending credit to the poor through forging appropriate linkages with the available NGOs/ Self-help Groups. The NGOs can also help in bringing about improvement in the quality of the lives of the poor fishermen by motivating them to engage in subsidiary income-generating activities to get out of their cast-based profession and look for alternative livelihoods. The IFAD/DANIDA-assisted ox-bow-lakes project, which is being implemented by the Directorate of Fisheries in collaboration with NGOs has, reportedly, addressed the issue of improving the standard of living of the fishing community living in the project area.

The Bangladesh Bank is implementing a credit guarantee scheme under which banks are lending to fisheries projects **without any collateral.** The Sonali Bank is also implementing a special programme under which it may lend for fish farming upto Tk.50,000 **without any collateral.** This is an intensively supervised credit programme which involves cost subsidization and therefore cannot be replicated throughout the country.

Bangladesh has already deregulated its financial system. As such, the days of directed credit for any particular sector or subsector are over.The financial institutions are absolutely free to choose their borrowers as also to fix their interest rates within the existing bands and set terms on the basis of banker-customer relationships. But occasionally this reality is not quite understood by the large

borrowers or by some people associated with the promotion and development of the fisheries sector. If the bank could be assured that their loans would be repaid in time there should not be any reason to discourage their lending to any sector, including the fisheries sector.

The recently taken Government decisions to extend the tenure of lease of Government lands, the abolition of the system of leasing of open waterbodies, the strengthening of the infrastructural facilities for culture of shrimp and marketing of fish, enforcement of quality control on exportable aquatic products, efforts to augment the technological support, and implementation of research and extension-cum-credit projects by the Directorate of Fisheries are all expected to bring about a flow of institutional credit to the fisheries sector and, thereby, usher in the much-desired ‘Rupali Biplab’ (Silver Revolution) in the country.

I. INTRODUCTION

Bangladesh, as one of the world's largest deltaic zones, has great potential for culture of aquatic resources in its large number of sweetwater rivers. closed inland waterbodies, brackishwater areas of the coastal regions. and the marine waters in the country's Exclusive Economic Zone. The details of Bangladesh's aquatic areas are shown alongside.

Table 1: Aquatic resource area of Bangladesh

Fisheries sector	*Water area (Hectare)*
A. Inland Fisheries	
a) Capture	
1. Rivers & estuaries (except Sundarban area)	1,031,563
2. Sundarbans	—
3. *Beefs*	114,161
4. Kaptai Lake	68,800
5. Floodlands	2,832,792
Capture total	4,047,316
b) Culture	
1. Ponds	146,890
2. *Baors*	5,488
3. Shrimp farms	108,280
Culture total	260,658
Inland total	4,307,974
B. Marine Fisheries	
a) Industrial fisheries (Trawl)	
b) Artisanal fisheries	
Marine total	48,365 square nautical miles

Source. Directorate of Fisheries, Ministry of Fisheries and Livestock, Government of Bangladesh

The inland waters in Bangladesh are, reportedly, the abode of 258 indigenous and eight exotic species of fish and 22 major species of prawn as well as of different species of turtles, crabs and other varieties of shellfish. The Bay of Bengal, along the Bangladesh coast, is reported to be the habitat of 47.5 species of fish and 38 species of shrimp. Fish production in 199495 has been estimated at 1.2 million tonnes, comprisin g of inland open waters, 0.58 million tonnes. closed waters 0.92 million tonnes and marine waters 0.27 million tonnes. The details of yearwise fish production in Bangladesh are shown on the facing page.

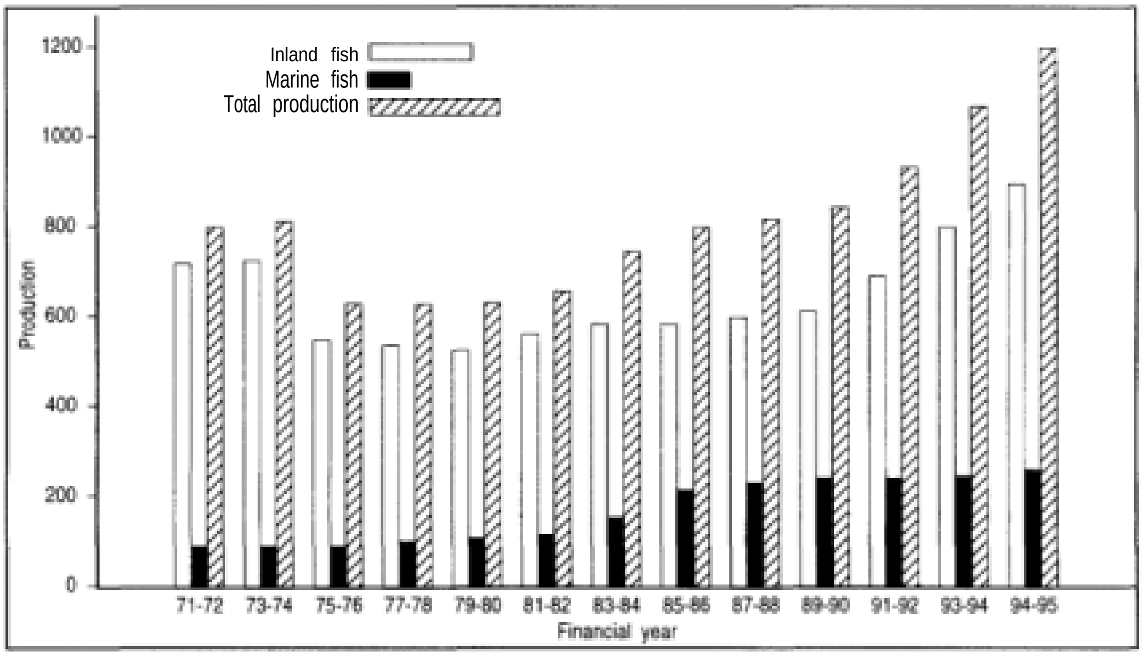
In the inland areas fish and shrimp are generally cultured in ponds of different sizes and shapes. Various types of nets, fishing rods and lines are used in the capture of these fish. In the large water bodies, locally known as *haors* and *baors,* and in the numerous rivers, creeks and canals, fish are

Table 2: Fish production in Bangladesh

Source	*Year-wise ProductiOn in M T*										
	1984-85	*1985-86*	*1986-87*	*1987-88*	*1988-89*	*1989-90*	*1990-91*	*/991-92*	*1992-93*	*1993-94*	*1994-95*
A. **Inland water**											
(a) Inland Openwater (Capture)											
(1) River & Estuaries	213,057	199,600	195,117	183,817	181140	173,410	135,355	124,843	138,746	130,235	135,550
(2) Sundarbans	6,825	7,112	6,035	8,066	6,416	6,393	6,651	6,297	6,939	6,970	7,550
(3) Depressions *(Bee/s & haors)*	45,893	45258	42,077	45,610	47,019	46,594	47,923	49,201	53,019	56,678	62.550
(4) Kaptai Lake	2,700	2,433	3,981	4,068	3,439	3,713	4,392	4,216	4,142	4815	5,500
(5) Floodland	194,130	187,396	183,796	182,037	186,126	193,762	249,083	295,185	329,573	353,530	365,500
Sub Total	462,605	441,799	431,005	423,598	424,140	423,872	443,404	479,742	532,419	552,226	576,650
(b) Inland Closewater (Culture)											
(1) Ponds	111,567	123,804	142,576	149,423	155,012	163,730	181,018	195.034	202,167	231,530	285,520
(2) Ox-bow Lake *(Baors)*	962	968	1,174	1,254	1,321	1,357	1,544	1,682	1,803	2,250	3.550
(3) Shrimp Farm	11,282	19,951	22,050	25,246	27,172	27,505	28,431	30,147	33,773	41,500	56.630
Sub Total	123,811	144,723	166,100	175,925	183,505	192,592	210,993	226,863	237,743	275,280	345,700
Total Inland	586416	586,522	597,106	599,523	607,645	616,464	654,397	706,605	**770,162**	**827,508**	**922,350**
B. **Marine Fisheries**											
(a) Industrial	12,440	11,898	12,356	10,395	10,353	11,379	6,760	9,623	12,227	14,600	17,530
(b) Artisanal	175,123	195,503	205,223	217,187	222,928	227,684	232,776	235,851	238,265	245,000	260,360
Total Marine	**187,563**	**207,401**	**217,579**	**227,582**	**233,281**	**239,063**	241,538	245,474	250,492	259,600	277,890
Country Total	773,979	793,923	814,685	827,105	840,926	855,527	895,935	952,079	1,020,654	1,087,108	1,200,240

Source: Directorate ot Fisheries, Ministry ot Fisheries & Live Stock, Government of Bangladesh.

Figure 1. **Trend of fish production in Bangladesh (in thousand MT)**



Source: Hussain, Alhaj M. Muzaftar Fish Marketing in Bangladesh" September, 1994 generally captured from non-mechanized boats using different types of traps and nets. However, mechanized boats are being increasingly used for transport of the catch, with or without ice. to the nearest wholesale fish market. Marine fishing is done by using both industrial and artisanal methods. The latest available data relating to total catch and species groupwise catch in marine fishing are shown below and on facing page.

Table 3: Total catch of the Marine Fisheries (1992-93)

Type of fishing	*Number of Craft*	*Number of Unit*	*Catch in Metric Ton*		
	(TawlerBoat)	*(Gear/Net)*	*Shrimp*	*Fish*	*Total*
A. Industrial					
(1) Trawl Fishing					
a) Shrimp Trawlet	**37**		*3,903*	*5,493*	*9,396*
b) Fii Trawler	**14**		**205**	**2,546**	2,831
Total Industrial	**51**		**4,188**	**8,039**	**12,227**
B. Artisanal					
(1) Gill Net Fishing					
a) Mechanised	**2,880**	**2,880**		123,680	123,680
b) Non-mechanised	3,509	3,509		20,210	**20,210**
Sub Total	6,389	6,389		143,890	143.890
(2) Set Bag Net Fishing					
a) Seasonal (M.B)	**182**	**5,400**	**6,581**	**40,424**	**47,005**
(N.M.B)	**2,689**				
b) All Season (N.M.B)	**4,590**	**7,215**	11,375	12,828	**24,203**
Sub Total	**7,452**	**12,615**	17,956	53,252	**71.208**
(3) Long Line Fishing					
Jewfish Long Line					
a) Mechanised	**255**	**1,121**		**6,960**	*6,960*
b) Non-mechanised	**127**				
c) Other Longline	1,000	963		2,930	*2,930*
Sub Total	1,382	**2,084**		**9,890**	*9,890*
(4) Trammel Net Fishing	**500**	**500**	**443**	**3,504**	**4,027**
(5) Other Gears Fishing	1,608	**2,222**	1,388	**7,862**	**9,250**
Total Artisanal (M.B)	**3,317**	**23,810**	**19,787**	**218,478**	**238,265**
(N.M.B)	**14,014**				
Grand TOTAL (Indus. t Artis.)	**Trawler 53 (M.B) 3,317 (M.M.B) 14,014**	**Gill 6,389 SBN 12,615 L.Line 2,222 Trammel 500**	**23,975**	**226,517**	**250,492**

M.B - Mechanised Boat; N.M.B - Non-mechanised Boat; SBN - Set Bag Net.

Source : Hussain, Alhaj M. Muzafar "Fish Marketing in Bangladesh" September, 1994.

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Table 4: Species groupwise catch in Marine Fisheries by type of fishing gear (1992-93)

Unit: metric tons

Sector	*Milan*	*Bombay Duck*	*Indian Salmon*	*Promfret*	*Jaw Fish*	*Cat Fish*	*Sharks & Rays*	*Other Marine Fish*	*Shrimp*	*Total*
A. Industrial										
(1) Trawl Fishing		28	**965**	201	2,343	1,109	338	3,055	4,188	12,227
B. Artisanal										
(1) Gill Net Fishing										
a) Mechanised	105,126		1,237	1,546	1,608	6,184	1,484	6,193	-	123,680
b) Non-mechanised	17,967			80	1,112	273		756	-	20,210
Sub Total	123,115		1,237	1,626	2,720	6,457	1,454	7,251	-	143,890
(2) Set Bag Net Fishing										
a) Seasonal		11,281		705				28,438	6,581	47,005
b) All Season		7,745			303	242	**97**	4,441	11,375	24,208
Sub Total		19,026		705	303	242	**97**	32,879	17,956	71,208
(3) Long Line Fishing										
a) Mechanised					3,132	2,018	1,392	418	-	**6,960**
b) Non-mechanised										
c) Other Long Line					a20	1,025	645	440	-	**2,930**
Sub Total					3,952	3,043	2,037	858	-	9,890
(4) Trammel Net Fishing				81	1,047	483	20	1,953	443	4,027
(5) Other Gears Fishrng		2,035		647	1.110	1,758		2,312	1,388	9,250
Total Artisanal	123,115	21,061	1,237	3,059	9,132	11,983	3,638	45,253	19,787	238,265
Grand Total	**123,115**	**21,089**	2,202	3,260	11,475	**13,092**	**3,976**	48,308	23,975	250,492
(Industrial+Artisanal)	**49.15**	a.42	0.88	1.30	4.58	5.23	**1.59**	**19.29**	**9.57**	100

Source: Hussain, Alhaj M. Muzaffar "Fish Marketing in Bangladesh" September, 1994.

Table 5: Trend of shrimp/prawn catches in Bangladesh (live-weight MT.)

F.Y	*Source- wise catch of shrimp/prawn*					
	Marine capture			*Coastal aquaculture*	*Fresh water capture*	*Countly Total*
	Tra wler catch	*Artisanal catch*	*Total*			
1983-84	4,500	7,520	12,020	4,386	41,250	57,656
1984-85	3,140	8,760	11,900	7,578	40,069	59,547
1985-86	4,031	3,550	7,581	14,658	53,085	75,324
1986-87	4,488	10,666	15,154	14,773	40,945	70,872
1987-88	3,545	11,535	15,000	17,889	36,386	69,355
1988-89	4,893	12,211	17,104	18,235	42,824	78,163
1989-90	3,117	12,751	15,868	18,624	36,284	70,776
1990-91	3,696	13,937	17,633	19,489	43,262	80,384
1991-92	2,902	17,140	20,042	20,335	46,500	86,877
1992-93	4,188	19,045	23,233	26,000	50,225	99,458

Source DOFIGOB.

After the capture of the fish, shrimp and other aquatic resources, these are transported to the different fish landing and processing centres for distribution and marketing in different parts of the country as well as for exports.

Bangladesh, with its large number of people living below the poverty line, is heavily dependent on fish for its population's intake of animal protein. In fact, available surveys indicate that the per capita annual consumption of fish is declining. The intake of the minimum required amount of fish protein can only be ensured through poverty alleviation and by increasing production through both extensive and intensive fish culture and aquaculture in closed waterbodies and in replenishing the dwindling natural fish resources in the floodplains and rivers that has been caused by overfishing, the erection of dykes and levies which disturb free movement of fish to their breeding grounds, and the widespread use of ecologically harmful pesticides, chemical fertilizers and industrial effluents.

2. THE FISHERFOLK

It is reported that 1.276 million people catch fish, 0.76 million in inland waters and 0.5 16 million in marine waters. Traditionally, the fisher community is comprised mostly of low caste Hindus, who, due to their beliefs and taboos, are generally reluctant to change their traditional profession. Poor Muslims are now engaging themselves in increasing number to eke out a living by working mainly as boathands in the boats of the boatowner-cum-moneylenders.

With the gradual depletion of aquatic resources in both the inland and marine waterbodies and with the existing exploitative system practised by lease-holders, owners of boats and fishing gear, and the middlemen involved in marketing, the poor fisher communities need to be helped in strengthening their group strength to obtain better wages and more reasonable prices for their catch and to find subsidiary income-generating activities and alternative employment for the unemployed and surplus among them. In this task, the Government, the financial institutions and the NGOs can join together to bring about improvement in the income-earning capacity of the fishing community's poor.

Women in Bangladesh have not generally been involved in aquaculture or fishing in the open waters. But, of late, the Grameen Bank, the Bangladesh Rural Development Board and some NGOs have successfully encouraged and financed the culture of fish and shrimp by groups of women as well as the peddling of fish by individual women micro-entrepreneurs through extension of micro-credit for income-generating activities. The Grameen Bank, the BRAC and the BRDB have achieved commendable success in organizing and reaching credit to the poor among the fishing communities of a few areas, like the IFAD-DANIDA financed Jessore Beel and Baor Project. The NGOs and even the Grameen Bank, on the other hand, have not taken much initiative in improving the lot of the poor fisher communities who live in not so easily accessible areas on the large river banks and coastal areas of Bangladesh. As a result, they continue to remain exposed to the exploitative arrangements of the lease-holders, boatowners, moneylenders, marketing middlemen and, occasionally, even to the exactions of extortionists. The welcome recent decision of Government not to lease out fishing rights of jal *mohals* (open water bodies) to individual bidders has to be enforced through strengthening the personnel of the relevant law-enforcing authorities and providing them logistic support facilities.

3. THE FISHERIES SECTOR

The fisheries sector, apart from providing employment to a sizeable part of the population, contributes about 3.5 per cent to the GDP of the country. With the Ministry of Fisheries, through its Directorate of Fisheries, the Grameen Bank and some NGOs encouraging modern artificial fish- and shrimp-breeding techniques, supplying fingerlings to potential pond fish culturists, releasing fish fingerlings in large *beels* and ox-bow lakes and open waterbodies, enforcing restrictions on the use of fine-mesh nylon nets, prohibiting fishing during the natural breeding periods in the open water, and declaring certain waterbodies as fish reservation areas to protect natural bio-diversity, production of fish and shrimp are increasing in the country. The export earnings from fish (all species) have also recorded steady increases and these account for 9.38% of the total export earnings of the country (details below).

Table 6: Statement showing exports of fish all sorts

Volume=Metric ton

Value=Million US Dollar

Fiscal Year	Shrimp		Frog legs		Frozen fish		Dry fish		Salted fish		Turtles/ Crabs		Shark fins/ maws		Total		% of Total Export
	Volume	Value	Volume	Value	Volume	Value	Volume	Value	Volume	Value	Volume	Value	Volume	Value	Volume	Value	
1981/82	6903	45.07	1851	5.63	631	2.08	39	0.20	123	0.65	507	1.16	63	0.64	10117	55.41	8.84
1982/83	9312	63.00	1878	5.03	1279	3.24	79	0.35	128	0.54	479	0.99	64	0.74	13219	73.88	10.88
1983/84	8818	62.34	2495	7.72	2817	5.68	74	0.34	283	1.29	440	1.01	43	0.52	14970	78.9	9.89
1984/85	12682	76.82	1360	3.96	3297	5.69	47	0.21	382	1.41	425	0.94	108	0.82	18316	89.84	9.66
1985/86	13631	90.11	2463	10.23	5017	12.21	786	3.37	422	1.66	679	1.44	50	0.36	23048	119.37	10.65
1986/87	16275	114.19	2168	9.98	4046	11.56	402	1.60	295	1.25	461	1.34	114	1.14	23761	141.08	12.99
1987-88	15023	115.60	2708	13.58	4191	9.07	475	2.14	372	1.54	524	1.94	130	1.48	23423	145.35	11.93
1988/89	15386	118.86	2685	13.63	2427	7.03	567	4.32	293	1.28	293	0.82	68	0.86	21719	146.81	11.51
1989/90	17505	125.85	730	3.13	3484	7.77	1278	7.11	161	0.44	146	0.29	35	0.85	2339	145.43	9.62
1990/91	17985	126.48	318	2.06	5702	11.60	427	1.61	1194	3.91	405	0.90	78	1.04	26109	147.62	8.64
1991/92	16730	119.47	771	4.91	2604	7.89	892	3.70	80	0.36	938	1.71	65	1.42	22080	137.46	6.91
1992193	19224	154.33	0	0.00	2704	9.79	1042	3.13	599	2.51	2800	5.52	238.39	3.64	26607	178.92	7.57
1993194	22054	196.92	0	0.00	3125	12.79	2473	10.46	50	0.26	4088	9.09	45	0.70	31835	230.23	9.12
1994-95	26277	260.11	0	0.00	9267	44.84	521	2.09	649	3.82	4760	10.12	212	4.13	41686	325.11	9.38

Source: Directorate of Fisheries

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The National Fish Policy and the Perspective Plan for Bangladesh underscore the importance of inland closed water fish and shrimp culture for augmenting production to meet local needs as well as increase export earnings. The shrimp subsector by itself has great potential for increasing export earnings within a very short period. However, in view of the adverse impact on the environment that expanding shrimp culture may have. there has to be clear policy guidelines on the zoning for the use of feed, water management. and maintenance of quality. according to internationally acceptable standards in processing and packaging of aquatic products. Proper zoning for semi-intensive aquaculture would not only help to minimize the extent of land used and the harmful effects to the fragile ecosystem, but would also help in avoiding social tensions arising from the same land being used for salt-water shrimp culture as well as cultivation of paddy.

The trade-offs need to be carefully considered and decisions taken to optimize use of land and minimize the possible impacts on the environment.

4. CREDIT POLICIES

Credit to the fisheries sector used to be classified as agricultural credit. The Bangladesh Bank, the central bank of the country, introduced credit norms for the fisheries sector in its agricultural and rural credit policy announced immediately after the independence of the country. However, initial credit for culture of fish was restricted to pond culture of carp.Later, the bank took special initiative to extend bank credit to saltwater shrimp culture in the coastal areas using traditional methods. There are some fishermen's co-operative societies which used to offer credit for the purchase of boats, nets and other fishing gear. However. their loans were mostly accessed by middlemen who became members of the co-operatives. Bangladesh, unfortunately. is a disaster-prone country. Borrowers both from the banking as well as the co-operative sectors, have generally avoided repayment of their loans on the plea of natural disasters. This default culture has at times, discouraged financial institutions from lending to the fisheries sector.

The Directorate of Fisheries was mainly concerned in the past with the pond culture of carp. They also introduced some exotic varieties of carp, namely Common Carp, Silver Carp, Grass Carp, Mirror Carp and Nylotika, *Tilapia,* Thai puti and, of late, hybrid catfish and Thai pangas. The Fisheries Research Institute. using extension personnel of the Directorate of Fisheries and NGOs, did a commendable job in disseminating information and for quick growing and economically profitable fish culture. The institute has also developed technologies for seasonal fish culture in derelict ponds and burrow pits as well as for the culture of fish in irrigated / rainfed paddy fields

Pond culture of fish was not initially taken up as a commercial venture by well-to-do gentlemen farmers, as. traditionally. rearing fish for commercial purposes was considered an occupation only for low caste fishermen. However, the potential for earning good profit from pond fish culture has. over time, encouraged the well-to-do farmers to drop their inhibitions.

Once they took to fish culture. they were not very inclined to repay their loans. giving one plea or another. The most common excuses are occurrence of droughts, floods and thefts. Although there are, in the rural areas of Bangladesh, severe systems of imposing penalties and social sanctions on any person guilty of stealing or damagin g other peoples' crops, vegetables and fruits, it seems stealing of fish is still considered a very minor offence. The law enforcement agencies, for their part, are not in a position to provide adequate protection to fish and shrimp culture in closed waterbodies. This dampens the enthusiasm of the financial institutions to directly lend for fish culture.

Past experience in lending to the fisheries sector clearly indicate that it needs to be closely supervised. The DANIDA-financed and supervised project in Mymensingh, in which the Directorate of Fisheries and certain banks were involved, was remarkably successful, mainly because of very close and intensive supervision. The role of the banks involved was limited to the keeping of loan accounts. The Mymensingh experience is being replicated in other districts by the Directorate of Fisheries, particularly in a couple of southern districts, with Government's own funds.

The ADB's second aquaculture credit could **not** be utilized in full due to the inability of the Directorate of Fisheries and the participating banks to ensure proper supervision. However, the Bangladesh Bank took a special interest and launched a drive to educate and motivate branch managers by holding workshops in different centres in the country. These initiatives have yielded good results, inasmuchas the participating banks have not only utilized the balance of the ADB credit but have also indicated their willingness to utilize more funds, if available, for extending credit to fish and shrimp farmers.

The Government's decision to declare fishery projects as industries has also helped in augmenting the flow of institutional credit to the fisheries sector.

Banks have lent for all sorts of requirements of fish culture. These include:

— Pond fish/shrimp culture projects;

— Seasonal fish-rearing in derelict ponds and other waterbodies and the raising of fish in rainfed/ irrigated paddyfields;

— Credit for purchase of fishing boats -- both mechanized and non-mechanized; and

— Fishing gears, sea-going trawlers, shore-based ice plants, processing and packaging plants. and refrigerated vans for transport of fish products to the major inland marketing centres as well as to the export points.

Banks also provide all the credit needs of exporters.

Details of banks credit for production of fish and shrimp are shown on the next page.

The Bangladesh Bank took the initiative, in November 1993, to respond to Government's request to provide bank credit to the semi-intensive shrimp culture subsector. As a result, banks and financial institutions sanctioned Tk. 104.03 crores and disbursed Tk. 61.49 crores upto August 1995 to this subsector.

Table 8: Statement on Sanction and Disbursement of Bank Credit for semi-intensive shrimp cultivation up to August, 1995

(Taka in crores)

Name of the Bank	*No. of projects*	*Amount sanctioned*	*Amount disbursed*	*Area of land (acre)*
Sonali Bank	8	3.44	3.35	370
Janata Bank	5	1.24	0.40	78.55
Rupali Bank	2	0.41	0.00	17.47
Arab Bangladesh Bank Ltd.	16	1.94	0.30	110
Basic	2	1.13	0.00	32
Bangladesh Shilpa Bank	12	7.03	1.03	268
SABINCO	15	23.09	21.96	750
Total	60	39.08	28.07	1642.02
FY 1993/94	64	64.95	34.42	2533
Total	**124**	**104.03**	**61.49**	**4175.02**

Source : Bangladesh Bank

Table 7: Statement on Disbursement and Recovery of Credit for Culture and Capture of Fish and Shrimp by the Government-owned Banks

Taka (in Crores)

Programme	Year			1989-99					1990-91					i991-92					1992-93					1993-94					1994-95		
	Name of the Bank	Disbursement	Recovery	Outstanding	Overdue	%	Disbursement	Recovery	Outstanding	Overdue	%	Disbursement	Recovery	Outstanding	Overdue	%	Disbursement	Recovery	Outstanding	Overdue	%	Disbursement	Recovery	Outstanding	Overdue	%	Disbursement	Recovery	Outstanding	Overdue	%
Pond	sonali	001	0.38	645	564	876	001	094	742	682	91 9	0 05	1.11	763	7.38	96.7	0.00	1 15	7 63	733	969	0.00	214	689	6 74	97 7	621	165	13.09	641	7953
Fisheries	Janata	002	055	5.00	493	986	0.00	048	526	522	992	002	061	499	493	98.8	0.06	0 39	505	498	986	0.04	077	457	447	978	0.004	0.56	414	412	88.03
	Agrani	005	0.26	1.82	178	94 7	0 03	0.29	1 89	179	94 7	003	0.30	1.85	173	93 5	003	0.38	165	1 53	92 7	003	0 %	1.50	135	68.9	0.06	0.15	1.36	119	88.81
	Rupali	0.00	0.14	1.90	1 84	547	005	0.16	0.90	1.79	942	0.02	037	177	164	92.7	0.00	0.09	1 %	1 93	709	0.00	012	1.96	194	990	0.00	0.06	2.08	2.04	96.23
	BKB	0.90	3.78	5305	3351	63.2	0 59	294	52.40	3577	68.3	1.02	377	49.14	40.86	83.2	099	462	50.41	34.80	69 0	074	432	4865	3993	82 1	169	279	4194	33.00	92.21
	RAKUB	0 04	135	2064	1169	566	0 05	069	2178	15.11	694	016	1.31	19.93	14.20	21.2	0.48	2.02	2116	1398	66.1	044	1.03	2192	18.00	82 1	043	0.68	2215	9249	
	Total	1.06	5.46	ea.92	59.39	66.8	0.73	5.50	90.65	73.4	1.30	7.47	82.31	70.74	74.2	1.56	8.65	87.86	64.55	73.5	1.25	9.8	85.69	72.40	84.7	8.39	5.91	65.76	55.18	91.72	
Shnmp	Sonali	016	036	1188	1173	98.7	015	0.33	1246	1234	99 0	0 1.3	0.54	1315	13.06	190	043	0.68	13.84	1367	770	7.88	0.77	20.12	12.56	62.4	5 85	425	2323	1270	7490
Culture	Janata	1.68	142	344	2.88	83.7	0.06	1 32	417	3.09	74 1	143	1 39	455	31.3	699	1.54	1.62	474	3.36	70 9	1.13	1.22	5.02	3.96	78.9	1.80	117	693	385	7669
(brackish	Agrani	1 50	1.43	464	3 42	73 7	2 01	147	543	3.90	718	201	099	5 97	463	775	2.06	1.64	6.00	4.99	832	898	164	13.68	6.03	44.4	642	3.90	1157	510	5667
Water)	Rupali	225	2 50	3 74	175	46.8	2.41	2 39	411	107	455	2.90	3.00	5 55	222	40 0	410	3 63	567	236	416	548	431	5 14	260	44.8	3.89	3.54	5.68	241	40.50
	RKB	142	188	10.10	9 79	96 9	1.63	194	1243	10.89	876	125	2.09	1262	1119	187	212	2.85	1534	13.06	85.1	13.54	3.59	25.20	1178	4476	1491	392	30.69	941	7059
	Total	7.01	7.59	33.80	29.57	87.5	5.23	7.45	38.51	32.M	83.11	7.77	8.01	41.82	34.28	12.0	10.25	10.42	45.51	37.44	82.1	37.03	11.63	59.15	36.40	52.75	32.87	16.74	78.10	33.47	56.61
Others'	Sonali	0.00	0.00	0.66	0.66	100	0.00	0.00	0.66	0.66	100	000	0.00	0.66	0.66	100	0.26	0.00	092	0.66	71 7	153	025	2.26	076	3.363	073	001	0 97	001	50.00
	Janata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	000	0.03	0.00	0.03	0.00	0.00	0.00	004	010	0.00	0.00	0.40	0.00	040	0.00	0.00
	Agrani	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	122	011	2 04	044	80.00
	Rupali	0.00	0.00	0.00	0.00	0.00	0.00	0.00	000	0.00	0.00	002	0.00	002	0.00	0.00	076	0.00	0.68	0.00	0.00	0.01	003	004	0.00	0.00	166	146	1.36	0.01	0 68
	RKB	134	163	1550	5 82	38 8	025	055	1605	1043	650	0 08	059	2649	1799	67 9	0 59	2.38	33.12	26.12	789	10.60	174	2542	2387	93.90	2720	3313	12644	60.83	6474
	RAKUB	0 00	000	0.00	0.00	0.00	000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0 05	098	067	93.06
	Total	1.34	1.53	16.15	5.48	40.1	0.25	0.55	16.71	11.09	66.1	0.10	0.59	27.17	18.65	9.64	1.64	2.38	34.75	26.78	77.06	12.14	2.06	27.62	24.63	88.51	31.21	34.76	132.19	61.96	64.06
Grand-total		9.41 "(1.37)	15.68 (14.11)	138.88	68.72	7.24	13.50 "(1.22)	145.97 (10.96)	109.68	75.14	9.17	16.07 "(1.15)	154.32 (11.50)	123.57	0.15	13.45	21.45 "(1.50)	168.22 (14.28)	128.77	76.55	50.42	22.95 "(4.58)	182.47 (14.67)	133.53	73.18	72.474	57.45 "(4.85)	296.05 (26.31)	160.91	73.69	

'Others = Foreign Aided Project and Cost of Equipments for Inland and Marine Capture

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The repayment rate of this credit has, reportedly, been satisfactory. The banker's risk has also been reduced through introduction of the shrimp culture insurance scheme by the Sadharan Bima Corporation. This compensates for the loss of shrimp fry and the cost of feeds used or lost as well as for damage to the infrastructural facilities of the shrimp project.

The Government has decided to set up a number of semi-intensive shrimp culture centres in various coastal areas to provide technological and natural support to small shrimp farmers.

The country already has as many as 116 fish processing plants, but, due to the inadequate supply of fish, only 18 to 20 per cent of their capacity is being utilized. As a result, most of these fish processing plants, which have been set up with credit from banks, are now experiencing difficulties in servicing their loans. Some of the bank loans have already been rescheduled by the banks involved. Yearwise details of outstanding bank credit to the fisheries sector, including fish and shrimp processing, are shown on Table 9.

The combined efforts of the banks and some of the non-financial institutions, like the Saudi Bangladesh Investment Company (SABINCO), in providing production, harvesting, transporting, processing and preshipment and postshipment export credit, are ensuring continuous support to the country's effort to boost exports in general and that of fish and shrimp in particular.

The structure of the rural and agricultural credit system of Bangladesh is shown on Figure 2.

Inspite of the efforts made over the last two decades, the amount of bank credit extended to the real fishermen for culture and capture of fish still remains at a low level. The needs for export credit, however, have been met adequately by the banking sector.

5. THE CONSTRAINTS BANKS FACE

In order to understand the constraints in extending and recovering institutional credit for culture and capture of fish and shrimp, it is necessary to be aware of the practices in fish and shrimp culture; the method of leasing ponds, coastal lands and open water bodies, the harvesting and processing technologies, and the structure and management complexities of fish marketing in Bangladesh.

The fishermen of Bangladesh are, mostly, illiterate and poor. They cannot afford to purchase their own boats, large nets and other fishing gear. They either have to take loans from moneylenders at exorbitant interest rates to rent boats, nets and other fishing gear, or work as contract labourers on very low wages in the boats of the moneylender-cum-boatowners. In either case they do not have the right to sell the fish at a reasonable price.

In the case of open waterbody fishing, the harvest is collected by the lease-holders, boatowners or their henchmen at dictated prices, which usually are a fraction of the inland retail prices or the prices at the export point. The fishermen do not have the right to take their catch to the markets themselves.

Attempts have been made in the past in different parts of the country to organize the actual fishermen in cooperatives, but these soon became indirectly controlled by the moneylenders or their henchmen. The Bangladesh Rural Development Board (BRDB) has, however, been successful in organizing assetless fishermen and women into co-operatives to produce brackish as well as sweetwater shrimp in certain parts of a coastal district. But they are facing stiff resistance from the big fish farmers and the moneylenders.

Table 9. Statement on Bank Credit to the Fisheries Sector including Fish and Shrimp Processing

(Amount in Lacs of Taka)

Bank	*June 1989*	*June 1990*	*June 1991*	*June 1992*	*June 1993*	*June 1994*
Agrani Bank	14.76	22.21	**29.32**	30.28	18.66	**28.98**
Janata Bank	11.52	9.65	15.09	16.48	18.71	35.14
Sonali Bank	36.77	46.31	28.21	30.01	37.58	46.82
Rupali Bank Ltd.	8.91	3.88	3.68	3.11	4.03	3.86
American Express		10.00		1.04	1.53	
Grindlays Bank Plc					22.00	
Standard Chartered		1.96	1.04	98.00	21 .oo	53.00
State Bank of India						
Habib Bank Ltd.						
Banque Indosuez			3.58	6.08	2.84	35.00
BCCI Ltd.	6.82	9.03				
BKB	144.96	188.60	186.06	208.55	202.78	211.38
BSB	37.70	40.09	31.96	46.72	53.21	67.24
RAKUB	22.74	36.59	34.65	30.04	27.69	30.52
AB Bank Ltd.	12.00	25.00	17.00	19.00	1.00	94.00
Islami Bank Bangladesh Ltd.	55.00	47.00	41.00	58.00	10.00	67.00
UCBL	2.00	2.00				
National Bank	1.97	4.70	2.17	1.17	1.48	2.42
The City Bank Ltd.					52.00	51 .oo
Pubali Bank Ltd.	3.62	6.77	6.55	6.30	6.84	8.79
Uttara Bank Ltd.	70.00	1.31	2.14	1.66	1.50	1.65
Al-Baraka Bank	25.00	87.00	64.00	83.00	83.00	83.00
Basic					30.00	
Eastern Bank Ltd.					9.32	7.79
NCCBL					23.00	25.00
IFIC Bank Ltd.	7.00	3.00	1.05	1.81	3.69	5.90
Total Fishing Loan	291 .48	372.53	346.72	385.63	393.36	454.57

Source : Bangladesh Bank

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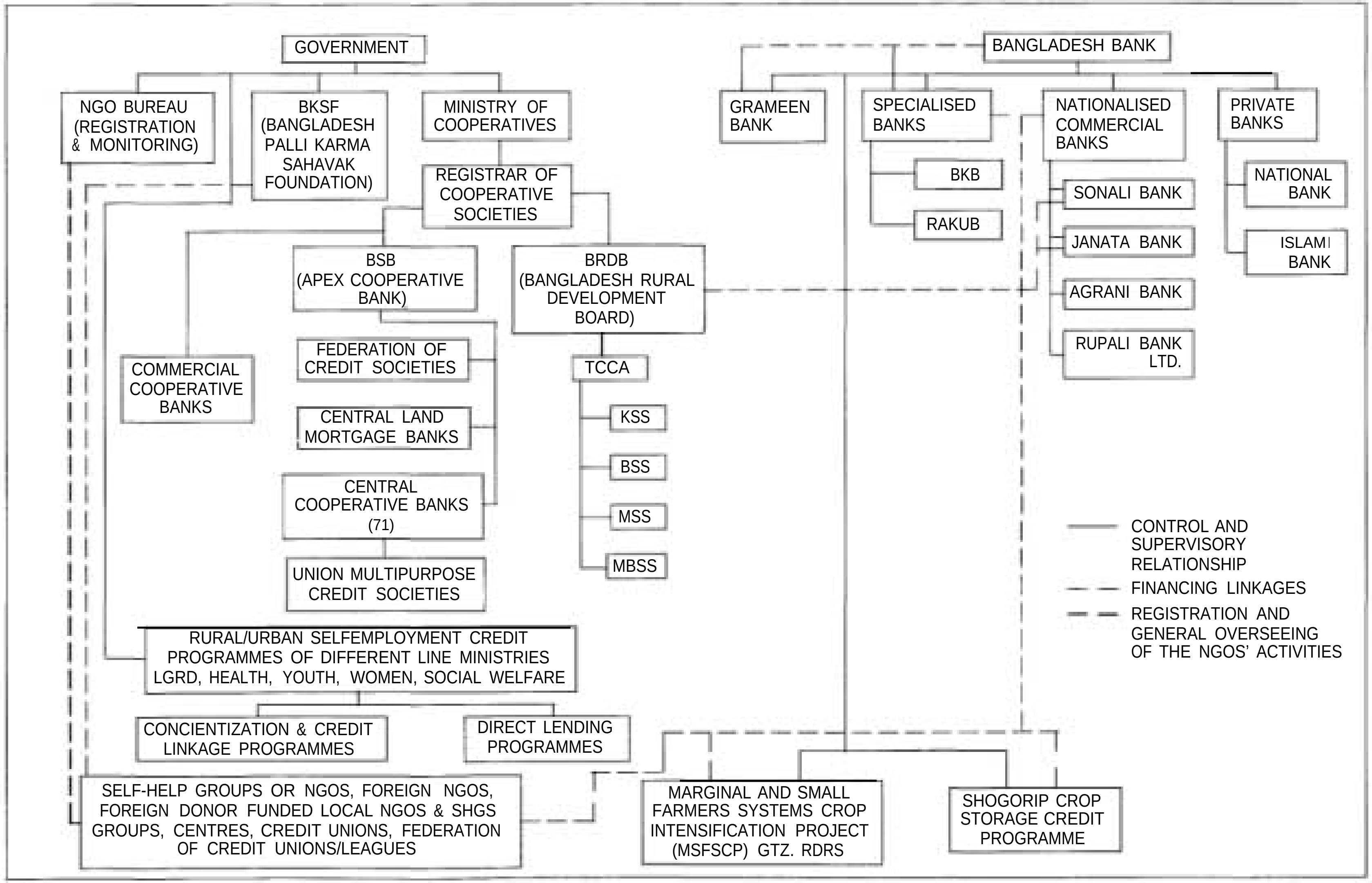
Figure 2. Rural and Agricultural Credit System of Bangladesh



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6. THE SUCCESS STORIES

One of the most successful innovative credit-cum fish culture schemes is the Grameen Bank's Neemgachi Project which was handed over to it by the Government following initial management failure. The project, with a large number of ponds, was originally funded by the British O/D/A.

The Grameen Bank, using innovative methods. organized the local community, who were mostly poor, in groups and motivated them through training and by allowing them an assured share of the harvests for their help in the culture, protection and overall management of different species of carp. The necessary technological advice, input support and credit are provided by the Grameen Bank.

The Grameen Bank has also organized assetless people in a coastal area and has got them to successfully engage in shrimp-farming. The Grameen Bank groups, however, have been not so successful in getting lease rights over large waterbodies or weekly/daily village markets.

The IFAD/DANIDA assisted ox-bow lakes project in the Jessore area has organized fishermen living near the lakes through BRAC and another NGO. The Directorate of Fisheries and the two NGOs are providing training and technological advice on the stocking. rearing, protecting and proper harvesting of fish.

These success stories and the fact that IFAD-assisted projects have not been considered as cyclone-affected rural households in coastal areas hit by cyclones indicate that formal institutions like banks **can** effectively reach the poor fishermen with credit and recover it successfully -- but only through having appropriate linkages with NGOs or local self-help groups, who can ensure the intensive supervision and the management needs of the fishermen groups necessary. for facilitating repayments of loans in time.

7. SPECIAL SCHEMES

The Sonali Bank, the largest commercial bank of the country, has introduced a special rural investment programme under which it may lend for fish farming upto Tk. 50,000 **without** any collateral. To implement this scheme, the Sonali Bank has designated only its branches which are adequately manned by suitable extension staff to ensure intensive supervision of the fishery projects. The Bangladesh Krishi Bank is also studying a scheme for lending to small fish farmers without collateral. However, the fact remains that in the absence of any effective supervisory arrangements of their own, or any linkage with NGOs self-help groups, banks would usually like to have some collateral.

The Government of Bangladesh has now declared fisheries projects as 'industries', which would allow entrepreneurs the benefits of lower interest rates and tax holidays. The Government has also made amendments to the relevant laws and regulations for extending the tenure of lease periods for Government-owned ponds/tanks and. particularly, land in coastal areas suitable for shrimp culture.

The Bangladesh Bank is implementing a credit guarantee scheme under which a borrower can set up a hatchery, a fish feed/fishing accessory-producing plant, a processing unit or even a fish and shrimp culture project without any collateral. As a result, a lot of enthusiasm has been generated in the country for investment in pond fishery projects, particularly for culturing quick-growing Catfish, sweetwater shrimp, exotic varieties of carp and Thai puti. The Bangladesh Bank is also encouraging seasonal culture of fish and shrimp, including fish culture in rainfed/irrigated ricefields.

8. MARKETING SYSTEM

It has already been pointed out that the actual fishermen and fish farmers do not get proper prices for their harvests due to a complex marketing system and the very dominant role of middlemen in it. There are four distinct tiers in the marketing system in Bangladesh, namely,

1. **Primary markets.** These are located near the points where the fish are caught. The moneylenders or moneylender-cum-wholesalers *(Aratdar)* procure the fish from the fishermen, generally through their henchmen, at predetermined prices. Only a part of the catch is allowed to be sold locally by local retailers. There is no problem of credit, as it can be easily obtained as trade finance from the nearest bank by affluent moneylenders/aratdars.

2. **Secondary markets.** The fish collectors at the primary markets bring the fish/shrimp to the landing ghats (jetties) in important commercial centres which are well-connected by river, road and/or rail transport. The dominant player in these markets are known as beparis (large traders).

3. **Higher Secondary Markets.** In these markets the *beparis* sell the fish to large wholesalers (paikers) through the local aratdars (commission agents). All the players in these markets can easily access institutional credit as trade finance.

4. **Final Consuming Market.** In this market, the big wholesalers sell their fish to the retailers who, in turn, either sell at permanent stalls in local markets or peddle it to homes on their heads or in rickshaw vans equipped with ice boxes.

With the availability of ice and fast-moving motorized boats, the fish catch is increasingly brought from the catch areas directly to the final consuming market.

There is no price control on wholesale or retail fish markets. While fish is generally auctioned in the large markets, this system is yet to be introduced for selling shrimp produced in closed waterbodies whose harvests processors/exporters usually buy at predetermined prices. The banks have generously financed the establishment of fish processing plants for processing. packing, storage and export of shrimp and whitefish although they do not usually receive timely repayment of their loans.

The role of the Bangladesh Fisheries Development Corporation in modernizing marine fishing, improving the landing places and storage facilities, popularizing the consumption of iced seafish, improving processing and storage of dry fish. and developing new, ready-to-cook products from trash fish, needs to be acknowledged. The infrastructure developed by this corporation is also being utilized by the private sector, which plays the dominant role in production, capture, processing, storage and internal and external marketing of shrimp, fish and fish products.

9. FISHERIES SECTOR PROBLEMS

Bangladesh has already deregulated its financial system. As such, the days of directed credit for any particular sector or subsector are over. The financial institutions are **absolutely free** to choose their borrower as well as to fix the interest rates, within the existing bands, and set terms on the basis of banker-customer-relationships. But, occasionally, this reality is not quite understood by the large borrowers and some people associated with the promotion and development of the fisheries sector. If the banks could be assured that their loans would be repaid in time, there should be no reason to discourage them from lending to any sector, including the fisheries sector.

However, the following problems have been identified as factors inhibiting increased flow of institutional credit to the fisheries sector:

1. Land record-keeping in Bangladesh needs to be updated and modernized. Most of the ponds and tanks in the country are jointly owned and the record of rights has not been properly updated. The co-sharers are not always willing to allow one of them to culture fish on a medium- or-long-term basis. Motivational work needs to be done by the Directorate of Fisheries/concerned banks/ the NGOs to encourage the entrepreneurs to initially go in for short-term or seasonal culture of quick-growing and high-valued species of fish, such as catfish, exotic varieties of carp and sweet water shrimp to demonstrate the high profitability to the co-sharers. This would encourage co-sharers to allow one of their number to culture fish or motivate the lot to join together in culture **and** make accessing institutional credit easier.

2. The promotional agency -- The Directorate of Fisheries -- should take appropriate steps to enforce the existing laws, which does not permit a pond/tank without fish culture. The training and motivational programmes which are being implemented by the Directorate are expected to create individual as well as social awareness about the importance and profitability of closedwater fish culture.

3. Apart from training, the prospective fish farmers should be provided with technical advice and guidance on overall farm management, including information on water management, the availability of fish fry and fingerlings, appropriate density of fish population in monoculture or polyculture and disease control etc.

4. In the case of open waterbodies, the Government has already abolished the system of leasing the *jal mahals.* But it might be difficult to enforce this decision and protect the small fishermen's right to freely fish in these waters unless there is proper enforcement by the relevant agencies.

5. The Government is continuing with its pragmatic policy of re-stocking the open waterbodies with fish fry/fingerlings. These programmes help in augmenting the catches of the fishermen who are dependent on fishing for their livelihood in the large *heels, haors, baors,* lakes and rivers. However, these efforts are being frustrated by the widespread use of densely meshed nylon nets which destroy the juveniles and hurt the prospects for several potential harvests of different species of inland water fish, particularly that of Hilsa which accounts for a sizeable portion of the annual fish production. The prohibition of densely meshed nylon nets alone is, however, not enough. Banning the capture of certain species of fish during their breeding periods should also be vigorously enforced.

6. The Government has already decided to maintain fish sanctuaries in different parts of the country. This is expected to augment the catch.

7. With the spread of shrimp culture in the country, the requirements for shrimp fry have gone up tremendously. This cannot be met only through collection of shrimp fry from rivers and the seashore by using nylon nets. This, in any event, is a harmful practice as it destroys the fry of other fish and affects the overall availability of fish both for internal consumption as well as export. It needs to be emphasized that the repayment capacity of credit is linked with the sustained flow of income of the borrowers, the fishermen.

8. There are reports of fishing grounds in the Bay being depleted due to overfishing, mostly by unauthorized trawlers. There have to be arrangements to protect the country's marine fishing zone from unauthorized fishing as well as to totally stop fishing, particularly trawling for shrimp, during the shrimp breeding periods.

9. Proper surveys needs to be conducted to assess Bangladesh's marine resources, if necessary with the assistance of FAO. The financial institutions which have lent to the owners of trawlers and artisanal boats, have a stake in this matter, as this information would help to evaluate their lending policies to this subsector and assess the regularity of repayments.

10. Government has already decided to extend the tenure of lease of *khas* lands for shrimp farming and make the lease inheritable. This has removed the constraints which had been experienced by banks in accepting *khas* land as collateral.

11. There has to be proper registration of a shrimp project with the law enforcement agencies so that the actual farmer can get protection for it from any disturbance.

12. The financial institutions have already started financing the semi-intensive shrimp sector and till now the repayment rate remains very encouraging. However, the relevant authorities should come but with a clear-cut policy with regard to the zoning of shrimp farming in genera1 and semi-intensive culture in particular and make expeditious arrangements for providing necessary infrastructural facilities such as all-weather roads, electricity, overall water management facilities and security arrangements.

13. The greatest constraint to expanding shrimp culture. which is very profitable, is the availability of shrimp fry at reasonable prices. While technology for sweetwater shrimp (Golda) has been successfully adopted by certain hatchery owners in the private sector, success with breeding brackishwater shrimp (Bagda) remains very limited and uncertain. Urgent attention is needed to ensuring the breeding of shrimp fry not only to augment export earnings from shrimp, but also to gradually enforce prohibition of collecting shrimp fry from the wild by means that destroy the fry of other fish.

14. Bangladesh is a disaster-prone country. This makes both pond culture in inland areas as well as shrimp culture in coastal areas a rather risky venture. While the Sadharan Bima Corporation has introduced an insurance scheme for shrimp culture projects, there is no insurance cover available for fish-farming. Therefore, the case for introducing insurance cover for fish farming, with proper evaluation of the projects and intensive supervision, merits urgent consideration. The availability of insurance cover and/or any guarantee fund would help in augmenting the flow of credit to the fisheries sector.

15. Bangladesh is very conscious about the environmental issues which are germane to fish farming in general and shrimp culture in particular. Government has already taken steps to protect the quality of inland waters and that of the Bay. But this also calls for co-operation from the upper riparian countries as well as from the marine traffic in the Bay of Bengal. In the case of shrimp culture, Government is determined to contain and minimize the possible adverse impact on the environment through zoning and evolving and introducing proper water management systems.

16. The financial institutions have a great stake in the maintenance of phyto-sanitary standards and quality control in production, processing, packaging and storage of shrimp. fish and other aquatic products, as problems with export consigmnents will undoubtedly affect repayment of loans. Government is very conscious of this and the relevant agencies are rigorously enforcing quality control according to internationally acceptable standards.

10. WHAT IS NEEDED

It is in the interest of Bangladesh's financial institutions to invest in profitable ventures. They have already voluntarily invested substantial amounts in the semi-intensive shrimp culture subsector. With proper co-ordination and technological support from the relevant Government agencies and by establishing links, where possible, with NGOs/Self Help Groups who would ensure intensive supervision of pond fishery projects, the financial institutions would be able to augment the flow of credit to the fisheries sector. And this would help usher in the much-desired 'silver revolution' for Bangladesh.

PAPER 8

LEGAL REGULATORY AND INSTITUTIONAL FRAMEWORK FOR FISHERIES AND FISHING COMMUNITY DEVELOPMENT AND MANAGEMENT

by

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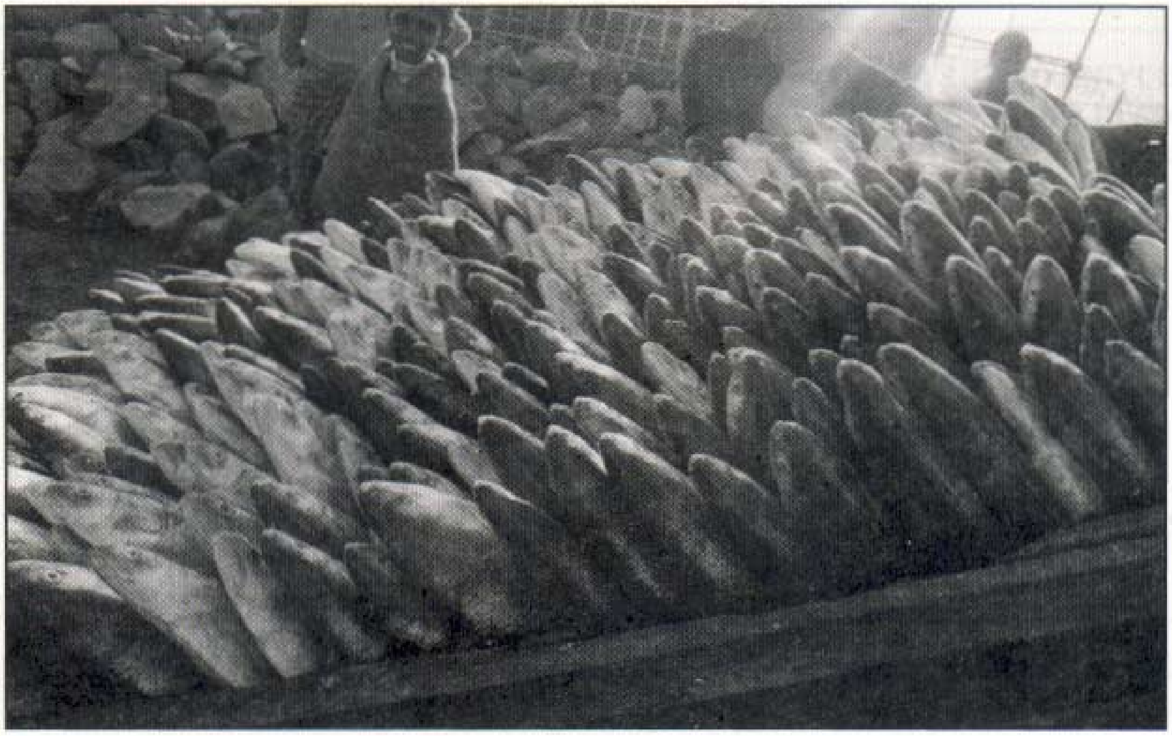

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SUMMARY

Fisheries are important for the supply of animal protein, employment-generation, foreign exchange earnings and economic growth of Bangladesh.

— Inland open water capture fisheries and the marine waters of the Bay of Bengal contribute the lion's share of the total fish production in Bangladesh. Better biological management techniques in these waters, stricter implementation of all rules, ordinances etc. to ensure natural productivity, need to establish sanctuaries and Jatka conservation, are all necessary.

— The present pyramid structure, of the Department of Fisheries (DOF) needs to be rectified and the frustration of staff and field workers have to be removed.

— The implementation of the New Fisheries Management Policy (NFMP) can safeguard the interests of the fisherfolk, but problems connected with the ownership of waterbodies need to be addressed. The fishing community in general is illiterate and poor, its social status low. Attention should be given to develop them.

— Many agencies, like the Department of Fisheries, Fisheries Research Institute, Fisheries Development Corporation, Bangladesh Agriculture Research Council, Water Development Board and NGO's, are working for the development of the fisheries sector. Co-operation and co-ordination among these organizations is essential.

— The Fish Act, the Tank Improvement Act, the Marine Ordinance etc. all need to be revised.

1. INTRODUCTION

The blessings of a subtropical climate, a prolonged rainy season, its topography, the flow of the Ganges, Padma and Brahmaputra rivers which cause floods during the monsoon, all facilitate the development of a unique fisheries environment in Bangladesh. Vast seasonal water areas, rivers and canals, millions of ponds (dhigis), ***baors, baors*** etc. are all potential sources of inland freshwater fish production. A large part of the coastal zone is suitable for shrimp culture. The marine waters of the country in the Bay of Bengal also contribute much to the total harvest.

The fisheries sector provides 80 per cent of the protein for Bangladesh's population, contributes 10 per cent of the foreign exchange earnings, generates employment for 12 per cent of the total working population and contributes 4.6 per cent to the GDP. Growth in the fisheries sector is 6.6 per cent. From these statistics the importance of fisheries in Bangladesh can easily be understood. However, compared to its water area, Bangladesh's production is not satisfactory.

Openwater is the greatest source of Bangladesh's fish supply, but production has declined a lot in this area for many reasons. So it is high time to take appropriate measures to develop the fishing community directly related with the openwater fishery and improve the agencies responsible for the management of openwaters and the implementation of the legal and regulatory measures in these waters. The existing linkages and working relationships between and among the various government and non-government organizations involved in fisheries education, research, training and extension need to be reviewed in order to develop an appropriate model for effective co-operation and co-ordination for development. Effective co-ordination is at present meagre.

In this paper the following aspects of the legal, regulatory and institutional framework for fisheries and fishing communities development and management are discussed:

- The adequacy of fisheries institutions to implement the regulatory acts and ordinances and the need for their strengthening.
- Regulatory measures provided in the New Fisheries Management Policy (NFMP), the problems with them and the need. to modify the policy.
- The adequacy of the legal and institutional set-up for the transfer of large waterbodies to the Ministry of Fisheries and Livestock.
- The need for conservation of juveniles (of Hilsa, Galda, carps etc.), the establishment of sanctuaries and the sustainability of fisheries resources.
- The fisherfolk, their problems and the means to improve their livelihood.
- Increased need for enforcing fisheries resources conservation acts and ordinances
- The problems and constraints in coastal and industrial fisheries in relation to the present legal and institutional framework, with particular reference to the Fisheries Ordinance 1983, and the need to revise the ordinance.
- Recommendations on how to streamline the present legal and institutional framework to suit local realities.

2. FISHERIES INSTITUTIONS AND THE REGULATORY ACTS AND ORDINANCES

2.1 The history of the Department of Fisheries

The Department of Fisheries was established in 1908 under the then Province of Bengal. This Department merged with the Department of Agriculture in 1910. It was again transformed, into a separate entity, in 1917. Due to some administrative problems, the Director of the Department of Agriculture acted as the officiating Director of the Department of Fisheries in 1920. The Department was entrusted with the task of application of the Indian Fisheries Act of 1897 for the protection of brood and immature fish and the conservation of resources. Its function was limited to districts and divisions.

Due to lack of adequate financial support and technical manpower, the Bengal Retrenchment Committee recommended the Department's abolition and this was done in 1923. The Department was again revived in 1942 to meet the demand for increased fish production during World War II.

After the partition of India in 1947, the organization was renamed the Directorate of Fisheries and its headquarters was shifted from Calcutta to Comilla. During its initial years, the Directorate of Fisheries mainly looked after fish marketing and fishermen's welfare. The East Bengal Protection and Conservation of Fish Act was prepared by the Directorate and was passed in 1950 by the then Provincial Legislature. with a view to conserving young and brood stocks of specific species of fish and to restrict certain fishing activities. The Directorate hired some ponds and managed nursery activities on a smallscale, growing fry and fingerlings of major carps for distribution among private fish farmers. The Directorate was bifurcated into the Research and Extension wings in 1954 and its headquarters was shifted to the secretariat in Dhaka. Fish seed multiplication farms and a fishery research and training complex came into operation in 1960-70. The headquarters was transferred to a rented building at Kakrail, Dhaka, in 1971.

After the Independence of Bangladesh in 1971, the marine wing was amalgamated with the Directorate and renamed the **Department of Fisheries.** At the outset, much of its activities remained centered on the development. promotion and expansion of fish culture in closed waterbodies, such as ponds and ox-bow lakes.

In order to intensify fish culture in derelict tanks, the Tank Improvement Act of 1939 (as amended) was further amended to allow requisition of derelict tanks and allocate them to people interested in fish culture. In order to improve biological management in government-owned fisheries, the department started pilot-scale management of a few fisheries with fishermen co-operative societies on a catch-sharing basis, providing for licensing of individual members of those co-operatives. In 1986. the headquarters of the Department was moved to **Matshya Bhahan,** its own premises. The same year, the New Fisheries Management Policy (NFMP) was formulated with a view to safeguard the interests of the fishermen.

2.2 The emerging significance of the DOF

The history of the creation, abolition, revival, transfer, and reconstitution of the DOF indicates the ambivalence that existed for nearly 90 years on the role and significance of the fisheries sector in the perceptions of the governments of those times. The original intention of the government was to involve itself in the fisheries sector to explore the possibility of collecting revenue from the sector. Gradually, the consciousness emerged that the real significance of the fisheries sector was that it was the largest animal protein source for the entire population and that it had tremendous potential to contribute to social uplift and development. The Government then recognized the fisheries sector not merely as a revenue source. but as a source of protein supply and employment and began to consider it a public responsibility to **manage** and **develop** it. This resulted in entrusting the DoF with the following responsibility

Advising the government on the extended management of the inland and marine fisheries resources and other aquatic animals of economic significance.

----- Advising the government on the environmental conservation. development and protection of waterbodies.

Assisting the line ministry in formulating policies on the management and development of fisheries resources and on fish-related matters.

Surveying and making stock assessments of the existing fisheries resources.

Identifying the present condition and productivity of marine waterbodies and monitoring the catch of the trawler fleet.

Taking steps for the management and conservation of the inland and marine fisheries resources.

– Implementing the New Fisheries Management Policy adopted in 1986.

Initiating the formulation of fisheries-related acts. and ensuring the enforcement of fisheries acts, ordinances, and regulations in this respect.

– Formulating and implementing development projects for fish culture, fisheries resources management. fish processing and utilization, and other fisheries development-related activities.

Monitoring, evaluating, analyzing. and coordinating fisheries development-related activities. Coordinating fisheries-related inter-organizational activities with other institutions and bodies engaged in this sector, like the Fisheries Research Institute, Bangladesh Fisheries Development Corporation. Bangladesh Agricultural Research Council, Rural Development Board, Bangladesh Water Development Board, Export Promotion Bureau, Department of Environment Control and Krishi Bank.

— Dissemination of improved fish cultivation techniques.

- Runing fish seed multiplication farms and fish hatcheries as demonstration units and supplying high-quality indigenous and exotic fish fry and fingerlings to fish farmers. Also imparting training to farmers through these farms.

Demonstrating and extending improved and appropriate technology for shrimp culture through the shrimp farms and shrimp hatcheries.

Arranging for institutional credit for fish farmers, shrimp cultivators, fishermen and fish traders.

- Organizing a fisheries extension service to transfer technology on fish farming, fish harvesting, fish preservation and fisheries management to the fisherfolk.

Arranging in-service training for officers, staff, and field level extension workers of the DOF.

Arranging training for the extension workers of various private organizations, landless peasants, unemployed youth, fish farmers, and fisherfolk.

Enforcing quality control measures and arranging for issue of health certificates for exportable fish and fish products.

— Arranging for the Thana Fishery Officers to participate in fisheries-related development and extension activities at the *thana* level. At the same time. ensuring implementation of Acts, Ordinances etc. by them.

- Taking steps for the socioeconomic development of the fisherfolk community.
- Liaising with fisheries-related regional and international organizations.
- Coordinating investments in the various sectors of the fisheries industry, such as trawling and fish processing.

2.3 Present structure of DOF

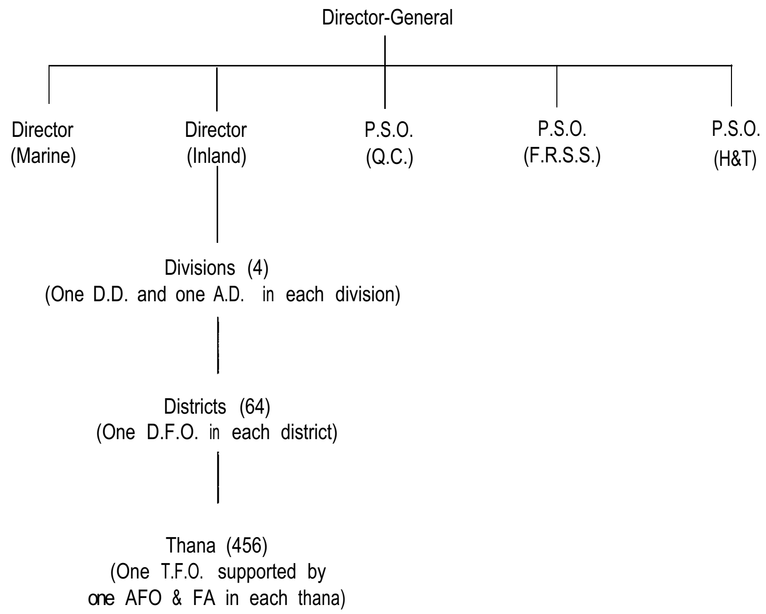
The existing organizational structure of the DOF is based on the findings and recommendations of the Matin Committee. The DOF is headed by the Director-General, who is supported by two Director\: one for marine fisheries and one for inland fisheries. The Director, Marine, is posted in Chittagong. and takes care of all functions related to marine survey, enforcement of laws and licensing etc. The Director, Inland, is located at Headquarters and is responsible for administration and finance, training, fish culture, extension activities and management of field offices. He also looks after completed **field-**based projects now included in the revenue budget.

There are three Principal Scientific Officers (PSO): one in the Raipur Hatchery and Training Institute. one for FRSS and another for QC. The posts of Director and PSO are equivalent.

The field level set-up consists of deputy directors in charge of four Divisions, District Fishery Officers in charge of 64 districts, and 456 Thana Fishery Officers.

The total staff of the DOF under the revenue budget is 3653. of which the number of Class I posts is 731, Class II post is 74, Class III is 1966 and Class IV is 882. Under the development head. the number of staff in Class I are 209 (89 vacant), Class II 51 (4 vacant), Class III 743 (70 vacant) and Class IV 169 (31 vacant).

Figure 1. Organization of the Department of Fisheries



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A Thana Fishery Officer (T.F.O.) is supposed to render extension service. At the same time, he is responsible for implementation of all rules. Acts, Ordinances etc. The nature of his two main responsibilities are conflicting!

2.4 Existing problems and constraints

Shortage of Manpower: The TFO has been entrusted with two conflicting assignments, viz. extension and implementation of regulatory measures. These should be done by separate officers at the *thana* level. There is, in each *thana,* on an average, 327 ha of closed area and 8798 ha of open water. The average population in each *thana* is about 20,000 persons. This work is too much for one TFO and extra technical manpower is therefore needed at this lower level. In the district level too there is only one officer and he is mainly responsible for supervision and co-ordination. In his absence, there is no one in his office to respond to requests for information and extension.

Fund constraints: On an average Tk. 5000 are given annually to one TFO to cover all his expenses. He cannot be expected to undertake much extension work and implement the rules with such meagre funding.

Infrastructure constraints: In many cases, a DFO or TFO does not have a vehicle or equipment. This limits his efficiency in respect of fishery extension and conservation work.

Lack of support: The Tank Improvement Act and other ordinances are supposed to be implemented by the TFO with the help of the TNO, Magistrate or Police. But it seems that such support is not mandatory. So TFOs in most cases are helpless. Everybody's work is actually nobody's work.

Inadequate trainers: To increase the efficiency of officers, frequent training is needed. There is little planned.

Frustrated staff: The Matin Committee has blocked the future of all entry level officers. New entry level officers are suffering from frustration. Further, recruitment rules have not been finalized nor have the services of many officers been regularized. There are severe problems in the field as a consequence.

Lack of information: The information system of the DoF is poor. An effective system should be developed.

Conflicting authorities: The waterbodies belong to the Land Ministry, while the DoF is in charge of their management. This system does not work. Waterbodies should be transferred to the DoF. In that case, responsibility can be fixed.

Not the right staff: At present, many of the staff in the Department of Fisheries are biologists. But there are fields in the sector where Economists, Sociologists, Environmentalists and Engineers are also needed. Recruitment policies need to be reviewed.

In the marine sector, the situation is even worse. Lack of manpower, facilities and funds are a severe problem. An assessment of the requirements and implementation of rules is urgently needed.

The problems cited above are acute. Therefore, these problems need to be resolved immediately.

2.5 Proposed mandate of DoF

The DoF should be responsible for extension, training, management and conservation, quality control of exports, formulation and implementation of development projects. and collection of statistics. The DoF should also be entrusted with the task of environmental impact analysis and overall socioeconomic improvement of the fishing communities. The NFMP should be extended everywhere and proper systems should be developed.

2.6 Proposed structure of DoF

The suggested organizational structure of the DoF would consist of six functional Directorates:

- Inland fisheries.
- Marine fisheries.
- Administration and finance.
- Planning and development.
- Extension and training.
- Quality control.

Each directorate would be headed by a Director or equivalent. All the directorates would function under the overall control and supervision of the Director-General, with maximum operational freedom within the house, but maintaining close and harmonious relationships with each other and with the field set-up.

The Inland and Marine Directorates would be responsible for operations and development relating to fisheries management. conservation. input supply and coordination in their respective areas. The Administration and Finance Directorate would control personnel, finance and support services of other directorates. The Planning and Development Directorate would plan for all other directorates, receive inputs in this connection (e.g. statistics, data and information) and monitor the development projects. The Extension and Training Directorate would be responsible for motivation, training etc.

The field set-up of the inland fisheries directorate would include six Regional Fisheries Offices, 64 District Fisheries Offices, 456 Thana Fisheries Offices and 8 1 demonstration farms, 5 fisheries extension and training centers as well a Fisheries Training Institute (Chandpur) and a Training Academy in Dhaka in addition to the existing Fisheries Development and Training Institute in Raipur, which at present, is under the direct charge of the Director-General.

In order to meet the requirements of foreign buyers. the concept of a quality control laboratory for pre-shipment inspection and microbiological examination of exportable fish and fisheries products was first considered in 1973. Preliminary work on the establishment of fish inspection and quality control was started in 1976-77 in a hired house at Khulna and in the CGO building Agrabad, Chittagong. with the appointment of staff, including Deputy Directors, and purchase of equipment.

The Government decided in 1979 to upgrade the existing inspection facilities and quality control of exportable fishery products to a level of professionalism that would ensure international recognition. The project was approved in 1983 and completed in June 1985 with the appointment of Inspectors, Deputy Directors and a Project Director (PSO) to coordinate the work of the various units. Manpower was increased from 24 to 55.

The Government also promulgated the Fish Inspection and Quality Control Ordinance on 10 May, 1983 and it came into force on 15 August, 1983.

By this time. the Government had set-up a microbiological laboratory at *Matshya Bhaban,* but the ancillary facilities of **this** laboratory are not adequate to meet the present requirements. The Government quality control structure alone cannot fully regulate fishery products. There should be self-regulatory measures in each industry. Each fish processing plant should have the ancillary facilities for quality control.

The EEC and US FDA (Food & Drug Administration) are pressing the Government to introduce the HACCP (Hazard Analysis Critical Control Points) concept in Bangladesh before the end of 1995. If the country fails to introduce this system at all levels of production, distribution, storage and sale of fish and fisheries products, there is a possibility of losing its present international market. At present, the quality of fish is controlled **when** it comes for processing, but appropriate care is not taken immediately after harvest. As a result, the quality of the fish is degraded in many cases. With this in view. service centre facilities, transport and ice facilities and skilled manpower at all levels are required.

In order to overcome these problems, the following are suggested:

— Modernization of the quality control laboratory through procurement of equipment. chemicals and transport.

— Ensuring skilled manpower development.

— Creation of units for inspection of the quality of the ice used and the condition of the fish at landing and selling points, and at processing plants.

— Transferring of modern technology to the fish processors in order to develop a system of self-regulation in their plants.

— Urgent training on HACCP (Hazard Analysis Critical Control Points) for official inspectors of the Department of Fisheries and the private sectors.

2.7 Involvement of Government of Bangladesh agencies in administration, management and development of fisheries

Ministry	*Department/Institution*	*Invofvement*
Ministry of Fisheries and Livestock (MFL)	Department of Fisheries (DoF)	Administration, management, and development; extension and training; conservation of resources; enforcement of fishery laws
	Bangladesh Fisheries Development Corporation (BFDC)	Exploitation and marketing
	Fisheries Research Institute (FRI)	Research; Training and extension
Mrnistry of Land (ML)	Land Administration Board (Land Reforms Division)	Leasing of public waterbodies above 20 acres
Ministry of Local Government, Rural Development and Co-operatives (LGRDC)	Bangladesh Rural Development Board (BRDB)	Fisheries component of integrated rural development
	Registrar of Co-operative Societies	Registration and supervision of fishermen's co-operative societies
	Bangladesh National Fishermen's Co-operative Societies (BJMSS)	Operation of ice-plants, Import of fishing gear

Ministry	Department/Institution	Involvement
	Co-operative Banks	Financing of fishermen's co-operatives
	District *Parishad*	Management of waterbodies above 20 acres
	Thana Park-had	Management of closed waterbodies below 20 but above 3 acres
	Union *Parishad*	Management of waterbodies below 3 acres, and with rent earlier fixed at Tk. 5000 (as of February 1987)
Ministry of Irrigation, Water Development and Flood Control (MIWDFC)	Bangladesh Water Development Board (BWDB)	Leasing of reservoir and irrigation channels
Ministry of Forest and Environment (MFE)	Forest Department (FD)	Exploitation and control of Sundarban-based fisheries loan
Ministry of Finance (MF)	Bangladesh Krishi Bank (BKB)	Administration of fisheries loan
	Commercial banks	Administration of fisheries loan
	Economic Relations Department (ERD)	Administration and co-ordination of foreign assistance for fisheries development
Ministry of Planning	Planning Commission (Planning)	Project evaluation and approval
Ministry of Shipping	Mercantile Marine Department	Registration of fishing boats
Ministry of Transport and Communication (BT&C)	Bangladesh Railway (BR)	Leasing of reservoirs and canals on railway land
Ministry of Defense (MD)	Bangladesh Navy (BN)	Leasing of waterbodies in the naval area; Patrolling Exclusive Economic Zone (EEZ) to prevent intrusion of foreign fishing vessels
Ministry of Commerce (MC)	Department of Commerce	Leasing of fish processing plants
Ministry of Foreign Affairs (MFA)	EEZ of Bangladesh	Exclusive Economic Zone (EEZ) negotiations
Ministry of Education	Bangladesh Agricultural University	Higher fisheries education; Extension and training
	Other Universities	Fisheries-related education
NGO Affairs Bureau	Various non-government organizations	Development activities in the fisheries sector by arrangement with other agencies

Source: Kutty and Haque 1991

3. REGULATORY MEASURES IN THE NEW FISHERIES MANAGEMENT POLICY

In Bangladesh. there has traditionally been no proper fisheries management system for the development of the *jalmuhals.* These jalmahals are leased out by Ministry of Land (ML) just to collect revenue. The ownership of *jalmahals* by the ML severely weakens the capacity of the Ministry of Fisheries and Livestock (MOFL) to carry out its mandate of scientifically managing, protecting and conserving the inland fisheries resources.

In 1987, a New Fisheries Management Policy (NFMP) was initiated by MOFL to deliver the maximum benefits from fishing to genuine fishermen and to introduce management systems to ensure long-term

Ministry	*Department/Institution*	*Involvement*
	Co-operative Banks	Financing of fishermen's co-operatives
	District *Parishad*	Management of waterbodies above 20 acres
	Thana Parishad	Management of closed waterbodies below 20 but above 3 acres
	Union *Parishad*	Management of waterbodies below 3 acres, and with rent earlier fixed at Tk. 5000 (as of February 1987)
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4. *CONSERVATION*

4.1 Conservation of fish sanctuaries

Sanctuaries are best located in least disturbed natural environments that harbour the maximum species diversity in a balanced natural equilibrium and which provide good opportunities for survival and reproduction of the species. Finding such waterbodies is difficult. Moreover, the management aspects of surveillance and the control of poaching influence the choice of sanctuary locations to those areas where they are most cost-effective and least disrupted by human activities Study is needed to identify possible sites by assessing the richness of aquatic fauna, species diversity and ecology. Feasibility assessments, are necessary when establishing fish bioreserves.

The immediate objectives are to:

- Identify the location of all major critical brood stock habitats and breeding sites.
- Devise appropriate structural measures to reduce fishing effort to an acceptable level in fish sanctuaries, or eliminate it entirely if feasible.
- Educate the local fishing community on the need for establishment of fish sanctuaries, supported by DOF surveillance, and
- Formulate an operational plan and implement it.

To achieve the objective of the Fish Sanctuaries Programme, the DoF would need to establish a planning unit to carry out the necessary field studies to identify all localities that need to be given sanctuary status. This could best be done in ***beels*** by installing sanctuary ***katha.*** Fishermen groups should be responsible for looking after sanctuaries so that they will be the real beneficiaries of the scheme. Critical stretches of the mainstreams of rivers their and tributaries, which are used as spawning habitat, should be protected. Large rivers, such as the Surma, Kushiyara, Kangsa and Baula, are important habitat for the most important major carp, large Catfish and other species. An education campaign should he carried out in the fishing villages to educate fishermen on the need, purpose and benefits to be expected from the establishment and protection of sanctuaries. Their support and participation should be obtained through this process.

4.2 Conservation of Jatka *(Hilsa/juveniles)*

Young ***Hilsa*** are part of the catch of several artisanal gear. The intensity of ***jatka*** fishing varies, depending on the abundance of young ***Hilsa.*** Indiscriminate catch of juveniles is indeed one of the serious constraints to development and management of the ***Hilsa*** fishery.

The immediate needs are to:

- Establish the relationship between breeding run abundance and juvenile populations;
- Establish, through field surveys. the downstream migration patterns of juvenile ***Hilsa (jatka)*** and the characteristics and level of mortality they suffer;
- Educate the local fishing community on the need to conserve juveniles and on the adverse effects of ***jatka*** fishing on the ***Hilsa*** fishery;
- Support community-based participation in ***jatka*** conservation with DoF enforcement capability,

based on a monitoring, control and surveillance programme for all major rivers and important secondary rivers during the *jatka* season.

An education programme needs to be carried out to educate *jatka* fishermen on the need for the conservation of juveniles and the greater benefits they can expect in harvesting adult Hilsa. A process including fishermen in a DoF-operated *Hilsa/jatka* monitoring, control and surveillance(MCS) system would be developed. The DoF should be equipped with sufficient speedboats/transport to carry out effective and comprehensive MCS activities during the *jatka* season.

5. ENVIRONMENT AND SUSTAINABILITY OF FISHERIES RESOURCES

The degradation and shrinkage of the environment in general and of fish habitats in particular are highlighted repeatedly. This has put into jeopardy the sustainability of the fisheries resources, particularly in the openwater capture fishery. The following are some recommendations to address this problem:

Some human interventions that affect fish habitats adversely are agrochemical and industrial pollution. closing of rivers and channels, and flood control drainage projects which prevent the fish from going from the river to the floodplain and their rearing and breeding grounds. Such interventions should be reconsidered, taking into account the possible adverse impacts on fishery resources. fishermen’s livelihoods, and the nutritional requirements of the people.

— The study of the sustainability of fisheries resources, particularly the openwater capture fishery, is extremely difficult and time-consuming. But studies of the sustainability of openwater habitats of important fish species are essential.

The fishing effort should be controlled wherever it appears the fish stock may reach the limit of sustainability.

— The fisheries resources of the openwater capture fisheries have limits of sustainability in many cases. They can be expanded only if interventions are made to enhance the productivity.

— Strict enforcement of regulations that prohibit the catch of the young as well as brood fish.

— Increased awareness, co-ordination and integrated multisectoral planning among the various ministries overseeing fisheries and water issues to ensure that inter sectoral trade-off, natural resources management. environmental impact assessment and pollution assessment are adequately addressed.

— Appropriate legislative power and resources need to be channelled to environment-oriented departments to ensure that environmental priorities are not overridden by sectoral short term interests.

6. THE FISHERFOLK

6. 1 Conflict between fishermen

There is conflict between the actual farmer and the people surrounding the waterbody --- farms. This situation is especially prevalent during the monsoon.

Conflict over shrimp and paddy land in coastal areas is a major issue nowadays. Legal steps will have to be taken to resolve such conflicts, provide protection to traditional farmers and prevent the certain destruction of habitat vital for the survival of aquatic fauna and juveniles.

6.2 Fishing community development

Fishing in Bangladesh has traditionally been an occupation primarily of members of particular Hindu castes, such as the Halder, Rajbangsi, Kaibarta and Malo. Given the low social status associated with fishing, these communities have traditionally occupied the lower ranks of the social hierarchy in rural communities. Even in Muslim societies, where caste is not recognized, groups traditionally involved in fisheries, such as the Maimal in the northeast of the country, have come to function as caste groups, being considered as having low social status.

While a core of full-time fisherfolk of particular castes are still to be found in most floodplain areas of the country, there is nowadays a wider range of rural people becoming more and more involved in fisheries. These new entrants to fisheries have been attracted by the profitability of certain fishery activities, at least seasonally.

The four groups who catch fish are:

— The traditional caste fishermen.

— Non-traditional fishermen.

— ***Jalmohal*** lease-holders and trawler or mechanized boatowners (who are not fishermen).

— The public who catch fish for subsistence purposes.

It is important that fishermen/fish farmers should have a strong association/platform to look after their common interests. These association should be registered and should follow proper system:;.

As there is no legal framework specifically designed for community welfare, integrated approaches are necessary, with the involvement of NGOs to implement such multipurpose activities as socioeconomic surveys, transfer of technology, women in fisheries development, community organizations. rural finance, infrastructure and services.

4.3 Expectations of public-private partnership

At the community level, the interaction and activities through the public-private partnerships are expected to produce

— Improved social cohesion amongst groups and members of community through community-based work by NGOs.

— Increase participation of fishers/community in the plannin,g and management of resources.

— Better relationships amongs fishing communities, DoF & NGOs.

— Increased sense of resource-ownership and sustained fisher groups capable of becoming co-managers through skills building and greater participation in the resource management process, and

— Increased livelihood opportunities and human development.

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6.4 Women 's participation

The population of women in Bangladesh is 52.5 million out of 120 million. In mobilizing resources, the Government has given much attention to women in the promotion of economic development in the country and feels they can make important contributions to its programme in nation-building.

Women in fishing communities have traditionally been involved in netmaking and mending, fish processing, smallscale retail trade of fish and fishery products and livestock rearing. It is estimated that about 80 per cent of the workforce gathering post-larvae in shrimp farming are women and children. A female labour force has also emerged in shrimp processing plants where 85 per cent of the work, such as sorting, peeling, washing, grading, weighing and packing are done by women.

In the development projects of the Fisheries Department. active participation of women is very significant. A good number of women workers are involved in the Third Fisheries project. the Mymensingh Fish Culture extension project, Food for Work programme, and in other projects. Even in the DoF, out of 818 fishery officers, 54 are women.

NGOs, such as Caritas, Proshikha, and RDRS, have assisted women in smallscale income- generating activities. Pond culture is the prevailing activity of NGO-assisted women's groups and training, credit and input supply are offered them.

6.4.1 Existing constraints

The lack of easy access to credit is one of the problems facing rural women who work in post-larvae shrimp collection. They are also engaged in fishing in rivers and in closed waters, such as beels and *baors,* where they have to pay fees to get licences for fishing and are often forced to pay such fees to a number of people, several times a year. In the floodplain and in coastal fishing, fewer women professionals are involved in the extension services of the DOF

6.4.2 Suggestions

- Women should be organized into small groups. They should be trained in technical matters and encouraged to make collective savings so as to enhance their ability to receive credit.
- Members of the organized groups should be provided with credit for fishing and non-fishing income-generating activities.
- Technical guidance is required for women engaged in netmaking.
- Female extension officials should be recruited and posted to areas where there is greater women's participation.

7. ENFORCEMENT OF FISHERIES CONSERVATION ACTS

Bangladesh used to get the lion's share of its fish supply from open water. There was a time when 80 per cent of the total production was contributed from open water. But due to overfishing, indiscriminate use of insecticides and pesticides, the building of flood control dams, siltation of rivers and other open waterbodies, water pollution by industrial effluents, lack of effective conservation policies and systems and capture of broodstock as well as juveniles, natural fish production has decreased tremendously in the open water. The following table demonstrates this.

Table 1: Open water fish production

Year wise production in MT

	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94
Inland open water (capture)	4.63	4.42	4.31	4.23	4.24	4.24	4.43	4.80	5.32	5.52
Total production	(7.74)	(7.94)	(8.15)	(8.27)	(8.41)	8.55	8.96	9.52	10.2	10.87

As fish production is declining in open water, the time has come to enforce the conservation acts strictly. The establishment of sanctuaries in suitable places is urgently needed. In this connection, the open water fingerling stocking programme initiated in 1990-91 should be mentioned. Since then, production has increased. Therefore, the programme should be continued. Proper stock assessment in marine waters is also required. On the basis of stock assessment information, fishing techniques should be controlled.

7.1 Inland fisheries acts

In order to promote and conserve the fisheries, Government passed The Protection and Conservation of Fish Act, 1950. Its enforcement was entrusted to the Directorate of Fisheries, but the waterbodies remained vested with the Ministry of Land.

This Act contained important major carp fishery regulations, which included prohibition of capture of undersized fish, declared certain seasons in certain areas to be closed for fishing, and controlled the type of trap and gear for fishing. Details of the Act may be found in Annexure I.

Government, under the Tank Improvement Act. 1939 (as amended on August 31, 1986). aimed to take over derelict tanks from multiple or single ownership for improvement for pisciculture purposes. A summary of the Act is to be found in Annexure - II.

7.2 Suggestions for enforcement of fish protection and conservation rules and regulations

Various rules and regulations under the Fish Act, 1950, are in existence, but these have not been properly enforced due to various reasons. It is suggested that at least the undermentioned measures be implemented through perception, motivation and enforcement:

— Ban on erection of fixed engines or gore/gera jal in the flowing rivers.

— The existing ban on the use of current jals, *mosharee jal* etc. with small mesh sizes be effectively enforced in all parts of the country.

The following steps should also be taken:

— Launching of an intensive publicity campaign through TV, radio, newspaper and other publicity media as well as through posters and leaflets. The publicity should be intensified during the period, when the resource-endangering devices are used.

— Law enforcement agencies at the field level should be urged to cooperate with fishery officers in implementing the rules and regulations. During peak seasons, the police force should be placed at the disposal of the DOF on deputation to implement the various Acts.

- Funds, manpower and facilities for movement should be provided to the District and Thana Fishery Officers to enable them to seize banned gear and devices as well as to detain or arrest violators, if such provisions exist. Magistracy power should be delegated when dealing with such offences. If the magistracy power is not given to TFO/DFO, then the magistrate should be placed on deputation to DOF for the purpose.

The following measures for fishery management of major carp in the riverine carp fishery are recommended:

- Establishing the minimum legal size for capture of major carps at 30 cm. throughout the year.
- Prohibiting fishing at ***kathas*** in two neighboring sections of a river in the same year.
- Limiting the length of drift gillnets, fixed gillnets, cages and other contrivances to less than half the width of the waterways.
- Establishing carp sanctuaries in deep pools in the mainstream of the Padma River.
- Conserving ***beels*** as fish and wild life sanctuaries.
- The recruitment of a legal advisor by the DOF to draw up regulations and help implement Acts in courts.
- Mobile inspection units should be introduced. The creation of such units would aid considerably in inspecting and controlling fishing and stopping theft. The units could also help the DoF managers of ***baors*** and other waterbodies.
- Monofilament net of all mesh size should be declared illegal for fishing
- People's participation to be encouraged in implementing the Act.
- The production, import, carrying and sale of current net of any mesh size should be banned.
- A Co-ordination meeting should be held every month and as and when required with the law enforcing department.
- Like major carps, the exotic carp (Silver, Grass, Common etc.) should be brought under the law.
- Clear mention of **'destruction'** of all seized fishing gear should be made in the law.
- The Fish Act itself cannot bring the desired result without education and awareness. Training on the Act should be given to Fishery Officers, Magistrates, Police Officers, Lawyers and Fishermen.

7.3 The Tank Improvement Act, 1939 (Bengal Act-15, 1939)

The Act provides for the improvement of tanks in Bangladesh for purposes of irrigation and pisciculture. The Act enables the Government to requisition ponds if necessary, and governs the acquisition and ownership of adjacent land. compensation etc. An announcement in 1986 gives special emphasis to making derelict ponds productive. Details of the Act are in Annexure - II.

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8. PROBLEMS WITH FISHERIES ORDINANCE 1983 AND RECOMMENDATIONS FOR REVISION

8. I Marine fisheries

Marine fisheries have contributed largely in compensating for the decline in catches in the inland fisheries sector. The share of marine fisheries in total national landings has risen from 10.6 per cent in 1970 to 28.22 per cent in 1993.

Bangladesh has an extensive continental shelf, extending virtually to the edge of the 200 mile Exclusive Economic Zone (EEZ). The total area of the shelf down to 200 metres is estimated at 67,000 km^2 of which an estimated 37,000 km^2 are of less than 50 metre depth. This area is exploited by the country's smallscale fleet composed of some 17,000 boats of different sizes, 6,000 of which are reported to be motorized. Around 95 per cent of the marine fish catches are made by artisanal fishermen and the rest 5 per cent by industrial trawlers.

8.1.1 Industrial fisheries

In Bangladesh, the term 'industrial fisheries' indicates 'largescale fisheries'. Industrial fisheries started in 1971 when seven trawlers were first introduced. At present. Bangladesh has 53 commercial trawlers fishing in the Bay of Bengal. The Industrial trawl fishery is a relatively new development and Government involvement is channeled through the BFDC, which operates a small fleet of fish and shrimp trawlers. Most other trawlers are privately owned, some being operated on a partnership basis. Of the trawlers in operation, 40 are engaged in shrimp trawling, the others target fish.

Like the other fisheries, the largescale marine fisheries also suffer from inefficiency; each trawler lands only about 86 tonnes of shrimp and 154 tonnes of fish per hour of trawl. However, it is not advisable at present to develop largescale industrial fisheries in deep sea waters. No nation has yet found a way to make largescale fisheries sustainable. Its development should not be encouraged until adequate resources are found and proved to be beyond the capacities of enlarged coastal fishing boats.

8.1.2 Coastal Fisheries (Artisanal Fisheries)

Artisanal fisheries includes both commercial and subsistence fisheries. This is still largely traditional and smallscale. It accounts for about 95 per cent of the marine fish landings and, together with smallscale inland fisheries, provides employment to 49,700 full-time and 2,52,000 part-time fishermen. Of 17,000 artisanal fishing boats, 6000 are mechanized but after 1988 no survey has been done of artisanal boats operated in the coastal areas. The boats employed in the coastal area are largely non-motorized. They fish very close to the shore. But whatever the number, the present scene makes it clear that artisanal fisheries is also overcrowded in Bangladesh.

8.1.3 Constraints

The marine fishery sector is constrained by the lack of proper management policy for conservation of marine fishery resources. The Fisheries Ordinance 1983, which makes provisions for the management. conservation and development of marine fisheries, is applicable only to waters deeper than SO metres. This leaves the bulk of the activities conducted by artisanal fishermen outside the scope of this legislation. There is evidence that inshore waters are heavily overfished.

With knowledge about the standing stock of fish. fish habitats and fish behaviour inadequate, it is difficult to establish a rational management policy and strategy. Sporadic exploratory surveys have been carried out, but they neither adequately covered the vast EEZ area nor provided sufficient information on the **status** of both pelagic and demersal resources.

Artisanal fishermen still use rudimentary gear and boats and their productivity is low. Except for a few major fishing bases, fishermen have little access to basic infrastructure facilities and this is de&mental to artisanal fishermen, especially when they operate motorized vessels.

8.2 The Marine Fisheries Ordinance, 1983

The Marine Fisheries Ordinance, 1983 deals with the matters relating to marine fisheries exploitation, including monitoring the operation of fishing vessels. The rules, as amended in 1993, provide for licensing and monitoring of artisanal mechanized fishing boats under the Ordinance. The officers of the marine wing of DoF has been empowered to check size or take any other actions required for surveillance and enforcement of the rules of the Ordinance. The contents of the Ordinance are to be found in Annexure-3.

8.3 Some suggestions

- The Fisheries Ordinance, 1983 stipulates regulations only for those fisheries which are operated in waters more than 50 m. deep. There is no specific resource management policy for the conservation of fishing resources in shore waters. Revision of the Fisheries ordinance 1983, to incorporate all types of gear used by artisanal fishermen, is necessary in order to establish effective management systems for artisanal fisheries. Recent studies carried **out** by the FAO-Bay of Bengal Programme highlight the need for control of the set bagnet fishery.
- In view of the current contribution of the artisanal fisheries to marine fish landings and the vast number of people involved, traditional smallscale fisheries should not **be** excluded from the management regime.
- Some degree of management is already being carried out for industrial fisheries. However, in view of the declining trend in shrimp catch, monitoring and analysis of trawlers catches, specieswise and groupwise, should **be** strengthened. The possibility of banning industrial trawling for two months (December-January). to protect shrimp resources, should be studied.
- The Bangladesh Navy is responsibile for enforcement of marine fisheries regulations. It is suggested that the Navy ensure that all trawlers trawl in areas beyond 40 metres depth. Coded mesh size regulations should also be enforced. The level of surveillance and enforcement effort need not be uniform throughout the entire 200 mile zone, but will need to be directed more to areas of high resource density and consequent fishing activities.
- Mobile inspection units should be introduced. The concept of such units is not new, because enforcement at sea is just that.
- The Bangladesh Navy and/or Air Force should carry **out** regular overflights of fishing areas and report where the vessels were concentrated. Gross counts of craft against total licenses would give a broad indication of over activity.
- The Officer in-Charge of Marine Fisheries should be responsible for inspection and licensing of marine fishing vessels in co-operation with the proposed Inspectorate Service. A register should also be started for all small motorized fishing craft.
- Alternate employment opportunities, for those who are to be siphoned off from the heavily exploited inshore fishing, should be identified.

— Monitoring and analysis of industrial trawler catches, specieswise and groupwise, should be carried out to assess the trends and status of the resources.

— Strengthening the control system and surveillance of illegal fishing by foreign vessels within the Bangladesh EEZ should be a continuous process.

9. CONCLUSIONS

There is potential in inland openwaters as well as marinewaters. If the identified problems are well addressed, the desired result can be achieved.

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Annexure-1

FISH CONSERVATION AND PROTECTION ACT, 1950 (IN DETAIL)

It is generally known as the Fish Conservation Act 1950. The following amendments were made later:

The East Bengal Protection and Conservation of Fish Act, 1950 (EB Act. xviii of 1950)

The East Bengal Protection and Conservation of Fish (Amendment) Act, 1963 (E.P. Act. No.- 11 of *1964).*

The East Bengal Protection and Conservation of Fish (Amendment) Ordinance. 1970 (East Pakistan Ordinance No.-xxvi of 1970).

The Protection and Conservation of Fish (Amendment) Ordinance, 1982 (Ordinance No.-55 of 1982).

The Protection and Conservation of Fish Rules, 1985 (SRO 442-L/85 October 16, 1985. MOFL).

The Protection and Conservation of Fish Rules, 1985 (Ordinance), 1986 (No.5/Fish Misc 263/84/97.) March 4, 1986 MOFL.

The Protection and Conservation of Fish Rules. 1985 (Amendment) 1987 (SRO-269-law/87.) November 4, 1987. MOFL.

The Protection and Conservation of Fish Rules, 1985 (Amendment) 1988 (SRO-24-law/88.) January 25, 1988. MOFL.

The Protection and Conservation of Fish (Amendment) Act 1995 (law/9.)

The main features of the Fish Act are:

— The fish included are all cartilagenous, bony fishes, prawn, shrimp, amphibians, tortoises, turtles, crustacean animals, molluscs, echinoderms and frogs in all stages of their life history.

— Fishery means fish production, conservation, exhibition, breeding, harvesting etc. in all types of waterbodies, including natural or artificial, open or closed, flowing or stagnant, but artificial aquariums are not included.

— Erection of fixed engines are prohibited in the rivers, canals, *khuls* and heels. Any fish caught by means of such engines may be seized, removed and forfeited.

— Construction of bunds, weirs, dams and embankments or any other structure, whether temporary or permanent, in, on, across or over the rivers, canals, *khals* or *heels* for any purpose other than irrigation and flood control are prohibited.

— Destruction of fish by explosives, gun or bow and arrow in inland waters or within coastal territorial waters is prohibited.

— Destruction of fish by poisoning of water or the depletion of fisheries by pollution, by trade effluent or otherwise, in land waters, is prohibited.

— Catching and destruction of certain fish *(Shol,* Gazar, Taki) during a certain period (April 1 - August 31, each year) is prohibited.

— Catching of carp *(Rui, Cutlu, Mrigal, Kalbaus, Ghania)* is prohibited in certain waters, provided that no license for catching of the above named carp fish shall be allowed for purposes other than pisiculture.

- No person is allowed to catch the following other than in pisiculture:

  July-December, each year, Carp species below 23 cm.
  November-April, each year, Hilsa (jatka) below 23 cm.
  November-April, each year, *Pangas* fish below 23 cm.
  February-June, each year, *Silon* fish below 30 cm.
  February-June, each year, *Bhol* fish below 30 cm.
  February-June, each year, *Air* fish below 30 cm.

- Sale of fish is prohibited, provided that the prohibition shall not apply to the catching, carrying, sale, transport or possession of any fish for the purpose of, or in connection with, pisiculture.
- Forfeited fish will be disposed of by auction and the money shall be deposited in the Government accounts.
- Catching, carrying, transporting, offering, exposing or possessing frogs is prohibited.
- Use of gillnet (commonly known as current net) less than 4.5 cm. mesh size is prohibited.
- Punishment and penalties for violation of rules will result in 1-6 months jail with labour and a maximum penalty of Tk. 1000.

  Subsequent punishment and penalties for violation of rules will result in 2-12 months jail with labour and a maximum penlty of Tk. 2000.
- In special cases, a person can be arrested without a warrant.
- Delegation of power:

  Class II Magistrate.
  Not below the rank of Sub-inspector of police.
  Not below the rank of Deputy Ranger in the Sundarbans.
  Not below the rank of Fishery Officer (TFO).

Annexure-2

The Tank Act of 1939

The main features of the Ordinance are as follows:

— Requisition hy collector to carry out improvements in certain tanks.

— Declaration of a tank to be a derelict irrigation works:

  — Order for possession of and improvement of derelict tank:

  -- Order for possession of lands adjoining a derelict tank to carry out improvements in such tank.

— Authorised person to retain possession of a derelict tank for a period not exceeding twenty years.

— Possession to be restored to owner on certain conditions.

-- Authorised person to retain possession of land adjoining a tank during the period of possession of such tank.

— Restoration of possession of land adjoining a derelict tank and retaking of possession of such land.

— Restoration of possession of land adjoining a derelict tank on the restoration of possession of such tank.

— Authorised person not liable to pay rent or compensation.

— Possession by an authorised person not to affect the rights or liabilities of other persons.

— Authorised person to pay rent to owner and compensation to person other than the owner dispossessed by him.

— Authorised person to pay compensation to persons who have right to fish in the tank. etc. on payment.

— Authorised person to pay compensation to cultivators who hold a lease of the bed of such tank.

— Payment of compensation to persons having rights in lands adjoining tank. possession of which is taken under this Act.

— Permission of the authorised person necessary, to use or occupy the tank etc.

— Rights to use the water of the tank.

— Maximum irrigation area.

— Payment and rate of fees.

— Power of authorised person to lease out the tank. etc.

— Bar to transfer of tank, except as provided in this Act.

— Bar to acquisition of occupancy rights in lands leased out;.

— Authorised person to maintain tank in proper condition.

— Authorised person to maintain in proper condition land adjoining a tank, possession of which has been taken by him.

— Restoration of possession of tank.

— Record of rights in respect of derelict tanks.

— Person to whom possession of a tank is restored to maintain it in proper condition.

Derelict Pond Development Act 1939 (Amended 1986)

- Identified derelict pond-owner will be given a notice by DC or TNO of the respective area. mentioning that the pond should be developed and brought to fish culture within a reasonable time.
- If the owner of the specific pond does not respond to the notice, the pond can be acquired. Pond should be given on lease. for a period (not more than 20 years) mentioned. to an interested fish-farmer. The lease money will be distributed to the pond-owner or owners.

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Annexure-3

Marine Fish Ordinance 1983

The main features of these rules are:

- A director appointed by the government is responsible for resources management, conservation, supervision and development of overall activities in marine fisheries and the implementation of the objectives of this Ordinance.
- Director to issue licence on licence fee, subject to certain conditions.
- The licence-holder is compelled to provide information of fish catch and sale, to the Director.
- Fishing vessels not to interfere with navigation.
- Ban on entry of foreign fishing vessels in Bangladesh-fisheries waters, except those licensed.
- Foreign fishing vessels liable to fine and forfeiture if found in Bangladesh fisheries waters illegally.
- Prohibited fishing methods (use of explosives, small mesh) etc.
- An authorized officer may stop, examine etc. any fishing vessel.
- An authorized officer may enter premises, seize vessels etc. without warrant. Person arrested without warrant to be taken to police station.
- Power to stop vessels and vessels and crew to be taken to nearest port.
- Perishables may be sold by Director.
- Government may permit scientific research.
- No action against authorized officer for acts done in good faith.
- All licensed fishing vessels shall use nets of the following mesh size:
  - For shrimp trawlnet (Boom) with low opening. the minimum mesh size shall be 45 mm. at the cod end.
  - For fish trawlnet, minimum mesh size at the cod end shall be 60 mm.
  - For large mesh drift net (LMD), the minimum mesh size shall be 200mm.
  - For small mesh drift net (SMD), the minimum mesh size shall be 100 mm.
  - For set bagnet, the minimum mesh size at the cod and shall be 30 mm.
- Area for fishing :
  - Area for fishing with set bagnets and hooks and lines: up to 40 m. depth of marine water at its highest tide.
  - Area for fishing with driftnet: trawlers must operate beyond 40 m. of marine waters at its highest tide.
- Prohibited methods of fishing:
  - Fishing with any gear not of specified mesh size.
  - Fishing with any kind of explosives, poison and other noxious substances.
  - Fishing by electrocuting the marine species of any type.
- To fish in Bangladesh fisheries waters, all fishing vessels shall have:

- Licenses for fishing in the waters.
- Possess valid certificates as required.
- A nationality sign, through flag and suitable markings, displayed on a visible part of the vessel.

- Every shrimp fishing vessel shall catch and land fish amounting to at least 30 per cent of its total catch during each trip.
- Every fishing vessel with freezers engaged in trawl fishing will be allowed sailing permission for a period not exceeding 30 days and every non-freezer fishing vessel will be allowed sailing permission for a period of 15 days.
- Every fishing vessel shall respond to the instruction of an authorized officer at a marine fisheries surveillance checkpost or at any other place.

PAPER 9

QUALITY CONTROL AND MARKETING OF FISH AND FISH PRODUCTS: NEEDS FOR INFRASTRUCTURE AND LEGAL SUPPORT

by

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SUMMARY

Quality control and marketing of fish and fish products are like the two sides of a coin. One cannot do without the other. Quality, in general, means the wholesomeness or the state of excellence of a particular product in terms of its appearance, shape, colour, taste and competitiveness in price to the buyer. In a nutshell, quality means the fulfillment of the customer's requirements.

Fish and fish products, being highly spoilable, deserve special care and attention being paid to them from the catching point to the frying-pen. The living habitats of fish are completely different from its post-harvest environments and its quality depends on many factors, such as intrinsic composition, degree of spoilage, damage, deterioration during harvesting, cleaning, washing, handling, preservation, processing, storage, transportation, distribution and marketing. A prolonged shelf-life and better quality can be maintained even under natural conditions in the cold countries than in tropical ones. In tropical and warm countries like Bangladesh, the quality of fish can better be controlled and shelf-life substantially increased through the introduction of a uniform cold-chain system from harvesting to marketing. This process being very costly, cannot be afforded for domestic fish processing and marketing. It is generally used only by the export-oriented fish and shrimp processing plants catering for the international market.

Processing of quality fish and fish products is again dependent on various physical factors, such as:

- primary quality of raw materials
- techniques employed in collecting raw materials
- landing, handling and preservation
- transportation and distribution
- facilities available in the processing plants
- processing technology used
- skilled workers and technicians
- sanitary and hygienic conditions of the plant
- cleanliness of equipment, and
- better storage facilities.

But in Bangladesh, many deviations and lapses are observed at the landing,handling, transportation and marketing stages as infrastructure in these subsectors, has not yet been developed commensurate to development in the modern aquaculture and processing industry.

In this paper, the authors will reflect the actual condition of the fishery industry *vis-a-vis* fish marketing and the quality assurance situation in Bangladesh, with particular respect to infrastructural development and legal support needed, and make recommendations on how to improve the situation.

1. INTRODUCTION

Bangladesh, with a land area of 1,43,998 sq.km. is surrounded by India on the west, north and northeast, by Myanmar (Burma) on the southeast, and by the Bay of Bengal in the south. For its size it has an extremely large population — of about 120 m people — that is one of the most densely populated countries in the world, having about 755 persons per sq.km. It is a country criss-crossed by innumerable rivers, tributaries, canals, ***ham-s, baors*** and floodplains which make it one of the largest inland fisheries in the world.

Bangladesh produced about 10.87 m MT of fish in 1993-94, of which about 827,000 MT (76%) came from the inland and 260,000 MT (24%) from marine fisheries. Inland openwater capture fishery constituted about 552.000 MT (67%) and closedwater culture fishery 275.000 MT (33%) of the total inland fish production. Marine fish catch from artisanal fisheries and industrial (trawler) fisheries were 245,000 MT (94.25%) and 150,000 MT (5.75%) respectively. Per capita consumption of fish has been one of the highest in the world during the first half of this century, which is why it is said "Fish and rice make a Bengali". Consumption of fish has, however, reduced greatly during the second half of the century. mainly due to the high rate of population growth. Annual per capita consumption of fish was 12 kg in 1962-63 and decreased to 7 kg in 1982-83. With the introduction of modern fish culture practices in inland waters and capture technology in deepsea waters, per capita production has risen to 8.80 kg per annum in 1993-94, but this is far below the Asian average of 25 kg and the world average of 12 kg per annum. The requirement of fish for the present population at the average Asian rate around 3.00 m MT. Thus, the shortfall is almost 2.00 m MT if all the people are to be provided with adequate fish protein.

Since 1978, Bangladesh has seen a rapid growth in the marine fishing industry. There are now over 6000 mechanized fishing sea trawlers, including 48 shrimp trawlers. Seafish landing of 89,000 MT in 1974-75 rose to 260,000 MT in 1993-94. Shrimp production rose from 57,656 MT in 1983-84 to 125,000 MT in 1992-93. Production of coastal cultured shrimp increased from 4368 MT to 23,500 MT during the same period. a 536% increase. The total production of 754,000 MT of fish in 1983-84 increased to 1087.000 MT in 1993-94 — an increase of over 44% in ten years. The number of processing and freezing plants has grown from nine plants with a capacity of 58 MT in 1971 to 115 plants with a capacity of about 750 MT per day in 1994. This has been an unplanned growth, with no consideration of the raw material situation. Export earnings from shrimp and fishery products was only US $ 4.49 m in 1972-73; this rose to 89.29 m in 1984-85 and US $ 325.83 m in 1994-95, an increase of 725%.

Fish marketing in the domestic market is not competitive in view of the huge gap in demand and supply. And international trading has been facing a serious challenge from other Asian countries. Infrastructural facilities. especially fish landing centres and wholesale and retail markets, are inadequate and unhygienic, often posing serious threats to public health. Quality assurance programmes in the country are also inadequate to cope with the developments in the industry and the consumer requirements in the major seafood markets of the world.

2. FISHERY RESOURCE POSITION

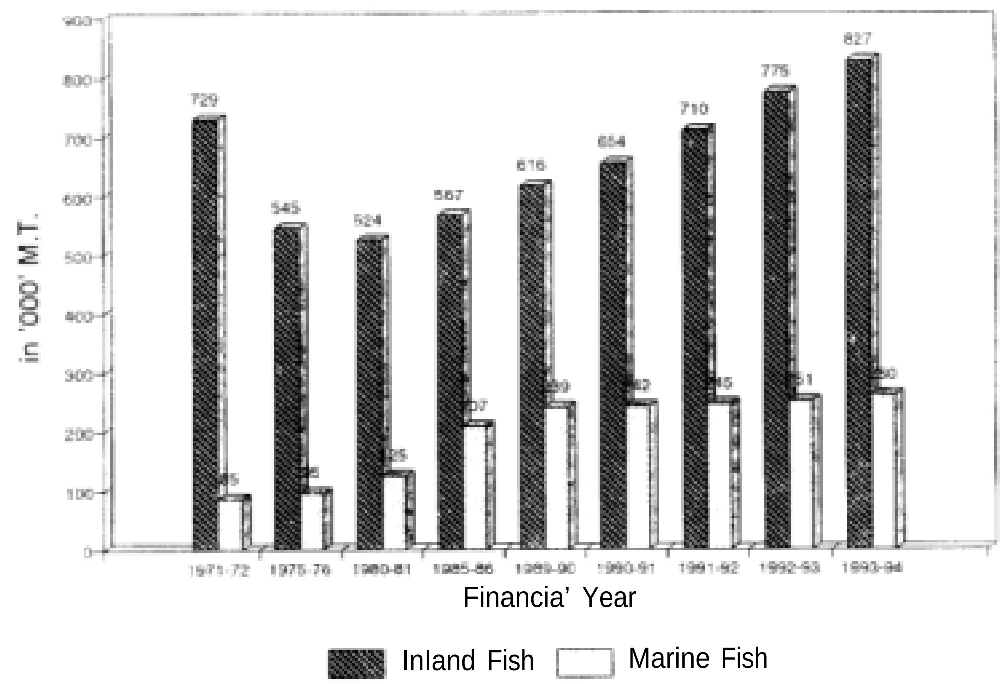
2.1 Total domestic production

Total production of fish in Bangladesh was 1.035.952 MT in 1992-93, of which 775.472 MT came from inland fisheriec and 250,480 MT from marine fisheries. a ratio of production of 3: l. Total production of fish in 1993-94 was I .087.000 MT of which 827.000 MT came from inland waters (76.08%) and 260.000 MT (23.92%) from marine waters. Fish production trend from 1971-72 to 1993-94 shown in Table 1.

Table 1: Trend of fish production in Bangladesh

F Y	*Inland fish*	*% Increase/ decrease*	*Marine fish*	*% Increase/ decrease*	*Total prodoction*	*% Increase/ decrease*
1971-72	729	10000	85	100.00	814	100.00
1972-73	731	100.27	87	102.35	816	100.50
1973-74	732	100.41	86	103.53	820	100.73
1974-75	733	100.55	89	104.70	822	100.96
1975-76	**545**	**74.75**	**95**	**111.76**	**640**	**76.62**
1976-77	541	74.21	100	117.75	641	76.75
1977-78	**533**	**73.11**	**110**	**129.40**	**643**	**79.00**
1978-79	529	72.29	116	138.82	645	79.24
1979-80	524	71.88	122	143.53	646	79.36
1980-81	524	71.88	125	147.06	650	79.85
1981-82	556	76.26	130	153.00	686	84.27
1982-83	584	80.11	144	169.41	726	89.43
1983-84	589	80.80	165	192.12	754	92.63
1984-85	586	80.40	186	221.17	774	95.06
1985-86	587	80.52	207	243.53	794	97.54
1986-87	597	81.90	216	256.47	815	100.12
1987-88	599	82.17	226	268.24	827	101.60
1988-89	606	83.40	233	272.12	841	103.32
1989-90	616	84.50	239	281.18	855	105.04
1990-91	654	89.70	242	264.70	896	110.07
1991-92	710	97.40	245	266.26	955	117.32
1992-93	775	106.30	251	295.30	1026	126.00
1993-94	827	113.44	260	305.86	1067	133.54

Figure 1. Trend of fish production in Bangladesh



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2.1.1 Inland production

Inland fish production was 827.000 MT (76.08%) in 1993-94, of which 552,000 MT (66.75% (came from the inland openwater capture fishery and 275,000 MT (33.25%) from closedwater culture fishery. Production from culture fishery has increased from 175.925 MT (21.30%) in 1987-88 to 275,000 MT (33.25%) in 1993-94 (see Figure 1).

2.1.2 Marine production

Marinc fish production in 1992-93 was 250.480 MT. of which 11,330 MT (3.50%) came frorn the industrial fishery or deepsea trawling fleet and 239.250 MT (95.5%) came from the artisanal fishery. consisting of mechanized and non-mechanized fishing boats. According to provisional statistics. total marine production in 1993-94 was 260,000 MT. of which 15.000 MT (5.77%) were from the industrial fishery and 245,000 MT (94.23%) from the arti ianal fishery (see Figure 1).

2.1.3 Shrimp production

Total production of shrimp and prawn in 1992-93 was 10 I .025 MT as against 57,656 MT a decade ago (1983-84) — an increase of 75%. During the same period, marine capture shrimp almost doubled (99.45%) from 12.020 MT to **23.975** MT. coastal aquaculture shrimp production increased hy 546% from 4386 MT to 23.530 MT and freshwater prawn capture increased by 30% from 41.250 MT to 53,520 MT. Details of shrimp and prawn production are shown in Figure 2 and Table 2.

Figure **2. Share of shrimp landings by fisheries (1992-93)**

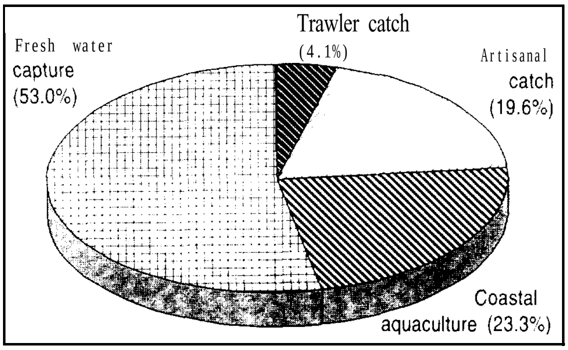

Table 2: Trend of shrimp/prawn catches in Bangladesh: Live-weight in M.T.

F.Y.	*Source- wise catch of shrimp/pra wn*					
	Marine capture			*Coastal aquaculture*	*Fresh water capture*	*country Total*
	Trawler catch	*Artisanal catch*	*Total*			
1983-84	4,500	7,520	12,020	4,386	41,250	57,656
1984-85	3,140	8,760	11.900	7.578	40,069	59,547
1985-86	4,031	3,550	7,581	14.658	53,085	75,324
1986-87	4,488	10,666	15,154	14.773	40,945	70,872
1987-88	3,545	11,535	15,000	17,889	36,386	69,355
1988-89	4,893	12.211	7,104	18,235	42,824	78,163
1989-90	3,117	12.751	5,868	18,624	36,284	70,776
1990-91	3,696	13,937	7.633	19,489	43,262	80,384
1991-92	2,902	17,140	20,042	20,335	46,500	86,877
1992-93	4,188	19,045	23,233	23,530	53,520	1,01,025

Source, DOF/GOB.

Table 1: Trend of fish production in Bangladesh

F Y	Inland fish	% Increase / decrease	Marine fish	% Increase/ decrease	Total production	% Increase/ decrease
1971-72	729	0000	85	100.00	814	100.00
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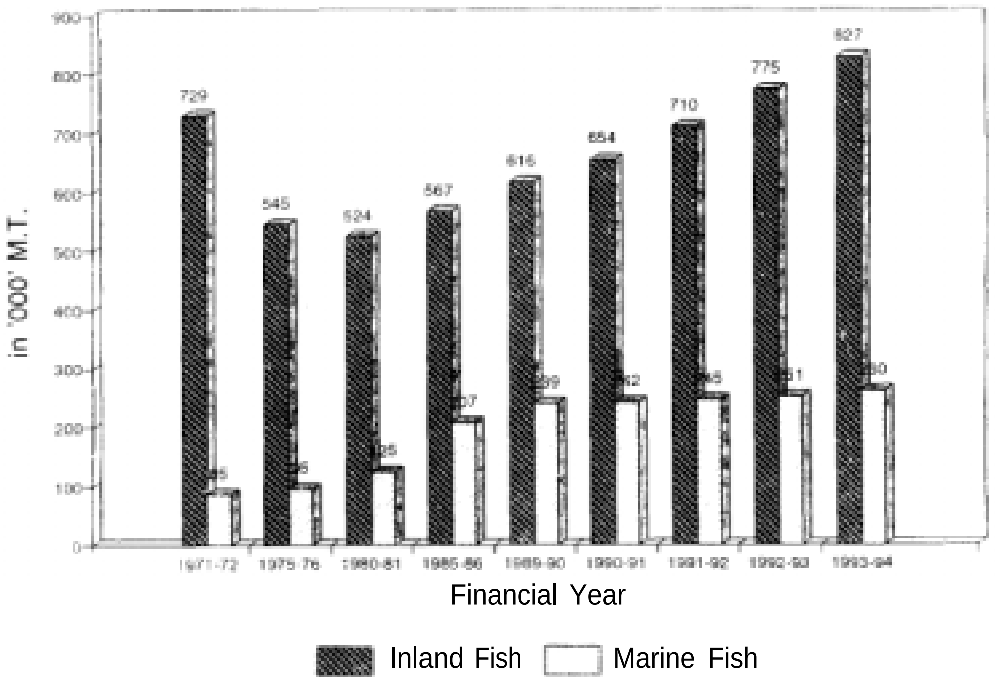
Figure 1. Trend of fish production in Bangladesh



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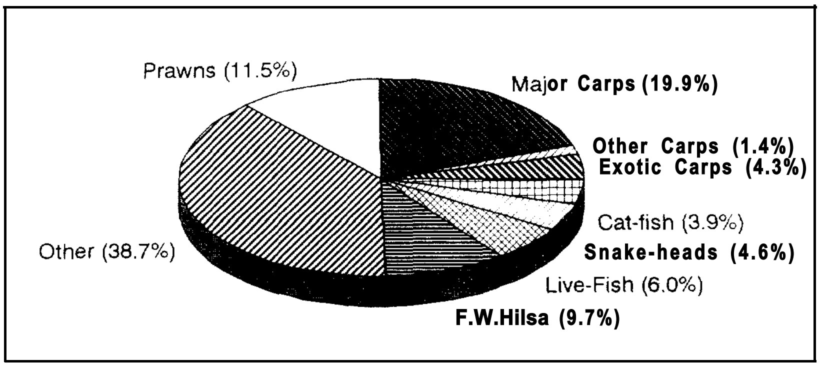
3. SPECIES COMPOSITION

Unlike the cold countries. the aquatic living resources of Bangladesh, including marine and freshwater fish. consist of highly multispecies fauna due to the tropical climate. As many as 475 species (Hussain, 1972) are known to exist in the Bangladesh waters of the Bay of Bengal and 260 freshwater species of fish have so far been identified inland (Rahman 1989). About 60 species of prawn and shrimp are known to exist in Bangladesh. Of these species 37 freshwater and 42 seawater finfish and ten freshwater and six seawater shrimp and prawn species exist in large commercial quantities and are available for domestic as well as export marketing.

3. 1 Freshwater fish landings by species/groups

Figure 3. Species/Groupwise landing of inland fish (1991-92)



The major species of freshwater fish are the local major carps. such as *Labeo rohitu (Ruhi), Catla catla (Katla), Cirrhina marigala (Mrigel), Labeo calbasu (Kansi/Kalibaush)* and Labeo *gonius (Gonia).* and the exotic carps, such as *Hypophthalmicthys molitrix* (Silver carp). *Ctenopharyngodon idella* (Grass carp) and *Cyprinus carpio* (Common carp). The exotic carp have had a good market in Bangladesh during the last decade. Another exotic species is the *Tilapia nilotica (Tilapia)* which has emerged as an important species in the freshwaters of Bangladesh during the last 25 years or so. Other important groups of fish are Catfish *(Pangasius pangasius), Mystes* spp., Wallago attu, *Omok* spp. *Notopterus chitald, Hilsa ilisha* (River shad) and *Anabus* spp. (Climbing perch) and Snakehead. In 199 l-92, the major species of groups of fish caught and marketed were carps (all types) 19% Catfish 2.92%. Snakeheads 3.39%, livefish 4.43%, river Shads 9.67%. freshwater prawns 8.5% and mixed fish 28.72%. Species and groupwise catch of inland fish during 1989-90, 90-91 are shown in Table 3 and Figure 3.

Table 3: Species/groupwise landing of Inland fish

Species/Group	1989-90		1990-91		*1991-92*	
	M.T.	*%*	*M.T.*	*%*	*M.T.*	*%*
Major Carps	103,606	12.11	120,178	13.41	140,957	14.81
Other Carps	14,458	1.69	16,473	1.84	9,875	1.04
Exotic Carps	16,903	1.98	24,858	2.77	30,197	3.17
Cat-fish	26,715	3.12	30,361	3.39	27,788	2.92
Snake-heads	17,034	1.99	25,625	2.86	32,306	3.39
Live-Fish	37,397	4.37	39,015	4.35	42,215	4.43
F.W. Hilsa	112,408	18.24	66,809	10.21	68,356	9.67
Other inland	233,035	27.24	268,327	29.95	273,534	28.70
Prawns	54,908	6.41	62,751	7.00	81,377	8.50
Total	616,464	72.06	654,397	73.04	706,605	74.22

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3.2 Marine fish landing by species/groups

The major species or groups of seawater fish are *Hilsa ilisha, H. kanagurta, Hilsa toli, Harpodon nehereus* (Bombay Duck), *Polynemus indicus* (Indian Salmon), *Stromateus Cinereus* (Silver pomfret), *Stromateus Chinensis* (Chinese pomfret) and *Parastromateus niger* (Black pomfret), *Johnius* spp. (Jewfish), *Tachysurus* spp. (Sea catfish) and sharks, skates and rays. The major seawater species of fish landed during FY 1991-92 was *Hilsa* (Sea-shad), comprising 12.60% of the total national production of both inland and marine fish. In terms of seafish, it consisted of 49% of total marine fish landed during the same period. Species and groupwise catch and marketing of seawater fish during 1989-90, 90-91 and 91-92 are shown in Table 4.

Table 4: Species/group-wise landing of marine fish

Species/Group	*1989-90*		**1990-91**		**1991-92**	
	M.T.	*%*	*MT*	*%*	*M T.*	*%*
Sea Hilsa	113,943	13.31	115,358	12.87	120,106	12.61
Bombay duck	18,338	2.14	19,209	2.14	19,197	2.02
Indian Salmon	1,206	0.14	974	0.11	2,138	0.22
Pomfret	3,386	0.40	3,922	0.44	3,357	0.35
Jew fish	10,579	1.24	9,759	1.09	11,576	1.22
Sea Catfish	10,833	1.27	11,820	1.32	11,106	1.17
Sharks, Skates& Rays	2,782	0.33	3,266	0.36	4,008	0.42
Other marine fish	62,106	7.26	59,897	6.65	53,944	5.67
Marine shrimps	15,868	1.86	17,633	1.96	20,042	2.10
Total Marine Fish	**239,063**	27.94	241,538	26.96	245,474	25.78

3.3 Product forms

People in Bangladesh generally prefer freshfish (without icing), which is available in all rural areas and in towns or cities with adjacent rivers, canals, *beels, haors,* aquaculture farms and ponds. The next preference is for iced fish. Fish is iced in consideration of transportation space and time. If the transportation time is less than 4-6 hours from catching to retail point, the fish is not iced or, if iced, it is not done properly. Other forms of fish products are frozen, salted, sundried, salted and dried, salted and dehydrated, smoked and canned fish and fishmeal for the poultry farms.

According to FAO (BOBP, I985), the percentage of fish product forms was 30% freshfish, 40% iced, 20% sundried, and around 10% frozen, salted, smoked, canned and mealed for poultry. This situation has changed considerably with the industrial development of freezing plants, cold storages, frozen storages, ice-plants and dehydrated facilities and with the addition of more deepsea trawlers and mechanized boats. All trawlers and mechanized **boats** now use ice for preserving fish. Deepsea trawlers land about 10,000 MT of frozen shrimp and fish and mechanized boats land 122,935 MT, almost all properly iced. In the absence of any specific survey, our estimates of fish product forms are as follows for 199 l-92 fish production.

4. CONSUMPTION AND DEMAND

4.1 Per capita consumption

The per capita consumption of fish and shellfish as human food in South Asian countries (1980-82) and in European countries (1982 and 1985) is shown in Table 5.

Table 5: Per capita consumption in South Asian & European Countries

South Asian Countries (1980-82)		European Count& (1982 and 1989		
Name of country	kg/capita	Name of country	kg/capita	
			1982	1985
1. Malaysia	47.6	1. Spain	29.6	25.4
2. Philippines	33.4	2. France	18.2	17.5
3. Singapore	32.6	3. U. K.	15.5	15.0
4. Thailand	20.2	4. Belgium	12.4	11.8
5. Sri Lanka	14.9	5. The Netherlands	7.9	10.4
6. Burma	14.5	6. Italy	6.8	8.1
7. Indonesia	11.8	7. F. R. Germany	6.0	6.4
8. Vietnam	11.4			
9. Bangladesh	7.5			
10. Laos	5.2			
11. India	3.2			
12. Pakistan	2.3			

4.2 Domestic consumption

Domestic consumption of fish and shellfish as human food in Bangladesh was about 12 kg per annum in 1962-63. But due to the population explosion and man-made causes, total fish production declined from 1975-76 till 1985-86, resulting in reduced per capita consumption. Per capita consumption of fish in Bangladesh during different periods is shown in Table 6.

Table 6: Per capita consumption of fish in Bangladesh (1962-94)

F-year	Per capita consumption	
	gms/day	kg/annum
1962-63	33	12.00
1974-75	28	10.00
1982-83	18	7.00
1985-86	21	7.60
1991-92	23	8.40
1993-94	24	8.80

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4.3 Domestic demand

As against the per capita consumption shown in Tables 5 and 6 and the world average of 12 kg, it is very difficult to determine as to what should be the per capita demand of fish in Bangladesh. There is no denying the fact that the people in Bangladesh are very fond of fish and rice. The optimum demand may be considered as 25 kg/annum. But it is not possible to achieve such a target within the next few years. Assuming the present world average per capita consumption of 12 kg and Asian average of 25 kg as being applicable for Bangladesh, the demand for fish is estimated as follows (Table 7).

Table 7: Demand of fish & shell fish for Bangladesh

A.	At the average rate of 12kg/annum/capita (which was the exact per capita consumption of fish in Bangladesh in 1962-63)	:	1.44 m. MT
	120 m. people x 12 kg/capita/annum		
B.	At the rate of Asian average of 25 kg/annum/capita		3.00 m. MT
	120 m. people x 25 kg/capita/annum		

4.4 Shortfall

Though Bangladesh produces a huge quantity of fish annually, its large and growing population has revealed a large short-fall of about 2m MT of fish and fishery products. This is demonstrated as follows:

On proposion-A above, the shortfall on 1993-94 catch level : 0.35 m MT:
On proposion-B above, the shortfall on 1993-94 catch level : 1.90 m MT:

5. DOMESTIC MARKETING SITUATION

5. I Overall fish marketing situation

As there is a big gap between supply and demand, fish marketing or, in other words, selling of fish is very easy domestically. All types of fish — high cost or low cost — are easily sold due to the presence of a heterogeneous mixture of buyers. High cost fish like Carps, Catfish, Livefish from inland waters and pomfrets, Indian Salmon, Snappers, Grunters and Eels, are either sold to the affluent or are processed for export. Mixed fish are usually sold to the vast majority of the people, those of the low income group. Due to high domestic and international demand, the prices of exportable species have increased a few folds.

The fish markets and the marketing of fish are generally conducted by fish traders, either individually or as groups, or Fish Traders' Associations or Fishermen's Cooperative Societies. Almost all fish markets operated by them are ill-managed, unhygienic and unscientific. There is no proper handling, washing, cleaning, icing or re-icing of the fish. They care very little for post-harvest management of the resource, being more interested in earning more revenue at the cost of the fishermen and the consumers. Most fish markets managed by fish traders in cities, district towns and rural areas have no modern infrastructural facilities, not even overhead covering. In the villages, fish is directly landed on the soil and in bamboo baskets and sold by auction, before being transported to cities/towns for retailing.

City markets built by the Municipal Corporations/Municipalities offer better facilities, but are not managed according to any standards. Municipal fish markets are usually a part of the general market. The Local Government Ministry is now constructing small fish markets in the rural areas of Bangladesh through the Local Government Engineering Department (LGED). These provide better facilities for rural fish marketing. There is no special or modern fish landing centres run by the municipalities or by the private sectors.

The BFDC (Bangladesh Fisheries Development Corporation) is the only organization which has constructed modern fish harbours and fish landing centres in such coastal areas as Chittagong, Cox's Bazaar, Barisal, Khepupara, Patharghata and Khulna. It has also constructed commercial fresh fish landing centres in Rangamati, Kaptai. Rajshahi and Daborghat. These landing centres provide modern and hygienic facilities for the fishermen and fish traders and there are facilities for berthing, landing, auctioning, cold storage, freezer storage, and transport. Post-harvest resource-management is properly taken care of only in these centres. But fishermen and fish traders are not very interested in utilizing these modern facilities due to ignorance and self-interest. As a result, fish landing centres in Barisal, Khepupara and Patharghata have not been started as planned.

5.2 Marketing systems of fish trade

Four levels of markets or marketing systems are observed in the distribution channel of fish trade (Figure 4). These are the primary secondary, higher secondary and final consuming markets

Primary market

This is a marketing place at the catching point, usually in a rural area. Fish collectors/assemblers. commonly known *as mahajans* or *aratdar/mahajans* procure fish from the catchers, with the help of local brokers called dalas who get a profit margin or commission from the *mahajan.* Part of the catch is also locally sold by the catcher/farmer or by local retailers.

Secondary market

The collectors bring the fish from the primary market to the landing ghats, usually to the nearest *thana* market or at a place well linked by rivers, road or rail transport. The *mahajans* sell the fish here to the distributors known as beparies, generally with the help of the *aratdars,* the commission agents.

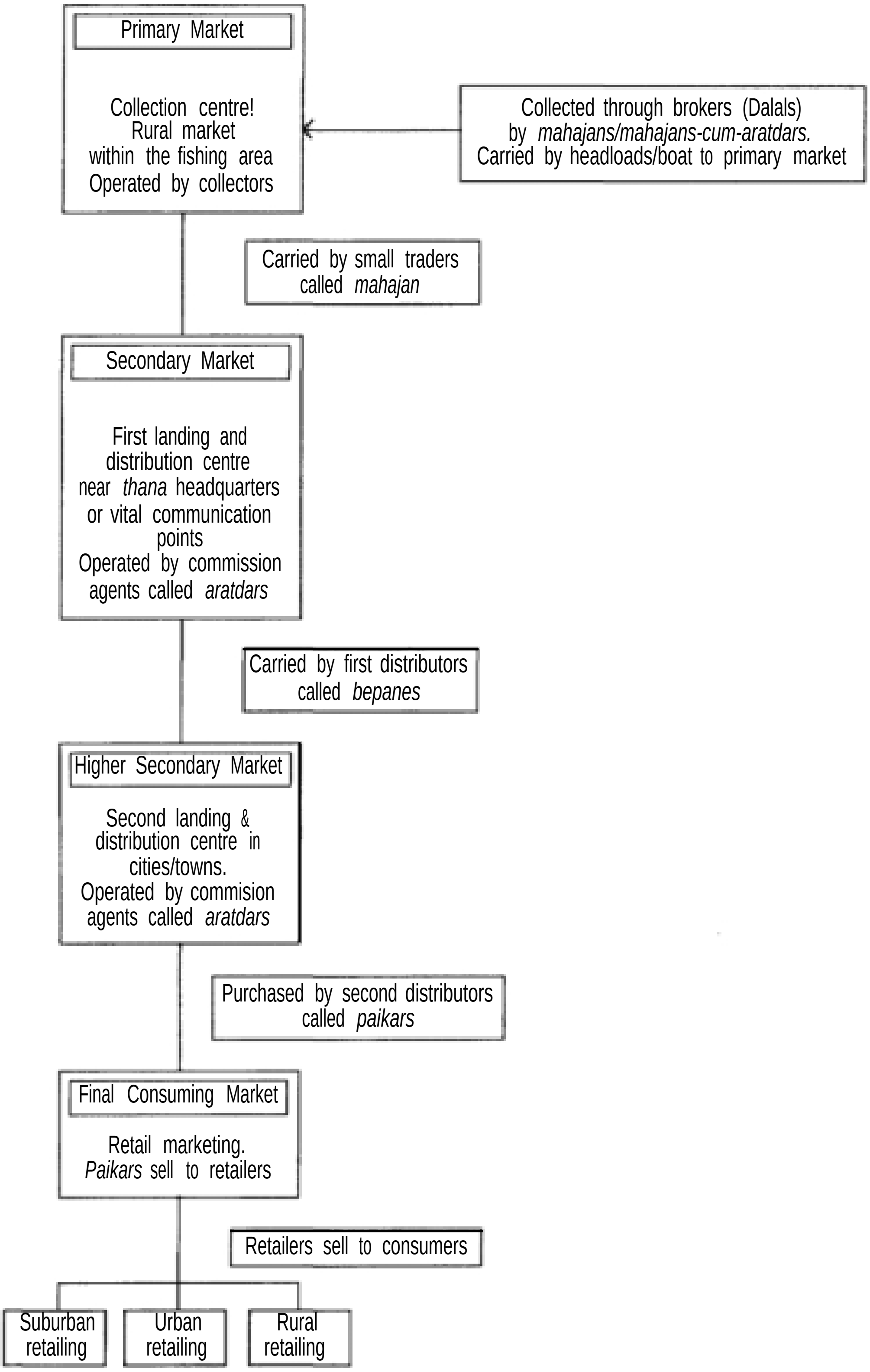
Higher secondary market

The *beparies* transport the fish to the nearest city/town markets by road, rail or boat. These are the main distribution markets and here the *beparies* sell the fish to another set of distributors known as *paikars,* again with the help of *aratdars.*

Final consuming markets

On purchasing the fish from the higher secondary market, the *paikars* sell the fish to the retailers. There are two channels of retailing — the urban retailers sell the fish in the urban markets in permanent stalls or set out with the fish on their heads or in tricycle (rickshaw) vans, to sell them at homes. Other retailers take the fish to suburban places or to the villages around the city/town.

Figure 4. Four Levels of Fish Markets In Bangladesh



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In the course of marketing at all these levels, the collector or distributor carries out the function of handling, cleaning, sorting, icing, preservation and transportation at his cost as far as possible. Expenses on such accounts are deducted from the bills of sellers.

5.3 Major fish markets and landing centres

Major coastal fish landing centres are located at Chittagong, Cox's Bazar, Teknaf, Shahparir Dhip, Kutubdia, Hatiya, Sandip, Sitakunda, Laxmipur, Hajimara, Ramgati, Bhola, Dauladia, Charfesson, Patuakhali, Galachipa, Khepupara, Mohipur/Kuakata, B arguna, Patharghata, Khulna, Bagerhat, Parerhat, Satkhira, Barisal and Chandpur (Figure *5).* Most of the catches from the Bay of Bengal are landed at these centres and *Hilsa* is the main species landed.

Major inland fish landing centres are located at Bhairab Bazar, Kuliarchar, Sylhet, Daudkandi, Choumohini, Mymensingh, Rajshahi, Rangpur, Dinajpur, Narshingdi, Bhayggokul, Minshigonj, Nilcomol, Chandpur, Goalunda, Madaripur and Faridpur. Carps and catfish are the main species landed at these centres.

Major floodplain *haors, baors, beels* and lake fish landing centres are located at Joykalash (Sunamganj), Azmeriganj, Mohonganj, Netrokona and Kishorganj, Bonwarinagar (Pabna), Cour Chandpur, Bergopindapur, Joydia, Kaligonj and Rangamati and Kaptai.

5.4 Trade flow

Trade flow, or movement of marine fish for domestic consumption, originates from Cox's Bazar, Chittagong, Barisal, Khulna, Bagerhat, Parerhat, Chandpur and many other coastal landing centres. After meeting local needs, the surplus fish is sent to the major markets of Dhaka, Syihet, Rajshahi and other markets.

Figure 5. Major fish landing centres in Bangladesh

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5.5 Marketing channels

Almost all fish traded for the domestic market passes through the channels described in 5.2. The market structure varies from area to area, but in general terms is as illustrated in Figure 4.

While the four levels of markets are the normal trade channels, there are sometimes variations between locations and types of fishermen. Sometimes fishermen/fish farmers bypass these channels and sell fish directly to the secondary markets, this being most commonly practised by the mechanized boat operators at the coastal fish landing centres.

5.6 Marketing margins

The fishermen's share and marketing margins in fish sold in Dhaka and Pabna in 1981 were analyzed for freshwater fish like Hilsa (River shad), *Ruhi* (Carps) and *Singhi (Heteropneustes fossiles)* by Ahmed (1983) and the following were the results:

Fishermen's share in consumer price	:	.51-63%
Middlemen's share in consumer price	:	37-49%
Expenses		12-24%
Net income after expenses		24-26%
Share of collectors		14-35%
Share of distributor		16-20%
Share of retailer		5 1 0%

The fishermen's share and marketing margins of marine fish sold in Chittagong and Cox's Bazar were as follows:

Fishermen's share	60-63%
Middlemen's share	40-37%
Breakdown of middlemen's margin:	
— Marketing costs	**2** 1.7-22.2%
— Quality/weight loss	1.6%
— Net income	13.3-16.1%

5.7 Existing auction systems

Most of the auctioning in Bangladesh is carried out by auctioneers locally called *aratdars.* They follow the price incremental system.

As soon as the fishermen land the fish in the market, the aratdar takes care of landing, handling. sorting and auctioning by species and size-groups. Even though the open-bidding system is the most prevalent one, there are other types of price-fixation systems followed by some traders' associations in some selected markets. In general, the sales systems are as follows:

Open bids

Auctioneers call out the bid by the bidders loudly in the presence of the buyers. The incremental system is followed. It is the most competitive form of auctioning and ensures better prices for fishermen. It takes place at all levels of fish marketing, excepting retailing. The auctioneer gets a 3-5% commission on sales value plus his actual expenses.

Syndicate-controlled price fixing

In fish landing centres in the coastal areas, especially in Cox's Bazar, Chittagong and Barisal, the private auctioneers in some markets have formed associations called 'syndicates', which fix the prices of fish either in the evening or on the next day, after disposing of local demand. They send the excess fish, properly iced and packed. to distant landing city/district markets to another set of local *aratdars,* who receive the fish and auction it locally. The fishermen, thus, do not know, nor are they able to know, what the auction value is for their fish, neither do the buyers know the beach price. After disposal of the fish, the inland aratdar sends information about the prices obtained to the auctioneers at the landing centres. The latter sit together and fix prices as they wish. This system works on faith and mutual trust only. The fishermen is bound to follow the system, since he is tied to the auctioneer by credit given to him. There is plenty of room for malpractices in this system.

Limited bidding

In this system, the auctioneer fixes the price by negotiation or partial bidding, usually in the absence of the seller. The auctioneer does not make loud calls, but he whispers prices in the ears of the intending buyers present. He then decides the highest price and awards the fish to the so-called highest bidder. This system is also faulty. But since both seller and buyer are tied to each other by advances or credit, there can be no protest.

Through tender

In case of trawler catch, the owners sometimes sell the fish through tender.

In smaller landing centres, or production areas, fish is also sold by negotiation between the local buyer and seller. Retail prices are always fixed by negotiation in the private sector. In Department Stalls, however, prices are fixed.

6. MARKETING INFRASTRUCTURE

6.1 Landing facilities and wholesale fish markets

Landing facilities and wholesale fish markets are not well developed throughout the country. Inland fish landing centres are entirely run by the private sector and this sector runs coastal landing centres in many places, too. These centres are not developed due to the indifference of the private sector.

The Government of Bangladesh, through its Ministry of Fisheries and Livestock and the BFDC, has established a fish harbour in 1972 for deep sea trawlers of 80-100' length. It has also established a modem fish landing centre with Japanese assistance in Chittagong for the 2000-3000 strong mechanized fishing fleet. operating from the Chittagong area. This centre started operation in August 1994, and about 45,000 tonnes of fish is expected to be landed here. BFDC also established fish landing centres at Cox's Bazar, Khulna, Barisal, Khepupara and Patharghata along the coast and at Rangamati, Kaptai, Rajshahi and Daborghat (Sylhet) inland. More modern fish landing centres and wholesale fish markets are planned by Government.

Fishermen's cooperative societies also run a major fish landing centre in Chittagong, but it has neither modern nor hygienic facilities.

Fish landing centres run by the fish traders are of very poor standard and need improvement. In most cases there are no auction sheds, no packing sheds and no landing terminals, no gangways, no pontoons and no proper drainage or hygienic facilities.

Wholesale fish markets in almost all cities and towns are operated by the concerned municipalities under the Ministry of Local Government. The state of landing and wholesaling facilities in the municipal markets are generally inadequate for handling a highly perishable commodity like fish.

6.2 Retail markets

In major cities like Dhaka, Chittagong, Khulna and Rajshahi, as well as in the district towns, the retail markets are managed by the municipalities. Conditions in these markets too are not adequate in respect of sales areas, parking, sanitation, water-supply, drainage, cleaning and washing and maintenance and repairs. A few new markets are however, an exception. The BFDC runs a modern fish distribution and retail centre in Dhaka city with half a dozen modern fish shops and fifty rickshaw vans which sell fish from door to door in Dhaka city. A few modern retail fish shops have also been established by private sector entrepreneurs in Dhaka.

6.3 Ice-plants and cold-storage

There has been much improvement in the ice supply situation during the last few years. Many ice-plants have been established in Cox's Bazar, Chittagong, Khulna, Barisal, Khepupara, Patharghata and other small fish landing areas along the coast. The number of ice-plants with their daily production capacity, in the major fish landing centres are listed below (1993 figures):

Name of centre	NOS.	Capacity/day
Chittagong	68	1055MT
Cox's Bazar	30	642 MT
Barisal	39	1654MT
Patuakhali		
Khulna	60	660 MT
Bagerhat	21	180 MT
Mongla	05	34 MT
Parerhat	04	55 MT

Most mechanized fishing boats carry ice with them to land fish properly iced. There is no dearth of ice-supply in these centres for the marine fish. During bumper *Hilsa* catches, which coincides with the full-moon and the dead-moon periods (a short period of 3-4 days at a time during the monsoon months or May to October every year) shortage of ice sometimes occurs. The average price per block of ice weighing about 140 kg varies from Taka 40.00 to Tk 100.00 (US $ 1.00-2.50) depending on fish landing intensity. The average price is around Tk. 600.00 (US $ 15) per tonne. The BFDC has established 14 ice plants in its ten coastal fish landing centres with a daily ice-making capacity of 260 tonnes (210 tonne block ice + 50 tonnes flake ice) a chill room capacity of 615 MT, and an ice-storage capacity of 670 MT. Cold storage for ice and chilled fish have not received proper attention from the private sector.

6.4 Freezing plants and frozen storage (shore-based)

Bangladesh has developed a big shrimp processing industry. There were 115 processing plants by 1993-94, having a total daily capacity of 800 MT of shrimp or fish (approximately 180,000 MT annually on the basis of 220 days of operation a year). As against this installed capacity, shrimps for export amount to only around 40,000 MT live-weight or about 25,000 MT headless weight. Capacity utilization for shrimp freezing was only 19 per cent in 1992-93. As a result, most shrimp processing plants are either lying idle or have diversified into finfish processing and freezing for export and domestic marketing. Of the 115 plants only four are in the public sector (BFDC) and have a daily freezing capacity of 51 MT (49 blast freezing + 12 MT plate freezing and 1380 MT of frozen storage capacity). BFDC plants are mainly used as service facilities by the private sector exporters. Growth of processing plants and its utilization is shown in Figure 6 and 7.

Figure 6. Growth of Processing Plants in Bangladesh

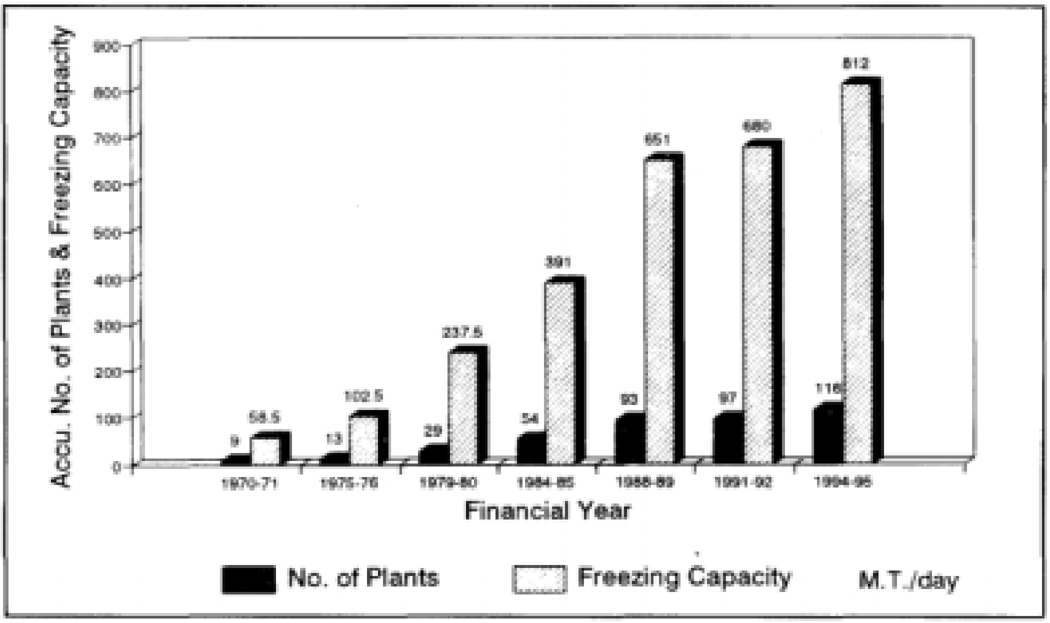

Figure 7. Capacity utilization of shore-based Processing Plants (%)

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6.5 *Trawler-based shrimp processing plants*

Deep shrimp trawlers were introduced in 1979. By 1994, the fleet grew to 48 shrimp trawlers with a daily freezing capacity of 108 MT. These trawlers catch over 4000 MT of marine shrimp annually. Of the 48 shrimp trawlers, only two belong to the public sector (BFDC). There are also four white fish trawlers belonging to the BFDC as against 16 in the private sector.

7. *THE ROLE OF PUBLIC FISH MARKETING ORGANIZATIONS*

There is no specific public fish marketing organization in Bangladesh. The Bangladesh Fisheries Development Corporation, established in 1964. is the only such organization. Its functions are:

- To take all measures necessary for the development of the fisheries and fishing industry of Bangladesh.
- To establish a fishing industry.
- To establish units for the capture of fish and promote a better organization for exploitation of fish wealth.
- To establish units for preservation, processing, distribution and marketing of fish and fish products.
- To undertake surveys and investigations of fisheries.
- To set up organizations for the export of fish and fishery products.
- To establish institutes or make arrangements for training and research in the methods of catching, processing, transportation, preservation and marketing of fish.
- To advance loans to fishing industries and to fishermen.

The BFDC, under its mandate, has carried out the following activities.

Industrial

- Introduction of deep sea trawlers;
- Mechanization of gillnet boats;
- Introduction of minitrawlers;
- Netmaking industries;
- Docking and slipways for fishing trawlers;
- Processing and preservation plants;
- Freshwater fish culture in lakes and large waterbodies:
- Fish meal and shrimp feed production;
- Fish drying;
- Shark liver oil extraction.

Infrastructural

- Establishment of fish harbour, fish landing centres and wholesale fish markets;
- Establishment of ice plants and cold storages;
- Establishment of freezing plants;
- Boatbuilding;
- Fishnet making;
- Training of manpower;
- Establishment of the marine fisheries academy.

Marketing of fish and fishery products

- Marketing of freshwater fish;
- Marketing and introduction of seafish to inland population;
- Marketing of ice, fishing nets, fishmeal. shark liver oil etc.
- Export of shrimp and fish.

In the course of implementing its various projects. BFDC helped develop deepsea fishing and coastal fishing by setting up freezing plants and improving the quality of fish landings, handling and marketing. BFDC's has been the power in the country of modern domestic cold-chain marketing.

7.1 BFDCS role in fish landing and marketing

Landing of fish

BFDC plays a vital role in the qualitative landing of fish, by helping the private sector fishermen and fish traders to use its modern facilities. About 8638 MT (3.3%) of seafish were landed through BFDC's three coastal landing centres at Cox's Bazar, Khulna and Chittagong in 1994-95. In August '94, 'The Fish Landing, Preservation and Distribution Project' was commissioned at Monoharkhali, Chittagong, at a cost of Tk. 550 m (US $ 15 m) with Japanese grant assistance. This landing project is a most modern one with 24-hour landing arrangements, and preservation and distribution facilities. It can handle about 45,000 MT of fish annually. Two other modern fish landing centres are likely to start operation at Barisal and Patharghata very soon. When all these five BFDC marine fish landing centres come into full operation, about 77,000 MT of marine fish (30% of seafish) will be landed annually through modern and hygienic fish landing centres. BFDC also landed and marketed 5200 MT of freshwater fish in 1994-95 from the Kaptai Lake fishery through its two landing centres at Rangmati and Cox's Bazar.

Direct fish marketing

BFDC operates direct fish marketing in a limited manner. It sells its trawler catch to fish traders directly. It also sells its share of freshwater fish from its Kaptai Lake and Dhaka City waterbodies (D.N.D. and Gulshan Lakes) projects traders in Dhaka. It also buys fish from Government aquaculture projects in Jessore District (ox-bow lake projects). Recently, it has begun to procure fish from private sector aquaculture farms and fish traders.

BFDC stocks frozen fish during peak season in its four freezing plants and stores for the holy month of Ramadhan and also for the lean season when fish is scarce. The purpose of this temporary stocking is to intervene if there are unusual price-hikes by fish traders, specially in the capital, Dhaka, which has population of about 8 million.

BFDC has been operating a retail marketing operation in Dhaka city from 1976-77. This operation supplies quality fish at fair prices to Government employees and fixed and low income groups of people in the city through five retail outlets and about 30 rickshaw vans. In 1993-94, it sold about 275 MT of fish through its retail chain in Dhaka City.

Production and sale of fish by-products

BFDC produces fishmeal, shark liver oil and crushed shells for the poultry industry. About 1000 MT of these products are directly sold every year. It also produces dried shark fins, fish maws, dried fish and salted and dehydrated fish for export.

New product development and marketing

BFDC has developed a range of ready-to-cook and eat frozen fish products from minced fish caught by its trawlers. These products are: Fish burgers, Fish fingers, Fish cake, Fish cutlets, Fish balls and Minced blocks. These products have met with a good response from consumers. This technology is ready to be transferred to the private sector.

Export of shrimp and fishery products

BFDC is a small processor and exporter of shrimp caught by its shrimp trawlers. It also exports seafish and freshwater fish to international markets, BFDC's processing and freezing facilities are offered to private packers, non-packers and exporters for the promotion of exports.

Sales of ice

BFDC produces and sells over 30,000 MT of ice annually to the private sector fishermen as part of its utility services at fish landing centres. Unlike the private ice manufacturers who often produce ice from running water, BFDC always makes it from safe water from deep tubewells, to ensure hygienic ice for fish.

Marketing of fishing nets

BFDC produces and sells over 200,000 kg of fishing nets produced in its three fishnet factories at Chittagong, Mongla and Comilla. These are offered at competitive prices to the fishermen annually.

BFDC's marketing achievements

BFDC has attempted to influence the marketing of fish in two ways:

- It has adapted a promotional and developmental role, by providing facilities for use by the private sector with a view to improving marketing efficiency. Its facilities, which are well-designed and hygienic, land quality fish for both the domestic and export markets.

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— BFDC has adapted a commercial role by marketing fish and fishery products, ice fishing nets, by providing docking and repairing facilities to the private sector fishing vessels, by aquaculture, etc. in competition with the private sector. It has been making operational profits all through. Simultaneously some of its commercial projects have brought benefits by virtue of its innovatory aspects such as:

  — It has taught inland people the benefits of buying seafish.

  — It has taught fishermen how to handle, preserve and ice fish for transportation over long periods.

  — It has taught the private sector how to freeze and store fish for long, for export as well as for the lean seasons in the domestic market.

  — It has introduced new fish products such as Fish fingers, Fish burgers, Fish balls, Fish cakes and Fish cutlets, which may open a new dimension in the export of value-added fish products by the private sector in the near future.

8. THE ROLE OF COOPERATIVES IN FZSH MARKETING

There are in Bangladesh about 4500 primary cooperative societies of fishermen, mainly in the marine fisheries sector, with a total membership of 5,37,224 (BOBP, 1985). There are 88 intermediary area societies also. All are registered with the national apex organization, Bangladesh Jatiya Matshyajibi Samabaya Samaty (BJMSS). The main source of funding for the cooperatives comes from Government loans and credits from Japan, Denmark and few other countries. These funds are mainly used for the mechanization of boats and acquisition of fishing gear and accessories.

Fishermen’s cooperative societies have not been active in fish marketing. Rather, they have helped to turn many fishermen into fish auctioneers, through the benefits of mechanization of boats. There are several socioeconomic and sociocultural factors which discourage the poorer fishermen from marketing activities.

Despite all the failures in the past in fish marketing by the co-operatives, Government continues to encourage them through NGOs. The approach emphasizes awareness-building, organizational skill development and some credit.

9. ACCESS TO CREDIT

Credit plays a vital role in the development of the fishery industry and fish marketing in Bangladesh, as in many other countries. The Government of Bangladesh as recently declared the fishery sector, including aquaculture, as an ‘industry’. All fish farmers, processors, ice-plant owners and fish traders are now treated equally with industrialists and can get bank loans on easy terms just like any other industry. The major credit flows to the fishery industrial sector is from the undermentioned banks. Projects get credit to the extent of 70-80 per cent as against 20-30 per cent collateral.

Government Banks : Bangladesh Bank, Sonali Bank, Bangladesh Krishi Bank, Bangladesh Shilpa bank, Bangladesh Shilpa Rin Sangstha, Agrani Bank, Janata Bank.

Multi-national financing institutions, like:

SABINCO (Saudi Bangladesh Investment Co.) DANIDA, NORAD, SIDA, CIDA, World Bank, ADV and IFAD.

Multinational Banks: Grindlay's Bank, Islamic Developmen Bank and Arab Bangladesh Bank.

Private banks, like : National Bank, City Bank and BCCI Bank.

It is usually only the fishery industrialists, the educated and the new entrepreneurs who have access to such bank loans. The poor fisherman or the small fish trader has no access to such bank loans, because:

— He is, in most cases, illiterate and so does not like to sign any paper regarding bank loans.
— He has nothing to offer as collateral.
— He is a floating person. Hence, bank officials are not interested in giving him loans because of insecurity in recovering the loans.
— He does not get a bank loan when he really needs it.
— There is a lack of business relationship and faith between him and the bank officials.
— The interest rates are high in the banks.

It is due to these reasons that the fisherman and the small fish trader approach the middleman — usually a rich fish trader (aratdar) — for loans. The fisherman, small fish trader or retailer prefers to take loans from ***aratdars*** because :

— He has a long-standing business relationship with the ***aratdar.***
— He gets long-term and short-term advances as and when required by him.
— He does not have to pay any interest to the *aratdar;* He has only to bind himself, by faith, to sell/ buy the fish only through/from the *aratdar.*
— The ***aratdar*** helps to rehabilitate him quickly, in the case of any loss or damage to his inputs, like boats, nets etc.

The poor fisherman or the retailer thinks that he is benefitted, but it is the ***aratdar*** who is the greater beneficiary. He may not charge interest directly, but he makes the double profit, from both the seller and the buyer, unknown to them.

The *aratdar* carries on his business as a fish trader as well as a financier. He is much more efficient because of his human relationship with his clients. He also benefits due to the failure of cooperative societies to help its members with credits. We feel it will be almost impossible to break this system in Bangladesh in the near future or even in the long-term. It is to be hoped that the Grameen Bank (rural bank), which has made a major breakthrough in providing supervisory credit to the rural people in agricultural, fisheries and livestock, small-scale cottage industries, and in small business and artisanal activities, will come forward to help the fishermen and small fish traders.

10. SOCIOECONOMIC ASPECTS OF FISH TRADE

10.1 Socioeconomic development

There is no denying the fact that fishermen and the fishing community as a whole-form the poorest and most disadvantaged group of Bangladesh society. Fishermen's villages are mostly located in inaccessible areas, where there is little communication. developmental or social impact. They have no other activities except fishing, which cannot be carried out throughout the year, and in the idle periods, they lack alternative employment opportunities. Their socioeconomic development is negligible.

In other sectors of fisheries development, such as the deep sea trawling industry, mechanized fishing and the fish processing industry, the socioeconomic development is conspicuous. as the fishermen or fish traders, are either literate or have adapted to the developmental aspects and skills of the concerned industry.

10.2 Gender aspects

In Bangladesh, fishing activities are carried out almost entirely by males. Women in fisherfolk communities are concerned only with helping the fishermen in preparations for their trips and in helping them to dispose of the fish. In the inland fish trade, the coastal areas of Chittagong, some women belonging to Scheduled Caste Hindu fishermen's families, engage in smallscale fish trading or retailing. In the families of fishermen using non-mechanized craft, the women make and repair fishing nets and dry and cure fish.

In the fish processing industry, women are employed in large numbers to clean, wash, sort, grade and pack fish. They are found to be more punctual, attentive and sincere in their duties. The processing industry employs over 5000 women for these purposes. Many women are also employed in fish technology, microbiology and management sections of the processing industry. A few women have taken up aquaculture as a profession.

11. PRICE POLZCY

There is no price policy fixed by the Government or the fisheries cooperatives or the trade associations. The price is influenced by the supply and demand situation.

In general, fish prices have been increasing faster than prices of other commodities. In 1972 the average auction price of all seafish caught by BFDC trawlers was TK. 2.00. This increased to Tk.12.00 in 1980 and to TK.22.00 in 1993. Prices during the last ten years have almost doubled. Compared to fish prices, prices of agricultural products have not registered such high rises. For instance, rice price has risen in the past 22 years from Tk. 2.00 in 1972 to Tk. 12.00 per kg in 1993. The fish price-hike has also been enhanced to a great extent by the ever-increasing volume of exports.

12. EXISTING QUALITY STANDARDS FOR DOMESTIC MARKETING

There are no separate quality control measures for domestic marketing of fish in Bangladesh. The

Department of Fisheries (DOF) is responsible for quality control under the Fish Inspection and Quality Control Services, which issues certificates to processors for export purposes.

There are three independent quality control laboratories under the DOF — at Chittagong, Dhaka and Khulna. These are the biggest landing centres for shrimp and fish. The main purpose of these laboratories is to analyze the end products for exports, mainly based on microbiological and chemical tests. Quality control at landing, handling, distribution and marketing places are also periodically carried out. The same quality standards are not practised for domestic marketing.

13. FUTURE OF DOMESTIC MARKETING

The main problems of the fish marketing that exist in Bangladesh are:

- The isolated locations of the fishing communities from their wholesale fish markets and landing centres, coupled with poor transportation and lack of ice.
- Ignorance or lack of awareness of quality needs in fish and ways of overcoming them.

Solutions to these major problems will involve huge amounts of money and a strong political will. However, the Government of Bangladesh has undertaken, and is in the process of undertaking, more and more infrastructural projects in the rural areas and in the fishing communities, building roads, landing centres in the coastal belts, improving wholesale fish markets in the cities and control systems at landing, handling, distribution stages are also under consideration by the Government in order to improve quality standards and control post-harvest losses.

14. EXPORTS AND REGZONAL TRADE

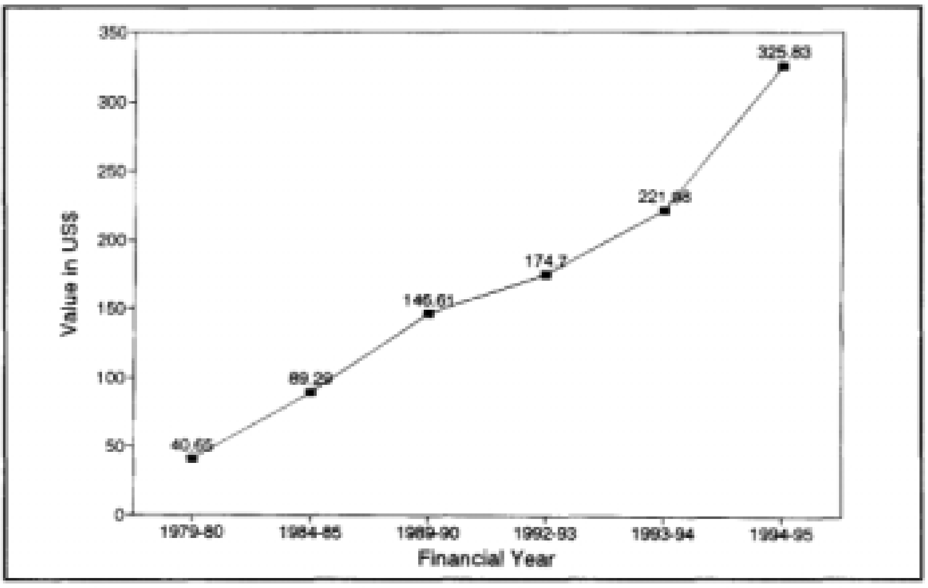
Exports of frozen shrimp, fish and frog'slegs and other fishery products was a non-traditional and negligible item at the time of the independence in 1971. In 1972-73, the total export from this sector was only US $ 4.49 m which increased to US $ 22 1.98 m in 1993-94 and to US $ 326 m in 1994-95. The main items exported are frozen shrimp and prawn, frozen fish, frozen, frog'slegs (now banned), dry fish, salted and dehydrated fish, shark fins and fish maws, crabs and tortoise and turtles. Small quantities of cephalopods, like squids and cuttle fish, are also exported. This sector constituted 7.33 per cent of the national export in 1992-93. It stood third after readymade garments and knitwear, and jute and jute goods.

Table 8: Fishery exports and its growth

F.Y.	*Total fishery export's in m. US $*	*Rate of growth*
1972-73	4.49	100%
1974-75		
1979-80	10.65	905.30%
1904-05	89.29	1988.60%
1989-90	146.61	3265.00%
1992-93	174.70	3890.90%
1993-94	221.98	4944.00%
1994-95	325.03	7257.00%

The rate of growth of exports of this sector has been spectacular — over 4900 per cent over the last two decades. The growth rate can best be illustrated in Table 8 and Figure 8.

Figure 8. Trend of export growth of fishery products (in US$)



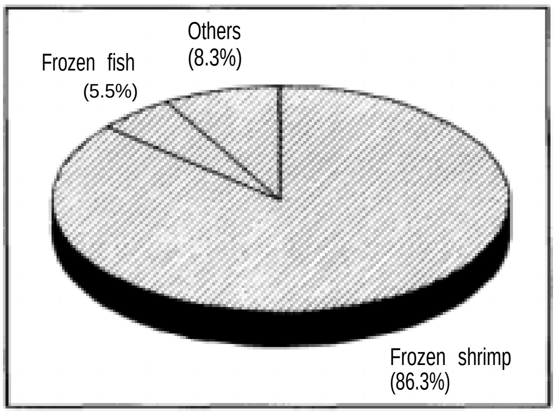
14.1 *Composition of export value offrozen foods and other fishery products*

In 1992-93, the total exports from this sector amounted to US $ 180.22 m. Commodity-wise break-up is given in Table 9 and Figure 9.

Table 9: Commodity-wise breakup of exports

	Value in million US$ $	*% of composition*
Total fishery exports	180.25	100.00%
A. Frozen foods	165.34	91 .73%
i. Frozen shrimp	155.48	86.26%
ii. Frozen fish	9.86	5.47%
B. Other products	14.91	8.27%
i. Dry fish	3.15	1.75%
ii. Salted and dehydrated fish	2.53	1.40%
iii. Sharkfins and fish maws	3.67	2.04%
iv. Crabs	3.78	2.10%
v. Tortoise and turtles	1.78	0.98%

Figure 9. Export value (%) of frozen shrimp and fish (1992-93)



14.2 *Major export markets for frozen shrimp and prawn*

The major export markets during 1992-93 for frozen shrimp and prawn from Bangladesh were the U.S.A. (40.22%), EEC (33.50%), Japan (12.64%) and Germany (10.41%). Regional countries in the Asean/S.E. Asia area buy only 2.88% of this commodity. Market-share of frozen shrimp and prawn are shown in Table 10 and Figure 10.

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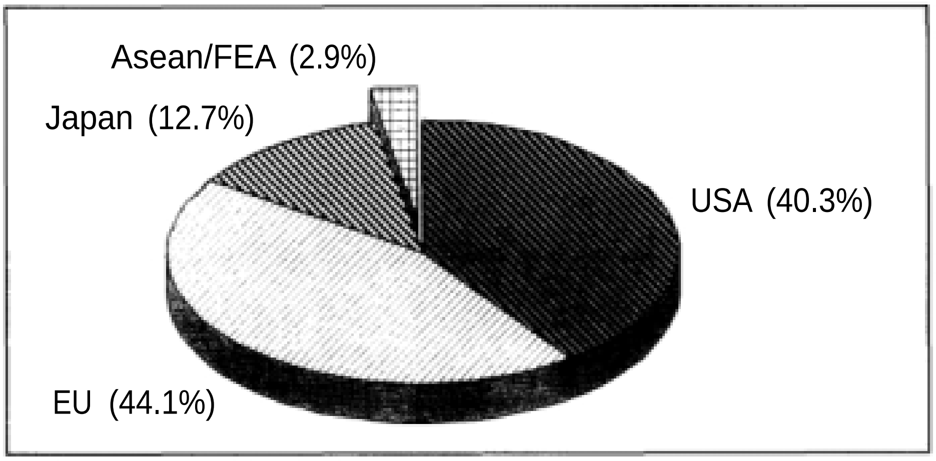
Table 10: Major export markets for frozen shrimp and prawn (1992-93)

(Value in million US $)

FY	Market share	USA	EU	Japan	Asean/ FEA	Total
1991-92	US $	**45.88**	**56.43**	**11.83**	**4.93**	119.71
		38.33	47.15	9.88	4.12	100%
1992-93	US $	62.50	68.27	19.65	4.48	155.48
		40.20	43,91	12.64	2.88	100%

Figure 10. Major export markets for frozen shrimp and prawn (1992-93)



15. *QUALITY ASSURANCE AND INSPECTION OF FISH AND FISH PRODUCTS*

15. 1 Background information about quality assurance programmes

Bangladesh entered the fish processing and export industry in 1959. when the first processing plant was established in Chittagong by a private sector entrepreneur. In the following decade, 1960-1970. nine processing plants were established with total production capacity of 58 MT of processed fish per day. These plants mainly used freshwater giant prawn locally known as *Golda Chingri (M. Rosenbergii).* Prawns processed and frozen in these plants were exported to the USA and some European countries. like the U.K., Italy. France and Belgium.

These pioneering processors and exporters knew very little of quality control measures to be taken to meet the international standards. As a result, some consignments of frozen prawns were detained and rejected by the foreign buyers in 1967.

After these incidents. Government felt the necessity for establishing Fish Inspection and Quality Control Service (FIQC) in the country to regulate the quality of fish and shrimp meant for export. The Directorate of Fisheries (DOF) prepared a scheme entitled Establishment of Fish Inspection and

Quality Control Laboratories in Bangladesh' and this was approved by the GOB in 1976. The purpose of the scheme was to ensure steady development of frozen foods exports from the country by improving quality control and inspection systems. Under this scheme, two testing laboratories, one each at Chittagong and Khulna, were established. Each of these laboratories was headed by a Deputy Director empowered with the authority to issue preshipment salubrity certificates on the basis of inspection and laboratory examinations of export products. Before full commissioning these laboratories of medical colleges, the Cholera Research Institute and the Bangladesh Council of Scientific and Industrial Research (BCSIR), Dhaka. The FIQ programme in Bangladesh was initially launched as a voluntary and co-operative effort by Industry and Government to meet the requirements of foreign buyers and their respective health authorities.

In the meantime, blacklisting by the USFDA of frozen foods from Bangladesh, along with four other countries of Southeast Asia, became a serious problem for the fish export trade of the country. It faced heavy losses in the form of rejection and of relatively low prices offered by foreign buyers. Government soon realized that the existing manpower and ancillary facilities were not adequate for effective inspection and quality control. So a new project was put forward. to establish a better Inspection and Quality Control Service. The Project got its approval in 1979 and completed its fifth year of operation in 1984-85. This laid emphasis on the strengthening of the capabilities of the analytical laboratories along with provision for the appointment of inspectors, one deputy director, and a project director to co-ordinate the work in Chittagong, Dhaka and Khulna. Although the voluntary Quality Control Programme in Bangladesh started functioning in 1977, it got legal backing only in 1983, when Government enacted a comprehensive legislation entitled 'The Fish and Fish Products (Inspection and Quality Control) Ordinance, 1983'. The Ordinance came into force the same year and since then, all fish and fish products, either live or processed, exported from Bangladesh are subject to compulsory quality control and preshipment inspection. The rules relevant to the implementation of the Quality Control Ordinance were framed by the Government and are now in practice.

During the last 1.5 years, fish processing plants in the country registered an impressive growth of about four times, from 29 plants in 1980 to 115 in 1994. This has created tremendous pressure on the existing FIQC facilities and manpower. To cope with the present situation, another project, with financial assistance of ODA, has been submitted to Government for approval. The project will provide support for the establishment and implementation of programmes to upgrade quality control and inspection of exportable fish products in order to establish a level of international standard, confidence and goodwill for Bangladesh fish products through the introduction of Hazard Analysis Critical Control Point (HACCP).

15.2 Fish inspection

The Fish Inspection and Quality Control Service of the DOF, under the Ministry of Fisheries and Livestock. has total responsibility for inspection and quality control of all fish and fish products meant for export as well as for sanitary and hygienic conditions in fish processing plants. The Inspectors of FIQC frequently inspect the fish processing plants and evaluate the processing units in respect of minimum sanitary and hygienic facilities required for good manufacturing practices. During in-plant inspection for assessment of plant standards, an inspector assesses the sanitation and cleanliness measures adopted in the factory by the personnel engaged in processing. He also assesses the quality of raw materials and final products in respect of dehydration, discoloration, texture, black spot, odour, weight, grade, presence of filth, objectionable materials, soft-shelled pieces. spoiled pieces, broken damaged pieces etc. Apart from inspection, the inspector collects representative samples at random for microbiological and chemical analysis in the laboratory. The export-worthiness of the product is judged on the basis of in-plant inspection and laboratory analysis reports. To obtain a pre-shipment salubrity certificate for any product, both the inspection and laboratory reports should conform to the standard specifications stipulated by the Bangladesh Standard and Testing Institute (BSII) for the particular product.

Id. QUALITY OF RAW MATERIALS

16.1 Harvesting and landing

Since freshwater fish and shrimp as well as marine fish and shrimp are harvested, landing of fish is round the year and widely dispersed throughout the country. Artisanal methods are mainly employed to tap the resource and there are limited facilities for landing the catch. The main inland fish landing points are Goalunda, Kuliarchar, Ajmirigonj, Habigonj, Bhairab, Chandpur, Jessore and Kustia.

Marine coastal fishing in Bangladesh is seasonal. The peak season is during the calm weather from October to March. Almost 95 per cent of the total marine catch is harvested from nearshore waters by smallscale fishermen and only about five per cent is from the deepsea trawlers. The major landings of marine and estuarine catch take place at Chittagong, Pahartali, Sitakunda, Teknaf, Shahparirdwip, Barisal, Khulna, Cox's Bazar, Hatiya, Sandwip, Bhola, Hajimara, Charfession, Mohipur (Kuakata), Patharghata, Dublarchar, Bagerhat, Parerhat, Karerhat, Chandpur and Patuakhali.

The catches of cultured shrimp are landed at Bagerhat, Khulna, Satkhira, Paikgacha, Kaligonj, Chackoria, Teknaf, Cox's Bazar and Chittagong.

16.2 Handling and transportation

Road, rail and water transport are used to carry fish to distant places from landing/collecting centres. In case of marine transport, mechanized boats with insulated fish-holds are used. But on land, road transport is mainly used as it is considered safe and speedy. For fish to reach distant urban centres from the fishing grounds needs 7-9 days after catch. This is less than the normal shelf-life of many tropical species, even if handling and storing conditions are ideal. Packing materials include bamboo baskets, wooden boxes and hessian bags. Usually banana leaves, seal, hoglamat and hessian are used as insulating material and they create problems for the keeping quality of the raw material.

16.3 Raw material collection system

In practice fishermen or farmers have little chance to deliver their catch to the industry directly. The collection of raw materials for processing plants passes through private channels. The structure of these channels varies from area to area, but in general, can be divided as follows:

- Primary landing/collecting centre.
- Secondary landing/collecting centre.
- Higher secondary landing/collecting centre.
- Final stage of delivery to industry.

At all levels of the collection and distribution system there are groups of collectors who collect raw materials for the wholesalers or suppliers. Most of the landing, collecting and wholesale centres are neither properly equipped nor provided with adequate facilities for fish handling. The sanitary conditions are also not good enough to maintain the proper quality of fish. In most cases, there is no supply of clean water and ice. The facilities for preservation are also unsatisfactory. There are only four modern and hygienic fish landing centres — in Cox's Bazar, Chittagong, Barisal and Khulna — all built by the public sector, but these are not enough to cope with the total landings.

17. QUALITY CONTROL SYSTEM OF SEAFOOD EXPORTS

17.1 Quality control system in the industry

Generally, fish is supplied by the ***bonafide*** suppliers or fish traders in bulk quantity or sometimes farmers or fishermen supply small quantities directly to the plants. So there is not much of control on raw material supplies from the harvesting point to the processing plants. Icing, separation, sorting, grading, etc., are done prior to receipt. In most cases sufficient care is not taken by the supplier from the time of catch to delivery of raw material at the plant's receiving counter and this offers possibilities for deterioration in quality.

The management of the plant engages some receiving graders under the control of a production supervisor or the plant administrator, who often interfere in the normal functions of the receiving process, pressing the receiving graders to accept defective goods in the interest of increased output. Due to scarcity of raw materials, this practice is quite common. Receiving shrimp with hanging meat, piece facility etc, provide grading defects in the final product.

Quality control of the fish or fisheries products is the responsibility of the production supervisor, who is directly responsible to the plant management. The control of quality in a small unit can be entrusted to an individual, but for a large unit, or when raw materials arrive in, a group of checkers is needed. Almost all fish processing plants line, the production controlled by a group of supervisors. Processing plants established in recent years are of international standard having the facilities of a smooth-flowing process line. But due to inadequate knowledge about plant sanitation and personal hygiene and negligence, the final product is not up to the mark.

To maintain the desired quality of the end product, a quality control unit in each individual plant is needed. In fact, there is no such unit, or department in many processing plants. But to fulfil the requirements of the consumers, mainly foreign buyers, it is essential for managements to set up in-plant quality control units.

17.2 Official quality control system

The idea of setting up a National Fish Inspection and Quality Control Organization was incorporated in the national plan after Independence. As the number of plants increased rapidly, the work of quality control became more and more difficult. Nevertheless, the Fish Inspection and Quality Control Service of DOF, under the MOFL, inspects all fish and fishery products meant for export and checks the sanitary and hygienic conditions in the processing plants.

The FIQC has three functioning laboratories, at Chittagong, Khulna and Dhaka. Its inspectors frequently inspect the fish processing plants to ensure that minimum sanitary and hygienic facilities exist in the fish processing plants. During a plant inspection, an inspector assesses the sanitation and cleanliness measures adopted in the factory and by the personnel engaged in processing. He also assesses the quality of raw materials and final products in respect of dehydration, discoloration, texture, black-spot odour. weight. grade. presence of objectionable materials, and soft-shelled. spoiled, broken or damaged pieces. Apart from inspection, the inspector collects representative samples at random for microbiological and chemical analysis in the laboratory. The export-worthiness of the product is judged on the basis of in-plant inspection reports and the laboratory analysis reports. To obtain a pre-shipment salubrity certificate for any product, **both** inspection and laboratory analysis reports should conform to the specifications stipulated by the Bangladesh Standard and Testing Institute (BSII) for a particular product.

FIQC is responsible for promoting the fish processing industry by improving the quality of fresh fish products and ensuring better utilization of the country's fishery resources (marine, estuarine and freshwater). At present, the activity of the FIQC is limited only to the processing plants and laboratory, since most of the plants have no quality control programme of their own.

FIQC's programme for improvement of quality of raw materials from the catching and landing centres upto end products is being extended upto field level. Most of the newly installed fish processing plants are equipped with modern facilities for fish processing. Good manufacturing practices are followed and sanitation has already improved to a great extent. The most difficult thing is to control the present system of peeling. This may soon be improved with the co-operation of the factory managements.

17.3 Modern concept of preventive quality control

Earlier, quality control was based on 'lot' inspection and sampling schemes, where there was almost no or little scope of overcoming the problems or defects, if identified in the final products. Rejection of final products involved heavy loss, so various efforts were made by Dr W E Deming, Croshy and Juran to develop a proper method of ensuring quality. For effective management, quality must be built into the process rather than be instilled through inspection. The basic philosophy must be 'Don't make mistakes in the first place' (Get it right first time, zero defect).'

Modern thinking on quality control offers programmes which vary slightly in methods without changing the basic objective, that is, improved quality. A total awareness in regard to quality management can be achieved. The philosophy of quality management is defined as an open style of management based on an appreciation of understanding, variation in prices, performance and eliminating the possible defects.

17.3.1 The HACCP concept

In contrast to the principles of retrospective microbiological analysis, a preventive strategy based on thorough analysis of the prevailing conditions is much more likely to provide greater safety. A study leading to control of all factors related to contamination. survival and growth of micro-organisms in food in all stages of the food chain is what is known as the 'Hazard Analysis Critical Control Point (HACCP)', the best system available for improving the microbiological safety of food.

The system originated in the U.S.A. in 1971 and was later adopted by different countries under different names: in E.U., 'Own Check', in Canada 'Quality Management Programme (QMP)' and in Japan 'Advance and Diverse Sanitary Control System'. But regardless of what it is called, the objectives are the same and the methods are similar. The anticipation of hazards and the identification of control points are the key elements in HACCP.

The system offers a rational and logical approach to controlling (microbiological) food hazards and avoids many weaknesses inherent in the inspectional approach. Once established, the main effort of quality assurance will be directed towards the CCPs and away from endless final product testing. This will assure a much higher degree of safety at less cost. An HACCP-type system is the system of choice for food safety and for non-safety hazards, such as the prevention of economic fraud in relation to labelling, misgrading, weight etc. As required by export inspection agencies, processors have to implement the system in their establishments.

A processor/exporter in Bangladesh may ask why he should be worried about HACCP. The answer is very simple: Any one exporting fish and fish products in E.U. U.S.A., Canada or Japan will have to implement such a programme. If he fails to demonstrate to the satisfaction of the regulatory agencies in importing countries that he has an effective programme operating in his processing plant, importers will not accept his products. The Codex Alimentarins Commission and GATT is also expected to do the same. In this context, Bangladesh has taken a positive step for inclusion of the ‘Quality Assurance Programme (QAP)’ in the ‘Fish and Fish Products (Inspection and Quality Control) Rules’. The main elements (7 steps) of an effective HACCP-system are:

- Identify all possible food safety and non-safety hazards that are likely to occur in the processing operation. based on the species being processed and the process used, and analyze the risks related to those hazards.
- Establish critical points in the process, at which any sort of failure could make food unsafe if proper control is not exercised. Each point may be identified as a Critical Control Point (CCP).
- Establish critical limits for every CCP. that is, set maximum] minimum limits (parameters) for every critical point, so that the concerned employees will know when the process or the product (at the Critical Point) fails to meet criteria required to ensure that the food will be safe. A ‘decision tree’ based on the idea of Mayes (1992) and QMP Process Flow, identifying 12 areas of potential hazards, and a chart showing how to find your own critical control points, are shown in Figures 11, 12 and 13 on the following pages.

Figure **11. QMP Process Flow: Identifying 12 areas of potential hazards**

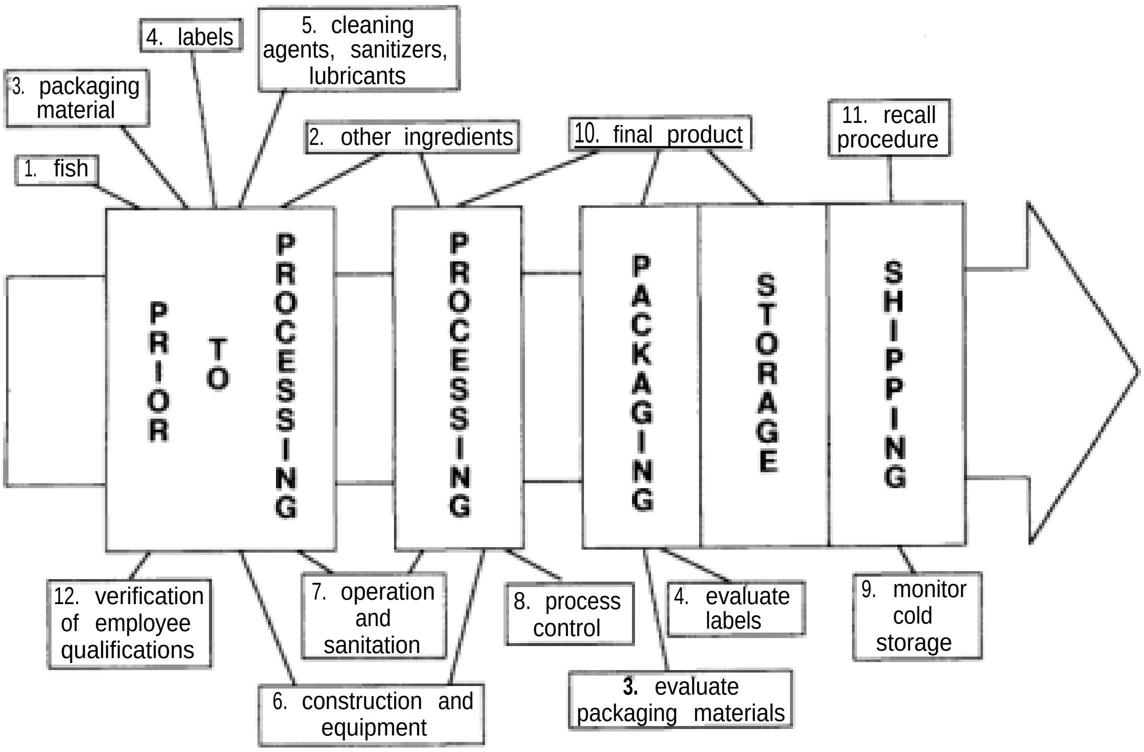


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Figure 12. Decision Tree to locate the Critical Control Points in a Process Flow

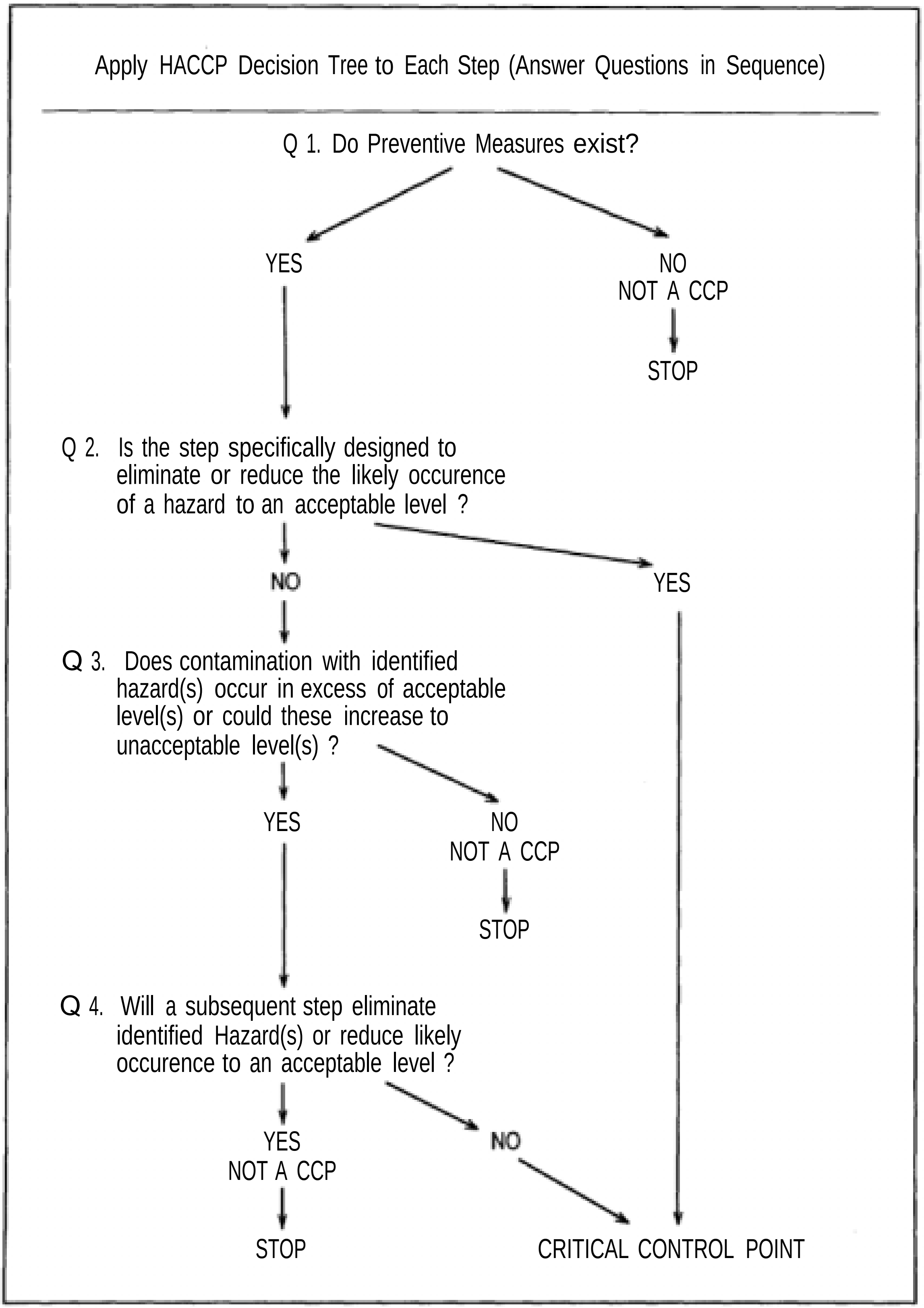

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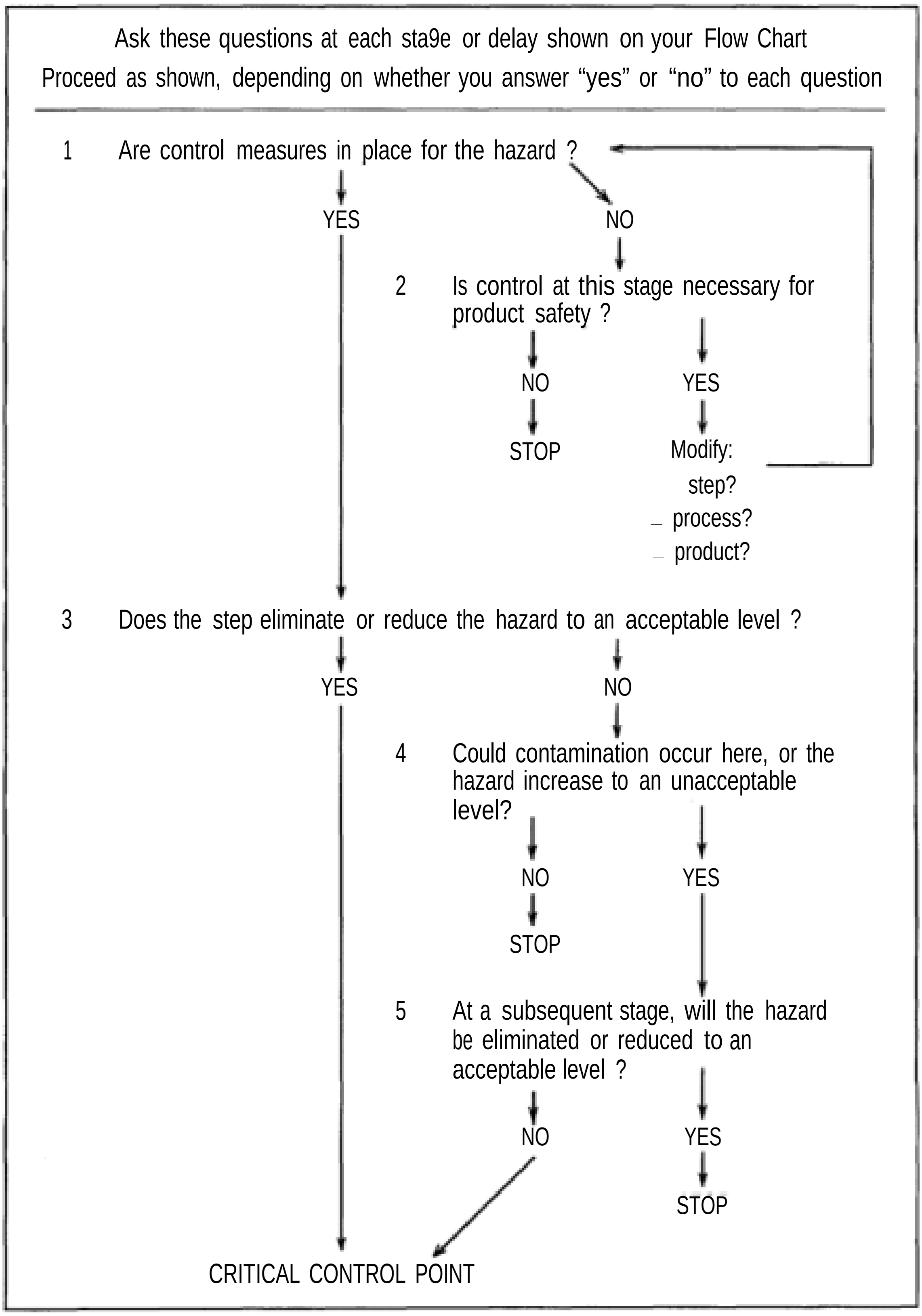
Figure 13. Find your own Critical Control Points (CCP)



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- Set up monitoring procedures to keep track of how all required tasks are performed at each Critical Control Point.
- Put a plan in place to ensure that corrective action is taken quickly whenever monitoring procedures show that there is a problem at any Critical Point.
- Set up verification and review procedures to ensure that the system of monitoring is working effectively.
- Establish an effective system of keeping records to document how every aspect of the system is working (to satisfy regulators, importers, etc. that the operation of the plant is in accordance with HACCP, 'Own Check' or QMP principles).

17.3.2 Introduction and application of an HACCP-system

The principles of HACCP are very logical, simple and straightforward. However, in practical application, a number of problems are likely to arise. It is advisable, therefore, to adopt a local and stepwise sequence for introduction of the HACCP-system, as suggested below.

Step 1. Commitment

The first step is to ensure that top management is firmly committed to introduce the system and make available sufficient resources (personnel, equipment) for its implementation.

Step 2. Assemble the HACCP-team and material

Introduction of a HACCP system in a food factory requires a multidisciplinary approach by a team of specialists. The microbiologist, the processing specialist, chemist, quality assurance manager, the engineer, packaging technologist, and sales training and personnel managers could be members of the team. Key members of the team must have an intimate knowledge of the HACCP-system.

Step 3. Initiation of programme

When the HACCP team is assembled, its terms of reference must be clearly defined and agreed on by the group. A detailed description and specification of the product, a precise process flow diagram, and a description of cleaning and sanitation procedures must be provided the team. The team will visit the processing site for verification of the process-flow diagram and also the facilities and equipment available to obtain information on the possibility of hazards.

Step 4. Process analvsis

When all the information regarding product and process have been collected, the data must be analyzed, all hazards identified, and Critical Control Points (CCPs) established. A Decision Tree can help this process. All the CCPs must be identified on the flow diagram. Other control points, which are not critical, can also be marked on the flow diagram with a clear distinction.

Step 5. Control ontions

Each CCP must have a clear and specific control procedure which specifies how the CCP will be controlled. Equipment and instruments used in control functions must also be kept under strict control and their performance validated regularly.

Step 6. Monitoring procedures

Monitoring and data recording are essential elements of the system. All actions, observations and measurements must be recorded for possible use later. All changes to product formulae or processing lines introduced as a result of the HACCP study, as well as the corrective action taken when something was out of control must be on record.

Step 7. Training of staff

When the HACCP study is completed and the programme is ready for implementation, training of staff must take place. All persons involved in the programme, from line operators to managers, must understand the principles and have a very clear idea of their own role in the system. Training and refresher courses must take place regularly and new members of the staff should not be allowed to begin work before they have gone through training in HACCP principles and procedures.

17.3.3 Regulatory agencies and HACCP

As it is primarily the responsibility of the processing industry to produce quality product according to standard specifications and to ensure that fishery products are safe and meet health requirements, the HACCP-system needs to be tailored to each individual fish processing establishment in its own In-Plant Quality Control (IPQC) system. A close cooperation between the regulatory agencies and the industry can make the programme a success. Once introduced, each plant needs to have its system approved by the Government Regulatory Authority. All CCPs and monitoring records can then be checked by inspectors and compliance with safe processing requirements can easily be confirmed. As a further guarantee, the regulatory agencies should also occasionally carry out verification tests, either on a routine basis or as surprise checks, to ensure that the HACCP system is working.

18. BOTTLENECKS AND CONSTRAINTS IN QUALITY CONTROL SYSTEM

18.1 Infrastructure

i. Lack of modem, hygienic fish landing centres makes maintaining primary quality standards almost impossible.

ii. Fishermen and fish traders, due to illiteracy, ignorance and lack of awareness, are not interested in hygienic landing centres.

iii. Shortage of adequate ice-plants with sufficient capacity in and around major fish landing centres.

iv. Too many processing plants compared to the availability of raw materials.

v. Shortage of cold storages, freezer storage and cold chain facilities.

vi. Lack of handling and preservation facilities.

vii. Too few fishing boats with ice-holds for overnight fishing.

viii. Inadequate transportation and distribution facilities and too few insulated and refrigerated fish vans. Open trucks are the main fish carriers at present.

xi. Lack of communication complex. And interconnected transport system has not been developed properly in the country, thereby causing problems with the distribution of raw material in the minimum possible time.

x. Lack of electric supply in the remote areas where fish/shrimp culture farms are located prevents introduction of improved technology for increased production and proper management.

xi. Modem technology is still not being used or adapted in fish culture and product development.

xii. Research and development programmes not emphasized.

xiii. Poor socioeconomic conditions and illiteracy in remote areas retard any development.

18.2 Plant management

i. Lack of commitment by the top management hinders quality control, which is directly proportional to the importance placed on it by top management.

ii. Lack of proper knowledge of modem sanitation techniques in controlling plants.

iii. Ignorance or carelessness in managing personal hygiene of the workers in fish processing.

iv. Competition between plant owners for procurement of raw material provides opportunities for acceptance of raw materials.

v. Absence of in-plant quality control unit in most processing plants.

vi. Extra pressure on the production manager/supervisor to produce undergrade products in order to maintain a quantitative balance between raw materials and finished products.

vii. Irregularity in electricity supply effecting product quality while in production and storage.

viii. Bulk quantities of seasonal supply (related to the phases of the moon) affect quality of products.

ix. Lack of interest on the part of plant managements in introducing the HACCP system and in-process control systems in the plants increases the chances of defective products.

18.3 Institutional

i. The present system of official inspection and quality control is restricted mainly to end products, which gives ample scope for deterioration of raw materials during transit from harvest or landing centres to the receiving section of the plants.

ii. The present inspection system is inadequate and cannot assure the quality of fish entering the internal markets.

iii. There is no R & D for improving and upgrading of fish handling, transportation, fish processing and marketing.

iv. Sufficient number of fish inspectors and technologists seriously retards FIQC activity.

v. Lack of computerized database, system of checking, data analysis and methodology development in the national quality assurance programme.

19. IMPROVEMENTS NEEDED

19.1 Infrastructure

Improvement and standardization of trawlers and mechanized boats together with appropriate fishing gear and refrigerated fish-holds are urgently needed to ensure post-harvest quality.

Modern hygienic fishing ports and fish landing centres are needed on a priority basis.

Proper utilization of the existing modem fish landing centres to ensure primary quality of fish and fish products.

Establishment of more ice-plants, cold-stores and preservation facilities.

Introduction of air-conditioned and refrigerated fish vans and fish carriers to maintain cold-chain during transportation.

Improvement of the existing urban fish markets in the country.

Establishment of exclusive shrimp landing centres/service centres in the shrimp farming zones of the country.

Establishment of modem retail marketing facilities with refrigerated fish vans, rickshaw vans and fish stalls and shops with refrigerators and deep freezes in the private sector.

Increasing the raw material supply situation through the introduction of semi-intensive fish/shrimp culture in order to increase capacity-utilization of existing processing plants.

19.2 In-plant quality control (IPQC)

Management of processing plants should be totally committed to quality assurance programmes.

The HACCP system should be introduced in all processing plants and in all phases, from catching/ harvesting to export.

Every fish processing plant should have an in-plant quality control unit for its 'own-check'.

Every processing unit management should ensure receipt of raw material supplies commensurate with its production capacity, so that quality deterioration might not result from stockpiling.

Hygienic and sanitary conditions of plant and machinery should be maintained at all times.

Proper attention should be paid by the plant management to the personal hygiene of the working staff.

Uniform temperature should be maintained in the freezer storage till export.

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19.3 Organizational facilities

The organizational facilities of the Q.C. unit of the DOF, being inadequate to meet the existing international and domestic requirements, need to be thoroughly overhauled and improved. Otherwise, serious problems, including a ban by 'E.U. USA and other countries on import of seafood may soon be proclaimed. The following improvements in organizational facilities are necessary:

1. Existing Q.C. laboratories need to be equipped with adequate modern equipment, machinery, chemicals and computerized facilities.

2. Two more regional laboratories, one each at the major fish and shrimp landing and processing zones of Cox's Bazar and Satkhira, need to be established on a priority basis.

3. Satellite Q.C. laboratories and Inspectorates need to be established in the Divisional Headquarters of Sylhet, Rajshahi and Barisal.

4. Smallscale Q.C. and inspection satellite stations are needed in about 40 other landing centres in Bangladesh.

5. The organizational set-up and manpower position of the proposed quality control department needs to be greatly strengthened and it should be headed by a Director independently responsible for its operation.

6. Laboratory equipment and facilities must be improved to ensure effective analysis of fish and fish products for pathogens, toxic elements, pesticidal residue, antibiotics and radioactivity.

19.4 Research, development and extension

Research, development and extension activities in the field of quality assurance are virtually absent in the country. The DOF and FRI should take up the following programmes:

1. A study to improve fish and shrimp seed procurement and transportation systems.

2. A study on the collection, handling, preservation and distribution of fish and fishery products.

3. Development of durable and cheaper sources of insulated fish containers.

4. Development of local technology for short-term preservation of fish and ice in remote areas.

5. A study on quality problems arising in the processing and storing of fish products.

6. A study on the development of value-added fish products and the diversification of such production.

7. A study on the environmental and disease problems of fisheries.

8. A study on the socioeconomic development of the fisherfolk community.

9. A study on the credit system in the field of fisheries.

10. A survey of fishery resources and fishing villages and fishermen's households.

19.5 International co-operation

Since improving the quality assurance programme is a gigantic task, involving various stages of development from the landing centres upto the processing plants, international co-operation from developed/importing countries, such as the E.U. USA, Canada and Japan and international development organizations like FAO, UNDP, UNIDO, World Bank, ADB, SIDA, DANIDA, NORAD and JICA will be very helpful in the following subsectors.

- The establishment of modern fishing harbours and fish landing centres in important fishing areas such as Cox's Bazar, Teknaf, St. Martin, Hatiya, Sandip, Sitakunda, Bhola, Charfesson, Hajimara, Patuakhali, Mohipur, Kuakata, Patharghata, Parerhat, Karerhat, Bagerhat, Satkhira, Chandpur, Kuliarchar, Bhairab, Sunamganj, Habiganj, Kishorgonj and Daudkandi.
- Establishing of cold-chain facilities and organizing refrigerated fish van transport.
- Financial and technical assistance from Stabex, JICA and USAID funds for new Quality Assurance Programmes aimed at introducing HACCP.
- Training of manpower in quality assurance.

19.6 Legal support

There is not enough legal support in the field of fisheries development, management and quality assurance. There is also no fish landing and marketing ordinance or act whatsoever. In the absence of such legal support fishermen do not care to land their catch in the modern and hygienic fish landing centres developed by Government.

The Marine Fisheries Ordinance (1983) is the only legal support for the management, development and conservation of marine fisheries resources. In the quality control sub-sector, 'The Fish and Fish Products (Inspection and Quality Control) Ordinance, 1983' is in force. But this cannot be properly implemented due to lack of equipment and manpower. The rules under the earlier Ordinance are now under amendment in view of the recent developments in the E.U and other countries. Legal support in the following fields is urgently needed:

- An independent act or ordinance for fish landing and marketing.
- Till then, fish landing activities should be strictly guided by the existing Marine Fisheries Rules, 1983.
- Rules under the Fish and Fish Products (Inspection and Quality Control) Ordinance need to be amended to cover all fish landing centres and fish markets.
- Licensing of all such landing centres and fish markets should be jointly regulated by the BFDC & DOF.
- All improvised or unhygienic landing centres and fish markets should be improved, as per quality control rules, or be closed down.

20. *CONCLUSIONS*

Fish is the main source of protein in Bangladesh. It is also one of the major sources of foreign exchange earnings, contributing to 10-12 per cent of the total exports of the country. Due to poor infrastructural facilities in the field of fish harvesting, landing, handling, preservation, distribution, marketing and quality assurance, Bangladesh produce has been fetching 10-15 per cent lower prices in the international markets. Quick and proper action is, therefore, needed by the GOB and the industry itself in this field. Immediate introduction of HACCP systems and their implementation is necessary. Otherwise Bangladesh seafoods might well be banned by importing countries.

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REPORT OF THE NATIONAL WORKSHOP ON FISHERIES RESOURCES DEVELOPMENT AND MANAGEMENT IN BANGLADESH

FOUR PROJECT PROPOSALS FOR TECHNICAL ASSISTANCE PRESENTED BY FAO AT THE WORKSHOP

1. **Strengthening marine fisheries resources management in Bangladesh**
   by Masamichi Hotta, *Senior Fishery Planning Officer, FAO, Rome, Italy.*

2. **Establishment of fish sanctuaries and ban on fishing for juvenile fish (Hilsa jatka)**
   by Kee-Chai Chong, *Programme Coordinator/Senior Fisheries Management Adviser, BOBP, Chennai, India.*

3. **Strengthening of commercial and specialised financial institutions and NGOs in Bangladesh to enable them to provide credit to the fisheries sector**
   by Uwe Tietze, *Fishery Industry Officer, FAO, Rome, Italy.*

4. **Strengthening of the Fishery Extension Service of the Department of Fisheries, Bangladesh**
   by Rathin Roy, *Communication Adviser, BOBP, Chennai, India.*

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PROJECT PROPOSAL FOR TECHNICAL ASSISTANCE

Project Title	:	**Strengthening Marine Fisheries Resources Management in Bangladesh**
Implementing Agency		The Bay of Bengal Programme, the Food and Agriculture Organization of the United Nations
Project Sites		Chittagong
Project Duration		May 1996
Government Contribution		To be determined
Donor Contribution		us $ 744,000

1. BACKGROUND AND RATIONALE

In Bangladesh, fisheries plays an important role in nutrition, employment and foreign exchange earnings. This subsector contributes 4.7 per cent to the GDP, about 80 per cent to the nation's animal protein intake and some 12 per cent to the total export earnings. Fisheries provide employment to about two million people in the primary production sector and 11 million people in fishery-related subsectors such as marketing, processing and boat construction.

Whilst fish production has made a steady increase during the last decade, reaching over one million tonnes in 1994, the rate of production increase has not kept pace with that of population growth. As a result, per capita consumption of fish has fallen from 11.7 kg per annum in 1972 to 7.2 kg in 1993. Even to maintain the present level of consumption, which is much lower than the world average of 13 kg per person, per year, fish production will have to be substantially increased to keep up with the population growth of over 2.5 per cent per year.

Marine fisheries have contributed to maintaining fish supplies by offsetting the decline in catches of the inland fisheries sector. The share of marine fisheries in total national landings has risen from 10.6 per cent in 1970 to 28.1 per cent in 1993. There has been, however, tremendous pressure on this fishery from subsistence fishery operators. The total area of the continental shelf, down to 200 metres, is estimated at 67,000 square kilometres, of which an estimated 37,000 square kilometres are of less than 40 metres depth. The area is exploited by the country's small-scale fleet composed of some 17,000 boats of different sizes, 6000 of which are reported to be motorized. Around 9.5 per cent of the marine fish catches are by artisanal fishermen and the remaining 5 per cent by the industrial trawlers.

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Industrial trawl boats are not permitted to operate in waters of less than 40 metres depth, but they often encroach in shallow waters. Since the gear is not selective, trawl operations in shallow waters cause damage to the resources of juvenile shrimp and finfish. This causes imbalance in the food chain and the overall ecology of marine habitats.

Other threats to coastal resources are the large quantities of pollutants discharged from land industries and the effluents of city sewage and agro-chemicals. Increase in the rate of mortality of the post-larvae and juveniles of shrimp and finfish in nursery grounds has been reported.

The marine fishery sector is constrained by lack of a proper management policy for the conservation of marine fishery resources. The Fisheries Ordinance 1983, which makes provisions for the management, conservation and development of marine fisheries, is applicable only to waters of more than 40 metres depth. This leaves the bulk of the activities conducted by artisanal fishermen in inshore waters outside the scope of this legislation. However, the Department of Fisheries has recently introduced a licensing system for mechanized boats. Because the Marine Wing of the DOF does not have sufficient staff and offices at the *thana* level in coastal areas, the licensing system is at present implemented only in Chittagong and its vicinity. The DOF intends to expand the geographical coverage to other regions of the country gradually.

The Marine Wing of the Department of Fisheries is responsible for fishery management planning and implementation. The Marine Wing is located in Dhaka and Chittagong. The Dhaka office undertakes the responsibility for the management policy formulation and planning, while the Chittagong office is responsible for data collection, stock assessment, management studies, implementation and enforcement. Various studies have been carried out on the socioeconomic and biological impacts of the estuarine set bagnet (ESBN), pushnet and driftnet, which are considered destructive gear. However, in-depth studies are still required to identify the quantum of damage, establish strategic plans, and design management measures for these gear.

2. OBJECTIVES

The development objectives are:

- to ensure socioeconomic benefits for disadvantaged smallscale fishermen who depend upon inshore resources, and
- to plan for long-term conservation and management of the marine and estuarine ecosystem and resources.

The immediate objectives are:

- to produce a profile of the coastal fishing communities as a basis for resource management planning and implementation.
- to strengthen the Marine Wing of the Department of Fisheries in respect of data collection and analysis, creating a database, evaluating fishery resource potentials, formulating of mangement plans and enforcing mangement measures.
- To design and initiate management measures for destructive gear, such as ESBN, large mesh driftnet and others.

3. ACTIVITIES

A team of international experts and national consultants will carry out the following activities:

— Prepare a profile of the selected coastal communities which will provide information on the present state of exploitation, resource potentials, socioeconomic conditions, resource use practices, conflicts among resource users, biophysical environment, fishery and social infrastructure facilities, etc.

— Formulate, on the basis of valid scientific information and stakeholder analysis, management measures aimed at withdrawal of the ESBN fishery.

— Establish strategies and plans to identify alternative employment opportunities for displaced fishermen inside and outside the fishery sector (e.g. bottom longline and trammelnet).

— Strengthen fishery statistics collection systems, including a review of the present sampling framework and establishment of a database.

— Conduct biological and socioeconomic studies on the pushnet fishery.

— Implement human resource development programmes to strengthen the Marine Wing of the DOF by arranging training courses, workshops and study tours to improve national capabilities in statistics collection and analysis, stock assessment, and formulating management measures. The existing extension network is to be fully utilized to disseminate relevant information and knowledge to target beneficiaries in order to make them aware of management and environment issues.

— Strengthen the Marine Fisheries Resources Survey Unit (FRSU) in respect of sampling procedures, assessment of fisheries resources, their status and potential, dissemination of the information and data in a form suitable for use in planning, designing and executing of the fisheries development and management programmes.

— Design the reorganization of the Marine Fisheries Enforcement Unit of the Marine Wing based in Chittagong to accommodate enforcement functions for inshore fisheries.

4. WORKPLAN

The duration of the Project will be three years and the Project headquarters will be located in the office of the Marine Wing based in Chittagong. The Fisheries Research Institute (FRI) and the Bangladesh Fisheries Development Corporation (BFDC) will be the collaborating agencies.

The Project will be operated under the umbrella of the Bay of Bengal Programme (BOBP). The Project will be headed by an externally recruited Team Leader (Fisheries Management) for the first year. The Team Leader will work in close consultation with the National Project Director who will be assigned by the government. From the second year onwards, the project will be implemented by the National Project Director under the guidance of the BOBP.

The Project will institute consultations with the local authorities to prepare detailed project activities and a timeframe, coordination mechanisms and other matters concerned with project implementation.

There is need to involve resource-users in the development and management planning process to ensure integration of bottom-up approaches in the Project. It is essential, therefore, to include representatives of community organizations and NGOs in the Steering Committee to be formed for the monitoring and supervision of the Project activities.

Guidelines for preparing a profile of fishing communities and conducting in-depth studies

Collect socioeconomic data (e.g. family structure, incomes, subsidiary occupations, educational attainment, mobility, marketing, access to credit, gender-specific social and economic roles).

Prepare an inventory of craft and gear (e.g. types and number of gear, boats, equipment), fishing seasons, fishing grounds, etc.

Examine relevant legislation and institutions (e.g. existing laws, regulations, local management rules, etc.).

Prepare profiles of community organizations, NGOs etc. and an inventory of target groups.

Conduct subsectoral analysis on assessments of the environmental impacts of various coastal activities, such as mangrove deforestation and water management in reserved forests, in order to make recommendations for the improvement of degraded coastal zones and environments.

Plan and implement gradual withdrawal of the Estuarine Set Bagnet (ESBN). As a first step, area and seasonal closures to be planned during the peak recruitment period of penaeid shrimp, *i.e.* July to September and February to April, at Cox's Bazar.

Design and pilot test an information system for catch and effort assessment, stock assessment and monitoring for management purposes.

Hold workshops to discuss the profiles compiled, the findings of in-depth studies, management plans designed for the ESBN and relocation programmes for the displaced fishermen (it is estimated that around 50,000 fishermen are engaged in this fishery).

5. DONOR INPUTS

International experts

Team Leader (Fisheries Management)	12 m/m
Stock assessment	12 m/m

National consultants

(a) National coordinator * (Fisheries management)	24 m/m
(b) Stock assessment	36 m/m
(c) Socioeconomics	24 m/m
(d) Legislation	12 m/m
(e) Community development	6 m/m

*National Project Director on deputation from the DOE

Provision will be made for the following components:

Travel: Official travel by project staff within the country.

Contracts: Several contracts to be issued for conducting in-depth studies and compilation of profiles of fishing communities.

Equipment: Provision to be made for purchase of a vehicle, computer/printer and photocopying machine.

General operating expenses: The budget to include project operation costs.

Training: Costs involved in organizing workshops of various disciplines.

6. GOVERNMENT INPUTS

Details of government inputs will be worked out at a later stage. The government will ensure that counterpart staff will be provided on a full-time basis to assist the Project in the fields of stock assessment, statistics, fisheries management, socioeconomics and extension training.

7. BUDGET

International experts		**U S $**
Team Leader (Fisheries Management)	12 m/m	180,000
Stock assessment	12 m/m	120,000
National expert consultants		
National Coordinator (Fisheries Management)	24 m/m	48,000
Stock assessment	36 m/m	72,000
Socioeconomics	24 m/m	48,000
Legislation	12 m/m	24,000
Community development	6m/m	12.000
Travel		15,000
Contracts		20,000
Equipment		150,000
General operating expenses		15,000
Training		40,000
Grand total		744,000

PROJECT PROPOSAL FOR TECHNICAL ASSISTANCE

Project Title	:	**Establishment of Fish Sanctuaries and Ban on Fishing for Juvenile Fish** ***(Hilsa jatka)***
Implementing Agency		BOBP of FAO/UN
Project Locations		To be determined
Project Duration		Five years (Phase I)
Estimated Starting Date		January 1997
GoB Contribution		**us $ 150,000**
Donor Contribution		US $ 1 million

A TECHNICAL ASSISTANCE (TA) PROPOSAL

1. INTRODUCTION AND RATIONALE

Bangladesh has carried out extensive water and land remodelling efforts which have drastically changed the country's water- and landscapes. The remodelling efforts are necessary to mitigate the destructive forces of voluminous water. But they alter and modify the natural wild habitats and ecosystems of the terrestrial and aquatic fauna and flora. To minimise any adverse impact arising from water and land remodelling activities, bioreserves and sanctuaries are clearly called for to protect and conserve these ecosystems and habitats and the living resources they contain.

Past economic, agricultural and industrial development in harnessing natural resources, in general, and fisheries development, in particular, have overlooked the importance and necessity of resource conservation and management. In addition, it was still thought to be a luxury to be concerned with such matters in the face of widespread poverty and hunger and the more pressing need to meet the basic needs of a rapidly spiralling population.

Further, the conservation and management of natural resources has also steadily been taken over and concentrated in the hands of Government. In the past, such functions, responsibilities and authorities were vested in the hands of the chieftain or community head, such community-based management systems having evolved at the local or grassroots level. The community, under the supervision and direction of the community leader, was actively involved in the management of the resources they relied on for sustenance and livelihood security. Such functions, responsibilities and authority, however, slowly changed hands and are now vested with Government.

In forestry and agriculture, forest reserves and land reservations were established long ago simply to protect and conserve these resources from human encroachment and kept them in virgin condition for future use. Agricultural zoning was likewise introduced to allocate use of land resources according to land use capability. However, for fisheries, such practices as bioreserves and sanctuaries were not employed as resource conservation and protection measures.

2. DESCRIPTION OF FISHERIES AND PROBLEMS

There is considerable overfishing of broodstock, mainly of major carp species, especially during the low water level in the winter/summer months and while they are in their spawning grounds, because they congregate together. As a result, they are more vulnerable to fishing effort. The high mortality of the broodstock, before they have a chance to spawn, reduces their abundance in the succeeding year, thereby reducing recruitment and, thus, overall production. In some cases, this has contributed locally to the near extinction of certain species. There is, thus, an urgent need to protect the broodstock of these major carp by establishing fish sanctuaries and bioreserves in the breeding and spawning grounds.

The ***hilsa*** fishery is also of strategic importance to Bangladesh's food supply, as this single species contributes a third of the country's total fish production. Currently, there is massive harvesting of juvenile ***Hilsa,*** or ***Jatka,*** while they are migrating down rivers to the sea in February-May each year. If these juveniles are allowed to mature, at least to first breeding, the total catch of adult ***Hilsa*** could be expected to increase. There is thus an urgent need to impose a complete ban on ***jatka*** fishing in the major riverine downstream migration routes from February to May.

3. REVZEW AND EVALUATION OF PAST EXPERIENCE

In the area of environment and natural resources management, reviews have been undertaken of Flood Control Drainage/Irrigation (FCD/I) impacts on fisheries, by the Master Plan Organization (MPO), Bangladesh Centre for Advanced Studies (BCAS), with the support of the International Union for the Conservation of Nature (IUCN). More recently, reviews have been undertaken by several of the 26 Flood Action Plan (FAP) projects. The general conclusion has been that the FCD/I structures and their operations have had a negative effect on the floodplain fisheries of Bangladesh through interference in fish life cycles and contraction of the flooded hectarage because specific fisheries criteria have not been incorporated into the projects at the design stage. As a result, the natural recruitment of the floodplain fisheries has been adversely curtailed.

FCD/I projects have, in turn, led to massive floodplain deforestation due to clearing of land for rice monoculture. A review of water quality problems, caused by pesticides, agricultural and industrial effluents and municipal sewage, was carried out by BCAS/IUCN. The review identified severe problems which were not being effectively addressed by the GOB programmes.

A review of the New Fisheries Management Policy (NFMP) was carried out by BCAS with Ford Foundation support. The review indicated that NFMP had positive impacts and was successful in meeting most of its objectives.

4. SITUATION ANALYSIS AND NEEDS ASSESSMENT

Both the MPO and FAP have carried out (or are currently carrying out) situation analysis and needs assessment in the area of environmental protection and natural resources management. The planning processes in the 26 FAPs have not yet been completed, so it would be premature to present their results at this juncture. However, it would seem safe to predict that there will be a strong recommendation that a major reorientation of FCD/I projects will be needed to include fisheries criteria, both in the modification of existing FCD/I projects and in the design of planned FCD/I projects, particularly in the construction and installation of fish-unfriendly structures. Complete needs assessment of other environmental resource-impairing problems identified (floodplain deforestation, pesticides, industrial effluent, municipal sewage) have not been carried out.

5. POLICY DIALOGUE

The international donor community, in particular the United Nations Development Programme (UNDP), has played a major role in supporting and coordinating the FAP programme, but not in the other four environmental issues identified. In the inland fisheries subsector, UNDP support has focused on general institutional capacity-building and strengthening of the DOF (although this has not focused on fisheries management per se) and on massive floodplain stocking (a programme which is both experimental and untested, as well as controversial in some of its aspects).

The international donor community has played little or no role in supporting the implementation of the New Fisheries Management Policy (NFMP), or any other programmes in conventional fisheries management. They have largely contracted their intervention in capital infrastructure investments (hardware) relative to management (software).

6. FISH SANCTUARIES AND BIORESERVES

The establishment of fish sanctuaries and bioreserves as well as the participatory/consultative enforcement of a phase-by-phase ban on fishing for *jatka* and other juvenile fish of economical or commercial importance will go a long way toward sustaining the fisheries in Bangladesh. Under the proposed scheme of participatory/consultative management of such fisheries, the fishing communities and other stakeholders are brought into the decision-making processes to determine the structure and mechanisms of the management regime.

7. OBJECTIVES, STRATEGY AND PROGRAMMES

In the areas of environment and natural resource management, the GOB objectives, as described in the Fifth Five-Year Plan , are:

— To enhance fish production and management techniques and methods.

— To improve general environment and public health.

The major policies and strategies being adopted by the GOB to achieve these objectives are:

— Biological management of *jalmahals,* by providing fishing rights to genuine fishers and replacement of the existing leasing system.

- Largescale stocking of inland open waters inundating floodplains, with rigid enforcement of fish and fish habitat conservation practices.
- An integrated community-based development and management approach for artisanal fisheries, providing improvements in technology, processing, marketing and distribution facilities.
- Formulation and implementation of a well-defined land/water-use policy which will avoid wasteful multiresource use conflicts, introduce effective measures against dumping of industrial and other wastes into the open water system, and ban the use of agricultural biocides of long residual effects.

A comprehensive national programme for environment and natural resource management for the fisheries sector, fully integrated with other relevant economic sectors, does not exist at present. Various aspects of such a programme are being produced by the FAPs and a number of initiatives have been taken by the DOF and other agencies. It is suggested that a national multisectoral programme be prepared to tackle such multisectoral development and management complexity.

8. ZNSTZTUTZONAL FRAMEWORK AND CAPACITY CONSTRAINTS

In the area of environment and natural resource management, an important institutional constraint is the redefinition of roles, functions and responsibilities of some GOB agencies. Their current roles and responsibilities are targeted more toward revenue collection and uni-sectoral control, while there may be a need to shift the emphasis towards relaxation of revenue collection, from the economically weaker and the poorer segments of society, and increasing technical support.

9. ROLE OF EXTERNAL COOPERATION

External support for the environmental and natural resource management, being addressed by the (FAP), is derived from different multilateral and bilateral sources. Other identified environmental and natural resource management issues, such as institutionalising management reforms, have not received adequate external support, Government of Bangladesh resources are hardly adequate to begin to address such issues. External support is still required for such intervention. A possible source of assistance is from the Global Environmental Fund (GEF).

10. PROGRAMME SUPPORT ELEMENTS

The development objective is the rehabilitation and enhancement of living aquatic and fisheries environments in Bangladesh and the conservation and protection of natural fish stocks. These objectives are in line with the stated objectives of the Fifth Five-Year Plan. The proposed programmes would strengthen the DOFs capacity to both carry out fisheries management and to support community-based management carried out by the fishing communities and stakeholders. It would also initiate collaboration between various ministries (specifically, the Ministries of Water, Land and Forestry) involved with the maintenance and repair of environmental quality and ensure that these ministries incorporate fisheries criteria into their development planning.

11. NATURAL RESOURCE MANAGEMENT

Fish sanctuaries project

Under the proposed fish sanctuaries project, **the immediate objectives** are as follows:

- Identify key locations of all major critical broodstock, particularly their wintering and breeding/ spawning sites.
- Devise appropriate structural measures to reduce fishing effort to an acceptable level, and/or eliminate it entirely, if feasible, in fish sanctuaries.
- Educate the local fishing communities as to the need for, and benefits of, the establishment of fish sanctuaries/bioreserves, and devise non-structural measures based on community participation and management to protect and conserve fisheries resources in the fish sanctuaries/bioreserves, supported by DOF surveillance.
- Formulate an operational plan and implement it.

The jatka *project*

Under the proposed *jatka* fishing ban project, **the immediate objectives are** as follows:

- Establish, through field surveys, the downstream migration patterns of juvenile *Hilsa* and the characteristics and level of fishing mortality inflicted upon them.
- Educate the local fishing communities as to the need for, and benefits of, the establishment of a phase-by-phase ban on *jatka* fishing and devise non-structural measures based on community participation and management to enforce the ban.
- Support community-based participation in the *jatka* ban with DOF enforcement capability, based on a monitoring, control and surveillance (MCS) programme for all major rivers and important secondary rivers during the *jatka* season.

12. OUTPUTS

Fish sanctuary project

The expected outputs of the fish sanctuaries and bioreserves projects would include a comprehensive geographical information base on all major critical broodstock's wintering and breeding sites. Effective structural measures (DOF-protected *katha,* concrete and metal gear-fouling structures) would be constructed to act as 'sleeping fish guards' in the declared sanctuary/bioreserve areas. Successful empowerment of local fishers and stakeholders with tenure to protect the broodstocks would enhance the effectiveness of structural measures, as would the support of community-based management by DOF surveillance using trained fish guards.

The jatka *project*

The expected outputs of the *jatka* fishing ban project are a comprehensive report on the migration pattern of *jatka* and a tactical information base on the deployment of fishing gear-fouling structures in all large and important secondary rivers. Awareness-building among all fishers and stakeholders could result in their acceptance of the ban and inclusion in the DOF MCS efforts. The DOF would operate its own MCS system to enforce the *jatka* ban.

13. ACTIVITIES

Fish sanctuaries project

To achieve the objectives of the fish sanctuaries and bioreserves programme, the Department of Fisheries (DOF) would need to establish a planning- and management-dedicated unit to carry out the necessary field studies to identify all possible localities (breeding and spawning grounds) requiring sanctuary status. In order to win their support and participation, rural fishers would have to be educated as to the need, purpose and benefits they would derive from the establishment and enforcement of the sanctuaries. Pilot projects would need to be carried out to test the effectiveness of different structural measures and their patterns of deployment. The DOF fish guards would need to be trained to carry out monitoring and surveillance activities and to assist the local fishing communities in enforcement.

The jatka *project*

The *jatka* fishing ban project activity would require a comprehensive field study over several *jatka* seasons (February to May) to collect the required information on *jatka* migration and fishing effort. Considerable historical data collected by the Bangladesh Fisheries Resources Survey (BFRSS), Fisheries Research Institute (FRI) and experienced DOF field officers should also be collated and analyzed to add a historic dimension to the database. An education programme should be carried out to educate *jutka* fishers as to the need for the ban and the greater benefit they can expect in harvesting adult *Hilsa.* A process for incorporating fishers and other stakeholders into a DOF-operated *Hilsa jatka* MCS system should be developed. The DOF should be equipped with appropriate and sufficient speedboats to carry out effective and comprehensive MCS activities, including enforcement of the fishing ban during the *jatka* season.

Specific activities

More specifically, the activities should include the following:

AWARENESS BUILDING IN INDUCING BEHAVIOURAL CHANGES

A sustained, comprehensive awareness-building campaign and educational programme should be carried out among all possible stakeholders in the concerned fisheries to create and build awareness and educate them on the need, value as well as benefits of fish sanctuaries or bioreserves, including techniques and methods of sanctuary operations and management. This activity will reach down to the school level, including rural youths, employed or unemployed. In this connection, appropriate revision of school curriculum will be made, subject to the local situation and requirements.

The entire fish marketing chain, from the fisherfolk to the final consumers, will be addressed along these lines, because educating fisherfolk alone will not be effective so long as housewives and consumers are willing to buy and pay for undersized or juvenile fish. Similarly, the middlepersons who market and distribute such fish have to be made aware that they should not promote the sale of such fish. Both the middlepersons and consumers, by their willingness to buy undersized fish, are giving fisher-folk the incentive to continue catching undersized fish.

SETTING UP NATIONAL, *THANA,* UNION AND DIVISION MANAGEMENT COMMITTEES.

A multi-tiered system of sanctuary operation and management mechanism is needed to encourage a participatory and consultative community-based management system.

BAN ON FISHING OF JUVENILE FISH

As the jatka fishing season lasts from February to May each year, a ban should be imposed on such fisheries during its run. In the initial stage, the ban will cover only *jatka* fishing. As experience and lessons are accumulated from the ban on *jatku* fishing, a ban can be extended to other commercially important species.

14. INPUTS

International donor inputs required for the fish sanctuaries programme would include equipment to carry out field studies, re-engineering and water/land re-modelling design, and development of fishing gear-fouling structures, awareness-building education programmes in both rural and urban areas, training of fish guards and provision of patrol speedboats. A nationwide programme is projected to cost US $ 600,000.

Inputs required for the jatka fishing ban project would include equipment to carry out field studies, awareness-building education programmes in rural and urban areas, and provision of patrol speedboats. A nationwide programme is estimated to cost US $ 400,000.

15. RISK AND ASSUMPTIONS

Government commitments are critical in the successful implementation of the proposed projects, especially in terms of timely government financial outlay and human resources. Close coordination between and among, the different GOB agencies is necessary and inter-ministry tensions and rivalries must be kept to a minimum. Officials should not work at cross-purposes, undermining efforts initiated by one ministry at the expense of the overall objective of the proposed project initiatives.

Competent international and local staff should be recruited to implement the projects.

Government should be willing and committed to begin sharing and decentralising limited fisheries management responsibility and authority with the fisherfolk and other fisheries stakeholders on an experimental or trial basis.

Prior Obligations and Prerequisites

See above

Implementation Arrangements

To be worked out after the initial field survey.

Management and Coordination

To be worked out after the initial field survey.

16. MONITORING AND EVALUATION

Accountability and transparency in the delivery of project outputs and performance of the project, including regular staff performance appraisal, will be built into the project implementation mechanism. The LogFrame model will be closely applied to establish project monitoring and evaluation activities. Microsoft software package is a good example of building-in such accountability in project performance and quality of project inputs delivered.

17. ESTIMATED PROJECT COSTS

Fish Sanctuary and Bioreserve Project

PROPOSED BUDGET

The overall contribution of US $ 600,000 will be requested from interested international donors. The budget breakdown is as follows:

Donor contribution	*Thousand US $*
Field studies and planning	100,000
Engineering works	100,000
Community education	150,000
Training of fish guards	50,000
Boats, engines, operation and maintenance	200,000
Total	600,000
Government contribution	75,000

Jatka *Fishing Ban Project*

PROPOSED BUDGET

The overall contribution of US $ 400,000 would be requested from interested international donors. The budget breakdown is as follows:

Donor contribution	*Thousand US $*
Field studies and planning	-
Community education	150,000
Training of fish guards	50,000
Boats, engines, operation and maintenance	200,000
Total	400,000
Government contribution	75,000

18. RESPONSZBZLZTY FOR DETAZLED PROJECT PREPARATION

Detailed project formulation would require extensive and comprehensive field site visits to existing critical wintering and spawning grounds and preparation of a complete biological, ecological, sociological and economic profile of the existing situation and potential for project implementation. A special task force will review this basic study. The task force will include representatives from various fisheries and other government agencies, relevant FAP projects, and individual fisher groups active in the proposed sanctuary and bioreserve areas. The recommendations of the task force will incorporate the detailed project proposal which will be presented to the GOB and the international donor community for consideration. An interactive process will be followed in amending the proposal until a final proposal is agreed on. The entire project formulation process should be completed within a year.

PROJECT PROPOSAL FOR TECHNICAL ASSISTANCE

STRENGTHENING OF COMMERCIAL AND SPECIALIZED FINANCIAL INSTITUTIONS AND NGOS IN BANGLADESH TO ENABLE THEM TO PROVIDE CREDIT TO THE FISHERIES SECTOR

1. BACKGROUND AND GENERAL OBJECTIVES

The proposed project to strengthen commercial and specialized financial institutions and NGOs in Bangladesh, aims at enhancing **national self-reliance and sustainable development** in the field of financially viable and economically beneficial fisheries finance and credit, with the objective of increasing the national economic benefit derived from the fisheries sector.

Particular attention is paid to the improvement of the **living conditions of rural fishing communities,** including women and youth, as well as to **food security** and to the provision of affordable animal protein for human consumption and to the generation of income and employment in rural areas.

The preservation and proper management of aquatic resources and environment has received special consideration within the context of the proposed project. Particular attention is paid to credit requirements for the introduction of community-based fisheries management programmes. This includes credit for the diversification of fishing effort away from over-exploited aquatic species to less exploited ones, to the introduction and expansion of semi-intensive aquaculture, to fisheries and non-fisheries related alternative income-generating economic activities, as well as to the utilization of by-products and waste from traditional fish handling and processing practices, and to the promotion of value-added aquatic products.

The project is part of a **comprehensive programme package** which addresses -- in a coordinated and comprehensive manner -- the major fisheries development issues in Bangladesh, such as the needs of special subsectors, e.g. marine capture fisheries, brackishwater culture fisheries, inlandwater culture fisheries, inlandwater capture fisheries and freshwater culture fisheries, fish marketing and processing, investment, fisheries management, preservation of the aquatic environment, socioeconomic issues and community development.

The fisheries credit components, as well as other components of the proposed fisheries development programme for Bangladesh, have been prepared in the context of a UNDP/FAO Technical Support Services (TSSI) mission. The proposed is fully compatible with the Five-Year Plan, which emphasises increasing flow of credit to the fisheries sector as well as to underprivileged social groups in Bangladesh.

The proposed project takes fully into account earlier assessments, by the World Bank, the Danish International Development Agency and other donor agencies as well as by non-governmental development agencies working in Bangladesh, of the lack of adequate fisheries credit facilities. The constraints of financial institutions with regard to supervised fisheries lending operations are also considered.

2. PRESENT SITUATION, PROJECT STRATEGY AND EXPECTED RESULTS

Present situation

Financial institutions in Bangladesh have been involved in financing the fisheries sector on a very modest scale and the achievements in terms of loan disbursements and loan recoveries have not been encouraging. This has been due to, among other things, lack of collateral in the small- and medium-scale fisheries sector and the lack of capacity of the financial institutions to carry out supervised credit operations. They follow inappropriate lending procedures in appraising loan applications and monitoring loan use.

From 1985 onwards, loan disbursements to the fisheries sector have been steadily declining while loan recovery has been deteriorating. An inadequate flow of credit has become a serious obstacle to the implementation of major investment projects of the World Bank and the Asian Development Bank. It has also prevented entrepreneurs and members of traditional fishing communities from taking full advantage of technical assistance projects and investment opportunities identified by them. At the same time, a shift of emphasis has taken place from medium-term financing of small- and medium-scale rural aquaculture and capture fisheries to short-term financing of export of shrimp.

As far as the role of **non-institutional financial intermediaries** and of non-governmental organizations is concerned, the provision of credit has been limited to traditional small-scale fisheries activities and, in most cases, only short-term credit requirements are being met. The amounts available for lending are relatively small.

In the case of **non-governmental organizations,** fishery credit operations are generally not investment- **and** activity-oriented but are aimed at satisfying the needs of the members of these organizations. The general public normally has no access to these credit facilities. The amounts disbursed so far are small, even when compared to the amounts channelled through commercial and specialized banks.

Non-institutional financial intermediaries, such as **fish traders, middlemen and moneylenders,** usually offer financially unattractive terms and conditions for loans. Loans provided by this segment of the rural financial market consist mainly of short-term capital advances.

3. STRATEGY

The project aims to **strengthen the capacity** of the specialized and commercial financial institutions and NGOs in Bangladesh to carry out fishery credit operations for the traditional small-scale as well as for the modem medium- and large-scale sectors through **technical assistance, training and provision of a credit guarantee fund.**

It is envisaged involving the financial institutions and NGOs in the project in a participatory process through the establishment of an **interbank/NGO fishery credit task force** to be headed by a representative of the Bangladesh Bank. From the beginning of the project the financial institutions will themselves be responsible for, and in charge of, the acquisition of expertise in supervised fisheries lending, development of appropriate lending norms and procedures for the fisheries sector, conduct of feasibility studies, recruitment and training of staff, and establishment and operation of the credit guarantee fund.

It is expected that the financial institutions will expand their fishery credit operations as they acquire more expertise and gain confidence in financially viable fishery credit operations.

Situation Expected at the End of the Project

Financial institutions and NGOs would have **increased** their lending to the fisheries sector in Bangladesh, **improved** their loan recoveries, **employed/trained appropriate staff** to undertake fishery credit operations, developed **linkages with fisheries extension officers** and conducted fishery credit operations on a **financially viable, economically beneficial and ecologically sound** basis.

4. SPECIFIC OBJECTIVES AND ACTZVITZES

Development Objective

The project aims at enabling financial institutions and NGOs in Bangladesh to cater to the short-term and medium credit needs of the fisheries sector in Bangladesh, including the small-scale fisheries sector, and to rural fishing communities, including their women and youth. Financial institutions are to support innovations and productivity increases in culture and capture fisheries and the processing and marketing of fish, the timely replacement of equipment, and the meeting of working capital requirements. Financial institutions are also to support the diversification of fishery effort away from over-exploited resources to less- exploited species and aquaculture, the promotion value-added fish processing, and the introduction of alternative income-generating activities. An adequate supply of credit will ultimately facilitate a higher income and increased economic benefits to fisherfolk and fish farmers, increased supplies of fish, and additional employment opportunities in the fisheries sector and outside it.

Immediate objective

Acquisition of knowledge by financial institutions of reasons for failure of past fisheries credit operations, in terms of loan recovery and loan use with regard to sub-sectors such as freshwater pond culture, brackishwater aquaculture.

ACTIVITY 1

Establishment of Interbank/NGO Fisheries Credit Task Force chaired by Bangladesh Bank and consisting of representatives of Bangladesh Bank, Rajashahi Krishi Bank, Sonali Bank, Janata Bank, Rupali Bank, Agrani Bank and Bangladesh Samabaya Bank, Grameen Bank, BRAC and Department of Fisheries.

TIME: Year 1, first month.

Local Input

Part-time deputation of staff and meeting facilities and administrative expenses.

output

Interbank/NGO Fisheries Credit Task Force established.

ACTIVITY 2

Review of fisheries lending operations by subsectors and financial institutions with regard to appropriateness of lending norms, *viz.* loan amounts, loan disbursement modalities and schedules, loan repayment schedules in view of actual costs, earnings and cash flows. Review of appropriateness of lending procedures, *viz.* identification of borrowers, loan application and appraisal, supervision of loan use, and arrears control.

TIME: Year 1, second and third months.

External Input

— International fisheries credit specialist for two months.

— National rural credit specialist for two months.

output

Evaluation Report of Fisheries Lending Operations of Financial Institutions in Bangladesh.

ACTIVITY 3

Review, finalization and adoption of evaluation report by task force and individual financial institutions/ NGOs.

TIME: year 1, fourth, fifth and sixth months.

output

Identification of past constraints in fisheries lending.

Immediate Objective

Adoption of appropriate fisheries lending policies, norms and procedures by specialized and commercial banks and NGOs in Bangladesh.

ACTIVITY 4

Design of lending policies, identification and financial analysis of investments and activities to be financed (including activities to be carried out by women) design of lending procedures and norms, preparation of lending programmes and disbursement schedules.

TIME: Year 1, seventh and eighth months.

External Input

-- International Fisheries Credit Specialist for two months.
-- National Rural Credit Expert for two months.

output

Appropriate fisheries lending policies, norms procedures and lending programmes for specialized and commercial banks and NGOs in Bangladesh.

ACTIVITY 5

Review, finalization and adoption of fisheries lending policies, norms and procedures by interbank/ NGO task force and by boards of specialized and commercial banks.

TIME: Year 1, ninth and tenth months.

output

Availability of appropriate lending policies, norms, procedures and programmes for the fisheries sector with specialized and commercial banks and NGOs in Bangladesh.

Immediate objectives

Appropriate staffing and training plans and programmes of specialized and commercial banks and NGOs in Bangladesh.

ACTIVITY 6

Identification of staffing and training requirements of specialized and commercial banks/NGOs and fisheries administration, for fisheries credit operations, and of suitable cooperating agencies, such as fisheries extension agencies at NGOs.

TIME: Year 1, eleventh and twelfth months.

External input

— International Fisheries Credit Manpower and Training Expert for one month.

— National Rural Credit Manpower and Training Expert, two months.

output

Fisheries credit staffing and training plans, and programmes and cooperation agreements, for specialized and commercial banks, NGOs and fisheries administration in Bangladesh.

ACTIVITY 7

Review, finalization and adoption of staffing and training plans and cooperation agreements by task force, banks and NGOs.

TIME: Year 2, first and second months.

output

Availability of fisheries credit and training plans and cooperation agreements with banks and NGOs in Bangladesh.

Immediate objectives

Fisheries credit monitoring mechanism in place with banks and NGOs in Bangladesh.

ACTIVITY 8

Design of institution-specific monitoring mechanism for fisheries lending operations, including micro-computer software for monitoring loan recovery.

TIME: Year 2, third and fourth months.

External input

International rural-credit monitoring specialist for one month.

output

Availability of fisheries credit monitoring mechanisms with banks and NGOs in Bangladesh.

ACTIVITY 9

Review, finalization and adoption of fisheries credit monitoring mechanisms by task force banks and by NGOs.

output

Availability of credit monitoring systems with banks and NGOs in Bangladesh.

Immediate objectives

Recruitment of technical officers by banks/NGOs and training of bank/NGO personnel.

ACTIVITY 10

Recruitment, as required, and training of senior- middle- and field-level bank, fisheries and NGO staff.

- Study tours for senior personnel to selected financial institutions running successful fisheries credit programmes in South and Southeast Asia.
- Training of middle-level officers in Asian rural banking training institutes on fisheries credit delivery and recovery.
- In-country training of field level staff.

TIME: Year 2, seventh to twelfth months.

External input

Study tours and foreign training

Local input

In-country training of field staff.

Output

Availability of trained manpower for fisheries credit operations with banks and fisheries administrations in Bangladesh.

immediate objective

Institutional fisheries credit guarantee arrangement.

ACTIVITY 11

Design of credit guarantee fund arrangement.

TIME: Year 3, first month.

External input

International Credit Guarantee Specialist for one month.

Local input

Local Credit Guarantee Specialist for one month.

Output

Fisheries credit guarantee arrangement.

ACTIVITY 12

Review, finalization and adoption of credit guarantee arrangement by task force, individual banks and NGOs in Bangladesh.

TIME: Year 3, second and third months.

output

Availability of fisheries credit guarantee arrangement.

Immediate objective

Implementation and monitoring of need-oriented and financially-viable fisheries credit operations.

ACTIVITY 13

Conduct and monitoring of fisheries lending operations according to newly-introduced fisheries lending policies, norms, procedures and programmes.

TIME: Year 3, fourth to twelfth months.

External input

External contribution to credit guarantee fund.

Local input

Local contribution to credit guarantee fund.

Local input

Funds for fisheries lending.

Output

Availability of financially viable fisheries credit operations in Bangladesh.

E. <u>Summarv of Project Inputs</u>

Donor contribution	US $
Internal personnel: 7 months, including international travel and DSA	105,000
National personnel: 6 months	2 1,000
Local travel	45,000
Training and study tours	125,000
Credit guarantee Fund contribution	340,000
Total	636,000

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PROJECT PROPOSAL FOR TECHNICAL ASSISTANCE

STRENGTHENING OF THE FISHERY EXTENSION SERVICE
OF
THE DEPARTMENT OF FISHERIES,
BANGLADESH

Implementation Agency :	FAO/DOF
Project location	Dhaka
Project duration	5 years
Estimated start date	July '96
Government contribution :	To be determined
Donor contribution	US$ 2,600,000

1. BACKGROUND/JUSTIFICATION

The fisheries sector in Bangladesh is faced with a peculiar dilemma. On the one hand, the fisheries sector is seen as an opportunity to provide the people of Bangladesh with animal protein at a reasonable price, to generate employment and enterprise which, in turn, will alleviate poverty, and to increase production for export to create foreign exchange earnings and contribute to the economy. On the other hand, the fisheries sector faces a crisis. Several fisheries, particularly the inshore marine, estuarine and inland openwater sectors are under stress due to overfishing, environmental and habitat degradation, and uncoordinated multiple use of the water bodies. Inland freshwater aquaculture and coastal aquaculture are facing infrastructural, environmental and socioeconomic hurdles that prevent the processes needed to increase production. The solution lies in facilitating and enabling the fisheries sector to simultaneously increase production and manage fisheries and aquaculture in order to ensure sustainability and profitability

In 1994, the UNDP and FAO worked with the Government of Bangladesh (GoB) to develop a programme proposal for the development of the fisheries sector. This study, which learnt from the situation prevailing in the sector, and from similar exercises undertaken by the World Bank;. proposed several investment and technical assistance projects to develop the sector. However, the success of the effort would largely depend on the capacity of the fisheries sector, in general, and the GoB'S Department of Fisheries. in particular, to absorb and do justice to the investments. **The cutting edge of the DOF is its field staff** who interact with and extend the Government's programmes to the fishers and fish farmers. This project **concept and brief** is **designed to strengthen the Fisheries Extension Service of the Department or Fisheries** to address the tasks of promoting, facilitating and enabling fisheries production and fisheries and aquaculture management to achieve ecological sustainability and economic profitability.

2. PROBLEMS, ISSUES AND OPTIONS

2.1 Freshwater and coastal aquaculture

Bangladesh is endowed with environmental conditions that make aquaculture a very viable sector. It also has a long cultural tradition of aquaculture. The DOF's efforts and knowledge acquired from projects such as the DANIDA-supported effort in Mymensingh and the UNDP/FAO-supported institutional strengthening effort, highlight the following:

- Farmers need technical and managerial skills/knowledge.
- Farmers, particularly the poorer sections, need access to waterbodies at reasonable rates.
- Farmers need access to economically viable credit, without undue collateral requirements.
- There is need to ensure seed supply that is not dependent on wild stocks.
- There is need to ensure feed supply.
- The infrastructure needs to be developed to facilitate sustainable aquaculture, particularly for water quality management and effluent management.
- The siting of aquaculture needs to be regulated and rationalized, keeping environmental and social factors in mind.
- The aquaculture sector needs to be managed through the development of appropriate legislation and regulations.
- Regulations and laws need to be enforced.
- The sector needs to be closely monitored and studied to ensure its further development.

2.2 Inland and marine capture fisheries

Capture fisheries, primarily in inland waterbodies, and increasingly in the marine waters, provide the bulk of Bangladesh's fish production. A combination of overfishing, destructive fishing, modification of fish habitats by other developments, and pollution of waters has led to a crisis in the sector. While opportunities of tapping under-tapped and untapped species exist, the real problem facing the sector **is to manage** fisheries to ensure biological sustainability and economic profitability. The DOF's efforts and the efforts of FAO and BOB-FAO supported efforts have generated knowledge that highlights the problems and needs of the sector. It is necessary to:

- Ensure that fish habitats are not adversely affected by developmental efforts of other sectors and by land-based and sea-based pollution.
- Reduce fishing capacity and effort and, in particular, reduce or eliminate destructive fisheries.
- Build awareness amongst all stakeholders of the need for, the benefits, and methods of fisheries management.
- Encourage and facilitate the availability of alternative income options to take fishers out of fisheries and to reduce the stress on fisheries.
- Manage fisheries.
- Identify under- and untapped species and promote their exploitation in a managed and sustainable manner.

— Develop markets and change customer-demand patterns to facilitate management of fisheries.

— Provide economically viable credit with reasonable collateral requirements.

— Build the capacity of fishers to develop necessary skills/knowledge.

— Develop infrastructure.

— Manage the fisheries sector through appropriate legislation and regulations.

— Enforce regulations and laws.

— Closely monitor and study the fisheries situation to guide its development.

2.3 Issues

(1) The DOF's task is to regulate and manage the fisheries sector to meet national and sectoral plans and objectives. So, its primary task is to guide and **promote change,** facilitate it **to monitor** the sector, **enforce laws** and regulations to ensure the sector's sustainability, and, through **research,** guide and direct its future directions. Looked at in this way, the task **of the DOF is mostly extension facilitation and enforcement.** A national workshop on fisheries extension organized by MOFL/DOF in 1992 identified these as the primary tasks of the DOF and of its extension service.

(2) Extension staff, in this case all DOF staff at *zilla* and thana levels, are the only staff of DOF that most fishers and fish farmers ever meet and interact with. Their performance determines the performance of the DOF

(3) The number of extension staff available at the *zilla* and thana levels is limited and inadequate and the GoB may not be able to add to its staff strength in the immediate future.

(4) The DOF and the 'revenue' staff at *zilla* and thana levels lack resources in terms of operational budgets and transportation.

(5) The DOF staff at *zilla* and thana levels have inadequate skills and knowledge to address the task at hand, as described in the sections above. This requires them to have:

— Technical skills in aquaculture and capture fisheries.

— Technical skills in fisheries management.

— Skills and abilities to rapidly get to know the community, its needs and dynamics.

— Skills to build rapport with the community and earn its confidence.

— Skills to communicate.

— Skills to facilitate consultations and mediate negotiations.

— Skills and the necessary support from DOF/FRI/other agencies to provide knowledge and skills to fishers and farmers.

— Training skills.

— Skills and the organizational structures to facilitate access to credit.

Most of these skills are of a non-technical nature.

(6) The experience of DANIDA, UNDP/FAO and BOB/FAO efforts convincingly show that it is possible to build in such skills in a very short time and at low cost. However, they also suggest that without the appropriate managerial environment in the DOF, such efforts are very difficult to sustain. Without organizational change and development,- technical assistance benefits may be difficult to absorb and sustain. The problems are several:

- The mandate of the DOF is not translated to locale specific situations and needs to generate clear mandates, workplans and output specifications at the *thana/zilla* levels.
- Staff at the *thana/zilla* level are generalists with little or no opportunities to upgrade their skills.
- Training and experience generated is often wasted due to transfers and shifts from division to division.
- There is little team orientation and little or no backstopping to support field staff.
- There is no incentive for excellence because of lack of performance-orientation in the DOF.

However, both the DOF and experience of development projects have shown that *thana/zilla* staff are capable and, with some training, support and appropriate management environments, can do an excellent job.

3. PROJECT STZ?ATEGY

(1) Enhance the skills/knowledge levels of *thana/zilla* staff to be able to better undertake their tasks.

(2) Minimum staff increases, possibly only to create an in-house training section.

(3) Enhance the skills/knowledge of Division and HQs staff of DOF to better manage, plan and support extension staff and extension activities.

(4) Only undertake tasks that cannot be done by fisheries and private sector.

(5) Use resources of private sector and NGOs wherever possible.

(6) Reduce efforts/costs by transferring management and enforcement responsibilities to fishers and other stakeholders through participation, management approaches.

(7) Give short-term on-job training to reduce disruption of work. All training to follow workcycles to enable staff to use their skills as they learn them.

(8) Raise organizational development needs by careful analysis of project and its learnings, to promote such changes.

4 . DEVELOPMENT OBJECTIVES

The development objectives of the project are to help alleviate rural poverty, by generating employment and income from fisheries and aquaculture, and to promote and facilitate management of fisheries and aquaculture to ensure sustainability of resources.

The project is designed to help achieve the objectives of the fisheries sector of the government's national plan and to build the capacity of the Department of Fisheries to be able to absorb and utilize support received in areas identified as priority by sector studies.

The project will strengthen and build the capacity of the extension staff of the Department of Fisheries, based on the leamings of the DANIDA Mymensingh Extension Project, the FAO/UNDP Institutional Strengthening of the Fisheries Sector Project, and the BOB-FAO programme.

5. *IMMEDIATE OBJECTIVES*

1. Strengthen the Fisheries Extension Service of the Department of Fisheries to facilitate and enable the promotion of aquaculture in a sustainable and equitable manner.

2 Strengthen the Fisheries Extension Service of the Department of Fisheries to facilitate and enable participatory fisheries management.

3. Establish a Training and HRD section with the DOF to train and continuously upgrade staff capacity to undertake the objectives of the DOE

6. *EXPECTED OUTPUTS*

I. Establishment of a Fishery Extension Service of the DOF consisting of all *zilla/thana* level staff with appropriate backstopping mechanisms at Division and Headquarters levels.

2. Development of training packages, materials, manuals, for all thana/zilla-level staff, on extension methodology, communication, extension management, consultation/ negotiation and awareness-building.

3. Development of training packages, materials, manuals, for all thana/zilla level staff of the DOF, on technical aspects of aquaculture and fisheries management.

4. Establishment of a Training and HRD section at Headquarters-level with cells at Divisional-levels.

5. Training of all DOF staff at thana/zilla level in areas described in Output 2 and in Output 3, as required.

6. Orientation and training of senior staff at Division- and Headquarters-level on extension management.

7. Training of fishers and fish farmers in aquaculture and fisheries initiated and undertaken in a graded.

8. Consultations and negotiations facilitated and mediated to promote participatory fisheries management amongst all stakeholders.

9. Knowledge generated to facilitate and enable organizational development of the DOF in order to improve the managerial environment.

7. WORK PLAN

The duration of the project will be five years. The project will have its headquarters in the DOF, Dhaka, and will have cells at Division Headquarters. The FRI will be a collaborating agency.

The project will be nationally executed, with the advisory support and technical assistance of the FAO. The project will be headed by an externally-recruited Extension/Training Adviser who will ensure that the leadership and management of the Project is handed over to a trained national staff by the third year of operation.

The Extension/Training adviser and his/her national counterpart shall, in consultation with the relevant authorities, evolve the detailed workplans/approaches as dictated by real needs ascertained by the activities of the project.

The first task of the project would be to identify a core team of trainers who will evolve training packages in the process of training and leading the DOF staff through the implementation of the training's learnings.

8. INPUTS

DONOR INPUTS

- International advisor/coordinator 36 m/m
- National consultants/contractual services for training of trainers, core training team, studies, materials development.
- Travel of project staf within country.
- Equipment to facilitate training, media material, equipment, vehicles (2), computer/printer, photo-copying machine.
- Training expenses
- Materials development and production expenses.

GOVERNMENT INPUTS

Full time (revenue) staffing to build core training/HRD team at Headquarters plus cells at Division Headquarters. Rest to be determined.

10. BUDGET (ESTIMATE)

	US $
International advisor	500,000
National consultants plus contractual services	250,000
Travel	250,000
General operation expenses	150,000
Equipment	200,000
Training	1,000,000
Materials production	250,000
Total	2,600,000

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