CASE STUDY 2:
FARMING CARPS IN LEASED PONDS BY GROUPS IN CHANDPUR, BANGLADESH

A. Background

1. Scope and Purpose

1. This case study was undertaken as part of an Asian Development Bank (ADB) special evaluation study on small-scale freshwater rural aquaculture development. The study used primary and secondary data and published information to document the human, social, natural, physical, and financial capital available to poor people involved in the production and consumption of freshwater farmed fish and to identify channels through which the poor can benefit, such as through access to livelihood assets, markets and prices, access to services and facilities, and key institutions and processes.[1]

2. The study is based on a part of the small-scale fisheries development component of the ADB-financed Command Area Development Project (CADP).[2] This project had 3 parts: (i) to develop on-farm field irrigation channels, improve the existing water distribution and drainage systems, and provide minor flood protection in the Pabna irrigation system in Pabna District and in the Meghna-Dhonagoda irrigation system (MDIS) in Chandpur District; (ii) promotion of integrated pest management to reduce the use of chemical pesticides through training of trainers, extension services to farmers, and demonstration of alternative cropping practices; and (iii) small-scale fisheries and aquaculture development within the irrigation command areas through extension services, organizational and management development support, and credit inputs to initiate small-scale freshwater aquaculture, primarily in small ponds, for the poor. The two irrigation systems were earlier developed and financed by ADB.[3] This case study focuses on small-scale freshwater aquaculture development in Matlab, an *upazila*[4] in the MDIS area.

2. Relevance

3. **Poverty Incidence.** The MDIS area had a population of 139,900 people in 1995 and poverty incidence a little higher than the national level, at 50%. Poverty among the landless was much higher, 74%. According to the project benchmark survey in 1997, 34% of the households were landless at that time, 43% owned less than 0.4 hectares (ha) of land, 16% had landholdings of 0.4–1.0 ha, and 7% had more than 1 ha of land.[5]

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[1] N. Ahmed led a survey of fish farming groups in Matlab, Chandpur. N. Ahmed, N. Bestari, P. Edwards, B. Katon, and R. Pullin collaborated on the methodology, information analyses, and preparation of this report.

[2] ADB. 1995. *Report and Recommendation of the President to the Board of Directors on a Proposed Loan to the People's Republic of Bangladesh for the Command Area Development Project*. Manila. (Loan 1399-BAN(SF): *Command Area Development Project*, for $30 million, approved on 7 November 1995.) The project was originally designed for implementation over 5 years, and the loan closing date was extended for 2 years from 30 June 2001 to 30 June 2003.

[3] ADB. 1977. *Report and Recommendation of the President to the Board of Directors on a Proposed Loan to the People's Republic of Bangladesh for the Meghna-Dhonagoda Irrigation Project*. Manila. (Loan 333-BAN[SF]: *Meghna-Dhonagoda Irrigation Project,* for $24 million, approved on 15 December 1977 and closed on 30 June 1989.); and ADB. 1978. *Report and Recommendation of the President to the Board of Directors on a Proposed Loan to the People's Republic of Bangladesh for the Pabna Irrigation and Rural Development Project*. Manila. (Loan 378-BAN[SF]: *Pabna Irrigation and Rural Development Project,* for $38 million, approved on 12 December 1978 and closed on 31 December 1992.)

[4] An *upazila* is an administrative government unit consisting of unions, each of which consists of villages.

[5] The unit of account for land in Bangladesh is commonly expressed in *decimals*. 1 acre of land = 100 *decimals*; 1 hectare (ha) = 2.47 acres.

4. **Mitigating the Loss of Capture Fisheries.** The small-scale freshwater aquaculture development component was designed to compensate for the decline of fisheries that accompanied the construction of flood embankments in the past. The CADP, in collaboration with the Department of Fisheries (DOF), promoted a semi-intensive fishpond culture in Matlab by adapting the increasingly popular carp polyculture farming system, which uses a mixture of endemic and alien carp species.[6] In practice, this system has not varied much in Bangladesh, except for differences in fish seed[7] stocking density, maintenance, harvesting schedules, and the types of ponds used, namely rainfed seasonal ponds and perennial ponds.[8] DOF promoted carp polyculture nationwide through many aquaculture development projects, including a component of the ADB-financed Second Aquaculture Development Project (implemented during 1988–1997), by establishing demonstration fishponds and promoting dissemination of fish farming technology in 22 districts including Chandpur.[9]

5. **Establishing Groups of Fish Farmers.** In November 1999, DOF engaged a nongovernment organization (NGO), the Voluntary Organization for Social Development (VOSD), to develop the capacity of the poor in Matlab Upazila through fish farming.[10] The approach taken was to (i) organize the poor, primarily women, into groups of 10–15; (ii) equip these groups with fish farming techniques and skills by training and extension; (iii) provide the groups with access to ponds by leasing private ponds; and (iv) provide the groups with microcredit and savings facilities. The selection criteria gave preference to women and marginal and landless farmers with land of less than 0.2 ha. Other criteria included unemployment, irregular employment, and people with limited access to cultivable land. The group formation took about 6 months. The project established 175 groups during 2000–2001, comprising 2,590 members including 2,440 women in 165 groups in 14 unions covering 77 villages in Matlab Upazila. Typically, each group acquired access to several fishponds

A group of women and their leased fishpond

[6] Popular endemic species include catla (*Catla catla*), rohu (*Labeo rohita*), and mrigal (*Cirrhinus mrigala*); and exotic species include silver carp (*Hypophthalmichthys molitrix*), grass carp (*Ctenopharyngodon idella*), and common carp (*Cyprinus carpio*).

[7] In Bangladesh, fish fry are defined as juvenile fish, larger than newly hatched fish (locally known as hatchlings) but smaller than fingerlings, which are defined as juvenile fish normally longer than 2.5 cm.

[8] The fish culture typically requires (i) a stocking density of about 10,000 fingerlings per hectare, with fingerlings of up to about 12 cm long; (ii) pond fertilization using inorganic fertilizers, such as urea and triple superphosphate and manure (chicken manure and cow manure); and (iii) supplementary feeding using rice bran, wheat bran, and mustard oil cake. With perennial ponds, multiple stocking and harvests throughout the year are feasible. When a high density of fish is stocked initially, partial harvests at intervals allow thinning of the fish population to optimize biomass production of fish.

[9] ADB. 2002. *Project Performance Audit Report on the Second Aquaculture Development Project in Bangladesh.* Manila. A total of 1,498 demonstration ponds were established in 22 districts. Dissemination of fish culture techniques benefited small farmers. The social structure in the villages helped to spread the introduced technology. Visits to demonstration ponds were made possible through neighbors, friends, relatives and local contacts.

[10] VOSD was awarded a contract of Tk5.93 million for the period 30 November 1999–30 November 2001, a contract extension of Tk2.20 million for 1 December 2001–30 June 2002, and another contract extension of Tk1.46 million for 1 July 2002–30 June 2003. These contracts covered the costs of training, group formation, other capacity-building initiatives, and the operating costs of VOSD staff.

covering a total of 1 ha of water surface. The lease value of the ponds was Tk25,000–30,000/ha annually, with leases of 1–5 years. Overall, VOSD helped the groups to gain livelihood assets: (i) skills, personal motivation, and confidence; (ii) organizational development and group formation; (iii) ponds leased from individuals or multiple owners[11] with tenure rights; (iv) access to markets; and (v) financial capital through microfinance services.


Microcredit recipients

6. **Providing Microcredit to the Poor.** The groups were new, with no previous access to alternative and affordable credit sources. Their own resources were limited and their assets, including savings, were not adequate to meet the investment and operating costs of fish farming. VOSD provided the groups with credit for working capital, with a limit of Tk50,000 per group. In all, Tk8.75 million were disbursed to the groups, who used the funds to pay for fish seed, feed, fertilizers, and hired labor for pond preparation and harvesting. The group members paid for the costs of pond leases, using their savings and proceeds from the sales of household assets. The credit facility did not require any collateral. Credit delivery began in early 2001. The credit terms were for 12 months, with an interest rate of 15% for the year and equal quarterly repayments of loan principal. Interest charges were calculated on the declining balance of the loan principal. In practice, the repayment terms were flexible and not strictly bound by the requirement for equal quarterly repayments. The group members each were required to save a minimum of Tk5/week. In September 2003, DOF renewed its agreement with VOSD for the operation of the credit facility on a revolving basis for 5 more years.

7. VOSD obtained no further grant assistance to finance its advisory and extension services in Matlab Upazila after July 2003. The organization opted to cover its operating costs from earnings gained from the interest rate spread,[12] but predicted that it would face increasing pressure to minimize its operating costs and to reduce lending risks by extending the credit facility to various other income-generating initiatives.

B. Methods and Sources

8. For the preparation of this case study, site visits and key informant interviews were conducted intermittently during June–November 2003. Information gathering included a survey in Matlab Upazila: (i) 100 fish farming groups were selected randomly as group respondents out of the total of 175 groups; (ii) 100 households were randomly selected, 1 household from each of the selected 100 groups; and (iii) market intermediaries comprising 10 fish traders, 10 seed traders, and 10 fish harvesters were interviewed. Secondary data came from DOF, VOSD, the Bangladesh Bureau of Statistics, and the Bangladesh Water Development Board.

[11] In many cases, several people owned the same ponds, and the lease arrangements involved users in a group and a group of owners. Absentee pond owners found leasing to be a convenient arrangement.

[12] VOSD charges 15% interest per annum to clients and pays an interest of 3% per annum to the Government for the credit facility. Thus, VOSD receives a spread of 12% per annum, and bears the full risks of lending and credit recovery.

C. Biophysical Features of the Case Study Area

9. Forming an island, MDIS is located on the Meghna River at its junction with Padma River and is surrounded by the branches of the Meghna and Dhonagodha rivers. The case study area is located in the MDIS covering 13,600 ha in Matlab Upazila. Prior to 1981, this entire area (human settlements, agricultural lands, and fishponds) was under several meters of floodwater for about 4 months every year. The construction of a flood protection embankment with associated peripheral roads and irrigation canals greatly improved the living conditions of its communities.[13] Flooding had occurred only twice since then: in 1987 in common with most of Bangladesh, and in 1988 because of a breach in the embankment during major flooding in the country. Occasional flooding seems inevitable with the continuing possibility of exceptional rains, sea level rise, and embankment failures. There are continuing efforts to cope with shifts in the courses of the rivers and threats of land erosion in Chandpur by the Bangladesh Water Development Board, which considers the embanked area as an important and strategic flood-protected area to be maintained.

10. Flood control structures here, as in other areas of Bangladesh, have contributed to the decline of inland capture fisheries, which also suffer from overfishing and general unmanageability. Reportedly, the production of inland capture fisheries declined from 962 t in 1983/84 to 336 t in 1991/92 at Meghna-Dhonagoda.[14] The development of freshwater aquaculture was an effort to compensate for the decline in inland capture fisheries. Within the MDIS embankment, the change from annual to exceptional flooding reduced inland capture fisheries but increased opportunities for agriculture and aquaculture with lower risks. The cessation of annual flooding will have long-term effects on the ecology and on the aquatic and terrestrial biodiversity of the area, from soil microorganisms to plants and animals, including fish.[15] The overall effect is increased retention of nutrients (from organic and inorganic fertilizers, human settlements, and livestock). The main change in agriculture since flood protection has been the assurance of two rice crops per year.[16] The embankment has become a site for growing trees.

11. There are possibly more than 10,000 ponds as well as numerous ditches and open water areas in Matlab Upazila, although there are no accurate statistics. Some of the fishponds are more than 75-years old and were originally excavated to raise the level of land for the village as well as for bathing, watering livestock, domestic water supply, and traditional fish farming.[17] Other ponds are 15–20 years old, and there is evidence of excavation of newer ponds and ditches along the embankment and roads.

12. The water quality of fishponds and ditches in the area is suitable for fish farming. Integrated pest management has been promoted, but heavy use of pesticides continues, as is

[13] Briscoe, John. 2001. Two Decades of Change in a Bangladeshi Village. *Economic and Political Weekly* Vol. XXXVI, No. 40: 1–8.

[14] Ali, M.Y. 1997 *Fish, Water and People. Reflections on Inland Openwater Fisheries Resources of Bangladesh*. Dhaka. Losses in capture fisheries were estimated at 2,800 t per year based on optimistic fisheries productivity of the floodplains and open waters, while a much lower estimate indicated annual losses at between 506 and 584 t.

[15] The VOSD recognizes that land use in the area should maintain a balance between rice farming, pond aquaculture, vegetable crops, and fishing.

[16] It is possible that livestock and poultry populations have also increased, but time series data cannot be obtained. Ducks are common on and around fishponds.

[17] Farmers recall this traditional fish farming as haphazard stocking of fish seed in ponds and harvesting whatever resulted from natural productivity, with little or no feeding or fertilization. Fish yields, following the stocking, husbandry, and harvesting methods promoted by VOSD, were reported by farmers to be 5–10 times higher than those of the previously unmanaged ponds.

common in irrigated areas growing high-yielding rice varieties. This condition does not appear likely to threaten fish health, but pesticide residues in fish might be a cause for concern. Farmers are not fertilizing or feeding at rates that could cause oxygen or other water quality problems for fish, and there appear to be no significant risks from off-farm sources of pollution. However, some tubewells in the area are regarded as arsenic-contaminated, and some villagers are appealing for wells deeper than 250 meters to be dug to find arsenic-free water. Groundwater is used in this area for both agriculture and aquaculture, but there are no indications to date that fish consumption has significantly increased human exposure to arsenic.

D. Fish Farming Technology and Management

13. **Seed Supply.** The fish farmers in this area obtain almost all of their fish seed (fry and fingerlings) for stocking in ponds from hatcheries and nurseries operated by others. The only exceptions to this are that some Nile tilapia and common carp fingerlings are produced locally (they breed in ponds and ditches) and there is undoubtedly some natural recruitment of small indigenous species.[18] Most farmers believe it is necessary to stock ponds with a mix of 7 or more carp species, although they have varying ideas about stocking tilapia with carp species.[19]

14. **Growout.** All 100 groups in the survey farmed a mixture of carps for 9–11 months each year. The groups generally complied with the recommended stocking density—an average stocking rate of 11,250/ha. Ponds were fertilized with urea, triple superphosphate (TSP), and cow manure, and fed rice bran, mustard oil cake, and to lesser extent grass, banana leaves, and wheat bran. These simple feeds also act as pond fertilizers to some extent, and the basal fertility of ponds is usually significant as well because of inputs from their surroundings. The groups did not fully follow the recommended fertilizer use and supplementary feed,[20] in that less cow manure was used, but the groups compensated for this with more urea and TSP. About two thirds of the respondents drained their ponds, nearly always by pumping, and usually every 2–3 years.

15. **Individual Group Members and Fish Farming.** Of the 100 individual group members surveyed, 64% were not involved in any other aquaculture activity than the group-based fish farming. A third (33%) farmed fish in household ponds and ditches, and 3% nursed fry. All members were attracted to fish farming because of its profitability and the possibility of having fish for household consumption. Other reasons for fish farming included prior knowledge of

[18] Carp seed of all farmed species can be obtained from seed traders, who purchase seed from hatcheries located in Chandpur and Comilla. Several households in the villages where the groups farmed fish also nursed fry to fingerlings in ponds, from which the groups purchased seed. There is one local private hatchery and one local state-owed hatchery in Matlab. Nile tilapia (*Oreochromis niloticus*) fingerlings are less common, but local sources of supply are emerging. For example, a local farmer in Shabaz Khandi village of East Fatapur Union currently produces about 70,000 tilapia fingerlings a year (70–100 pieces per kg; at Tk80/kg) from free breeding broodstock in ponds, fed regularly on rice bran and mustard oil cake. This farmer sells tilapia fingerlings to 50–60 farmers in the vicinity, some of whom stock tilapia with carps. His tilapia broodstock were obtained from his grandfather's pond, which came from a tilapia hatchery in Mymensingh. He is keen to obtain genetically improved farmed tilapia (GIFT) after hearing about their good performance though a television program ("Mahti-o-Manush"; meaning "Land and People"). He has received no training in tilapia seed production and is unaware of the reduced fecundity of tilapia broodstock after 2 years of use.

[19] There are, however, some indications that new tilapia farmers are stocking tilapia with common carp and rohu (*Labeo rohita*) and fewer species in polyculture.

[20] The recommended VOSD fertilization rates/ha/week were equivalent to 270 kg cow manure, 5.2 kg urea, and 6.9 kg of triple superphosphate (TSP). The recommended feeding rates were rice bran, wheat bran, and oil cake in a 1:1:1 ratio fed at 5% body weight for newly stocked 7.5–12.5 cm long fish for 1.5 months, 4% of body weight for the next 1.5 months, and 2–3% of body weight up to harvest. The average annual fertilization rates actually used were 3.1 t/ha of cow manure, 420 kg/ha of urea, and 520 kg/ha of TSP.

aquaculture (11%), availability of fish seed (2%), availability of fertilizers (1%), and availability of feed (1%). Individual members used pond water for multiple purposes: washing clothes (98%), washing dishes (95%), bathing (93%), livestock (30%), cooking (26%), and watering crops (14%). Nevertheless, there were relatively few water-use conflicts. Most respondents (86%) milled their own rice and used the rice bran to feed fish (84%), cattle (15%), and poultry (1%). About half (47%) of the respondents had enough rice bran to feed their fish, and most of the others (47%) reported buying rice bran for this purpose.

E. Livelihood Assets

1. Human Capital

16. The respondent households had an average family size of 6.3 persons, 52% male and 48% female. Ninety-two percent were Muslim and the others were Hindu. The respondents reported that 53% of their family members were 18-years old or more, and 32% attended school. Although primary education is compulsory in Bangladesh, not all children could attend school because of poverty. Children provided household labor and, in some cases, schooling costs were unaffordable. With the sole exception of a widow, all household heads were male. Only 6% of the household heads were 30-years old or younger, 83% were 31–50 years old, and the rest were more than 50-years old. Excluding the widow, spouses of household heads were generally younger than the household heads: 21% were 30 years old or younger, and 71% were 31–50 years. The educational status of household heads and their spouses is presented in Table 1.

Table 1: Educational Status of Respondent Household Heads and their Spouses in Chandpur

Educational Status	Household Head (%, n=100)	Spouse (%, n=99)
No Education	10	15
Primary (class 1–5)	36	45
Secondary (class 6–10)	29	25
SSC (class 10 pass)	19	11
HSC (class 12 pass)	3	3
Undergraduate, University/College	3	1

n = number of respondents, SSC = secondary school certificate, HSC = higher secondary certificate.

Group of women fish farmers

Fish consumers and potential fish farmers

17. Fish farming was not a full-time occupation or the sole source of income for the households. Among the household heads, the most important primary occupations were rice farming (32%) and self-employment in microenterprises (28%), compared with only 9% for fish farming. Fish farming was a significant secondary occupation for household heads (24%) after rice farming (33%). Nearly all the spouses were primarily homemakers and 94% of them reported fish farming as their secondary occupation. Table 2 presents the occupations of household heads and their spouses.

Table 2: Occupations of Respondent Household Heads and Spouses in Chandpur

Occupation/Source of Income	Household Head (%, n=100)		Spouse (%, n=99)		Household Income Sources (%, n=100)		
	Primary	Secondary	Primary	Secondary	First	Second	Third
Fish Farming	9	24	3	94	8	34	58
Rice Farming	32	33	0	0	34	35	2
Wage Labor	8	2	0	0	7	3	2
Carpentry	1	0	0	0	2	0	0
Office Worker	15	2	2	0	14	4	0
Vendor/Trader	2	0	0	1	1	2	2
Microenterprise	28	3	0	0	27	3	3
Rickshaw Driver	1	2	0	0	1	3	0
Capture Fishing	1	0	0	0	1	0	0
Working Abroad	2	0	0	0	0	0	0
Other Crops	0	14	0	0	0	8	23
Sharecropper	0	2	0	0	0	2	0
Livestock	0	12	0	0	1	6	10
None	0	6	0	3	0	0	0
Homemaker	1	0	95	2	0	0	0
Remittances	0	0	0	0	3	0	0
School Teacher	0	0	0	0	1	0	0
Others	0	0	0	0	0	0	0

n = number of respondents.

18. The participating people were only recently formed into groups. They had relatively little prior experience in fish farming; only 4% had more than 5 years of experience. None of them considered that fish farming had ever placed their health at risk. Women and men shared many of the tasks associated with fish farming, although males did nearly all the harvesting and marketing and most of the grading of fish (Table 3).

Table 3: Aquaculture Activities of Respondents in Chandpur, Based on Gender

Activity	Only Male (%)	Only Female (%)	Shared (%)
Pond Preparation	28	2	70
Fish Seed Procurement	10	3	87
Feed Procurement	6	4	90
Fertilizer Procurement	6	4	90
Fertilization	1	10	89
Feeding Fish	1	13	86
Harvesting Fish	87	3	10
Grading Fish	44	10	46
Marketing Fish	92	1	7

2. Natural Capital: Access to Land and Ponds

19. Some respondents had no land; the maximum landholding was 0.8 ha. Thus, the groups comprised landless and marginal farmers. The number of ponds leased by each group was 2–9 with a mean of 3.4 ponds. Only 10% owned a pond. All groups had access to 1 ha of ponds (water surface area), which was the targeted lease size under the project. In general, the leased ponds had 1–18 owners, with an average of 5 owners per pond. Lease durations were 1–5 years with renewal options. Almost all the ponds were more than 10-years old and had previously been used for fish farming, but mainly only by stocking without fertilization or supplementary feeding. Groundwater was the main water source (84%), together with water from an irrigation canal (40%) and rainwater (16%). The ponds were perennial and the groups reported no conflicts over water.

Leased pond

Washing cooking utensils in a multipurpose pond

20. All the respondent households had a small plot of homestead land; most had small ponds or ditches (77%) and a small area of agricultural land (76%). Few households had an orchard (12%) or fallow land (6%), and many (35%) leased land. The average area of owned land (excluding leased land) was only 0.21 ha. All these households cultivated 2–3 crops of rice per year, with yields averaging 4.5 t/ha/crop. Only 18% reported catching wild fish from their own ponds. However, 79% caught wild fish from elsewhere, although catches have reportedly decreased over the last 10 years.

3. Social Capital

21. The respondents were almost entirely local people, but only 21% of them were born in the village where they now resided: 72% were born in a different union within their *upazila*, and 5% from a different *upazila* within Chandpur. Only 2% came from a different district. All of the 79% who had moved to their present village had done so because of marriage.

22. The interviewed groups all had 10 members. Members of all groups met once per week, and also met members of other groups occasionally. All groups reported that other women in the area were interested in setting up a group. There were no major issues in the functioning of the groups and only 4 identified specific problems in management. All groups received training on fish farming from VOSD for 3 days. In addition, 30% of the groups received 2 days of training from DOF, and 2% received a further 30 days of training from DOF. Nevertheless, the groups perceived that the training was inadequate. All groups reported that they met VOSD staff weekly, suggesting that formal training had been complemented with advisory services through

regular visits and meetings. The survey indicated that 56% of the sampled groups received handouts of training material.[21] Although the extension workers were predominantly male, none of the groups reported that it was as a problem to be advised by a male extension worker. A few women expressed reluctance to talk to male extension workers, but this situation was overcome with the help of women extension workers. Among the interviewed group members, 47% indicated that they would be willing to pay for good extension advice if it could significantly increase their fish harvest. Among those expressing a willingness to pay for extension, 74% indicated that they could pay the equivalent of Tk12,350/ha, and they were willing to pay for the advice with a portion of their harvest.

4. Physical Capital and Access to Facilities

23. All of the interviewed group members owned their homes, although none were well constructed. Two thirds (67%) were of wood and galvanized sheet metal, and the others of light natural materials (such as bamboo, rice straw, jute sticks, leaves, earth, and wood) with galvanized sheet metal. Major assets owned by group members were a radio (37%), a cassette player (24%), a television (15%), a fan (19%), and a sewing machine (8%) among household items; and a bicycle (39%), a boat (2%), and a rickshaw (2%) for transportation. Almost all had scavenging poultry (96%), a few had goats (5%), and 66% had a cow used for plowing and milk. Bullocks (9%) were not used for plowing, but for sale for meat during religious festivals. Most group members reported some difficulties in accessing facilities (Table 4).

Table 4: Access to Facilities by Respondents in Chandpur
(n=100)

Facility	Very Difficult	Difficult	Neither Difficult Nor Easy	Easy	Very Easy
Road	0	93	7	0	0
Transportation	0	99	1	0	0
Communication	97	3	0	0	0
Medical	8	83	9	0	0
Electricity	16	74	10	0	0
Reliable Water Supply	0	27	73	0	0
Toilet	1	22	76	1	0

n = number of respondents.

24. All of the interviewed group members had access to a tubewell as their main source of drinking water (64% owned a tubewell, 12% partly owned one, and 24% used a community tubewell). Probably all wells had been arsenic tested—97% responded affirmatively and the others did not know if their wells had been tested—and 66% reported that their wells were arsenic free, while 29% reported contamination, and 5% were not aware of the results of testing. All individual group members had access to a toilet of generally inadequate sanitation.[22] Fuels used for cooking included fuelwood (100%), rice straw (54%), jute sticks (50%), cow manure (28%), leaf litter (26%), and kerosene (2%).

[21] These were probably of limited use to group members, many of whom had limited education. The two handouts were (i) a 30-page "*Training Module on Fish Farming*" with no illustrations; and (ii) a 32-page technical report *"Fish Farming in Flood Control, Drainage and Irrigation Project Water Bodies, Command Area Development Project: Part-C (Fisheries)."*

[22] Among the respondents, 54% reported that they had access to a *kacha* (made of bamboo with a thatched shelter and inadequate drainage disposal), and 46% to a *semi-pacca* (made of wood/galvanized metal with a squat plate over a pit latrine). None had access to a *pacca* (made of brick with a water seal squat plate).

5. Financial Capital and Returns from Fish Farming

25. With about 175 ha of fishponds, the 175 groups harvested 756.7 t during November 2000–April 2003. These harvests were valued at Tk34.3 million at an average farm gate price of Tk45/kg. The cumulative total production , including estimated stocks remaining in the ponds as of April 2003, was 1,225 t valued at Tk55.5 million (about $1 million).[23] The average annual yield was 3.7 t/ha, worth Tk170,000–180,000 at the farm gate. At 2002 constant prices, annual production costs would be Tk83,000/ha, including lease payments, inputs, hired labor, and harvesting costs. Net incomes of not less than Tk80,000/ha could be attained, providing minimum net returns of Tk8,000 per person, depending on the group size. With minimum required savings of Tk260/person/year, each member could gain a disposable income of up to Tk7,740/year, allowing increased spending on basic needs.

26. All the surveyed groups harvested fish four times per year, with increasing amounts harvested as the fish grew: the first harvest averaged 277 kg/ha, the second 492 kg/ha, third 683 kg/ha, and fourth 2,240 kg/ha (total 3,692 kg/ha/year). These yields are comparable to those achieved among the top performers in Bangladesh. Only 2% of the groups harvested fish on their own, with the majority hiring a local harvesting team, and relying to a small extent on fish buyers. None experienced any major fish kill in the ponds. The vast majority of fish (94%) was sold; 4% were eaten by the household members, and the rest given away and for other use. The surveyed groups reported average gross earnings of Tk158,877, and net incomes of Tk82,818 per group, excluding the fish for their own consumption and other disposal.

27. The major constraints to the groups were inadequate technical knowledge (92%), lack of transport facilities (93%), poor road quality (93%), and inadequate credit (83%). The groups also perceived that they could produce more fish through better management (39%), more inputs (32%), and better fingerlings (29%). All groups intended to continue to farm fish, with 96% indicating that they would continue with their current operation, 3% intending to produce more fish, and 1% intending to increase the pond area. The groups quoted profitability as their primary reason for continuing to farm fish.

28. Each group borrowed Tk50,000 per year from VOSD for fish farming. Only 2% of the groups experienced difficulties in repaying the loan—because of lower than expected fish production during the first 3 months of the growing cycle. Weekly savings among the surveyed groups reached a mean of Tk81, reflecting a savings rate of Tk5–10/person/week. Overall, the groups indicated that the credit of Tk50,000 was not enough to cover all operating expenses, which included Tk25,000–Tk30,000 spent annually for leasing ponds.

29. None of the groups felt that they could manage their fish farms without credit. They needed an average of Tk76,670/ha of working capital, which would take an average of 87 months to save. However, if sufficient working capital were available to the groups, all said they would be able to obtain their own fish seed, fertilizers, and feeds. This condition emphasizes the importance of access to credit, without which the groups would have stopped farming fish. Financial resources among the groups were generally minimal. Only 11% received remittances from family members, at a mean of Tk25,236 per year. All had savings, but only 20% could save from sources other than fish farming. Among the latter, additional savings amounted to a mean of Tk5,593 per year. Savings from fish farming were used for various purposes, including for children's education (50%), food purchase (44%), house improvement (40%), and health (39%).

[23] VOSD Quarterly Report, April 2003.

6. Vulnerability, Coping Strategies, and Perceived Benefits

30. The surveyed group members faced a variety of crises (Table 5). The most serious were illnesses of household members, shortage of food, low production of rice, loss of livestock or poultry, and theft. When a household member becomes ill, the time and other resources required to care for this person reduce the household's capacity to earn and often deplete their savings. The main coping strategies for crisis situations were taking a loan from friends, neighbors or relatives (90%), adjustments to meals (68%), consumption of low-cost food (28%), and sale of livestock (24%). Sampled group members reported that they faced food shortages for a certain period each year: from 1 month (27%), 2 months (57%), to 3–4 months (16%). Months with the largest incidence of food insecurity were June–August and December–February. All members said that they had consumed fish in the 7 days before being interviewed, as well as vegetables (98%), eggs (92%), fruit (82%), milk (51%), beef (34%), chicken (23%) and mutton (2%). However, the amounts consumed could not be easily determined.

Table 5: Crises Faced by Respondents in Chandpur
(n=100)

Types of Crisis	%
Illness of Household Members	89
Shortage of Food	61
Poor Production of Rice	24
Loss of Livestock/Poultry	21
Theft	14
Excess Rain	9
Accident of Household Members	9
Death of Household Members	7
Dowry/Wedding	5
Wind Damage	4
Loss of Job	4
Loss of Land	4
Market Fluctuation of Farmed Produce	3
Loss of Assets to Powerful Person	2
Inter/Intra Community Conflict	1
Loss of Business	1

n = number of respondents.

31. The surveyed groups felt that aquaculture had improved their welfare in the context of food consumption (100%), home improvement (99%), children's education (99%), clothes (87%), sanitation (46%), and increased access to health services (25%) and drinking water (12%). The same pattern was seen when the groups ranked the three most important benefits of fish farming (Table 6).

Table 6: Group Ranking of the Three Most Important Benefits from Aquaculture by Respondents in Chandpur
(n=100)

Item	Groups (%)		
	First	Second	Third
Food Consumption	29	22	29
Home Improvement	26	43	13
Children Education	33	28	17
Health Services	2	1	15
Clothes	8	5	19
Sanitation	2	1	6
Drinking Water	0	0	1

n = number of respondents.

32. Asked to compare their present situation with that 5 years ago, the surveyed group members overwhelmingly perceived that (i) their overall food and fish consumption had improved, (ii) they had gained from employment and cash incomes from fish farming, (iii) the natural resource conditions for fish farming had improved, (iv) they had acquired means to finance fish farming, (v) their housing conditions had improved, (vi) they had gained access to fish farming technology, (vii) there had been an increase in the adoption of fish farming technology, and (viii) their access to credit had improved. They were also optimistic for the future on these aspects.

F. Markets and Marketing Agents

33. The groups mostly sold fish locally at the village markets (81%) or at the *upazila* market. They sold fish mainly to local agents (57%) or wholesalers-assemblers (41%), with only 2% selling fish directly to a retailer. Because they sold relatively large amounts of fish, the groups wanted to sell directly to a wholesaler rather than to a local agent. Their most important reason for choosing a particular market outlet was convenience (76%), with price a relatively minor consideration (22%), as was cash payment (2%). Most of the groups (79%) claimed that they set the sales price of their fish, while buyers/traders determined the sales price for 21% of the groups. None had significant problems in selling fish; demand was high. The groups reported that they were, however, restricted from seeking other markets because of the distance (45%), inadequate transportation (34%), poor roads (17%), or time constraints (4%).

34. **Fish Traders.** At local markets, retail fish trading may be considered as a small business activity that does not provide a full-time occupation. Market agents and fish harvesters bring their fish from various villages to the traders (wholesalers and retailers) in market centers, and on occasions take small amounts of credit (*dadon*)[24] from wholesalers to ensure a steady supply of fish from farmers. All 10 fish traders interviewed at Changerchar market in Chandpur were male, 25–40 years old. They had minimal education: 8 of them had less than 5 years of primary school and 2 had 6–10 years of school. Although the religion in the area is predominantly Muslim, half of these fish traders were Hindu. Their average family size was 6 persons, ranging from 4 to 9 persons. Household assets included a radio (9 traders), a cassette player (4), a television (3), and a fan (1). Fish trading was neither a full-time nor a

[24] *Dadon* is a system of tied credit through which fish traders advance money to the agents in exchange for assured supply of fish.

primary occupation for most—only 2 said fish trading was their primary occupation—6 were farmers and 2 fish farmers. Half had been trading fish for more than 7 years, with a range of experience of 2–20 years. Although fish trading is not usually a full-time job, it takes place all year with a peak in November–February. Typically, fish traders sell their fish in the morning for about 4 hours, 7 days per week. The number of fish traders in the market ranged from 19 to 27 people. Farmed fish came mainly from the vicinity: 98% from fish farms and 2% from capture fisheries. Fish were transported by bicycle or rickshaw.

35. The fish traders handled 35–45 kg of fish a day, selling them to customers on the same day. In fact, all transactions, from harvests to fish traders and final consumers, normally took place within a day. Depending on fish species, fish traders sold their fish at average prices of Tk64/kg. Fish traders earned net incomes of about Tk170/day; their main expenses were hired labor, transportation, ice, electricity, and shop rental at the market. They typically operated with little working capital, Tk10,000–20,000, and their sources of capital included informal loans from friends or relatives, savings, and sales of personal assets. All fish traders employed wage laborers, with an average of 2 laborers per trader. Major problems reported by the fish traders included transportation (6) and ice supply (4). However, they all felt that trading fish had improved their welfare through increased food security, children's education, clothing, and housing.

Wholesale fish trader

Retail fish trader

36. **Fish Seed Traders.** Seed traders maintain a strong network and relations with client farmers and owners of hatcheries and nurseries, providing a critical link between seed producers and fish farmers. The 10 seed traders interviewed had very little working capital, Tk2,000–5,000. They often took short-term renewable loans of several days from hatchery owners instead of paying cash each time they obtained seed from the hatcheries. They were all male, 32–45 years old, with little education: half had less than 5 years of primary schooling, and the remainder had generally less than 10 years. One was Hindu, and the rest Muslim. Family size was 4–10 people, with a mean of 5.2, and their household assets included a radio (10 traders), a fan (9), a television (7), and a cassette player (2). Only 1 sold fry as a primary occupation, while 5 were farmers, 3 were fish farmers, and the rest had other jobs. However, 9 reported fry trading as their secondary occupation.

37. Most traders had considerable experience trading fry, and 4 of them had more than 7 years experience. Their average length of experience was 7.1 years, with a range of 4–13 years. The peak fry-trading season was March–July, extending up to September and October because farmers practice multiple stocking. Fish seed mainly came from Comilla, Chandpur, and Laxipur districts, and was supplied by hatcheries and nurseries. Fry were transported on foot, bicycle, rickshaw, and pickup trucks. The volume of fry sold daily was 1,000–2,000 pieces per trader (average 1,360), at prices of Tk295–520 per 1,000 pieces depending on the fish species. Daily net incomes of these traders were Tk136–275. Fry traders reported two major problems: poor road and transport, and fry mortality due to elevated water temperature and from changing water. They reported fry mortality of 2–10% during transportation. All fry traders reported that seed trading had improved their socioeconomic conditions.

38. **Fish Harvesters.** Fish farmers do not generally harvest their own fishponds, but rely on fish harvesters. The 10 fish harvesters interviewed were Muslim men, 25–40 years of age, with low levels of education: only 2 had more than 5 years of schooling. Their family size was 3–5 members. Nine of them had a radio, 6 had a fan, and 2 a cassette player; none had a television. Seven reported harvesting fish as their primary occupation, and the other 3 as a secondary occupation.

39. The fish harvesters interviewed had an average length of experience of 5.2 years, range 3–10 years. They worked year round, with a peak in October–January. Harvesting usually took place in the morning before noon. On average, the harvesters did 1–2 harvests per week. They employed 6–8 laborers in a harvesting team. The gross income was 8–12% of the fish value per harvest. Daily net income of fish harvesters, after paying for labor, fishnet rental, repairs, and fishnet transport, was Tk150–260. They reported two major constraints to their activities: poor access to transportation (6 traders) and a high fishnet rental cost (4). Nevertheless, they all said that their occupation had improved their socioeconomic conditions.

Harvest team getting ready

Fish harvest in a group's pond

G. Conclusions

40. Fish farming brought profits, generated cash, and significantly improved households' incomes among the 175 groups surveyed, at a scale of production that represented a sizable contribution to the local rural economy. Marketable fish could easily reach 650 t annually with farm gate value of Tk29.3 million (more than $0.5 million), providing direct employment to 2,590 group members, and spinning off employment benefits to seed traders, small-scale input

suppliers, fish harvesters, and market intermediaries. Fish marketing activities through various intermediaries to final consumers added 100% to the farm gate value of the fish and provided significant self-employment opportunities to market intermediaries and their wage laborers.

41. The project initiatives benefited the poor, primarily disadvantaged women who were not heads of households. These spouses, nearly all homemakers, could not have earned their own incomes if they had not been assisted by the project. The major barriers to women for seeking other employment included social barriers (45%), household work responsibilities (34%), and inability to work physically as wage laborer (7%).

42. Fish farming significantly empowered the women group members, providing them with lucrative opportunities in pursuing income-generating activities and allowing them to play a significant shared role with men in social and cultural contexts normally dominated by men. Group members gained skills and confidence in operating and maintaining fish farms, including skills in marketing.

43. The project helped the disadvantaged poor by overcoming barriers and providing access to opportunities. The key channels by which the poor benefited from fish farming were primarily through accessing livelihood assets, extension/advisory services, and markets.

44. The project developed human and social capital in skill acquisition, promoting confidence building, and establishing groups and motivating them. The project also helped the groups in accessing land and water (fishponds) by securing renewable lease arrangements. Without these leases, the disadvantaged poor would not have had access to fishponds.

45. Limited financial capital was another barrier for the poor. Microcredit helped them access working capital to complement their meager resources. Without credit and the NGO advisory services that accompanied this credit, the poor would not have been able to start and sustain their fish farms. Although the group members started saving a portion of their incomes, their savings alone would not be able to replace their reliance on credit. The groups indicated that it would take them on average more than 7 years to save enough working capital (an average of Tk76,670/ha). Thus, the continuation of access to credit with affordable terms and conditions is one of the key channels for enabling the poor to engage in small-scale aquaculture.

46. Access to markets, for input supplies and fish, made fish farming feasible and profitable. Although access to facilities and infrastructure (road, transportation, and water supply) was not optimal, the existing facilities were sufficient to make fish farming feasible. Rainfall, the use of wells, and water retention in ponds enabled farmers to farm fish all year round in Matlab Upazila. With high demand for fish, the harvested fish were mostly sold in local village and *upazila* markets. Thus, fish farming contributed to local food security.

47. Considerable project support was required and mobilized to develop the requisite human and social capital of the fish farming groups. The use of a local NGO familiar with the social dimensions of poverty affecting the area, was instrumental to the positive outcomes to date. Coupled with microfinance services, capacity building with practical training in aquaculture for the groups in the context of feasible income-generating initiatives provided a breakthrough in providing self-help employment opportunities for the disadvantaged.