BJAE, V, 1-2(1982) 1-24

SOCIAL FACTORS AFFECTING PROSPECTS FOR INTENSIFIED FISH FARMING IN BANGLADESH

Gerard J. Gill and Syed Abu Motahar*

ABSTRACT

There is apparently enormous potential for intensified fish farming in Bangladesh. This paper reports on a pilot study which investigated possible social and economic constraints on realising this potential. The range of uses of ponds is very large and includes household uses, field drainage, irrigation, duck and fish firming, cattle watering and the production of crops for both human and cattle. Very few ponds are actually derelict, but intensity of use varies greatly. Multiple pond ownership is commonly thought to be a major constraint of fish farming, but the problem was found mainly to be one of inheritance which throws together people of different generations and of different, often competing, interests. Other multi-owner ponds farm fish quite successfully. Other problems identified were non-availability of fish fry, lack of technical *training* for the farmers, shortage of investment capital and the theft of fish or their deliberate poisoning due to rivalry, enmity or even jealousy. Areas for further research are outlined.

INTRODUCTION

The potential for increased fish production from ponds, *heels* and similar fresh water sources in Bangladesh would appear to be enormous. On the one hand fish is a highly acceptable form of food at all socio-economic levels of society and can command high prices.[1] At the same time the country has vast resources of such non-riverine inland waters (varying seasonally between one and eight million acres), only a small fraction of which are 'presently employed for fish culture. The possibilities being opened up by a combination of newly introduced (exotic) species, new knowledge and technological advances all suggest that many of the technical problems of fish culture are readily amenable to solution.[2] However; the apparent brightness of this prospect should not be permitted to blind one to the potential stumbling blocks which could impede realisation of this potential. There are, unfortunately, numerous historical instances of innovations

*Respectively A/D/C Associate, BARC, and former Research Officer. The authors wish to thank Dr. M.A. Jabber of Bangladesh Agricultural University for helpful comments on an earlier draft. However all views expressed are the authors' own and do not necessarily reflect those of any organisation or individual named.

in the rural sector which seemed technically attractive but which either failed to produce results in the real world or produced returns which were entirely captured by rural elites without benefiting, sometimes even to the detriment of, the rural disadvantaged.

In the 1960's and early 1970's, for example, the 'green revolution' was hailed as the technological breakthrough which, in the assessment of many, would eliminate world food shortages.[3] In many areas, however, the adoption of the new technology on a wide scab caused local gluts which totally swamped local processing, storage and transportation facilities, resulting in a disastrous slump in grain prices which ruined many small farmers in areas like the Punjab. Some of the larger farmers were able not only to withstand or bypass the slump, but even to benefit from it by buying up the land of their smaller neighbours at rock bottom prices.[4] Thus the now technology in practice far from assisting the poor too often resulted in increasing landlessness and growing income disparities.

Nearer home, the Second Five Year Development Plan of Bangladesh (1980-85) set ambitious targets for increased food output over the Plan Period. The main instrument whereby these targets are to be achieved is improved water resources development and management in general and improved irrigation facilities in particular (Bangladesh 1980, p. XII-79). After a great deal of investment in irrigation facilities and evaluation of their progress over the past two decades it is now widely recognised that a major contributory cause of the disappointingly poor performance of the irrigation sector has been the failure to solve the social and economic problems inherent in command areas which include hundreds of small plots belonging to large numbers of different farmers.[5]

In the case of fisheries, similar problems can and do arise. Despite its potential, fish production from inland waters in Bangladesh is officially estimated to have declined from 701,000 to 545,000 tons (22 per cent) over the period 1962/63 to 1976/77, more than cancelling out a concomitant rise in marine fisheries production over the period (Bangladesh 1980b, p. 2). The decline is attributed "mainly to absence of rational management (and of) judicious utilisation and exploitation of the resources" *(ibid)*. This last statement dearly suggests that negative socio-economic forces are at work.

In order to avoid a recurrence of the above type of problem in the event that a large scale effort is mounted to expand fish farming in Bangladesh, it is essential to try to appreciate the economic and social forces which presently operate and/or are likely to come into play in any future development. Only by doing so will it be possible to devise strategies which anticipate social and economic problems and hence provide an opportunity to plan to overcome them.

Very little research has been devoted to the social and economic aspects of fisheries in Bangladesh.[6] A recent comprehensive survey of the past output, present status and future

programme of fisheries research in the country brings out this fact very clearly (BARC 1982). Of the 74 scientists listed, all are qualified in fields such as pond management, limnology, fisheries technology and the biological sciences. No one appears in the list with a qualification in, for example, fisheries economics or sociology. Much the same can be said of past and ongoing research projects and scientific writings ; of more than 700 listed only seven deal with social or economic aspects of the subject and, of those, five emanate from a single seminar[7] and deal exclusively with distribution and marketing.[8] The Inventory concludes (*inter alia*) that the studies being carried out are more academic than applied and that non-biological disciplines, including economics, statistics and planning should be given appropriate importance in future.[9] Other social aspects of the subject do not receive specific mention. The purpose of the present paper is to describe a first step towards correcting the above situation.

METHODOLOGY

The study of ponds and their integration into (small) farming systems formed a central part of a recent Base Line Pilot Study of Joydebpur Thana[10]. The component described here comprised two main elements : first the inclusion of a set of questions on ponds in the Small Farm Survey questionnaire and second a more intensive Survey of Ponds which was conducted subsequently. The present authors were closely involved in the former and responsible for the latter. The sampling frames of the two surveys were different. In the Small Farm Survey the sampling frame comprised all small (less than 10 bigha or 1.336 ha) farms ; the method of construction is described elsewhere (Jackson *et al*, 1982).

The Survey of Ponds was conducted in the mouza of South Shalna. The sampling frame was the set of (three) large scale (16 inches = 1 mile) mouza maps which identify individual plots, homesteads and ponds. The maps in question were last updated in 1975, but it is clear that they do not include all ponds in the *mouza*, since a great deal of pond construction has taken place since then. Initially an attempt was made to update the maps by ground survey and by interviewing local elders, but it soon became clear that this could not be completed in the short period of time available and given the personnel constraints. It was therefore decided to concentrate the Survey on mapped ponds. This was partly for the above logistic reasons and partly because those mapped are the older ponds and therefore those in which time-related social problems, such as those resulting from fragmentation of ownership, would be most likely to occur. Preliminary investigation suggested that the newer ponds tended to be signle-owner and to have been constructed specifically, or mainly, for fish culture.

The three maps of South Shalna depict a total of 25 ponds or 'tanks'. A 100 per cent survey was conducted and this revealed that three of these ponds had subsequently been

filled in and that the land was now under cultivation. The owner of a fourth pond, an absentee, could not be contacted despite repeated attempts. Owners, part-owner or lesses of the other 21 ponds were interviewed.

Filled in ponds. The (reputed) owners of the were contacted and interviewed as to their reasons for filling in the ponds. In every case it was stated that the pond in question had become so heavily silted that expensive re-excavation would have been necessary to make them suitable for fish culture and that it was less expensive to demolish the banks and fill in the pond so as to bring it back into cultivation. This statement, if correct, casts considerable doubt on the widespread assumption that fish culture is more profitable than paddy cultivation.[11] There is, however, some reason for doubt. First the evident relative affluence of the individuals concerned suggested that lack of access to resources for investment could hardly be a very serious constraint. Second at least one of these individuals had excavated a new pond in recent years. An alternaive explanation was advanced and subsequently independently confirmed by other residents of the area. The area concerned was at one time part of the Bhawal Estate. At the time of abolition of the *zamindari*,[12] this estate including a number of ponds, passed into government hands as *khas* property. A number of influential individuals are said to have acquired *khas* lands at that time by purchasing predated documents purporting to show that they had acquired title before passage of the Act, and to have filled in the ponds so as to hamper any subsequent attempt to identify the sites. Whether or not this explanation applies to many of the filled-in ponds found in this Survey was not further investigated.

A COMPARISON OF SMALL FARMERS AND POND OWNERS

The ponds covered in the two Surveys may be regarded as representing, respectively, small farmers' ponds and—at least older—ponds in general.[13] Table 1 compares the two classes of ponds with respect to their physical dimensions. As would be expected, the small farm ponds are much smaller than the average pond—only about one-tenth as large.[14] The small farmers' ponds are also significantly shallower and show a much greater tendency to dry up in the winter : 73 per cent of the small farmers' ponds, but only 5 per cent of ponds in general, dry up at some point in the year.

Not all of the owners in the Ponds Survey were found to be farmers. Slightly more than one-third farmed no land at all, so that the potential for integrating such ponds into any self-sufficient farming system is clearly not very great. Table 2 compares three classes of farmers from the two Surveys : pond owners and non-owners from the Small Farm Survey and farmers from the Ponds Survey. There is no significant difference comparing mean cropping intensities, but in all other cases the differences are significant. Thus the

TABLE 1. PONDS, CULTIVATED AREAS AND LIVESTOCK

		Mean	COEFFICIETNTS Variation(%)	Skewness	Kurtosis	Percent Reporting
SMALL FARM SURVEY[a]						
Reported Pond Area	(m^2)	446	101.0	1.24	2.95	100.0
Max. Water Depth	(m)	1.3	36.1	-0.48	1.89	100.0
Min. Water Depth	(m)	0.3	163.1	1.12	2.40	100.0
Net Sown Area	(ha)	0.64	14.0	-0.39	2.34	100.0
Multiple Cropping Index	(%)	192	10.9	-0.09	2.29	100.0
Livestock Units		1.87	59.8	0.54	3.47	100.0
Livestock Units per hectare		3.03	53.0	0.60	2.34	100.0
SURVEY OF PONDS						
Reported Pond Area	(m^2)	4288	69.9	2.15	8.49	95.2
Mapped Pond Area	(m^2)[b]	4309	66.3	2.44	9.71	100.0
Max. Water Depth	(m)[b]	3.2	34.7	0.69	2.36	100.0
Min. Water Depth	(m)[b]	1.8	43.4	0.26	3.07	100.0
Net Sown Area	(ha)[c]	1.5	73.8	2.35	8.30	61.9
Multiple Cropping Index	(%)[c]	189	9.7	-1.50	3.81	61.9
Livestock Units		4.11	61.4	1.10	3.24	61.9
Livestock Units per hectare		3.40	47.2	0.09	2.16	61.9

NOTES : a. Pond owners only b. All owners in Survey of Ponds c. Farmers only.

TABLE 2. MEAN VALUES FOR FARM VARIABLES AND ANALYSIS OF VARIANCE

	Small Frarmers Survey		Ponds Survey Farmers	F— ratio	Level of signif. (%)
	without Ponds	With Ponds			
Net Sown Area (hectares)	0.42	0.64	1.49	9.98	0.01
Multiple Cropping Index (%)	191	192	189	0.05	n.s.
Livestock Units	1.78	1.87	4.11	8.29	0.01
Livestock Units per hectare	6.42	3.03	3.46	4.38	2.50

Ponds Survey farmers cultivate on average three times as much land as the small farmers' (and approximately 1.5 times as much as the national average[15]).

The question of livestock stocking rates is an interesting one. The Ponds Survey farmers have significantly more livestock than the other two groups, which is presumably a reflection of their relative wealth. On a per hectare basis, however, the farmrs without ponds have the highest stocking rates. This is partly a result of indivisibilities (the need for two animals for cultivation) and the fact that some of the smallest farmers have part-time jobs in transportation.

As can be inferred from Table 3, there are uses for ponds in addition to those covered in Table 4. Field drainage is an important such case. This both drains surrounding land and simultaneously provides a source of fish which have found their way into the flooded fields from neighbouring rivers, streams, canals, beels, etc. Ponds also provide both water and space for growing vegetables on trellises. Dried out parts of ponds are frequently used for winter (*boro*) paddy cultivation—either for nursery seedbeds or for transplanting the paddy itself. Aquatic plants play an essential role. As was shown earlier, fish farmers deliberately introduce plants like water hyacinth for the fish to graze, and the growth of algae is encouraged for the same purpose. Other aquatic plants such as *Kalmi shak* and *shapla* (water lily) are used for human consumption and the grasslike water plant *dol* or *dam* is grown as a cattle feed. This last plant plays an extremely important role in integrating

ponds with the farming system as it grows prolifically during the monsoon when other cattle feed is in very short supply.

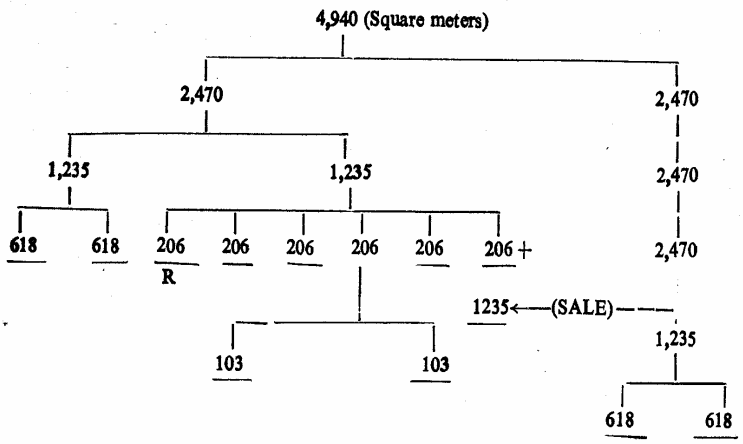

FIGURE. Fragmentation of Pond Through Inheritance (Case Study No. 4)
R = Respondent. Underline denotes living co-owner

OWNERSHIP OF PONDS

The existing uses of ponds, their integration into the farming system and the potential for further intensification are questions which are inextricably tied up with ownership and usufructuary rights. Multiple ownership is officially believed to be one of the basic constraints on such intensification[16]. This fragmentation derives from the Muslim laws of inheritance which give a share of the patrimony to all children, a single share to each daughter and a double share to each son[17]. A widow is entitled to one-eighth share if she has children and one-fourth if her husband dies childless. In practice however, the situation is more complex with women often surrendering their shares to sons or brothers in exchange for the right to visit their families[18]. Some concentration of ownership can also take place as some of the joint owners buy up (or inherit) shares from others. The accompanying figure illustrates the above points from an actual family case history encountered in the course of the Ponds Survey. It is the pond with the largest number of owners in the individually-owned group and is also described below (Case No. 4).

TABLE 3. OBSERVED PHYSICAL CHARACTERISTICS OF SAMPLE PONDS

Characteristics	Percent Ponds	Characteristics	Percent Ponds
Boundary Trees : Mature	100.0	Sunken Branches	81.0
Boundary Trees : Immature	71.4	Trellises for vines	23.8
Clear/Green Water	19.0	Inlet channel(s)	85.7
Muddy Water	81.0	Outlet Channel(s)	85.7
Platform for Washing	81.0	Surface Plants	52.4

TABLE 4. USE OF PONDS

	POND USED FOR :				Percentage
Household Purposes	Fish Production	Field Irrigation	Cattle Watering	Duck Rearing	Reporting Combination
X	X	X			33
X	X				22
X		X	X		9
X	X	X	X		9
X	X		X		6
X		X			6
	X				6
		X			3
X	X			X	3
X	X	X	X	X	3
91	82	63	27	6	100

Percentage of Owners Reporting this Use

Table 5 shows the distribution of ponds by number of co-sharers and by means of acquisition. These figures bring out several salient, perhaps surprising, features. First, most of the ponds were not acquired through inheritance. Second, fragmentation of ownership is not, it would seem, primarily the result of inheritance. Indeed the three ponds with the largest number of co-sharers are leased in and run by co-operatives. Apart from these, almost all multiple ownership ponds, whether inherited, purchased, constructed or leased in are held by male members of the same family : brothers, cousins, uncles, nephews.[19]

TABLE 5. DISTRIBUTION OF PONDS BY MEANS OF ACQUISITION AND NUMBER OF CO-SHARERS

Means of Acquisition	No of Co-sharers									Total
	1	2	3	4	5	6	7	10	10+	
	% of total ponds									
Inheritance	4.7	4.7	4.7	9.5	—	4.7	4.7	4.7	—	38.1
Purchase	—	4.7	—	—	—	—	—	—	—	4.7
Construction	9.5	—	4.7	—	4.7	—	—	—	—	19.1
Lease	4.7	4.7	9.5	—	—	—	4.7	—	14.3	38.1
TOTAL	19.1	14.3	19.1	9.5	4.7	4.7	9.5	4.7	14.3	100.0

Note : Survey of Ponds only.

UTILIZATION OF PONDS

Each pond in the Ponds Survey was visited and a basic set of physical characteristics recorded. These characteristics can to the reasonably experienced eye reveal a great deal about the uses to which a pond is put. All of the ponds in this Survey were found to have mature trees around the boundary and this is a fairly good indicaion that the pond was not recently constructed. This is to be expected in this particular case, since all of these ponds were mapped in 1975 or earlier.[20] The information inferred from the presence of a platform for washing is fairly obvious and water colour provides a rough indication of its quality, especially for household purposes. Surface plants and sunken branches are

both indicative of fish culture. Plants are introduced to provide both shade and feed for the fish. Branches are sunk to prevent clandestine netting of fish by night. They also provide a surface on which algae grows and this in turn provides feed for the fish.

Trellises for various gourds, especially pumpkin, are often constructed over a pond. This has the advantage of providing water for the plants, and shade for the fish as well utilising space that would otherwise be wasted. Inlet channels indicate either that the pond is used for field drainage/wild fish supply or that it is fed from a tubewell (which of these it is can easily be verified). Outlet channels suggest that the pond is used for irrigation—which can also be verified from the lie of the land and from the presence of small pools at the channel entrance.

Table 4 shows that almost all ponds (91 per cent) are multipurpose, with a wide variety of combinations of uses. 'Household Uses' include bathing, dishwashing, clothes washing and the supply of water for cooking. The use of ponds for duck rearing is not normally combined with household uses, as the ducks are said to foul the water. Three quarters of those who have ducks use their ponds for household purposes and not for the ducks.

OWNERSHIP AND POND USE

Apart from any problems resulting from multiple ownership as such, variations in the size of shares are likely to constitute a compounding factor, since they will further complicate problems of ensuring that shares in inputs (most especially non-purchased inputs like the co-sharers' labour) and output are proportionate to each other and to the share in the pond itself. Table 6 provides details of four such ponds which were encountered in the course of the Study. Again, although varying shares are a feature of inherited ponds, they are not exclusive to them.

The findings of the Ponds Survey have indicated quite clearly that multiple ownership of ponds causes problems only when the pond is—or could be—used for fish farming. For all other uses there is communal access and no instances of dispute were recorded. The following case studies exemplify ways in which ownership disputes have in practice hindred, prevented or terminated fish farming on such ponds. It will of course be appreciated that there is more than one side to every dispute. In these particular cases there are probably often as many sides as there are co-sharers. Provided this caveat is kept in mind, the studies do provide some useful insight into the nature and consequences of the problem.

CASE NO I : Respondent shares a 0.45 hectare pond equally with two uncles. He reported having stocked the pond at his own expense after the co-sharers had refused

TABLE 6. PONDS WITH UNEQUAL OWNERSHIP SHARES

Pond No.	No. of Owners	Range of Shares (%)	Means of Acquisitions
1	7	8.3-33.3	Inheritence
2	10	1.8-25.0	Inheritance
3	4	12.5-50.0	Inheritance
4	3	25.0-37.35	Leased In
5	2	31.0-69.0	Leased In

to contribute. When it became obvious that the productivity of the pond would be high, the latter forced him to harvest the immature fish, allegedly so that they could all share in the cost and benefit of restocking. However no agreement was subsequently reached and fish farming in this pond has now ceased.

CASE NO. 2 : Four brothers share equally in a 0.45 hectare pond originally excavated by their father. Two of the brothers wanted to stock with fry, but the other two refused to contribute to the cost. Some fish have been harvested but the pond was not then restocked for lack of a concensus.

CASE NO. 3 : Control of a 0.59 hectare *khas* (government leased) pond was disputed by two influential farmers. The respondent, whose land surrounds the pond, forcibly excluded the other claimant in order to raise fish. He reports ultimately having been obliged to buy out the other's (allegedly spurious) claim.

CASE No 4 : This is a pond of 0.5 hectare with 16 joint owners whose shares range from 2 to 30 per cent. Six of the joint owners are minor children under the Respondent's care. The dynamic of ownership fragmentation for this particular pond is illustrated above. The Respondent reports that some owners are interested in fish culture but others are not and will neither share in the cost of the required deepening of the pond nor will they assign to the others the exclusive right to raise fish on it. In frustration one of the owners has excavated a new pond on his own land and now raises fish without hindrance.

In the majority of cases, nevertheless, it has been found that multiple ownership, even where shares are unequal, has not prevented fish farming from taking place. There is

however, some evidence that, with the exception of ponds managed by co-operative associations, intensity of fish farming varies inversely with the number of different owners[21]. These co-operative associations are an important phenomenon tothe extent that they provide evidence that multiple ownership as such need not present a barrier to fish farming. Three such associations were encountered in the Ponds Survey. The largest, of 0.42 hectares, is run as a philanthropic operation and has no less than 132 members. The other two, of 0.39 and 0.38 hectares and 31 and 32 members respectively, are both *khas* ponds and both are fish-farmed fairly intensively. Howéver in Bangladesh it is not unknown for bogus co-operative associations to be formed on paper for the purpose of obtaining *khas* leases and other facilities from the government. It was not possible with resources to investigate these particular associations from this standpoint.

FISH FARMING AND ITS PROBLEMS

The particular focus of the present section should not be seen as an attempt in any way to depreciate the potential for fish farming in Bangladesh. It is rather an attempt to anticipate problems which may arise if and when a major thrust is put on this sector so as to facilitate their solution and realise the potential that undoubtedly exists. Fish farmers among the Ponds Survey respondents (97 per cent of the toal) were asked to report on difficulties they faced. Table 7 provides a summary of their answers. Not all of these statements should be taken at face value (particularly those relating to finance) - respondents have their own perceptions as to the possible outcome of a survey !

AVAILABILITY OF FRY : The major sources of fish fry are local fishermen (53 per cent), merchants (21 %) and other pond owners (18 %). In only nine per cent of cases were the fry obtained from the Department of Fisheries, despite the fact that there is a hatchery within 10 kilometres. Table 8 indicates the distribution by species of fish fry stocked. Carps are obviously favoured, but in every case a mixture is stocked. Stocking rates are very variable (Table 9) and this is according to the farmers, a reflection of supply shortages and irregularities[22].

ECONOMIC ASPECTS: Given the limited resources available for the Study, it was not possible to attempt a throughgoing analysis of the economics of fish cultivation[23]. Some data on costs have, however, been collected and this is summarised in Tables 9 and 10 in the text. The figures on cost of stocking fry do seem very high when compared to comparable costs for agricultural alternatives. For example, the cost of seed for a crop of *aman* paddy would be around 100 to 133 taka per hectare. If the cost of cultivation were added, it would total 500 to 750 taka per hectare.[24]

TABLE 7. PROBLEMS WITH FISH FARMING

Supply of Fry	Financial Difficulties	Lack of Consensus	Lack of Know-how	Pond Silted up	Poor Fish Growth	Percentage Reporting Combination
X						25
	X					15
X		X				10
X					X	10
X			X			10
X				X		10
		X				5
	X					5
	X			X		5
		X	X			5
65	25	20	15	15	10	100

Percentage of Farmers Reporting this Problem

Since most of the ponds are inherited, it is usually impossible to determine the original cost of construction. In other cases (20 per cent) there are many sources of variation-area, depth, soil type, use of family labour, year of construction, etc., which together with the small number of observations make it too difficult to draw meaningful conclusions from the Ponds Survey data on older ponds. However a check on recently constructed small (50-500 m^2) ponds in the area indicates construction costs of 119-124 thousand taka per hectare in 1979 (2 ponds) rising to Tk. 194,000 in 1981. The cost of land must be added and this is expensive, ranging from 75-375,000 taka per hectare (depending upon accessibility).

TABLE 8. CULTIVATED SPECIES OF FISH

SPECIES									Percentage Reporting Combination
Ruhi	Katla	Tilapia	Curfew	Mrigal	Kalbaus	Ire	Singhi	Magur	
X	X			X					25
X	X		X	X					15
X	X	X							10
X	X			X	X				10
X	X			X			X	X	10
X	X		X						5
X	X								5
X	X		X	X	X				5
X	X					X			5
X	X			X	X	X			5
X	X	X	X	X					5
100	100	15	30	75	20	10	10	10	100

Percentage of Farmers Reporting the species

Ruhi - *Labeo rohita* / Katla - *Catla Catla* / Tilapia - *Tilapia nilotica* / Curfew - *Cyprinus carpio* / Mrigal - *Cirrhina mrigala* / Kalbaus - *Labeo calbous* / Ire *Mystus sor* / Singhi - *Heteropreustes fossilis* / Magur - *Clavias batrachus.*

For a full description of species see Rashid (1965) chapter IX.

TABLE 9. FISH FRY STOCKING RATES AND COSTS

	Mean	COEFFICIENTS Variation (%)	Skewness	Kurtosis	% Reporting
No. of fry stocked ('000)	2.39	88.4	1.61	5.49	100.0
Stocking Rate ('000/ha)	5.72	78.2	1.36	4.21	100.0
Cost (Taka)	888	62.2	1.23	4.44	100.0
Cost per hectare (taka)	2458	74.4	1.16	3.44	100.0
Cost per thousand fry (taka)	554	63.0	0.33	1.83	100.0

TABLE 10. RENT ON FIVE KHAS PONDS

Lease No.	Period of Lease (years)	Amount Paid (taka)	Pond Size (m^2)	Effective Annual Rent[a] Tk/annum	Tk/ha/annum
1	6	200	3720	52.85	142.08
2	5	115	4250	34.31	80.72
3	3	150	3760	65.70	174.74
4	5	120	3930	35.80	91.09
5	5	90	3800	26.85	70.66
MEAN	4.8	135	3892	43.10	111.86

a. Based on the present value of an annuity. The 'annuity' here is the calculated annual rent and the 'present value' is the lump sum paid in advance. A mark-up rate of 15 per cent has been used.

There are several *khas* ponds in the area which are leased for fish cultivation. Several of these were obtained thirty years or so ago on a permanent lease against a down payment or annual rents which now seem incredibly low : e.g 3 taka ($0.15) per annum for a .5 hectare pond ! Some of the later leases are marginally more in tune with the market value of these assets, but still a very attractive proposition from the leasee's viewpoint[25]. Table 10 provides details of the five such leases encountered in the course of the Ponds Survey.

FEEDING : Most (68%) of fish farmers never feed their fish. Others do so only irregularly. Where they do feed, estimation of the cost is more than usually difficult : first the basis of the estimates is recall and second the inputs are almost exclusively farm produced. This means that neither their quantities nor their market values can be stated with any degree of accuracy. The most commonly reported fish feed is rice bran (86 per cent of those who feed their fish). This is fed together with either leftover cooked rice (43%) or fresh cowdung (43%). Puffed rice and mustard cake are also occasionally reported as feeds. The amounts fed vary greatly, averaging 64 kg per month of which 57 per cent is rice bran, and 20 per cent each leftover rice and cowdung.

TRAINING : Although lack of training is reported to be a problem by only a minority of fish farmers, it is evident that few of them have received instruction in modern methods of fish farming. Two members of the co-operatives reported having attended a one-month training course and rather less than one farmer in four has received technical advice either from the local Fisheries Department office or from a radio programme. The remaining three-quarters of the fish farmers have had no formal instruction at all.

OTHER PROBLEMS : A few problems relating to fish farming, other than those reported by the respondents, were encountered during the course of the study. Some of these may be minor at the moment, but could come increasingly into play as fish farming is intensified. Some of these relate to (non-human) predators such as snakes, carnivorous fish and kites, but most of the difficulties are man-made.

Among the latter class probably the most prevalent is theft. This is especially a problem for wealtheir owners with several ponds, some of which may be far from their residences. It also particularly plagues those who provide fish food, as the fish learn to gather when food is dropped into the water, thereby rendering them more easily caught. As noted earlier, branches are often placed in the water to prevent clandestine netting.

Another problem is that of evidently deliberate poisoning. This may be done by a personal enemy or, reportedly, simply from envy. It is usually done by putting insecticide in the water. This last problem was also encountered in Comilla by Bari a number of years ago. His explanation was that "one's rise does not encourage others ; rather one becomes victim of another's jealousy....in this social attitude people oppose new

ideas and innovations" (Bari 1974, p. 26). He then goes on to list a number of instances - including one of fish poisoning - in which innovative farmers have suffered loss, evidently at the hands of their neighbours. It is however very difficult to say if this problem is at all widespread. The fact that none of the sample farmers reported the problem suggests that reports may be exaggerated.

CONCLUSIONS

The study reported here has been an exploratory effort aimed at investigating key variables and relationships. As such it has produced some interesting findings which deserve to be tested on a larger scale. It has also revealed cartain topics whose complexity calls for study in greater depth. These ideas will be explored further, but first a brief note on methodology would be appropriate.

METHODOLOGY : In a survey of ponds a geographical sampling frame, such as the one employed here, is clearly appropriate. The *mouza* maps are extremely helpful as a starting point, but must be updated if newly constructed ponds are to be included. This could be very time-consuming unless an area sample were used. The alternative of a complete survey of mapped ponds will almost certainly produce a biased sample. In this case the bias was accepted on the grounds that such a sample would be most likely to throw the problems of fish cultivation into sharp relief. This last point has to be borne in mind when interpreting results.

The technique of the investigators themselves interviewing respondents is time-consuming and is best limited to small scale exploratory efforts such as this. The method, however, is appropriate for this purpose as it minimises enumerator bias. One test, built in to help assess the reliability of answers, was to measure the pond on the map as a check on the area stated by the respondent. The correspondence was found to be extremely close[26]. As a general rule as many such checks as possible should be built into a study-particularly if relatively less qualified enumerators are used. If possible non-survey sources of data should be tapped first in order to gain a picture of what a 'reasonable' answer to certain questions should look like. (This does not imply that 'unreasonable' answers are wrong - simply that they require further detailed investigation.)

The best approach to the type of work which would be required on a larger-scale study would probably be :

(a) an extensive survey based on area sampling ;

(b) an in-depth study of (randomly selected) examples of such areas ;

(c) market studies in as many local markets and over as long a period as possible ;

(d) a study of marketing, storage, preservation and processing facilities in order to estimate the possible impact of any marked increase in supply ;

(e) a study of fish traders - both those who supply fry and those who trade in fish.

PRESENT PROBLEMS : The major problems of fish farming uncovered in the course of the Study are non-availability of fish fry, lack of technical knowledge on the part of the farmers, the need for capital to construct or impove ponds and the question of multiple ownership claims. This last question will be deferred until later, but some observations on the other three may be useful at this point.

Non-availability of fish fry is reported by a large majority of fish farmers to be a major problem. It is one which has received considerable attention of late and measures are in hand which will, hopefully, improve the situation. Where capital requirements are not too great it might be possible to help certain farmers to become established as fish fry contractors in the same way that the Bangladesh Agricultural Development Corporation (BADC) has contract seed growers for crops like potato.

Lack of technical knowledge is a complaint of a number of farmers, and the great majority have had no technical training. This is an obvious requirement but further elaboration is beyond the scope of the present paper. One point which does, however, deserve mention is that the information imparted to farmers should be economically as well as technically optimal, since the farmer is in the business of making a living rather than trying to maximise fish production regardless of cost.

Fish ponds require considerable investment. First in the land itself and second in the construction and maintenance of ponds. Many farmers have reported need to re-excavate their ponds - and this is borne out by the fact that so many of the ponds, particularly those of smaller farmers with relatively few resources, dry up in the winter season. Since fish production seems a potentially very profitable business, pond excavation or improvement would seem an obvious candidate for loans-particularly in a case such as this, where the asset which provides surety for the loan is immovable.

INTEGRATION OF AQUACULTURE AND AGRICULTURE : This is not a simple issue. On the one hand it has been shown that as many as a third of pond owners are not farmers at all, so that the question of integration does not arise. Whether this is true in other less accessible parts of the country remains to be seen. Where fish ponds are owned by farmers, the degree of integration has been shown, already to be important. Farm products used as major fish foods are rice bran, leftover cooked rice and fresh cow-

dung. Minor products are mustard cake and puffed rice. Pond produce used on the farm includes fish, water, edible water plants, cattle fodder (particularly in the monsoon season) irrigation water, mulches, winter paddy (on the uncovered margins) and vegetables (on trellises). Ducks can be reared on fish ponds, but are not normally so where the pond is also used for household purposes.

MULTIPLE OWNERSHIP OF PONDS : This has been recognised as a problem for a long time in Bangladesh and legal measures to counteract it by means of requisitioning unused or derelict ponds go back almost half a century.[27] The findings of this study suggest that the problem may be more complex than is generally recognised. In fact in no case was a completely derelict pond actually discovered (unless one includes filled-in tanks which are a different phenomenon). All ponds are used for some purpose-bathing, irrigation, etc, apparently without dispute. Where problems do arise, especially over fish culture, they do not appear to have arisen from multiple ownership as such, or even from unequal ownership shares, but from multiple ownership by people forced together by inheritance. This is aggravated by frequent disputes as to the proportion owned by the various individual members of the group.

As the various constraints on fish farming are eased (eg fish fry availability, dissemition of technical knowledge), ponds will become increasingly valuable assets and the problem of any which are unutilised or under utilised will loom larger. First it will represent a waste of an increasingly important national asset and second, disputes within the group are likely to intensify given a jointly held asset whose potential value is growing. The difficulty in many such cases could become that of preventing the most powerful member of the group from simply appropriating the rights of the group as a whole.

If 'derelict' ponds were taken under public control, a large number of economic and equity issues would arise. Prominent among these would be the questions of disposal (as is presently the case with *khas* ponds). Present policy with regard to allocation of *khas* ponds is to favour co-operative groups and associations, and it would appear from the present findings that these can operate well. It must be stressed, however, that more detailed studies woud be required before any definitive judgement could be passed regarding the formation and operation of these associations. Some of them may well transpire to be more apparent than real. A related issue would be that of determining the optimum level of rental to charge - from the viewpoints of both owners and lesses. A major objective of a study such as that proposed here would be to determine the ruling market rate for pond rental in the private sector, as this would be a most useful input into policy decisions aimed at determining realistic rental levels for publicly-owned and publicly-operated ponds.

ECONOMIC FACTORS : The economics of aquaculture and of its integration with agriculture are difficult and fascinating areas for investigation. The required research ranges from the micro to the macro level. At the micro (farm) level, study of the optimum mix of agriculture and aquaculture is required, given the competing use of resources, especially land, and the need to optimise the balance of inputs and outputs between the different competing or mutually supportive elements of the farming system.

At the national level a very marked increase in production of a highly perishable product like fish has very important implications for marketing, storage, processing and food preservation policy. Without adequate such facilities, fish production will never rise substantially above the levels required for subsistence and local consumption. One vital area in which studies are required is to determine the price elasticities of demand for and supply of fish, and hence the likely effect of any anticipated price fall on production and consumption levels. The success or failure of income and employment generating activities is also likely to have a marked impact on the demand for a high quality preferred food like fish, as is the supply and demand situation for staple foods such as rice and wheat, that of competing forms of protein like pulses, and that of complementary foods like vegetable oils. Hence reliable estimates of income and cross elasticities are also highly desirable.

The collection of such data will present challenging problems. At the farm level some fairly detailed farm management studies repeated over a reasonably long time period are required. Only in this way can reliable estimates be obtained at the micro level. At higher levels of aggregation studies of local marketing, storage, processing and transportation facilities will have to be conducted in such a way as to take seasonal variations into account.

Notes

1. Fish presently provides around 80 per cent of all animal protein supplies in Bangladesh, 85 per cent of it deriving from fresh water sources (Bangladesh 1980b). The retail price of fish exhibits much greater seasonality than that of other animal proteins. At its cheapest the preferred fresh water carp, *rubi* (*Labeo rohita*) retails at about the same price as beef and at its most expensive around 60 per cent more per kg.

2. See, for example, Bailey (1982) for a graphic account of the production increases achieved in demonstration farmers' ponds in Noakhali District.

3. "It is difficult to remember that only a few years ago there seemed to be a very serious prospect of starvation in the poorer world, particularly in Asia" (Sir Arthur Gaitskell in the Foreword to Nulty (1972)) Similarly optimistic views were expressed by others, of whom one of the better known was Lester Brown.

4. A very great deal has been written on this topic. Among the most enlightening are Falcon (1970), Yudelman *et al* (1971) and Griffin (1974).

5. See, for example, Bangladesh (1980), p. XII. 87 and IBRD (1980) pp. 27-31.

6. There is presently a proposal to conduct socio-economic research among marine fisherman (Bangladesh 1982, p. 34).

7. BFDC (1977).

8. The two exceptions are Banik (1979) and Islam (n.d.).

9. See the paper by Gill and Sultana (1982).

10. Described more fully in Jackson *et al* (1982).

11. See for example Chowdhury and Bailey (1978) for an assessment of profitability of fish culture.

12. The State Acquisition and Tenancy Act, 1950.

13. Although the Surveys were conducted in North and South Shalna respectively (in order to avoid any overlap) there is no reason to believe there is any difference between the Survey Areas.

14. Analysis of Variance : difference in means is significant at the 0.01 per cent level for both mean area and mean depth.

15. The mean is, however, pulled up by a few large farmers : two in three of the Ponds Survey farmers would have qualified for inclusion in the Small Farm Sample, having less than ten bigha of land.

16. See for example, (BARC 1982, p. 95) ; (Bangladesh 1980b, p. 6) and (Bangladesh 1980, pp. XXII 54-68)

17. The laws of inheritance as laid down in the *Quran* are quite comprehensive. See especially Sura II verse 240 and Sura IV verses 11, 12, 19 and 176.

18. See, for example, Jahan (1975).

19. An exception is a pond three quarters of which is shared eqully between and for the support of the school and the mosque. The owner retains the remaining quarter share.

20. With training it should be possible to estimate the age of the pond from that of the trees.

21. For example, there is a negative correlation between number of owners and the rate at which fish fry are stocked per unit area ($r^2=0.26$, $p<0.05$).

22. There is a low-lying riverine area to the west of the *mouza* where fish fry are reportedly plentiful. However no statistically significant relationship was found between stocking rate and distance from the pond to the *mouza's* western boundry.

23. Such an evaluation would of course have to include relative benefits as well as costs. However regardless of anticipated benefits, a heavy initial outlay might by itself debar the poorer farmer from fish cultivation.

24. Seeding rates and planting times for *t. aman* were computed from Bagladesh (1980a) p. 4 ; paddy prices (nizershail) were kindly supplied by D.C. Millar, BRRI and are the Joydebpur average for the 1981 planting season ; ploughing charges are computed from Gill (1981) Table 4.1.9.

25. The effective average annual rental of Tk. 112 per hectare (Table 10) might usefully be cmpared with that of privately leased agricultural land. This is typically on a 50-50 sharecrop basis with the tenant supplying all inputs. Even in the 1981 season, which was a year of poor harvests, annual paddy production averaged 32.6 quintals per heactare (2 crops) worth approximately Tk. 4,560. The average rent was therefore Tk. 2,280 per annum. This is without the investment and improvement inherent in pond construction. (Sources of data : Small Farms Survey (Yields) and Bangladesh Rice Research Institute (prices).

26. $Y=22.9+0.99\ X$ where Y=reported area and X=mapped area ; ($r^2=0.93$, $p<0.001$) ; The value of the slope coefficient indicates a virtually one-for-one relationship, as does the very small intercept value.

27. The Tank Improvement Act, 1939, contains a number of such provisions.

REFERENCES

Bailey 1982 W. Bailey : *Fish Ponds and Agriculture Development in Bangladesh,* in Jackson (ed) (1982).

Bangladesh 1978 Bangladesh Government : *Status and Potential of Bangladesh Fisheries.* Dhaka : Ministry of Fisheries and Livestock, 1978.

Bangladesh 1980 Bangladesh Government : *The Second Five Year Plan,* 1980-85. Dhaka : Planning Commission, 1980.

Bangladesh 1980b Bangladesh Government : *The Yearbook of Agricultural Statistics of Bangladesh,* 1979-80. Dhaka: Bangladesh Bureau of Statistics, 1980.

Bangladesh 1980c Bangladesh Government : *Development Programme of the Directorate of Fisheries.* Dhaka : Directorate of Fisheries, 1980.

Bangladesh 1982 Bangladesh Government : *Marine Fisheries Research, Management and Development Project (draft).* Dhaka : Directorate of Fisheries, 1982.

Banik 1979 R. C. Kangsa Banik : *Survey of the Use of Night Soil and Other Household Wastes for Fish Culture.* Chandpur : Directorate of Fisheries, 1979.

BARC 1982 Bangladesh Agricultural Reserach Council : *Inventory on Present Status of Fisheries Research in Bangladesh.* Fisheries Technical Working Group. Dhaka : April 1982.

Bari 1974 Fazlul Bari : *An Innovator in a Traditional Environment.* Comilla : Bangladesh Academy for Rural Development, 1974.

BFDC 1977 BFDC : *Proceedings of the Seminar on Quality Control and Marketing of Fish at Chittagong Fish Harbour.* Chittagong : Bangladesh Fisheries Development Corporation, 1977.

Brown 1970 L. Brown : *Seeds of Change, The Green Revolution and Development of the* 1970s. Washington : Praegar for the Overseas Development Council, 1970.

Chowdhury and Bailey 1978 A. Q. Chowdhury and W. M. Bailey : *Fishery Development in Irrigation and Flood Control Systems.* First annual Report ; Bangladesh Directorate of Fisheries with Snell Environmental Group. Dhaka : June 1978.

— : Second Annual Report (July 1979).
— : Third Annual Report (August 1980).
— : Fourth Annual Report (July 1981).

Falcon 1970 W. P. Falcon : The Green Revolution, Generations of Problems *American Journal of Agricultural Economics,* LII, 5 (1970).

Gill 1981 G. J. Gill : *Farm Power in Bangladesh,* Vol. 1. University of Reading Development Study No. 19. Reading, England : 1981.

Gill and Sultana 1982 G. J. Gill and W. Sultana, : *Women's Role in Small Farm Resource Management, A Case Study in Joydebpur, Bangladesh, in* Preston (ed), 1983.

Griffiin 1979 K. Griffiin : *The Political Economy of Agrarian Change, An Essay on the Green Revolution.* London : McMillan, 1974.

IBRD 1980 IBRD Bangladesh : *Current Economic Position and Short-Term Outlook.* Washington : March 1980.

Islam n. d. Aminul Islam : *A Survey on the Socio-economic Conditions of the Mobeskhali Islands with particular Reference to the Crafts and Gears they Use for Fishing in Coastal waters.* Mymen singh : Bangladesh Agricultural University.

Jahan 1975 Rounaq Jahan : "*Women in Bangladesh*" Dhaka : Women for Women Research and Study Group, 1975.

Nulty 1972 L. Nulty : *The Green Revolution in East Pakistan, Implications of Technological Changes.* New York : Praeger, 1972.

Preston 1983 T. R. Preston : *Maximum Livestock Production from Minimum Land, Proceedings of the Third International Seminar.* Mymensingh : Bangladesh Agricultural University (Forthcoming).

Rashid 1965 Haroun or Rashid : *East Pakistan, A systematic Regional Geography and its development planning Aspects.* Lahore : Sh. Ghulam Ali and Sons, 1965.

Yudelman et. al 1971 Yudelman, Butler and Banerji : *Technological Change in Agriculture and Employment in Developing Countries.* Paris: OECD Development Centre, 1971.