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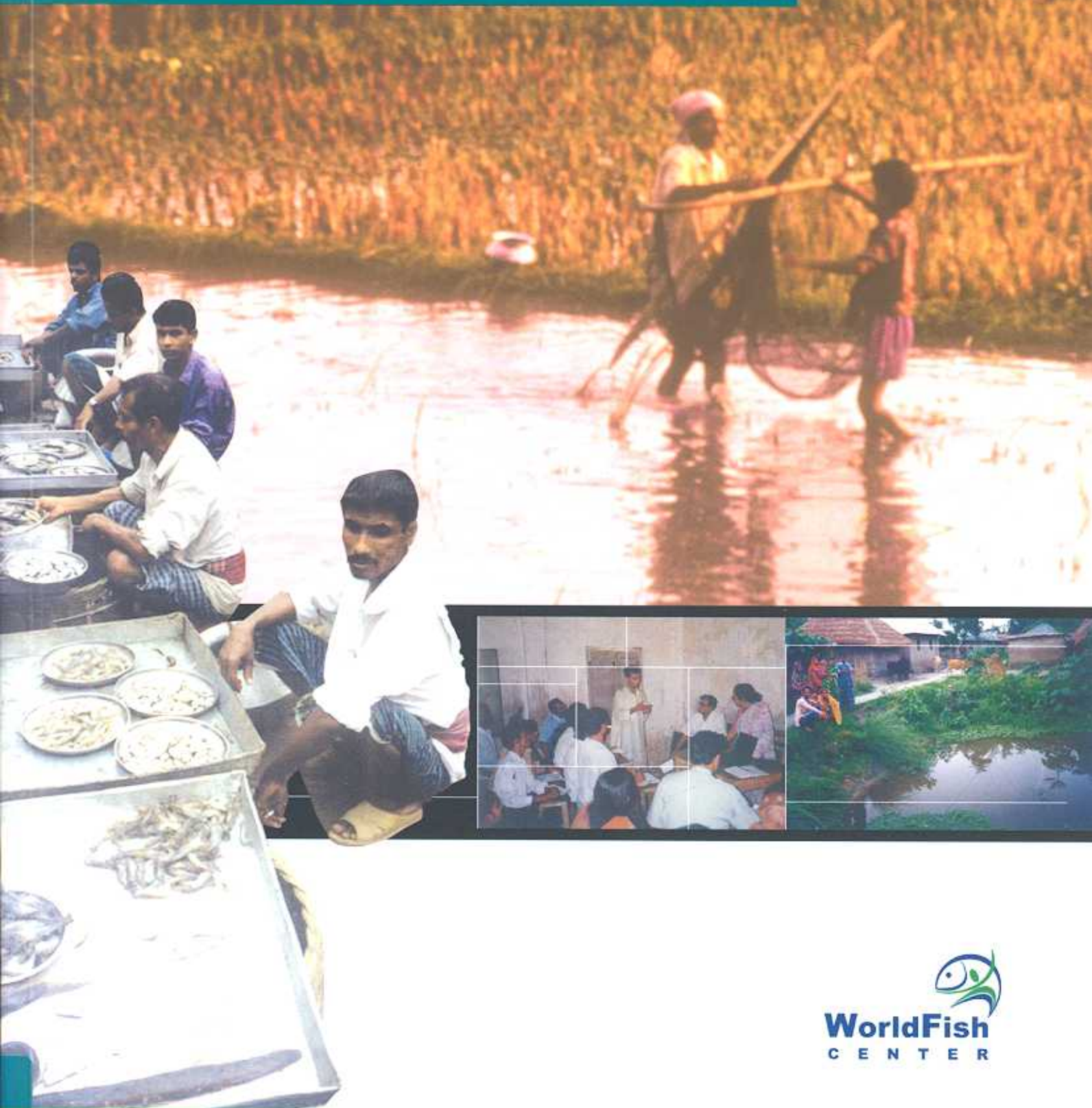

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Contents

Foreword

A follow-up study was made on the impact of fish-culture extension work on the farming systems of Bangladesh. The hypothesis under consideration stated that "a planned effort to disseminate knowledge and practices about aquaculture can help farmers adopt new technologies within their existing farming systems and can lead to increases in production, consumption and income." The original project, which introduced several new technologies through training and demonstration activities, was implemented during 1990-94 by the joint effort of the WorldFish Center and the Department of Fisheries, Bangladesh, and funded by IFAD and DANIDA. At that time information about improved aquaculture technologies and farming practices was less available, and small-scale farmers were at a particular disadvantage due to lack of access to extension services. The project demonstrated that farmers, encouraged and motivated to adopt improved fish farming practices, could increase fish production from existing ponds and small water bodies by 4-5 fold, even in the absence of credit and input support.

Over the last decade Bangladesh has seen a notable increase in the production of fish from aquaculture—with average annual growth rates from 10-12%. A combination of local and national level efforts such as private sector participation, on-farm research, micro-level technology transfer, expansion of markets, and information dissemination through mass media have contributed to this growth. This household-level impact study confirmed that making the knowledge about technologies available through extension services could accelerate the rate of adoption, especially in the early stages of the development of the aquaculture industry. The quantity of fish consumed by fish farming households also increased; another significant impact. In the post-extension situation farmers not only continued with the fish farming practices, they also made changes to their farming practices, adapting further when supplied with new knowledge about technologies and markets.

This type of ex-post study emphasizes the benefits of innovation and the role of communication. It is particularly important in the rural economy of Bangladesh, which is still based on small-holder cropping, livestock and fish enterprises.

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We also thank all of the many pond operators and fry traders who cooperated in the study by answering the surveys or participating in discussions. Special thanks are due to the 69 households in Kapasia that undertook detailed monitoring of their ponds and fish and food consumption for 14 months. We hope that the findings of the study do justice to all their hard work and interest in the project.

Abstract

With many ponds and a high demand for fish, Bangladesh has a high potential for aquaculture. Since the 1980s, there have been many aquaculture extension projects. As a result, pond aquaculture production is estimated to have trebled between approximately 1990 and 2000, and is currently estimated to be in the order of 750 000 t per year. This gave an ideal opportunity to understand the impacts of aquaculture extension. This study investigated the practices and performance of farmers about six years after specific extension efforts had ended, in order to gain a better understanding of the sustained practices and benefits achieved by fish farmers from extension. It followed up an earlier project in Kapasia Upazila (subdistrict) in Gazipur District north of the capital Dhaka, where the WorldFish Center (then ICLARM), with funding from the International Fund for Agricultural Development (IFAD) and the Danish International Development Agency (Danida), had researched on farming systems and had introduced adaptive integrated aquaculture practices. Surveys were undertaken to compare the aquaculture systems with baseline and project period data.

In 1990-93 in Kapasia, WorldFish introduced low-input aquaculture for pond owners to adapt to the farming systems. Impacts on production, fish consumption and markets were then assessed by the study reported here in 1998-99. The percentage of ponds stocked increased from 1990 to 1998, but did not differ significantly between past participants (increased from 61% to 90%), neighboring pond operators or a control area. In 1992, participants' fish production was 2 t/ha compared with 0.5 t/ha in 1990. Benefits had been sustained by 1997-98 with some demonstration effect apparent: the previous participants produced (2.2 t/ha) significantly more than other pond operators in Kapasia (1.6 t/ha) and control area farmers (1.3 t/ha, $p<0.001$, t-test). Nonparticipants learned about aquaculture from their neighbors or the mass media. Total production from ponds in the project area in 1998 was 4.2 times greater than in 1990. Without the earlier project, production would probably have gradually increased but only by 2.8 times over the same period (based on trends in the nearby control area of Sreepur where there was no specific extension project). Local fish markets were surveyed in 1991 and 1999. The volume of fish traded increased eight times. Carp from local ponds now dominate trade. Consequently, the real price of carp has fallen, while that of indigenous wild-caught fish has increased. Detailed participatory household monitoring over a year revealed much higher fish consumption than shown in recall data. Pond-owning households consumed 211 kg of fish per household in 1998-99 (just under 90 g/person/day), about 25% came from their own ponds. Small fish purchased or caught in flooded fields were mainly consumed, pond fish were sold for income. However, aquaculture growth failed to compensate poorer households for the coincident loss of small fish that they had caught for self-consumption from floodplains and open waters. Loss of wetlands to agriculture and siltation, plus enclosure of some wetlands for stocking fish were reported to be the main causes. Consequently nonpond owners (majority of the population) reported reduced fish consumption over the last decade.

Stocking carp in ponds has now become widespread in Bangladesh, but direct extension recipients six years after extension on average have higher yields and follow better practices than do other farmers who have adopted aquaculture based on observation of their neighbors or information presented in the mass media. Overstocking is common among all pond operators, but extension recipients follow lower stocking densities and fertilize their ponds and feed fish more. Irrespective of input use, there is evidence of better production from ponds operated by extension recipients suggesting that they have learned how to manage their ponds, but those who do not sell fish tend to have low production relative to input use. Demonstration effects have occurred but the general expansion of aquaculture is also linked to information received through the mass media.

Chapter 1
Introduction

Study Overview and Objectives

The true test of an extension program is the sustainability of the practices that it extended, the associated increases in production, and the resulting improvements in incomes and welfare of technology adopters when there is no further project intervention or intensive extension. With funding from the International Fund for Agricultural Development (IFAD), in 1997-2000, the International Center for Living Aquatic Resources Management (ICLARM, now known as the WorldFish Center) working with the Bangladesh Department of Fisheries (DOF) undertook such an impact assessment. The aim of the project was to assess longer-term sustainability of aquaculture technologies introduced by an earlier project supported by IFAD and the Danish International Development Agency (Danida) and led by WorldFish and of aquaculture technologies extended by other projects and approaches. Hence, the project was designed to carry out evaluations of aquaculture practice and outcomes several years after the intensive extension efforts ended.

Specifically, this project studied the sustainability of aquaculture in Kapasia Upazila in Gazipur District north of Dhaka (where the earlier ICLARM project was located) and also made a comparative assessment of the impacts of three other fish culture extension efforts. The immediate objectives of the project were to:

1. Evaluate different fish culture technology transfer methods and approaches practiced by DOF;
2. Evaluate fish production input and credit access of fish farmers through different projects;
3. Evaluate demonstration and training activities provided to fish farmers through different projects of DOF and nongovernment organizations (NGOs);
4. Evaluate the sustainability of fish culture systems of farmers where specific project extension efforts have been completed; and
5. Assess input-output relationships and benefit-cost analysis of fish culture within farming systems of small-scale farmers.

The long-term development objectives of DOF that underlie this project are to:

1. Develop sustainable fish culture extension services suitable for poor rural fish farmers;
2. Strengthen the institutional capability of the fish culture extension service of DOF; and
3. Develop the planning capability of the fish culture extension services of DOF.

For the comparative aspects of the study, the following DOF aquaculture extension projects were investigated:

- Mymensingh Aquaculture Extension Project (MAEP) which is assisted by Danida has adopted a higher input approach to promote aquaculture by including a package of technology and providing credit to fish farmers;
- North-west Fisheries Extension Project (NFEP) which is supported by the Department for International Development and has adopted a range of extension approaches including demonstration ponds, training of communities (model villages) and developing fish seed traders as informal extension agents; and
- Thana Level Aquaculture Extension Project (TLAEP) which is funded by the Government of Bangladesh (GOB) and is the main national-level program of extension based on demonstration ponds.

However, this technical report presents the findings from the studies in only Kapasia Upazila. The results and observations of the impact studies of fish culture extension projects are expected to help guide the improvement of future extension programs of DOF throughout the country.

Background

Pond aquaculture was one of the main contributors to the 7% per year growth in Bangladesh fish production from 1989-90 to 1998-99 (DOF 2000). Bangladesh has perhaps 1.3 million ponds covering 215 000 ha (Bhuiyan 1999; DOF 2000). Most were created when households excavated earth to raise their

homesteads above normal flood levels. With the advent of large-scale production of carp fingerlings from private hatcheries in the late 1980s, and their distribution to potential small-scale customers throughout much of the country through complex networks of fry traders (Lewis et al. 1996), there has been a major increase in pond fish production. According to official figures, this has helped to compensate for declining catches, particularly of carps, from inland open waters. According to DOF (2000), production from ponds more than trebled between 1988-89 and 1998-99 to almost 0.5 million t or 32% of the total fish production. This trend has been supported by a number of aquaculture extension projects of DOF and by extension messages in the mass media.

Rahman et al. (2002) found that there were about 10 substantial freshwater aquaculture extension projects active in Bangladesh in 2001 funded by external donor agencies and that donor support to Bangladesh aquaculture during 1985-2005 has averaged about US$15.9 million per year. Most were DOF projects, but many of these also involved the very large NGO sector in Bangladesh, and some were/are operated directly by NGOs. Moreover, DOF has its regular extension services and a number of NGOs also have their own extensive aquaculture programs. There are thus a wide range of national and localized aquaculture extension activities involving a range of extension approaches and packages. These include work to extend rice-fish culture, cage aquaculture and training of extension staff. However, the main focus of extension has been on polyculture of carp in many small private ponds. Although tilapia (*Oreochromis mossambicus/niloticus*) is important in some regions (Barman et al. 2002), about 85% of fish produced in ponds are carps (DOF 2000): indigenous major carps (Rui, *Labeo rohita*; Catla, *Catla catla*; and Mrigal, *Cirrhinus cirrhosus*), introduced silver carp (*Hypophthalmichthys molitrix*), and common carp (*Cyprinus carpio*). DOF (2000) estimated fish production of 3 080 kg/ha/year in cultured ponds and 2 610 kg/ha/year in all ponds during 1998-99, but these figures may be higher than those normally achieved in typical ponds.

Despite this large investment in aquaculture extension, there has been virtually no assessment in Bangladesh of the practices of pond operators after extension and thus of the sustainability or impacts of aquaculture extension, or of the wider implications of pond aquaculture on local fish availability. Similarly in other countries there have been diverse extension efforts for freshwater aquaculture, and considerable debate over appropriate approaches. For example, traditional government systems were widely criticized for being top-down, and for over a decade WorldFish has been developing and using participatory approaches to integrated aquaculture (Lightfoot et al. 1991). Different extension approaches have been documented and compared, and the appropriateness and flexibility of NGO approaches have been noted, for example, in rice-fish culture extension in Thailand (Surintaraseree and Little 1998) and for pond aquaculture in Bangladesh (Lewis 1998). Some studies have documented networking and fish seed supply as a way of extending aquaculture through the availability of the key input, fingerlings (Lithdamlong et al. 2002), and extension messages and appropriate recommendations for poor farmers are regularly considered and developed by development projects, for example in Vietnam (Tu and Giang 2002). But there are few published assessments of the uptake and impacts of extension. Some project reports in Bangladesh have reported the gains in aquaculture production from different extension approaches immediately after extension (Chowdhury et al. 1998b and 1998c). Some detailed household impacts from aquaculture in Mymensingh have also been assessed but this was done when extension support was still being provided – extension participant households had about 80% higher cash profits from aquaculture and sold about three times the amount of fish as nonparticipants with ponds, but they did not eat more fish by simply substituting a small amount of cultivated (larger) fish for small fish bought in local markets (IFPRI et al. 1998). However, there appear to be virtually no ex-post assessments of the continued practices and performance of small-scale pond aquaculture several years after extension or of the impacts at the household and wider community levels. This study aimed to address this gap.

The Previous Project

During 1990-94, ICLARM in collaboration with GOB agencies (DOF, Bangladesh Agricultural Research Council and Bangladesh Fisheries Research Institute) carried out a project, Socio-economic Impact of Fish Culture Extension Program on the Farming Systems of Bangladesh. It was funded by IFAD and Danida, and was carried out in Gazipur District to the north of Dhaka, the capital of Bangladesh. It involved both extension

and research with many of the households with ponds in a small part of this district.

Because many ponds were underutilized in terms of fish production, it was expected that an extension program to provide farmers and pond owners with information on pond fish cultivation would have a significant impact on incomes and production. The extension program aimed to make fish cultivation accessible to all rural households; to increase pond fish productivity, on-farm fish consumption and household incomes; and to increase the general supply of fish. The research objectives of that project were to:

1. Determine the degree by which an intensified fish culture extension program affects the rate of technology adoption by rural households;
2. Develop a framework to assess the socio-economic impact of extending fish culture techniques to rural households;
3. Evaluate the effects on fish production in the target farming region; and
4. Provide a model for estimating the benefits and costs of rural fish culture programs.

Table 1.1. Components of extension in the earlier WorldFish project in Kapasia

A. Extension services
1. Farm visit and monitoring - scheduled visits, followups on farm activities, farm monitoring, identifying problems
2. Farm assessment - technology, input needs, input availability, budget needs
3. Technical advice - problem solving, advisories on farm activities, pond preparation, stocking, fertilizer and manure applications, preparation of composts, caretaking and pond management, harvesting and marketing
4. Assistance in inputs - arrangements of fry/ fingerlings, fertilizer and food, equipment
B. Training, publicity and demonstration
1. Meeting and lectures
2. Farm demonstration - method, result
3. Farmer rallies
4. Farmer to farmer visits
5. Leaflets and pamphlets
6. Audiovisuals
C. Input support
1. Access to supply of fry/fingerlings
2. Fertilizer
3. Tools and equipment
D. Recordkeeping
1. Farm budget (input-output)
2. Records of inputs and outputs
3. Records of purchases, sales and consumption
4. Records of training visits and advice

Source: Quarterly and annual progress reports of the earlier WorldFish (at that time ICLARM) project in Kapasia.

Before the project, fish culture knowledge in the target area was low, and there was potential to improve techniques, input use patterns and pond management. Extension focused on participatory information exchange where flexible aquaculture techniques were suggested to meet the needs and problems identified by farmers, for example using fish species preferred by poor people and using feed available from onfarm resources. It was hoped that this approach would be more cost-effective and sustainable than provision of more prescribed packages including those that are tied with credit provision.

Table 1.1 summarizes the components of extension-related activities of that project, but it should be remembered that the earlier project was also a research project. Table 1.2 summarizes the numbers of participants in various technologies introduced by the earlier project and the production levels achieved.

A project-control methodology for this earlier study was adopted, with Kapasia Upazila (subdistrict) forming the target area and Sreepur Upazila the control area. A benchmark survey was carried out at the start of the project (Ahmed 1992). This showed that owners and operators of small waterbodies (ponds) averaged higher socioeconomic status than the rest of the farming community in terms of land ownership, farm size and income. It also indicated that functionally landless households (those with under 0.2 ha of own land) could be involved in aquaculture in small ponds and roadside ditches. This was followed by a more detailed socioeconomic baseline survey in both project and control areas before the extension efforts, along with surveys of local fish markets. The results were summarized and analyzed in Ahmed et al. (1993) which form the basis for comparison with many socio-economic results from the present study.

Assessment at the end of the project showed that minimal investment (even without credit provision) increased production and incomes of participating fish cultivators (Ahmed et al. 1995). Carp and tilapia yields were four times higher than they were before the project extension activities. Production was measured by the species cultured, size of waterbody and land area owned. For 215 ponds where the technology was adopted, average annual production was highest for carp

Table 1.2. Achievements of the original extension activities in Kapasia

Activities	Year 1 1990-91	Year 2 1991-92	Year 3 1992-93
Ponds under project-advised aquaculture	-	257	348
Nurseries	-	6	55
Beels stocked	-	2	16
Rice-fish farm	-	4	8
Poultry-fish farms	-	-	5
Farmers trained	-	345	242
Farmers who attended rallies	-	258	197
Production from pond fish culture (kg/ha)			
Sharputi	-	1 149	NA
Nile tilapia	-	2 087	NA
Carp	546	2 057	NA
Production from beel fish culture (kg/ha)	-	-	598
Production from rice-fish farm (kg/ha)	-	-	735

Note that the first year was composed of baseline work before extension was introduced. While there was some extension work in the fourth year, this expanded the project into another two unions of Kapasia, but details and outcomes in this expansion area were not fully reported by the earlier project. Data on production by participants in year 3 are not available.
Source: Quarterly and annual progress reports of the earlier WorldFish (at that time ICLARM) project in Kapasia.

polyculture (2.7 t/ha/year) and Nile tilapia (3.3 t/ha/year), compared with average pre-project production of 0.6 t/ha/year from locally developed systems of polyculture of Indian major carp. As a result of extension, physical input levels increased in some cases modestly (for example, use of cattle manure increased by just under four times), and in other cases increased greatly (for example, a 12-time increase in the average quantity of rice bran fed to fish in carp polyculture ponds). Input costs averaged just over Tk14 000 per ha for technology adopters over a 12-month period for carp and tilapia, but of this, 25 to 50% was an imputed value for inputs provided from on-farm sources. Overall net return to purchased inputs averaged Tk45 700 per ha for the same period, but this included ponds affected by fish disease. The return on investment (ratio of net income to total costs) for disease-free carp polyculture was about 500%.

A model was developed to calculate costs and benefits for fish farmers by species of the fish cultured. This showed that small-scale fish culture developed through this project gave high net incomes relative to production costs. The project was, therefore, regarded as successful in extending low-cost fish culture technology, which was adopted by the target population and proved to be profitable.

Surveys in Kapasia and Sreepur during 1998-99

Background to survey design

The original baseline survey in the WorldFish project was based on a sample of ponds in Kapasia (project area) and Sreepur (control area). Subsequent detailed recording of pond culture systems was for participants in only Kapasia Upazila, with the most detailed information available on fish culture following the first year of extension (Ahmed et al. 1995). The ponds were categorized as small (under 15 decimals – 0.06 ha), medium (15 to 30 decimals – 0.06 to 0.12 ha) or large (over 30 decimals – 0.12 ha). This determined the preferred fish culture system recommended to participants (operators of small ponds were encouraged to cultivate tilapia or silver barb), but as reported in the first year, uptake of tilapia was low. Operators of medium and large ponds were encouraged to adopt a polyculture of native and exotic carps. However, actual practice of the pond operators depended on their preferences. The design of monitoring under the earlier project separated ponds by fish culture system (species adopted).

Based on consultations and group discussions with past participants held in early 1998, it was concluded that drawing samples in 1998 by previous technology adopted was not feasible. Sampling should distinguish between small and medium-large ponds since the operating conditions are different (more small ponds are seasonal) and the original technologies recommended were different.

In addition, pond operators in the group discussions reported a clear demonstration effect, an important benefit may, therefore, have been that more noncontact farmers in Kapasia have adopted fish culture because of the experience of their neighbors. Therefore, it was decided that the surveys should also cover nonparticipants in Kapasia. The experiences and achievements of past and nonparticipants in Kapasia also needed to be compared with pond operators in Sreepur as a control area that represents the normal extension effort which would have taken place in any case in Kapasia during and after the WorldFish project. The previous baseline survey in Sreepur meant that a paired comparison of change in the control area and change in the project area could be made. That is a before-after comparison in both with and without extension areas, with an

Table 1.3. Categories of pond operator with numbers found in census (1998 update) and sample size adopted in parentheses

Location and extension status	Small pond operator	Medium-large pond operator	All pond operators
Kapasia participant (years 1 and 2) and not MAEP	134 (30)	138 (30)	272 (60)
Kapasia participant (year 3) and not MAEP	83 (20)	63 (20)	146 (40)
Kapasia not WorldFish participant and not MAEP	1 017 (30)	550 (30)	1 567 (60)
Kapasia MAEP participant	37 (0)	37 (0)	74 (0)
Total Kapasia	1 271 (80)	788 (80)	2 059 (160)
Sreepur	161 (30)	499 (30)	660 (60)

additional after sample of nonparticipants in the "with extension" area.

A last factor to consider was that MAEP had started to work from 1997 in parts of Kapasia, including some of the unions where the earlier project worked. Up to the time of this study, the number of participants was relatively low, but they had clearly benefited (based on group discussions) from the package extension-credit approach adopted by that project and needed to be excluded from this study. Otherwise, recent MAEP extension benefits might have been attributed to the earlier project. It would have been very difficult to separate any recent demonstration effect of this project from the WorldFish project and so MAEP participants were excluded from the surveys.

Given the objectives of the present study, the analytical opportunities offered by the earlier research in Kapasia and Sreepur, and the range of extension-related activities undertaken in the earlier project, a number of surveys were designed as follows:

1. Main household survey of pond operators in the project and control areas based on a single round of interviews;
2. Detailed monitoring over 18 months of pond operations and fish consumption, with less detailed field crop data, for a sample of practicing fish farmer participants of the original project extension effort;
3. More qualitative case studies of past participants who adopted other technologies not covered by the first two surveys (i.e., excluding pond aquaculture to produce table-size fish); and
4. Survey of traders in fish markets and qualitative study of fish consumers (people with no pond).

Main survey design and sampling

Several categories of pond operator were distinguished for sampling. Note that the operator is more important than the pond, since some pond cultivators have invested in more than one pond, but the technology is adopted by people (pond operators) who then apply it to ponds.

Location and involvement in the earlier project were factors that were considered. The separate samples surveyed were: WorldFish participants in years 1 and 2 of the earlier project; WorldFish participants in year 3 of that project (these were separated because of differences in intensity of extension and in location); other households with ponds in Kapasia (for possible demonstration effect); and pond owners in Sreepur Upazila (the control area). Subsamples were taken, stratified by pond size. Operators of small ponds (up to 15 decimals) were sampled separately from large pond owners (over 15 decimals) because the earlier project had made different recommendations for these small ponds (suggesting that their owners stock with tilapia and silver barb or "Thai sharputi", *Barboides gonoides*).

Before conducting the survey, lists of pond operators categorized according to survey design were updated from earlier censuses and beneficiary lists. This required in practice a complete census of pond operating households due to problems reconciling earlier lists. Thus, the number of WorldFish participating households is lower than the number of reported participants in the earlier project's progress reports because in some cases more than one person from the same household received training, and in other cases a household was counted twice because it operated two ponds following the technologies recommended by WorldFish. The revised listing of pond-operating households in 1998, summarized by strata in Table 1.3, ensured that each household only appeared once.

The sample sizes for the one-round survey to record the pond culture system, farming system and household economic condition in the

previous year (1997-98) are given in Table 1.3. These samples were designed to be sufficient to make statistical inferences in comparisons along each row (small versus medium-large ponds) as well as between participants and nonparticipants. Systematic one-stage random sampling was adopted with pond operators arranged by village and union in each category in Table 1.3. Although the participants are well scattered (among some 150 villages or 101 mouzas [spatially defined villages delineated for administrative purposes] in Kapasia), this method means that samples can be smaller than if a two-stage design is adopted, and also makes it simple to make parameter estimates for all the participants and ponds of Kapasia.

Sampling was list-based for each category of pond operator arranged by village and union. Each first choice sample had two alternatives drawn during sampling. If the first choice sample farmer was not available or was found not to fit the sample criteria, then the field investigator took an interview with the second or then the third choice, if necessary. But the survey design always emphasized to interview the first choice. The reasons for sample replacement were mainly that the pond had been sold to another person or there was some other change in ownership, or the pond operator was not available for a long time, or the reluctance of a respondent to give information.

The socioeconomic survey format was designed to cover detailed information on the pond operation and aquaculture practices, farming system (crops, trees, etc.), aquaculture information and knowledge, income and assets, and population, education, health and sanitation. This survey started in June 1998 and concluded in August 1998. The results are reported in Chapters 2 and 3.

Detailed monitoring in Kapasia

The socioeconomic survey in Kapasia covered 100 WorldFish participants. It was found that 69 ponds were actively cultivated in 1998 (i.e., they were stocked with fish in 1998). These ponds were monitored intensively from stocking in April-June 1998 until September 1999 to cover restocking and harvesting (some are managed on an annual cycle and others on a more continual system). As some ponds were affected by severe flooding in 1998, monitoring continued in the monsoon of 1999 for comparison. The other 31 ponds in the initial survey were not stocked in 1998, although some had been stocked in the previous year, and so were not monitored.

Monitoring gave details of the inputs used in pond culture and catches based on weekly records rather than recall, and also recorded crop agriculture inputs and outputs on a seasonal basis. In addition, consumption of fish by source and of other major food items was recorded. This was done to reliably quantify the fish and other protein-rich foods consumed by the 69 monitored households. These households received aquaculture extension during 1991-93 and have continued aquaculture, and this was expected to enhance their fish consumption and general incomes. The survey also aimed to compare the results with those of other similar surveys undertaken by WorldFish for nonpond operators. This year-round consumption survey started in August 1998 and ran to September 1999.

This part of the study was based on the active involvement of the participating households. One educated person (typically students/children or adults) from each household filled out a simple consumption record form for each day of the first week each month. This participatory method incurred minimal costs and involved active and interested participation from the households. The households were each given a simple weighing balance and weights, writing materials and training. Two rounds of followup meetings and discussions were held to review their experiences and methods and to understand and share some of the interim results. A final workshop was held covering the findings of monitoring of both pond production systems and food consumption.

Market and consumer surveys

During the previous project in Kapasia and Sreepur a survey was conducted in 1991 in 10 markets to assess the demand for and supply of fish at that time, and to understand the sources and destinations of fish marketed in the project area (Ahmed et al. 1993). For this study, a repeat market survey was conducted during 1999 in 15 markets of Kapasia to assess changes from the earlier period. Sample size was 150 traders from all of these markets (10 per market). A profile was also compiled for each market. Traders interviewed during the survey were: fishers who catch fish for sale directly in the market, traders who purchase fish and sell it in the market, and

pond owners who sell directly in the market. In addition, during the study local concerns at declining catches of noncultured fish from floodplain areas were raised, and it was found that much of the fish eaten even by pond operators was wild-caught. So it was decided near the end of the study to investigate changes in fishing and fish consumption by nonpond owners and focus group discussions on this were held with landless and land-owning households lacking ponds in each union covered by the study.

Uptake and continued aquaculture in Kapasia

To further investigate the extent that past recipients of training have continued aquaculture and the reasons for not continuing, a brief survey was made of another 100 WorldFish participants in Kapasia from the remaining 318 previous participants. Pond operators were again categorized in two groups according to their pond size: below 15 decimals (small pond owner) and above 15 decimals (medium-large pond owner). Sampled were 50 pond operators of each category.

It was found that out of an additional 100 WorldFish participants, 90% were actively cultivating fish and 10% were inactive. In 99% of the active ponds, the system followed was carp polyculture and only one followed monoculture. The reasons for inactivity and thus not continuing to use the information and capability developed in the earlier project were either related to access to ponds or to the perceived relative costs and returns of aquaculture. Examples of the former were problems of poaching, loss of access to *khas* (publicly owned, i.e., state property) ponds and disputes among joint owners of ponds. Examples of the latter were a preference for using water for irrigation rather than aquaculture, and the high risk of inundation of the pond due to low dikes (which presumably were not worth raising).

Chapter 2
Household Socioeconomic Changes in Kapasia and Sreepur

Household Characteristics

The sample design in the main survey of households was summarized in the first chapter. The aim was to compare the recipients of extension training during 1991-93 under the earlier WorldFish Center (previously ICLARM)-supported project with other pond owners from the same unions who did not receive training, and with pond owners in Sreepur where the earlier project did not provide training, but where baseline surveys had been undertaken. For sampling in Kapasia, the previous participants were subdivided between the first two year's participants and the third year's participants because in the third year the project worked in different unions from the previous two years and training and support was less intensive in the last year. However, the differences between these two batches of participants were small and so they have been combined in reporting the results.

There are few female-headed households among pond operators in the samples, but only 4% of past Kapasia participants have female household heads compared with 15 to 17% for random samples in Kapasia and Sreepur, thus the earlier project did not target women (Table 2.1). Household heads were evenly distributed in the 30 to 60+ age range. For the sample households as a whole the male:female ratio is about 53:47, and over 25% of the people are in what may be termed the dependent age ranges (0 to 10 and 60+ years).

The heads of past participant households on average were more educated, thus 50% of the male heads among the past participants had 10+ years in school compared with about 30% for the other samples (Table 2.2). However, literacy rates were very high in the area, at least among pond-owning households, averaging about 80%.

About half of the household heads are mainly farmers, but the past participants in Kapasia are more dependent on supplementary income sources (business and service) than the other households (Table 2.3). Overall, most of the population do not earn cash incomes - about 80% are reported to be students, infants, housewives or unemployed. (See Table 2.4).

Assets

On average, pond operators have substantial land holdings. Very few were functionally landless (0 to 50 decimals; 0 to 0.2 ha). About 30% were marginal and small-scale farmers (51 to 250 decimals; 0.2 to 1.01 ha). About 40% were medium-scale farm owners (251 to 750 decimals; 1.01 to 3.04 ha) and about 30% own large farms (over 750 decimals; 3.04 ha) (Table 2.5). There

Table 2.1. Age in years of household head and members of sample pond owner/operator households in 1998

Category	Kapasia participants						Kapasia - others						Sreepur					
	Male		Female		Total		Male		Female		Total		Male		Female		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Household head																		
<30 years	10	10	1	1	11	11	2	3	2	3	4	7	11	18	3	5	14	23
30-45 years	34	34	2	2	36	36	17	28	5	8	22	37	10	17	5	8	15	25
46-60 years	26	26	1	1	27	27	18	30	1	2	19	32	19	32	1	2	20	33
>60 years	26	26	0	0	26	26	14	23	1	2	15	25	10	17	1	2	11	18
Total	96	96	4	4	100	100	51	85	9	15	60	100	50	83	10	17	60	100
Entire household																		
<10 years	43	7	54	9	97	16	44	11	32	8	76	19	39	10	27	7	66	17
10-20 years	92	15	81	13	173	28	55	14	56	14	111	27	57	15	56	15	113	30
21-60 years	144	23	142	23	286	46	99	24	96	24	195	48	94	25	90	24	184	48
>60 years	39	6	21	3	60	10	16	4	8	2	24	6	13	3	5	1	18	5
Total	318	52	298	48	616	100	214	53	192	47	406	100	203	53	178	47	381	100

Table 2.2. Educational status of household head and members (above 6 years), by gender, for sample pond owner/operator households in 1998

Category	Kapasia participants				Kapasia - others				Sreepur			
	Male		Female		Male		Female		Male		Female	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Household head												
None	7	7	0	0	3	6	1	11	3	6	3	30
Can sign/count only	8	8	1	25	6	12	1	11	7	14	0	0
1-5 years of school	12	13	0	0	15	29	1	11	6	12	3	30
6-10 years of school	20	21	2	50	12	24	3	33	19	38	3	30
>10 years	49	51	1	25	15	29	3	33	15	30	1	10
Entire household												
None	20	7	31	12	13	7	24	14	17	10	23	14
Can sign/count only	21	7	20	7	7	4	7	4	17	10	21	13
1-5 years of school	51	18	70	26	58	31	49	29	34	19	42	25
6-10 years of school	97	33	96	36	54	29	52	31	65	37	62	38
>10 years	101	35	50	19	55	29	36	21	42	24	17	10
Literacy (%)												
Household head		84		75		82		78		80		70
Entire household		86		81		89		82		81		73

Table 2.3. Household heads' main occupation by sample category in 1998

Occupation	Kapasia participants		Kapasia - others		Sreepur	
	No.	%	No.	%	No.	%
Farmer	43	43	32	53	30	50
Small trader	3	3	1	2	1	2
Businessperson	15	15	4	7	3	5
Service person	18	18	9	15	6	10
Housewife	3	3	7	12	9	15
Student	7	7	2	3	4	7
Unemployed	8	8	4	7	6	10
Others	3	3	1	2	1	2
Total	100	100	60	100	60	100

Table 2.4. Other household members' occupations by sample category in 1998

Occupation	Kapasia participants		Kapasia - others		Sreepur	
	No.	%	No.	%	No.	%
First occupation						
Farmer	37	7	20	6	22	7
Laborer	23	4	11	3	30	9
Small trader	4	1	7	2	1	0
Businessperson	17	3	10	3	6	2
Service person	21	4	19	5	18	6
Housewife	131	25	83	24	91	28
Unemployed	75	15	59	17	47	15
Student	205	40	135	39	104	32
Others	3	1	2	1	2	1
Total	516	100	346	100	321	100
Second occupation						
Farmer	8	29	7	47	23	72
Laborer	1	4	3	20	1	3
Small trader	2	7	1	7	1	3
Businessperson	5	18	0	0	0	0
Service person	2	7	1	7	2	6
Housewife	5	18	3	20	4	13
Student	1	4	0	0	0	0
Others	4	14	0	0	1	3
Total	28	100	15	100	32	100

Table 2.5. Comparison of land ownership (%) in 1991 and 1998 sample surveys

Land ownership	Kapasia			Sreepur	
	1991	1998		1991	1998
		Participants	Others		
< 1.0 ha	30	28	32	30	25
1.0-2.4 ha	39	40	45	34	38
>2.4 ha	31	32	23	36	37
All (no)	193	100	60	140	60

Sources: 1991 data - Ahmed et al. (1993); 1998 data - this survey.

were no clear differences between WorldFish participants and their neighbors, indicating that the previous project did not target poorer pond owners. This is also confirmed by comparison with the landholdings and pond sizes of households surveyed in 1991, when pond-owning households in Kapasia (193) and in Sreepur (140) were surveyed before any project-related aquaculture extension. There was no difference in landholding distribution between 1991 and 1998. As was expected, larger land owners have larger homestead areas and own larger pond areas than small land owners. In Kapasia, orchards are as important by area as cultivated land (Table 2.6) but their area per household is substantially less in Sreepur. Small farms appear to have declined in size between 1990 and 1998.

In the baseline survey in both Kapasia and Sreepur, just under half the ponds were small,

Table 2.6. Average landholding (ha) by participant and landholding category in 1998 (Small - <1.0 ha; medium - 1.0-2.4 ha; large - >2.4 ha)

Land type	Kapasia participants			Kapasia - others			Sreepur - control		
	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large
Homestead land	0.054	0.127	0.175	0.075	0.092	0.177	0.048	0.096	0.195
Owned and operated pond/ditches	0.041	0.113	0.230	0.081	0.143	0.164	0.087	0.202	0.288
Leased in pond/ditches	0.007	0.014	0.010	0.019	0	0	0	0	0.010
Leased out pond/ditches	0.009	0	0	0	0	0	0.002	0.005	0.028
Owned and cultivated land	0.333	0.679	1.333	0.190	0.632	1.230	0.200	0.658	1.544
Sharecropped/rent/mortgaged in land	0.030	0.009	0.021	0.196	0.040	0	0.104	0	0.032
Sharecropped/rent/mortgaged out land	0.081	0.372	1.030	0.035	0.384	1.231	0.161	0.547	2.110
Orchard/forest	0.077	0.259	1.218	0.089	0.405	1.339	0.015	0.161	0.412
Fallow	0.020	0.062	0.126	0	0.034	0.117	0.012	0.024	0.273
Total (own land 1998)	0.606	1.612	4.112	0.470	1.690	4.258	0.523	1.688	4.822
Total (own land 1990)*	0.656	1.531	4.423	0.656	1.531	4.423	0.628	1.663	4.918

* Averages from baseline survey of different households. Source: Ahmed et al. (1993).

Table 2.7. Distribution of sample household by pond size in 1991 and 1998

Pond size	1998						1991			
	Kapasia participants		Kapasia - others		Sreepur – control		Kapasia		Sreepur	
	No.	%	No.	%	No.	%	No.	%	No.	%
Small (<0.06 ha)	44	44	22	37	17	28	94	49	64	46
Medium (0.06-0.12 ha)	17	17	13	22	11	18	47	24	36	26
Large (>0.12 ha)	39	39	25	42	32	53	52	27	40	29
Total	100	100	60	100	60	100	193	100	140	100

with around a quarter each in the medium and large categories (Table 2.7). However, over half the sampled ponds in Sreepur in 1998 were large, suggesting that the list used by the Department of Fisheries may have been biased towards larger ponds. In Kapasia, more of the ponds were larger than in the baseline survey, among both ex-participants and nonparticipants. About 44% of the past participants in Kapasia had small ponds.

Because most of the sample households have medium to large landholdings, they have large houses (average, four rooms) and house construction is good as the vast majority have tin roofs and katcha ("non-brick") walls (Table 2.8); non-brick walls could be made of mud, bamboo, straw or thatch.

On average, the past participants have better access to safe drinking water and sanitation facilities than other pond owners in Kapasia or Sreepur (Table 2.9). Although all households use tubewell water, over a quarter in the non-participant samples now own their own tubewell. Possible factors are the smaller landholdings of small-scale farmers in the nonparticipant samples and lower pond and nonfarm incomes.

On average, the nonparticipants (others) in Kapasia have fewer livestock than either past participants or farmers in the Sreepur control area (Table 2.10). The main exception is that some larger farmers including ones in the nonparticipant sample have adopted commercial scale poultry farming with the advent of improved communications between the area and Dhaka. In 1990-91, large-scale farmers averaged 20 chickens per household; now they average 40 to 58 per household. Numbers of bullocks have fallen since 1990-91, when large farms averaged 2.5 per farm, but medium and large farms now have slightly more cows than before (respectively, 0.7 to 0.8 and about 1.3 per farm in 1990-91). Hence, livestock ownership remains strongly associated with landholding, but overall it has not fallen during the 1990s in these areas, and hence supplies of onfarm organic manure are likely to be at least as high as in 1990-91.

Fruit production in the area has expanded since 1990-91. In both baseline and 1998 surveys, households in Kapasia had on average more trees than households in Sreepur (Table 2.11). The main change is the growth in guava production, which had not been so notable earlier. Valuing trees is difficult, but the estimates made by farmers in 1990-91 and in 1998 (Table 2.12) indicate that large farmers in the past participant sample in Kapasia have a high value of trees that is 5.2 times more than in 1990-91 for the same

Table 2.8. House structure of sample households (%) in 1998

Sample	Landholding	Pacca	All tin	Tin roof	All katcha	Households
Kapasia participants	Landless - small	0	0	93	7	28
	Medium	8	0	93	0	40
	Large	6	3	91	0	32
Kapasia - others	Landless - small	0	0	89	11	19
	Medium	4	7	85	4	27
	Large	21	7	72	0	14
Sreepur - control	Landless - small	0	0	87	13	15
	Medium	0	0	96	4	23
	Large	9	5	86	0	22

Table 2.9. Household water and sanitation condition in 1998

Water and sanitation	Kapasia participants		Kapasia - others		Sreepur - control	
	No.	%	No.	%	No.	%
Source of water						
Own hand tubewell	90	90	39	65	44	73
Joint/part owned hand tubewell	3	3	7	12	3	5
Community/another person's tubewell	7	7	14	23	13	22
Total	100	100	60	100	60	100
Type of latrine						
None	3	3	4	7	8	13
Pacca	41	41	20	33	23	38
Semi-pacca	24	24	12	20	8	13
Katcha	32	32	24	40	21	35
Total	100	100	60	100	60	100

Table 2.10. Livestock ownership by participant and landholding category (mean of all households* [hh]) in 1998

Livestock type	Small (<1.0 ha)			Medium (1.0-2.4 ha)			Large (>2.4 ha)			All		
	% hh	No./hh (*all)	Value Tk/hh	% hh	No./hh (*all)	Value Tk/hh	% hh	No./hh (*all)	Value Tk/hh	% hh	No./hh (*all)	Value Tk/hh
Kapasia participants												
Bullock	56	0.78	2 815	27	0.46	1 561	44	1.00	2 594	40	0.72	2 230
Cow	52	0.93	2 525	56	1.20	3 106	84	2.25	4 560	64	1.46	3 414
Calves	22	0.37	356	44	0.61	1 002	41	0.75	877	37	0.59	788
Sheep/goats	37	0.93	219	32	0.85	300	44	1.59	361	37	1.11	298
Chicken/duck	74	7.93	38	78	17.61	44	78	32.75	46	77	19.84	43
Pigeon	15	1.26	15	2	0.05	1	13	0.81	8	9	0.62	7
Total	100	12.19	5 968	100	20.78	6 015	100	39.16	8 446	100	24.34	6 780
Bullock	26	0.37	1 479	30	0.41	1 519	57	1.50	3 250	35	0.65	1 910
Cow	47	1.00	2 383	81	1.41	4 296	79	1.64	4 207	70	1.33	3 670
Calves	16	0.32	411	37	0.37	567	43	0.93	664	32	0.48	540
Sheep/goats	21	0.47	91	30	0.59	145	14	0.36	90	23	0.50	115
Chicken/duck	79	8.00	41	78	6.41	36	100	53.50	66	83	17.90	44
Pigeon	5	0.11	3	4	0.15	2	0	0.00	0	3	0.10	2
Total	100	10.26	4 407	100	9.33	6 564	100	57.93	8 278	100	20.97	6 281
Bullock	13	0.20	667	30	0.61	1 467	77	1.77	3 932	43	0.93	2 171
Cow	27	0.60	1 167	52	1.00	2 652	68	1.50	3 364	52	1.08	2 542
Calves	20	0.33	317	39	0.65	504	73	1.36	1 280	47	0.83	742
Sheep/goats	40	1.13	206	48	1.00	247	27	0.82	174	38	0.97	210
Chicken/duck	93	9.33	80	96	24.26	49	95	37.23	67	95	25.28	63
Pigeon	13	0.53	5	17	0.65	5	23	5.68	7	18	2.47	6
Total	100	12.13	2 441	100	28.17	4 925	100	48.36	8 824	100	31.57	5 734

* Mean over all households, including those with none of that type of livestock.

Table 2.11. Number of productive trees per household by type

Tree	Kapasia			Sreepur		All
	1990	1998 participants	1998 others	1990	1998	1998
Mango	15	23.9	20.8	8	15.3	20.7
Jackfruit	29	47.4	36.0	14	37.2	41.5
Coconut	3	6.5	7.1	3	4.9	6.3
Bamboo	49	592.1	480.5	55	297.0	481.2
Guava	-	77.2	119.8	-	31.9	76.4
Litchi	-	5.4	3.3	-	0.5	3.5
Betel nut	4	22.8	28.4	3	9.2	20.6
Others	-	10.1	22.4	-	22.3	16.8

Note: Bamboo recorded in clumps in 1990, stems in 1998.

farm size category. The reported value of trees for small and medium farms was about 3 times higher in 1998 than in 1990-91. Similar differences were found in Sreepur. To some extent, this may simply be due to trees maturing, but substantially more jackfruit, betel nut and guava trees were reported per household in 1998 than in 1990-91 indicating an investment in fruit trees.

Incomes, Household Assets, Expenditure and Credit

Incomes

Reported farm incomes of the sample households in 1997-98 were much higher than in 1990-91: 2.2 times higher for past participants, 1.4 times higher for others in Kapasia and 2.4 times higher in Sreepur (comparison of Table 2.13 with Table 2.15 in Ahmed et al. 1993). Average per household incomes from different farm sources have all increased, resulting in similar contributions from the farm income sources shown in Table 2.13 to those in 1990-91, with the exception that livestock has become more important as an income source. Compared with 1990-91, cereal crops are now much less important - a change from 80% of farm income to 36%, with livestock and orchards as the main growth areas.

In the context of diverse agriculture and high nonfarm incomes (see below), it cannot be expected that aquaculture would be a major component of household income for many of the households. The share of ponds/fish in income contribution has changed little despite the extension project, but aquaculture contributes 9% of the farm income of small-scale farmers with ponds who participated in the earlier project, compared to only 2-7% for other farm sizes and nonparticipants. Aquaculture income was higher for participants of the previous project than for other pond owners in Kapasia and Sreepur, and this reflects higher production (see Chapter 3). Household income from aquaculture was quite variable reflecting different pond areas and intensities of cultivation, and so differences were not highly significant.

Nonfarm incomes have also apparently more than doubled in both subdistricts (upazilas) since 1990-91. Petty trade and laboring are important for small-scale farmers compared with medium and large-scale farmers (Table 2.14) but wages such as from government employment ("service") were less important in 1997-98 than in 1990-91 (42% of overall nonfarm income of pond owners in Kapasia) (Ahmed et al. 1993). Remittances were not distinguished in the baseline survey, but are particularly important for medium and large-scale farms in Kapasia. Overall nonfarm income is positively associated with farm size (and hence farm income), larger landholders tend to have diversified into business and to send family members to other areas (including overseas) to remit income.

Table 2.12. Number of trees owned per household by participant and landholding category (mean of all households) in 1998

	Kapasia participants			Kapasia - others			Sreepur - control		
	Small (<1.0 ha)	Medium (1.0-2.4 ha)	Large (>2.4 ha)	Small (<1.0 ha)	Medium (1.0-2.4 ha)	Large (>2.4 ha)	Small (<1.0 ha)	Medium (1.0-2.4 ha)	Large (>2.4 ha)
Mango	8.8	16.3	46.6	7.4	15.3	49.6	4.2	12.0	26.3
Jackfruit	13.3	31.1	97.6	18.6	27.1	76.9	12.2	41.8	49.3
Litchi	2.8	5.6	7.5	3.3	3.2	3.3	0.2	0.6	0.7
Guava	27.3	83.1	113.5	33.4	69.1	334.6	3.5	68.9	12.6
Bamboo	143.8	540.6	1 048.8	176.2	542.2	774.5	239.3	297.0	336.4
Betel nut	27.2	20.8	21.4	24.8	13.3	62.4	1.9	17.7	5.4
Coconut	5.1	5.9	8.7	2.5	4.7	18.1	2.6	4.3	7.2
Timber	3.0	43.8	273.3	30.0	76.8	203.8	37.5	66.0	126.0
Others	1.7	15.3	46.8	2.0	16.7	4.1	5.0	46.8	18.3
Total	232.9	762.4	1 664.2	298.3	768.4	1 527.1	306.4	555.0	582.1
Value (Tk/household)	56 542	125 916	475 471	55 442	127 443	281 562	29 961	91 113	199 862

Table 2.13. Breakdown of average annual farm income (Tk/household[hh]) by source and farm size in 1997-98

Sample	Income source	Landholding (% of income)			
		Small (<1.0 ha)	Medium (1.0 – 2.4 ha)	Large (>2.4 ha)	All
Kapasia participants	Cereal crop	36	28	25	27
	Other crops	6	4	8	7
	Sharecropped out land	3	7	5	5
	Orchard/tree	29	45	41	41
	Livestock	16	9	17	14
	Aquaculture	9	7	5	6
	All	100	100	100	100
	Annual income (Tk/hh)	26 920	48 113	119 640	65 068
Kapasia - others	Cereal crop	26	33	20	26
	Other crops	4	9	11	9
	Sharecropped out land	0	13	16	12
	Orchard/tree	54	31	44	40
	Livestock	11	9	7	8
	Aquaculture	5	5	2	4
	All	100	100	100	100
	Annual income (Tk/hh)	22 162	38 272	82 138	43 406
Sreepur - control	Cereal crop	38	25	49	36
	Other crops	0	1	8	4
	Sharecropped out land	15	9	19	14
	Orchard/tree	12	11	14	12
	Livestock	31	47	9	29
	Aquaculture	4	7	2	5
	All	100	100	100	100
	Annual income (Tk/hh)	23 236	62 379	59 944	51 700
All	Cereal crop	34	28	29	29
	Other crops	4	4	8	6
	Sharecropped out land	5	9	10	9
	Orchard/tree	32	31	36	33
	Livestock	18	21	13	17
	Aquaculture	7	7	4	5
	All	100	100	100	100
	Annual income (Tk/hh)	24 571	48 807	92 605	55 514

The Kapasia participants tended to have higher incomes for each landholding class than nonparticipants from the same subdistrict (upazila) and from Sreepur in 1997-98. By comparison, in the 1990-91 baseline there was no significant difference in household income between Kapasia and Sreepur households in each landholding category.

Hence there appears to have been very substantial growth in the average household incomes in this area since 1990-91. An average increase of 2.5 times for past extension participants and 2.3 times in Sreepur was estimated for pond operators. Pond owners of different landholding classes have shared these increases. This is substantially higher than the combination of inflation (about 38%) and growth in real per capita national income (24%) during this period, indicating that these landed households have gained much more than average. The explanation is mainly in nonfarm income sources and household changes.

Qualitative information in 1998 revealed that many households now have at least one person working overseas and remitting money to them, whereas in 1990-91 far fewer of these households reported that they had someone working overseas. Consequently, average household sizes have fallen for each landholding size and in both subdistricts (upazilas) compared with 1990-91, although larger farms tend to be operated by larger households (Table 2.15). In 1990-91, 47% of household income in Kapasia and 58% in Sreepur came from nonfarm sources (Ahmed et al. 1993). In 1997-98, 71% of Kapasia (participants) and 67% of Sreepur sample household incomes came from nonfarm sources (Table 2.16). The apparent increase in per capita incomes is of course even more, given the lower household sizes in 1997-98.

Table 2.14. Breakdown of average annual nonfarm income (Tk/household[hh]) by source and farm size in 1997-98

Sample	Income source	Landholding (% of income)			
		Small (<1.0 ha)	Medium (1.0 - 2.4 ha)	Large (>2.4 ha)	All
Kapasia participants	Remittances	9	26	17	20
	Rent/loans/interest/credit realization	0	1	4	2
	Labor	4	0	4	2
	Petty trade	21	5	0	5
	Business	24	39	49	41
	Service	26	21	13	18
	Sale assets	15	8	13	11
	All	100	100	100	100
	Annual income (Tk/hh)	52 779	89 797	122 243	89 815
Kapasia - others	Remittances	10	35	31	29
	Rent/loans/interest/credit realization	6	1	7	5
	Labor	4	0	0	1
	Petty trade	25	3	0	5
	Business	21	24	31	27
	Service	33	26	31	29
	Sale assets	1	11	0	4
	All	100	100	100	100
	Annual income (Tk/hh)	15 516	40 619	121 557	54 722
Sreepur - control	Remittances	22	15	13	15
	Rent/loans/interest/credit realization	0	1	5	3
	Labor	9	0	0	1
	Petty trade	19	0	0	3
	Business	19	26	43	34
	Service	18	49	26	34
	Sale assets	13	9	12	11
	All	100	100	100	100
	Annual income (Tk/hh)	33 880	65 130	87 409	65 487
All	Remittances	12	25	19	20
	Rent/loans/interest/credit realization	1	1	5	3
	Labor	5	0	2	2
	Petty trade	21	3	0	5
	Business	22	33	43	36
	Service	26	29	20	24
	Sale assets	12	9	10	10
	All	100	100	100	100
	Annual income (Tk/hh)	39 852	68 740	110 832	73 609

Household assets

If real incomes have risen so much, this should be reflected in an improved standard of living. Durable assets were counted and approximate values were recorded in both the baseline and impact surveys, but to avoid valuation and inflation problems only numbers are shown in Table 2.17. These are based on the same detailed inventory list used in both surveys. In Kapasia, the participants of the previous project have substantially higher numbers of electrical goods, furniture and fishing gear to the extent that small-scale farmers apparently had a similar asset status

Table 2.15. Household size by farm size in 1997-98

Sample	Small	Medium	Large
Kapasia participants	5.34	6.19	4.98
Kapasia - others	5.17	6.03	8.55
Sreepur - control	3.78	6.35	6.90

in 1998 to that of medium-scale farmers in 1991. However, the same pattern was found in the control area of Sreepur. Therefore, the improved standard of living is not related with aquaculture and even fishing gear ownership was higher in the control area in 1998 than in 1991 (presumably reflecting a general increase in importance of aquaculture).

Table 2.16. Household income in 1997-98 of sample households by landholding size and source

Sample	Landholding size		Fish	Farm	Nonfarm	All	Tk/person
Kapasia participants	Small (<1.0 ha)	Mean	2 402	24 518	52 779	79 700	14 899
		Std. dev.*	(7 701)	(15 084)	(50 391)	(53 971)	(12 017)
	Medium (1.0 - 2.4 ha)	Mean	3 208	44 905	89 797	137 911	22 277
		Std. dev.	(4 194)	(37 957)	(99 124)	(114 769)	(16 387)
	Large (>2.4 ha)	Mean	5 944	113 696	122 243	241 882	48 527
		Std. dev.	(16 311)	(115 154)	(201 499)	(282 457)	(57 025)
	All	Mean	3 858	61 210	89 815	154 883	28 611
		Std. dev.	(10 421)	(78 489)	(134 182)	(187 422)	(36 892)
Kapasia - others	Small (<1.0 ha)	Mean	1 021	21 141	25 516	47 677	9 223
		Std. dev.	(2 511)	(29 332)	(28 594)	(38 674)	(7 870)
	Medium (1.0 - 2.4 ha)	Mean	2 075	36 197	40 619	78 891	13 084
		Std. dev.	(2 826)	(20 736)	(42 397)	(47 894)	(8 188)
	Large (>2.4 ha)	Mean	1 930	80 208	121 557	203 695	23 829
		Std. dev.	(2 053)	(52 151)	(148 326)	(171 619)	(15 799)
	All	Mean	1 707	41 699	54 722	98 128	14 368
		Std. dev.	(2 569)	(39 409)	(85 527)	(107 658)	(11 574)
Sreepur - control	Small (<1.0 ha)	Mean	922	22 314	33 880	57 116	15 107
		Std. dev.	(1 943)	(23 956)	(29 436)	(26 742)	(8 332)
	Medium (1.0 - 2.4 ha)	Mean	4 405	57 974	65 130	127 509	20 074
		Std. dev.	(7 820)	(106 275)	(56 619)	(107 193)	(17 749)
	Large (>2.4 ha)	Mean	1 456	58 487	87 409	147 353	21 365
		Std. dev.	(3 924)	(43 634)	(74 569)	(90 933)	(13 727)
	All	Mean	2 453	49 247	65 487	117 187	19 306
		Std. dev.	(5 624)	(72 604)	(61 753)	(93 251)	(14 398)

*Std. dev. – standard deviation.

Table 2.17. Average number of durable assets owned in 1991 and 1998 by sample pond owners in Kapasia (1998 data are only for previous participants) and Sreepur

Asset type	Landholding size						All	
	Small (<1ha)		Medium (1.0-2.4 ha)		Large (>2.4 ha)			
	1991	1998	1991	1998	1991	1998	1991	1998
Kapasia	N=57	N=28	N=76	N=40	N=60	N=32	N=193	N=100
Electrical	0.28	1.11	0.50	1.50	1.05	1.44	0.61	1.37
Agricultural process	0.00	0.04	0.04	0.00	0.03	0.00	0.03	0.01
Transport								
Manual	0.23	0.50	0.57	0.73	0.95	0.56	0.58	0.61
Mechanized	0.02	0.00	0.01	0.08	0.07	0.09	0.03	0.06
Furniture	4.53	10.82	9.44	16.08	14.90	21.41	9.69	16.31
Farm equipment								
Traditional	9.63	10.11	11.64	10.85	16.27	13.72	12.49	11.65
Modern	NA	0.07	NA	0.18	NA	0.41	NA	0.22
Fishing gear	1.81	8.79	2.58	5.90	3.32	8.69	2.58	7.60
Others	NA	1.32	NA	1.60	NA	2.06	NA	1.67
Sreepur	N=42	N=15	N=47	N=23	N=51	N=22	N=140	N=60
Electrical	0.41	1.00	0.98	2.00	1.39	2.91	0.94	2.08
Agricultural process	0.00	0.00	0.00	0.00	0.08	0.05	0.03	0.02
Transport								
Manual	0.32	0.20	0.49	0.52	0.82	0.59	0.55	0.47
Mechanized	0.00	0.00	0.06	0.00	0.06	0.27	0.04	0.10
Furniture	3.18	8.27	9.79	17.13	17.24	25.82	10.32	18.10
Farm equipment								
Traditional	9.55	8.80	13.98	11.34	15.35	15.86	13.06	12.37
Modern	NA	0.00	NA	0.17	NA	0.32	NA	0.18
Fishing gear	2.14	6.93	3.11	5.30	3.47	5.50	2.93	5.78
Others	NA	0.67	NA	1.61	NA	2.00	NA	1.52

Source: 1991 data – Ahmed et al. (1993); 1998 data – this study.

Expenditure and consumption

Recall information for 1997-98 was collected for comparison with similar data from the baseline survey covering 1990-91 (in addition, fish and other food consumption was monitored by most of the sample of former extension participant households in Kapasia in the following year and is reported separately in Chapter 5). In 1990-91, consumption of most items tended to be higher in Sreepur than in Kapasia, but the reverse was found in general in 1997-98. Large-scale farmers tend to have higher per household and per capita consumption of the main food items (Table 2.18). Per capita consumption of vegetables was substantially higher in 1997-98 than in the baseline in Kapasia (230% for participants, 140% for nonparticipants), but had fallen in Sreepur. Fish consumption by past participants was slightly higher than in Kapasia in the baseline (114%), but fish consumption of nonparticipants in Kapasia and Sreepur was lower than the respective averages (73% and 52% of previous reports) from the baseline.

However, recall is probably unreliable for estimating consumption of less frequently eaten foods. In Chapter 5, the results of detailed monitoring are given – 69 of the 100 past participants in Kapasia monitored some of their own food consumption for a week in each month during 1998-99. Rice consumption was identical to the recall average in the previous year in Table 2.18 (239 kg/person/year), but fish consumption was about 38 kg/person/year (people are taken here to be the average number of household members) – much higher than recall estimates by the same households for the previous year. Likewise, meat consumption from monitoring was over twice the amount estimated by recall in the previous year. Hence fish consumption probably has increased for pond owners.

Fruit consumption per household was comparable with similar data from the baseline survey, although average consumption of jackfruit, litchis and guava had increased substantially. Consumption is higher for larger land owners and in Kapasia, reflecting the larger areas of orchards and numbers of trees owned by households (Table 2.19). However, estimation of the amounts of fruit eaten and sold proved difficult to make in the surveys and it is suspected that some household consumption was in fact given away or sold (for example, it is highly unlikely that nonparticipant large-scale land-owner households in Kapasia ate over 2 000 guava per person in a year).

In Kapasia, larger land-owning households tend to obtain more of their food from their own production, but in Sreepur there was less difference between landholding categories (Table 2.20). Consequently, although the total value of food consumed is higher for larger farms, the cash expenditure on food does not increase with the landholding category as much as overall food consumption. More than half of the rice, fish, milk and eggs consumed came from onfarm sources, with large-scale farmers self-sufficient in rice. The main purchased foods by value were vegetables and meat (the latter mainly for large-scale land-owners).

Estimates of total nonfood expenditures and imputed and purchase values of food consumed

Table 2.18. Average consumption (kg/household) of different food items by sample households in 1997-98

Food	Kapasia participants				Kapasia - others				Sreepur - control			
	Small (<1 ha)	Medium (1-2.4 ha)	Large (>2.4 ha)	All	Small (<1 ha)	Medium (1-2.4 ha)	Large (>2.4 ha)	All	Small (<1 ha)	Medium (1-2.4 ha)	Large (>2.4 ha)	All
Rice	1 183	1 258	1 683	1 373	989	1 243	1 726	1 275	829	1 383	1 566	1 312
Wheat	11	13	25	16	17	7	9	11	18	25	45	31
Pulses	26	30	34	30	19	28	38	27	18	27	36	28
Vegetables	577	571	902	679	482	448	736	526	240	391	454	376
Fish	52	81	83	74	43	58	88	60	29	47	62	48
Dry fish	3	5	4	4	4	2	7	4	2	3	3	3
Meat	22	38	49	37	23	34	64	37	19	41	50	39
Salt	32	36	40	36	26	32	46	33	32	39	50	41
Oil	30	37	39	36	22	36	48	35	19	33	41	33
Sugar	7	10	12	10	6	13	25	14	11	18	20	17
Milk	53	79	294	141	34	127	260	129	60	166	271	178
Eggs (no.)	116	119	196	143	103	124	274	152	116	200	253	198
Household size	5.9	6.1	6.5	6.2	5.7	6.7	8.4	6.8	4.5	6.7	7.3	6.4

Table 2.19. Average number of fruit eaten per household in 1997-98

Fruit	Kapasia participants				Kapasia - others				Sreepur - control			
	Small (<1 ha)	Medium (1-2.4 ha)	Large (>2.4 ha)	All	Small (<1 ha)	Medium (1-2.4 ha)	Large (>2.4 ha)	All	Small (<1 ha)	Medium (1-2.4 ha)	Large (>2.4 ha)	All
Jackfruit	88	223	432	252	109	131	465	202	92	125	336	194
Banana (bunch)	9	17	21	16	6	12	62	22	5	9	18	11
Mango	148	494	702	464	136	205	463	243	134	247	1 042	510
Litchi	1 586	1 828	4 660	2 666	1 005	2 030	4 971	2 392	503	1 128	1 500	1 108
Pineapple	23	39	70	45	41	100	142	91	18	25	77	42
Papaya	23	34	38	32	8	19	64	26	16	33	43	32
Guava	314	2 818	2 488	2 012	727	1 087	17 321	4 761	271	1 202	864	845
Coconut	51	62	194	101	29	39	124	55	45	50	132	79

were made, but fruit consumption has been omitted due to uncertainties over the reliability of the data. Nonfood expenditure is strongly associated with landholding. Small-scale land owners spent relatively more on clothing; large-scale farmers, more on education and social functions (Table 2.21). Nonfood expenditure per household in actual values has approximately doubled since 1990-91 and this may more accurately reflect changed living standards and incomes than income estimates. Under 40% of small-scale farm households' consumption and expenditure were on nonfood items.

Credit and NGO support

Few of the sample households are involved with NGOs or other development or welfare groups. On average, 14% belong to a NGO or similar (Table 2.22). Most pond-owning households fall outside NGO service criteria, and so this is not a major source of credit for pond operations. Such support as was received went mainly for agriculture and livestock. More ex-participants took bank credit in the previous five years than others, reflecting greater credit worthiness. In the survey year, more credit from nonformal sources, mainly relatives, was used; this may be an important short-term source of working capital for agriculture and business (Table 2.23).

Farming System and Use of Onfarm Resources

Crop inputs and outputs

How has agriculture changed since the 1990-91 baseline survey? In general, the percentages of households growing the main crops were lower in 1997-98 than before. In the baseline, some 70% of Kapasia households grew aus, aman and boro paddy, although only 40% of Sreepur households grew boro. Aus has since dropped almost completely out of production, with incidence of aman cultivation reportedly slightly reduced (notably local varieties are no longer grown in Sreepur) and little change in the incidence of boro cultivation (Table 2.24). Jute and sugarcane also apparently are less widely grown.

The apparent lower frequency of growing some crops is surprising given the reported yields that on average are higher than in 1990-91. However, some crop identifications may have been incorrect — for example, "local" T aman in Kapasia apparently gives a higher yield than high-yielding varieties (HYV) T aman (Table 2.25). In any case, on average aman yields are about 20% higher and boro yields, about 24% higher in Kapasia and 70% higher in Sreepur than they were in 1990-91. There is no reason to believe that aquaculture has had any impact on crop agriculture.

Input use by crop was similar among the three samples in 1997-98, with substantial amounts of cow dung used for most crops, and compost used particularly in Sreepur (Appendix 3: Table A3.1). As was to be expected, chemical fertilizer and labor inputs were relatively high for HYV boro.

About 75% of the seeds used by all households came from their own saved seeds; almost all organic fertilizers came from onfarm sources; over 50% of the draft power and 30-70% of the human labor came from the farm family (Table A3.2). Chapters 4 and 5 show that substantial amounts of organic fertilizer and feed are used in these households' ponds but this does not appear to handicap crops. The value of onfarm inputs used differed little among the types of paddy, but was substantially higher per hectare for other crops (Table 2.26). By comparison, cash costs of production were less for cultivation in Sreepur because less hired labor was used. Past participants were no more dependent on purchased inputs than their neighbors in Kapasia. HYV boro and

Table 2.20. Average value (Tk/household) of own-produced and bought food items consumed by sample households in 1997-98

Food item	Landholding size and food source												All			
	Small (<1 ha)				Medium (1-2.4 ha)				Large (>2.4 ha)							
	Own	%	Bought	%	Own	%	Bought	%	Own	%	Bought	%	Own	%	Bought	%
Kapasia participant																
Rice	11 518	77	3 396	23	13 222	83	2 672	17	17 911	90	2 001	10	14 246	84	2 660	16
Wheat	0	0	125	100	46	32	97	68	0	0	299	100	18	10	169	90
Pulses	0	0	935	100	19	2	1 042	98	0	0	1 142	100	8	1	1 044	99
Vegetables	578	18	2 615	82	688	22	2 491	78	1 269	27	3 488	73	843	23	2 845	77
Fish	1 322	56	1 042	44	2 323	56	1 856	44	2 771	61	1 740	39	2 186	58	1 591	42
Dried fish	0	0	297	100	0	0	568	100	0	0	351	100	0	0	423	100
Meat	308	20	1 256	80	532	26	1 547	74	1 260	32	2 671	68	702	28	1 825	72
Salt	0	0	336	100	0	0	329	100	0	0	367	100	0	0	343	100
Oil	0	0	1 574	100	0	0	1 966	100	0	0	2 100	100	0	0	1 899	100
Sugar	0	0	197	100	0	0	358	100	0	0	483	100	0	0	352	100
Milk	556	59	389	41	740	47	840	53	3 958	74	1 361	26	1 718	66	880	34
Eggs	191	67	93	33	210	69	92	31	285	59	201	41	229	64	127	36
Other foods	3	2	182	98	0	0	301	100	0	0	231	100	1	0	245	100
Total	14 476	54	12 437	46	17 780	56	14 160	44	27 455	63	16 436	37	19 951	58	14 405	42
Kapasia - others																
Rice	8 563	68	3 950	32	14 631	93	1 020	7	22 443	100	0	0	14 532	89	1 710	11
Wheat	0	0	167	100	30	39	47	61	0	0	111	100	13	12	100	88
Pulses	0	0	583	100	71	7	905	93	67	5	1 163	95	48	5	863	95
Vegetables	769	30	1 791	70	1 008	39	1 572	61	1 483	36	2 600	64	1 043	36	1 881	64
Fish	942	40	1 387	60	1 409	48	1 521	52	2 852	66	1 476	34	1 598	52	1 468	48
Dried fish	0	0	612	100	0	0	246	100	0	0	996	100	0	0	537	100
Meat	159	12	1 222	88	362	16	1 952	84	820	18	3 629	82	405	16	2 112	84
Salt	0	0	261	100	0	0	278	100	0	0	393	100	0	0	299	100
Oil	0	0	1 189	100	0	0	1 909	100	0	0	2 597	100	0	0	1 841	100
Sugar	0	0	148	100	113	31	246	69	143	24	457	76	84	24	264	76
Milk	87	16	469	84	1 421	64	815	36	3 216	69	1 477	31	1 417	62	860	38
Eggs	213	79	55	21	276	75	91	25	538	81	128	19	317	78	88	22
Other foods	34	12	240	88	30	7	371	93	261	34	504	66	85	19	361	81
Total	10 767	47	12 073	53	19 349	64	10 972	36	31 823	67	15 530	33	19 542	61	12 384	39
Sreepur - control																
Rice	9 668	89	1 196	11	17 232	94	1 130	6	19 301	100	26	0	16 100	96	742	4
Wheat	0	0	186	100	57	23	197	77	68	14	406	86	47	15	271	85
Pulses	0	0	577	100	0	0	863	100	27	2	1 144	98	10	1	894	99
Vegetables	307	26	887	74	732	37	1 254	63	771	33	1 583	67	640	33	1 283	67
Fish	908	64	516	36	1 621	63	957	37	1 471	47	1 656	53	1 388	56	1 103	44
Dried fish	0	0	167	100	0	0	262	100	0	0	296	100	0	0	251	100
Meat	354	24	1 123	76	843	28	2 166	72	1 079	28	2 828	72	807	27	2 148	73
Salt	0	0	217	100	0	0	305	100	0	0	393	100	0	0	315	100
Oil	0	0	1 058	100	0	0	1 873	100	63	3	2 261	97	23	1	1 812	99
Sugar	0	0	242	100	24	5	442	95	38	8	448	92	23	6	394	94
Milk	454	43	600	57	1 673	57	1 250	43	3 453	74	1 214	26	2 021	65	1 074	35
Eggs	301	96	13	4	537	99	5	1	622	89	80	11	509	94	34	6
Other foods	0	0	220	100	20	3	566	97	34	7	455	93	20	4	439	96
Total	11 993	63	7 002	37	22 739	67	11 271	33	26 928	68	12 790	32	21 588	67	10 761	33

Table 2.21. Expenditure (Tk/household) by landholding category in 1997-98

Item	Kapasia participants				Kapasia - others				Sreepur - control			
	Small (<1.0 ha)	Medium (1.0-2.4 ha)	Large (>2.4 ha)	All	Small (<1.0 ha)	Medium (1.0-2.4 ha)	Large (>2.4 ha)	All	Small (<1.0 ha)	Medium (1.0-2.4 ha)	Large (>2.4 ha)	All
Own food	14 476	17 780	27 455	19 951	10 767	19 349	31 823	19 542	11 993	22 739	26 928	21 588
Bought food	12 437	14 160	16 436	14 405	12 073	10 972	15 530	12 384	7 002	11 271	12 790	10 761
Clothing	3 946	5 898	7 406	5 834	3 642	4 981	7 321	5 103	2 047	4 652	6 295	4 603
Education	4 257	6 035	5 776	5 454	1 874	4 552	11 329	5 285	1 297	2 948	14 409	6 738
Marriage/ festival	1 679	3 150	18 250	7 570	1 284	4 000	9 157	4 343	1 553	6 370	8 273	5 863
Medical, etc.	1 907	1 868	5 125	2 921	929	4 541	5 486	3 618	2 580	2 800	8 795	4 943
Savings, etc.	48	123	3 238	1 099	84	237	1 586	503	130	489	1 495	768
Loan repayment	1 608	1 103	8 648	3 659	2 241	593	489	1 090	1 267	3 674	2 832	2 763
Others	1 369	6 188	1 013	3 182	663	8 167	36 571	12 418	2 667	14 652	8 455	9 383
Total, nonfood	14 815	24 363	49 456	29 719	10 717	27 070	71 939	32 361	11 540	35 585	50 555	35 062
Total (excluding fruit)	41 728	56 303	93 347	64 075	33 557	57 391	119 292	64 287	30 535	69 595	90 273	67 411
% nonfood	36	43	53	46	32	47	60	50	38	51	56	52

Table 2.22. Household's involvement with NGOs in 1998

NGO/support	Kapasia participants	Kapasia - others	Sreepur - control	Total
Households with NGO member (%)	13	13	17	14
No. of households belonging to NGO groups				
Bangladesh Rural Advancement Committee	1	2	0	3
Proshika	0	0	1	1
Association for Social Advancement	1	0	2	3
Grameen Bank	3	2	3	8
Bangladesh Rural Development Board	2	2	4	8
Department of Youth Development	3	0	0	3
Social Welfare Department	1	0	0	1
Local Pond Culture Society	1	0	0	1
Other clubs/societies	2	1	1	4
Social Welfare Department	1	0	0	1
Households getting support (%)	92	100	100	97
Cultivation	15	14	30	20
Livestock	23	14	20	20
Fish culture	8	14	0	7
Homestead gardening	8	0	0	3
Training	8	0	0	3
Credit for business	0	0	20	7
House repair	0	0	10	3
Food/nutrition	17	0	0	7

Table 2.23. Credit taken by household (hh) members in 1997-98

Credit source/use	Kapasia participants		Kapasia - others		Sreepur - control		All	
	No. of hh	Tk/hh	No. of hh	Tk/hh	No. of hh	Tk/hh	No. of hh	Tk/hh
Bank loan	7	15 543	2	10 000	4	11 250	13	13 369
NGO	6	9 167	4	9 875	6	4 833	16	7 719
Mohajan (money lender)	1	20 000	0	NA	1	8 000	2	14 000
Relatives and others	11	29 836	5	52 000	9	21 078	25	31 116
All	23	22 261	11	29 045	17	15 982	51	21 631
% of respondents using credit for the following purposes:								
Business	35		0		16		21	
Buy livestock	9		9		26		15	
Meet daily needs	13		9		21		15	
Agriculture/nursery	22		18		5		15	
Education	0		18		11		8	
Send people abroad	9		18		0		8	
Fish culture and pond excavation	0		27		0		6	
Buy/mortgage in land	4		0		11		6	
Election	0		0		11		4	
Purchase machinery	4		0		0		2	
Marriage	4		0		0		2	

Table 2.24. Percentage of households engaged in crop production in 1997-98

Crop	Kapasia participants				Kapasia - others				Sreepur - control			
	Small	Medium	Large	All	Small	Medium	Large	All	Small	Medium	Large	All
	N=28	N=40	N=32	N=100	N=19	N=27	N=14	N=60	N=15	N=23	N=22	N=60
B aus	11	13	6	10	0	11	21	10	7	9	9	8
TL aus	4	0	0	1	0	0	7	2	0	0	5	2
HYV aus	0	0	6	2	0	4	0	2	13	22	18	18
TL aman	29	25	38	30	37	41	29	37	0	0	0	0
HYV aman	25	28	19	24	26	26	29	27	73	57	59	62
HYV boro	75	58	72	67	68	59	50	60	67	35	36	43
Wheat	4	5	0	3	5	7	0	5	0	9	9	7
Jute	21	23	22	22	21	26	36	27	0	22	36	22
Sugarcane	7	13	16	12	0	19	29	15	0	9	5	5
Dal	0	5	0	2	0	7	14	7	0	0	5	2
Turmeric	0	3	9	4	5	0	0	2	0	0	0	0
Vegetables	7	10	9	9	5	19	14	13	0	9	23	12

Notes:
Landholding sizes: small - <1.0 ha; medium - 1-2.4 ha; large - >2.4 ha.
B = broadcast; TL = transplanted local varieties; HYV = high-yielding varieties;
aus = early monsoon season paddy crop; aman = main monsoon season paddy crop; boro = winter/dry season paddy crop.

Table 2.25. Average yield (kg/ha) of different crops reported by the sample pond owner/operator households in 1997-98

Crop	Kapasia participants				Kapasia - others				Sreepur - control			
	Small	Medium	Large	All	Small	Medium	Large	All	Small	Medium	Large	All
	N=28	N=40	N=32	N=100	N=19	N=27	N=14	N=60	N=15	N=23	N=22	N=60
B aus	2 073	1 091	2 189	1 605	NA	1 243	1 741	1 492	471	1 159	1 271	1 066
TL aus	1 384	NA	NA	1 384	NA	NA	5 295	5 295	NA	NA	988	988
HYV aus	NA	NA	988	988	NA	2 965	NA	2 965	3 347	2 081	1 771	2 199
TL aman	3 161	2 269	2 867	2 746	2 777	2 868	3 281	2 914	NA	NA	NA	NA
HYV aman	2 832	2 540	2 332	2 573	3 123	2 581	3 104	2 881	4 244	3 711	3 994	3 969
HYV boro	5 395	5 432	5 472	5 434	5 544	5 249	5 128	5 332	4 828	5 311	11 409	7 001
Wheat	760	1 296	NA	1 117	12 355	3 336	NA	6 342	NA	3 671	1 942	2 806
Jute	1 743	1 557	1 610	1 624	1 986	2 033	1 257	1 779	NA	1 546	1 485	1 508
Sugarcane	93 182	69 137	69 753	73 401	NA	75 233	63 822	70 162	NA	44 478	54 463	47 806
Dal	NA	758	NA	758	NA	1 942	395	1 169	NA	NA	247	247
Turmeric	NA	5 930	22 074	18 038	12 355	NA	NA	12 355	NA	NA	NA	NA

Notes:
Landholding sizes: small - <1.0 ha; medium - 1-2.4 ha; large - >2.4 ha.
B = broadcast; TL = transplanted local varieties; HYV = high-yielding varieties;
aus = early monsoon season paddy crop; aman = main monsoon season paddy crop; boro = winter/dry season paddy crop.
Yield for vegetables not calculable due to wide range of types grown.

Table 2.26. Total imputed value of own onfarm inputs (Tk/ha) for crop production in 1997-98

Crop	Kapasia participants	Kapasia - others	Sreepur - control	All
B aus	2 002	2 323	2 248	2 152
TL aus	3 438	2 083	1 882	2 468
HYV aus	3 027	2 917	2 459	2 573
TL aman	1 944	1 892	NA	1 922
HYV aman	3 047	2 929	2 351	2 688
HYV boro	2 633	2 576	3 272	2 746
Wheat	4 680	7 665	3 750	5 203
Jute	3 041	5 406	7 575	4 939
Sugarcane	7 209	2 964	6 064	5 474
Dal	1 761	1 407	1 482	1 519
Turmeric	21 333	16 357	NA	20 338
Vegetables	3 061	3 956	4 676	3 831

B = broadcast; TL = transplanted local varieties;
HYV = high-yielding varieties;
aus = early monsoon season paddy crop;
aman = main monsoon season paddy crop;
boro = winter/dry season paddy crop.

sugarcane had relatively high cash costs for irrigation, seed and labor.

More than half of paddy produced was for own consumption, but other crops were mainly cash crops. Very little of crop by-products were sold. Some 85% of straw from paddy was used as cattle feed, while wheat straw, jute sticks and sugarcane residue were used as fuel (Table 2.27). Overall, several farmers failed to make a cash profit on several of their crops (sale income less cash costs), but allowing for onfarm inputs and home consumption indicates that all crops except perhaps aus (Table A3.3) were viable. Aman, boro and sugarcane tended to generate the best net returns.

Use of by-products

The earlier project aimed to make better use of underused onfarm by-products and bioresources for fish culture. Table 2.28 summarizes the availability and use of these resources: large-scale farms tend to have more resources available, except that the levels of composting are the same among past participants irrespective of farm size.

Thus, bran is mainly used for animal and fish feed and none is unused. An estimated 20% of cow dung was not specifically employed, but about 25% of the resource available was deliberately used to fertilize ponds. The proportion was only slightly higher for past participants compared with the nonparticipants. The main use of poultry manure is to fertilize ponds - over 50% was used in Kapasia compared with 36% in Sreepur. Compost is widely produced especially by large-scale farmers in Sreepur, and almost all was used for crop fertilization. Kitchen wastes are included in this category since it would be illogical to waste 20% having made the effort to compost it. Straw was used mainly to feed cattle in similar percentages across landholding sizes despite the much higher straw production of large farmers.

There have been some major changes in by-product use since 1990-91. Apparently, quantities of rice bran available have fallen (although there is no indication of reduced rice yields, the average area of own cultivated land has fallen for large-scale landholders since 1990-91), but any fall in bran availability may be overstated. Nevertheless,

Table 2.27. Production and use of crop outputs (main and by-products) by crop in 1997-98

Crop	Main product				By-product							
	Kg/ha	Consumed	Sold	Landlord	Tk/ha (sold)	kg/ha	Sold	Feed	Fuel	Fence	Given	Tk/ha (sold)
		(%)					(%)					
B aus	1 444	65	33	2	3 991	1 069	5	90	6	0	0	28
TL aus	2 556	49	39	12	10 947	2 142	0	83	17	0	0	0
HYV aus	2 080	67	29	4	4 152	1 022	0	100	0	0	0	0
TL aman	2 817	50	49	1	10 497	1 437	9	85	2	0	3	74
HYV aman	3 308	73	26	1	6 405	2 221	1	88	11	0	1	11
HYV boro	5 721	51	46	3	18 785	3 607	2	83	11	0	4	93
Wheat	3 360	38	62	0	10 120	1 887	0	13	71	16	0	0
Jute	1 643	17	81	3	10 126	3 805	1	5	83	9	2	194
Sugarcane	68 987	5	94	0	78 641	10 270	4	17	71	1	13	0
Dal	920	35	65	0	10 707	513	0	1	86	0	0	0
Turmeric	16 902	15	85	0	52 138	0	NA	NA	NA	NA	NA	0
Vegetables	9 358	37	63	0	25 951	524	0	44	44	0	6	0

Notes: B = broadcast; TL = transplanted local varieties; HYV = high-yielding varieties;
aus = early monsoon season paddy crop; aman = main monsoon season paddy crop; boro = winter/dry season paddy crop.

Table 2.28. Production (kg/household [hh]) and utilization (%) of onfarm bioresources in 1997-98

By-product/ use	Kapasia participants				Kapasia - others				Sreepur - control				All
	Small	Medium	Large	All	Small	Medium	Large	All	Small	Medium	Large	All	
Bran (kg/hh)	452	513	763	576	307	609	1,114	631	326	504	716	537	581
Animal feed	62	43	54	52	59	48	56	53	43	50	57	51	52
Fuel	11	11	6	9	7	5	4	5	20	20	14	18	10
Fish feed	27	44	41	38	33	45	39	40	38	30	28	31	37
Sold	0	2	0	1	0	2	1	1	0	0	0	0	1
Cow dung (kg/hh)	2 986	3 462	6 094	4 171	2 682	3 301	6 068	3 751	1 962	3 602	6 275	4 172	4 057
Crop fertilizer	62	53	47	54	49	62	53	56	37	43	60	48	53
Pond (fish) fertilizer	15	27	24	23	28	18	32	24	50	38	17	34	26
Unused	23	20	29	24	23	20	14	19	13	19	23	19	21
Chicken manure (kg/hh)	238	368	572	397	87	20	451	142	35	109	138	101	247
Crop fertilizer	23	31	16	24	20	28	15	20	6	21	14	15	20
Pond (fish) fertilizer	19	24	51	32	9	36	44	32	10	27	21	21	29
Unused	58	45	33	44	70	37	41	49	83	53	65	64	51
Compost (kg/hh)	380	376	417	390	171	403	686	396	373	1 230	1 868	1 250	626
Crop fertilizer	69	78	79	75	72	82	70	76	51	81	80	76	76
Pond (fish) fertilizer	9	2	4	5	0	9	5	6	0	0	0	0	3
Unused	22	21	17	20	28	9	25	18	49	19	20	24	21
Straw (kg/hh)	1 563	2 079	4 628	2 750	1 149	2 307	3 956	2 325	1 861	2 339	5 527	3 389	2 808
Sold	2	11	4	6	1	5	2	3	4	0	0	0	3
Animal feed	85	78	87	84	89	82	88	85	72	76	77	76	82
Fuel	10	8	5	7	7	10	10	10	24	21	20	21	12
Given away	2	1	4	3	3	3	0	2	0	2	4	3	3
Unused	1	1	0	1	0	0	0	0	0	0	0	0	0
Jute stick (kg/hh)	61	356	169	213	64	122	214	125	0	65	87	57	147
Sold	0	7	0	5	0	0	0	0	NA	0	0	0	3
Fuel	87	78	94	82	92	91	98	94	NA	61	94	80	85
Roof/fence	13	11	3	9	8	7	0	4	NA	38	5	20	9
Given away	0	4	4	4	0	2	2	2	NA	1	0	1	3
Unused	0	0	0	0	0	0	0	0	NA	0	0	0	0

Note: Landholding sizes: small - <1.0 ha; medium - 1-2.4 ha; large - >2.4 ha.

there has been about a ten-fold increase in the reported use of bran as fish feed (Table 2.29), at the expense of fuel and some animal feed use, and this has occurred for farmers in the control area as well as in Kapasia. Bran use was higher than recommended in the early 1990s by WorldFish and further study of the marginal returns from its use for fish or animal feed seems warranted.

Since cattle numbers have fallen slightly and by-product production estimates are difficult to make, the apparent increase in cow dung availability in Table 2.29 may not be real. However, the responses do point to a massive increase in its use in ponds that has continued since the project and also has occurred to an even greater extent in the control area. The main unused onfarm resources that are now used are compost (which was virtually unheard of in 1990-91 but is now used especially for crop production), and use of poultry manure especially for pond fertiliza-tion. Overall, sustained pond aqua-culture in the area is based on better use of onfarm resources, as intended in the WorldFish project, but the same trends are found among control farmers. It may be now that some bioresources are used excessively for ponds compared with alternative uses, and that this would merit onfarm studies of integrated systems.

Table 2.29. Changes in farm by-product production and use (%) from 1990-91 to 1997-98

By-product and use	Kapasia participants			Kapasia - others			Sreepur - control		
	1990-91	1997-98	Change (%)	1990-91	1997-98	Change (%)	1990-91	1997-98	Change (%)
Rice bran (kg/household)	981	576	-41	981	631	-36	1 086	537	-51
Animal feed	72	52	-58	72	53	-53	64	51	-61
Fish feed	2	38	+995	2	40	+1 160	1	31	+1 410
Fuel	22	9	-76	22	5	-85	31	18	-71
Cow dung (kg/household)	3 025	4 171	+38	3 025	3 751	+24	3 825	4 172	+9
Crops	85	54	-12	85	56	-18	83	48	-37
Pond	4	23	+692	4	24	+644	3	34	+1 133
Poultry manure (kg/household)	47	397	+745	47	142	+202	8	101	+1 162
Crops	6	24	+3 067	6	20	+833	0	15	+NC
Pond	0	32	+NC	0	32	+NC	0	21	+NC
Unused	94	44	+298	94	49	+59	100	64	+700

Notes: Change (%) based on quantities: average amount of each by-product in each use in the two surveys.
NC - not calculable.
Sources: 1990-91 data – Ahmed et al. (1993); 1997-98 data – this study.

Conclusion

Pond-owning households in Kapasia and Sreepur appeared to be considerably better off in 1997-98 than in 1990-91. They may not have more land or cattle and have modest improvements in crop production, but nonfarm incomes are much higher; remittances, business and enterprises, such as poultry rearing, have taken off. Pond aquaculture is also prevalent (see Chapters 3 and 4), but has not contributed much to most household incomes. Nevertheless, fish consumption appears to have increased for pond owners, particularly those in Kapasia who participated in the earlier project. Also more onfarm by-products are used for farm enterprises and there has been a shift in their use for fish culture.

Chapter 3
Pond Aquaculture Practices and Changes in Kapasia and Sreepur Upazilas

Pond Characteristics

In 1990, a census by the WorldFish Center (formerly known as ICLARM) in the four unions of Kapasia Upazila (subdistrict) that were to form the initial project area (Barishaba, Chandpur, Rayed and Torgaon) found that there were just 634 ponds and ditches with a total area of 77.16 ha or 0.5% of the total land area (Ahmed 1992). Similarly in the two unions of Sreepur Upazila (Bormi and Gazipur) that formed the control area, there were 670 ponds and ditches with a total area of 75.75 ha or 0.8% of total land area. At that time, 61% of these ponds in Kapasia and 70% in Sreepur were stocked with fish, either irregularly or regularly, but production was reported to average only 550 kg/ha (Ahmed 1992). A detailed socioeconomic survey in 1990-91 found that only 33% of the pond operators stocked fish that year in Kapasia compared with 51% in Sreepur (Ahmed et al. 1993). Out of the 193 households sampled in Kapasia, 44% were those that adopted improved aquaculture in 1991-92 as extended at that time by the WorldFish project (Ahmed et al. 1995). Details of 215 adopting ponds and their management practices were reported for 1991-92 by Ahmed et al. (1995).

Table 3.1. Age of sample ponds (%) in Kapasia and Sreepur in 1998

Period of pond construction	Kapasia participants (n=107)	Kapasia – others (n=63)	Sreepur (n=67)	Total (n=237)
1995-1998	5	21	13	13
1990-1994	19	29	22	22
1980-1989	25	14	19	19
1970-1979	14	8	11	11
Pre-1970	32	14	24	24
Don't know	6	14	12	12
Total	100	100	100	100

Where appropriate, these data were compared with those in 1998.

In 1998, a fresh census conducted by WorldFish found there were 1 278 ponds and ditches with a total area of 114.48 ha in the same four unions of Kapasia indicating a 101% increase in number and 48% increase in area over eight years (respectively, increases of about 9% and 5% per annum). In Sreepur, no census was carried out. For sampling purposes, a list of ponds compiled by the Department of Fisheries (DOF) in 1994 was used. The list showed 610 pond-operating households. Ponds had a total area of 119.03 ha in the same two unions of Sreepur, a 57% increase over 1990. It appears that the DOF list may have ignored smaller ditches. These lists and censuses formed the population from which samples of pond-operating households were drawn for surveys (see Chapter 1 for sample details). Because of multiple-pond operation, the 220 sample households operate 237 ponds. Naturally, the past Kapasia participants already had ponds in 1990-93 at the time of the earlier project and so they had excavated few ponds since then. However, random samples of other pond owners in Kapasia and Sreepur showed that many ponds had been excavated in the last four years (1995-98). The number of ponds owned by people not covered by the earlier project in Kapasia approximately doubled during the 1990s (again about 8 to 9% per annum compound growth rate) (Table 3.1). In Sreepur, the number of ponds increased by 52% (approximately 5% per annum compound growth rate).

The pond operators had already been categorized by the reported pond size when updating the censuses. Table 3.2 shows the results of this

Table 3.2. Size of sampled ponds in Kapasia and Sreepur in 1998

Size of pond	Participants									
	1st and 2nd year		3rd year		Kapasia – combined		Kapasia - others		Sreepur - control	
	No.	%	No.	%	No.	%	No.	%	No.	%
Small (<= 15 decimals)	34	54	18	42	52	49	33	52	30	45
Medium-large (> 15 decimals)	29	46	25	58	54	51	30	48	37	55
All	63	100	43	100	106	100	63	100	67	100

Note: Kapasia - combined – first and second year + third year participants.

crosschecking. A few pond operators have more than one pond and all were surveyed. Categorization was generally correct, but a number of ponds on the borderline between above and below 15 decimals (0.06 ha) may have been misestimated.

The actual areas of ponds were measured to improve the analysis. Table 3.3 compares original classifications used in sampling, areas reported by the respondents and measured areas. Original classifications match closely with the reported maximum area including pond dikes, while the measured area is that during monsoon 1999 and so most closely matches reported monsoon extent of the ponds. All area measures were highly correlated, but 20% of Kapasia participants, 18% of other Kapasia pond operators and 23% of Sreepur pond operators were misclassified in the census compared with their measured pond area. In general, more ponds proved to be smaller and to fall in the small-scale category (up to 15 decimals, 0.06 ha) and fewer were actually larger than reported. It is believed that this does not substantially affect the validity of the samples.

Surprisingly, most respondents claimed that their ponds were excavated purposely for fish culture (Table 3.4). Given that many were dug before the WorldFish project when there was very little aquaculture in the area (Ahmed 1992), this seems unlikely, although it may have been an important factor for the ponds dug since about 1992. Hence, although the reasons for digging ponds may have originally been multipurpose and not as stated, now the majority of the households surveyed regard their main use as being for fish culture.

In 1990-91, 97% of ponds in Kapasia and 98% in Sreepur were privately owned and the rest were institutional or khas ("public property") ponds (Ahmed et al. 1993). By 1998, virtually all of the ponds operated in the area were owned by members of the operating household (Table 3.5),

Table 3.3. Comparison of pond areas and categories in Kapasia and Sreepur (number of pond-operating households in each category and mean areas)

Pond area/category	Kapasia participants		Kapasia - others		Control area - Sreepur	
Census ->	Small	Medium-large	Small	Medium-large	Small	Medium-large
Reported maximum						
Small	33	3	20	0	19	1
Medium-large	9	56	3	37	4	36
Monsoon area						
Small	39	10	20	7	22	5
Medium-large	2	49	3	30	1	32
Measured						
Small	34	13	21	9	21	12
Medium-large	7	46	2	28	2	25
Measured ->	Small	Medium-large	Small	Medium-large	Small	Medium-large
Monsoon area						
Small	42	7	26	1	25	2
Medium-large	5	46	4	29	8	25
Area (ha)						
Maximum reported		0.149		0.136		0.173
Monsoon reported		0.099		0.094		0.110
Dry season reported		0.080		0.082		0.099
Measured		0.107		0.083		0.109

Note: Pond area: small (<= 15 decimals), medium-large (> 15 decimals).

Table 3.4. Distribution of ponds by purpose of pond excavation

Purpose of pond excavation	Pond owners											
	Kapasia participants				Kapasia - others				Sreepur - control			
	Small		Medium-large		Small		Medium-large		Small		Medium-large	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Raising of homestead	4	10	2	3	0	0	1	3	0	0	0	0
Fish culture	30	73	49	74	19	83	29	73	20	87	31	70
Household water use	6	15	14	21	2	9	10	25	3	13	13	30
Road construction	1	2	1	2	2	9	0	0	0	0	0	0
All	41	100	66	100	23	100	40	100	23	100	44	100

and very few were rented in on a share basis or were government ponds. However, in 1990-91, about 40% of ponds were jointly owned, and a similar proportion was jointly operated in both Kapasia and Sreepur. In 1998, some 22% of ponds in Kapasia and 25% in Sreepur were reported to be jointly operated (Table 3.6). In particular, the medium-large ponds are often jointly owned: about 30% in all three main household categories are jointly operated compared with 8 to 18% for small ponds. This means that the benefits of cultivating larger ponds are shared, but can also lead to disputes and conflicts over sharing of costs and benefits. It would appear that this may affect practices and production, as shown in the rest of this chapter.

Although this chapter and report is primarily concerned with the productive use of ponds themselves, associated with each pond is the surrounding strip of raised land or dike, built to retain water and fish in case of external flooding

Table 3.5. Distribution of ponds by type of ownership

Ownership type	Pond											
	Kapasia participants				Kapasia - others				Sreepur - control			
	Small		Medium-large		Small		Medium-large		Small		Medium-large	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Owned by household	41	100	63	95	22	96	39	98	23	100	43	98
Khas (government)	0	0	3	5	0	0	1	3	0	0	1	2
Share in	0	0	0	0	1	4	0	0	0	0	0	0
All	41	100	66	100	23	100	40	100	23	100	44	100

Table 3.6. Distribution of ponds by type of operator

Operator status	Pond											
	Kapasia participants				Kapasia - others				Sreepur - control			
	Small		Medium-large		Small		Medium-large		Small		Medium-large	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
No fish culture	6	15	1	2	2	9	0	0	0	0	3	7
Single operator	28	68	47	71	16	70	31	78	20	87	27	61
Joint operator	6	15	15	23	0	0	0	0	0	0	0	0
Single lease operator	1	2	1	2	0	0	0	0	0	0	0	0
Joint lease operator	0	0	2	3	5	22	9	23	3	13	14	32
All	41	100	66	100	23	100	40	100	23	100	44	100

Table 3.7. Utilization of pond dikes and condition of pond in Kapasia and Sreepur in 1990 and 1998

Attribute	Kapasia			Sreepur	
	1990	1998 participants	1998 - others	1990	1998
Pond dike area per pond (ha)	NA	0.049	0.043	NA	0.073
Pond dike area per pond (decimal)	NA	12.0	11.0		19.0
Dikes as % of pond monsoon water area	10-20%	49%	46%	10-20%	42%
Number of trees per pond					
Big	5.25	7.2	5.4	10.19	7.3
Small	NA	15.1	17.3	NA	35.1
% of pond dikes used for:					
Gardening	16.7	24.6	20.1	5.7	6.9
Animal shed	0.7	2.4	1.5	0.7	6.0
Grazing	13.8	10.7	21.0	7.5	30.8
Storage (straw, etc.)	2.1	0.7	0.2	1.1	6.1
Graveyard	0.5	0.1	0.5	1.0	1.3
Others	15.8	14.8	23.7	6.8	44.3
Unused	50.4	46.7	33.0	77.3	4.6
% ponds with:					
Overhanging trellises	7	6	5	13	10
Water hyacinth	19	12	21	11	5
Kalmilata	20	16	10	15	10
Other water plants	11	8	0	24	13

Sources: 1990 – Ahmed et al. (1993); 1998 – field survey.

(Table 3.7). This also represents a land resource for use by the household. The area of dikes relative to water has increased since 1990, presumably through raising and strengthening of banks to reduce the risk of loss of fish in floods. Numbers of large trees have not changed substantially, but there are many small trees surrounding ponds (many of which were constructed in the last 10 years). Although gardening (vegetables, etc.) has apparently increased on the dikes, it is only practiced on a quarter of the area by previous participants, and has not developed in the control area (Sreepur). Pond management in general has improved with regard to surface cover – the number of ponds with surface cover of aquatic plants has fallen since 1990 both for those ponds whose operators received training in the earlier project and for other ponds.

Aquaculture Practices and System

The percentage of ponds stocked in the year surveyed (85 to 91%) did not differ significantly between past participants and the two comparison samples – neighbors in Kapasia and the control area (Table 3.8). Thus, by 1998 fish culture had become widespread in the project area, but it had also developed in the control area without any specific extension effort, and so would presumably have expanded in Kapasia also. Hence, the project brought fish farming a few years earlier to Kapasia but has not resulted in the medium-term in a higher incidence of aquaculture. Moreover, the proportion of ponds in Kapasia stocked, using inputs and producing fish was only slightly higher on each factor than in Sreepur.

The main differences recorded were in the density of fingerlings stocked and the production levels. The participants of the previous project reported rearing 65 g of fish for market or consumption per fingerling stocked compared with 35 g/fingerling for other ponds in Kapasia and only 20 g/fingerling for Sreepur. This indicates that the growth or survival of fish in Sreepur must be very poor, or that quality of fingerlings was poor or that the stocking density was overreported there. Studies elsewhere indicate that access to quality fingerlings and the capability of the fry traders who distribute fingerlings to farmers are probably the key factors in pond aquaculture (Chowdhury et al. 1998a).

Production among the participants was reported to be 2.3 t/ha in 1997-98 after the end of project support (Table 3.9). There was no difference between the participants from years 1 to 2 and 3 of the project with regard to stocking density and production, or between yields during the project and in 1997-98 (Table 3.10), indicating that the gains from earlier extension have been maintained. It is notable that both extension recipients (past participants) and nonparticipants with small ponds have significantly higher yields in Kapasia but not Sreepur, and this is associated with significantly higher stocking densities in smaller ponds.

There appears to have been some demonstration effect from the earlier project as the stocking levels (55 750 fingerlings/ha) and production (1.6 t/ha) of other Kapasia ponds are intermediate between participants and the control group (Sreepur) ponds. The nonparticipants in Kapasia had just significantly different stocking density and production (respectively higher and lower) than past participants and also had significantly lower stocking densities than the Sreepur pond operators. It also appears that there is an inverse relationship between the number of fingerlings stocked and production per hectare within the range reported by respondents. This is believed to reflect stocking of large numbers of small fingerlings by nonparticipants.

The earlier project made some recommendations on stocking composition for carp but they were not expected to be followed rigidly. That project also introduced use of Thai sharputi in the area, and promoted culture of tilapia as well as carp polyculture. Now the farmers use those fingerlings that are readily available. They believe that access

Table 3.8. Aquaculture status of ponds in 1997-98

Pond status	Kapasia participants		Kapasia - others		Sreepur - control	
	No.	%	No.	%	No.	%
Sampled	107	100	64	100	67	100
Stocked	95	89	56	88	57	85
With production	94	88	54	84	54	81
Used inputs	93	87	54	84	53	79
Stocked but no production	3	3	2	3	5	7
Not stocked but has production	2	2	0	0	2	3
Not stocked but used inputs	2	2	0	0	1	1

Table 3.9. Stocking density and fish production by pond and participant category for ponds stocking fish

Local measurement unit

Attribute and pond size		Kapasia participants		Kapasia - others		Sreepur - control	
		Average	Standard deviation	Average	Standard deviation	Average	Standard deviation
Number of stocked ponds		95		56		57	
Stocking density (no./decimal)	Small pond owner	230	223	279	275	334	291
	Medium + large pond owner	85	64	101	104	193	242
	All	157	178	196	229	267	276
Production (kg/decimal)	Small pond owner	11.8	9.0	7.4	6.5	5.4	5.4
	Medium + large pond owner	5.0	4.9	3.7	3.5	3.8	4.4
	All	8.4	8.0	5.7	5.6	4.7	5.0

Metric measurement unit

Attribute and pond size		Kapasia participants		Kapasia - others		Sreepur - control	
		Average	Standard deviation	Average	Standard deviation	Average	Standard deviation
Number of stocked ponds		95		56		57	
Stocking density (no./ha)	Small pond owner	56 642	55 738	74 210	67 863	90 333	70 371
	Medium + large pond owner	26 001	35 051	31 136	24 957	61 059	61 391
	All	41 160	48 701	55 750	57 610	77 493	67 611
Production (kg/ha)	Small pond owner	2 883	2 393	1 999	1 642	1 464	1 341
	Medium + large pond owner	1 687	3 294	1 135	811	1 175	1 113
	All	2 278	2 930	1 629	1 407	1 337	1 244

Table 3.10. Significance tests of difference in mean stocking density and production (stocking ponds only) for data presented in Table 3.9

Comparison		Stocking density		Production	
		t-test	Significance	t-test	Significance
Between small and medium + large pond	1st and 2nd year participant	2.680	0.011	3.060	0.003
	3rd year participant	5.299	0.000	3.462	0.002
	Combined participants (Kapasia)	4.289	0.000	4.607	0.000
	Kapasia - others	3.243	0.002	2.524	0.015
	Sreepur - control	1.675	0.100	0.889	0.378
Between 1st and 2nd year and 3rd year participants		-0.955	0.342	-0.801	0.426
Between all Kapasia participants and Kapasia - others		-1.853	0.067	1.694	0.092
Between all Kapasia participants and Sreepur - control		-3.862	0.000	2.789	0.006
Between Kapasia - others and Sreepur - control		-1.887	0.062	1.088	0.279

to high-quality fingerlings is a limiting factor in the area. Species composition in 1997-98 was similar in all samples. The main species cultured were Rui, Mrigal, Catla, Silver carp and Thai sharputi (Table 3.11). The nonparticipants generally used more Rui and Thai sharputi than the participants.

As Fig. 3.1 shows, past participants stock some four times more fish than was recommended and have added Thai sharputi to their carp polyculture. The same is true of the nonparticipants, although their stocking densities are even higher they use similar proportions of the different categories of fish, with surface feeders (Silver carp) dominating.

Despite this, the average expenditure on stocking was almost the same for all three pond operator categories implying that the extension recipients tend to buy more expensive (larger) fingerlings (Table 3.12). Expenditure was also more evenly spread between species by the past participants, who also use less Thai sharputi by value than the others.

Comparing input use with recommendations indicates that while average levels of use are similar to recommendations, many households did not use some inputs. Liming is virtually never done before stocking; presumably, the farmers in Kapasia found it was not worthwhile. Almost all operators used bran as feed and the majority also fertilized their ponds with cow dung, and about half used urea. Use of lime after stocking was more common in Kapasia than Sreepur, but otherwise there were few differences in the percentage

Fig. 3.1. Kapasia stocking recommendation and practice

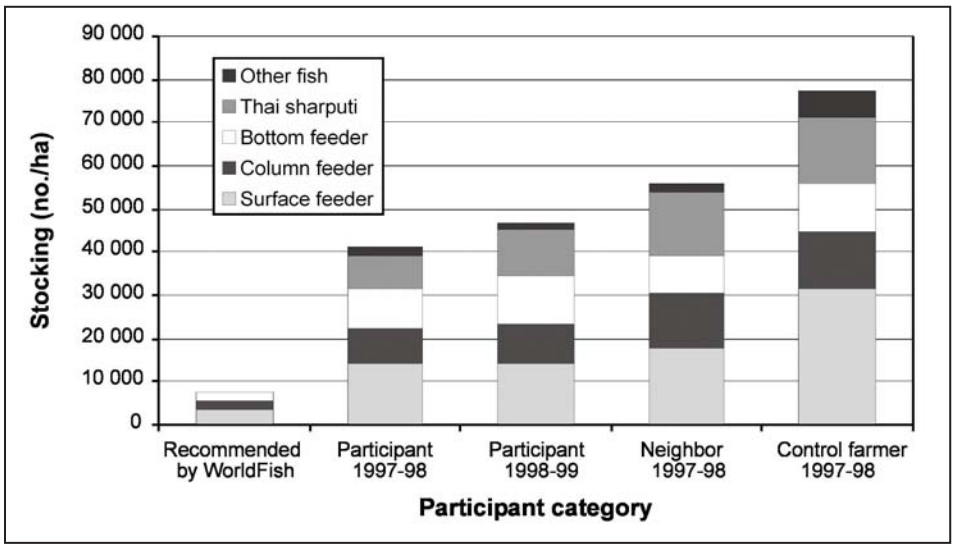


Table 3.11. Stocking densities (no./ha) for ponds stocking fish in 1997-98

Species	Kapasia participants				Kapasia - others				Sreepur - control			
	% pond	No./ha	Range	SD	% pond	No./ha	Range	SD	% pond	No./ha	Range	SD
No. of ponds	95				56				57			
Rui	85	9 471	(544-96 525)	14 055	86	14 916	(701-175 734)	28 191	72	18 854	(2 052-74 856)	16 978
Catla	74	5 690	(239-56 038)	8 754	73	8 391	(389-56 928)	10 667	67	12 339	(434-49 904)	12 080
Mrigal	78	8 292	(272-96 525)	13 010	80	8 019	(389-22 415)	5 757	67	12 577	(1 594-49 400)	9 652
Kalbaos	1	2 844	(2 844-2 844)	NA	4	837	(736-938)	143	2	897	(897-897)	NA
Silver carp	73	13 281	(161-71 182)	15 477	73	15 673	(635-88 481)	17 120	70	30 955	(434-229 247)	48 515
Common carp	38	7 122	(136-128 700)	21 160	34	5 700	(433-22 415)	5 119	23	10 797	(587-24 843)	10 342
Grass carp	14	2 303	(253-6 861)	2 449	9	1 007	(64-2 015)	780	14	10 168	(1 195-55 893)	18 620
Nilotica	8	2 226	(85-7 582)	2 585	14	10 974	(866-30 291)	9 996	18	5 645	(598-12 476)	4 624
Thai sharputi	64	11 666	(541-59 774)	13 338	73	20 795	(736-96 237)	23 862	77	20 082	(1 647-64 972)	15 833
Others	7	28 021	(382-124 534)	46 192	2	3 113	(3 113-3 113)	NA	5	98 813	(25 709-224 153)	109 048
All	100	41 160	(2 908-321 750)	48 701	100	55 750	(5 198-285 568)	57 610	100	77 493	(3 113-308 719)	67 611

Notes: No./ha is number of fingerlings stocked for only those ponds stocking a species (i.e., excluding zeros). SD – standard deviation.

Table 3.12. Stocking cost (Tk/ha) of cultured pond

Species	Kapasia participants	Kapasia - others	Sreepur - control	All
Rui	3 175	4 917	3 465	3 721
Catla	2 211	2 737	2 189	2 345
Mrigal	2 168	2 355	2 190	2 224
Kalbaos	9	11	3	8
Silver carp	2 636	2 894	5 473	3 502
Common carp	1 091	747	662	879
Grass carp	156	29	348	176
Nilotica	50	299	222	165
Thai sharputi	2 315	5 067	4 400	3 634
Goinna	65	0	0	29
Magur	7 136	0	2 282	3 869
All	21 011	19 056	21 235	20 553

using inputs. Input use levels on average were lower than recommended except for cow dung and rice bran. For these inputs, the nonparticipants use more than the participants who are closer to the recommendations (Table 3.13).

Among pond operators using specific inputs, use of cow dung was much more than recommended, but use of all other inputs was less then recommended (this applies to both past participants and nonparticipants). As these inputs are mostly purchased except for manure which is readily available (as most of these farmers' own cattle), they mainly used onfarm resources (Table 3.14).

Table 3.13. Input use for ponds that were stocked in 1997-98

Input	Recommended[a]	Kapasia participants			Kapasia - others			Sreepur - control		
		kg/ha	SD	% pond	kg/ha	SD	% pond	kg/ha	SD	% pond
A. Prestocking (pond preparation)										
Lime	247	27	208	2	0	0	0	411	1 829	5
Cow dung	2 964	2 162	3 991	55	1 257	2 535	38	2 628	5 761	44
Urea	62	36	63	40	55	132	41	21	53	21
TSP	62	18	42	27	39	126	30	11	47	14
B. Post-stocking										
Urea	309	96	154	56	82	121	59	51	97	40
TSP	309	43	100	32	45	82	41	20	48	26
Lime	247	75	152	41	33	65	34	28	124	18
Cow dung	7 410	10 430	16 429	79	14 009	15 952	82	13 324	21 712	77
Chicken manure	618	722	2 656	32	407	2 096	23	405	993	23
C. Post-stocking (feed)										
Rice/wheat bran	4 940	5 271	7 257	86	7 955	11 113	91	5 932	7 168	81
Oilcake	2 470	345	899	43	355	806	54	190	319	40
Grass/vegetation	6 175	238	948	14	140	608	7	293	1 880	4

Note: Means are for all ponds stocked in that year. TSP – Triple superphosphate; SD – standard deviation.
[a]Ahmed et al. (1993).

Table 3.14. Average input use for those who used each specific input

Input	Kapasia participants		Kapasia - others		Sreepur - control	
	kg/ha	Standard deviation	kg/ha	Standard deviation	kg/ha	Standard deviation
A. Prestocking (pond preparation)						
Lime	1 302	870	NA	NA	7 803	2 680
Cow dung	3 950	4 708	3 352	3 208	5 992	7 513
Urea	89	72	133	181	98	76
TSP	65	58	130	204	79	107
B. Post-stocking						
Urea	173	171	139	130	127	117
TSP	135	141	109	97	76	67
Lime	184	192	98	80	159	268
Cow dung	13 212	17 482	17 055	16 059	17 261	23 332
Chicken manure	2 287	4 377	1 753	4 192	1 776	1 403
C. Post-stocking (feed)						
Rice/wheat bran	6 107	7 480	8 735	11 353	7 351	7 299
Oilcake	799	1 236	663	1 011	470	348
Grass/vegetation	1 740	2 053	1 955	1 431	8 359	7 940

Note: TSP – Triple superphosphate.

Consequently, even though the imputed value of cow dung is low, it still represented the main feed and fertilizer input to the ponds by value, comprising about half of these costs for past participants. Bran and oilcake were the main purchased inputs by value (Table 3.15). The nonparticipants in Kapasia buy and use substantial amounts of them, particularly bran, although they have lower fish production than the past participants. The control group has similar material inputs by value and the Kapasia nonparticipants have higher expenditure on inputs compared with past participants. Hence, the earlier extension with its emphasis on low cost onfarm inputs appears to have had a sustained impact on practice in keeping input costs low.

Labor inputs were similar for the three categories of pond operator, around 650 person-days per ha, although this may not represent full working days. This translates to around 26 person-days per household (Table 3.16). Women were reported to be substantially involved in only the control area (feeding and fertilizing ponds). Hired laborers worked mainly to re-excavate some ponds and as skilled fishers for harvesting some ponds where their wages were close to 70% above the normal daily wage rate.

An average annual fish production of 2.25 t/ha was observed from past participants who cultured fish in 1997-98 (including some ponds that harvested cultured fish but did not stock in that

Table 3.15. Aquaculture input cost[a] (Tk/ha) for cultured ponds only in 1997-98

Input	Kapasia participants			Kapasia - others			Sreepur - control			All		
	All	Own	Bought	All	Own	Bought	All	Own	Bought	All	Own	Bought
Water pumping	20	0	20	0	0	0	397	0	397	121	0	121
Lime	994	0	994	641	0	641	495	0	495	759	0	759
Urea	808	0	808	879	0	879	417	0	417	717	0	717
TSP	565	0	565	1 053	0	1 053	406	0	406	650	0	650
Piscicide	17	0	17	5	0	5	0	0	0	9	0	9
Cow dung	12 039	11 898	141	14 888	14 609	279	14 355	14 081	274	13 449	13 234	215
Chicken manure	863	842	21	458	421	37	462	402	60	643	606	36
Bran	6 435	4 590	1 845	11 125	5 648	5 477	7 613	4 861	2 752	8 017	4 949	3 068
Oilcake	2 139	5	2 134	2 144	51	2 093	1 172	0	1 172	1 869	16	1 853
Grass/leaves	233	231	2	140	140	0	283	283	0	222	221	1
Viscera	6	2	5	0	0	0	599	599	0	171	169	2
Flour	0	0	0	98	0	98	37	0	37	37	0	37
Cooked rice	185	185	0	127	127	0	191	191	0	171	171	0
Termite	76	76	0	19	19	0	0	0	0	39	39	0
Jackfruit by-products	4	4	0	46	46	0	2	2	0	15	15	0
Bread	0	0	0	78	78	0	0	0	0	21	21	0
Compost	0	0	0	16	16	0	0	0	0	4	4	0
All	24 385	17 834	6 552	31 716	21 154	10 562	26 428	20 420	6 009	26 914	19 446	7 468

[a]Combines cost of purchased inputs with imputed value of onfarm inputs.
Note: TSP – Triple superphosphate.

Table 3.16. Labor inputs, days and wage rate for cultured ponds in 1997-98. (M – male, F – female)

Labor inputs (days/ha)

Operation	Kapasia participants						Kapasia - others						Sreepur - control					
	Own			Hired			Own			Hired			Own			Hired		
	M	F	All	M	F	All	M	F	All	M	F	All	M	F	All	M	F	All
Preparation	45	0.1	45	13	0.3	14	25	0.5	25	13	0	13	44	2.2	46	18	0	18
Operation	190	36	226	16	0.3	17	168	66	234	40	0	40	256	147	403	4.8	0	4.8
Harvest/market	123	0	123	58	11	70	174	0	174	17	0	17	178	2.6	180	26	0	26

Total labor days per hectare and proportion from household and hired sources in cultured ponds

Operation	Kapasia participants			Kapasia - others			Sreepur - control		
	Days	% own	% hired	Days	% own	% hired	Days	% own	% hired
Preparation	58	77	23	38	65	35	64	72	28
Operation	242	93	7	274	86	14	408	99	1
Harvest/market	193	64	36	191	91	9	206	88	12

Labor inputs (days/household) in cultured ponds

Operation	Kapasia participants						Kapasia - others						Sreepur - control					
	Own			Hired			Own			Hired			Own			Hired		
	M	F	All	M	F	All	M	F	All	M	F	All	M	F	All	M	F	All
Preparation	1.75	0.01	1.76	2.01	0.02	2.03	1.26	0.05	1.31	0.75	0	0.75	1.85	0.07	1.92	0.78	0	0.78
Operation	8.84	1.4	10.2	3.67	0.02	3.69	8.14	3	11.1	2.23	0	2.23	11	5.28	16.3	0.43	0	0.43
Harvest/market	4.68	0	4.68	3.38	0.51	3.89	6.57	0	6.57	1.43	0	1.43	6.75	0.22	6.97	1.77	0	1.77

Wage rate (Tk/day)

Operation	Kapasia participants	Kapasia - others	Sreepur - control	All
Preparation	49	51	56	52
Operation	45	53	43	48
Harvest/market	85	96	73	85

year); see Table 3.17a. This was about 10% more than the production achieved during the previous extension project (2.1 t/ha in a 12-month period – average 9 months of operation - for carp polyculture). However, this yield was for a "normal year". Detailed monitoring in the following flood-affected year (1998-99) revealed average production of only 1.7 t /ha in a 12-month period for 69 out of the same 100 past participants (Chapter 4). By comparison in 1997-98, other pond operators in Kapasia achieved only 1.6 t/ha. The ex-participants production was 77% above the current fish production level of the control area farmers without extension support (1.3 t/ha). Silver carp dominated production at 28% of the total weight of fish, and since the earlier project, Thai sharputi has been included as an important component of polyculture (Table 3.17b). By comparison 32% of fingerlings stocked by past participants were Silver carp and 28% were Thai sharputi.

Thus the species with the lowest price is the one that farmers produce more of (Table 3.18). Despite relatively low growth of Thai sharputi, as indicated by the low proportion of production compared with stocking, and a low average price, it has been widely included in pond culture.

The total of own-produced fish consumed per hectare was over 70% higher in Kapasia than Sreepur, with neighbors in Kapasia consuming the highest proportion of fish, and past participants being relatively more commercial (Table 3.19). At least part of the higher proportion of sales (from lower production) in Sreepur may be used to meet co-owners' demands for a return.

Production levels are low compared to fingerlings stocked, but this can be better expressed as too many small fingerlings are used for the sizes of pond. Hence, stocking is a high proportion of total expenditure on their ponds for all categories of household (Table 3.20), but the other main input is onfarm resources even when valued with low imputed costs. The economic return from aquaculture is substantially different for the participants and nonparticipants. The gross return on investment (ratio of gross income to total costs excluding household labor) for carp polyculture was estimated to be about 200% for past extension recipients and 150% for

Table 3.17a. Fish production (kg/ha) by species (cultured ponds) in 1997-98

Species	Kapasia participants	Kapasia - others	Sreepur - control	All
Rohu	400	292	200	315
Catla	339	246	156	263
Mrigal	302	224	136	235
Kalbaos	2	0	0	1
Silver carp	636	456	362	511
Common carp	99	85	38	78
Grass carp	43	11	29	31
Nilotica	41	50	21	38
Thai sharputi	269	238	207	244
Goinna	4	0	0	2
Magur	78	0	153	78
Small fish	37	22	1	23
Shingi/koi	0	5	0	1
All	2 250	1 629	1 304	1 818

Table 3.17b. Fish production (%) by species (cultured ponds) in 1997-98; excludes species comprising under 1%

Species	Kapasia participants	Kapasia - others	Sreepur - control	All
Rohu	18	18	15	17
Catla	15	15	12	14
Mrigal	13	14	10	13
Silver carp	28	28	28	28
Common carp	4	5	3	4
Grass carp	2	1	2	2
Nilotica	2	3	2	2
Thai sharputi	12	15	16	13
Magur	3	0	12	4
Small fish	2	1	0	1
All	100	100	100	100

Table 3.18. Reported price (Tk/kg) received by farmers by species (cultured pond) in 1997-98

Species	Kapasia participants	Kapasia - others	Sreepur - control	All
Rohu	52	59	59	56
Catla	50	59	60	55
Mrigal	47	53	56	51
Kalbaos	40	70	60	57
Silver carp	37	38	44	39
Common carp	45	53	53	49
Grass carp	50	56	54	53
Nilotica	39	31	49	41
Thai sharputi	50	52	52	51
Goinna	55	NA	NA	55
Magur	55	NA	58	56
Small fish	36	53	50	42
Shingi/koi	NA	88	NA	88

Table 3.19. Disposal of fish in cultured ponds in 1997-98

Use	Kapasia participants		Kapasia - others		Sreepur - control		All	
	kg/ha	%	kg/ha	%	kg/ha	%	kg/ha	%
Self-consumed	934	41	908	56	530	41	814	45
Given away	146	6	68	4	66	5	103	6
Sold for respondent household's income	814	36	489	30	426	33	618	34
Sold for co-owners' income	317	14	154	9	281	22	263	14
Fisher's share	40	2	10	1	0	0	21	1
All	2 250	100	1 629	100	1 304	100	1 818	100

Table 3.20. Costs and returns from aquaculture for all households (hh) in 1997-98

Costs and returns	Kapasia participants		Kapasia - others		Sreepur - control		All	
	Tk/hh	Tk/ha	Tk/hh	Tk/ha	Tk/hh	Tk/ha	Tk/hh	Tk/ha
Stocking cost	1 178	24 669	1 007	19 084	1 356	21 393	1 183	22 259
Fertilizer cost	229	2 448	205	2 990	74	1,510	179	2 329
Piscicide	3	17	0	5	0	0	1	9
Feed cost	267	4 146	370	7 649	304	4 129	305	5 075
Labor cost	222	1 206	167	3 177	69	1 563	165	1 832
Harvest cost	134	4 285	92	1 247	73	1 511	106	2 696
Total cash cost	2 034	36 771	1 841	34 151	1 876	30 106	1 938	34 200
Imputed value of fertilizer	383	5 329	307	5 657	251	5 745	325	5 533
Imputed value of feed	523	10 727	628	13 097	390	11 712	514	11 636
Imputed value of own labor	578	13 601	628	13 797	896	24 608	681	16 746
Imputed value of own harvest labor	404	11 366	586	16 303	585	17 017	503	14 270
Gross value of harvested fish	6 810	104 195	4 534	78 895	4 795	69 758	5 637	87 773
Gross value of harvested fish/(total cash + imputed fertilizer + imputed feed cost)	2.3	2	1.6	1.5	1.9	1.5	2	1.7

nonparticipants, although the return could have been much more if the stocking density were lower. Diffusion of technology to nonparticipants in Kapasia (neighbors of extension recipients) appears to have happened, since they have intermediary pond management practice and yields between that of the past participants and the control samples, indicating stimulation of considerable interest among neighboring farmers.

To take account of some of the many factors involved in determining the performance of pond aquaculture in the study, production functions were estimated for fish production in 1997-98. Both value and physical unit-based functions were estimated. For physical units, the original inputs were converted to protein (feed) and nitrogen and phosphate (fertilizer) using figures in Lovell (1989) and Lin et al. (1997). Dummy variables were used for the sale strategy

of the household and for past extension experience. Based on monitoring of 69 of the Kapasia participant households in 1998-99 and on workshops with those participants (see Chapter 4), three categories were distinguished: households that did not sell any of the production from their ponds ("subsistence"), households selling 75% or more of their production ("commercial") and all other households (1 to 74% sold).

Table 3.21 indicates that smaller ponds are more intensively used and have higher production, and confirms a positive influence of extension that is not reflected only in the quantities or value of inputs used but presumably is connected with better management practices. Thus, extension recipients have significantly higher production in quantity and value terms over and above the influence of higher intensity in smaller ponds, and quantities of fingerlings and other inputs. Also neighbors (the Kapasia - others sample) also produce more than they would were they in the control area, indicating a spillover learning effect. Moreover, this also allows for the strong negative impact of producing fish only for consumption – subsistence pond cultivators have low returns. Most of the ponds have high feed rates (bran and oilcake), and neither feed nor nitrogen inputs were significant factors in the function. The significant coefficient for phosphate is consistent with aquaculture science, for example: "phosphorous is often the first limiting nutrient to higher primary productivity in freshwater" (Lin et al. 1997).

Table 3.21. Cobb-Douglas production functions for carp polyculture in Kapasia and Sreepur in 1997-98

Physical units		Value	
Dependent: fish production (kg/ha)		**Dependent: fish produced (Tk/ha)**	
Constant	+2.09	Constant	+5.98
Area (ha)	-0.46	Area (ha)	-0.50
Labor (days/ha)	+0.17	Labor (Tk/ha)	+0.09
Fingerlings (no./ha)	+0.23	Fingerlings (Tk/ha)	+0.26
Subsistence (1)*	-0.66	Subsistence (1)	-0.87
Extension (1)*	+0.66	Extension (1)*	+0.35
Neighbor (1)*	+0.34	Neighbor (1)*	+0.28
Phosphate (kg/ha)	+0.06		
		Fertilizer (Tk/ha)	+0.06
Commercial (1)*	+0.26		
	$R^2 = 0.57$		$R^2 = 0.52$
	$F_{(8,189)} = 33$; $p<0.001$		$F_{(7,183)} = 28$ $p<0.001$

Notes: All units transformed to natural log. form, except dummy variables. All coefficients significantly different from 0 at $p<0.1$.
Dummy variables: Subsistence = 1, if household did not sell any fish from pond; commercial = 1, if household sold over 75% of fish produced; extension = 1, if previous extension participant; neighbor = 1, if lives in the same area (union) as past extension participants.

Aquaculture Information Sources

How did the control farmers in Sreepur and neighbors in Kapasia get information on aquaculture practices? The participants in the WorldFish project originally got information from that project during 1991-1993, and thereafter between 1994 and the surveys reported here did not have contact with the Center's staff, except during reconnaissance visits and exploratory group meetings in early 1998. The sample of past participants and control farmers did not receive any substantial advice from the Mymensingh Aquaculture Extension Project – the survey design excluded participants in that project to avoid assessing impacts of more than one extension program.

Responses were disaggregated by pond size category of the respondent, and among the Kapasia participants between years 1 and 2 of the project and year 3 when the extension effort was less intense. However, differences by pond size or year of participation were relatively small. The results (Table 3.22) clearly show that other fish farmers (word of mouth and seeing other farmer's experience) and the radio were the main information sources for nonparticipants, with TV also reaching over 50% of pond operators in Sreepur. Past participants also reported getting less outside information in 1997-98 than the control farmers and appeared to be relying on their earlier knowledge from the WorldFish project.

The earlier project did not appear to have promoted local networking among the farmers despite their attending courses together, since the past participants reported overall substantially less contact with other farmers for information exchange than the nonparticipants. Table 3.23 summarizes the information source data. Word of mouth and mass media were just as important for the neighbors in Kapasia as for the control sample in Sreepur, so any differences in production may be due to the quality of information passed on by trained farmers in Kapasia.

Conclusion

Being an action research project, the earlier project had relatively high costs per direct

Table 3.22. Sources of information (% of respondents) on aquaculture reported in 1997-98

Information source	Kapasia participants		Kapasia - others		Sreepur - control		All
	Small	Medium-large	Small	Medium-large	Small	Medium-large	
Number of households	50	50	30	30	30	30	220
"ICLARM"[a]	2	0	3	3	0	0	1
MAEP[b]	0	2	0	7	0	0	1
Other fish farmers	26	32	70	53	50	80	48
Radio	24	40	47	60	27	33	37
TV	16	24	40	30	53	63	35
Fry traders	18	14	7	13	10	7	12
Newspaper	8	10	13	10	10	13	11
DOF	10	4	13	7	7	13	9
Hatchery	4	4	13	7	3	7	6
Book/leaflet	0	8	0	0	7	0	2
NGO	0	2	0	0	0	0	0

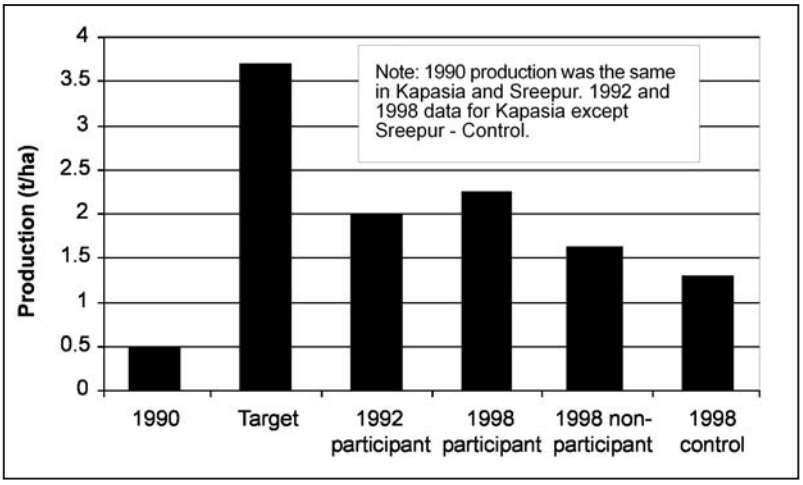
[a]Participants of the previous WorldFish project were sampled from lists of pond operators trained by that project during 1991-94. Information received later was presumably due to group discussions for this study.
[b]MAEP - Mymensingh Aquaculture Extension Project: Since 1996, this project has been active in Kapasia, but direct participants who were reported to have received extension were excluded during sampling.

Table 3.23. Sources of information (% of respondents) on aquaculture ever experienced

Source	Kapasia participants (N=100)	Kapasia - others (N=60)	Sreepur - control (N=60)	All (N=220)
"ICLARM"	97	10	0	47
MAEP/ DOF/NGO	24	20	13	20
Radio	37	55	30	40
TV	23	35	58	36
Newspaper	12	12	13	12
Book/ leaflet	2	0	3	2
Other fish farmers	34	62	67	50
Fry traders	16	10	10	13
Hatchery	6	10	5	7

MAEP - Mymensingh Aquaculture Extension Project.

Fig. 3.2. Changes in carp polyculture production in Kapasia and Sreepur.



beneficiary - about Tk 10 000 in 1990-93 – which includes costs of research activities. Intensive work in a few unions had a demonstration effect, and the costs also covered detailed baseline and control area surveys that form a basis for this impact assessment.

The study has demonstrated that benefits of extension in terms of improved aquaculture productivity and returns to operators of ponds and ditches were maintained some five years after extension ended. Some of these benefits were diffused to neighbors, and had a significant impact on them (Fig. 3.2). However, they do not follow such effective practices and achieve lower yields than the past extension participants. There has also been an expansion of stocking fish in ponds in the control area, although production is significantly lower than among past extension participants while input costs do not differ significantly. In addition, production even among past extension recipients is variable according to outside factors, such as floods, and also shows quite wide variation according to a range of factors including the size of pond and motivation of pond operators in terms of their use of pond fish.

Chapter 4
Results from Detailed Monitoring of Sixty-nine Ponds in Kapasia

Monitoring Results

Farm and pond operator characteristics

Pond monitoring was carried out with 69 households from the previous participants in Kapasia during 1998-99. During the socioeconomic survey, 100 households were sampled to gather information, including pond management. Sixty-nine ponds out of 100 stocked with fingerlings in April-May 1998. These 69 were selected for continual monitoring for a period of 16 months (June 1998 - September 1999) with visits at approximately 10 to 14-day intervals by a team of two fieldworkers. These households were quite well off; their average landholding was about 1.56 ha, composed of: 0.12 ha of homestead land, 0.81 ha of cultivable land, 0.53 ha of orchard/forest and 0.10 ha of pond.

After analysis of the monitoring data, the pond operators were categorized according to their use of fish produced, and the categories were validated in a workshop with all of the participant households where results from the study were discussed (Chapter 4). The groups were composed of: (1) those who did not sell any of their harvest ("subsistence" pond operators); (2) those who sold up to 74% of their harvest ("mixed" pond operators); and (3) those who sold 75% or more of their total fish production ("commercial" pond operators). Pond operators who sold up to 74% of their fish possess more cultivable land (1.06 ha) than the other two groups, while those who sold more than 75% possess more orchard/forest land (0.74 ha) and bigger ponds (0.20 ha) than the other two groups (Table 4.1).

Table 4.1. Average land area (ha) owned by pond operation category (% of fish sold), Kapasia

Land type	No sale	1-74% sell	75-100% sell	All
Number of households	28	19	22	69
Homestead land	0.11	0.11	0.16	0.13
Owned and operated pond/ditches	0.06	0.07	0.20	0.10
Leased in pond/ditches	0.00	0.00	0.05	0.02
Leased out pond/ditches	0.00	0.00	0.00	0.00
Owned and cultivated land	0.62	1.06	0.70	0.77
Sharecropped/rent/mortgaged in land	0.01	0.03	0.02	0.02
Sharecropped/rent/mortgaged out land	0.26	0.57	0.74	0.50
Orchard/forest	0.30	0.92	0.48	0.53
Fallow	0.06	0.04	0.13	0.08
Total	1.31	2.77	2.41	2.11

Farming system

On average, ponds comprise only 5% of the land owned by the 69 monitored households, with own operated cultivated land comprising 36%; orchards, 25%; and the remainder leased out, fallow or homestead land. The results discussed in the following sections indicate an average net income of Tk 15 000 per ha of cultivated land (and a cropping intensity of 102, i.e., single cropped land), an average net income of Tk 24 000 per ha of orchard, and an average net cash income (excluding household consumption) of Tk 36 500 per ha of ponds, indicating that aquaculture is the most profitable land use in the area.

The smaller farms had reportedly less diverse cropping systems, with only 7 types of field crop and vegetable and 5 types of fruit reported by 20 farms in 1998-99, compared with 22 crop and vegetable types and 7 fruit types among 29 medium farms and 15 crop and vegetable types and 8 fruit types among 20 large farms (Table 4.2). Also, yields on average were lower for small farms than for larger ones.

Pond management with respect to the sale of fish is not strongly associated with farm size, and the farms operated by pond owners who consume all their fish tend to have more diverse cropping, and for some crops have higher yields. However, boro paddy yields were lower for households that consume all their fish (Table 4.3). The more commercial pond operators have larger orchard areas on average, implying that their overall land use is more commercially oriented given that

Table 4.2. Crop, vegetable and fruit production by landholding category in Kapasia in 1998-99

Field crops

Crop	Small farm (< 1.0 ha) (N=20)			Medium farm (1.0-2.4 ha) (N=29)			Large farm (> 2.4 ha) (N=20)			All (N=69)		
	% hh	kg/ha	ha	% hh	kg/ha	ha	% hh	kg/ha	ha	% hh	kg/ha	ha
B aus	0	NA	NA	7	1 410	0.26	10	1 836	2.55	6	1 623	1.4
B aman	40	2 329	0.38	34	2 307	0.74	35	1 957	1.6	36	2 216	0.87
TL aman	35	659	0.35	45	1 727	0.48	50	2 289	0.51	43	1 665	0.46
HYV aman	5	1 865	0.21	7	1 510	1.59	5	2 259	0.28	6	1 786	0.92
L boro	40	3 647	0.44	45	3 490	0.85	40	3 355	2.04	42	3 496	1.06
HYV boro	30	4 154	0.36	28	5 038	0.58	35	3 835	0.48	30	4 384	0.48
Wheat	0	NA	NA	3	1 765	0.14	5	2 326	0.07	3	2 045	0.11
Jute	0	NA	NA	7	1 468	0.21	5	988	0.08	4	1 308	0.17
Sugarcane	5	2 824	0.07	24	37 006	0.2	15	2 495	0.21	16	24 486	0.19
Oilseeds	0	NA	NA	3	198	0.06	0	NA	NA	1	198	0.06
Dal	0	NA	NA	0	NA	NA	5	371	0.16	1	371	0.16
Potato	0	NA	NA	7	13 179	0.05	10	6 432	0.07	6	9 805	0.06
Onion	0	NA	NA	7	10 193	0.01	0	NA	NA	3	10 193	0.01
Garlic	0	NA	NA	10	5 519	0.02	0	NA	NA	4	5 519	0.02
Turmeric	0	NA	NA	3	29 652	0	0	NA	NA	1	29 652	0
Betel leaf	0	NA	NA	7	220	0.07	0	NA	NA	3	220	0.07
Sweet potato	0	NA	NA	3	98 840	0.02	0	NA	NA	1	98 840	0.02

Vegetables

Crop	Small farm (< 1.0 ha) (N=20)			Medium farm (1.0-2.4 ha) (N=29)			Large farm (> 2.4 ha) (N=20)			All (N=69)		
	% hh	kg/ha	ha	% hh	kg/ha	ha	% hh	kg/ha	ha	% hh	kg/ha	ha
Vegetables	5	4 942	0	14	9 319	0.02	20	9 112	0.01	13	8 741	0.01
Chili	0	NA	NA	17	4 689	0.04	15	5 560	0.01	12	5 016	0.03
Arum	0	NA	NA	3	7 413	0.02	5	18 533	0.02	3	12 973	0.02
Radish	0	NA	NA	7	14 826	0.02	0	NA	NA	3	14 826	0.02
Ladies' finger	0	NA	NA	3	4 942	0.02	0	NA	NA	1	4 942	0.02
Tomato	0	NA	NA	14	10 872	0.02	10	6 178	0.02	9	9 307	0.02

Fruits

Fruit	Small farm (< 1.0 ha) (N=20)			Medium farm (1.0-2.4 ha) (N=29)			Large farm (> 2.4 ha) (N=20)			All (N=69)		
	% hh	/ha	ha	% hh	/ha	ha	% hh	/ha	ha	% hh	/ha	ha
Papaya (kg)	0	NA	NA	7	8 649	0.02	0	NA	NA	3	8 649	0.02
Banana (no.)	25	1 590	0.05	14	1 390	0.02	15	3 142	0.1	17	1 911	0.05
Mango (kg)	35	688	0.04	28	896	0.06	25	984	0.13	29	846	0.07
Jackfruit (no.)	45	1 391	0.04	38	2 841	0.07	40	2 598	0.1	41	2 305	0.07
Litchi (no.)	15	171 432	0.03	0	NA	NA	5	20 592	0.05	6	133 722	0.04
Guava (no.)	25	37 472	0.07	17	125 409	0.16	10	38 830	0.42	17	74 339	0.17
Olive (kg)	0	NA	NA	3	309	0.08	5	1 977	0.02	3	1 143	0.05
Palm (no.)	0	NA	NA	0	NA	NA	5	2 059	0.02	1	2 059	0.02
Jujube (kg)	0	NA	NA	0	NA	NA	5	9 884	0.02	1	9 884	0.02
Amloki (no.)	0	NA	NA	3	107 077	0.01	0	NA	NA	1	107 077	0.01

Notes: % hh = percentage of households growing; /ha = yield; ha = average area per household.
B = broadcast; L = local varieties; TL = transplanted local varieties; HYV = high-yielding varieties;
aus = early monsoon season paddy crop; aman = main monsoon season paddy crop; boro = winter/dry season paddy crop.

fruit production is commercialized in the study area.

Overall, the farms of all three categories of pond operators were used more for producing food for own consumption (56% by value) than for earning cash income. Table 4.4 indicates that they made on average small cash losses on agriculture and orchards after taking account of expenditure. However, this is inconsistent with the higher returns reported in 1997-98 and may reflect underrecording of areas as well as some flood

Table 4.3. Crop, vegetable and fruit production by fish farmer type in Kapasia in 1998-99

Field crops

Crop	Not sell			1-74% sell			75-100% sell			All		
	% hh	kg/ha	ha	% hh	kg/ha	ha	% hh	kg/ha	ha	% hh	kg/ha	ha
B aus	11	1 882	1.12	0	NA	NA	5	847	2.27	6	1 623	1.40
B aman	36	2 249	0.85	32	2 424	0.57	41	2 040	1.09	36	2 216	0.87
TL aman	43	1 599	0.36	58	2 220	0.59	32	908	0.42	43	1 665	0.46
HYV aman	14	1 786	0.92	0	NA	NA	0	NA	NA	6	1 786	0.92
L boro	46	3 249	0.96	32	3 800	0.83	45	3 635	1.35	42	3 496	1.06
HYV boro	21	3 310	0.59	37	4 665	0.41	36	4 945	0.46	30	4 384	0.48
Wheat	4	1 765	0.14	5	2 326	0.07	0	NA	NA	3	2 045	0.11
Jute	4	2 372	0.20	0	NA	NA	9	777	0.15	4	1 308	0.17
Sugarcane	11	36 810	0.07	16	30 711	0.21	23	7 357	0.25	16	21 759	0.19
Oilseeds	4	198	0.06	0	NA	NA	0	NA	NA	1	198	0.06
Dal	0	NA	NA	5	371	0.16	0	NA	NA	1	371	0.16
Potato	4	11 120	0.08	16	9 367	0.06	0	NA	NA	6	9 805	0.06
Onion	4	14 826	0.01	5	5 560	0.02	0	NA	NA	3	10 193	0.01
Garlic	7	5 498	0.02	5	5 560	0.01	0	NA	NA	4	5 519	0.02
Turmeric	4	29 652	0.00	0	NA	NA	0	NA	NA	1	29 652	0.00
Betel leaf	0	NA	NA	0	NA	NA	9	220	0.07	3	220	0.07
Sweet potato	0	NA	NA	5	98 840	0.02	0	NA	NA	1	98 840	0.02

Vegetables

Crop	Not sell			1-74% sell			75-100% sell			All		
	% hh	kg/ha	ha	% hh	kg/ha	ha	% hh	kg/ha	ha	% hh	kg/ha	ha
Vegetables	11	6 825	0.01	21	11 150	0.01	9	6 795	0.01	13	8 741	0.01
Chili	14	5 630	0.04	11	1 390	0.02	9	7 413	0.01	12	5 016	0.03
Tomato	11	12 026	0.02	5	4 942	0.00	9	7 413	0.02	9	9 307	0.02
Arum	4	7 413	0.02	0	NA	NA	5	18 533	0.02	3	12 973	0.02
Radish	4	14 826	0.02	5	14 826	0.02	0	NA	NA	3	14 826	0.02
Ladies' finger	4	4 942	0.02	0	NA	NA	0	NA	NA	1	4 942	0.02

Fruits

Fruit	Not sell			1-74% sell			75-100% sell			All		
	% hh	/ha	ha	% hh	/ha	ha	% hh	/ha	ha	% hh	/ha	ha
Papaya (kg)	4	17 297	0.00	5	0	0.04	0	NA	NA	3	8 649	0.02
Banana (no.)	14	1 678	0.06	26	2 157	0.07	14	1 812	0.02	17	1 911	0.05
Mango (kg)	36	926	0.05	11	885	0.04	36	735	0.11	29	846	0.07
Jackfruit (no.)	50	2 250	0.05	21	2 471	0.05	45	2 317	0.10	41	2 305	0.07
Litchi (no.)	7	16 226	0.04	0	NA	NA	9	251 218	0.03	6	133 722	0.04
Guava (no.)	32	39 108	0.14	11	252 395	0.09	5	35 300	0.57	17	74 339	0.17
Olive (kg)	0	NA	NA	0	NA	NA	9	1,143	0.05	3	1 143	0.05
Palm tree (no.)	0	NA	NA	0	NA	NA	5	2 059	0.02	1	2 059	0.02
Jujube (kg)	0	NA	NA	0	NA	NA	5	9 884	0.02	1	9 884	0.02
Amloki (no.)	4	107 077	0.01	0	NA	NA	0	NA	NA	1	107 077	0.01

Notes: % hh = percentage of households growing; /ha = yield; ha = average area per household.
B = broadcast; L = local varieties; TL = transplanted local varieties; HYV = high yielding varieties;
aus = early monsoon season paddy crop; aman = main monsoon season paddy crop; boro = winter/dry season paddy crop.

losses. The reported crop incomes from monitored households were also on average lower than they had reported in the previous years (1997-98) (see Chapter 3). Rice bran is the main crop by-product in terms of value and in multiple uses, including for aquaculture. Pond operators who sold fish on average used over 50% of their own produced bran for aquaculture, with animal feed as the next main use. However, despite using only 39% in their ponds, households that did not sell fish still used almost double the earlier recommendation of bran in

their ponds (Table 4.5 and later tables) indicating ample availability of bran relative to their (smaller) pond sizes.

Aquaculture practice

Those who did not sell fish or sold under 75% of their production tended on average to own smaller ponds; those who sold 75% and above of their pond production averaged larger ponds. These pond owners have continued to follow improved aquaculture practices in respect to fingerling stocking. However, 14% of subsistence and 5% of mixed pond operators did not stock in the monitored year (Table 4.6). High stocking densities were maintained by all categories of pond owners. The subsistence operations stocked the highest numbers of fingerlings (60 620) per hectare whereas the commercial pond owners stocked at the lowest density (27 887). This still represents a large gap between the current practice and project period practice (the recommendation was about 9 000 fingerlings per ha). Subsistence pond owners stocked seven times higher than the recommendation while commercial pond owners stocked three times higher.

All pond owners prefer to stock major carp (Rui, Catla and Mrigal), Silver carp, Thai sharputi and Common carp. These species comprised 96% of all fingerlings stocked in the monitored ponds. Commercial pond owners stocked more Silver carp and Thai sharputi – 47% of their total stocking (Table 4.7) presumably as they grow fast and can easily be sold at a range of sizes. Given their high stocking density, it is no surprise that the pond operators who did not sell fish had the highest stocking costs (2.5 times more than for farmers who sold 75% or more of their fish). However, if the average cost per fingerling is taken as an indication of size, there was little difference in the overall cost and size per fingerling between categories of operators (Table 4.8). Overall, the fish stocked must have been small, with Thai sharputi costing Tk 1 for three "fingerlings", Indian major carp "fingerlings" costing Tk 1 for two and only Grass carp and Common carp costing over Tk 1 per fingerling. In addition small numbers of other species including native ones were stocked by some of the less commercial farmers.

As shown in Table 4.9, pond owners who did not sell fish used less chemical fertilizer compared to

Table 4.4. Overall costs and returns of crop agriculture per household in Kapasia in 1998-99

Cost and return	Not sell	1-74% sell	75-100% sell	All
Total cash expenditure (Tk)	8 002	6 455	8 942	7 876
Estimated value of own inputs (nonlabor) (Tk)	365	138	376	306
Estimated value of own labor (human + animal) (Tk)	112	324	633	336
Estimated value of own consumption (main product) (Tk)	9 098	8 856	9 645	9 205
Value of sold main product (Tk)	6 071	8 571	7 361	7 170
Value of sold by-product (Tk)	0	0	100	32
Biomass of crop by-products excluding bran (kg)	1 722	1 644	2 140	1 834
Biomass of crop by-products (excluding bran) used on farm (kg)	1 710	1 640	2 040	1 796

Table 4.5. Use of rice bran in Kapasia in 1998-99

Use	Not sell		1-74% sell		75-100% sell		All	
	Kg	%	kg	%	kg	%	kg	%
Animal fodder	68	25	109	35	43	18	71	26
Fuel	66	24	8	2	58	25	47	18
Fish culture	107	39	172	56	127	55	131	49
Sold	32	12	21	7	5	2	20	8
Total	273	100	309	100	232	100	270	100

Table 4.6. Stocking density and fish production by operator category in Kapasia in 1998-99

	Not sell			1-74% sell			75-100% sell			All		
	% pond stock	Average	SD	% pond stock	Average	SD	% pond stock	Average	SD	% pond stock	Average	SD
Stocking density (no./ha)	86	61 648	64 151	95	48 046	48 253	100	26 373	18 108	93	46 656	50 772
Production (kg/ha)		935	1 147		2 326	2 726		2 092	1 549		1 687	1 906

Note: SD – standard deviation.

Table 4.7. Species stocked and stocking densities in all 69 sample ponds in Kapasia in 1998-99

Species	Not sell		1-74% sell		75-100% sell		All	
	% pond	No./ha	% pond	No./ha	% pond	No./ha	% pond	No./ha
Rui	71	14 510	68	8 040	91	5 350	77	9 810
Catla	54	7 760	47	4 160	55	2 120	52	4 970
Mrigal	57	10 180	68	9 370	77	4 770	67	8 230
Kalibaus	4	150	0	0	0	0	1	60
Silver carp	46	7 660	74	11 040	86	7 050	67	8 400
Grass carp	18	570	37	1 470	14	240	22	710
Mirror carp	4	1 240	5	150	18	270	9	630
Common carp	29	3 640	42	2 940	50	1 250	39	2 690
Thai sharputi	64	15 500	68	8 300	82	5 320	71	10 270
Magur	0	0	5	1 360	0	0	1	370
Pangus	4	1	0	0	0	0	1	1
Tilapia	11	220	11	1 140	0	0	7	410
Goinna	4	190	0	0	0	0	1	80
Shing	0	0	5	60	0	0	1	20
Foli	0	0	5	20	0	0	1	6
Bhangon	4	24	0	0	0	0	1	10
All	86	61 650	95	48 050	100	26 370	93	46 660

the other two groups. The opposite is true for onfarm inputs, pond operators who did not sell fish used 2.4 times more cow dung, twice as much poultry manure and 1.8 times more rice bran than pond operators who sold over 75% of their fish. Cow dung and rice bran were the main inputs used by all categories of operators and almost all of the monitored ponds. Chemicals were used by more of the middle category of pond operators (75%), although the more commercial pond operators who use chemical fertilizers used more.

Consequently, the cash costs of bought inputs were highest - about twice as much per hectare - for ponds where 75% or more of fish were sold (Table 4.10). But the imputed value of onfarm inputs was high for the other pond operators. There is a limited market for cow dung, but some pond operators could probably make better use of it as fuel or for agricultural land than in ponds, and these same households that sell little or no fish could also make better use of rice bran than in their ponds. Overall, 40% of bought inputs by value were rice bran while 54% of onfarm inputs by value were rice bran.

Table 4.8. Average stocking cost (Tk/ha) in Kapasia in 1998-99

Species	Not sell	1-74% sell	75-100% sell	All
Rui	6 402	5 774	2 958	5 131
Catla	2 964	2 775	1 399	2 413
Mrigal	3 225	4 728	1 807	3 187
Kalibaus	79	0	0	32
Silver carp	7 148	4 401	2 835	5 017
Grass carp	1 725	1 077	94	1 027
Mirror carp	327	154	350	287
Common carp	4 338	3 254	992	2 973
Thai sharputi	4 858	3 166	1 686	3 381
Magur	0	1 798	0	495
Tilapia	70	396	0	137
Goinna	64	0	0	26
Foli	0	77	0	21
Bhangon	13	0	0	5
All	31 214	27 600	12 121	24 131

Labor use per hectare of pond was much less for ponds operated to sell most of the fish than for the other two categories (Table 4.11). For the more commercial operations, most labor was male and most was from the farm family although 14% was hired. On a per hectare basis, the subsistence-operated ponds reported using 3.5 times more labor, although this is mostly a few hours per day for feeding fish.

An average annual fish production of 1.7 t/ha was achieved by these pond owners during the monitoring period. The mixed category of pond operators achieved the highest production (2.3 t/ha) while those who did not sell fish only achieved 0.9 t/ha (Table 4.12). Overall, 7% of production from the ponds came from nonstocked fish due to the inundation of several ponds by the severe flooding in 1998. While only 23% of the ponds monitored were flooded in 1998, 69% were among the households that did not sell any fish (Table 4.12). Thus, the households that did not sell fish fall into two main groups - those that were flooded and those making partial harvests for own consumption. However, "flooded" ponds tended to have higher

Table 4.9. Input use for 69 monitored ponds in Kapasia in 1998-99

Input	Not sell			1-74% sell			75-100% sell			All		
	% pond	kg/ha	% bought	% pond	kg/ha	% bought	% pond	kg/ha	% bought	% pond	kg/ha	% bought
Lime	43	54	100	84	132	100	45	59	100	55	77	100
Urea	61	114	100	89	162	100	68	183	100	71	149	100
TSP	36	30	100	74	89	100	59	93	100	54	66	100
Potash	0	0	NA	16	0	100	14	1	100	9	0	100
MP	11	4	100	5	1	100	0	0	NA	6	2	100
Piscicide	0	0	NA	5	0.12	100	0	0	NA	1	0.03	100
Cow dung	96	20 433	0	100	16 527	2	91	8 604	5	96	15 586	2
Poultry manure	46	2 269	1	68	840	19	41	1 189	16	51	1 531	8
Compost	7	134	8	26	970	7	14	874	0	14	600	4
Rice bran	96	9 502	18	100	9 319	9	91	5 112	66	96	8 052	25
Wheat bran	7	41	96	37	193	98	45	413	100	28	201	99
Rice/wheat	7	70	95	0	0	NA	5	1	100	4	29	95
Cooked rice	14	102	0	5	3	0	5	1	0	9	42	0
Bread	4	76	0	0	0	NA	5	4	100	3	32	4
Grass/leaf	11	132	0	26	737	0	23	133	0	19	299	0
Oilcake	43	155	76	74	216	99	77	284	100	62	213	93
Fish meal	4	70	90	0	0	NA	0	0	NA	1	29	90
Shrimp	0	0	NA	5	26	100	0	0	NA	1	7	100
Termites	7	364	0	5	419	0	0	0	NA	4	263	0
Snail	0	0	NA	5	191	0	0	0	NA	1	53	0
Viscera	0	0	NA	11	91	0	0	0	NA	3	25	0

Note: TSP = Triple superphosphate; MP = Muriate of potash.

Table 4.10. Input cost for pond aquaculture (Tk/ha) in Kapasia in 1998-99

Input	Not sell			1-74% sell			75-100% sell			All		
	Own	Bought	Total	Own	Bought	Total	Own	Bought	Total	Own	Bought	Total
Lime	0	369	369	0	812	812	0	347	347	0	484	484
Urea	0	684	684	0	973	973	0	1 102	1 102	0	897	897
TSP	0	310	310	0	1 147	1,147	0	1 277	1 277	0	849	849
Potash	0	0	0	0	65	65	0	25	25	0	26	26
Cow dung	10 113	12	10 125	7 894	173	8 067	4 033	181	4 213	7 563	110	7 673
Poultry manure	834	13	847	229	68	298	404	30	434	531	33	564
Compost	59	5	64	428	33	461	419	0	419	275	11	286
Pesticide	0	0	0	0	75	75	0	0	0	0	21	21
Rice bran	12 543	2 859	15 402	15 991	1 538	17 529	3 240	6 225	9 465	10 526	3 569	14 095
Wheat bran	11	275	286	29	1 465	1 493	0	2 216	2 216	12	1 221	1 234
Rice/wheat	26	422	448	0	0	0	0	15	15	11	176	187
Cooked rice	409	0	409	12	0	12	2	0	2	170	0	170
Bread	76	0	76	0	0	0	0	4	4	31	1	32
Grass/leaves	33	0	33	183	1	184	33	0	33	75	0	75
Oilcake	234	696	930	18	1 541	1 558	0	2 038	2 038	100	1 356	1 456
Fish meal	42	359	401	0	0	0	0	0	0	17	146	163
Shrimp	0	0	0	0	75	75	0	0	0	0	21	21
Termites	182	0	182	210	0	210	0	0	0	132	0	132
Snail	0	0	0	382	0	382	0	0	0	105	0	105
Viscera	0	0	0	182	0	182	0	0	0	50	0	50
Others	0	45	45	0	7	7	0	122	122	0	59	59
All	24 562	6 049	30 612	25 557	7 973	33 530	8 131	13 582	21 713	19 597	8 981	28 578

Notes: Own inputs are imputed values.
TSP = Triple superphosphate; MP = Muriate of potash.

Table 4.11. Labor inputs in monitored ponds in Kapasia in 1998-99

Labor inputs (days/ha)

Category	Own			Hired		
	Male	Female	All	Male	Female	All
Not sell	414.6	67.1	481.8	89.0	0.0	89.0
1-74% sell	361.4	49.0	410.4	22.4	0.0	22.4
75-100% sell	140.1	1.5	141.6	22.3	0.0	22.3
All	312.4	41.2	353.6	49.4	0.0	49.4

Total labor days per ha and proportion from household and hired sources in monitored ponds

Category	Total days	% own	% hired
Not sell	571	84	16
1-74% sell	433	95	5
75-100% sell	164	86	14
All	403	88	12

Labor inputs (days/household) in monitored ponds

Category	Own			Hired		
	Male	Female	All	Male	Female	All
Not sell	10.5	1.1	11.7	1.6	0.0	1.6
1-74% sell	15.2	0.8	16.0	1.3	0.0	1.3
75-100% sell	17.5	0.1	17.7	2.0	0.0	2.0
All	14.0	0.7	14.8	1.7	0.0	1.7

Wage rate (Tk/day)

Pond operator	Not sell	1-74% sell	75-100% sell	All
Rate (Tk/day)	43	45	54	48

production than "nonflooded" ponds with no sale, and a higher proportion of the catch from them was of wild fish. Marketing of fish was associated with more complete harvests and higher proportions of stocked fish in production.

Indian major carp (42%) dominated production, although Silver carp was the single most important species (25%) overall and for those not selling fish and those selling 75% or more of fish (Table 4.13). Average size at harvest of stocked fish was recorded (numbers of fish and total weight) and harvesting was spread over several months for many of the ponds. Major carp on average were harvested at 400 g size except for Catla (closer to 600 g). Slightly larger fish were caught from the ponds where none were sold. Silver carp were harvested at just over 300 g per fish despite normally being regarded as fast-growing, whereas other exotic carp were harvested at around 600 g. It may be that Silver carp are normally completely harvested, while some of the stock of other carps were left to grow for more than one year. The larger size of Silver carp from more commercial ponds is likely to reflect lower stocking density. In addition, as will be seen in Chapters 5 and 6, one of the attractions of Silver carp and Thai sharputi is that they are readily sold at smaller sizes – Thai sharputi on average weighed 160 g at harvest.

By definition most of the fish produced from ponds where none of the fish were sold were for home consumption, although 14% were given away (Table 4.14). On a per hectare basis, households selling under 75% of their fish consumed more and gave away more, selling on average 47% of production, while those selling most of their fish consumed much less per hectare.

Prices per kilogram obtained by farmers for cultured fish ranged from Tk 35 (Tilapia) and Tk 39 (Silver carp) up to Tk 52 for Rui, Catla and Grass carp (Table 4.15). Despite their smaller size at sale, Thai sharputi achieved Tk 46 per kg, 18% higher than the price of Silver carp. There was little variation in prices by species and no significant differences between more and less commercially operated ponds.

Hence, general features of the monitored ponds were overstocking of fingerlings, low dose of chemical fertilizer and overdose of organic fertilizer. Thus, production levels were low compared to fingerlings stocked, and too many small fingerlings were used for the sizes of pond. Simultaneously, overstocking tends to result in high total expenditure; as a result net return from the ponds was below its potential. During the monitoring period average gross value of fish produced per household was Tk 6 900 (Table 4.16), with a net return per household (considering cash costs only) of under Tk 4 000.

Table 4.12. Production of monitored ponds in Kapasia in 1998-99, according to harvesting mode

How operated	Not sell (n=28)			1-74% sell (n=19)			75-100% sell (n=22)			Total		
	No. of ponds	kg/ha	% stocked	No. of ponds	kg/ha	% stocked	No. of ponds	kg/ha	% stocked	No. of Ponds	kg/ha	% stocked
Complete harvest	2	256	100	3	7 114	100	9	3 194	100	14	3 615	100
Partial harvest	15	912	93	14	1 480	93	10	1 235	100	39	1 199	95
Flooded	11	1 090	73	2	1 068	100	3	1 638	100	16	1 190	81
All ponds	28	935	86	19	2 326	95	22	2 092	100	69	1 687	93

Table 4.13. Production (kg/ha and proportion of all species) of fishes in all 69 ponds in Kapasia in 1998-99

Cultured fish

Species	Not sell			1-74% sell			75-100% sell			All		
	kg/ha	Weight g/fish	% by weight	kg/ha	Weight g/fish	% by weight	kg/ha	Weight g/fish	% by weight	kg/ha	Weight g/fish	% by weight
Goinna	41.0	113	4.4	3.5	341	0.2	8.9	290	0.4	20.5	254	1.2
Rui	96.7	464	10.3	440.6	416	18.9	352.9	377	16.9	273.1	419	16.2
Catla	38.1	755	4.1	220.0	590	9.5	181.5	574	8.7	133.9	631	7.9
Mrigal	58.3	388	6.2	530.0	396	22.8	408.5	406	19.5	299.8	397	17.8
Kalibaus	0.0		0.0	0.7	192	0.0	2.3	422	0.1	0.9	307	0.1
Magur	26.5	173	2.8	223.1	288	9.6	0.0		0.0	72.2	224	4.3
Pangus	0.0		0.0	0.0		0.0	0.6	666	0.0	0.2	666	0.0
Sharputi	0.0		0.0	0.0		0.0	13.5	311	0.6	4.3	311	0.3
Tilapia	155.1	60	16.6	86.2	107	3.7	10.2	99	0.5	89.9	85	5.3
Silver carp	216.7	313	23.2	366.5	276	15.8	732.6	361	35.0	422.5	321	25.0
Grass carp	18.7	481	2.0	28.1	1 114	1.2	4.9	483	0.2	16.9	640	1.0
Mirror carp	8.7	1 410	0.9	15.5	392	0.7	36.9	225	1.8	19.6	608	1.2
Common carp	34.3	1 029	3.7	81.0	491	3.5	94.7	578	4.5	66.4	676	3.9
Bighead carp	0.0		0.0	0.5	1 169	0.0	0.0		0.0	0.1	1 169	0.0
Thai sharputi	118.6	166	12.7	231.8	152	10.0	195.4	160	9.3	174.3	159	10.3
Subtotal	813		86.9	2 228		95.8	2 043		97.7	1 595		94.5
All	935		100	2 326		100	2 092		100	1 687		100

Native nonstocked fish

Species	Not sell			1-74% sell			75-100% sell			All		
	kg/ha	Weight g/fish	% by weight	kg/ha	Weight g/fish	% by weight	kg/ha	Weight g/fish	% by weight	kg/ha	Weight g/fish	% by weight
Taki	9.9	*	1.1	20.8	*	0.9	0.6	*	0.0	10.0	*	0.6
Shol	3.3		0.3	2.5		0.1	1.2		0.1	2.4		0.1
Koi	19.5		2.1	0.0		0.0	0.0		0.0	7.9		0.5
Bajari tengra	1.0		0.1	0.7		0.0	0.2		0.0	0.7		0.0
Shing	1.8		0.2	2.5		0.1	1.7		0.1	2.0		0.1
Foli	16.0		1.7	2.5		0.1	2.5		0.1	8.0		0.5
Boal	0.0		0.0	1.0		0.0	0.9		0.0	0.6		0.0
Guchi baim	0.2		0.0	0.0		0.0	0.0		0.0	0.1		0.0
Tatkini	0.1		0.0	0.0		0.0	0.0		0.0	0.1		0.0
Bata	2.1		0.2	0.0		0.0	0.0		0.0	0.9		0.1
Baila	0.6		0.1	0.0		0.0	0.0		0.0	0.3		0.0
Jatputi	24.4		2.6	9.9		0.4	4.5		0.2	14.1		0.8
Mola	26.7		2.9	50.3		2.2	27.2		1.3	33.3		2.0
Dhela	0.0		0.0	0.0		0.0	0.0		0.0	0.0		0.0
Ranga chanda	5.2		0.6	0.0		0.0	0.3		0.0	2.2		0.1
Lal khalisha	1.1		0.1	0.0		0.0	0.0		0.0	0.4		0.0
Chuna kholisha	0.6		0.1	0.0		0.0	0.0		0.0	0.2		0.0
Darkina	0.9		0.1	0.0		0.0	7.5		0.4	2.8		0.2
Anju	0.8		0.1	0.0		0.0	0.0		0.0	0.3		0.0
Gura icha	8.1		0.9	8.5		0.4	2.1		0.1	6.3		0.4
Chatka icha	0.0		0.0	0.0		0.0	0.0		0.0	0.0		0.0
Subtotal	122.4		13.1	98.7		4.2	48.9		2.3	92.4		5.5
All	935		100	2 326		100	2 092		100	1 687		100

* Average weight of nonstocked species not estimated.

However, as Table 4.16 indicates, there was great variation among the three categories of operator. Considering the value of fish consumed, the ponds from which no fish were sold made a loss even without calculating imputed values for onfarm inputs, and flooding in 1998 was part of the reason for this. Despite exceptional flooding during the monitoring period, most ponds generated a substantially greater return per hectare than crop agriculture: Tk 42 800 per ha

Table 4.14. Disposal of fish (kg/ha) in 1998-99

Use	Not sell	1-74% sell	75-100% sell	All
Self-consumed	789	869	124	599
Given away	133	355	43	166
Sold	0	1 086	1 918	911
Harvest share	13	19	7	13
All	935	2 326	2 092	1 687

Table 4.15. Average sale price (Tk/kg) of main species in Kapasia in 1998-99

Species	1-74% sell	75-100% sell	All
Goinna	40	45	44
Rui	51	52	52
Catla	51	54	52
Mrigal	43	49	47
Kalibaus	-	45	45
Tilapia	38	33	35
Silver carp	38	40	39
Grass carp	55	51	52
Mirror carp	40	40	40
Common carp	48	49	48
Thai sharputi	47	45	46
Jatputi	35	-	35
Mola	30	28	29
Darkina	-	30	30
All	45	47	46

for ponds where 1 to 74% of fish were sold and Tk 52 600 per ha for ponds where 75% or more of fish were sold.

A comparison of the findings from detailed monitoring in 1998-99 with the survey reported in Chapter 3 shows that there was very little difference in the total costs or cost structure in Kapasia between the two years except for lower harvesting costs due to some ponds being flooded. Effectively the impact of flooding brought down the performance of the ex-participants in 1998-99 to that of their neighbors in 1997-98 (Table 4.17). That pond aquaculture is on average viable is also indicated by the return per day of household labor which is more than double the average daily wage rates.

Results of Workshop with Participants

To assess the development and dissemination of aquaculture technologies, 69 ponds and their operating households were monitored intensively (every week) for 16 months in 1998-99, as described above. After analysis, three different styles of pond operation were identified by the research team and used to characterize pond owners according to the extent of sale of fish produced from their ponds. This categorization was used as part of the basis of a workshop held in Kapasia in March 2000. In the workshop, all the participants were informed about the outcome of their monitoring, and the pond operators reviewed the results, explained their rationale for practices and confirmed some of the differences identified.

Group 1: Subsistence pond operators

This group consisted of 28 participants. They did not sell any fish from their ponds in 1998-99, but consumed all their production. Most of them possess smaller ponds. Only one of these households was not present in the workshop due to the death of the head and his older son had migrated to the Middle East.

Table 4.16. Costs and returns from aquaculture in Kapasia in 1998-99

Costs/returns	Not sell		1-74% sell		75-100% sell		All	
	Tk/hh	Tk/ha	Tk/hh	Tk/ha	Tk/hh	Tk/ha	Tk/hh	Tk/ha
Stocking cost	967	31 214	1 349	27 600	1 827	12 121	1 346	24 131
Fertilizer cost	64	1 393	211	3 271	399	2 962	212	2 410
Piscicide	0	0	11	75	0	0	3	21
Feed cost	128	4 336	193	3 155	915	8 278	397	5 268
Labor cost	72	4 324	63	1 059	112	1 130	82	2 406
Total cash cost	1 232	41 268	1 826	35 160	3 253	24 490	2 040	34 237
Imputed value of fertilizer	336	11 007	396	8 551	971	4 856	555	8 369
Imputed value of feed	307	12 878	636	16 192	494	3 273	457	10 728
Imputed value of own labor	532	20 850	746	19 133	873	6 528	700	15 811
Gross value of harvested fish	1 198	40 171	4 343	102 740	16 477	85 222	6 936	71 764
Net return against cash costs	-34	-1 097	2 517	67 580	13 224	60 732	4 896	37 527
Net return to household labor	-677	-24 982	1 485	42 837	11 759	52 603	3 884	18 430
Gross value of harvested fish/(total cash + imputed fertilizer + imputed feed cost)	0.64	0.62	1.52	1.72	3.49	2.61	2.27	1.35

Note: hh = household.

Table 4.17. Costs and returns from aquaculture (Tk/ha) in Kapasia, Gazipur in 1997-98

Costs/returns	Kapasia - ex-participants 1997-98 (N=95)	Kapasia - monitored ex-participants 1998-99 (N=69)	Kapasia - other farmers 1997-98 (N=56)	Sreepur - control farmers 1997-98 (N=59)
Stocking cost	24 669	24 131	19 084	21 393
% of total	44	44	35	42
Other bought input cost	6 552	8 981	10 562	6 009
% of total	12	16	19	12
Imputed value of onfarm inputs	17 834	19 597	21 154	20 420
% of total	32	36	38	40
Hired labor including harvest	6 491	2 415	4 424	3 074
% of total	12	4	8	6
Total cash cost	37 712	34 237	34 151	30 106
Value of harvest	104 195	71 764	78 895	69 758
% consumed by household/owner	41	35	56	41
Net return to household	67 424	37 527	44 744	39 652
Net return (Tk/decimal) (Tk/40 m^2)	273	152	181	160
Net return (Tk/day household labor)	171	106	103	63

Table 4.18. Use (%) of by-products for pond aquaculture by subsistence pond operators

By-product	1990	1994	1999
Cow dung	43	79	89
Bran	50	82	89
Poultry litter	0	0	43
Chemical fertilizer	21	75	71

Table 4.19. Changes in household fish consumption by source (% of households reporting a source) for subsistence pond operators

Sources	1990	1994	1999
Pond	64	64	89
Bazaar	89	46	57
River (market)	54	29	25
Floodplain	36	39	32

The group's objectives behind fish culture were as follows:

1. For own (households) fish consumption;
2. For financial benefit, own fish consumption reduces cash cost of family food expenditure;
3. Fish culture reduces the nutritional gap of a family; and
4. The activity brings pleasure to them.

Agricultural crops were ranked and prioritized in terms of importance to their households as follows: (1) paddy, (2) sugarcane, (3) jute, (4) orchard, and (5) vegetables. About 30% of these households sharecrop out their lands. The main reason for this is scarcity of human resource and of capital.

Use of by-product. The percentage of subsistence pond-operator households that used different types of by-product in their ponds during the last decade is shown in Table 4.18. Incidence of use has increased since the end of the earlier project. After using household-produced cow dung for their ponds, they use any surplus amount for their agricultural fields. Generally, bran was reported to be used for three purposes: for those who have cattle, their first use is as fodder; second, for poultry; and third, for fish culture.

Trend in fish consumption. Most of these households have increased their fish consumption from their ponds (Table 4.19) but one household reported a fall in its fish consumption from its own pond; 43% of these households can afford to buy big catfish but 89% normally consume small fish.

Fish stocking. The normal tendency of these households is to overstock. They do not follow any technological package. About 43% usually stock fish at one time whereas the rest stock several times in a year. They reported the following causes behind overstocking: (1) for more consumption; (2) poor survival rate of fingerlings; (3) low price of fry; (4) otters consume a proportion of fish; and (5) because they experience poaching.

Fish harvesting. Most of these households harvest fish throughout the year. About 25% mostly wait to harvest when fish reach maturity (i.e., about nine months from the date of stocking).

Fry source. All of these households purchase fry from vendors but could not ensure the quality of fry from this source. Polyculture is the only aquaculture system they follow. Table 4.20 shows that despite having had extension advice in the

Table 4.20. Problems related to extension and aquaculture as reported by subsistence pond operators

Problems	Suggestions
Fisheries extension fieldworkers are insufficient.	Give more emphasis on circulating aquaculture information through mass media.
Quality fingerlings are scarce.	Establish a fish hatchery in each upazila for smooth supply of quality fry.
There is lack of fundamental knowledge of fish culture, e.g., books, leaflets are not available.	Workshops, rally, books and leaflet distribution will spread primary knowledge about fish culture/aquaculture.
Very little time was spent.	
Fish culture inputs are not available.	Ensure smooth supply of fish feed and other inputs in the markets.
There is very little scope of training for unemployed youths and interested pond owners.	Ensure frequent visits of fishery officials to the rural pond side.
Cooperatives for fish culture and its resource development are insufficient.	
Easy loans are not available for fish culture.	Provide credit and training by forming pond owners' cooperatives. In this way, some skilled human resources will be developed.

earlier project, lack of knowledge was the main constraint to their aquaculture.

Group 2: Mixed pond operators

This group is composed of 9 pond-owning households, who sold at least some of their pond production but less than 75% of their cultured fish in 1998-99. During the group discussion, one of the monitoring pond owners was absent but they were joined by an additional person who has a hatchery and also was one of the previous project's participants.

Their objectives to fish culture were as follows:

1. All said - for their own consumption; fish has been becoming scarce day by day, so they culture fish to fulfil their daily needs;
2. Financial gain was a major factor; fish culture needs less human resource than agriculture but gives more returns;
3. To fulfil the fish deficit of the country;
4. To generate employment in the rural area and in the country;
5. To supply fish to their neighbors and relatives;
6. To reduce the area of fallow land by converting it into ponds; as a result, these farm households' economic conditions have further improved; and
7. To reverse the loss of fish in the country.

Their reported selection criteria for crop cultivation in different seasons were land fertility, profitability, and land elevation.

The participants ranked in terms of importance to their households the following main crops: (1) boro paddy (HYV), (2) aman paddy (75% - HYV and 25% - local), (3) sugarcane, (4) pulses, (5) mustard, and (6) vegetables. About 60% of these households sharecrop out their land due to scarcity of human resource and financial problems.

Use of crop by-products. Table 4.21 shows the incidence of use and sale of by-products by these households. As can be seen, there is considerable competition between uses.

Fish stocking. These people do not follow any specific rules for fish culture, but usually stock fish according to their experience and own choice. However, they said that usually vendors push them to stock more fingerlings. Most of them forget the earlier recommended stocking ratios. The household head decides how many fry they should stock. Normally, fish stocking starts in March and continues up to July.

Source of fingerlings. All these households purchase fingerlings from vendors who usually come to their pond side. None of them purchase fingerlings from a hatchery or nursery. The characteristics of fingerlings stocked are shown in Table 4.22. About 65% of these households did not culture fish before 1990.

Harvesting. Usually, fish harvesting starts six months after the date of stocking. Those who have old stock harvest several times through the year.

Table 4.21. Use of by-products by mixed pond operators

By-product	Cattle feed	Fuel	Pond	Sale (%)
Straw	Yes	Yes	Yes	25
Bran	Yes	Yes	Yes	0
Leaf	Yes	Yes	Yes	0
Cow dung	No	Yes	Yes	0

Table 4.22. Size of fingerlings stocked and species ranking by mixed operators

Species	Size (inches)
Silver carp and Mrigal	2-3; 2-6
Sharputi	0.5-1
Rohu	1-2
Catla	2-3
Common carp	1-1.5

Trends in input use. The pond operators reported decreasing use of organic fertilizer, but increasing use of rice bran since the earlier project ended (Table 4.23).

Fish consumption. The incidence of eating pond fish reported by the households has risen relative to wild-caught fish over the last decade (Table 4.24). However, the following reasons for limited own pond fish consumption were given:

1. For financial benefit, they sell more fish in the market;
2. Due to scarcity of human resource, frequent harvesting is a problem; and
3. Own-pond fish is less tasty to them as they apply cow dung, poultry manure and other fertilizer inputs from their farms.

Table 4.25 shows that these farmers identified access to inputs (particularly quality fingerlings) and hazards (poaching, flood and diseases) as the main constraints to their aquaculture.

Table 4.23. Changes in use of onfarm inputs for pond aquaculture (amount per month per decimal) reported by mixed pond operators

Inputs	1990	1994	1999	Source
Cow dung	Not measured	40 kg	20 kg	Own
Rice bran	3 kg	2 kg	4 kg	Own
Poultry litter	Did not use	0.5 kg	1.25 kg	Own
Compost	Did not use	Did not measure produce in one corner of the pond	Did not use	Own

Table 4.24. Trends in fish consumption by sources (%) for mixed pond operators

Type/source of fish	1990	1994	1999
Wild fish	80	50	25
Cultured fish	20	50	75
Purchased (cultured and wild fish)	60	75	95
Caught from open water	40	25	5

Group 3: Commercial pond operators

This group consisted of 22 pond-owner households; their common feature is that they sold 75% or more of their pond fish production. One of the monitoring participants was absent from the workshop. Their reported objectives of fish culture were as follows:

1. For financial benefit;
2. To mitigate family protein and nutritional demand;

Table 4.25. Problems related to extension and aquaculture as reported by mixed pond operators

Problems	Suggestions
Financial problem, e.g., scarcity of credit, lack of emergency fund during flooding.	Financial support from government and nongovernment organizations.
Poaching is a great problem; thieves use current nets which are widely available.	Administrative support is essential to reduce poaching. Normally, pond owners catch thieves but the police release them by taking bribe.
Ponds are frequently inundated by floodwater. During the last decade, they suffered from flood three times.	
Fish disease reduces pond production: Each year, one or two species suffer by disease/s.	
Scarcity of quality fingerlings: Vendors usually come from Mymensingh region but do not maintain quality.	Supplies of quality fingerlings by different organization must be ensured.
Fry traders usually come at their own schedule, so when pond owners want fry they cannot purchase these, delaying stocking.	
Scarcity of fishing gear, e.g., fishing nets.	Supplies of fishing nets on hire basis need to be ensured, so that fish can be harvested in time.
Marketing in time is also a problem due to scarcity of human resource and transport facility.	
People lack technological knowledge.	Local DOF officials should have good liaison with pond owners to strengthen fish culture knowledge and social status.

3. Activity is a pleasure to them; and
4. To reduce unemployment by creating more jobs for them.

Agriculture and use of by-products. The main crops grown by these households are boro paddy (HYV), aman paddy, sugarcane, jute and bananas. Onfarm supplies of fertilizer are used substantially for aquaculture (Table 4.26), but their own-farm rice bran was not used for aquaculture even though monitoring data showed that about a third of the rice bran used in their ponds came from onfarm sources. However, this is consistent with these pond operators' own assessments of input sources (Table 4.27).

Fish stocking and sale. These fish farmers reported the following:

1. Stocking fish is profitable;
2. They do it to get more production and then income;
3. If market prices would rise, then sale of fish would increase, but to ensure reasonable prices they need to ensure fish of a reasonable uniform size (i.e., uniform growth in a pond);
4. Market demand for native species is higher than that for exotic species; and
5. There is a positive relation between fish demand and supply. When demand increases, fish supply also increases with the pond owners growing and selling more.

They buy fish fry both from private hatcheries and local fry traders. Use of most inputs, both organic and inorganic, had increased since the end of the earlier project (Table 4.28).

Fish consumption. These pond operators reported that they depended entirely on pond-produced fish for consumption – the share of wild-caught fish having dropped from 80% to 0 in 9 years (Table 4.29). However, as Chapter 5 shows, they also eat wild-caught fish, although these may be mainly from the market.

This group gave the following reasons for the decline of fish in other openwater bodies:

1. Growth of human population is one cause;
2. Maximum water bodies in the area are private property; during the post-monsoon season, land owners prevented everybody from catching fish; and

Table 4.26. By-product use (ranking) of commercial pond operators

Cow dung	Poultry litter	Rice bran
1. Agriculture	1. Pond/fish culture	1. Cattle feed
2. Aquaculture	2. Agriculture	2. Poultry feed
3. Tree plantation	3. Tree plantation	3. Fuel
4. Fuel		4. House building (with mud)
5. Biogas		
6. Betel leaf cultivation		

Table 4.27. Sources (%) of aquaculture inputs of commercial ponds

Inputs	Purchased	Own
Cow dung	0	100*
Rice bran	70	30
Oilcake	100	0
Urea	100	0
TSP	100	0
Lime	100	0
Potash	100	0

*40% for agriculture.
Note: TSP = Triple superphosphate.

Table 4.28. Reported trends in input use (%) in commercial ponds

Input	1990	1994	1999
Cow dung*	0	0	50
Rice bran	10	30	50
Oilcake	0	5	10
Urea/TSP	0	20	50
Potash	0	Used	Used
Compost	0	20	10
DAP	0	0	1

* Remainder is used for agriculture.
Note: TSP = Triple superphosphate; DAP = Diammonium phosphate.

Table 4.29. Fish consumption (%) trend of commercial pond operators

Source	1990	1994	1999
Pond	20	35	100
Open water	80	65	0

3. Those who have waterbodies can catch fish in their own area, others cannot.

The more commercial fish farmers raised a range of constraints – quality fingerlings, hazards such as flood and disease, and marketing problems – to their aquaculture (Table 4.30).

Table 4.30. Problems related to aquaculture and extension as reported by commercial pond operators

Problems	Suggestions
Quality fingerlings and fry are scarce and not available in time.	New hatcheries and nurseries should be established to ensure supply of quality fingerlings. The local authority should punish those who sell bad quality fingerlings.
There is lack of technical knowledge about fish culture.	Each pond-owning household needs basic aquaculture training.
There are financial problems for fish culture.	Financial assistance should be provided for aquaculture.
Use of current nets interrupts fish culture. Thieves use these nets for poaching. As a result, pond owners lose their capital.	
Fish marketing is a problem; maximum households lack human resource for this.	
Fishing materials (e.g., nets for harvesting) are scarce.	
Flooding is a common interruption for aquaculture.	Pond dikes should be raised to prevent flood damage.
Fish disease hampers production; pond owners cannot diagnose disease in time.	

Chapter 5
Fish Consumption Study in Kapasia

Introduction and Methods

The socioeconomic impact survey in 1998 covered a random sample of 220 households, of which 100 were participants in the previous project (see Chapter 1). Out of the 100 surveyed past participants, the 69 pond-owning households, which stocked their ponds with fish in 1998, were selected for the pond monitoring survey reported in Chapter 4. At the same time, a fish consumption study was undertaken with those same households between August 1998 and September 1999. The main survey design aimed to compare recipients of training and extension during 1991-93 from the WorldFish-supported project, with other pond owners and with pond owners in a control area (Sreepur). For the consumption study, the aim was to understand the impact of aquaculture resulting from the earlier extension packages and associated farming systems on fish consumption patterns, including consumption by species, amount consumed per household and sources of fish eaten.

For the consumption survey, the 69 households can be subdivided into two categories on the basis of pond area: small (less than 15 decimals, 0.15 acre or 0.06 ha pond area) and medium-to-large (more than 15 decimals pond area). Another category used in examining differences in fish consumption was land ownership: marginal and small-scale (owning up to 250 decimals, 1.01 ha, of land), medium-scale (owning farms of between 251 and 750 decimals, 1.01-3.03 ha), and large-scale (owning farms larger than 750 decimals, 3.03 ha) farmers. Table 5.1 shows the number of households in each category.

Table 5.1. Categories of household monitored

Category	Number of households
Pond category	
Small (<15 decimals)	39
Medium and large (>15 decimals)	30
Landholding category	
Marginal and small (<250 decimals)	21
Medium (251-750 decimals)	36
Large (>750 decimals)	12

Table 5.2. Number of households by farm size and pond ownership

Pond size	Farm size		
	Marginal and small	Medium	Large
Small	12	13	5
Medium and large	9	23	7
Total	21	36	12

Notes: Pond size: small (<15 decimals), medium and large (>15 decimals). Farm size: marginal and small (<250 decimals, 1.01 ha), medium (251-750 decimals, 1.01-3.04 ha), large (>750 decimals, 3.04 ha).

As Table 5.2 shows, one-third of the sample of 69 were medium-scale farmers with medium-to-large ponds, and the farm size and pond size were somewhat correlated.

A member of each household (either adult or student, from 12 years of age upwards) volunteered to help in the study and was trained in basic record keeping and provided with traditional weighing balance and weights, forms and pens. These participants recorded fish consumption daily for seven consecutive days every month. They recorded fish eaten by species, weight, source and price if bought. The study was conducted for 14 months: between August 1998 and September 1999. Feedback sessions were held part way through the study with small groups of all the participant monitors, and they also took part in the workshop reported in Chapter 4 along with the fish farmers from their households. In the interim discussions, some of the monitoring results were presented through graphs and computer displays; trends and reasons for consumption patterns were discussed along with observations on the study method. In the final workshop, the overall findings were presented and the monitors contributed to the discussion of aquaculture practice. Individual analyses of consumption patterns of fish (and other monitored foods) were provided to each household and compared with the household normal nutritional requirements.

Frequency of Eating Fish

On average, all the households ate fish almost every day in a month (Tables 5.3 and 5.4). Small pond owners ate fish on slightly fewer days than the medium-scale and large-scale pond owners. Pond owners in Kapasia are rich compared with rural households as a whole. Average annual

income per household from all sources of the medium-scale farmers was Tk 141 800 and that of the large-scale farmers was Tk 251 500 in 1997-98. Hence, they can afford to eat fish every day. Even among marginal and small-scale farmers, the average annual income was about Tk 85 500 that is much higher than the annual average income of a Bangladeshi household of about Tk 11 300 (BBS 1997).

Although all households of different landholding categories ate fish almost every day, there were slight differences between categories: medium and large farm owners ate fish on more days than the single landless household in the study (Table 5.3). That fish was not eaten every day was due to meat consumption on some days during the study period. It is an issue of prestige in rural Bangladesh to eat meat and big fish as this shows a household's financial superiority. Also when guests visit, it is a tradition to entertain them with meat. The large-scale land owners could easily afford to buy meat and entertain guests often.

Fresh fish was consumed on many more days by the participant households than dried fish was consumed. (Fig. 5.1). Most of the pond owners cultivate fish for both their own consumption and sale or just for consumption or sale. They eat stocked fish, and even when they sell these from their ponds, they buy other fresh fish with the money. Dried fish consumption was only seen in the months after stocking ponds when less fish are available. There was no significant difference in the days of consuming fresh or dried fish among different pond or landholding categories.

Table 5.3. Frequency of fish consumption (days/household/month)

Farm size	Days consumed
Landless	24.65
Small	26.41
Medium	26.60
Large	26.70
All	26.53

Fish Consumption

Fish consumption was highest in October when fish from the floodplains are caught in maximum numbers (and in 1998 there were more wild fish available in the area), and lowest (just under 50% of the peak level) in June-July (Table. 5.5), when the water level rises and there are few fish to catch in the rivers or other waterbodies. Fish consumption has a positive correlation to wild fish catch and a negative or lagged correlation to water level.

On average, the 69 surveyed households consumed about 17.6 kg of fish/month or 161 kg/household/year (201 kg/household for small pond owners and 210 kg/household for medium-large pond owners). There was no significant difference in fish consumption according to pond size. However, small-scale farm households consumed 14.84 kg/month or 83 g/person/day, whereas medium-scale farm households consumed 17.66 kg/month or 85 g/person/day, and large-scale farm households consumed 22.17 kg/month or 96 g/person/day. Thus, large-scale farm households consumed 49% more than small-scale farmers (Fig. 5.2) on a household basis but

Table 5.4. Frequency of consumption of fish by month (days consumed/household/month)

Pond size	1998					1999							
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	All
>15 decimals	30.0	28.3	29.6	28.7	28.1	27.9	25.0	27.2	24.6	25.3	23.9	24.3	26.9
<15 decimals	28.9	28.1	28.7	26.7	27.2	27.2	22.6	26.0	23.5	25.9	24.7	23.9	26.2
All	29.5	28.2	29.1	27.7	27.7	27.6	23.8	26.6	24.1	25.6	24.3	24.1	26.5

Fig. 5.1. Number of days per month when fresh and dried fish were eaten

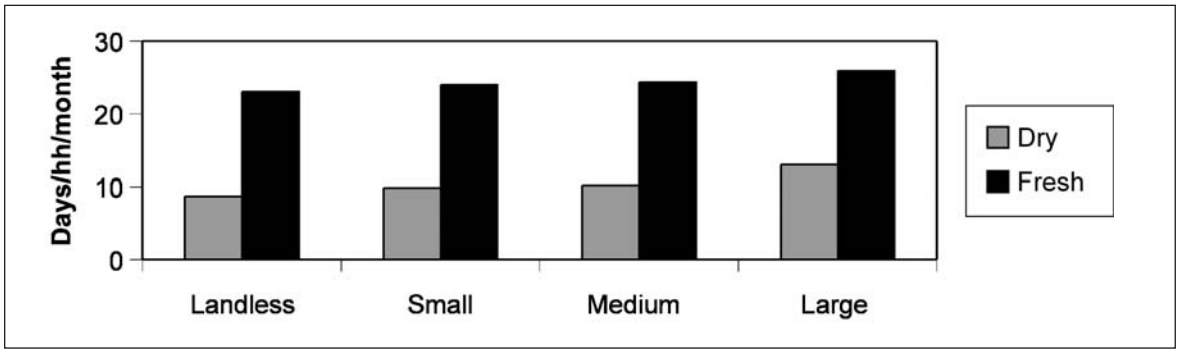


Fig. 5.2. Fish consumption in Kapasia by landholding

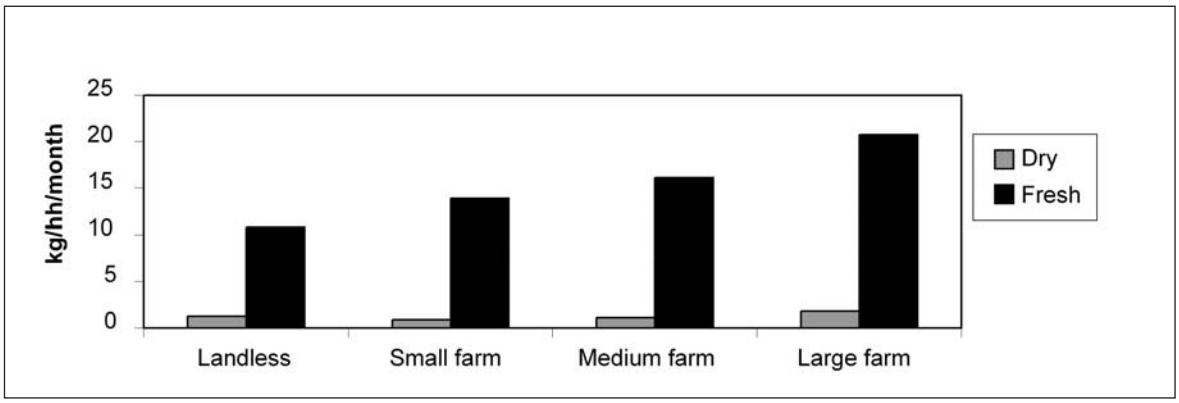


Table 5.5. Fish consumption (kg/household/month) by farm and pond size

	1998					1999							
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	All
Landholding category													
Landless	17.1	13.7	25.2	16.3	10.9	12.1	6.0	11.1	9.6	4.4	9.6	11.3	12.3
Small farm	17.8	17.9	18.3	14.7	15.9	15.0	17.1	14.5	14.9	11.9	10.6	9.4	14.8
Medium farm	19.3	21.5	28.2	23.1	17.4	18.6	13.9	16.7	14.6	15.5	12.1	11.0	17.7
Large farm	19.9	20.7	26.0	23.2	25.1	24.7	23.3	30.7	18.3	18.5	16.0	20.3	22.2
All	19.0	20.2	25.0	20.7	18.2	18.6	16.3	18.3	15.3	14.8	12.3	12.1	17.6
Pond area													
>15 decimals	17.5	19.4	23.0	20.1	17.0	18.4	16.7	18.3	13.7	14.4	11.5	11.2	16.8
<15 decimals	20.5	21.1	27.1	21.3	19.5	18.7	15.9	18.3	16.9	15.3	13.1	13.1	18.4
All	19.0	20.2	25.0	20.7	18.2	18.6	16.3	18.3	15.3	14.8	12.3	12.1	17.6

Table 5.6. Fish consumption (g/person/day) by landholding and pond size

	1998					1999							
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	All
Land category													
Landless	75.6	86.1	154.1	95.0	58.6	77.7	41.7	62.5	62.5	35.7	56.3	67.1	73.9
Small	82.6	87.0	110.5	99.2	89.8	82.8	101.6	74.7	79.4	70.9	67.8	50.5	83.3
Medium	82.2	85.4	133.4	123.0	85.0	95.7	74.7	78.6	73.7	68.8	63.0	52.3	84.6
Large	82.0	84.1	131.5	115.1	113.5	117.7	116.6	113.8	76.1	88.9	65.4	64.7	95.5
All	82.2	85.6	127.0	114.6	90.9	95.7	88.9	83.5	75.6	72.4	64.6	54.2	86.0
Pond size													
>5 decimals	76.1	86.1	122.9	111.7	89.1	94.0	91.8	84.0	73.9	75.8	66.2	57.9	85.1
<15 decimals	88.5	85.2	131.3	117.7	92.7	97.4	85.9	82.9	77.3	68.8	62.9	50.3	86.9
All	82.2	85.6	127.0	114.6	90.9	95.7	88.9	83.5	75.6	72.4	64.6	54.2	86.0

only 15% more per person-day (Table 5.6) since they on average had more people eating each day – larger household size plus laborers and helpers.

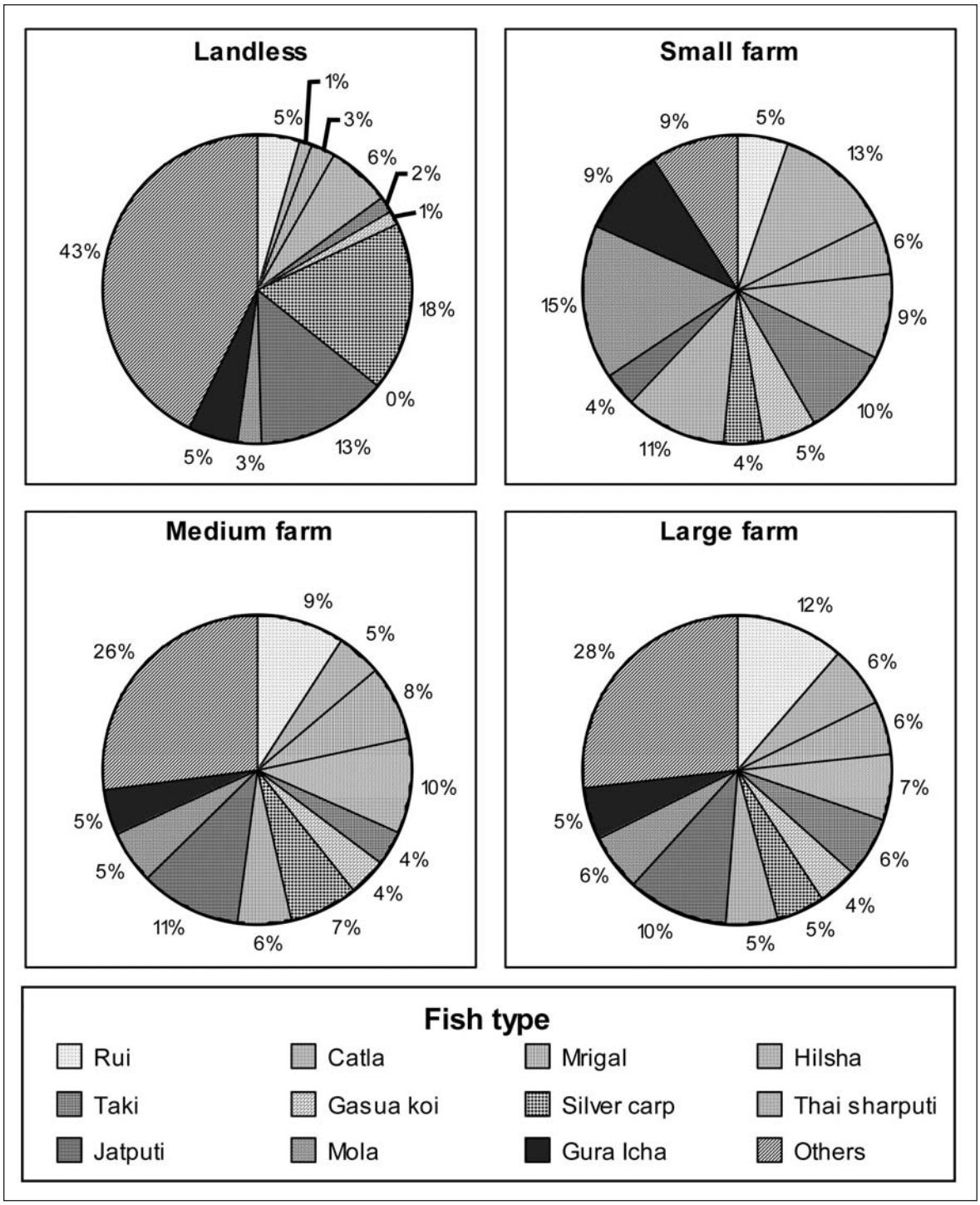
Diversity of Fish Consumed

The 69 pond-owning households consumed 82 species of fish during 25% of the 12-month period, of which 43% by weight were cultured species. Jatputi (11% by weight) was on the top of the list among individual species consumed, with Rui (10%) next. Most species were consumed in very small quantities: 52 species combined contributed less than one-third of the total amount consumed.

The 20 small land-owning households consumed 59 species, of which 41% were cultured species (Fig. 5.3). The 48 medium-scale and large-scale land owners consumed 76 species; of these, consumption of the small fish Jatputi was clearly the highest. About 44% of the fish consumed by medium-scale land owners were cultured species, while 43% of the fish consumed by large-scale farm owners were cultured species.

Out of 54 species consumed by the 12 large-scale farm households, 11 contributed 72% of the total amount consumed. Hilsha (a preferred species mostly caught in estuarine areas) was slightly more important for small-scale and medium-

Fig. 5.3. Types of fish eaten in Kapasia by weight



scale land owners, although it is now an expensive fish (see Chapter 7). Silver carp (a low-priced species regarded as inferior to others in taste) was the dominant species consumed by the one landless household but was rarely eaten by the other households even though it formed 29% of the total production from their own ponds. The small-scale farmers consumed a high proportion of Catla (a native filter feeder which fills the same role in aquaculture as Silver carp). As might be predicted, consumption of the preferred cultured species, Rui, increased with farm size. After Jatputi, Mola was the other most commonly eaten small fish, especially by the small-scale farmers, and this is important given the nutritional value of this species as a source of vitamin A (Zafri and Ahmed 1981; Thilsted and Roos 1999). Koi, a very expensive and scarce wild fish, was consumed only a little by the medium-scale and large-scale land owners. Table 5.7

summarizes the ranking of dominant fish species in the diet of these pond owners and confirms the overall importance of wild small indigenous species.

Consumption of cultured fish (major carps and exotics) was about 50% of total consumption by weight in the monsoon and post-monsoon, but fell during December-May (a period of moderate overall fish consumption) when Hilsa and small fish (all noncultured species) were relatively more important in the diet (Fig. 5.4). Many ponds are harvested during this latter period yet relatively less cultured fish were consumed by the pond-owning households. This may partly be explained by the fact that final harvesting is on a contractual basis, while for the rest of the year the households catch fish occasionally from their own ponds for food.

Sources of Fish Consumed

All the landed participant pond owners bought more than half of the total fish they consumed (Fig. 5.5). About one-fourth of the fish consumed by large pond owners was caught from other waterbodies. Usually, large pond owners own more cultivable land where they excavate ditches to retain water for irrigation during the dry season and also excavate earth for house building. During the monsoon when water floods the fields, fish from beels, canals and rivers enter into these fields, and when the water recedes, fish become trapped in the ditches. During the monsoon, the land owners fish in their fields and after the monsoon, they catch fish from the ditches. This explains the greater amount of fish consumed from other waterbodies (their own ditches and floodplains) by medium-scale and large-scale

Table 5.7. Ranking of fish species consumed in rural households in Kapasia in 1997-98

Rank	Weight consumed (% of total amount of fish recorded eaten by raw edible parts)		No. of fish meals eaten (% of total surveyed fish meals in which the species was recorded)		No. of households[a] eating (% of household in which the species was consumed)	
1	26	Puti	49	Puti	98	**Puti**
2	11	Silver carp	15	Taki	72	**Mola**
3	9	Taki	15	**Mola**	68	Baim/chikra
4	6	Baim/chikra	12	*Silver carp*	66	*Silver carp*
5	5	**Mola**	11	Baim/chikra	66	Taki
6	4	Magur	9	**Chanda**	59	**Chingri**
7	4	Rui	9	**Chingri**	56	**Chanda**
8	3	Hilsha	9	**Darkina**	50	**Darkina**
9	2	Chingri	6	**Shing**	41	Rui
10	2	Common carp	6	**Gutum**	39	Gutum

[a]n = 69.
Notes: Only the top 10 species are shown for each site and by each criterion.
Boldfaced text – small, indigenous fish species (SIS) and shrimps; roman (plain) text – wild-caught, medium-large fishes; italicized text - cultured species, including all major carps.

Fig. 5.4. Composition of fish consumption in Kapasia by month

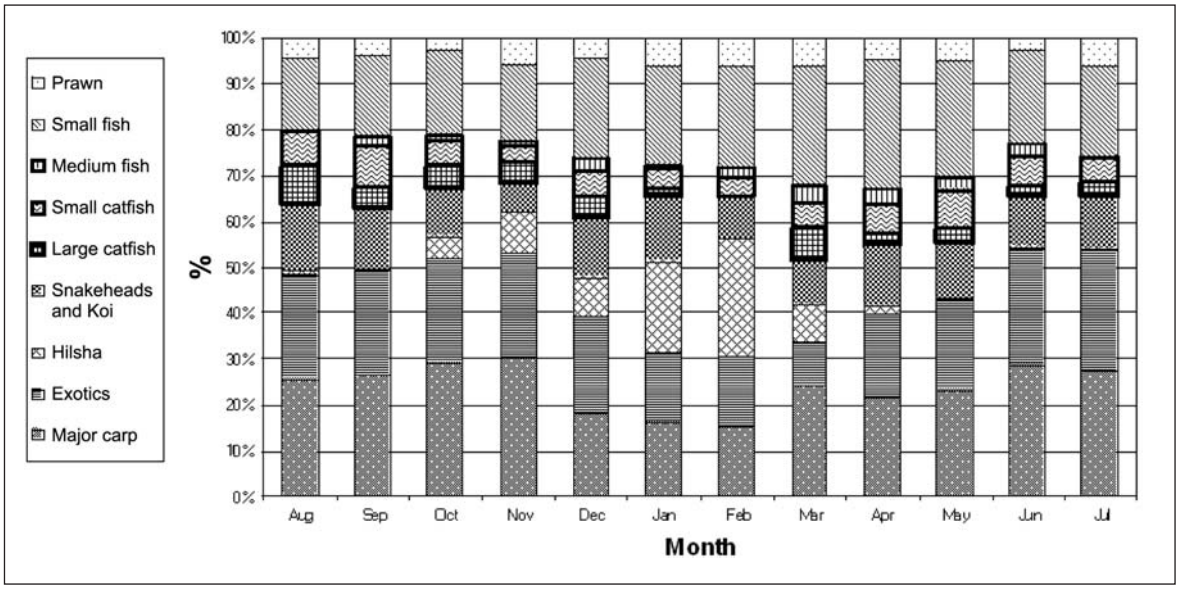
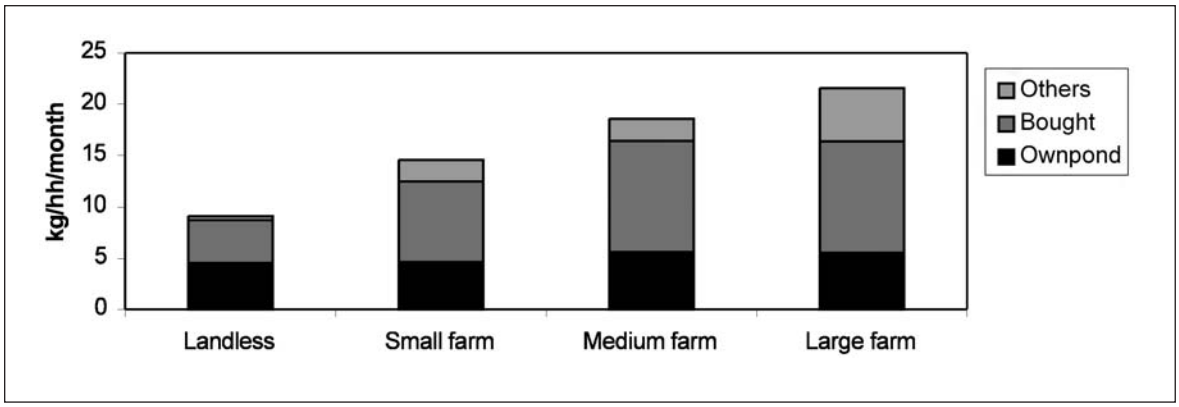


Fig. 5.5. Fish consumption in Kapasia by source land owners



land owners. However, landless and small-scale farm owners have very little access to the open waterbodies during the peak fishing season (after the monsoon when water drains out). They only can fish in these areas when water levels are high.

Medium and large-scale land owners consumed much more cultivated fish (7.8 kg/month and 9.5 kg/month, respectively) than small-scale land owners (6.1 kg/month), and a slightly higher proportion of cultured species, but a smaller percentage came from their own ponds (Fig. 5.5). Hence expenditure on fish increased with farm size. The farmers explained that they sell a large part of the fish they grow in their ponds in a lot and buy other (preferred and mainly higher value) fish through the year to eat. Also rural rich people do not always prefer cultured fish and the price of the main species grown (Silver carp) is low. As its price is low, the relatively less well-off small-scale land owners find it cost-effective to eat these stocked fish and are more motivated to produce fish for consumption from ponds that on average are smaller than those of larger land owners.

Consumption of Other Foods and Role of Fish

On average, the monitored households consumed just under 4 kg of rice/day, and about 630 g of fish/day (Table 5.8), and pond fish contributed only 21% by weight of the total fish consumption. Actual per person consumption figures derived from monitoring allow for consumption by, for example, guests and laborers fed by the participating households. If for simplicity and comparability with other studies, an average household size of 6 people is assumed, then consumption per person in the 12 months can be estimated at: 240 kg rice, 38.5 kg fish, 16.4 kg meat, 39.7 kg milk and 9.5 kg dal. This confirms that on average pond owners in this area are well off and eat relatively larger amounts of better foods, compared with an average of 8.4 to 14.6 kg of fish per person annually in other surveys (Thompson et al. 2002).

It is no surprise that overall, fish were not a key energy source in household nutrition, but were the main source of animal protein at 55%. However, pond fish contributed only 11% of animal protein (Table 5.8). Small fish were also especially important as a source of calcium. Thus, aquaculture is generating some income and food for pond-owning households, but pond owners are more dependent on capture fisheries than aquaculture for key nutrients in their diet.

Box 5.1.

LPPFish = 19.23 –3.44LFPr –4.47LMPr
+0.39LPPExp –0.23LPPExp2 +0.43ExpF
+0.47ExpM –0.04LProd

Where all terms are in a natural log form and:
LPPFish - per person expenditure on fish (Tk)
LFPr - average fish price (Tk/kg)
LMPr - average meat price (Tk/kg)
LPPExp - per person total expenditure (Tk)
LPPExp2 - squared term of LPPExp
ExpF - LFP and LPPExp
ExpM - LMPr and LPPExp
LProd - total pond fish production (kg)

Applying a simple demand function to the survey data (Box 5.1) resulted in a poor fit (R^2 = 0.15) and suggested that expenditure on fish for household consumption is not related with own fish production, and gave a very low elasticity of fish price (-0.01) compared with an elasticity of

Table 5.8. Daily food and nutrient consumption per household in 1998-99

Food	Total g	Energy		Protein		Animal protein		Calcium	
		Kcal	%	g	%	g	%	mg	%
Rice	3 940	13 750	86.5	334.9	57.9	0.0	0.0	3 940	40.4
Pond fish	133	145	0.9	23.2	4.0	23.2	11.3	390	4.0
Other big fish	151	165	1.0	26.3	4.5	26.3	12.8	442	4.5
Other small fish	352	401	2.5	63.0	10.9	63.0	30.7	4 007	41.1
Dal	156	536	3.4	38.6	6.7	0.0	0.0	112	1.1
Egg	89	153	1.0	11.8	2.0	11.8	5.7	53	0.5
Meat	270	300	1.9	60.0	10.4	60.0	29.3	30	0.3
Milk	652	437	2.8	20.9	3.6	20.9	10.2	783	8.0
Total	NA	15 888	100.0	578.6	100.0	205.2	100.0	9 758	100.0

Consumption converted to components using Darnton-Hill et al. (1988).

meat price of -0.73. For relatively wealthy households cultivating fish, market purchases probably depend more on preferences between types of fish and the interplay of status and own-pond production rather than on prices.

Conclusion

Detailed participant monitoring of fish consumption over 14 months by this sample of practicing fish farmers indicates the following:

- Households owning ponds consumed fish on most days.
- Per capita fish consumption among the pond owner households in Kapasia is more than double the national average. Medium-scale and large-scale land owners consumed about 40% more fish than the small-scale land owners.
- The medium-scale and large-scale land owners sold mostly stocked fish. Small-scale land owners also sell stocked fish but they consume a good amount of their own cultivated fish.
- Of the many wild fish species (65) consumed during the year, the main ones by weight were Jatputi and Hilsha. Hilsha was the most expensive fish purchased during the survey, and even smaller fish on average are more expensive than the main cultured species.
- All types of pond owners consumed a wide range of species but 10 species comprised 75% of consumption.
- The proportion of wild-caught fish consumed increases with landholding size. Medium and large land owners consumed more own-caught fish, mainly from their own fields.
- Detailed and reliable data on fish consumption can be collected by school children and students in pond-owning households (but this was helped by having regular visits from project staff to check on progress and data). Feedback sessions at roughly four to five-month intervals to discuss the survey, share findings and discuss methodology issues are important to maintain interest and make such studies participatory.

Chapter 6
Case Studies of Aquaculture Technologies in Kapasia

Background and Context

In Bangladesh, transfer to farmers of new technologies, other than the traditional ones, is a crucial step that needs motivation of farmers through demonstration, information dissemination and encouraging new markets. If demonstration impacts show positive results, then rich farmers adopt the technology very quickly whereas poorer farmers typically wait to see the effect. Farmers usually do cost-benefit analysis in their own way and if they see a high return, they adopt and continue a practice.

This chapter reviews the impacts and experiences of the WorldFish project in Kapasia in the early 1990s in introducing other new aquaculture technologies (excluding carp polyculture, which is covered in detail in Chapters 3 to 5). In addition to three aquaculture technologies: carp polyculture, monoculture of Nile tilapia and monoculture of Thai sharputi (Silver barb), the project provided training and input support for poultry-fish farming, fish nursery creation/operation, rice-fish farming, a fish hatchery, and beel stocking (Table 6.1).

Input support provided by the WorldFish project included tools and equipment for dewatering ponds, netting and harvesting; chemicals for killing unwanted fish in ponds; help in obtaining poultry birds for selected cooperator farmers for fish-cum-poultry farming; and arrangement of fry/fingerlings for stocking beels, ponds and ricefields. Training included classroom lectures, meetings, demonstrations, farmer rallies and distribution of information in printed form such as leaflets and pamphlets. The extension strategy followed involved organization of an outreach training program at the community level, technical advice, farm visits, demonstrations, fingerling procurement and equipment services. The basic two-day fish culture training focused on pond preparation, stocking and post-stocking management, harvesting, marketing and other pond management practices.

The main contents of the one-day poultry-fish rearing training program were: construction of poultry shed, selection of chicken varieties, ratio of poultry birds to fingerlings stocked, feeding of poultry birds, common poultry diseases and their control measures, costs and benefits, and other routine poultry-cum-fish management practices. The main stocking levels recommended in the WorldFish project for this and other technologies are shown in Table 6.2. The nursery-training program included important aspects of nursery operations, such as pond selection and preparation, stocking and post-stocking management, feeding, fertilizing, harvesting and marketing.

The present case studies were designed to find out to what extent adoption of the technologies has been sustained in practice, and the current aquaculture practices among the trained people. Because of the limited number of initial participants with each technology, a case study approach was adopted, which was more flexible than a formal survey and gave an opportunity to

Table 6.1. Additional technologies extended by WorldFish during 1990-94 in Kapasia

Technology	No. of farmers
Rice-fish culture	12
Poultry-fish culture	5
Hatchery	1
Beel stocking	16
Nursery raising	61

Table 6.2. Some details of the aquaculture technologies disseminated earlier by WorldFish in Kapasia

Technology	Stocking level recommended
Nursery raising	6.88 g spawn/ha
Thai sharputi monoculture	16 055 fingerlings/ha
Rice-fish culture	7 014 fingerlings/ha
Beel stocking	8 448 fingerlings/ha
Poultry-fish culture	**Poultry:** No. of broiler 1/ft^2 ; no. of layer 2/ft^2 ; feed/day 115-125 g Fish: Catla - 10%, Silver carp - 30%, Rui - 25%, Mirror carp - 5%, Grass carp - 10%, and Mrigal - 20%, 4-6" long, 24-40 fingerlings/decimal (40 m^2)

the participants to explain their experiences and history with the technologies. The case studies completed in 1998 included: nursery pond raising (3), monoculture of Thai sharputi (3), rice-fish culture (3), hatchery (1), beel fish culture (6 plus a short survey of 30 beels), and poultry-fish culture (2).

Adoption of Technology

Nursery raising

Before initiation of the project, there was no fish nursery in Kapasia Upazila. In 1992-93, the project launched a motivation program. The target was to establish 61 nurseries up to 1993, but only 28 persons received training on fish nursery rearing. Out of them, three were interviewed who still remembered the major topics of the training. They all could recall the basic contents of the training - about pond preparation, spawn transportation, acclimatization and liberation, feeding, and control of harmful insects. However, the amount of inputs that they mentioned they used in the pond was less than the recommended dosage. Either they forgot what they used or they used less than the recommended amounts of inputs. The farmers said that they stocked on average 14.5 g spawn/decimal (40 m^2). This was almost double the recommended amount.

Thai sharputi monoculture

Under the earlier project, all the participant farmers used the same basic technology elaborated during the training course. They reported that in practice they used poison at the average rate of 2 290 tablets per ha of pond area to kill predators in the pond, whereas the WorldFish project recommended application of 39.5 kg of rotenone per ha. They reported use of urea, TSP and cow dung at the rates of 15.5 kg/ha, 46.3 kg/ha, and 2 780 kg/ha, respectively. The amounts used were almost half of the recommended doses. The reported stocking density averaged 15 645 fingerlings/ha.

Rice-fish culture

People traditionally catch fish in ricefields in Kapasia. Stocking fish was a new idea and was usually done in seasonal beels with a deep depression on one side of the plot. None of the previous participants interviewed could remember the techniques recommended for rice-fish culture. However, they said that they used lots of inputs for rice and fish. Within six months (from June to November), growth of some fish they observed was about 1 kg. The stocking density averaged about 1 800 fingerlings/ha.

Hatchery

This technology was adopted after the end of the project. One hatchery was established as a result of suggestions from the WorldFish project but without direct technical assistance.

Beel stocking

Among the 125 small seasonal beels (areas of private land that are flooded in the monsoon, those in Kapasia are mostly surrounded by higher land) surveyed by the earlier project, only 16 beels were selected for promoting/testing fish stocking. Most of those had multiple owners. There was no specific set of technical recommendations for stocking fish in beels, and none of the people interviewed had any formal training. They got the idea from TV broadcasts and started the business. On average, they stocked a beel for two years and made a profit. The recommended stocking density was 3 000 to 3 700 fingerlings per ha (12 to 15 fingerlings per decimal) whereas they reported that they actually stocked about 15 000 fingerlings per ha (60 fingerlings per decimal).

Poultry-fish culture

Only one of the original participants is still practicing poultry-fish farming and he has followed project recommendations except that now he is stocking more fish to compensate for the risk of loss due to fish disease.

Sustainability of the Technologies

Nursery raising

Most of the nursery operators practiced this for the first year, but rather than continue to sell fingerlings they turned to carp polyculture. Some continued up to the second year but none of the original participants are now in the fish nursery business (see Box 6.1).

Thai sharputi monoculture

Culture of Thai sharputi was not sustained after the project, as the risk of monoculture is high in

Box 6.1. Fish Nursery Case Study

Santosh Kumar participated in a two-day aquaculture training with special focus on carp nursery in 1993. After training, he started a carp nursery in his shallow 20-decimal (0.08 ha) pond. He prepared the pond according to the knowledge acquired from training by applying 3-4 kg of cow dung per decimal and 1 kg of lime per decimal, killed all predators with rotenone at the rate of 1-1.5 kg per 35 decimals, and stocked the pond with three-day old spawn obtained from the Bangladesh Fisheries Research Institute (BFRI). He also used cow dung, weeds, grass and rice bran from his own farm as feed. He earned Tk 24 000 in the first year and Tk 20 000 in the second year.

In the second year, he supplied fingerlings to almost all the pond owners trained by WorldFish. When the project activities stopped in 1994, he had problems marketing fingerlings; also expert laborers were charging a high wage. However, he managed to use his fingerlings in four shared beels. He then turned into a carp polyculture farmer. While buying fingerlings from the fish fry traders, he realized that people lost their faith in these vendors as they sell low-quality fingerlings that do not grow fast and have a high mortality rate. These fingerlings are procured from private nurseries that supply on credit. He said that the good quality fry producers – BFRI and Department of Fisheries (DOF) – do not sell fingerlings on credit so their fingerlings are not available locally. He had decided to start raising and selling fingerlings again as he realized that before his fingerlings were of good quality as he used to bring fry from BFRI or DOF. At the time of the interview, he had completed all the requirements to start this business again in 1999 by renting and cleaning a big pond.

Santosh Kumar thinks that carp nurseries are very profitable.

the farmers' opinion (many of the monoculture ponds suffered from epizootic ulcerative syndrome in 1992, Ahmed and Rab 1995). However, Thai sharputi has been commonly incorporated in carp polyculture systems in the area. This species can thrive on household wastes and by-products, and grows to a harvestable size within four months.

Rice-fish culture

In Bangladesh, fishing in the ricefields during the monsoon is a common practice. Stocking fish in ricefields was a new technology. Rice always needs water. During the monsoon rice season (aman) paddy fields are always inundated under water. During the dry season (boro rice), a certain amount of water is necessary for cultivating boro rice. Therefore, the ricefield environment is suitable for fish culture. In Bangladesh during the monsoon people catch wild fish from ricefields for consumption as well as for sale. When the land owners stock fish in their ricefields, they prevent any fishing and local people no longer have access to natural fish resources. Subsistence fishing is restricted to the owners of the fields. Besides producing fish for regular consumption, some of the participants earned double the amount of money they invested. But most of their stocked fish escaped by overtopping the dikes (see Box 6.2).

Hatchery

Sustainability depends on the attitude and technical capacity of the hatchery owner, on quality of fry produced and on the marketing channels established. For a successful hatchery, maintenance of sufficient water level in the brood ponds is also needed. Having trained personnel for spawn management is also one of the preconditions. Only one hatchery was established as a result of the project. The owner invested heavily but has not been able to get the expected return. He is still continuing but the quality of his spawn is very low (see Box 6.3). He has also turned to carp polyculture.

Poultry-fish culture

Out of the five participants who received training during the earlier project, one farmer was still practicing poultry-fish farming in 1998. He is a large-scale farmer having 8 ha of land. He is reluctant to increase his farm income as he thinks what he is getting is enough for the family. Actually his land area is underutilized (See Box 6.4).

Box 6.2. Case Study of Rice-fish Culture

Oliullah Fakir is a primary teacher who was trained by WorldFish in 1993. He has a ricefield of 35 decimals (0.14 ha) of which about a third is a ditch. This ditch holds 0.6 to 0.75 m of water for four to five months of the year. He prepared the field, fertilized it and used supplemental feed for the fish but could not remember the dosage. He stocked fingerlings from a mixture of carp species in May 1993 but could not remember the number or amount of fingerlings he used. He could not recall the total amount harvested but he said that the total production was used for family consumption. The common carp he released in the ricefield became 1 kg within six months.

Being interested by the result of the first year's production, he motivated six of his brothers, and they jointly combined their own land and leased-in land making a combined plot of 245 decimals (1 ha) of land in 1994, they raised a dike around this area at a cost of Tk 11 000. Since he had dry season rice in his field, he maintained water in the field for a longer period of time. He continued rice-fish culture and after deducting all the expenses the seven brothers each earned Tk 500 to 700 per year. This amount was in addition to the fish used for family consumption. Oljullah and his brothers did not buy any fish to eat. In 1998, he spent Tk 13 000 to buy fingerlings and also used 240 kg lime, 75 kg TSP, 50 kg urea and cow dung, and compost from his own farm. He used 800 kg rice bran and 60 kg mustard oilcake as fish feed. Until the plots were flooded in September, good growth of fish was observed. But he lost all the fish after flooding.

Box 6.3. Hatchery Case Study

Majibor Rahman of Toke Union owns three seasonal ponds that can retain water for 8-9 months of the year. After receiving training from WorldFish during the earlier project, he borrowed Tk 500 000 from a commercial bank and constructed sheds and a hatchery complex on 50 decimals (0.2 ha) of land adjacent to the ponds. He was not able to start the hatchery before the project closed, and so did not get access to advice when actually setting up his hatchery. He tried to produce some hatchlings but due to unsuitable water the eggs did not hatch. He changed the location of his tubewell three times and finally achieved a good result. He lost all his investments in the first and second year, but in 1998 he made some money that he used to pay off part of his loan. He could not sell all of his spawn in 1998 because the mortality rate was too high. His broodstock fish were not of good quality. He could not maintain the required level of water in his pond. He decided to produce fingerlings from the spawn and stock these to produce marketable fish in a seasonal beel of about 3.5 ha which he leased.

Box 6.4. Poultry-fish Case Study

Md Atiqul Islam Ratan is a fish farmer by hobby. He received a 1-day poultry-fish farming training from the earlier project. After training, he started with a 33-decimal (0.13 ha) pond and gradually expanded it to 300 decimals (1.2 ha). Although his family cultivates their farm land, about 80% of their income comes from the poultry-fish farm. Owing to poultry fish farming, their social status has risen. A group of fishers is earning money from harvesting and marketing fish and poultry.

In 1998, Atiqul earned about Tk 317 000 from the farm. He used all the poultry litter and cow dung from his farm to fertilize the pond. Because of fish disease, he lost about 30% of his potential income. He sold 80% of his fish and poultry in the local market. He mentioned that lack of electricity restricts preservation of eggs and meat for long. Therefore, he had to sell his products at a cheaper rate to avoid loss. He taught 8-10 persons how to rear chicks as well as fish. They are now practicing it on a small scale.

Stocking of Fish in Small Beels

There are at least 134 small seasonal beels in Kapasia Upazila as a whole (based on previous censuses), of which 85 are in the 6 unions covered by the earlier project. All the beels are seasonally inundated and composed of private land, some of which is cultivated with paddy. During the earlier project, the concept of stocking carp in these seasonal beels was introduced and tested in

16 beels, most of which had multiple owners. Recommendations on stocking fish were made but there was no other support.

Spread and achievements

In the whole upazila, 30 beels were selected at random and information on these fisheries was collected in 1999. The average reported beel area was 9.8 ha implying a total area in the 6 unions of 833 ha, 9 (30%) of the sample were stocked in 1998 and achieved production of 2 625 kg/beel of carp, but the largest stocked beel was flooded and no catch was reported (Table 6.3). Similar species of small fish were reported from both stocked and nonstocked beels, although the catches could not be estimated as they are open to small-scale fishing in addition to organized harvesting. Assuming that these beels are representative, then in total 30% or 25 of the beels in the project area were stocked in 1999 and the incremental catch from them was about 65.6 t of carp (in addition to natural fish). While the project initiated this activity, it has subsequently been influenced by a mixture of conflicts among co-owners, experience elsewhere and mass media.

Table 6.3. Features of small beels in Kapasia

Total number of beels in Kapasia	204
Number of beels surveyed	30
Total area of beels (ha)	294
Average area of a beel in monsoon (ha)	9.81
Number of beels stocked	9
Total area of stocked beels (ha)	140
Average number of participants/beel	12
Average number of fingerlings stocked/ha	7 595
Average fish production (kg/ha)	169
Average cash expenditure (Tk per ha)	11 549
Average gross income (Tk per ha)	15 359
Number of large fish species available	12
Number of large fish species now rare	10
Number of large fish species disappeared	7
Number of small fish species available	27
Number of small fish species now rare	22
Number of small fish species disappeared	11

Problems revealed by the case studies

Coordinated stocking of fish in private beels is hampered when a conflict arises between land owners over their shares. It was reported that some land owners do not want to pay their share of expenditure but want to get an equal share of income and fish. Some land owners do not want to sacrifice their land for stocking but rather they want to drain out water and cultivate rice. In some beels, land owners get a lump-sum compensation paid for their land by the fish cultivators. In others, there are management committees that sold shares in the enterprise to others. Some outsiders tried to lease beels to cultivate fish. Overstocking is a common practice in the beels. Most fish produced are sold in the locality. Beel stocking is profitable but has not been able to continue in each beel for a long time. In one case, a group of unemployed youths have started to harvest beels on behalf of the people stocking them or the land owners, and get as their share 15-29% of the total income. However, no outsiders have access to the fishery resources of a beel when it is started. Box 6.5 gives a case study on beel stocking.

The case studies indicated that groups (usually of land owners) managed to cooperate for a few years in stocking and then often abandoned the practice due to conflicts over sharing costs and benefits. After a short gap (one to two years), stocking in the same beel would restart either by some of the same people or at the initiative of individual local entrepreneurs. Consequently, perhaps half of the current beel stocking can be attributed to the earlier extension.

Factors Adversely Affecting the Sustainability of Aquaculture Technologies

This section summarizes those problems and factors identified from the case studies that we believe limited the continued adoption of these aquaculture technologies.

Nursery raising

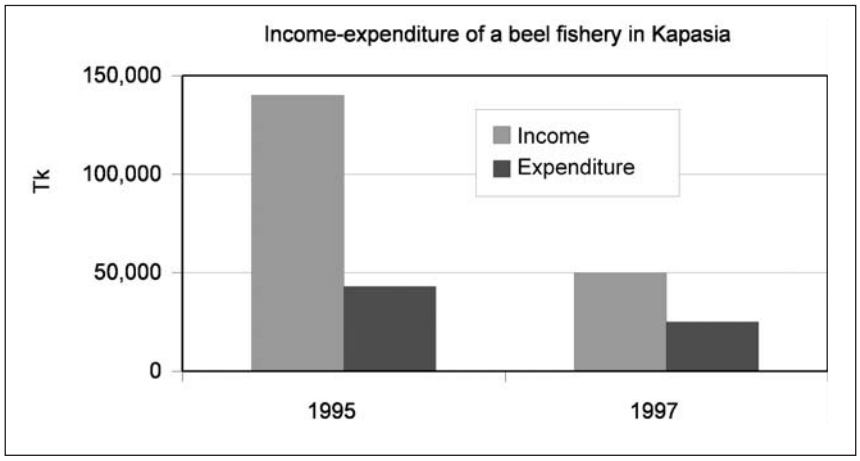
- number of ponds not sufficient in a group for one operator;
- nonavailability of small ponds;
- pond operators either cannot distinguish high-quality fingerlings or are not prepared to pay a premium for them;
- low-quality, cheaper fingerlings available from outsider vendors;
- high-cost of labor for fingerling vending;
- lack of family labor to support the business;
- lack of time for the job; and
- lack of working capital.

Thai sharputi monoculture

- outbreak of acute ulcerative syndrome disease in Thai sharputi;

Box 6.5. Beel Stocking Case Study

Nurer Beel was one of the beels surveyed and where advice on stocking was given in the previous project. The total area of the beel is 12 acres (4.9 ha) of which 4 acres (0.6 ha) have permanent water. The rest of the area is double-cropped with aman rice in the monsoon and boro rice in the dry season. One cross dam retains water throughout the year. Seven people own the land in the beel. In the years before stocking, the owners had allowed other people to fish in the beel, and they estimated that other (poor) people living nearby caught about 10% of the wild fish in the beel. After stocking for two years, the owners achieved a good profit. But then due to conflict between the land owners, the return decreased and they now earn only 5-10% of their total income from the beel.



From the figure above, it is evident that income from stocking fish in the beel has decreased with time. Although the participants still believe that stock enhancement in their beel is profitable, they could not overcome the conflict. They sell 60% of the fish caught from the beel in the local market, and give 20% of the total harvest to the fishers contracted to do the harvesting.

Three out of seven partners in the beel fishery received training from the project. All of the partners believe that fish culture is more profitable than agriculture.

- some people say Thai sharputi is less tasty and is full of bones; and
- monoculture does not utilize full productivity of the pond.

Rice-fish culture

- difficult to maintain appropriate level of water in the field (0.6 to 0.75 m);
- lack of continuous sources of water;
- lack of initiative to make within the agricultural plot a deep ditch that would form a fish refuge; and
- risk of loss of fish from flooding.

Hatchery

- lack of good-quality broodfish;
- high mortality of the spawn;
- poaching of broodfish;
- low ground water level and poor quality of water;
- lack of marketing facilities; and
- lack of capital.

Beel stocking

- many shareholders (land owners);
- mistrust among land owners;
- access and financial arrangements among owners difficult to enforce, e.g., private or leased-in land; and
- multipurpose use of beel (for cultivation, irrigation, etc.), e.g., stocked fish prevent some alternative uses of land and water.

Poultry-fish culture

- poor road communications for sending poultry to markets (now improving);
- limited local demand for poultry;

- low price of the product;
- less enthusiasm; and
- lack of electricity supply.

Lessons Learned

Nursery raising

- An operator should have a plan and the means to fulfil it.
- An operator should be able to manage enough ponds to operate (either ponds already owned or by leasing or renting in) and have working capital or access to credit facilities.
- Local demand for the fingerlings should be assessed before starting. Fingerling marketing needs to be improved.

Thai sharputi monoculture

- Fish disease is a big barrier for monoculture of Thai sharputi. However, most of the pond owners are rearing it along with other species that are more appropriate.

Rice-fish culture

- Large-scale land owners traditionally catch fish in their ricefields. Rice-fish culture has not been done commercially; but for own household consumption, some fish have been stocked.
- There is a high risk of flooding and overtopping of the field if dikes are not high enough to keep water out, but this may obstruct water flow.

Hatchery

- Ponds need to be prepared before rearing broodstock.
- It is necessary to select good quality broodstock.
- Water level in the pond needs to be maintained to keep broodfish healthy.
- Ensuring good quality spawn for sale is a major problem for the operator.
- Ensuring a high survival rate of the spawn is difficult.
- Marketing opportunities and mechanisms need to be explored before establishing a hatchery.

Beel stocking

- Like-minded people should be involved in the business.
- There should be a formal agreement among all the shareholders before stocking a beel.
- A beel should not be used for different purposes if it is stocked.
- Responsibilities for the fishery enhancement system should be allocated among all partners.
- Responsibilities should be rotated to minimize mistrust (for example, over handling funds and release of fingerlings).

Poultry-fish culture

- Marketing facilities should be assessed for both poultry and fish before extending this technology.

Chapter 7
Fish Markets and Consumers

Introduction

In November 1991, the WorldFish project undertook a market survey in Kapasia to determine fish marketing channels, types of fish available and major sources of supply of fish in the rural markets and to gather data on fish prices. The survey was repeated in Kapasia as part of this study to assess changes in fish availability, sources, prices, etc. In accordance with the previous survey design, 15 markets from six unions in Kapasia were surveyed. Although the previous project conducted market surveys in both Kapasia and Sreepur, this study simply surveyed in Kapasia Upazila as this was the impact area of the project, for comparison with 1991 data.

Methodology

An inventory of local markets where fish are traded was made in 1991, recording various attributes (market size, number of buyers and sellers, and sitting days), but the names of the markets surveyed in 1991 were not preserved. Fifteen markets, including the main upazila (subdistrict) market that was surveyed in 1991, were surveyed in February 1999. The remaining 14 were selected randomly from the six unions covered by the study.

Two field investigators were employed on a short-term basis to conduct the survey. They completed a one-page profile for each market and a two-page questionnaire for each of a random sample of 10 fish traders interviewed on the survey day in each market. This second format covered information on the fish traded that day by the sample traders. A total of 150 fish traders were surveyed during February 1999.

Market Survey Results

Markets and traders

The traders surveyed in 1999 had very similar socioeconomic characteristics to those surveyed in 1991: education levels were slightly higher on average, but most had no education and were primarily fish traders. Average incomes from fish trading for those traders mainly dependent on fish trading were 2.4 times greater than in 1991, and the secondary fish traders had much higher incomes from fish trading than similar traders in 1991 (Table 7.1).

On average, the markets surveyed in 1999 were larger in area with 67% greater than 5 000 m^2. Also, the frequency of operating had increased compared with 1991: none now operate on only one day a week (Table 7.2). Increased area is a reflection of much more active markets: the number of buyers has increased per market. In 1991, 67% of markets had not more than 2 000

Table 7.1. Socioeconomic profile of fish sellers/traders in the sample markets in Kapasia

Characteristic	1991 (n=134)	1999 (n=150)
Average number of people per household	5.98	5.90
Educational status (%):		
No education	75	69
Primary	24	17
Secondary	1	9
Higher secondary and above	0	5
Principal occupation (%):		
Agriculture	10	17
Daily trading	6	1
Fish trading	82	76
Petty trade	NA	1
Rickshaw pulling	1	1
Others	1	3
Average annual income (Tk per seller) from selling fish:		
Principal occupation is fish trading	17 570	41 890
Secondary occupation is fish trading	1 570	18 750
Average annual income (Tk per seller) from other sources:		
Principal occupation is fish trading	NA	2 030
Secondary occupation is fish trading	NA	44 310
Residential location (%)		
Within union of the market place	42	47
Within thana but different union	34	19
Different thana	24	25
Different district	NA	9

NA – not available.
Sources: 1991 data – Ahmed et al. (1993); 1999 data - this study.

Table 7.2. Distribution of sample markets by physical area (m^2) and number of market days per week in Kapasia in 1991 and 1999

Size of market (m^2)	Number of sitting days per week					
	Once	Twice	Thrice	Daily	Total	%
1991	4	10	0	1	15	100
<800	1	1	0	0	2	13
801 – 1 600	2	3	0	0	5	33
1,601 – 5 000	0	1	0	0	7	7
>5,000	1	5	0	1	7	47
1999	0	12	1	2	15	0
<800	0	0	0	0	0	0
801 – 1 600	0	1	0	0	1	7
1,601 – 5 000	0	4	0	0	4	27
>5,000	0	7	1	2	10	67

Sources: 1991 data – Ahmed et al. (1993); 1999 data - this study.

buyers in a day; in 1999, 60% had over 2 000 buyers per day (Table 7.3). But there has been an even more dramatic increase in the number of fish traders active: in 1991, only the main upazila market had over 15 sellers (the actual number was not recorded); in 1999, only 1 market had up to 15 fish sellers and 9 had over 45 sellers.

The average number of sellers per market increased 5.8 times to 52 (Table 7.4) while the average number of buyers increased only 1.5 times; consequently, the number of potential customers per trader fell to just under 50. The data indicate that the availability of fish and amounts traded per seller and per customer have increased, and that this may be the reason for the major increase in the number of fish traders. The volume of fish traded has increased by over eight times, and (assuming that all fish are sold in a day) the amount purchased per customer increased over five times. Another explanation for these differences is the timing of the surveys. The 1999 survey took place in February, the peak month for pond harvesting. In 1991, the survey was during November-December. Although this was not the time of the peak supply, there were few ponds cultivated at that time and this would have been soon after the peak period for availability of fish from capture sources.

Table 7.3. Distribution of sample markets by number of buyers and fish sellers on a market day in Kapasia

Number of buyers	Number of fish sellers				
	<15	15 - 30	31 - 45	>45	All
1991	14	1	0		15
<500	6	0	0	0	6
500 – 2 000	4	0	0	0	4
2 000 – 4 000	3	0	0	0	3
>4 000	1	1	0	0	2
1999	1	4	1	9	15
<500	1	0	0	0	1
500 – 2 000	0	1	0	4	5
2 000 – 4 000	0	1	1	2	4
>4 000	0	2	0	3	5

Sources: 1991 data – Ahmed et al. (1993); 1999 data - this study.

Table 7.4. Average number of buyers, fish sellers and availability of fish in the sample markets on a market day in Kapasia

	1991	1999
Average number of buyers	1 700	2 567
Average number of sellers	9	52
Average volume of fish in the market on a market day (kg)	91	801
Buyer/seller ratio	189	49
Availability of fish in the market (g/buyer)	54	312

Sources: 1991 data – Ahmed et al. (1993); 1999 data - this study.

Types of fish traded

Major changes in the types of fish recorded in the markets were partly associated with the month of the surveys, but mainly reflected the considerable expansion of aquaculture in the upazila (subdistrict). In 1991, small indigenous fish species were recorded in all surveyed markets, but cultured fish were found in less than a third of markets. In 1999, carps of various species were for sale in some 90% of the markets. Thai sharputi and tilapia (both effectively introduced to the area by the earlier project) were available in 87% and 27% of markets, respectively (Table 7.5).

Further evidence of the increased importance of aquaculture in the area is shown by the source of fish sold. In 1991, the single most important known source of fish in the sampled markets was the catch of the seller derived from open waters, presumably, the fish bought by traders to sell in these markets also mainly came from open waters. By comparison, 16% of the traders surveyed in 1999 were selling fish from ponds and much of the fish that had been bought from other

Table 7.5. Number of sample markets in Kapasia where different types of fish were recorded

Species	1991 (n=15)		1999 (n=15)	
	No.	%	No.	%
Major carps	4	27	14	93
Chinese carps	3	20	14	93
Common carp	2	13	13	87
Thai sharputi	NA	NA	13	87
Tilapia	1	7	4	27
Airbreathers	12	80	13	87
Hilsha	2	13	3	20
Marine fish	1	7	1	7
Small indigenous fish	15	100	8	53
Small/large prawn	12	8	5	33
Other wild fish	6	40	10	67

Sources: 1991 data – Ahmed et al. (1993); 1999 data - this study.

suppliers were almost certainly from ponds (Table 7.6).

The volume of fish traded in a day in 15 markets increased greatly in 8 years (although this may also be affected by the 1999 survey coinciding with the peak period of harvesting cultivated ponds). In addition, the dominance of small waterbodies (including ponds) as a source increased from 33% to 59% of the total weight of fish sampled (Table 7.7). Carps and tilapia are largely cultivated in ponds, and their contribution to the total fish marketed increased from 39% to 77%. However, in 1999, a higher proportion of carp came from beels, probably because of stocking small beels in the area – a direct consequence of the earlier project – and escape of stocked fish into beels because of the exceptional flood in 1998. In 1991, small indigenous fish were the main type of fish in the markets, but with the major expansion of aquaculture in the area, in 1999, major carps and Chinese carp were the main types.

Table 7.6. Origin of fish supply in the sample markets in Kapasia by the number of sellers/traders reporting each source

Origin of fish	1991 (n=134)		1999 (n=150)	
	No.	%	No.	%
Selling harvest from own pond/ditch	0	0	13	9
Selling harvest from others' pond	5	4	11	7
Selling own harvest from open water	65	48	44	29
Selling others' harvest (bought fish)	64	48	78	52
Selling dry fish	NA	NA	2	1
Mixed sources	NA	NA	1	1
Selling fish of leased beel	NA	NA	1	1

NA - not applicable.
Sources: 1991 data – Ahmed et al. (1993); 1999 data - this study.

Fish prices

The volume of fish traded and numbers of traders have increased substantially, more than the

Table 7.7. Types and sources of fish in sample markets in Kapasia

Fish type	1991						1999					
	Small waterbodies	Beels/ haors	Rivers	Sea	Don't know	Total	Small waterbodies	Beels/ haors	Rivers	Sea	Don't know	Total
Weight (kg)												
Major carps	306	0	90	0	0	396	1 066	350	251	0	9	1 675
Chinese carp	61	0	0	0	0	61	631	107	0	0	0	738
Common carp	76	0	0	0	0	76	71	51	0	0	2	124
Tilapia	3	0	0	0	0	3	41	0	0	0	0	41
Airbreathers	0	130	0	0	0	130	5	48	0	0	1	54
Hilsha	0	0	101	0	0	101	0	0	30	0	0	30
Thai sharputi	NA	NA	NA	NA	NA	NA	87	9	0	0	0	96
Marine fish	0	5	2	0	0	7	0	0	0	25	0	25
Small indigenous fish	0	288	152	0	0	440	47	265	129	15	0	457
Shrimp/prawn (small)	0	65	10	0	0	75	1	30	6	0	1	38
Other wild fish	2	58	18	0	0	78	9	53	6	0	0	68
Total fish (kg)	448	546	373	0	0	1 367	1 958	913	422	40	13	3 346
Percentage												
Major carps	77	0	23	0	0	29	64	21	15	0	0	50
Chinese carp	100	0	0	0	0	4	86	14	0	0	0	22
Common carp	100	0	0	0	0	6	57	41	0	0	2	4
Tilapia	100	0	0	0	0	0	100	0	0	0	0	1
Airbreathers	0	100	0	0	0	10	8	89	0	0	2	2
Hilsha	0	0	100	0	0	7	0	0	100	0	0	1
Thai sharputi	NA	NA	NA	NA	NA	0	90	9	0	0	0	3
Marine fish	0	71	29	0	0	1	0	0	0	100	0	1
Small indigenous fish	0	65	35	0	0	32	10	58	28	3	0	14
Shrimp/prawn (small)	0	87	13	0	0	5	1	79	17	0	3	1
Other wild fish	3	74	23	0	0	6	13	78	9	0	0	2
% of total supply	33	40	27	0	0	100	59	27	13	1	0	100

Notes: Small waterbodies include ponds and ditches; NA - not applicable.
Sources: 1991 data – Ahmed et al. (1993); 1999 data - this study.

general rate of population increase. Fish prices have shown a complex pattern of changes (Table 7.8). For example, the purchase and sale prices of native major carps have not changed in this area between 1991 and 1999, but other fish prices such as that for common carp have increased substantially.

The price of Hilsha was also much higher in 1999 than in 1991, but this species originates from outside the study area and the trend partly reflects the months of the surveys and also a more general decline in Hilsha catches. The margins earned by the fish traders were generally lower in 1999 compared with 1991. In 1991, the margins ranged from 22% to 281%, for example, small fish, air breathers and prawns were apparently sold for very large markups in 1991. In 1999, the amount traded of these types of fish had not increased and the margins were within the same narrow range as for all other fish types (Table 7.8) of 17 to 24% of the purchase price. This suggests that increased availability of cultivated fish and competition between traders due to the increased number of active traders, relative to the number of customers, has squeezed margins on the wild-caught fish that have not increased in availability.

The national level of general inflation during the period between the two surveys was about 38% (Bangladesh Bureau of Statistics), but the changes in purchase and selling prices in the Kapasia fish markets have generally shown much higher increases for wild-caught fish and lower increases for cultivated species (Table 7.9). Among the cultivated species, only common carp prices have increased at more than the general inflation rate, and in 1991 this species appeared to command a slight premium even over the average market price for major carps (the average retail price of these – Rui, Mrigal and Catla - was static for eight years in Kapasia). For virtually all types of "wild" fish, the price increases were on average around 200%. The change in price shown for prawns has

Table 7.8. Prices and market margins (in Tk/kg) by fish type in the sample markets in Kapasia

Fish type	1991				1999			
	Purchase price	Selling price	Price margin	Rate of margin (%)	Purchase price	Selling price	Price margin	Rate of margin (%)
Major carps	47.1	59.4	12.3	26	47.9	58.9	11.0	23.0
Chinese carp	22.5	30.0	7.5	33	28.5	35.2	6.7	23.7
Common carp	30.0	38.0	8.0	27	52.3	61.5	9.3	17.7
Tilapia	45.	55.0	10.0	22	45.0	52.5	7.5	16.7
Airbreathers	21.0	53.0	32.1	153	54.1	65.2	11.1	20.5
Hilsha	31.0	51.3	19.3	63	120.0	140.0	20.0	16.7
Thai sharputi	NA	NA	NA	NA	45.0	53.5	8.5	18.9
Marine fish	22.5	30.0	7.5	33	100.0	120.0	20.0	20.0
Small indigenous fish	10.7	26.9	16.2	151	37.1	45.3	8.2	22.2
Small/large prawn	7.2	27.6	20.3	281	68.0	80.0	12.0	17.6
Other wild fish	34.4	49.6	15.2	44	63.8	78.8	15.0	23.5

Sources: 1991 data – Ahmed et al. (1993); 1999 data - this study.

Table 7.9. Purchase and selling price changes (Tk/kg) between 1991 and 1999 by fish type

Fish type	Purchase price		Change in price	Inflation (% change)	Selling price		Change in price	Inflation (% change)
	1991	1999			1991	1999		
Indian major carps	47.1	47.9	0.8	1.7	59.4	58.9	-0.5	-0.9
Chinese carp	22.5	28.5	6.0	26.7	30.0	35.2	5.2	17.3
Common carp	30.0	52.3	22.3	74.3	38.0	61.5	23.5	61.8
Tilapia	45.0	45.0	0.0	0.0	55.0	52.5	-2.5	-4.6
Airbreathers	21.0	54.1	33.1	157.6	53.1	65.2	12.1	22.9
Hilsha	31.0	120.0	89.0	287.1	51.3	140.0	88.8	173.2
Thai sharputi	NA	45.0	NA	NA	NA	53.5	NA	NA
Marine fish	22.5	100.0	77.5	344.4	30.0	120.0	90.0	300.0
Small indigenous fish	10.7	37.1	26.4	246.7	26.9	45.3	18.4	68.5
Small/large prawn	7.2	68.0	60.8	839.2	27.6	80.0	52.4	190.3
Other wild fish	34.4	63.8	29.4	85.6	49.6	78.8	29.2	58.8

NA - not applicable.
Sources: 1991 data – Ahmed et al. (1993); 1999 data - this study.

been disregarded because it is not representative: in the 1999 survey, some large prawns (which have a much higher price than small ones) were recorded in this category, but none were recorded in 1991.

The reasons for the major difference in price and margin trends between cultivated fish and other species are clear in Table 7.10. While the volume of fish traded in the upazila (subdistrict) market has grown by 57% between 1991 and 1999, the trade in local (union level) markets has apparently grown by over 11 times. The upazila market has seen increasing concentration of some high-value, noncultivated fish which are marketed there, such as airbreathers; but the majority of the phenomenal growth in fish marketed in the union markets has been cultivated species.

Kapasia. The detailed fish consumption monitoring in 1998-99 reported in Chapter 5 only covered pond operators. To have a comparative perspective on changes in fishing practice and fish consumption of nonpond owners, group discussions were held in 1999 with landless and landowning people who were without ponds. Eleven group discussions were completed in six unions: five discussions with landless people and six with farmers. Finding farmers without ponds proved quite difficult.

Fishing and fish consumption trends for farmers

Focus group discussions were held with six farmer groups composed of 32 farmers. Only 3% of farmers used to catch fish regularly in 1990, 78%

Table 7.10. Average supply of fish (kg) per market day by fish type in the sample markets in Kapasia

Fish type	1991			1999		
	Upazila market (N=1)	Union market (N=14)	All (N=15)	Upazila market (N=1)	Union market (N=14)	All (N=15)
Major carps	275	9	27	320	352	350
Chinese carp	28	2	4	200	203	203
Common carp	66	1	5	30	43	42
Tilapia	3	0	<1	0	4	4
Airbreathers	31	7	9	100	19	25
Hilsha	0	7	7	50	4	7
Thai sharputi	0	0	0	100	24	30
Marine fish	0	1	<1	0	1	1
Small indigenous fish	181	19	30	120	32	38
Small/large prawn	15	4	5	10	34	32
Other wild fish	55	2	5	100	24	29
Total	655	66	40	1031	754	776

Sources: 1991 data – Ahmed et al. (1993); 1999 data - this study.

Changes Experienced by Consumers

Background

In Kapasia, floodplains and low-lying, small beels were the main sources of fish in the past, when most of the beels were perennial but had a dense growth of aquatic plants. Since the 1970s, many of the beels have silted up and came under paddy cultivation, and the area of fish habitat has declined. Up to 1990, beels were still the major source of fish in the area but the market study reported above shows a dramatic change in markets in the importance of cultured fish relative to capture fish since the introduction of aquaculture in 1991-93 by the earlier project in

caught fish 3 to 4 days in a week in the monsoon, 16%, 5 to 7 times in a month and only 3% never caught any fish. Ten years later, in 1999, 25% said they no longer fish, 16% caught fish during 5 to 7 days in a month, and 56%, 1 to 2 times a week. Fishing in open water has become more complicated due to restrictions on fishing set by the land owners. Moreover, populations of wild fish were reported to have fallen due to reduced waterholding capacity of floodplains. This is the outcome of regular siltation from the adjacent higher lands and carried in by floodwater.

Farmers said that they spend less time for fishing nowadays because fish are scarcer then before. The opportunity cost of fishing is higher than in earlier times. However, in the monsoon they still spend some of their leisure time fishing. For the

farmers' family, fishing is a kind of hobby rather than an income-earning or saving activity.

There are different ecological factors indirectly affecting fishing practices. The declining perennial water area has squeezed the fishing season compared to 10 years ago. In 1990, generally the fishing season started in late April and ended in March (almost 11 months a year), but in 1999, the season started in May and ended in January (some 7 months). Although the number of fishing areas (beels and rivers) has remained the same, per capita fish catch was reported to have decreased by about 73% during this ten-year period. The distribution (use) of caught fish has not changed, although these farmers now hardly give any of their catch to relatives (before it was about 10%).

Based on discussions, the ranking of different fish species in their floodplain and beel catches has changed little between 1990 and 1999 (Table 7.11). This ranking shows that large catfish have disappeared from the open water catch during the last 10 years. Although other species have declined, their order or ranking in importance in the total catch is little changed. Average catch per person per day was about 1 kg in 1990, but dropped to 0.28 kg on average in 1999. Meni, local Sharputi, Tatkini and Pabda have disappeared, and Khalisa, Magur, Shol and Baus have declined greatly. It is notable that all these species were reported to have disappeared after the 1998 flood. Many farmers believed fish disease is an important factor behind the disappearance.

Normally, households lacking ponds consume fish from two sources: bought from markets and their own catch. In 1990, the contribution of their own catch was 26% and the rest was bought. In 1999, the contribution of household catch fell to only 9%. These farmers, largely customers in the local fish markets, reported that the species available in the markets have changed. In 1990, about 75% of fish in the market were openwater natural fish, but in 1999, cultured fish dominated the market supply (confirming the market survey findings). Table 7.12 gives the farmers' rankings of fish types by the quantities they consume.

Overall, household sizes changed a little: members in 38% of the households increased; in 31%, they stayed the same; and in 31%, they decreased during 1990-99. However, fish consumption of these households has reportedly fallen by about 50% during this period. Silver carp is the single most consumed species now and is available at relatively low prices in all markets. The prices that farmers face (Table 7.13) are broadly consistent with the market surveys. Retail prices of small fish, snakeheads and major carps in the markets increased during the period by 95%, 67% and 69%, respectively, – the change for major carps is more than that found in the market survey.

Table 7.11. Comparative ranking by farmers of fishes in their floodplain catch in Kapasia

1990	1999
1. Small fish (Puti, Mola, Khalisa), small shrimp, etc.	1. Small fish
2. Snakeheads, etc. (Shol, Gazar, Koi, Taki, Shing, Magur)	2. Snakeheads
3. Small catfish (Tengra, Pabda, Foli, Batasi, etc.)	3. Major carps
4. Major carps (Rui, Catla, Mrigal)	4. Small catfish
5. Large catfish (Ayr, Boyal, Pangas, Rita, Chital, etc.)	
6. Shrimps (more than 4 cm)	

Source: Focus group discussion in 1999.

Fishing and fish consumption trends for landless households

Since people from different classes reside in the same villages together, it is very difficult to gather only landless people without ponds into a focus group without also having landed people around. To solve this problem landless focus groups were held in different cluster villages known as *gucho*

Table 7.12. Ranking of fish consumed by farmers without ponds in Kapasia

Rank	1990	1999
1	Small fish	Silver carp
2	Small catfish	Small fish
3	Snakeheads	Thai sharputi
4	Major carps	Major carps
5	Large catfish	Common carp
6	Shrimps	Snakeheads

Source: Focus group discussion in 1999.

Table 7.13. Fish prices (Tk/kg) reported to have been faced by farmers in Kapasia markets

Rank	1990		1999	
	Species	Tk/kg	Species	Tk/kg
1	Small fish	20	Silver carp	30
2	Small catfish	35	Small fish	39
4	Major carps	36	Thai sharputi	54
3	Snakeheads	43	Common carp	65
5	Large catfish	52	Major carps	61
			Snakeheads	72

Source: Focus group discussion in 1999.

gram in the study unions. These villages are only inhabited by landless people. The aim of the discussions was to compare fishing practices and fish consumption between 1990 and 1999, for comparison with the farmer groups reported in Chapter 7. Five group discussions with a total of 24 people were conducted in 5 cluster villages - 1 in each of 5 unions in Kapasia.

In 1990, only 4% of these people were never involved in fishing; 21%, caught fish during 5-7 days a month; 71%, on 3-4 days a week; and only 4%, more regularly during the main season. They stated that after 10 years (1999), i.e., at the time of the discussion, 29% never caught fish; 33%, during 5-7 days a month, and 38%, 1-2 times in week. None of them said that they fished more regularly. It is notable that 29% of these landless households do not now fish, as it is no longer cost-effective for them. Most of them reported they had diversified their occupations in the last 10 years: rickshaw pulling and selling labor are more profitable than fishing. About 40% of these landless households said they were marginal farmers a decade earlier, so they could spend more time for fishing and more fish could be caught then.

The small floodplain beels in Kapasia are private land. Only the river is common (public) property. Owing to increasing siltation borne by floodwater, land in the beels is now relatively higher and they dry up earlier than a decade before. The landless groups reported that more land has been converted to cultivation, reducing the fishing area and fishing season simultaneously, as was also reported by the landed households. These people do not go far to fish; they catch fish from adjacent beels and rivers. Most of them do not treat fishing as a profession but as an extra source of food and cash, and they do not have time to travel far to fish.

Table 7.14. Ranking of fish types by importance in catch of landless households in Kapasia

Rank	1990	1999
1	Small fish (Puti, Mola, Khalisa), small shrimp, etc.	Snakeheads
2	Snakeheads, etc. (Shol, Gozar, Koi, Taki, Sing, Magur)	Small fish
3	Small catfish (Tengra, Pabda, Fali, Batasi, etc.)	Small catfish
4	Major carps (Rui, Catla, Mrigal)	Indian carp
5	Large catfish (Ayr, Boyal, Pangas, Rita, Chital, etc.)	Shrimp
6	Shrimp	

Table 7.14 indicates that the landless households also have found that large catfish populations have fallen significantly during the last decade. Some species became locally extinct during this period (1990-99): Meni, Khalisa, native sharputi, Chital, Pabda and Kalibous. Like the farmers, they believed that the flood in 1998 brought fish disease to the area and caused some species to disappear.

Landless households usually employ traditional fishing gears, such as bamboo trap, *dharma jal, jhaki jal, thala jal* and hook and line. There was no change in fishing gear in the last decade and none of them reported using current nets. They spend less time fishing now, as it is not cost-effective for them. Per capita fish catch has fallen day-by-day. In 1990, the catch of landless households was on average about 0.82 kg/person/day, whereas in 1999 it was 0.22 kg/person/day.

The households consumed most of their catch; 19% was sold in local markets in 1990, but this has dropped to just 4% in 1999. The proportion of fish consumption from their own catch and from purchased sources has changed a lot in the last decade. The landless reported that in 1990, 50% of the fish they ate came from their own catch, but that this has fallen to only 11% in 1999 with 89% now purchased from local markets. The average fish consumption per landless household has declined substantially from about 425 g/day/household in 1990 to 155 g/day/household in 1999. This situation was reported to be due to reduced amounts, diversity and access to fish in the local floodplain beels.

The landless confirmed major changes in the composition of fish for sale in markets during this decade with a consequent change in their own ranking of importance of different types of fish in their consumption (Table 7.15). Consumption by landless people of other protein-rich food (meat, dal and milk) has also decreased. Their household meat consumption has reportedly fallen by 57% dal, by 59%, and milk, by 90%.

Table 7.15. Ranking of fish types by importance in consumption of landless households in Kapasia

Rank	1990	1999
1	Small fish	Silver carp
2	Snakeheads	Small fish
3	Small catfish	Thai sharputi
4	Large catfish	Major carps
5	Major carps	Small catfish
6	Shrimp	Common carp
7		Snakeheads

This indicates a desperate overall situation for protein intake among the landless in local society. Moreover, the focus groups reported that in 46% of the cases, their household size had increased in the last decade and in 42% of the cases, this had decreased, with 12% of the households remaining the same size.

The landless have continued to use the same adjacent bazaars to buy fish in the last decade. Openwater fish (wild fish) dominated the markets (rather than cultured fish) a decade before. They reported that Silver carp and Thai sharputi in particular were now competitively priced for them relative to small fish (Table 7.16), and hence their high ranking in the consumption of landless households.

Table 7.16. Fish prices paid by landless households in Kapasia

1990		1999	
Fish type	**Tk/kg**	**Fish type**	**Tk/kg**
Small fish	20	Silver carp	30
Small catfish	35	Small fish	30
Major carps	43	Common carp	60
Snakeheads	45	Snakeheads	60
Large catfish	55	Thai sharputi	35
Shrimp	30	Major carps	70

Conclusions from consumer study

Farmers and landless households use traditional fishing gears that have not changed in the last 10 years. During the 1990s, use of current nets was generally agreed to have increased in open waters in Bangladesh, but in the group discussion, nobody felt free to discuss the use of these banned nets. Fish consumption decreased between 1990 and 1999. Landed households were able to substitute meat for fish, increasing meat consumption by 40%, but the landless households had more than 50% reduction in their meat, dal and milk consumption. Landed households also reported that dal and milk consumption had fallen since they were producing less. Livestock have become more and more expensive to keep as fodder prices have risen.

Overall Impacts on Fish Supply in Kapasia

To what extent are these reported changes consistent and a product of aquaculture extension?

In 1998, in 6 unions of Kapasia, 418 out of 2 059 ponds had been under the earlier adaptive extension program undertaken by WorldFish. The area of ponds per household averaged 0.11 ha per ex-participant and 0.084 for other households. Growth in the number of ponds was about 9% per year in Kapasia during the period 1990-98. In 1990-91, 61% of the ponds were cultivated with fish but yielded only 0.55 t/ha. In 1998, 90% of the past participants were cultivating their own ponds, and overall, about 10% of the ponds were not cultivated (stocked with fish) - the ex-participants' ponds yielded 2.25 t/ha and the nonparticipants' ponds yielded 1.63 t/ha. The control area of Sreepur shows what would have happened without the earlier project: in 1991, aquaculture was similar in extent and productivity to Kapasia, but in 1998, 88% of the ponds were cultured and their average production was 1.30 t/ha.

Calculations summarized in Table 7.17 indicate that about 52 t of cultivated fish and 18 t of wild fish were produced from ponds in these unions in 1991, and that 281 t of cultivated fish were produced in the same unions from ponds in 1998 (289 t including the few noncultured ponds). In addition some 66 t of extra fish were produced from stocking beels, which the earlier project encouraged (see Chapter 6).

Most of the increased supply of cultivated fish in the markets appears to have been produced within the upazila (subdistrict), given that there was a four-fold increase in pond aquaculture production. The difference in average production between Kapasia and Sreepur indicates that a substantial part of this growth may be attributed to the earlier project. Data from the earlier project suggest that smaller ponds were selected for extension and larger ones were left out of the extension. Based on this calculation, the large increase was mainly in the number of very small ponds. Had the Sreepur trend occurred in Kapasia, then the production of fish from ponds would have been only 192 t in 1998, reflecting both lower production and less growth in pond numbers. This indicates that in 1998, about 44% of the higher aquaculture production in Kapasia could be attributed to the earlier extension project's influence over and above general extension activities and trends of adopting basic aquaculture practices within Bangladesh. Roughly 42% of the incremental growth in Kapasia pond fish production over what it would otherwise have been can be attributed to direct benefits to participants of the earlier project, the remainder being through demonstration effects on operators

Table 7.17. Estimated fish production from ponds in six unions of Kapasia before, with and without extension under the earlier project

Scenario	Category	No. of ponds/ household	Pond area (ha)	% cultured	Cultured		Noncultured	Total production (t)
					t/ha	Production (t)	Production (t)	
1991 Before extension	Participant	418	30.72	61	0.67	12.56	4.31	16.87
	Nonparticipant	627	84.62	61	0.67	34.58	11.88	46.46
	Total	1 045	126.48			51.69	17.76	69.45
1998 With extension	Participant	418	45.98	90	2.25	93.11	1.66	94.76
	Nonparticipant	627	84.62	88	1.63	121.38	3.66	125.03
	New pond	1 014	46.66	88	1.63	66.93	2.02	68.94
	Total	2 059	177.26			281.42	7.33	288.74
1998 Without extension	Participant	418	45.98	88	1.30	52.60	1.99	54.59
	Nonparticipant	627	84.62	88	1.30	96.81	3.66	100.46
	New pond	425	31.10	88	1.30	35.58	1.34	36.92
	Total	1 470	161.70			184.98	6.99	191.97

Notes: Basis of calculation for 1991: four unions: known total ponds and their area from pond census, known number of participants from 1997 resurvey and compilation of lists, average area from first year monitoring report, nonparticipants by subtraction.
Two unions added later – number of households in 1991 census was 65% of that in four unions, therefore, estimate same incidence of pond ownership, known number of participants, nonparticipants by deduction, apply same pond areas for each category as in first 4 unions.
Census in 1990 showed 61% of ponds were cultured in some way, with fish production of 670 kg/ha and 39% were not cultured and producing 360 kg/ha. The same production figure has been used for 1998 for noncultured ponds.
Calculation for 1998 with extension is based on surveys in Kapasia, adjusting for observed areas of ponds and growth in pond area of participants.
Calculation for 1998 without extension is based on 1991 ponds plus rate of growth in pond numbers observed in Sreepur, plus production levels and incidence of aquaculture found in 1998 in Sreepur.

with ponds in 1991, and induced growth in pond numbers and the use of those ponds for aquaculture. However, these gains also occurred earlier in Kapasia than the growth in pond production in Sreepur, since at least the participants of the earlier project achieved increased production by 1992.

Aquaculture has, in terms of the quantity of fish produced, helped to compensate for loss of capture fisheries in the area. However, the beneficiaries have been households with land and diversified livelihoods who have achieved increases in real incomes (mainly from non-agricultural jobs and remittances) and who gain either from producing fish (those with ponds) or from their purchasing power in the markets where they can afford to buy both cultured fish and the dwindling supply of wild fish. Similar people in neighboring upazilas have also gained since part of the Kapasia fish production is sold outside the upazila. There were estimated to be some 41 000 households in 1999 in the six unions of Kapasia studied, but only 2 059 were found to own ponds. Although the estimates of changes in fishing effort and catch made in the focus groups are not precise, they indicate a massive fall in catches of wild fish in the area – from about 90 kg/household/year to about 8 kg/household/year. This implies a loss of some 3 000 t of fish caught from floodplains and small beels per year, which is much more than aquaculture has been able to replace.

Hence, with an increasing landless population there are now a large number of people who can no longer catch as much fish from the wild as before and who now buy fish (mainly cultured species) but cannot afford as much fish as they once ate.

Chapter 8
Conclusions on Impacts of Aquaculture Research and Extension in Kapasia

Based on the assessment of aquaculture changes and practices in Kapasia Upazila following the earlier project in the early 1990s, and the comparison with experience in the control area of Sreepur Upazila as discussed in the earlier chapters of this report, the main conclusions are as follows:

1. The past recipients/participants in adaptive aquaculture technology transfer through the earlier research and development project (implemented by WorldFish) have continued their practices and in 1997-98 achieved at least as good yields as they did when they received regular advice under that project in 1991-93. Yields of the past participants were significantly higher in the later surveys than those of control farmers. However, pond operators in the control area also increased their production significantly, compared with the 1990 baseline level and did this through adopting stocking of fish based on information from mass media.
2. Pond operators (neighbors) who did not participate in the earlier project but who live in the same areas of Kapasia Upazila also achieve fish yields higher than those of the control farmers indicating a demonstration effect, but their production levels are lower than the participants.
3. Use of onfarm by-products has increased compared with the 1990 baseline survey, with previously unused and underused resources, such as cow and poultry manure contributing to aquaculture, but there is little difference in the incidence of use of onfarm resources between past extension recipients and control farmers.
4. Smaller ponds are cultivated more intensively, including higher stocking densities and excess use of onfarm resources. There appears to be scope to reduce use of some of these inputs (fertilizer and feed) in ponds so that they can be put to other more productive uses. This may be because the smaller ponds are operated by relatively well-off farmers who have limited onfarm uses for the resources, or they have not considered or are not interested in how to ensure higher marginal returns from these onfarm resources.
5. Pond operators who are more commercially oriented (i.e., who sell a high percentage of the fish they produce) achieve higher returns relative to costs, and higher yields from aquaculture.
6. The returns from pond aquaculture appear to have induced digging more ponds in Kapasia (where the earlier project worked and returns from aquaculture remain higher) than in the control area – a faster increase in the number of ponds in Kapasia.
7. Fish yields from pond aquaculture are variable and are particularly affected by floods which cause overtopping of ponds and escape of fish, as in 1998. These risks are rarely considered when predicting the viability of pond aquaculture, but will be relatively more important for smaller farmers with limited household income diversity since floods damage both aquaculture and crops. Capture fisheries have some compensating effect as there is more floodwater for wild fish to grow in, but these fisheries have declined to the extent that this can only now be a partial compensation.
8. Pond aquaculture generated positive net incomes for pond owners, but had minimal impact on participant household incomes in general as new opportunities for nonfarm income unrelated with aquaculture arose after the earlier project. The main growth in the study area has come from improved communications with the capital Dhaka and associated remittances from work outside the area, nonfarm business and high-value agribusinesses, such as fruit and poultry supplying the capital.
9. Pond-owning households tend to have relatively high incomes and prefer to buy or catch indigenous (noncultured) small fish for their own consumption while selling cultured fish (except for some households with smaller ponds that produce pond fish for their own consumption as well as buying noncultured fish for food).

10. People without ponds are now more dependent on the purchase of cultured fish in local markets rather than catching fish from seasonal common property resources (floodplains and seasonal beels). Some of the latter have come under stocking by the land owners or entrepreneurs. These efforts do not seem to be sustained in any one beel for more than a few years, but stocking by land owners or lessees results in the exclusion of the poor from subsistence fishing.
11. The relative local retail market prices of cultured fish species have fallen compared with wild (noncultured) species during the period 1990-99 in Kapasia, where because of the previous project, aquaculture production has grown more than in the control area.
12. The sustained increase in production from aquaculture in the study area has failed to compensate for the loss to landless people of access to and catches from local capture fisheries that are reported to have declined greatly over a 10-year period mainly due to drainage/siltation, conversion to agriculture and enclosure.

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