AGRICULTURAL RESEARCH PROJECT-II (SUPPLEMENT)
FISHERIES COMPONENT

FINAL REPORT

MAY 1993

Prepared by

Dr. M. V. Gupta
Aquaculture Specialist

INTERNATIONAL CENTER FOR LIVING AQUATIC RESOURCES MANAGEMENT
(ICLARM)

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EXECUTIVE SUMMARY

International Center for Living Aquatic Resources Management (ICLARM) provided technical assistance in aquaculture research since 1989 to Bangladesh Agricultural Research Council (BARC) and the NARS institutions, mainly Fisheries Research Institute (FRI), under Agricultural Research Project-II (Supplement) funded by USAID. Technical assistance included research planning, implementation of on-station and on-farm research, development of inter-institutional linkages especially with NGOs and manpower development.

Research concentrated on the development of low-cost culture systems which can easily be adopted by the rural poor. On-station experiments allowed technologies to be defined, suitable management strategies identified, and specific technical issues addressed. These were followed by on-farm trials which verified the viability of the technologies under farmers' conditions and gave valuable feedback on how they should be modified to fit farmers' circumstances and on other problems in the field.

Fish culture efforts in Bangladesh remain limited by the scarcity in availability of fish seed, due mainly to high mortalities in nurseries. The nursery management practices developed at FRI resulted in increased survivals. These results need to be tested elsewhere in the country, then modified and disseminated as appropriate.

Many perennial ponds throughout the country are underutilized, for various reasons. This project's efforts have demonstrated the extent to which production and income can be increased through appropriate management. The successful examples generated on-farm should serve as convincing evidence to many hesitant pond-owners and concerned personnel in development agencies.

Most seasonal ponds in Bangladesh are not used for fish culture, because they are not suitable for traditionally-cultured species. On-station and on-farm trials using short-cycle species have given very promising results, some of which are already being disseminated throughout the country by NGO's. Women and very poor families are more likely to have access to these water bodies, and the potential benefit for these disadvantaged groups is great.

Integrated poultry-cum-fish farming can be a highly efficient and very profitable enterprise for farmers who can afford the necessary inputs.

Integrated rice-fish farming is a low-cost enterprise, with potential for increasing incomes and nutrition of rural households. Rice-fish farming and integrated pest management activities are mutually supportive.

Investigations undertaken by Farming Systems Research Program indicated how fish culture could be incorporated into farmers' systems, optimizing resource use and increasing benefits. These research efforts need to be strengthened.

Collaboration between FRI and NGO's has been an important component of project activities. On-farm research conducted in collaboration with BRAC, has shown how researchers and extension workers can closely work together for identification of farmer's resources, problems and develop improved, sustainable practices for optimizing resource utilization.

Under the collaborative fish culture technology dissemination and feedback program, nine NGO's were exposed to technologies developed at FRI and disseminate them in various sites throughout the country. This program is not only leading to improved fish culture management by farmers, but is also providing FRI with needed feedback on the extent to which these technologies are appropriate, how they can be modified to suit different conditions, and what problems need to be addressed.

Collaboration with various government agencies has been initiated. Development and dissemination of integrated rice-fish farming has been carried out by FRI in cooperation with DAE. The Farming Systems Research Program's fish culture trials have been conducted at sites under study by BARI, SRTI, BJRI, and BRRI. Other technology development efforts have been carried out in cooperation with BLRI and Jahangirnagar University. Technology transfer activities included cooperation with FRI, DOF and BRDB.

With the support of the project, FRI held numerous trainings for government officers, NGO workers and farmers.

Over one hundred farmers' rallies to disseminate various technologies were held by FRI in cooperation with different institutions/agencies.

AGRICULTURAL RESEARCH PROJECT-II (SUPPLEMENT)
FISHERIES COMPONENT

1. BACKGROUND

The Government of Bangladesh (GOB) is implementing Agricultural Research Project II (Supplement), funded by USAID. The project is aimed primarily at strengthening the Bangladesh Agricultural Research Council's (BARC) ability to manage and service the National Agricultural Research System. The project's focus includes : (i) research management and support services, (ii) core discipline development in economics and social sciences, crop research, livestock and fisheries research, soil management, water management and pest management and (iii) farming systems research.

The International Center for Living Aquatic Resources Management (ICLARM) an autonomous, international scientific and technical center, has been requested by the GOB, to participate in the ARP-II (Supplement), to fulfill its mandate with regard to fisheries under a host-country contract with BARC. ICLARM's main task was to provide the BARC, the national implementing agency, with technical assistance in aquaculture, a core discipline given high priority in BARC's efforts to strengthen its research system, management and support capabilities. For this purpose, ICLARM is to provide the services of a resident Aquaculture Specialist. In addition, ICLARM was asked to provide home office technical support by way of short term services of its headquarter's staff in aquaculture and economics; up-to-date information on aquaculture technology and development; assistance in development and organization of training programs such as workshops, conferences, study tours and assistance in planning research and extension publications from the project.

The contract was initially for a period of 36 months, but was subsequently extended till June 4,1993. The scope of work under the contract, is detailed in Appendix-1. ICLARM initiated project operations with posting of its Resident Aquaculture Specialist in May 1989.

2. INTRODUCTION

Fisheries play an important role in the economy of Bangladesh, in terms of nutrition, income, employment and foreign exchange earnings. Fish is the main dietary animal protein source to people of Bangladesh, contributing some 80% of the animal protein intake. The sector employs 1.1 million full-time fishers. In addition, 70% of rural households or over 10 million people, are involved in subsistence fishing from open waters. In spite of its importance in nutrition, the average per caput fish consumption is only 7.9 kg per annum. This average figure does not indicate reality, as fish consumption among rural poor, who constitute 69% of the population, is very low, being only 4.4 kg per annum among low-income groups, as against 22.1 kg per annum among higher income urban population. Consumption in rural households declined from 97% of that in urban areas in 1975-76, to 75% in 1985-86. Retail prices of fish have increased faster than prices of other food commodities. Catches and per caput availability of fish are declining because of increasing demand concomitant with increasing population, increasing fishing pressure and environmental degradation. Decline in fish from open waters, on which the rural population depends, higher prices and low purchasing power of rural households are resulting in a growing class of malnourished families, especially women and children.

Bangladesh wants to improve the nutrition and incomes of its rural population through increased fish production. It is estimated that to maintain even the present low-level of consumption, fish production has to increase to 1.2 million tons, to meet the demands of the increasing population by the year 2,000, against the present production of some 0.85 million tons. This cannot be achieved with the present rate of production increase. This would mean that poor households will suffer from further protein insufficiency, unless efforts are made to increase the production.

Realizing the need for increasing fish production to meet the needs of its growing population, the Government of Bangladesh set a fish production target of one million tons by the end of Second Five Year Plan period (1984-85). Against this target, the actual production was only 751,000 tons, thus falling short of projected development. Taking this into consideration, the GOB again set a target of one million tons by the end of Third Five Year Plan (1989-90), while the actual production was only 0.85 million tons.

Available information indicates that marine catches have reached maximum sustainable yields and increasing fish production from riverine fisheries is difficult, if not impossible. In this context, there are over 1.3 million ponds and an equal number of seasonal ponds and ditches in the country. In addition, implementation of flood control, drainage and irrigation (FCD and FCDI) projects is expected to result in thousands of hectares of borrow pits. All these resources offer excellent opportunities for increased

fish production through aquaculture. Majority of households have homestead ponds and/or ditches, which are presently under or unutilized, resulting in no or little fish production due to various biotechnical, social and economic reasons. Realizing the importance of these water resources for increasing nutrition and incomes of rural households and increasing production of fish, the Government is giving importance to aquaculture technology development and dissemination. Current high-cost input aquaculture technologies are beyond the means of rural poor and hence, alternate sustainable and environmentally-sound techniques that integrate with the on-going farming activities of the resource-poor, are to be developed.

Fisheries research in Bangladesh is in its infancy. The Fisheries Research Institute (FRI) was established in 1984 and started functioning in 1986. All its scientists are young and need technical assistance for planning and implementation of programs in different fields of fisheries research. The project provided technical assistance in the field of aquaculture research and development, through assistance in planning and implementation of on-station and on-farm research programs, manpower development and publication of training and extension materials. The activities undertaken by the project and major accomplishments are presented briefly in this report.

3. RESEARCH PLANNING AND PRIORITIZATION

Fisheries research and Fisheries Research Institute are new, with limited manpower resources. At the same time, the country cannot afford costly research agendas. Problems and development potentials in the fisheries sector have been broadly known, but not well defined and translated into practicable projects. In view of this, available plans for fisheries research and development were reviewed and work done by FRI and other agencies till 1989 was evaluated. Based on this, BARC and FRI were assisted in prioritizing research programs that need to be undertaken to optimize aquaculture production, taking into consideration manpower and financial resources available to the research system. This research prioritization was approved by the Government. Subsequently, management and scientists of FRI were assisted in preparation of project proposals for each prioritized area. Scientists were trained in relevant research methodologies through training programs, workshops and on-the job training.

As a Member of the Technical Committee of BARC, the Aquaculture Specialist assisted in evaluating the research proposals submitted by different research institutions and universities for funding. Assistance was also provided to BARC, in evaluating progress of fisheries research programs.

4. ON-STATION RESEARCH

Based on the priorities identified, long and short-term (annual) plans were developed for on-station research in freshwater aquaculture. While assistance was provided in general to eleven on-station research programs of FRI in the fields of fish reproduction and hatchery management, nursery pond management, different pond production systems and fish disease, as detailed in Appendix-2, emphasis was given on research programs dealing with development of nursery management practices and different low-cost pond fish production systems, which have potential major impact on increasing incomes and nutrition of rural households and at the same time, increasing country's fish production, are described in brief hereunder.

(i) Nursery pond management :

Availability of fry/fingerlings is a major constraint for aquaculture development. Though there are some 400 small and large hatcheries in the country producing enough hatchlings/spawn to meet requirements, still there is shortage of fry/fingerlings in rural areas. This is because of low survival of fry, estimated at 25-30% in nursery ponds. To solve this problems, on-station studies were initiated with different carp species, for increasing survival through assessment of optimum densities for stocking in primary and secondary nurseries, fertilization and feeding requirements (types and quantities of fertilizers and feeds needed for optimum survival and growth of fry). These studies revealed the feasibility of increasing survival in primary nurseries to about 75% on an average even at stocking densities as high as 10 million/ha and up to 95% in secondary nurseries. These research findings will have much impact when adopted by large number of farmers, in increasing fry/fingerling availability in the country. These results need to be tested in different parts of the country.

(ii) Pond culture systems development :

Estimatedly there are over 1.3 million perennial ponds in addition to a more or less similar number of seasonal ponds/ditches. Production from perennial ponds on an average is estimated at 500-900 kg/ha/year, while seasonal ponds/ditches are mostly un-utilized except for catching wild fish. Hence, assistance was provided to FRI, for optimizing production from these different water resources as detailed below :

a) Polyculture of carps in perennial ponds :

Traditional fish culture involves releasing fry/fingerlings in pond(s), without giving due cognizance to the number and species of fish that need to be stocked. No further management, such as fertilization of ponds

or feeding of fish is undertaken, resulting in very low and inefficient production. Hence, studies were initiated to develop management practices for increasing production through use of low-cost inputs. The research undertaken for the purpose involved selection of species, species combinations and densities; types and doses of fertilizers needed; and supplementary feeding with different agricultural wastes and by-products.

These studies have revealed that against average productions of 500-900 kg/ha obtained by farmers under traditional culture system, production could be increased to 4-5 tons/ha/year, without much capital investment or operating costs. Net benefits from the operation are over Tk.100,000/ha.

b) Fish culture practices for seasonal ponds/ditches:

Presently, seasonal ponds/ditches are lying fallow, covered with aquatic weeds, causing environmental problems. Since the traditional carps do not grow well in these water resources, due to short-duration of water retention, short-cycle species - nile tilapia (*Oreochromis niloticus*), red tilapia and silver barb (*Puntius gonionotus*) were tested and production systems developed for these species. The studies have shown that it is possible to obtain productions of up to 2.5 tons/ha in 5-6 months through monoculture of these species, using agricultural waste, rice bran, as supplementary feed and cattle dung as fertilizer. Productions can be further increased to 3-4 tons/ha in 5-6 months by supplementing mustard oil cake in the feed. These results have much relevance to rural farmers, as they no more need to keep their seasonal ponds/ditches fallow, for lack of aquaculture practices suitable for the resource, and can benefit in terms of higher income and better nutrition.

c) Integrated poultry-fish farming :

Major operational costs in aquaculture are feeds and fertilizers, which account for as much as 70% of the total costs. These are the costs that deter small farmers from taking to aquaculture. Most farmers in Bangladesh raise some sort of livestock, mostly poultry. Integration of livestock raising with fish farming, in which livestock wastes are recycled in fish ponds, would not necessitate use of feeds and fertilizers in fish culture. Keeping this in view, the project assisted FRI in studying technical feasibility, economic viability and social acceptability of integrating poultry (chicken and ducks) with fish culture. Since majority of ponds are put to many uses - bathing, washing and other domestic purposes, studies were undertaken to assess the density of poultry birds that could be raised over ponds, without polluting the water. This work

revealed that 500 poultry birds/ha water area will not pollute pond water, but at the same time increase pond fish production as high as 5 tons/ha. The studies have revealed that it is feasible to raise broiler chickens or layer chickens over ponds and both operations are highly profitable, with net benefits from poultry and fish integration reaching as high as Tk 200,000/ha. Through proper management of poultry, it was possible to get 70-80% egg production in case of layers and over 5 tons of poultry meat (live weight), in case of broilers, from a one-hectare pond in one year. However, in case of ducks, raising of Khaki-Campbell ducks proved uneconomical because of low egg laying, while hybrids of Khaki-Campbell and native ducks proved more economical.

(iii) Breeding and rearing of catfishes (*Clarias batrachus and Pangasius sutchi*):

The native catfish *C. batrachus*, has high demand in Bangladesh, but unfortunately, its culture has not been taken up by farmers due to non-availability of seed (fingerlings). Though scientists at FRI were successful in breeding the species, hatching and survival of fry was very low. Hence, the project demonstrated methods for breeding *C. batrachus* that require low hormone treatment, saving considerable expenditure on imported hormones.

The scientists of FRI in their work were able to get only 60-70% fertilization and 50-75% hatching. One of the problems is simultaneous collection of milt, at the time of stripping, which has to be done by cutting open males. To overcome this problem, scientists were trained in gamete (sperm) preservation. This resulted in increased fertilization and hatching.

Only 20-30% survival of fry was obtained by scientists, and this has been increased to 68-95%. Also demonstration and training of scientists resulted in increasing survival of fry and fingerlings from about 20% to about 50-90%. A small-scale hatchery was designed and scientists of FRI and Farm Managers of Department of Fisheries (DOF) were trained in these improved practices.

Another catfish *Pangasius sutchi* was introduced into the country two years back. FRI scientists were helped in breeding this fish for the first time in Bangladesh. Due to poor water quality in Chandpur farm, all the hatchlings died.

CONSEQUENCES OF ON-STATION RESEARCH

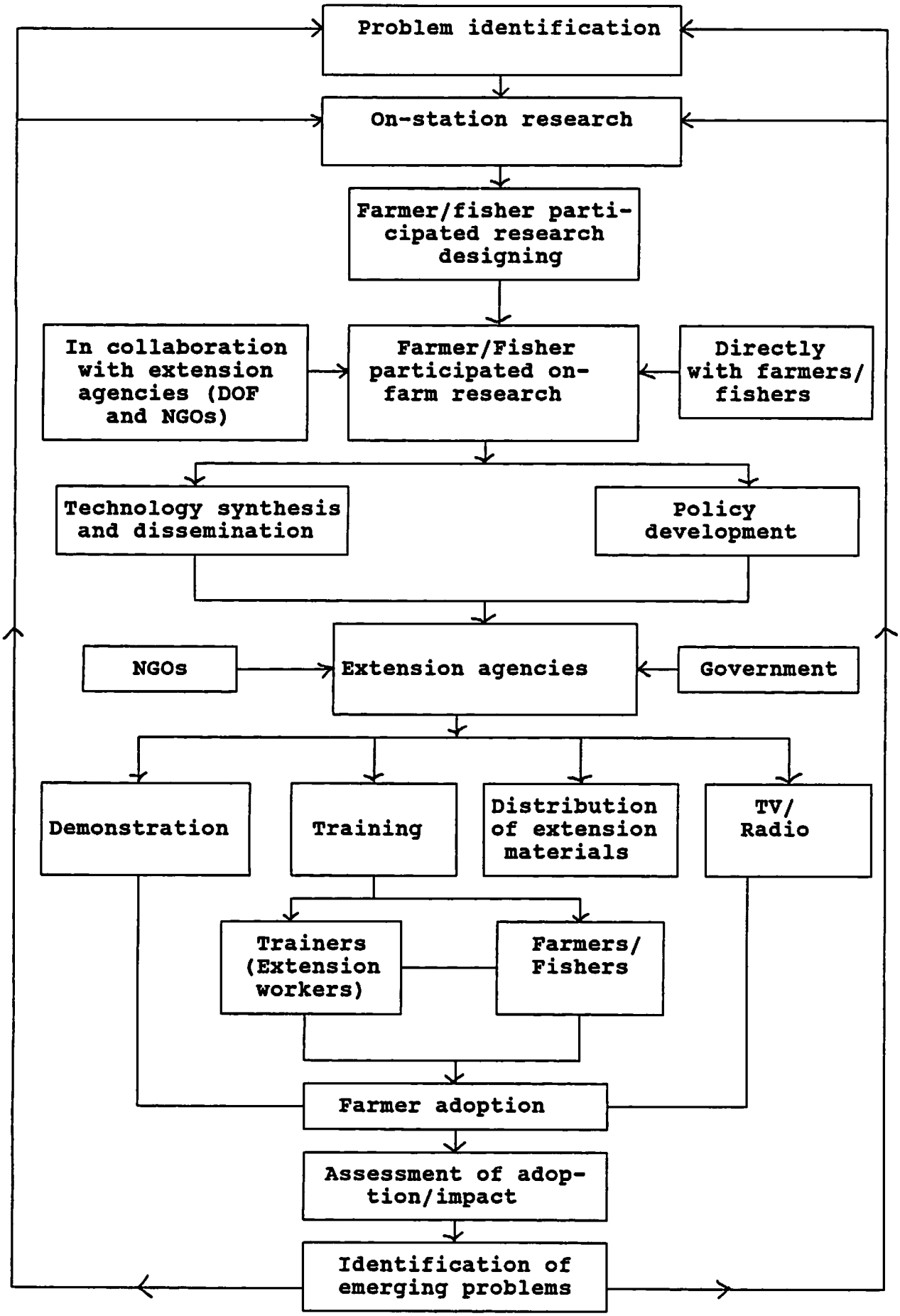
The nursery technologies developed could greatly increase the producation and availability of fry/fingerlings through out the country, given on-farm verification and appropriate modifications in different regions. Perennial pond polyculture is viable for a number of species, which can be stocked in different combinations according to availability, farmer preference and pond conditions, increasing production by 4-5 times. Hundreds of thousands of farmers whose seasonal ponds are now under-utilized can choose which of several species they prefer to culture, and obtain high productions and incomes. Integrated poultry-fish farming is highly efficient in terms of fish production and the potential for successfully raising poultry is good.

The on-station research undertaken has served a number of purposes: it has given an initial understanding of production potential, economics and problems associated with various technologies. It has enabled researchers to address technology specific questions and to answer these with confidence. Promising technologies have been indicated. **These research efforts need to be continued to improve culture systems.** The on-station research results needed subsequent verification through on-farm research before conclusions could be drawn about viability under farmers' conditions.

5. FARMER PARTICIPATORY ON-FARM RESEARCH :

Often research undertaken in the research stations do not take into consideration farmers' resources and social and economic conditions. As a result, the technologies developed fail to have impact when taken to farmers. Hence, it was necessary to involve the farmers in research and undertake studies with their participation. In view of this, the project developed a system of technology development and dissemination and feedback system as shown in the flow chart in page 8. Wherever possible, NGOs were involved in on-farm research. This involved discussion of proposed research for generation of technologies with farmers and extension agencies and taking their views into consideration in finalizing on-farm research programs. During technology generation, farmers' rally's/motivation sessions were held, wherein farmers witness different stages of fish culture practices, hear to the experience of the practicing farmer(s) and see for themselves the benefit. This farmer-to-farmer information exchange is proving to be very fruitful.

On-farm, farmer participatory research undertaken in collaboration with an NGO-Bangladesh Rural Advancement Committee (BRAC) has resulted in development of sustainable low-input technologies, as evident from the adoption of the technologies developed, by a large number of farmers throughout the country. The work undertaken under the program is given briefly hereunder :



Aquaculture technology development and dissemination mechanisms developed under the ICLARM-FRI-BARC-USAID project.

A. POND CULTURE SYSTEMS

(i) Culture of nile tilapia in seasonal ponds :

Nile tilapia was introduced into Bangladesh way back in 1974. However, the species did not get established, as no efforts were made to develop culture practices or educate farmers on how to culture the fish. Hence, subsequent to the development of management practices through on-station research, farmer participatory research was undertaken to develop a viable culture technology, using very few external inputs, but optimizing the utilization of on-farm wastes and by-products. The results have shown that by using cattle dung and rice bran as inputs, the farmers can get productions of 1-2 tons/ha after 5-6 months rearing, depending on level of inputs used. Against a market price of Tk. 35/kg, production cost worked out to only Tk. 5-6/kg, indicating very little investment needs, but high profit. A case study and cost of production and benefits obtained by 304 farmers who practiced the technology is given in Appendix 3.

This species has great potential in seasonal ponds, particularly those with poor water quality. Its resistance to ulcerative disease is an added advantage. Management of stocks to mitigate competition must be further developed and disseminated.

(ii) Culture of silver barb (Puntius gonionotus) in seasonal ponds :

Silver barb (*P. gonionotus*) locally known as "Thai sharputi" or "Rajputi" was introduced into the country in 1976, but no effort was made to develop culture techniques for the species, with the result the species was restricted to only two Government farms. On-station studies revealed the suitability of the species for culture even in turbid seasonal ponds/ditches. Hence, farmer participatory studies were undertaken in collaboration with BRAC. These studies revealed that like nile tilapia, silver barb is also a good candidate species for culture in seasonal ditches and farmers can obtain productions of 1.2 to 2.0 tons/ha in 5-6 months rearing, using on-farm inputs (cattle dung, rice bran, wheat bran, kitchen waste etc.). Through the management practices developed, it was possible for farmers to get a crop of marketable size fish (120-150 g) even in three months time. Subject to availability of seed, 3-4 crops a year could be obtained from a perennial pond and 2-3 crops from seasonal ponds/ditches. Details of the economics of the operation are given in case studies in Appendix 4.

Culture of the species in both seasonal and perennial ponds is spreading rapidly throughout the country. The modest inputs required combined with high market price for the harvested fish, make it highly attractive.

(iii) Culture of red tilapia in seasonal ponds :

One of the disadvantages observed by the farmers in culture of nile tilapia is overpopulation due to breeding. On-station studies revealed that red tilapia reproduces less and hence reaches a higher average size. On-farm studies indicated the following advantages of the species over nile tilapia in that: (i) lower fry production, (ii) higher average harvested size, (iii) easier to capture/harvest and (iv) a red color attractive to farmers. This species can reach a marketable size of 100-150 g in 3-4 months rearing. Farmers are able to obtain two crops of fish in six months, with production usually exceeding 2 tons/ha.

While large number of NGOs and farmers are interested in red tilapia culture, non-availability of seed has become a constraint and research needs to be undertaken for developing techniques for mass production of seed.

(iv) Mixed culture of short-cycle species and carps in seasonal ponds

Monoculture of tilapia and silver barb have proved to be quite profitable for the farmers. Studies were undertaken to assess whether productions could be further increased through mixed culture of these species. Productions were higher than in monoculture, and mixed culture of tilapia, silver barb, silver carp and mirror carp was found to be better because of (i) less risk of losses due to disease, (ii) diversified species for home consumption and (iii) increased production.

(v) Polyculture of carps :

Studies have indicated that production of fish from perennial ponds could be increased without using costly off-farm inputs such as mustard oil cake/fish meal, but through judicious stocking followed by fertilization of ponds with organic and/or inorganic fertilizers and feeding with rice bran. Farmers were able to get productions of 2-4 tons/ha/year, depending on input use. These studies have revealed that silver barb could be cultured along with carps, without any competition. Silver barb reaches market size in three months and farmers could have first harvest and returns in three months time.

(vi) Integrated poultry-fish farming :

The studies have indicated that it is technically feasible, economically viable, and socially acceptable to raise chicken (broiler or layer) in integration with fish culture, over ponds, saving costs on feeds and fertilizers in fish culture. Farmers were able to get fish productions of 4-5 tons/ha in one year, in addition to benefits from poultry. Economic benefits of integration can be as high as Tk. 293,000/ha in 14 months time, as can be seen from a farmers' case study detailed in Appendix 5.

Presently, availability of day old broiler and layer chicks to farmers is a constraint and for large-scale adoption of the technology, availability of chicks need to be ensured.

B. INTEGRATED RICE-FISH FARMING :

Small farmers constitute the bulk of the population of Bangladesh. Due to over-population, amount of arable land per person is decreasing. Hence, there is urgent need to improve the efficiency of utilization of limited resource base of small farmers and raise the productivity per unit area, labour and capital input. In this respect, Bangladesh's estimated 2.83 million ha of rice fields offer opportunities for integrating fish culture. Farmers in the past have been collecting wild fish from rice fields. Introduction of high yielding varieties (HYV) of rice, resulted in higher use of pesticides and insecticides, decline in catches of fish from rice fields and decline in availability of fish to rural farming families. Considering the importance of this integration to the poor, rural population, the project assisted FRI and DAE in developing sustainable integrated farming approaches. Work started in 1989 in Muktagacha and Gouripur thanas of Mymensingh district during aman season. Silver barb fingerlings were stocked in rice fields transplanted with BR 11 variety rice. In 70-90 days, farmers obtained fish productions of 58-105 kg/ha, without any additional inputs, excepting for the cost of fingerlings. As against an average cost of Tk. 1,211/ha for incorporation of aquaculture into rice plots, net benefit from integration amounted to Tk. 2,045/ha. Integration of aquaculture has given farmers an additional income of 4-21%, with an average of 13.5%.

The studies were continued during aman season of 1992 in four thanas of Mymensingh district, involving 52 farmers. The farmers dug a ditch for the shelter of fish during adverse conditions. The fields were transplanted with BR 11 or Paijam rice and stocked with silver barb and/or mirror carp. While fish culture period averaged 84 days, there was water in rice fields on an average for only 54 days, due to low rainfall. In spite of this, fish productions ranged from 15-262 kg/ha.

While additional cost to the farmer for integrating fish culture amounted to some Tk. 2,290/ha, net benefit amounted to Tk. 2,118/ha. In 67% of cases, rice yields were higher from fields stocked with fish, as compared to the plots without fish. On an average, rice yields were higher by 13% in fields stocked with fish.

A workshop attended by 64 farmers and 25 DAE officials identified the following benefits from rice-fish integration: (i) the practice is profitable, (ii) rice yields from integrated fields are higher, (iii) weed infestation is less, (iv) pest infestation is low, reducing the need for pesticides, leading to integrated pest management, and (v) water from ditches in rice fields can be used for supplementary irrigation. Thus, the workshop opined that integration of fish with rice farming, not only increases benefits to farmers, but also results in better environment, through use of less or no pesticides.

The work created much interest among farmers and the Government officials, who see a potential for increasing farmers' incomes and nutrition. The project was requested to train officials of DAE, in order to promote transfer of the technology to farmers in different parts of the country. In view of this, project assisted FRI in training to 100 DAE officials and demonstrations have been organized in 12 thanas of Mymensingh and Jamalpur districts.

Bangladesh has 10.8% of the total rice land under deepwater. About 80% of this area gets submerged upto a depth of 1-4 m. Bangladesh Rice Research Institute (BRRI) was assisted in studying the feasibility of culturing fish in this environment. Studies undertaken since 1990 in enclosures of 21 x21 x 3.5 m size and stocked with different species of carps indicated that productions as high as 4.2-6.7 tons/ha can be obtained in about six months time. Herbivores and detritutes feeders grew better than plankton feeders. However, high investment on net enclosures will be a deterrant for its adoption. It is necessary to take up culture in large areas, instead of in small enclosures, which will drastically cut down the costs and increase net benefits. This work needs to be undertaken in collaboration with NGOs.

CONSEQUENCES OF ON-FARM RESEARCH

These on-farm research programs have served to verify the viability of technologies developed, under farmers' conditions. The numerous successful examples of low-cost perennial pond polyculture generated on-farm, are helping convince both development agencies and hesitant pond-owners of the feasibility of the technology. The extent to which it can be modified to fit farmers' differing resource bases and aqua-ecological conditions requires further investigation.

The on-farm work with seasonal ponds has additional important ramifications. Given the very limited resource bases of many villagers and the small size of most seasonal ponds, higher productivity per unit area can be easily achieved from such ponds. Problems of landlessness and multiple ownership often limit the access of very poor villagers to larger water bodies. The returns from these water bodies, by virtue of their size and growing period are likely to be more attractive to poor villagers. These trials have demonstrated a number of species which can be profitably cultured in this highly underutilized resource. Farmers are free to choose according to availability, preference, and pond characteristics. The rapid spread of rajputi culture throughout the country, with the active encouragement of several NGO's, is a direct consequence of this work, and similar development initiatives are anticipated.

Access to resources and in the case of broilers, markets, imposes some hindrances to the spread of this technology. The risks inherent in beginning any new activity coupled with relatively high initial investment costs make poultry-cum-fish culture prohibitive for poor villagers, but attractive to resource-rich farmers.

Risks inherent in integrated rice-fish farming are minimal, and this has allowed farmers, extension workers, and officials to appreciate immediately the potentials associated with the technology. Given timely stocking, sufficient water, and appropriate water management, this technology should have great potential to spread among rice farmers in Bangladesh. Major limitations are likely to be associated with uncontrollable water regimes, seed fish supply, and pesticide use. Further work needs to be undertaken for refinement and dissemination of the technology.

On-farm research has provided valuable feedback to FRI on the feasibility of the technologies developed at the Institute, and how they can and should be modified to suit farmers' conditions. The participation of farmers in the management of the technologies has led to the generation of examples which are convincing other farmers of the viability of the technologies. This process should become an integral, permanent part of the activities of the Research Institute.

On-station and on-farm studies, combined with evaluation of adoption by farmers, has indicated that production and benefits per unit area can be increased with increases in input costs. However, the low-cost technologies developed through farmer-participatory research are more adoptable by resource-poor rural farmers with minimum risk, by comparison with higher-input, high output technologies. As illustrates in Table 1, returns on costs are actually higher for low-input technologies. The productions obtained are still much higher than what the farmers were getting before, and the investments required can be sustained by the farmers.

While the farmer participatory on-farm research activities have shown that fish production and farmers' incomes and nutrition could be increased through the management practices developed, for a wider impact, it would be necessary: (i) for further reduction in cost of production, through optimum utilization of on-farm inputs, (ii) to identify and solve the problems that impede wider adoption , such as, low survival of seed in nursery ponds, fish disease, (iii) to encourage involvement of women in aquaculture activities and (iv) to study socioeconomic factors that affect aquaculture adoption.

Table 1 : Productions, Costs, Net Benefit and Cost-Benefit Ratio of Nile Tilapia (*Oreochromis niloticus*) Culture in Seasonal Ponds under different management systems in Mymensingh District.

Inputs used	Production obtained (kg/ha)	Production cost (Tk./ha)	Net benefit (Tk./ha)	Cost benefit ratio
On-station				
Rice bran and mustard oil cake	3,554	51,590	72,827	1:1.41
Rice bran	2,739	27,394	54,806	1:2.00
Fertilizers	1,510	17,200	35,675	1:2.07
On-farm				
Rice bran and fertilizers	1,960	21,675	48,925	1:2.26
Farmer adoption				
Rice bran and fertilizers	1,394	9,244	30,930	1:3.34

6. FARMING SYSTEMS RESEARCH

In Bangladesh, where farmers are resource poor, and mostly depend on their farms for their total requirements, there is need for a farming systems approach, wherein farm-household-community linkages are better understood, and farmers' resources are better utilized for higher economic returns.

Farming systems research is being undertaken at 19 sites located in different agro-ecological zones of the country, by different agricultural research institutions. Till 1990, focus of research at these centres was on cropping patterns and homestead vegetable production. Water is a resource which is mostly used for domestic and irrigation purposes and could be beneficially used for fish culture without conflict with other uses, for better nutrition and incomes to rural households. With this in view, eight sites of which five are managed by Bangladesh Agriculture Research Institute (BARI), one by Sugarcane Research and Training Institute (SRTI), one by Bangladesh Jute Research Institute (BJRI) and one by FRI, representing different aqua-ecological zones, were selected for incorporating aquaculture as a component of the farming system.

Before starting the program, scientists involved in the program were trained in farming systems research methodologies. Subsequently, in consultation with farmers, extension workers and scientists, research agendas were drawn for different sites, for optimization of water resource utilization. Research undertaken in the last two years has indicated that the farmers can increase their incomes and nutrition through integration of aquaculture with other farm activities. Some of the achievements of the program are highlighted hereunder :

Tangail, situated in Brahmaputra - Jamuna floodplain, is subject to flooding. Due to risk of losing fish during floods, aquaculture was not practised by farmers. With the introduction of post-flood stocking and pre-flood harvesting and developing management practices for such a system, the farmers now are able to take to aquaculture. All the seasonal ponds in the area earlier were lying fallow and introduction of tilapia, a species which the farmers have not seen before, has resulted in farmers' taking to culture of the species using on-farm inputs.

In Faridpur, a jute growing area, majority of seasonal ponds and some perennial ponds, are used for retting jute. At this time, fish cannot be cultured due to low oxygen and high BOD levels. Studies undertaken have indicated the feasibility of culturing tilapia in these ditches/ponds, two weeks after jute retting is over. In 3-4 months rearing, farmers obtained productions of 1.0-1.2 tons/ha.

In Rajshahi, which is in the Barind area, with low and erratic rainfall, farmers are advised to dig ditches/ponds in or near rice fields, for supplementary irrigation. But the farmers are reluctant to sacrifice their land for storing water. The project has shown that these water storage reservoirs can be used for fish culture till water is used for irrigation. Through this integration, farmers can save their crops, and at the same time, are able to produce a crop of fish in 3-4 months, increasing incomes and nutrition of their families.

In Ishurdi, situated in High Ganges Floodplain, the project has been successful in introducing silver barb culture in seasonal ponds, increasing fish production and farmers' incomes. Two years ago, farmers have not seen the species, but now it is available regularly in the market. An impact survey has revealed that ponds under fish culture have increased by 50% and production has increased from pre-project production of 338 kg/ha to present production of 1,530/ha.

Besides the above, studies have indicated feasibility of increasing fish production from different water resources. However, further studies need to be undertaken, to minimize off-farm input use, integrate with other farm activities and find ways for large-scale adoption and dissemination of research results.

This program has been operating throughout the country for only two years, and a number of important questions need to be addressed. Nevertheless, the work undertaken so far has indicated the feasibility of increasing fish production through integration with other farming activities. The program should be continued in order to optimize the efficient use of farmers' resources through identification of potential opportunities, constraints, and ways of dealing with these constraints. Outstanding questions remain, and new ones will arise. Ultimately, the program should become a permanent component of NARS research, since these questions cannot be answered satisfactorily on-station, nor at only one on-farm research site.

7. WOMEN'S PARTICIPATION IN AQUACULTURE RESEARCH AND DEVELOPMENT :

Rural women constitute a vast human resource in Bangladesh. Due to religious restrictions, they are not able to undertake activities away from their households. The project has given importance for involvement of women in aquaculture research and development activities. Over sixty percent of the participants involved in on-farm research were women. The project organized regular farmers' trainings programs and rallies in villages, where practising women transfer their knowledge to other women in their villages. Since technologies developed are low-cost, low-labor intensive, and simple to implement, many women have taken to aquaculture, especially in seasonal ponds/ditches without conflict with their menfolks for resources. These project activities have caught the attention of many extension agencies, specially NGOs, who are now training and involving women in aquaculture. For example, two NGOs, BRAC and Proshika, are assisting more than 30,000 farmers in aquaculture, of which nearly 45% are women.

To cite an example of the extent to which a rural housewife who has taken to aquaculture with project assistance, was able to help her family's nutrition and income, a case study is given Appendix 6. A rural housewife has produced 41 kg of fish from a ditch of 160 m^2 and earned a net benefit of Tk. 1,525 (Tk. 95,312/ha), which is equivalent to two months earnings of her husband.

8. INTER-INSTITUTIONAL LINKAGES

The Project has developed linkages between the Fisheries Research Institute and various government and non-government research and development organizations. A joint program between FRI and Jahangirnagar University was initiated to develop aquaculture practices for large water bodies which are subject to flooding.

Collaborative farming systems research programs were initiated between FRI, BARI, SRTI, BJRI, and BRRI at different sites throughout the country.

A collaborative research project was initiated between FRI and the Bangladesh Livestock Research Institute (BLRI) for developing management practices for duck raising in integrated farming.

Linkages were developed between the FRI and DAE for the development and dissemination of integrated rice-fish farming practices.

The project has arranged trainings for DOF officers, and has developed technology transfer and feedback linkages between FRI and the Department. Trainings and technology transfer demonstrations were also arranged for Bangladesh Rural Development Board (BRDB).

9. FARMERS' RALLIES :

The project has had a hand in both organizing farmers' rallies directly, and in assisting other agencies in organizing such rallies. These rallies have been found very effective in stimulating interest among visiting farmers, who are able to see the physical layout of the fish culture operation, discuss directly with the operator, and see the production from the enterprise.

Women have made up a large proportion of the participants in these rallies, particularly those relating to seasonal ponds. Among the host farmers, both husbands and wives have explained inputs, culture procedures, and benefits.

To cite an example, prior to stocking ponds in 1992, two rallies-cum-trainings were held for seasonal and perennial pond culture. At the rally dealing with seasonal ponds, 49 women and 8 men attended; the perennial pond session was attended by eleven women and 29 men. This pattern was repeated at the mid-season rally, held three months later. This suggests that culture of fish in seasonal ponds is more appropriate for most rural women than perennial pond culture. Seasonal ponds place very modest demands on inputs, and therefore may be more affordable to women, whose access to off-farm inputs is normally very restricted.

The project has assisted in organizing over one hundred farmers' rallies and demonstrations.

10. GO-NGO LINKAGES :

Government fisheries extension services, unlike in agriculture extension, are not staffed with enough manpower, with the result, they are not in a position to service the needs of the farming community. Also, the links between Government extension department and the research institution are weak, with the result the researchers do not get feedback on the problems of the farmers. This results in the development of technologies that do not meet farmer's needs and resource base. On the other hand, a large number of NGOs are involved in aquaculture technology transfer, to address nutritional, income and employment needs of country's rural poor, and are in a position to complement Government's extension and development efforts. Hence, the project for the first time in Bangladesh, developed close links between FRI and NGOs, both in on-farm research activities, technology dissemination and feedback on new entrants.

The project initiated on-farm research activities by FRI in collaboration with BRAC, for development of sustainable, low-input, low-cost technologies that could be adopted by the poor, rural farmers. The efforts as detailed in section 5, resulted in development of aquaculture practices that could be integrated with other farming activities. Similarly, links were developed with another NGO - Mennonite Central Committee (MCC). These collaborative linkages proved beneficial in many ways: (i) The technologies developed were appropriate to farmers' needs and resource base; (ii) Confidence was created among extension workers of the viability of the technologies; (iii) Along with technologies, NGOs were able to ensure availability of needed inputs especially seed, to the farmers; (iv) Once convinced of the technology, NGOs provided credit where necessary, to the farmers; (v) The time gap between technology development and dissemination has been narrowed and (vi) Research costs have been minimized. The success of this collaboration could be judged by an example: collaborative research for culture of silver barb in seasonal ponds/ditches was started with 9 farmers in 1989, and the resultant technology has been disseminated to over 20,000 farmers in 1992, just by one NGO (BRAC) alone.

Though Bangladesh is small in terms of area, it has diversified water resources, under different ecological conditions. The technologies developed in Mymensingh area, may need minor modifications to suit different ecosystems and farmers' resources in different parts of the country. At the same time, feed-back is needed by the researchers on the performance of the technologies developed. In view of this, a technology transfer and feed-back program was initiated between FRI, DOF and nine NGOs viz., BRAC, Proshika, Caritas, Rangpur-Dinajpur Rural Service (RDRS), Unnayan Sangha, Tengamara Mohila Sabuj Sangha (TMSS), Jagoroni Chakra, Uttaran and Gandhi Ashram Trust. Under the program, 293 farmers from 19 thanas in 14 districts are involved in technology testing/demonstration/feedback program (details in Table 2). Over one thousand farmers were trained in low-input aquaculture technologies, mostly using on-farm inputs. To assess the impact of introduced technologies, bench-mark surveys

Table 2. Details of fish culture demonstrations and training programs undertaken by different NGOs during 1992-93 under Agricultural Research Project-II (Supplement).

Organization	District	Thana	No. of demonstration						Culture status	No. of farmers trained
			Perennial		Seasonal		Nursery			
			No.	Area (ha)	No.	Area (ha)	No.	Area (ha)		
BRAC	Rangpur	Mithapukur	-	-	39	2.03	-	-	Stocked	166
	Gaibandha	Palashbari	26	3.30	-	-	-	-	Stocked	187
	Rajbari	Aladdipur	2	0.32	44	2.39	-	-	Stocked	154
	Faridpur	Boalmari	24	3.09	-	-	-	-	Stocked	234
Proshika	Madaripur	Kalkini	22	4.25	-	-	-	-	Stocked	18
	Brahmanbaria	Sadar	7	1.49	10	4.05	-	-	Stocked	85
	Barisal	Sadar	11	0.70	7	0.36	-	-	Stocked	54
	Barisal	Gournadi	11	1.87	2	0.11	-	-	Stocked	43
RDRS	Lalmonirhat	Kaliganj	6	1.75	-	-	-	-	Stocked	
	Lalmonirhat	Aditmari	2	0.58	-	-	-	-	Stocked	54
	Lalmonirhat	Sadar	4	1.51	10	2.04	-	-	Stocked	
	Lalmonirhat	Hatibandha	2	0.56	-	-	-	-	Stocked	-
	Thakurgaon/ Panchagar	-	-	-	-	-	-	-	-	25
Unnayan Sangha	Sherpur	Jhinaigati	5	0.32					Stocking in progress	12
	Sherpur	Sadar	3	0.20					Stocked	
	Jamalpur	Melandoh	5	0.30	-	-	3		Stocked	
Thengramara Mohila Sangha	Bogra	Sadar	5	2.18	8	0.92	3	0.18	Stocked	32
Jagoroni Chakra	Magura	Mohammadpur	8	1.59	-	-	-	-	Stocked	64
	Jessore	Monirampur	8	1.46	-	-	-	-	Stocked	
Uttaran	Satkhira	Tala	8	2.17	7	0.85	1	0.32	Stocked	72
Gandhi Ashram Trust	Noakhali	Begumganj	2	0.58	-	-	-	-	Stocked	27
	Noakhali	Chatkhil	4	0.54	-	-	-	-	Stocked	
Total 8 NGOs	14	19	165	28.76	127	12.7	7	0.5		1,227

were undertaken and progress of the program is being monitored through monthly meetings organized at different field sites in the country, where the program is being implemented.

Involvement of NGOs has helped address some of the social and economic issues that constrain adoption and development of aquaculture. These are :

(i) Over 40% of the ponds in the country are under multiple ownership or under Government control and are unused or under-utilized. NGOs are able to organize landless people into groups and assist them in leasing these ponds for aquaculture benefiting the landless people;

(ii) Women are an important target group for these aquaculture activities and they are able to contribute to the incomes and nutrition of their families;

(iii) Access to credit is a limiting factor in rural areas. NGOs are able to provide credit to landless and small-holder farmers, without any collateral, enabling resource poor to take benefit of the technologies developed;

(iv) Theft of fish has been a constraint for aquaculture development in the past. But with group formation, and involvement of large number of people in developmental activities, this social problem has been reduced to a large extent;

(v) The program has begun to provide valuable feedback to FRI on the feasibility of the technologies in different parts of the country and on problems which should be addressed by research.

This collaborative program also indicated deficiencies on the part of the NGOs, which need to be addressed. While they are highly motivated, NGO staff often lack sufficient training in aquaculture, especially mid-and low-level staff who work directly with farmers. These extension workers should be better-equipped to provide on-the-spot advice that farmers require. Aquaculture is too often seen as an independent activity: if resource-poor farmers are to adopt it successfully, aquaculture must be considered as an integral part of the farming system. Workers must consider farmers' other activities when suggesting aquaculture practices.

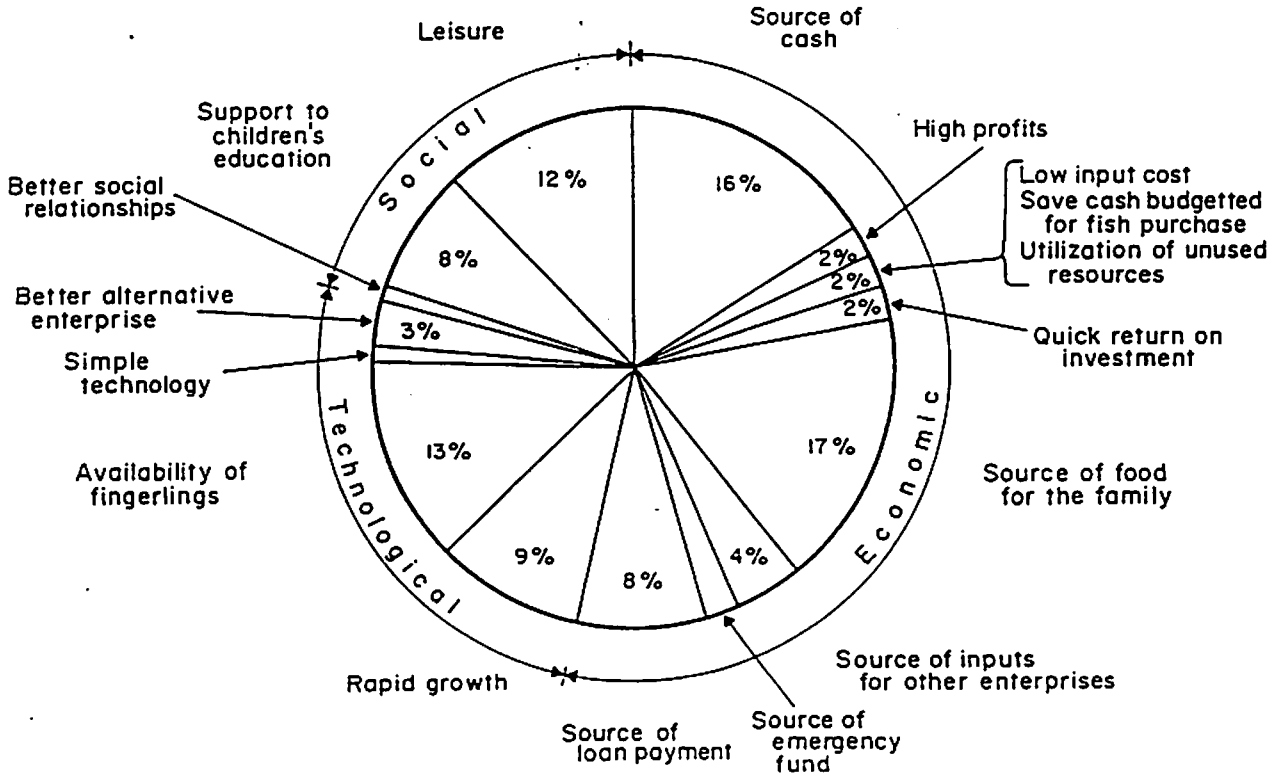
The training-feedback linkage between FRI and NGO's has begun to generate valuable lessons for both sides, but requires further support if it is to continue. As the first case of such a linkage between a government agency and an NGO, it can ultimately serve as a model for other agencies to follow, thereby making the efforts of the government agencies and the NGO's more effective and beneficial.

11. IMPACT STUDIES

Subsequent to development of a culture system and its transfer to farmers by the extension agencies, the project undertook studies to assess socioeconomic impact and farmers' assessment of the technology. These surveys are revealing: (i) the benefits the farmers are getting through implementation of the technology, (ii) constraints if any, in practising the culture system, (iii) refinements/improvements needed in the technology and (iv) policy issues involved.

Two surveys were undertaken to assess the socioeconomic impact and farmers' assessment of tilapia and silver barb culture in seasonal ponds. A survey of 113 tilapia farmers revealed that: (i) a pond of 170m^2 can produce on an average 23.5 kg of fish, which is almost equivalent to the national annual consumption of low income rural households, with six family members; (ii) 70% of the fish produced is consumed on-farm, thus improving nutrition of farming families; (iii) revenue from 23% of fish sold was enough to meet the operational costs and (iv) return on investment was 354%, indicating economic viability of the operation. Farmer's assessment of encouraging factors for culture, are depicted in Fig.1.

Fig. 1 Encouragement factors for tilapia culture as reported by farmers surveyed.



Survey of 253 farmers from ten districts who adopted silver barb culture for the first time in their seasonal ponds revealed that in spite of the use of less than 40% of suggested inputs, farmers obtained fish productions of 1,345 kg/ha, which are 74% higher than their previous productions. Forty six percent of fish produced was sold as against 31% before, indicating higher incomes and household consumption as a result of introduced technology. These surveys have identified problems involved in large-scale adoption of the technology. For example, though culture of silver barb has been well accepted by the farmers, non-availability of seed to farmers (due to low survival in nursery ponds) and susceptibility of the species to epizootic ulcerative syndrome, and lack of credit were identified as problems that need to be solved. These problems have been referred to on-station research.

12. TRAINING AND MANPOWER DEVELOPMENT

Manpower development activities undertaken by the project included both overseas and in-country training programs. While overseas training programs were organized for scientists of NARS, in-country training programs were organized for scientists, extension workers - Government and NGOs, and farmers.

In all, 83 training programs were organized, including 6 for scientists of NARS, 14 for Government trainers (extension workers), 19 for NGO trainers and 44 for farmers (Fig.2a). A total of 134 scientists, 305 Government trainers, 370 trainers from 30 NGOs and 1767 farmers were trained by the project in different aspects of aquaculture (Fig.2b). Details of training programs organized are in Appendix 7.

Scientists were trained in research planning and management, farming systems research methodologies, fisheries data analysis and socioeconomic aspects of fisheries research (Fig.2c). Guidance was provided to three scientists in their research for Ph.D degree and to ten scientists in their dissertations for M.S degree.

Overseas study tours were organized for ten senior management personnel of BARC, FRI and DOF, to Philippines, Thailand and Singapore, to study fisheries research and development activities in these countries, especially with regard to aquaculture.

Technology development itself will not help the farmers, unless the developed technologies are passed on to the clients of research viz., farmers. In view of this, the project in collaboration with FRI and BARC, organized Trainers' Training Programs to extension workers of Government organizations - Department of Fisheries (DOF), Department of Agricultural Extension (DAE) and Bangladesh Rural Development Board (BRDB); extension officers and workers of non-government organizations (NGOs);

Fig.2a. No. of training programs organized.

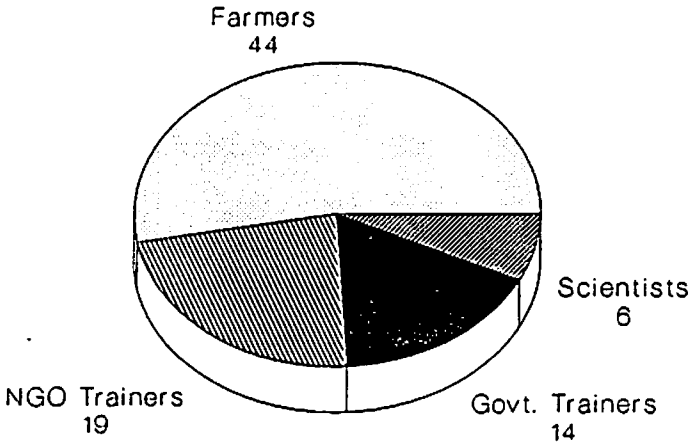


Fig.2b. Number of Scientists, Government and NGO Trainers and farmers trained.

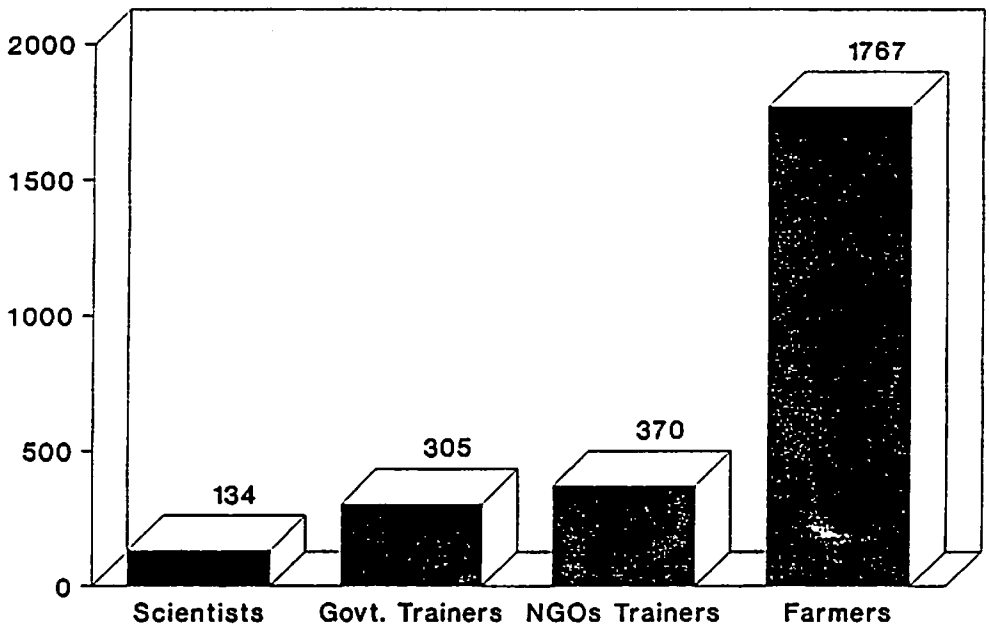
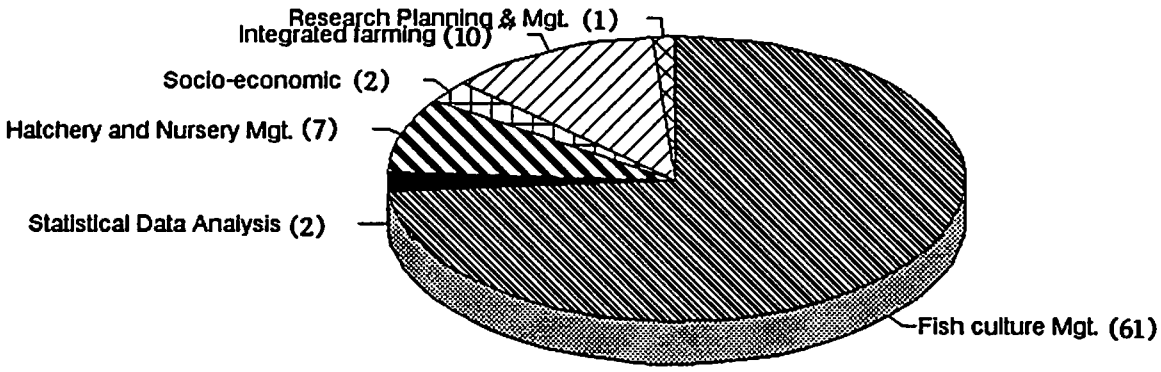


Fig.2c. No.of training programs organized on different subjects



post-graduate students and farmers, in different aspects of aquaculture. The details of NGOs, whose staff were trained are in Appendix 8. Duration of each training program ranged from one to fifteen days, depending on the subject of the training and the persons to be trained. The training involved both class room lectures and hands-on practical training in the field. The subjects covered by the training programs were: fish reproduction and hatchery management; nursery pond management; fish pond management; aquaculture technologies; tilapia culture; catfish breeding and rearing; integrated agriculture-aquaculture-livestock farming systems; farming systems research methodologies; and socio-economic aspects in fisheries research. Training manuals (in english/bengali) were prepared for each of the training program and provided to the trainees.

The project staff participated as resource persons in training programs organized by different NARS institutions.

Bangladesh Agricultural University was assisted in developing curriculum for "Aquaculture Engineering", a subject which was hitherto not given importance in the agriculture graduate program.

As Co-opted member of the Fisheries Sub-Committee of Agriculture Expert Committee appointed by the Government, to draft a curriculum for agriculture education in the country, the Aquaculture Specialist assisted in drafting a detailed course curriculum for fisheries graduate studies.

13. ASSISTANCE TO FRI DOCUMENTATION CENTRE :

The Chief Librarian of ICLARM trained the staff of FRI Library and Documentation Centre in library management. Installation by the project of ASFA CD-ROM (1978-1992 bibliographic records) in the library will facilitate and enhance the information services by providing quick and easy retrieval of fisheries and aquaculture materials published worldwide. This is the only facility for fisheries abstracts in the country.

Scientists of FRI were provided with literature searches and reprints of documents that are not available in FRI and other libraries.

14. PUBLICATION OF RESEARCH RESULTS AND EXTENSION MATERIALS :

Results of research undertaken with the project assistance were presented in various in-country and overseas workshops/seminars and published in scientific journals by the scientists of FRI and the project personnel.

To make the research results easily available to extension workers and farmers, BARC and FRI were assisted in bringing out 15 training manuals (in English and Bengali) and 7 extension pamphlets (in Bengali) on fish breeding, nursery management, different culture systems, statistical data analysis and socioeconomics. Details of training and extension manuals brought out are in Appendix 9 and 10. Over 80,000 extension pamphlets were distributed by FRI, to government and NGO extension workers and farmers. An audio-visual slide show and a video program were also produced.

15. WORKSHOPS

The project in collaboration with BARC, organized a three-day National Workshop on "Inland Aquaculture Development Strategies for Bangladesh", which was inaugurated by the Hon'ble Minister for Agriculture, Irrigation and Flood Control and attended by the Hon'ble Minister for Fisheries and Livestock and Forests and Environment. The workshop was attended by over 120 persons from Government research and development agencies, Ministries, Universities, NGOs, International Organizations, national and expatriate consultants and enterprising farmers. Potentials, constraints and strategies for development of inland aquaculture were discussed in detail in five sessions and recommendations were made to the Government (Appendix 11) for inland aquaculture development in Bangladesh. The workshop created much interest among planners and policy makers, in addition to the scientific community, and has received wide publicity in local media (Newspapers, T.V and radio; see Appendix 12).

The project provided assistance to FRI in organizing an International Workshop on "Fish Seed Production", for SAARC (South Asian Association for Regional Cooperation) countries. Also the project assisted BARC and FRI in organizing workshops on farming systems research.

16. PROCUREMENT OF EQUIPMENT

List of office and laboratory equipment procured by the project is in Appendix 13.

17. PROJECT EVALUATION

The project was evaluated by an external team of scientists appointed by USAID/BARC during 1991. Some quotes from the report:

> "ICLARM assistance has strengthened research and technology transfer by FRI. The Aquaculture Specialist provided guidance to FRI scientists on both on-farm and on-station research programs. He assisted FRI in developing excellent relationships with a large NGO: the Bangladesh Rural Advancement Committee; with commercial farmers; with FSR approaches to BARC, BARI and BRRI; and with Ministry of Fisheries and Livestock. These relationships have allowed FRI to test their technologies well beyond the limits of their staff and fisheries extension staff".
>
> The Aquaculture Specialist has done an excellent job of integrating the Fisheries Research Institute, on-farm research and field level farming systems research programs with wide scale impact. Perhaps one of the most valuable inputs has been to show the economic potential of less input projects for small pond holders in Bangladesh".

18. KEY INDICATORS, SCOPE OF WORK AND ACHIEVEMENTS

Key indicators in project document	Scope of work in contract	Achievements
1. Establishment of research priorities	Review national fishery development plan and recommend components for research	National fishery development plans and on-going research programs of FRI were reviewed and priority areas for freshwater aquaculture research identified and incorporated in FRI Master Plan
2. Preparation of research proposals at Station and farming system sites and reflected in NARP	a. Assist FRI to prepare their research project proposals	a. FRI management/scientists were assisted in preparation of project proposals and annual plans for inland aquaculture research and in implementation of these research programs.
	b. Recommend research ideas/technologies for incorporation into FRS programs	b. Through regular field visits and interaction with scientists of FRI, BARI, BJRI, SRTI, extension workers of DOF, DAE and farmers, recommended research ideas/proposals for integrating aquaculture with other farming activities, which are in place.
3. Improved aquaculture production generated	Identify potential pilot sites for appropriate production technologies and work with FRI scientists and farmers.	Working with FRI scientists, extension workers and farmers, developed low-input, sustainable aquaculture practices through on-station and farmer participated on-farm research; the technologies developed are widely accepted by extension agencies (Govt. and NGOs) and farmers and practised by over 30,000 farmers.
4. Socio-economic studies integrated with development and dissemination of new technologies; role of women.		Socio-economic studies incorporated in all research programs - which include bench-mark surveys to assess farmers resources and develop technologies that suit their resource base; economic analysis of all technologies and their sustainability; studies to assess impact of technologies on farm households and their assessment of the technology. Participation of women emphasized in technology development and dissemination. 75% of participants of on-farm research are women. Technologies disseminated to over 30,000 farmers of which 45% are women.

Key indicators in project documents	Scope of work in contract	Achievements
5. Research findings disseminated through publications and farmer field days.	Working closely with DAE, disseminated research results to farmers/fishermen.	Six technologies developed/disseminated to large number of farmers in collaboration with DOF, DAE and NGOs through training 675 extension workers and 1767 farmers; publication of 15 training manuals and 7 extension manuals; preparation of audio-visual and organization of over 100 field days/rallys.
6.	Organize workshop on inland fisheries research.	A national workshop on "Inland aquaculture development strategies for Bangladesh" organized and recommendations made to Government. Assisted FRI in organizing an international workshop on "Fish Seed Production". Assisted BARC/FRI in organizing many aquaculture and farming systems research workshop.
7.	Prepare of annual workplans.	Annual workplans prepared and implemented.

19. PROBLEMS AND RECOMMENDATIONS

A. PROBLEMS :

1. The scope of work under the contract included a great diversity of activities : research planning; on-station and on-farm research programs; farming systems research; development of linkages between Government institutions and NGOs for technology development and dissemination; manpower development - overseas study tours and large number of in-country training programs; preparation of training and extension manuals; procurement of equipment etc., all to be done mostly by a single Resident Specialist, who was joined by a Consultant only in the last year of the project. This has led to excessive work loads. Limited number of activities could have increased efficiency.

2. There is shortage of manpower in the Fisheries Research Institute, for the research programs undertaken. The Institute is not able to fill up vacant positions due to lack of funds. Action needs to be taken to resolve the problem.

3. Since July 1992, FRI did not have any budget for research expenses and is depending on sale proceeds to keep research going on a low-key. Unless this problem is resolved, gains made so far will be lost due to lack of continuity.

4. Coordination needs to be improved between different Government institutions (e.g. BARC, FRI, DOF, DAE).

5. Farming Systems Research is being undertaken on an ad-hoc, yearly-to-yearly basis without any commitment of funds on a long-term basis by the Government or the donor(s). Morale of scientific staff is very low because of short-term (one year) appointments.

B. RECOMMENDATIONS

1. On-farm, farmer participatory research undertaken by FRI through project initiative has resulted in development of sustainable, low-input technologies and this initiative needs to be sustained, through creation of an on-farm research division in the Institute.

2. Long-term plans need to be drawn up, supported by manpower and funds, if the farming systems research has to be meaningful and fruitful.

3. Linkages being developed between FRI and NGOs for technology development, dissemination and feedback, are bearing fruits and this work needs to be continued and strengthened for dissemination of FRI research results by NGOs and feedback to the Institute. The linkages developed could be used as a MODEL by other NARS institutes.

4. Timely delivery and utilization of budget should be given priority for efficient implementation of research proposals. In the absence of a development project, FRI is mostly depending on PL 480 funds, and relevant authorities may consider increased allocation till World Bank funded project is implemented.

5. Integrated rice-fish farming has potential of benefiting many rice farmers. Hence, the work initiated earlier should be continued in different parts of the country through collaborative programs with DAE, DOF and NGOs. Collaboration between integrated rice-fish farming program and integrated pest management efforts is desirable, since the two practices are compatible and mutually supportive.

APPENDIX-1.

APPENDIX 1

SCOPE OF WORK

ICLARM's Role

ICLARM has been requested by the Government of Bangladesh to participate in the Bangladesh Agricultural Research Project Supplement. ICLARM's main task is to supply the Bangladesh Agricultural Research Council (BARC) with technical assistance in aquaculture, a core disciple given high priority in BARC's efforts to strengthen its research system management and support capabilities.

For this purpose, ICLARM will provide the services of a Resident Aquaculture Specialist for a period of 36 months. In addition, ICLARM will provide home office technical support by way of :

a) The short-term services of ICLARM headquarters staff in aquaculture and economics. These short-term services are expected to amount to approximately seven-man-months per year to be accomplished in Bangladesh as well as in ICLARM Headquarters, Manila. They will include technical backstopping on research methodology; advice on data collection, data handling and processing and the interpretation of results; and appraisals of future research directions and development strategy.

b) Information services to ensure that the Aquaculture Specialist and his counterparts in Bangladesh are provided with the most up-to-date information regarding aquaculture technology and development relevant to the work being undertaken there;

c) Assistance in the development and organization of training programs such as workshops, conferences and study tours, and study periods at ICLARM headquarters in Manila, Philippines; and

d) Assistance in planning research and extension publications from the project.

A. General responsibilities

The Aquaculture Specialist will assist the Bangladesh Agricultural Research Council (BARC) and the Fisheries Research Institute (FRI) coordinate and prioritize research on inland fisheries production systems in Bangladesh. The Aquaculture Specialist will devote approximately 50% of his time with BARC and FRI and the other 50% of time in the field designing, monitoring and evaluating FSR activities. It is important that the Specialist be able to effectively coordinate his work with BARC, FRI and the Ministry of Livestock and Fisheries Sector. The Aquaculture Specialist will assist in coordinating a linkage between the International Center for Living Aquatic Resources Management (ICLARM) and BARC/FRI. He will assist ICLARM and BARC/FRI scientists in developing and introducing aquaculture into Bangladesh's farming systems research programs and assist BARC/FRI scientists in research methodologies and training.

B. Specific responsibilities

- Review the FAO/BDG 20 year (1985-2005) National Fishery Development Plan and recommend support for selected components of research and training to BARC, FRI and USAID;

- Working closely with the coordinator of the Field Specialist Team and other members of the Team, recommend specific research ideas/technologies that could be incorporated into the farming systems research programs;

- Identify potential pilot sites to carry out rice-cum-fish culture, cage/pen culture or other appropriate production technologies and work with FRI scientists and farmers at these pilot sites;

- Recommend measures for implementing short-term and long-term programs on fisheries research, specially as these programs relate to farming systems in Bangladesh (i.e. training and workshops);

- Assist BARC/FRI to prepare their research project proposals and experiments on fisheries;

- Work closely with the Department of Agricultural Extension (DAE) in disseminating research results to farmers and fishermen and livestock producers;

- Provide technical guidance to all Farming Systems Research sites when requested through the Field Team Coordinator;

- With assistance from the Communications Specialist and Field Team Coordinator, arrange one international and one national conference/workshop on inland fisheries research; and

- Prepare annual and financial work plans in collaboration with counterparts from BARC, FRI and the Field Team Coordinator.

APPENDIX-2.

APPENDIX-2.

ON-STATION RESEARCH PROGRAMS OF FRI FOR WHICH PROJECT PROVIDED ASSISTANCE IN PLANNING AND IMPLEMENTATION

1. Carp reproduction and hatchery systems management;
2. Development of nursery pond management practices;
3. Breeding and culture of indigenous and introduced small size fish species;
4. Breeding and culture of magur (*Clarias batrachus*);
5. Polyculture of cultured species for optimization of pond production;
6. Polyculture of carps and shrimp;
7. Development of integrated livestock-fish farming practices;
8. Integrated agriculture-aquaculture farming systems;
9. Culture of catfish *Pangasius pangasius*;
10. Culture of fish in pens and cages; and
11. Pond culture of freshwater prawn (*Macrobrachium rosenbergii*)

APPENDIX-3.

APPENDIX-3.

UTILIZATION OF FALLOW, SEASONAL DITCHES/PONDS FOR FISH CULTURE

CASE STUDY OF A TILAPIA FARMER

Bangladesh is strewn with hundreds of thousands of seasonal ponds/ditches/road side canals which retain water for short periods of 4-6 months. Presently, these water areas are not put to any use and often are covered with abnoxious weeds like water hyacinth, forming breeding grounds of mosquitoes and an eye sore to passers-bye. These presently un-utilized water areas could be beneficially brought under aquaculture and could provide much needed animal protein to the under nourished rural population. Aquaculture in such waters can not only provide nutrition, but can also provide additional income to the rural poor.

Mr. Jashimuddin is a landless farmer of Boilor union in Trishal upazila of Mymensingh district. He has a family of 4 members - a wife and three children. He works as a rickshaw puller and gets a net income of Tk. 25-30 per day after paying the rent of rickshaw he hires. He is hardly able to feed the five mouths of his family members. He has no land to cultivate, excepting for a small hut to live in. Adjacent to his house is a ditch of 3 decimal (120 m^2), which was formed when earth was taken for house building. It retains 40-80 cm of water for about 4-5 months during the rainy season. It was fully covered with water hyacinth (Plate 1). When he heard that technology is available for raising tilapia (Oreochromis niloticus) in such waters, he approached for assistance. In collaboration with a NGO - Bangladesh Rural Advancement Committee (BRAC), he was opted as a cooperator farmer. The Fisheries Research Institute with the assistance of the ICLARM Aquaculture Specialist of Agricultural Research Project II (Supplement), provided advise to Mr. Jashimuddin, while BRAC provided necessary inputs (fingerlings and feed-rice bran) on credit to him. He cleared water hyacinth and released 240 tilapia fingerlings in the ditch (Plate 2).

Plate 1. Mr. Jashimuddin's ditch covered with water hyacinth before initiation of tilapia culture.

Plate 2. Mr. Jashimuddin's pond under tilapia culture, after clearing of weeds.

After stocking fingerlings, as per suggestions of the project, he regularly gave rice bran as feed to fish in the pond. His face used to be lit with happiness when he sees the fish feeding on rice bran. He caught fish from time to time after 3 months of stocking for his home consumption and finally all fish were netted out when the ditch dried out after 4.5 months in December 1989.From a ditch of 3 decimals (120 m^2) which was not yielding anything before, he harvested 25.5 kg of fish in 4.5 months (2,125 kg/ha/ in 4.5 months) (Plate 3).

Plate 3. A bountiful harvest of tilapia.

Since water hyacinth was cleared for growing fish, the ditch was clean after harvesting of fish. He took advantage of this and in January '90, he planted pajam paddy in the ditch (Plate 4). The crop was harvested during second week of May 1990. As soon as the ditch accumulates atleast one foot of rain water, Mr. Jashimuddin will start tilapia culture again. Thus, Mr. Jashimuddin was able to get a crop of fish and a crop of rice from a ditch which was not yielding anything before.

Plate 4. Boro crop in ditch after harvesting of tilapia.

The average per capita consumption of fish in Bangladesh is estimated at 7.9 kg/year. Though separate figures are not available for different strata of people, fish consumption amongst landless farmers who have no purchasing power, is expected to be very low. Against the national average per capita consumption of 7.9 kg/year, Mr. Jashimuddin from his small ditch using very little inputs was able to produce 25.5 kg of fish in 4.5 months which works out to 5.1 kg/4.5 months/family member.

If what Jashimuddin has done can be brought to the knowledge of other farmers in the country, large seasonal areas could be brought under aquaculture using low input technologies, resulting in nutritional and economic upliftment of rural landless and marginal farmers. With the project and BRAC assistance, already 304 farmers have taken to this technology in 1989 and efforts are being made to transfer this technolgy to a larger number of farmers in different parts of the country, during 1990.

Economics of tilapia culture operations undertaken by Mr. Jashimuddin in his ditch are given in attachment 1. These calculations does not include benefits he got from the crop of paddy.

This low input technology is so simple, it could be easily undertaken by rural women without the assistance/involvement of men. Preliminary assessment of costs and returns of culture operations undertaken by 304 farmers is given in attachment 2. As could be seen, out of 304 farmers involved, 97 or 32% were women.

ECONOMICS OF TILAPIA FARMING USING LOW INPUT TECHNOLOGY

A low input technology using rice bran as a feed has been developed for culture of tilapia in seasonal ponds/ditches which hitherto were lying fallow. The technology is being transferred to farmers through collaborative efforts with a NGO - the Bangladesh Rural Advancement Committee (BRAC). The technology was transferred to 304 farmers, covering 309 ponds. Economics of the operation is detailed below :

Area covered: Trishal, and Fulbaria upazilas of Mymensingh district.

No. of farmers covered: 304
No. women farmers : 97 (32%)
No. of ponds/ditches : 309
Average size of pond/ditch : 5.60 decimal (224 m^2)

Cost of production per decimal (40 m^2):

Item	Quantity (kg)	Cost (Tk)
Lime	0.37	2.34
Inorganic fertilizer	0.11	0.58
Organic manure	8.51	1.62
Feed - rice bran	12.60	13.65
Fingerlings	78.67 nos.	14.96
Labour	0.23	6.43
Lease of pond/ditch	--	9.86
Total costs		Tk. 49.44

Average cost of production: Tk. 49.44/decimal
or Tk. 12,360/ha

Average production : 5.05 kg/decimal/6 months
or : 1,262.50 kg/ha/6 months

Average return : Tk. 141.40/decimal/6 months
or : Tk. 35,350.00/ha/6 months

Average net profit : Tk. 91.96/decimal/6 months
or : Tk. 22,990/ha/6 months

APPENDIX-4.

CASE STUDIES OF THAI SHARPUTI (*PUNTIUS GONIONOTUS*) CULTURE IN SEASONAL PONDS

NAME	:	Mr. Momtaj Ali
VILLAGE	:	Danikhola, Boilor
UPAZILA	:	Trishal, Mymensingh
SIZE OF POND	:	360 m^2 (9 decimal)
NO.OF FINGERLINGS STOCKED	:	540 nos (15,000/ha)
AVERAGE SIZE OF FINGERLINGS	:	8.0 gm
DATE OF STOCKING	:	20.5.90

INPUTS USED

Item	Quantity (kg)	Cost (Tk.)
Lime	10.00	40.00
Cattledung	40.00	20.00
Poison	60.00 tab	63.00
Supplementary feed (rice bran)	183.00	234.00
Urea + TSP	11.00	55.00
TOTAL INPUT COSTS		**412.00**

DATE OF HARVESTING	:	**12.12.90**
CULTURE PERIOD	:	**6 months**
AVERAGE WEIGHT OF FISH	:	**120.81 gm**
SURVIVAL RATE	:	**90%**
QUANTITY OF FISH HARVESTED	:	**59.20 kg**
FISH PRODUCTION/HA	:	**1,644.50 kg/ha/ha/6 months**
SALE PRICE OF FISH	:	**Tk. 40.00/kg**
REVENUE FROM SALE OF FISH	:	**Tk. 2,368.00**
NET PROFIT	:	**Tk. 1,956.00**
	OR	**Tk. 54,334.00/ha/6 months.**

CASE STUDIES OF THAI SHARPUTI (*PUNTIUS GONIONOTUS*) CULTURE IN SEASONAL PONDS

NAME OF FARMER : Mr. Abdul Salam
VILLAGE : Trishal
UPAZILA/DISTRICT : Trishal, Mymensingh

SIZE OF POND : 160 m^2
FINGERLINGS STOCKED : 240 nos. (15,000/ha)
AV. SIZE OF FINGERLINGS : 8.0 gm
DATE OF STOCKING : 2.5.90

INPUTS USED :

Item	Quantity	Cost(Tk.)
Lime	4.0 kg	20.00
Chicken manure	60.00	30.00
Fingerlings	240 nos	72.00
Supplementary feed (rice bran)	95.0 kg	114.00

TOTAL COST OF PRODUCTION : Tk. 236.00

DATE OF HARVESTING : 2.09.90

CULTURE PERIOD : 4 months

AVERAGE WEIGHT OF FISH : 99.2 gm

TOTAL WEIGHT OF HARVESTING FISH : 23.0 kg

SURVIVIAL RATE : 96%

FISH PRODUCTION/HA : 1,437.50 kg/ha/4 months

SALE PRICE OF FISH : Tk. 50.00/kg

REVENUE FROM SALE OF FISH : Tk. 1,150.00

NET PROFIT : Tk. 914.00 from 160 m^2 in 4 months

OR Tk.57,125.00/ha/in 4 months

APPENDIX-5.

APPENDIX-5.

CASE STUDY OF AN ENTERPRISING AQUACULTURIST

Mr. Md. Shahidullah Bhuiyan of Chakrampur in Trishal upazila, is an unemployed youth, in search of innovative ideas to make a living. He has a big family of 11 members - father, mother, 3 brothers and 5 sisters. He started raising fingerlings in family's small backyard pond, but failed to get any profit. At this time, he approached the project for assistance and was given one week training at Fisheries Research Institute (FRI) in integrated fish farming. With his zeal and enthusiasm, he was taken as a cooperator farmer, for on-farm trials of integrated farming.

With the technical assistance (no financial assistance from project), he initiated integrated broiler-fish farming in September, 1989, in his backyard pond of 1000m^2. A small shed using bamboo and straw was constructed above the pond for housing chicken (Plate 1). The pond was stocked with fingerlings of carps - catla (Catla catla), rohu (Labeo rohita), mrigal (Cirrhinus mrigala), silver carp (Hypophthalmichthys molitrix), grass carp (Ctenopharyngodon idella) and mirror carp (Cyprinus carpio). Fifty broiler chicken are being raised in the shed constructed above the pond (Plate 2). The chicken are fed with feed formulated

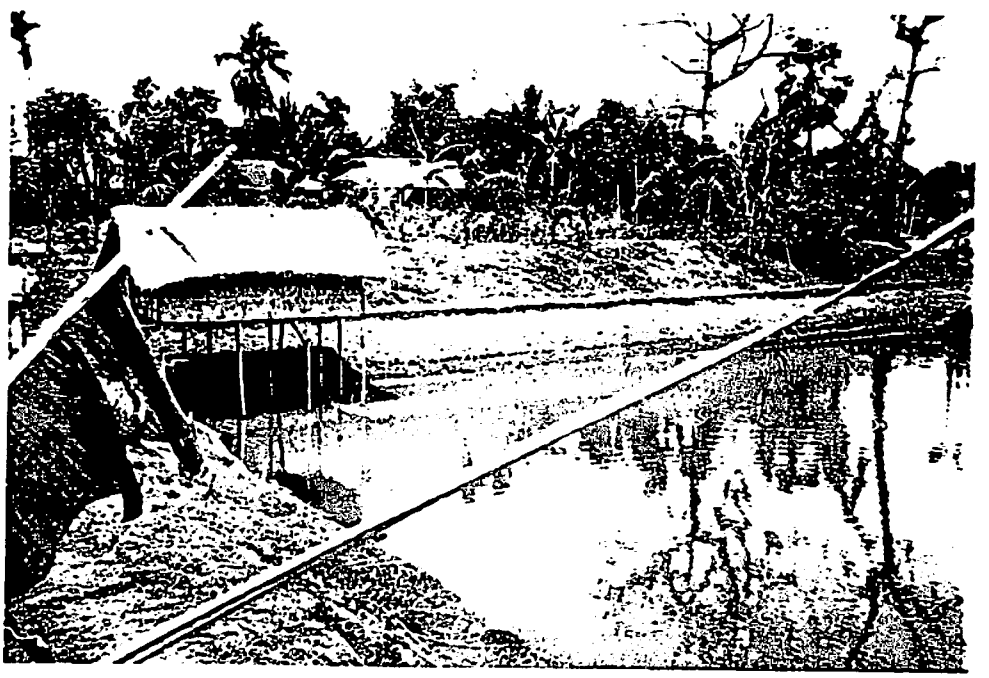


Plate 1. Chicken shed over pond in integrated farming

from locally available ingredients such as wheat bran, rice bran, broken wheat, sesame oil cake and fish meal. Fish in the pond are not given any supplemental feed nor the pond water fertilized excepting for the excreta of chicken and spilled chicken feed falling into the pond. The chicks reach marketable size of 1.4 - 1.8 kg each in 7 - 8 weeks rearing (2 weeks in brood house and 6 weeks on pond).After 14 months

Plate 2. Broiler chicken being raised over pond

of rearing, Mr. Shahidullah harvested the pond and obtained a total of 566 kg of fish (Plate-3). Some of these fish he sold as brood fish to hatcheries and the others for table purpose, to local vendors. He obtained a total revenue of Tk. 19,800 from sale of fish. Taking into consideration that he has spent Tk. 1,080 on fish culture towards cost of fingerlings, lime and labor for harvesting, it leaves him a net profit of Tk. 18,720 from fish culture in 14 months time. Mr. Shahidullah raised 400 chickens in 8 batches, of which 392 survived to rearch market. He spent a total of Tk. 20,718 on chicken raising in 8 batches or about Tk. 2,500 for each batch (annex-1). He sold the chicken at an average price of Tk. 46/kg (live weight) and earned a revenue of Tk. 31,301, leaving a net benefit of Tk. 10,589 from chicken raising. Thus, Mr. Shahidullah was able to make a net benefit of Tk. 29,309 from the integrated poultry fish farming from a backyard pond of 1000 m^2 (or Tk. 293,090/ha/14 months). Tk. 20,718 he spent on raising 8

batches of broiler chicken may look much, but that was not his investment. For each batch of chicken, on an average he spent out Tk. 2,500 and obtained a net benefit of Tk. 1,300 per batch, which he invested for raising subsequent batch of chicken.

Plate 3. A bumper crop of fish

This profitable venture made him to think of using 8 acre beel adjacent to his house for integrated aquaculture-livestock-agriculture farming. The ownership of the beel is invested in 12 partners and was leased to him for Tk. 40,000 for 4 years. He constructed a poultry house in the beel for 450 broilers and released carp fingerlings in the beel (Plate 4). The beel gets flooded for six months (May - November), after which a crop of boro paddy is raised during December - May. Only 0.5 acre area of beel retains water all through the year. Mr. Shahidullah has sold over 3,000 broiler chicken so far, from this enterprise, making a net profit of about Tk. 50,000. He leased the fishing rights for one month in the beel to a fish merchant in April 1990, for Tk. 28,000, hoping what he is getting is a good return. But he was dismayed when the fish merchant harvested fish worth Tk. 80,000 in one month's time. Subsequently, Mr. Shahidullah further harvested fish worth Tk. 8,000, bringing the total amount of fish harvested from 8 acre beel to Tk. 88,000. Earlier to this, annual fish yield from the beel

Plate 4. Poultry shed in the beel

was worth only Tk. 25,000. Further, Mr. Shahidullah says that yield of boro crop from the beel is much better than in other years, as poultry droppings falling into the beel has not only given a good crop of fish but also acted as a fertilizer for the crop (Plate 5).

Plate 5. A good boro crop from beel in integrated aquaculture - agriculture - livestock farming

APPENDIX-6.

Mr. Shahidullah seeing further opportunities for aquaculture and demand for fingerlings in the area, leased three ponds near to his house and is raising fingerlings of carps. Now, Mr. Shahidullah is a busy man, with his operations of raising fingerlings, table fish and chicken. He even developed a marketing net work for his broilers. He sells the dressed chicekn to shops in Dhaka.

PRODUCTION ECONOMICS
OF
INTEGRATED BROILER - FISH FARMING

NAME OF FARMER : Mr. Md. Shahidullah
VILLAGE & UPAZILA : Chakrampur, Trishal
POND SIZE : 1000 M^2

BROILER FARMING

NO. OF BROILERS/BATCH : 50
NO.OF BATCHES RAISED IN 14 MONTHS : 8
TOTAL NO. OF CHICKEN RAISED : 400
REARING PERIOD / BATCH : 7-8 weeks
NO. OF CHICKEN SOLD : 392
SURVIVAL : 98%

PRODUCTION COSTS:

ITEM	QUANTITY	COST (TK.)
Chicks	400 Nos.	6,000.00
Feed	1,738.00 Kg	13,468.00
Fuel	--	250.00
Cost of chicken shed (Total cost 2,000; longivity 2 years)	--	1,000.00
TOTAL PRODUCTION COSTS		**20,718.00**

TOTAL LIVE WEIGHT OF CHICKEN SOLD : 680.60 Kg
AVERAGE SALE PRICE OF LIVE CHICKEN : Tk. 46.00/KG
TOTAL REVENUE FROM SALE OF CHICKEN : Tk. 31,307.00
NET PROFIT FROM CHICKEN RAISING IN 14 MONTHS : Tk. 10,589.00

FISH CULTURE:

NO. OF FINGERLINGS STOCKED : 600 (6,000/ha)
SPECIES & RATIO : Catla 10%; silver carp 35%; rohu 25%; mrigal 20%, grass carp 5% ; mirror carp 5%.

COST OF FINGERLINGS : Tk. 600.00
COST OF 20 KG LIME : Tk. 80.00
FISH HARVESTING COSTS : Tk. 400.00
TOTAL OPERATIONAL COSTS FOR FISH CULTURE : Tk. 1,080.00
TOTAL FISH HARVESTED : 566.0 KG/POND
OR : 5,660 KG/HA

TOTAL REVENUE FROM SALE OF FISH : Tk.19,800.00
NET BENEFIT FROM FISH CULTURE : Tk.19,800-1,080 = 18,720.00

TOTAL NET BENEFIT FROM INTEGRATED SYSTEM : Tk. 10,589.00 + 18,720.00 = Tk. 29,309.00/1000 m^2 pond

OR Tk. 293,090.00/ha/14 months

INVOLVEMENT OF RURAL WOMEN TO INCREASE FAMILY INCOME AND NUTRITION THROUGH AQUACULTURE IN HOMESTEAD PONDS/DITCHES

A CASE STUDY

Bangladesh abound with vast seasonal and perennial waters in the form of ditches, ponds, road side canals, borrow pits etc., which are either un-utilized or under-utilized. Not only that these waters are un-utilized, but also they pose potential health hazards as they are covered with abnoxious aquatic weeds (Plate 1) and form the breeding grounds of mosquitoes.

In a country like Bangladesh where over 60% of population live in rural areas under absolute poverty, with no purchasing power, and very low protein intake leading to malnutrition, these waterbodies hold tremendous potential for aquaculture of short-cycle species like silver barb and or tilapia in seasonal ponds and carps in perennial ponds. Culture of these species in presently un-utilized or under-utilized ditches/ponds can not only lead to increased intake of animal protein in rural areas, with the resultant

Plate 1: Ditches, valuable resource for aquaculture, covered with abnoxious water hyacinth, posing health hazard.

improved health, but can also generate additional family income and employment. Small-scale aquaculture can often be integrated with farming operations, with wastes from farming activities used as inputs for the aquaculture.

The Fisheries Research Institute with the assistance of Bangladesh Agricultural Research Council (BARC), United States Agency for International Development (USAID) and the technical guidance of ICLARM Aquaculture Specialist through Agricultural Research Project II (Supplement), has developed technologies for utilizing these seasonal water areas. The technologies developed are so simple in terms of technical aspects, low inputs and labour needed, that they could be implemented by the rural women folk without diverting the efforts of men who are involved in agriculture. Thus, the rural women with their involvement in aquaculture activities, could reduce the burden on men for providing nutritious food to their families and improve the health of family members through increased animal protein intake and to a certain extent increase the family income.

The technologies developed are being transferred to rural farmers with the assistance a number of NGOs like Bangladesh Rural Advancement Committee (BRAC), Proshika, CARITAS, Mennonite Central Committee (MCC),Rangpur Dinajpur Rural Service (RDRS), Tengamara Mohila Sabuj Sangha (TMSS), Uttaran, Unnayan Sangha, Jagorani Chakra, Gandhi Ashram Trust etc.

To high light the benefits the new technology could provide to rural population, case study of a rural woman who has taken advantage of this technology developed by the project is given below :

Ms. Nur Banu is a housewife living in Rampur union of Trishal Upazila, Mymensingh district. Her husband working in their meagre land is not able to generate enough income to meet the demands of the hungry mouths of the family. She was keenly looking for ways and means to help her family. Ms. Nur Banu has a small ditch/pond of 4 decimal (160 m^2) in her backyard where she tried to raise Indian major carps - catla (Catla catla), rohu (Labeo rohita) and mrigal (Cirrhinus mrigala), but failed, as the fish could not reach table size after a period of 2 years. When she came to know that technology is available for raising Thai Sharputi in shallow ponds, she approached FRI/BRAC, who were more than willing to provide assistance in introducing her to aquaculture and at the same time use her as a resource person to teach other women in the area. In addition to fish culture, she was assisted in raising 20 broiler chicken and a homestead vegetable garden, for better utilization of all her farm resources.

She applied 3 kg of lime in her pond and released 250 fingerlings of Thai sharputi (average 5 cm in length). Subsequent to stocking, she fed the fish daily with rice bran, an agricultural bi-product which is readily available

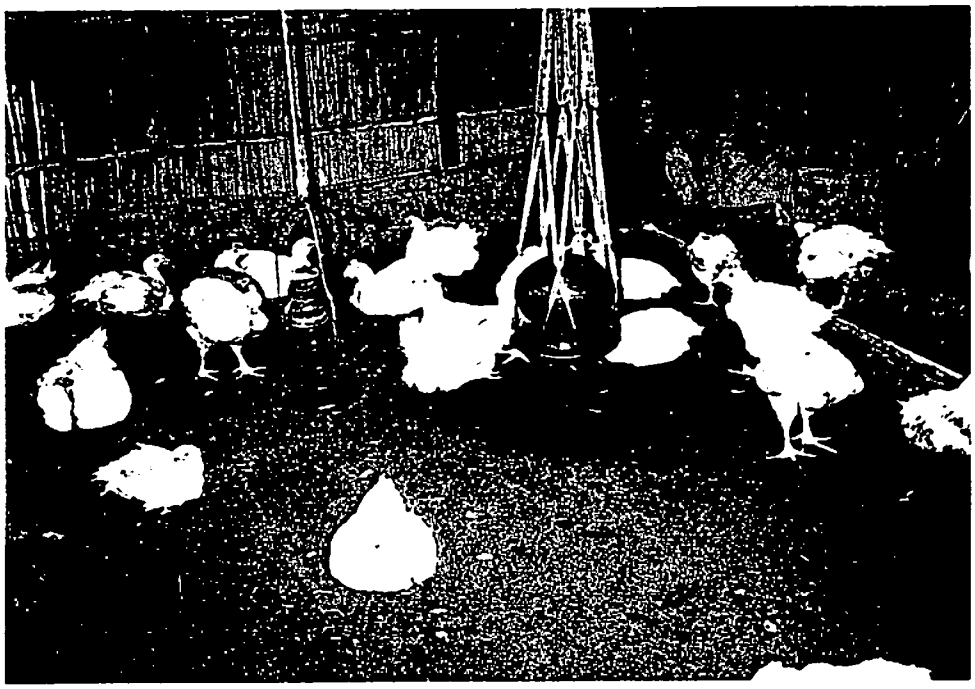


Plate 2: Chicken being raised in part of Ms. Nur Banu's house

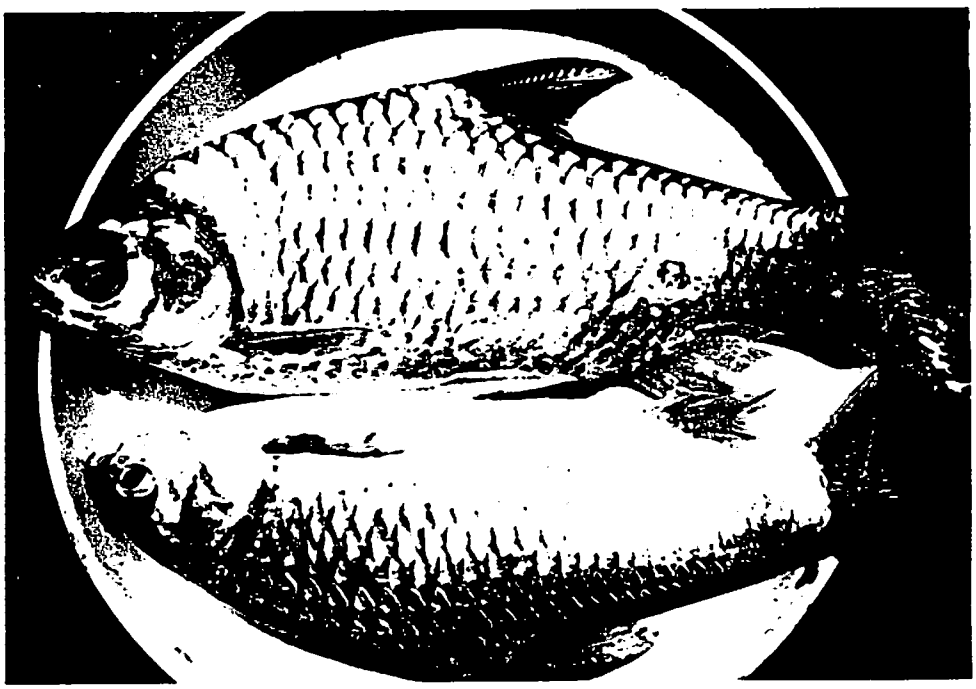


Plate 3: Thai sharpunti (Puntius gonionotus) suitable for culture in seasonal ditches

in her house. She collected every day faeces of 20 chicken she has been raising in her house, dumped them in a place and applied the faeces at weekly intervals - half the amount

Plate 4: Smiling faces - Ms. Nur Banu's family with fish catch from their ditch

Plate 5: Ms Nur Banu with her catch of fish - ready for sale

in the pond and half the amount in her backyard vegetable garden. In three months time, the fish have grown to an average marketable size of 100 gm from the initial 10 gm size. She was very happy as she could not believe that they could grow so fast to table size in such a short time.

The fish were harvested by repeated netting and a total of 22.0 kg fish were harvested. Some fish were left in the pond, and she restocked the pond with some more fingerlings. Subsequently, she harvested the pond after 4 months and got 19 kg of fish. Thus she was able to produce 2 crops of fish in 7 months amounting to a total of 41 kg. The fish were sold in minutes after harvesting at a rate of Tk. 50.00/kg. Thus, Ms. Nur Babu was able to harvest 41.0 kg of fish from a ditch of 160 m^2 (2,562 kg/ha) in a period of 7 months and got Tk. 2,050.00. She incurred an expenditure of Tk. 525.00 towards cost of lime, fingerlings and rice bran leaving a net benefit of Tk. 1,525.00 from a ditch of 160 ^{2} (Tk. 95,312.00/ha/ 7 months), which is equivalent to 60 days earnings of her husband. The annual fish comsumption of a low-income rural family of six members in Bangladesh is estimated at some 24 kg, which is much less than what Ms. Nur Banu has produced from a small ditch.

To bring to the notice of other women in the area the technology and the benefits they could accrue by taking to aquaculture in their homestead ponds/ditches, a 'Farmer's Day' was arranged at Ms. Nur Banu's house when the pond was harvested. Over 200 women and 45 men attended the Farmer's Day. The function was attended by the Executive Vice-Chairman of BARC, Director of FRI, the Director of Commercial Operations, BRAC, the Specialist and other officials of FRI and BRAC. When the Executive Vice-Chairman of BARC enquired as to how many of the women assembled on the day have homestead ditches/ponds, 80% responded saying that they have backyard ditches which presently are not being used for any purpose and expressed keen interest in taking to fish culture. Mr. A. Q. Siddique, Director Commercial of BRAC has expressed that his organization BRAC is very happy to act as a **'Match Maker'** between the technology developer (FRI) and technology user (Farmers) and expressed optimism that the collaborative efforts will be further strengthened in future to cover large number of farmers (especially women) in different parts of the country and thanked BARC, FRI, USAID and ICLARM for their assistance.

Plate 6: Farmers Day - women interested in rural aquaculture

Plate 7: Ms. Nur Banu narrating her aquaculture experience to her neighbouring women

APPENDIX-7.

APPENDIX-7.

LIST OF FISHERIES TRAINING PROGRAMS CONDUCTED UNDER AGRICULTURAL RESEARCH PROJECT-II (SUPPLEMENT)

Sl. No.	Date of training	Subject	Participants	Number
1.	19.2.90 - 24.2.90	Nursery Pond Management	Farmers	17
2.	15.5.90 - 16.5.90	Farming Systems Research Planning	FSR Scientists	11
3.	21.5.90 - 26.5.90	Aquaculture Technologies	BRAC Officers	12
4.	14.6.90 - 19.6.90	Aquaculture Technologies	Extension Officer - BRAC - RDRS	 9 3
5.	5.6.90 - 6.6.90	Nursery Management of Thai sharputi	Farmers	29
6.	30.06.90	Fish Pond Management	Farmers at Ishurdi	40
7.	11.07.90	Fish Pond Management	Farmers at Tangail	35
8.	22.7.90 - 9.8.90	Fisheries Data Analysis	Fisheries Scientists	20
9.	28.7.90	Tilapia culture	Farmers at Tangail	25
10.	18.8.90 - 3.9.90	Fisheries Data Analysis	Fisheries Scientists	20
11.	06.10.90 - 15.10.90	Farming System Research Methodologies and Aquaculture Technologies	FSR Scientists BRAC Officers	13 2
12.	21.10.90 - 23.10.90	Orientation Training on fish culture	MCC Scientific Officers	7
13.	11-14 March '91	Aquaculture technologies	Upazila Fishery Officers (DOF)	25

Sl. No.	Date of training	Training Program	Participants	Number
14.	17-23 March '91	Aquaculture technologies	Extentions Officers - BRAC - Proshika - CARITAS	 18 5 2
15.	27 March-2 April'91	Nursery pond management	Nursery operators - BRAC - Gono Kallyan Trust - Unnayan Sangha	 25 1 2
16.	03-06 April '91	Aquaculture technologies	Field extension workers - BRAC	 25
17.	07-12 April '91	Nursery pond management	Nursery operators - BRAC	 30
18.	22-25 April'91	Fish stocking, feeding characteristics and regimes	Farmers sponsored by NGOs	60
19.	04-07 May '91	Aquaculture technologies	Field extension workers - BRAC - Proshika - Somaj-O-Jati Gathan - Tengamara Mohila Sabuj Sangha - Gana Unnyan Prochesta - CARITAS	 3 2 2 1 2 7
20.	12 May '91	Rice-fish farming	Dept.of Agricultural Extension	6
21.	1.6.91 - 26.6.91	Fish Farm Management	Progressive Fish Farmers of Nepal	4
22.	17.8.91-22.8.91	Improved Fish Culture Management Practices	Upazila Fishery Officers	23

Sl. No.	Date of training	Training Program	Participants	Number
23.	12-16 April'92	Brood fish & hatchery management	Extension Workers - Rangpur Dinajpur Rural Service - Save the Children - Gono Unnayan Prochesta (GUP) - Seva Manobik Unnayan Kendra - Dwip Unnayan Sangstha - USHA - Gandhi Ashram Trust - Dak Deya Jai	 6 3 1 2 2 2 1 1
24.	19-23 April'92	Nursery pond management	Extension Workers - Proshika - BRAC - Mymensingh Palli - Unnayan Kendra - AMVTI - Gandhi Ashram Trust - Farmer	 15 6 1 1 1 1 1
25.	03-09 May 1992	Nursery pond management	Extension Workers - MCC - Dwip Unnayan Sangstha - Rangpur Dinajpur Rural Service - Community Dev. Association - Somaj Progati Sangstha - Palli Unnayan Sangstha - Nayan Action Foundation - CPURD - Sonali Joint Venture Fish Farm - Farmer	 5 1 2 1 1 1 2 1 1 10

Sl. No.	Date of training	Training Program	Participants	Number
26.	16-22 May '92	Pond fish culture management	Extension Workers	
			- BRAC	14
			- VARD	1
			- Palli Unnayan Sangstha	1
			- Somaj Progati Sangstha	1
			- Farmer	8
27.	27-30 May '92	Integrated fish farming	Extension Workers	
			- Dwip Unnayan Sangstha	1
			- Save the Children (USA)	3
			- Palli Unnayan Sangstha	2
			- Gono Kallyan Kendra	1
			- Nayan Action Foundation	2
			- VPKA	2
			- Samajik Progati Sangstha	1
			- Unit for Social and Help Adv.	1
			- Rangpur Dinajpur Rural Service	3
			- Dak Deya Jai	1
			- Farmer	8
28.	21-27 June '92	Pond fish culture management	Extension Workers	
			- BRAC	11
			- Somaj Unnayan Sangstha	1
			- Shikha	1
			- Mymensingh Pally Un. Proash	1
			- Nayan Action Foundation	1
			- Samajik Agrogati Kendra	1
			- Grameen Manobik Unn. Sangstha	1
			- Society for Social Service	1
			- Farmer	2

Sl. No.	Date of training	Training Program	Participants	Number
29.	22 June 1992	Seasonal pond management	Farmers of BRAC	58
30.	25 June 1992	Perennial pond management	Farmers of BRAC	41
31.	04-10 July '92	Pond fish culture management	Extension workers - BRAC - AVRD - Farmer	 16 1 2
32.	19-25 July '92	Pond fish culture management	Extension workers - BRAC - Rangpur Dinajpur Rural Service - Gono Aid Sangstha	 17 4 6
33.	25 July'92	Aquaculture management in seasonal and perennial ponds	Farmers sponsored by Gandhi Ashram Trust	24
34.	27-30 July'92	Technology transfer and impact studies	- CARITAS - BRAC - Proshika	7 5 4
35.	28 July'92	Aquaculture management in seasonal and perennial ponds	Farmers sponsored by Jagorani Chakra	16
36.	29 July'92	Aquaculture management in seasonal and perennial ponds	Farmers sponsored by BRAC	63
37.	03 August'92	Aquaculture management in seasonal and perennial ponds	Farmers sponsored by Jagorani Chakra	16
38.	04 August'92	Aquaculture management in seasonal and perennial ponds	Farmers sponsored by Proshika	18
39.	03 August'92	Integrated rice-fish culture	DAE Block Supervisor	79
40.	06 August'92	Aquaculture management in seasonal and perennial ponds	Farmers sponsored by Gandhi Ashram Trust	24
41.	09-13 August'92	Fisheries Research Planning and Management	FRI Scientists	25
42.	15-20 August'92	Pond fish culture	BRAC Extension Workers	15

Sl. No.	Date of training	Training Program	Participants	Number
43.	12 August'92	Aquaculture management in seasonal and perennial ponds	Farmers sponsored by Proshika	27
44.	15 August'93	Aquaculture management in seasonal and perennial ponds	Farmers sponsored by BRAC	72
45.	21 August'92	Aquaculture management in seasonal and perennial ponds	Farmers sponsored by Proshika	22
46.	22 August'92	Aquaculture management in seasonal and perennial ponds	Farmers sponsored by BRAC	83
47.	23 August'92	Aquaculture management in seasonal and perennial ponds	Farmers sponsored by Proshika	27
48.	27 August'92	Aquaculture management in seasonal and perennial ponds	Farmers sponsored by Gandhi Ashram Trust	24
49.	28 August'92	Aquaculture management in seasonal and perennial ponds	Farmers sponsored by BRAC	83
50.	30 August'92	Aquaculture management in seasonal and perennial ponds	Farmers sponsored by BRAC	62
51.	03 September'92	Breeding, fry and fingerling rearing of Clarias spp.	DOF Farm Managers and FRI Scientists	10
52.	04 September'92	Aquaculture management in seasonal and perennial ponds	Farmers sponsored by Rangpur Dinajpur Rural Service	18
53.	08 September'92	Aquaculture management in seasonal and perennial ponds	Farmers sponsored by BRAC	77
54.	09 September'92	Aquaculture management in seasonal and perennial ponds	Farmers sponsored by Rangpur Dinajpur Rural Service	18
55.	15 September'92	Aquaculture management in seasonal and perennial ponds	Farmers sponsored by Rangpur Dinajpur Rural Service	18
56.	25 September'92	Aquaculture management in seasonal and perennial ponds	Farmers sponsored by Unnayan Sangha	12

Sl. No.	Date of training	Training Program	Participants	Number
57.	26 September'92	Pond Fish Culture	BRAC Farmers	56
58.	27 September'92	Pond Fish Culture	BRAC Farmers	69
59.	28 September'92	Aquaculture management in seasonal and perennial ponds	Farmers sponsored by Thengramara Mohila Sabuj Sangha	16
60.	28 September'92	Aquaculture management in seasonal and perennial ponds	Farmers sponsored by Gandhi Ashram Trust	27
61.	10 October'92	Aquaculture management in seasonal and perennial ponds	Farmers sponsored by Rangpur Dinajpur Rural Service	25
62.	11 October'92	Aquaculture management in seasonal and perennial ponds	Farmers sponsored by Proshika	30
63.	21 October'92	Aquaculture management in seasonal and perennial ponds	Farmers sponsored by Proshika	38
64.	24 October'92	Aquaculture management in seasonal and perennial ponds	Farmers sponsored by BRAC	77
65.	12 November'92	Aquaculture management in seasonal and perennial ponds	Farmers sponsored by Proshika	28
66.	15 November'92	Aquaculture management in seasonal and perennial ponds	Farmers sponsored by BRAC	61
67.	29 November'92	Aquaculture management in seasonal and perennial ponds	Farmers sponsored by BRAC	59
68.	7-24 Dec.'92	Socioeconomic Aspects of Aquaculture; Basic concepts, Acquisition of Data and Information and Methods of Analysis.	FRI Scientists	27
69.	15 December'92	Aquaculture management in seasonal and perennial ponds	Farmers sponsored by BRAC	57
70.	25 December'92	Aquaculture management in seasonal and perennial ponds	Farmers sponsored by Thengramara Mohila Sabuj Sangha	16

Sl. No.	Date of training	Training Program	Participants	Number
71.	6-27 Jan.'93	Economics of Fish Production : Basic Concepts, Acquisition of Data and Information and Methods of Analysis.	FRI Scientists	16
72.	19 Jan.'92	Aquaculture management in seasonal and perennial ponds	Farmers sponsored by BRAC	57
73.	03 February'93	Aquaculture management in seasonal and perennial ponds	Farmers sponsored by Jagorani Chakra	16
74.	15 February'93	Aquaculture management in seasonal and perennial ponds	Farmers sponsored by Jagorani Chakra	16
75.	16 February'93	Integrated rice-fish farming	Agriculture Officers, Department of Agriculture Extension	31
76.	17 February'93	Integrated rice-fish farming	Extension Officers Farmers	6 44
77.	18 February'93	Integrated rice-fish farming	Extension Officers Farmers	5 31
78.	01-04 March'93	Aquaculture technologies Technologies	Primary School Teachers	25
79.	11-12 April'93	Integrated rice-fish farming	DAE district levels	20
80.	24 April '93	Integrated rice-fish farming	DAE Thana levels	20
81.	28-29 April'93	Integrated rice-fish farming	DAE Block supervisors	26
82.	May 3-4, 1993	Integrated rice-fish farming	DAE Block supervisors	31
83.	May 9-13,1993	Aquaculture technologies and management	NGOs extension officers	23

APPENDIX-8.

APPENDIX-8.

List of NGOs and No. of extension workers trained from each organization

Sl.No.	NGO	No.of trained
1.	Bangladesh Rural Advancement Committee	207
2.	Mennonite Central Committee (MCC)	12
3.	Proshika	35
4.	CARITAS	16
5.	Gono Kallyan Trust	2
6.	Unnayan Sangha	8
7.	Somaj-O-Jati Gathan	7
8.	Thengamara Mohila Sabuj Sangha	9
9.	Gana Unnayan Prochesta	3
10.	Rangpur Dinajpur Rural Service (RDRS)	22
11.	Save the Children	6
12.	Seva Manobik Unnayan Kendra	2
13.	Dwip Unnayan Sangstha	4
14.	Gandhi Ashram Trust	6
15.	Dak Deya Jai	2
16.	Mymensingh Palli Unnayan Kendra	1
17.	AMVTI	1
18.	Community Development Association	1
19.	Nayan Action Foundation	5
20.	CPURD	1
21.	Sonali Joint Venture Fish Farm	1
22.	VARD	2
23.	VPKA	2
24.	Unit for Social and Help Advanced	1
25.	Shika	1
26.	Grameen Manobik Unnayan Sangstha	1
27.	Society for social service	1
28.	Gono Aid Sangstha	6
29.	Jagorani Chakra	2
30.	UTTARAN	3
	Total	370

APPENDIX-9.

APPENDIX-9.

LIST OF TRAINING MANUALS PREPARED

1. Trainer's Training Manual on Aquaculture Technologies (english)
2. Trainer's Training Manual on Improved Fish Culture Management Practices (english)
3. Training Manual on Improved Fish Culture Management Practices (bengali)
4. Trainer's Training Manual on Nursery Pond Management (bengali)
5. Trainer's Training Manual on Brood Fish and Hatchery Management (bengali)
6. Trainer's Training Manual on Nursery Pond Management (bengali)
7. Trainer's Training Manual on Integrated Poultry-Fish Farming (bengali)
8. Trainer's Training Manual on Pond Fish Culture (bengali)
9. Manual on Statistical Methods for Fisheries Data Analysis (english)
10. Practical manual for seed production of *Clarias batrachus* (L.) (english)
11. Practical Manual on Induced Spawning, Larval Rearing and Fingerling Raising of *Clarias Batrachus* (Linnaeus) (english)
12. Training manual on tilapia culture (bengali)
13. Training manual on small fish culture (bengali)
14. Manual on socioeconomics in fisheries research (english)
15. Manual on improved fish culture practices (bengali)

APPENDIX-10.

APPENDIX-10.

LIST OF EXTENSION MANUALS PREPARED

1. Manual on tilapia (*Oreochronis niloticus*) culture
2. Manual on rajputi (*Puntius gonionotus*) culture
3. Manual on nursery pond management
4. Manual on integrated duck-fish farming
5. Manual on polyculture of carps
6. Manual on integrated chicken-fish farming
7. Manual on fish diseases

APPENDIX-11.

APPENDIX-11.

RECOMMENDATIONS OF THE WORKSHOP ON *"INLAND AQUACULTURE DEVELOPMENT STRATEGIES FOR BANGLADESH"*

Organized by
Bangladesh Agricultural Research Council (BARC)
and
International Center for Living Aquatic
Resources Management (ICLARM)
29 September - 01 October 1991

Aquaculture has been recognised as a sector of economic importance, both for domestic supply and for export, by the Government of Bangladesh. To meet the increasing demand for fish, the Government has set an annual fish production target of 1.2 million tons by the end of Fourth Five Year Plan, as against a production of 0.847 million tons at the end of the Third Five Year Plan. Since available information indicates that marine fish production has reached maximum sustainable yield (MSY) and increasing fish production from inland capture fisheries is difficult, if not impossible, major portion of the projected increase in production has to come from inland aquaculture.

Realising the potential of inland aquaculture for increasing national fish production, the Bangladesh Agricultural Research Council (BARC) in collaboration with the International Center for Living Aquatic Resources Management (ICLARM), organised a three day **Workshop on "Inland Aquaculture Development Strategies for Bangladesh"**, from 29 September - 01 October 1991, at BARC auditorium in Dhaka. The workshop was attended by over 120 researchers, planners, administrators and development workers from Government and non-government organisations, as well as a number of national and expatriate consultants. After lengthy discussions in five sessions spread over a period of three days, the workshop came up with a set of recommendations to the Government for the development of inland aquaculture. The recommendations of the workshop are detailed here under.

RECOMMENDATIONS :

In view of immense opportunities for production of fish for local consumption and export, production of fry/fingerlings for increasing productivity of degraded and impoverished open water systems, creating employment and improvement of rural and urban environment, the Workshop recommends that the Government of Bangladesh should give top-most priority for development of inland aquaculture, in the National Development Plans. In this context, problems and technology generated opportunities shall be the basis for research plans/projects, while mature technologies emerging from research/projects, shall be the basis of technology synthesis and technology transfer programs. Appropriate policy support instruments should be formulated, which would ensure the full utilization of such mature technologies in aquaculture and marketing systems. Specically, the Workshop suggests the implementation of the following recommendations:

1. Two National Committees should be set-up, one to review strategies for research and development of aquaculture, on an on-going basis, and another, a National Screening Committee, to examine the desirability of any further introduction of exotic species. A quarantine system for introduction of aquatic organisms should be established.

2. An inventory of aquaculture related resources (including feeds and feed ingredients) should be undertaken. Present status and developmental needs of water resources such as ponds, road-side ditches, borrow pits, FCDI canals, enclosed flood lands, dead rivers and other water areas, where aquaculture could be undertaken, should be assessed.

3. A National Aquaculture Development Plan should be formulated based on aquaculture prospects and constraints, upto smallest administrative units, viz., unions.

4. With a view to increasing aquaculture production, emphasis should be given for establishment and operation of adequate number of carp and prawn/shrimp hatcheries and improvement of existing facilities.

5. In view of massive fingerlings requirement for aquaculture, and lack of nursery space, technologies for intensive rearing of fingerlings in nursery cages, pens and enclosures should be developed and adopted. Road-side ditches, seasonal canals and other impoundments should be utilized as nurseries. Intensive, high density rearing of fry/ fingerlings should be demonstrated to nursery operators by the Department of Fisheries and the Fisheries Research Institute.

6. In order to ensure early stocking of floodplains, it is necessary to develop brood fish management techniques for early maturity and breeding of native carps.

7. Prospective shrimp areas should be classified on the basis of tidal inundation, salinity gradient and soil conditions.

   Keeping in view environmental and socio-economic aspects, horizontal expansion of shrimp farming should be discouraged and intensification in culture practices should be encouraged.

   Brackishwater aquaculture farms to be developed in future, be constructed with adequate water exchange facilities. Area specific pond preparation methods should be developed.

8. Brackishwater aquaculture development is constrained by shortage of Penaeus monodon seed and feed. In view of this, high priority should be given for research on raising brood stock, nursery management, feed formulation, water quality management, polyculture of shrimp and finfish and disease control.

9. Only those species whose biology and production potential are known, should be recommended for culture. Species selection and culture technology should be based on the ecology of water body and the socio-economic condition of fish farmers.

10. Environmental and biological impact of stocking of exotic species should be monitored and studied.

11. Studies on foodwebs in selected aquatic ecosystems should be undertaken, to determine compatible species composition, size, and intensity of stocking in floodplains.

12. All planned flood control, drainage and irrigation programs (FCD and FCDI) should take into consideration the impact of the programs on fisheries and incorporate remedial measures, in case of negative impacts.

13. All waters in FCD and FCDI projects should be brought under aquaculture, using culture-based fisheries enhancement concept. The Government should seek additional funding if needed, to initiate such activities at the earliest possible time.

14. To prevent over-fishing and fishing of under-sized fish, floodplain stocking should be supported by effective programs for conservation, through involvement of fishermen and farmer communities, in addition to Government departments. The Government should follow the guidelines of New Fisheries Management Policy (NFMP), with reinforced arrangements for institutional support and community involvement.

15. Once the viability of culture-based fisheries program is established and impact of such stocking is quantified, necessary measures should be taken to enable the private sector to take over the operations.

16. Public sector Fish Seed Multiplication Farms should be declared as training, demonstration and technology transfer centres.

17. Advice oriented aquaculture extension should be replaced with practical demonstration of aquaculture in private ponds, pens, cages and nursery ponds.

18. Government should increase investment in support services, to provide assistance in management, extension and technology transfer mechanisms in culture-based fisheries development.

    Creation of sanctuaries and shelters within culture-based fisheries areas, needs to be established.

    A mechanism to recover public sector investment in culture- based fisheries, should be developed.

19. Government technical and policy support should be extended to NGOs involved in fisheries extension activities.

20. The Government should provide institutional support to create a positive investment climate and stimulate private sector participation, for meeting the fingerling requirements of openwater stocking and aquaculture.

21. Small-scale cottage industries for production of fish feed using local ingredients, should be supported and encouraged by the Government.

22. Imported aquaculture inputs like hormones, Artemia cysts, piscicides, chemicals and machinaries, should be included as tax-free items for import, specially in case of shrimp farming, an export oriented industry.

23. Aquaculture should be identified as a seperate and important focus area for institutional credit. This will mean both allocation of proportionately greater amounts of credit for aquaculture sector, as well as, restructuring the credit sector to achieve full disbursement of such fund allocation. Upazila Fishery Officers should be included as a member of the Upazila Credit Committee.

24. Small and medium size public waters (ponds, road-side canals, borrow pits, FCDI canals, dead rivers, etc.) should be placed under the Upazila Parishad, for long-term distribution to selected target groups. In order to introduce improved aquaculture technologies and to ensure equitable distribution of water resources, public waters should be distributed to following three classes of people:

    - fisherfolk, landless and marginal farmers and unemployed youths;

- people trained in aquaculture;

- entrepreneurs truly interested in investing in aquaculture development.

25. An Aqua Ecological Zone (AEZ) map should be prepared so that technology transfer advice and support services can be made effective.

26. Coordination among various research institutions, universities, development and extension agencies, should be strengthened by Bangladesh Agricultural Research Council (BARC).

27. Development projects of the Department of Fisheries should have a research budget to solve problems that may arise during their implementation.

28. Socio-economic divisions should be created within Fisheries Research Institute and the Department of Fisheries.

29. Environmental evaluation should be a part of all major fisheries sector activities and projects, including, expanding shrimp farming area, flood control, drainage and irrigation projects, use of harmful pesticides, etc.

APPENDIX-12.

The Daily Star

ASHWIN 16, 1398 BS, DHAKA WEDNESDAY OCTOBER 2, 1991 RABIUL AWAL 22, 1412 HIJ

Marketing facilities at home and abroad sought

Plea to formulate national aquaculture development plan

A national workshop on aquaculture which concluded in Dhaka Tuesday recommended formulation of national aquaculture development plan considering the prospects and constraints, reports BSS.

It also suggested to attach topmost priority on aquaculture in the national development plan with a view to enhancing fish production and create productive employment opportunities.

In a number of recommendations the workshop also suggested identification of research, technology transfer and policy support for development of aquaculture on the basis of current production and marketing systems of fry fingerling, matured fish, fish feed and equipment related to aquaculture.

It said all aquaculture production and marketing should be made through the private sector and production and marketing policy should be formulated on the basis of marketing opportunities at home and abroad.

Jointly organised by Bangladesh Agricultural Research Council (BARC), Manila-based Aquaculture Specialist Centre (ICLARM) and USAID, the three-day workshop was inaugurated by the Agriculture Minister M Majid-ul- Haq on September 29.

The concluding session was presided over by Home Secretary M. Lutfullahil Mazid. Among others BARC Acting Chairman Dr M Sujayetuiah Chowdhury, Members Secretary of the workshop Dr A K M Nuruzzaman, Fisheries Director A K Ataur Rahman spoke.

The workshop also recommended for setting up a National Fisheries Advisory Committee to determine the research and development strategies in this sector, and formation of a National Screening Committee consisting of competent scientists to examine the desirability of introduction of any new exotics. It demanded strict restriction on further introduction of new exotic species.

It said the indigenous species whose biology, production potential etc are known should be extended for culture.

The workshop also suggested supporting development of fish feed industries as cottage industry, tax relaxation on import of aquaculture inputs, special credit for aquaculture, strengthening of institutional facilities and linkages between different Government organisations, conducting socio-economic researc: on fisheries and utilisation of the Government farms and hatcheries as training, demonstration and technology transfer centres.

For brackish water aquaculture the workshop recommended classification of prospective shrimp farming areas on the basis of salinity and development of these farms with adequate water exchange facilities and disease control measures.

It discouraged horizontal expansion of shrimp farming and encouraged increase of production per unit area with due consideration to environmental socio-economic consequences and market demands.

The workshop also suggested distribution of all public waters including ponds, roadside canals, borrow pits, development canals, dead rivers to fishermen, landless and marginal farmers, unemployed youths, people trained in aquaculture, and interested entreprencurs against convincing production projects. This distribution should be made through the Upazila Parishad, it added.

Referring to environmental aspects, the workshop suggested giving priority on conservation and development of fisheries environment and habitat while planning or considering any development plan affecting that habitat.

Emphasising the need for encouraging private sector participation in aquaculture the workshop suggested providing institutional and financial support to create a positive investment climate.

It recommended adoption of technologies for intensive rearing fingerlings in nursery cases, pens and enclosures as well as study and monitoring of environmental and biological aspects of stocking of exotic species.

The workshop further recommended that floodplain stocking should be supported by effective programmes of conservation and protection with a view to over preventing over-fishing and fishing of undersized fish. The fishermen should be involved in these efforts, it concluded.

THE BANGLADESH OBSERVER

DHAKA, WEDNESDAY, OCTOBER 2, 1991

Aquaculture workshop concludes

A national workshop on Aquaculture which concluded in Dhaka Tuesday recommended formulation of national aquaculture development plan considering the prospects and constraints, reports BSS.

It also suggested to attach topmost priority on aquaculture in the national development plan with a view to enhance fish production and create productive employment opportunities.

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Emphasising the need for stimulating private sector participation in aquaculture the workshop suggested providing institutional and financial support to create a positive investment climate.

The Bangladesh Times

IN 16, 1398 DHAKA, WEDNESDAY, OCTOBER 2, 1991 RABI-UL-AWAL 22, 1412

National aquaculture uplift plan urged

A national workshop on aquaculture which concluded in Dhaka on Tuesday recommended formulation of national aquaculture development plan considering the prospects and constraints, reports BSS.

It also suggested to attach topmost priority on aquaculture in the national development plan with a view to enhance fish production and create productive employment opportunities.

In a number of recommendations the workshop also suggested identification of research, technology transfer and policy support for development of aquaculture on the basis of current production and marketing systems of fry, fingerling, matured fish-feed and equipment related to aquaculture.

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The concluding session Tuesday was presided over by Home Secretary M Lutfullahil Mazid. Among others BARC Acting Chairman Dr M Sujayetullah Chowdhury, Member-Secretary of the workshop Dr AKM Nuruzzaman, Fisheries Director AK Ataur Rahman spoke.

The workshop also recommended for setting up a national fisheries advisory committee to determine the research and development strategies in this sector, and formation of a national screening committee consisting of competent scientists to examine the desirability of introduction of any new exotics. It demanded strict restriction on further introduction of new exotic species.

It said the indigenous species whose biology, production potential etc. are known should be extended for culture.

The workshop also suggested supporting development of fish-feed industries as cottage industry, tax relaxation on import of aquaculture inputs, special credit for aquaculture, strengthening of institutional facilities and linkages between different government organisations, conducting socio-economic research on fisheries and utilisation of the government farms and hatcheries as training, demonstration and technology transfer centres.

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The workshop also suggested distribution of all public waters including ponds, road-side canals, borrow pits, development canals, dead rivers to fishermen, landless and marginal farmers, unemployed youths, people trained in aquaculture and interested entrepreneurs against convincing production projects. This distribution should be made through the upazila parishad, it added.

APPENDIX-13.

APPENDIX-13.

LIST OF EQUIPMENT PROCURED BY ICLARM UNDER AGRICULTURAL RESEARCH PROJECT-II (SUPPLEMENT) PROJECT

Sl.No.	Item	Quantity
1.	Photocopier CANON plain paper with reduction as well as enlargement facilities. Model : NP-1215 Made in Japan	1 unit
2.	CAR Mitsubishi Pajero LWB Model : L049GVNSR with Airconditioner	1 unit
3.	Computer ALR - Power Flex Plus with processor 80286, Floppy and MFM hard drive controller, clock calender with battery back up, 101 key enhanced keyboard, 14" Microline,	1 unit
4.	391 printer, PK 2060 UPS 600VA with automatic Voltage regulator and surge suppressor.	1 unit
5.	Electronic Typewriter Unit Model : AE-465, Electronic Office Typewriter	1 unit
6.	Binocular Microscope without camera Model CHB Olympus	1 Pc.
7.	Max. & Min. Thermometer Zeal	10 Pcs.
8.	Hemocytometer	6 Pcs.
9.	Pipette Burette Cleaning Set Model 10291 Fortuna	1 Set
10.	Gloves Rubber Ansel Brand	20 Pairs
11.	Pipette Filter	1 Pc.
12.	Desicator 240 mm	3 Pcs.
13.	Distillation Plant all glass Model W 4000 Whatman	1 pc.
14.	Analytical Balance Electronic Model AJ 100 Mettler	1 pc.

Sl.No.	Item	Quantity
15.	Trolley Stainless Steel	1 Pc.
16.	DO Meter Portable Model No. OT 8 WPA	1 Pc.
17.	Water Bath Model No.W-350 Memmert	1 Pc.
18.	Washing Bottle 500 ml.	25 Pcs.
19.	Beaker 25 ml. Beaker 50 ml. Beaker 100 ml. Beaker 250 ml. Beaker 500 ml.	50 Pcs. 50 Pcs. 50 Pcs. 50 Pcs. 50 Pcs.
20.	Conical Flask 100 ml. Conical Flask 250 ml. Conical Flask 500 ml.	50 Pcs. 50 Pcs. 50 Pcs.
21.	Pipette Cap. 1 ml. Pipette Cap. 2 ml. Pipette Cap. 5 ml. Pipette Cap. 10 ml. Pipette Cap. 25 ml. Pipette Cap. 50 ml.	20 Pcs. 20 Pcs. 20 Pcs. 20 Pcs. 20 Pcs. 20 Pcs.
22.	Weighing balance Globe brand	10 Nos.
23.	Net (412' x 18') (247' x 18')	2 pcs.
24.	Blood agar merck	500 gm
26.	Beef Extract Gipco	500 gm
27.	Bactopeptone Difco	500 gm
28.	Triptone Difco	500 gm
29.	Triple Sugar Iron Agar Oxide	500 gm
30.	Nutrant Agar Oxide	500 gm
31.	Muller Hinton Agar Oxide	500 gm
32.	Proteose Peptone Difco	500 gm

Sl.No.	Item	Quantity
33.	Gelatin Difco	500 gm
34.	Amoxicillin 30ug Canada	50 dise
35.	Nalidixic acid 30ug Canada	50 dise
36.	Sulpha/Trim SXT 30.75/1.25ug	50 dise
37.	Streptomycin(s) 10ug Canada	50 dise
38.	Tetracycline (TE) 30ug Canada	50 dise
39.	Chloramphenenicol 30ug Canada	50 dise
40.	Amiculine 10ug Canada	50 dise
41.	Ocularmincrometer (for OSK Microscope) Germany	1200 pcs.