Aquaculture extension through trickle-down: Bangladesh

ABSTRACT

Bangladesh is considered one of the most suitable countries in the world for aquaculture, because of its favourable agroclimatic conditions. Development of aquaculture has generated considerable employment through the production and marketing of fish and fish seed.

The revolution in water/aquaculture-based food production systems (the so-called "blue revolution") in Bangladesh has achieved a 50 percent increase in aquaculture production, mainly as a result of new semi-intensive technology using locally available feed ingredients and other inputs. The Food and Agriculture Organization of the United Nations (FAO) has been helping the government to develop and test this technology in different agroclimatic regions of the country. Householders have at least doubled their income from raising carp and other fish in traditional backyard pools.

This achievement has been facilitated through innovations in extension. The experience described here involves an approach developed to disseminate new technology on a mass scale. An FA0 pilot project, Strengthening Rural Pond Fish Culture Extension Services, taught the new semi-intensive, low-cost methods to selected farmers, who in return trained other fish farmers at no cost – a "trickle-down'' extension approach. This 1994-96 project markedly improved rural pond-fish culture extension services throughout Bangladesh and the government has now used the project as a model for a low-cost countrywide extension service.

Before the introduction of the system, the lack of concerted extension activities had hampered development and prevented fish farmers from realizing the full potential of their ponds. The major constraints affecting the spread and improvement of aquaculture had been:

- **inadequate supply of seed cultures of species at the village level;**
- absence of appropriate technology packages;
- poor distribution of technical information in rural areas;
- insufficient resources;
- lack of understanding about the dynamics of pond production.

The trickle-down extension system is a participatory approach, designed *to* disseminate appropriate technology through method and result demonstrations. Details are given later in this paper.

Several factors are fundamental to the success of the trickle-down system. Good working relationships should be established among all parties and appropriate training organized for extension staff and fish farmers. The technologies for transfer must be consonant with local conditions and any required inputs should be readily available. There should be a requisite number of field staff at the *thana* (subdistrict) level, transport facilities and an effective supervision and monitoring system. Social recognition should be awarded to result demonstrators for their services.

The work of the result demonstrators and fellow farmers has generated enthusiasm and initiative in the aquaculture sector. **A** reporting mechanism provided regular information on activities and progress, training, problems encountered, pond/home visits and other work undertaken by extension staff. Extension training materials, computer software, audiocassettes and videos were developed by the project for dissemination of the trickle-down approach.

The technology and methods for technology transfer were found to reinforce each other. The demonstration of semi-intensive aquaculture in rural ponds showed that pond-fish production can easily be increased three- to fourfold by replacing traditional aquaculture practices with appropriate low-cost technology. For example, the final results from 701 demonstration ponds indicated that average pond production increased to 4 104 tonnes/ha/year from the previous average production level of 1 461 tonnes/ha/year. Inspired by the large-scale implementation of the aquaculture extension initiatives in rural ponds through the trickle-down system, the Government of Bangladesh has begun a national follow-up project covering 400 *thanas.* The government is using its own resources and closely following the example of the **FA0** project.

Undrainable rural ponds in Bangladesh are closely associated with socio-economic and cultural life and offer considerable scope for fish culture. Since almost all the ponds in Bangladesh are household ponds where women are closely involved, a project could be designed for the development of rural women through pond-fish culture. Organizing large-scale demonstrations in farmers' ponds, without giving input/credit support and within the limited time of one year, was possible mainly because of the highest level of government support and involvement by counterpart officers and farmers. It was noted that fish farmers,

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58 Result demonstrators are selected farmers who demonstrate to other members of their community the results they have achieved in growth, size and health of their fish crops and overall yield and income. They also demonstrate the technological steps employed in fish breeding.

TABLE 1
Freshwater fish species cultivated in Bangladesh

Species	Common name	Culture system	Intensity
Catla catla	Catla	Pond/baor	Extensive/semi-intensive
Cirrhinus mrigala	Mrigala	Pond/baor	**Extensive/semi-intensive**
Labeo calbasu	Kalbashu	Pond/baor	Extensive
Labeo rohita	Rohu	Pond/baor	**Extensive/semi-intensive**
Ompok pabda	Butter catfish	Pond	Semi-intensive
Pangasius pangasius	Pangas catfish	Pond	Semi-intensive
Pangasius sutchi	Pangas catfish	Pond	Semi-intensive
Clarias batrachus	Asian catfish	Pond/baor	**Extensive/semi-intensive**
Clarias qariepinus	African catfish	Pond	Intensive
Hypopthalmichthys nobilis	Bighead carp	Pond/baor	Semi-intensive
Ctenopharyngodon idellus	Grass carp	Pond/baor	Semi-intensive
Cyprinus carpio var. comminus	Common carp	Pond/baor	Semi-intensive
Cyprinus carpio var. specularis	Mirror carp	Pond/baor	Semi-intensive
Hypophthalmichthys molitirix	Silver carp	Pond/baor	Semi-intensive
Mylopharnygodon picesus	Black carp	Pond/baor	Semi-intensive
Puntius gonionotus	Minnow	Pond/baor	Semi-intensive
Oreochromis niloticus	Nile tilapia	Pond/rice field/cage	Semi-intensive
O. mossambicus	Red tilapia	Pond/rice field/cage	Semi-intensive
Amblypharyngodon mola	Mola	Pond	Semi-intensive

like any other professionals, should start their enterprises on a modest scale and gradually intensify activities as they gain experience. The one-day *in situ* or pond-site training provided by the project created a much more positive impact than traditional and lengthier classroom training for farmers.

Bangladesh has successfully tackled one of the most challenging aspects of extension activities – the transfer of aquaculture technology. Lessons can be learned from this example about the impact of farmer participation in the development of aquaculture.

INTRODUCTION

Ponds account for only 3.5 percent of the inland waters of Bangladesh but contribute about 31 percent of inland fish production. Nevertheless, the average rate of fish production using traditional fish-culture practices is only **1.3** tonnes/ha/year. Production could be increased three- to fourfold by bringing ponds under semi-intensive fish culture. It is estimated that this could raise the level of inland fish production to some 353 000 tonnes per year. Table **1** lists the types of freshwater fish cultivated in Bangladesh.

Several aquaculture systems have been attempted in Bangladesh but not all have been of equal intensity; not all ponds are suitable for all types of aquaculture.

Twenty-three technology packages have been identified for extension. Some of the major factors determining the suitability of a body of water for a particular aquaculture technology include soil type, local climate, geographical location, size, depth and water-holding capacity, water availability and local environmental impact.

In order for a technology to be transferable to farmers, it must be flexible and possess universal characteristics that enable it to be adapted to different situations. Situations that hinder technology transfer include:

- multiple ownership
- pond size
- other uses of pond water
- inadequate supervision of pond activities
- lack of finance
- occupation and educational level of owners
- efficiency of the extension agent
- effectiveness of the extension system
- availability of various inputs

A participatory approach, in which local fish farmers can play an effective role in decision-making and implementation processes concerned with pond aquaculture, can help overcome the problems that may arise during the introduction of technology.

PRE-INNOVATION

Implementation of a scheme for fisheries extension services was begun during the early 1960s. Development projects over the years have strengthened extension services through the establishment of infrastructures and provision for logistic support.

Delivery of extension services to rural households, however, faced serious problems resulting from a shortage of workers at the grassroots level. Extension services were restricted to the supply of fish seed and training for farmers at fish seed multiplication farms and training centres. Very few demonstration programmes were launched, with the result that extension services could not encourage or advise farmers on the technical and economic aspects of aquaculture, since the programmes and services were not based on demonstrations to farmers. Extension efforts were poorly organized and there was no systematic plan to cover the needs of the farming community. Material input assistance mostly failed to identify the right farmers.

There was, however, some recognition of the importance of extension, reflected in the fact that extension was made an essential component in most development projects where sustainability was in doubt.

Attempts were made to provide extension service support to primary producers in the freshwater fishery sector but, given the vast extent of available water, human resources and the country's fishery potential, existing extension services were unable to provide sufficient support. To overcome this problem, a number **of** projects incorporated a large extension component, thus helping to build up a strong extension base. Development projects sponsored by the Danish International Development Agency (DANIDA) and the Asian Development Bank (ADB), for example, have large extension components. However, no systematic extension programme was initiated by the Department of Fisheries and field personnel remained engaged primarily in fisheries administration and other non-extension activities.

The major constraints affecting the spread and improvement of aquaculture were:

- inadequate supply of seed cultures at village level;
- absence of appropriate technology packages;
- poor distribution of simple technical messages in rural areas;
- insufficient financial resources;
- lack of understanding about the dynamics of pond production.

INTRODUCING INNOVATION

In an attempt to fill these gaps, the fishery extension component of the FAO/UNDP project Strengthening Rural Pond Fish Culture Extension Service designed **a** model aquaculture extension system suited to the field situation and the Department of Fisheries workforce. The expected outputs and planned activities **of** this innovative system – the "trickle-down''extension system – are shown in Table 2.

The system was first introduced in late 1990 in seven *thanas* in three districts, spreading in two phases to 35 *thanas* in ten districts. Nearly two years after its initial execution, the result demonstrators and other staff expressed their desire to share their experiences through a participatory workshop.

Because the extension system was under trial, the main purposes of the workshop were to review progress, evaluate the efficiency of technology transfer and improve the system further. This involved identifying weak points, constraints and limitations and seeking remedies through the active involvement of participating fish farmers, extension personnel and senior officers **of** the Department of **Fisheries. The objectives** of **the workshop were to:**

- clarify the concept, design, strategies and operation of the trickle-down extension system;
- review the progress of technology transfer activities and fish production/income performance by the result demonstrators;

TABLE 2
Outputs and activities of the trickle-down extension system

Expected outputs	Related planned activities
100 TFOs trained in improved aquaculture technology, technology transfer methods and aspects of extension management	Orientation training Field training Comprehensive training in fish culture extension Field exercises
100 FAs trained in improved aquaculture technology, technology transfer methods and extension monitoring	Field training Comprehensive training in fish culture extension Field exercises
100 FAs trained in improved fish culture, methods of technology transfer and monitoring of extension programme	Field training comprehensive training in fish culture extension Field exercises
55 senior DOF officers (DD, DFO and AD) trained in various aspects of aquaculture extension management	Orientation training Field training Operational workshop/participatory training
Training materials for thana level officers	Training materials for TFOs Training materials for AFOs and FAs
500 RDFFs trained in improved semi-intensive fish culture and conducting method and result demonstrations 2 500 FFs trained in semi-intensive fish culture	First spell of training Second spell of in situ or pond site training In situ training for 2 500 FFs involving their respective RDFFs
500 result demonstrations in farmers' ponds in improved semi-intensive fish culture in 100 thanas of the country	Demonstrations in farmers' ponds (RDFF ponds) Periodic visits Periodic visits by thana level fisheries officers/field workers to provide technical support to RDFFs
	Design bookkeeping records for farmers Design and introduce pro forma reporting Design and introduce pro forma socio-economic survey and impact studv
Preparation of guidelines and manuals	Production of manuals/guidelines on aquaculture extension, fish culture instructions for farmers (in English and Bangla) and appropriate aquaculture technology for undrainable rural ponds
Compute aquaculture extension management information system	Segments on personal details of RDFFs, technical and socio-economic aspects
Practical and cost-effective extension teaching tools	Flannel board set, game card, audiocassette, folk music and fish culture songs, videos on "Fish culture in undrainable rural ponds", "Trickle-down system for aquaculture extension" and "Dream of Rameez"

Acronyms:

AD	Assistant Director of Fisheries
AFO	Assistant Fishery Officer
DD	Deputy Director of Fisheries
DFO	District Fisheries Officer
DOF	Department of Fisheries
FO	Field Officer
FF	Fish Fanner
RDFF	Result Demonstration Fish Fanner
TFO	Thana Fishery Officer

- pool problems and constraints faced by the farmers and extension personnel, identifying possible solutions;
- further strengthen the trickle-down extension system by incorporating valuable recommendations.

These recommendations concerned:

- selection of result demonstrators and their ponds;
- selection of fish farmers and their ponds;
- involvement of non-governmental organizations (NGOs);
- home and pond visits by extension agents;
- training for officers/staff;
- *in situ* training programmes for result demonstrators and fish farmers;
- record-keeping;
- monitoring fish farmers' activities;
- human development issues such as developing the leadership qualities of result demonstrators;
- coordination with related agencies.

Guiding factors for the success of the trickle-down extension system

The following factors are key to the success of the trickle-down extension system:

- personal profiles of extension workers and officers (interest, sincerity, hard work and commitment);
- good relationships between result demonstrators, extension staff and fish farmers;
- technologies for transfer consistent with local conditions;
- training for extension staff and fish farmers;
- knowledge of water resource management;
- timely availability of inputs;
- a requisite number of field staff;
- transport facilities;
- supervision and monitoring systems;
- social recognition for officers and result demonstrators for their services.

One of the most challenging aspects of aquaculture extension activities has been the transfer of technology. The trickle-down system was designed as a participatory extension approach, demonstrating and disseminating appropriate aquaculture technology among farmers. This is achieved through:

- method and result demonstrations, incorporating both individual and group extension methods;
- repeated day-long *in situ* training for fish farmers;

- use of instruction manuals and other training tools;
- a teacher-pupil relationship between result demonstrators and fellow farmers;
- personalized service;
- close monitoring of operations.

Appropriate technology

A low-cost semi-intensive fish culture technology was selected for the programme. Against the background **of** existing practices, the project considered factors such as the technical capacity and ability of farmers to provide the required inputs exclusively from their own resources and the undrainable and multi-purpose nature of rural ponds. Modifications were made for further improvement, making the technology more suitable for local conditions.

Green manuring

Widespread adoption of manure-based aquaculture technology has resulted in a sharp increase in demand for cow dung and other organic manures. Besides reducing the demand for organic manure, green manuring has been found to increase significantly production and water retentiveness in sandy-bottomed ponds. *Dhanicha,* as it is locally called, is already used as green manure in paddy fields. Seed is thus easily available in rural areas.

Introduction of tea-seed powder as a fish toxicant

The multipurpose use of a pond does not always permit de-watering. Certain permissible and environmentally safe fish toxicants may be applied, such as rotenone powder and phostoxin tablets. Tea-seed cake, containing **8-9** percent of saponin, is a good locally available substitute. **A** firm that deals with agricultural chemicals, MacDonald Bangladesh Ltd., has already started large-scale production and distribution of the toxicant, advised by the project. Tea-seed powder is half the cost of imported materials, the fish are safe for human consumption and the toxicity lasts for only 4-5 days.

Introduction of predatory fish (Notopterus chitala)

As selective eradication is not possible, the introduction **of** 20-25 fingerlings/ha of ***Notopterus*** *chitala* (chital, moy) has been found to control the population of **smaller weed** fish.

Training

One-day orientation training courses for field counterparts of the Government of Bangladesh were conducted to initiate demonstrations in farmers' ponds,

TABLE 3
Problems encountered and some recommended solutions

Problem encountered	Recommended solution
Lack of fishing net, spring balance and sampling bag for periodic sampling	RDFFs should purchase these items through joint efforts
Non-availability of fish toxicants for eradicating weeds and predatory fish in undrainable rural ponds	Fish toxicant should be made available either by the Department of Fisheries or by pesticide companies, who should be approached to form a proper distribution system after assessing their own requirements
Non-availability of fingerlings	Involve some of the RDs in fry/fingerling rearing in the locality throughout the year
Lack of fish instruction manual	Make the instruction manual available to fellow fish farmers
No social recognition yet given to RDs	Successful RDs should be awarded a medal at various levels of the DOF establishments They should be invited to workshops, symposia, etc to recount their experiences and views
Nosignboardzany RD pond site	A signboard should be fixed at each RD pond site
Lack of extension teaching tools	A flannel board and a set of game cards should be aiven to each TFO and AFO.
Lack of transport for extension workers	Motorcycle/bicycleshould be provided

following selection and training of result-demonstrator fish farmers. A total of 187 field counterparts were trained in six courses.

Training for result demonstrator fish farmers and field training for government counterparts

A total of 42 field training courses were conducted for result demonstrator fish farmers and field counterparts, covering 53 districts and 5 divisions of the country. Altogether, 727 result demonstrator fish farmers were trained. Voluntary extension staff worked on behalf of the Department of Fisheries. A total of 500 government field counterparts also received field training.

Comprehensive aquaculture extension training for thana fishery officers

Six 5-day courses were conducted, training a total of 191 *thana* fishery officers. Extension officers working under development projects also participated in the training.

Comprehensive aquaculture extension training for assistant thana fishery officers

Seven 3-day training courses were organized, covering 148 assistant *thana* fishery officers, compared with the set target of 100.

Comprehensive aquaculture extension training for field assistants

Seven 2-day courses were conducted to train the field assistants of the five divisions. A total of 173 field assistants were trained, as compared to the set target of 100.

Operational training/workshop for senior government officers

In line with provisions made under the project, training for senior government officers (Deputy Directors, District Fisheries Officers and Assistant Directors) was planned in two sets of two days each. A total of 60 senior officers participated in the training compared to the target of 55. Ongoing activities were reviewed, while the concept, objective, approach and operation of the extension programme were discussed and recommendations were made to strengthen the system further.

Fellow fish farmers

One-day *in situ* training was organized for fellow fish farmers. Training was exclusively organized by the respective *thana* team members consisting of the *Thanu* Fishery Officer, Assistant Fishery Officer and Field Officer at the result demonstration pond site. A total of 6 520 fellow fish fanners were trained, against the set target of 2 500.

Refresher course

In response to government needs, day-long refresher courses were organized to replace the second set of operational workshops for senior government officials. A total of 46 courses were organized and 651 senior, mid-level and junior officers and staff of the Department of Fisheries were trained.

Computer training in the extension management information system

A week-long training course in the management of quarterly reports of field information was conducted for headquarters officers and staff. Participants were introduced to software developed for the management of data related to the identification of result demonstrators, monitoring production improvements and cost-effectiveness of the demonstration and socio-economic aspects.

Demonstration

Before demonstrations began, baseline surveys were conducted to register profit margins, socio-economic status and annual yields under existing culture practices. Fish farmers were selected from different strata of rural society to be result demonstrators. Most of the ponds were owned by result demonstrator farmers;

a considerable number were taken on lease. All the demonstrations were organized by the result demonstrators, using their own resources.

Final results were received from 701 demonstrations. The data indicated that average production went up from just over 1.46 tonnes/ha/year to almost 4 tonnes/ha/year. Incidental to the demonstration area of some 187 ha of water (701 demonstrations), a total of 282.5 tonnes of fish was produced.

Operational workshop and participatory training

The main objective of the operational workshop was to review progress in implementation, operational design including the reporting system, field problems related to technology and technology transfer and measures to be taken for making further improvements to the extension approach. A total of 60 senior fishery officers participated in the training, against the set target of 55.

Dissemination of the trickledown approach

Based on the principle of learning while playing, fish-culture game cards were developed as extension teaching tools. The pack of cards consists of 31 coloured pictures depicting various procedures in semi-intensive fish-culture practice. The cards also help in conducting post-training evaluation and achieving post-training clarity. A further extension teaching tool was the flannel board set, consisting of 105 m of flannel cloth with the printed FAO logo and the name of the project, 41 sketches printed on coloured cardboard paper, 5-6 sheets of sandpaper and a few ordinary paper clips.

The following three videos were also produced for extension activities:

1. Rameezer Swapna – Dream of Rameez. The film – in Bangla – is divided into two parts. The first is a drama showing how Rameez, a result demonstrator fish farmer, becomes important in his village through fish culture. He narrates his experience, giving viewers a clear account of the technology he has adopted. The second part is based on a common religion-based activity, through which knowledge of fish-culture technology is propagated for the welfare of the people by the religious village head.

2. The trickledown system of aquaculture extension (TDEs). The documentary film – in both Bangla and English – gives a clear account of the system and its design and serves as attractive material for training officers in aquaculture extension through TDEs.

3. Fish culture in undrainable rural ponds. This documentary – also in Bangla and English – provides complete technical information about the semi-intensive fish culture technology being practised by farmers, including women, in their ponds.

Field documents

The following publications have been produced:

- Training Manual for TFO (English)
- Training Manual for AFO and FA (Bangla)
- Instruction Manual on Fish Culture in Undrainable Rural Ponds for Farmers (English)
- Instruction Manual on Fish Culture in Undrainable Rural Ponds (Bangla)
- Manual on aquaculture extension through the trickle-down system (English)

POST-INNOVATION

It is desirable to change priorities and mandates from technical administration and commercial activities to strengthening extension services for the sectoral clientele. It has been recognized that an increase in production, with associated socio-economic benefits, could be achieved only if improved production technologies are applied to rural household ponds.

The demonstration of semi-intensive aquaculture in rural ponds has proved that production of pond fish can be increased three to fourfold by replacing traditional culture practices with appropriate low-cost technology. The gap between existing average production of 1.3 tonnes/ha/year and the level achieved by result demonstrator fish farmers is considered to be the extension gap. By strengthening fish culture extension services, this gap can be reduced, resulting in a multifold increase in pond production through a participatory approach.

Inspired by the results of the large-scale implementation of the aquaculture extension programme in rural ponds through the trickle-down system, the Government of Bangladesh has started a nationwide follow-up project. This covers 400 *thanas*, uses only government resources and closely follows the pattern of this FA0 project. The move is viewed as the final step towards institutionalization of fisheries extension under the Department of Fisheries. The extension approach, as well as the technology selected for semi-intensive culture in rural undrainable ponds, is adapting well to local conditions, the structural and functional situation in the Department of Fisheries and the socio-economic and cultural profile of the clientele. The technology and the methods of technology transfer have reinforced each other. The development of low-cost technology and practical training/extension materials has been replicated in other projects and sectors, as well as in other countries.

LESSONS LEARNED

- Undrainable rural ponds are closely associated with the socio-economic and cultural life of the people of Bangladesh and offer extensive scope for fish culture.
- Organizing large-scale demonstrations (886) in farmers' ponds, without giving any input/credit support and within a limited time frame of one year, was possible mainly because of the high level of support by the Government of Bangladesh and the commitment of counterpart officers and farmers.
- The technology and the methods of technology transfer have been found to reinforce each other.
- Technical assistance may be provided for further intensification of aquaculture in undrainable ponds throughout Bangladesh.
- Comprehensive aquaculture extension training may be organized in reverse order, i.e. Field Officer, Assistant Field Officer and *Thana* Fishery Officer, in order to maintain the quality of extension services.
- Almost all ponds in Bangladesh are household ponds where women are closely involved, but as "invisible" workers. A project could be designed for the development of rural women through household pond fish culture.
- A fish farmer, like any other professional, should start on a small scale, then grow and gradually intensify activities while gaining experience.

One-day *in situ* or pond site training creates a much more positive impact than traditional lengthy classroom training.