8.7 Decentralized seed – poorer farmers producing large size fingerlings in irrigated rice fields in Bangladesh

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ABSTRACT

Fish seed production and supply are well established in the private sector in Bangladesh and had greatly contributed to the rapid development of aquaculture. Hatcheries and nurseries producing fish seed are largely located as clusters in certain areas of the country and produce mainly riverine carps which are then supplied to farmers through an established trading network. Such clustered locations of hatcheries and nurseries are useful for cost effective institutional support, to share knowledge and to attract customers. But they are facing various constraints. There is high competition to sell their produce which can result in reduced profit margins. Constraints are minimized by increasing the efficiency of production but this is often at the cost of quality and there are few incentives to improve the quality of fish seed. As seed has become more available and aquaculture reached the current level of development, improving production and availability of large size quality fish seed are important to farmers in Bangladesh.

"Decentralized" seed production and supply may result in more benefits to poor people involved in aquaculture in rural areas in Asia. Several methods such as breeding and nursing of fry to fingerlings in hapas in ponds and in rice fields, nursing of fry in cages in ponds and nursing of fry in small seasonal ponds can be considered as "decentralized" approaches. Of these, the use of irrigated rice fields for production of fingerlings of common carp and Nile tilapia had shown great success among poor farming households in Bangladesh.

Common carp and Nile tilapia (GIFT strain) are currently of secondary importance to riverine carps in Bangladesh aquaculture but are showing increasing demand by farmers. Common carp can breed in ponds and farmers can produce fingerlings by stocking fertilized eggs in their irrigated spring rice ("*boro*") field. Similarly, breeding

and production of fingerlings of mature Nile tilapia can be simply managed in irrigated rice fields. Both species reproduce without any special requirements and facilities making production of juveniles possible outside of specialized hatcheries. Considering the simplicity of common carp fingerling production, initiatives have been taken by CARE Bangladesh to promote the technology among poor and marginal farmers. Before on-farm trials to assess GIFT tilapia fingerling production in 1999, only common carp fingerlings were produced in rice fields. Farmers successfully produced common carp fingerlings in their rice fields to meet subsistence needs for stocking ponds and rice fields. There appeared to be little interest in developing more commercial seed production.

A participatory trial was initiated to introduce Nile tilapia (GIFT strain) to farmers already producing common carp in irrigated "*boro*" rice fields. Monitoring of 19 farmers in two communities in northwest Bangladesh showed that the approach stimulated broader behavioural and management changes, was accessible to poor households and led to a range of different benefits. Stocking of very small numbers of broodfish in one rice field plot per household only marginally modified in February-March led to more than 90 percent of farmers producing good numbers of fingerlings. Production during the spring rice "*boro*" rice season (April- July) was more effective than during the rainfed "*amon*" rice season (August- December) for several reasons. Demand for fingerlings is high during spring rice season as majority of farmers stocked their ponds around this time. In addition, the relatively low level of water in the rice fields makes it easier to harvest the fingerlings. The lower risk of flood at this time also means minimal loss of fingerlings during the spring rice season. The cost of fingerling production was low and incomes were four times more than the expenditure. Introducing Nile tilapia resulted to higher yields of juveniles than using common carp alone and a greater diversity of benefits, for e.g. on average 43 percent were sold, 39 percent were re-stocked for grow-out and 17 percent of the large fingerlings were directly used for household consumption. The introduction of GIFT and common carp in rice fields for fingerling production has substantially enhanced resource productivity and profitability (Barman and Little, 2006).

The successes of the initial research programme were quickly extended and replicated directly by other nearby households. Non-producers such as fingerling traders were critical to the approach spreading further afield. The organisation CARE hosted a second strand of research designed to improve adoption and dissemination strategies within a large-scale development project aiming to establish lower external input dependence among rice farmers in the northwest region. The outcomes of this research led to the technology being incorporated into the Farmer Field School (FFS) curricula used by CARE throughout the region.

A further outcome of this research was that extension practitioners have improved selection of appropriate households and production sites and successfully co-developed with farmers new ways to produce fingerlings at different times of the year in varying conditions. The rise in good quality fingerling sales had led to another important outcome. The production of common carp and GIFT as foodfish from rice fish and pond culture increased two fold among households producing juveniles suggesting the value of large-sized seed being available on farm at the right time.

INTRODUCTION

Fish seed production in Bangladesh is concentrated around traditional supply centres and government stations across the country. An informal army of traders distribute the seed to villages even in remote locations which has undoubtedly stimulated uptake of fish culture but not without constraints. Farmers are dependent on unsolicited and often untimely deliveries of small, weak fingerlings which may not be sufficient for their pond or may not have the right mix of species. To counter this, local seed

production based on species that reproduce easily were piloted in modified existing production systems owned by poor people. Rice fields were found to be advantageous for production of juveniles of common carp (*Cyprinus carpio*) and Nile tilapia (*Oreochromis niloticus*) by small-scale farming households in Bangladesh.

Since 1990s, the Cooperative for Assistance and Relief Everywhere (CARE) Bangladesh promoted ricefield-based fish seed production in the region initially with common carp and later with both common carp and Nile tilapia, introducing "GIFT' Tilapia in 1999. The Decentralised Seed Project (2003-2006), a collaborative research program funded by the Department for International Development (DFID of the United Kingdom), managed by the WorldFish Center (WFC) and the University of Stirling in the United Kingdom implemented, along with partner NGOs, three key sub-projects to advance this technology for the benefit of poor fish producers, namely: i) promotion and adoption strategies of ricefield-based fingerling production determined in 25 randomly selected communities from five out of 8 Districts in northwest Bangladesh, ii) livelihood impact assessments of fish seed production in rice fields of 30 rice fish households in comparison to 30 non-rice fish farming households selected from the northwest region and iii) fine tuning of the technology and scaling up the adoption process with 33 partner NGOs of WFC who managed on-farm research trials on Nile tilapia seed production in rice fields with 250 households in several regions of the country.

FINGERLING PRODUCTION IN RICE FIELDS

Common carp seed production

Rice fields are normally considered for the production of foodfish but it was in the 1980s when the Northwest Fisheries Extension Project (NFEP) and CARE Bangladesh tried to establish systems on the use of rice fields for fingerling production. It was initially tried with common carp by stocking hatchlings from hatcheries in irrigated spring "*boro*" rice fields in northwest Bangladesh. Later on, the use of fertilized eggs of common carp attached to the roots of water hyacinth, after local spawning in small ponds and ditches, was promoted. These systems showed success in the production of common carp fingerlings with minimum investment. The Food and Agriculture Organization of the United Nations (FAO) supported an initial pilot project in 1992 and from 1993 CARE implemented larger projects to promote ricefield-based common carp seed production. Farmers used the seed produced for subsistence purposes and a field study revealed no development of revenue generation among seed producers (Barman and Little, 2004).

COURTESY OF D.C. LITTLE

Inspecting of water hyacinth roots for common carp eggs prior to stocking in boro ricefields. Common carp broodfish had been stocked in a small ditch close to the rice field with the floating weed to induce natural spawning

Nile tilapia seed production

A research trial in 1999 was implemented in cooperation with the local field offices of CARE IF project participated by two communities (four and 15 households) who had previously adopted common carp production. Each household selected one plot for stocking 18 tilapia broodfish (GIFT strain; 12 female and 6 male) provided to their rice field ditches during the irrigated "*boro*" season from end of February to the beginning of March.

The outcomes of the trial were very successful as most of the partcipating households were able to produce significant

COURTESY OF D.C. LITTLE

Small GIFT strain Nile tilapia broodfish used for stocking ricefields. Fish seed traders have been important in moving broodfish between areas encouraging farmers to produce seed

numbers of large tilapia fingerlings. On average, 43 percent of the fingerlings were sold, 39 percent were stocked for grow-out and 17 percent of the large fingerlings were directly used for household consumption. News of the outcomes of the trial were known to most of the neighbours in the communities, to farmers from outside the trial communities through CARE and to relatives and fish seed traders through informal channels. A significant number of fingerlings were purchased by traders who sold them on to farmers in other communities. Research outcomes were shared, during the trial period, with CARE field staff through workshops and field visits.

PROMOTION AND ADOPTION OF RICEFIELD-BASED FINGERLING PRODUCTION

The number of farming households adopting juvenile fish production and the number of rice fields used increased over three consecutive seasons in communities that were subsequently monitored (Table 8.7.1). The introduction of Nile tilapia in areas where common carp fish seed production in rice fields was already established led to several significant improvements to farming households. There were significant increases in productivity of the system, the numbers of fingerlings used for re-stocking, household fish consumption and the numbers of fingerlings sold for cash income. In addition, farming households further developed their systems to facilitate the production of the other species, such as Indian major carps and Chinese carps, along with common carp and GIFT for restocking and their own foodfish production.

The introduction of the GIFT tilapias stimulated rapid adoption in surrounding communities. Further analysis showed that the practice spread from its introduction to four households in one community to 121 households in 20 communities within three years without further formal/institutional support (Barman and Little, 2004).

The introduction of tilapia in areas where common carps were established also stimulated the advanced nursing of riverine carp species (Indian major carps, Chinese carps and silver barb) obtained from traders as fry (Table 8.7.2). Most households stocked the fertilized eggs of common carp attached to a substrate that can be obtained locally at no cost. Purchase of hatchlings from hatcheries and nurseries is more resource-intensive. The retention and use of brood fish locally, whether common carp or tilapia is an important advantage of these species but necessitates access to perennial water. Evidence suggests that this does not require ownership of perennial water bodies but that a range of strategies are employed. However, most households report that the numbers of tilapia broodfish were insufficient to optimize the contribution of tilapia to their overall production.

A key feature of the pattern of management observed is the harvesting of the majority of fingerlings produced in irrigated "*boro*" rice during times of high demand at the beginning of the monsoon

TABLE 8.7.1
Rice fish farmers and corresponding rice field plots for fish seed production during three years of monitoring

Production season	Number of farmers	Number of ricefield plots
'boro' year 1	134	145
'boro' year 2	163	181
'boro' year 3	174	203

Source: Barman, Little and Janseen, 2004

TABLE 8.7.2
Percentage of households using different species combinations for large size fingerling production in spring (boro) rice fields in northwest Bangladesh

Production season	Common carp (percentage)	Only tilapia (percentage)	Common carp and tilapia (percentage)	Common carp, tilapia and and riverine carps (percentage)
'boro' year 1	54	3	7	36
'boro' year 2	40	4	11	44
'boro' year 3	31	4	9	56

Source: Barman, Little and Janseen, 2004

rains. The productivity of the systems appears to increase if farmers retain fingerlings into the fallow period following the harvest of "*boro*" rice and before the start of the main crop "*amon*" rice transplantation. The fallow rice fields are a favourable environment for the fingerlings to grow and this approach also facilitates harvest of seed from the rice field plots. This strategy, apart from corresponding to the period of maximum demand, also avoids the risk of flood loss which is highest during the season from August to October. The value of using ricefields for fish culture is clearly established in the area and some farmers developed their plots to prevent or mitigate flood loss and allow use of rice fields through both seasons.

The productivity of ricefield-based seed systems was greatly enhanced by using Nile tilapia; the mean productivity of this species (2088 ± 632/household) was almost double the production attained using common carp (1083 ± 135/household) or riverine carps (1281± 438/household). The large-sized fingerlings produced from rice fields (20-30 g) are favoured for their enhanced outcomes during subsequent grow-out production compared to smaller size fry that are typically available in rural areas. They are particularly valued in seasonal water resource based systems (seasonal ponds, seasonal ricefield-based systems) in which production duration is limited. In seasonal pond-based systems, a 36 percent increase in productivity was achieved and obtained by stocking large juvenile Nile tilapia with other species in polyculture compared to ponds without tilapia in northwest Bangladesh (Barman, 2000).

THE IMPACTS OF RICEFIELD-BASED FINGERLING PRODUCTION

The WFC (Bangladesh and South Asia office) reported impacts of the ricefield-based fish seed production in Bangladesh as described below.

Due to its success towards self-sufficiency and opportunity for poor people to earn cash from sales of fingerlings, the approach was incorporated into CARE's national integrated agricultural development program. As a result, studies revealed that of the 194 840 households trained using the FFS approach - over 30 000 households adopted the technology, maintaining both self-sufficiency in seed supply and on average, selling 2 000 fingerlings per seed-producing farmer, valued at $40 to the benefit of 120 000 to 150 000 foodfish farmers per year.

In addition to fish seed sales, farmers also benefitted from improved nutrition through improved access to

COURTESY OF D.C. LITTLE

Plots used for seed production are often located close to the homestead. This picture shows preparation of the ditch or refuge, used for holding breeding fish and then for concentrating juveniles prior to harvest

COURTESY OF D.C. LITTLE

Children catch many of the fish used for home consumption derived from ricefield based fingerling production. The harvest is used for selling juveniles, re-stocking for further culture or eaten or sold for food fish. This flexibility is highly valued by farming households

foodfish. Studies also revealed that annual fish consumption of rice fish households was 23 kg higher than non-ricefish households.

Poverty profile analysis suggests that about two-thirds of the technology adopting households were defined by community key informants as "poor" owning less than 0.4 ha of land, earning less than US$600 per household and home-grown rice supported the family for less than 6 months per year. The pro-poor aspect of this technology may be further highlighted by its modest investment requirement (<15 US$), its simplicity, a relatively simple add-on to existing production technology and applicability to small rice plots (0. 1 ha). In fact, the research has shown that seed production efficiencies were found to be greatest in smaller plots generally owned by poor people as rice plot size is positively correlated with wealth.

The poor rice fish households may be defined as "pluri-active"; 87 percent of farmers reported that the ricefield-based fish seed production is compatible with their other occupations especially for women and children. For 60 percent of adopters, the distribution of some fingerlings as gifts to relatives and neighbours increased their social capital.

Environmental benefits were evident from 97 percent of rice fish farmers reporting no use of pesticides and the majority of households reported that rice fish adoption increased harvest of fish and other aquatic animals from rice field ecosystems thus making better use of irrigated water.

THE IMPLICATIONS OF THE CONCEPT AT NATIONAL, REGIONAL AND GLOBAL LEVELS

The approach has been incorporated by CARE into its aquaculture development programs thus reaching out to many communities across the country. At the regional level, the outcomes of the concept of "decentralized seed" were shared with the project personnel and scientists of north Viet Nam in 2005. Thereafter, the technology has been incorporated into the Aquaculture Program of the Danish International Development Agency (DANIDA) in Viet Nam starting with an on-going pilot project working with 60 farmers. Globally decentralised seed production has the potential to contribute to poverty reduction and economic growth anywhere that rice farming and unmet demand for fish co-exist. It is currently promoted by the WFC and the University of Stirling in international events and scientific publications.

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