Institution: University of Stirling

Unit of Assessment: C17 Geography, Environmental Studies and Archaeology

Title of case study: Multiple benefits from improved tilapia production: contributions to food security in Bangladesh

1. Summary of the impact

Tilapia, an important farmed fish is of fundamental importance to the food security of poor people in less developed countries, and ensuring high quality juveniles are available locally is critical. Stirling's Sustainable Aquaculture group have been instrumental in developing a novel decentralised approach to sustainable tilapia farming which has now been piloted and scaled up in NW Bangladesh (NWB). This work has improved the availability of high quality seed and more efficient and productive food fish. This has led to seasonal income smoothing and elevated household nutrition among the targeted poorer households producing the juveniles, as well as reduced costs and use of agrochemicals in associated rice production. Landless people have also benefitted through trading fish in targeted areas and further afield.

2. Underpinning research

An enduring challenge for effective rural development is the targeting of environmentally-benign, value-added, innovative technologies among poorer farming households. Aquaculture is relatively novel in most contexts, even in Asia where it is longest established, but there is limited evidence for any substantive contribution to poorer livelihoods; indeed the Sustainable Aquaculture group at Stirling have found that the resource intensity of most aquaculture often limits direct benefits as producers and that better-off entrepreneurs tend to control the most valuable niches especially juvenile production (Little et al., 2007). Targeting poorer actors in production and distribution of juveniles can theoretically improve benefits to the hardest-to-reach in rural areas and result in significant multiplier effects. A prerequisite for people with access to water for adoption of aquaculture is the timely availability of juvenile fish. The quality of juvenile tilapias reaching small-holder fish producers affects their adoption in the longer term, and this has been linked to both genetic and non-genetic factors such as transportation stress (MacNiven and Little, 2001). Furthermore, seasonality of water availability, and a high reliance on rain-fed food production, causes a distinct peak in demand for juvenile fish at the onset of the monsoon season in NWB to which any hatchery strategy needs to align.

The key criterion of quality for juvenile tilapia in the context of NWB is the potential to reach a size of 250g before onset of maturity. This can be achieved using mixed sex fish produced in simple decentralised, low-input, systems appropriate for adoption by poorer, rice-growing households; there is no necessity for production of monosex stocks fish which are the preserve of well capitalised entrepreneurs. The expectation was that a decentralised approach, could also result in benefits to a broad range of poor people involved in fish value chains as service providers and consumers. A participatory field research study funded by DFID was undertaken in two communities in NWB in 1999 involving David Little and Benoy Barman, within the context of a larger development project. After the encouraging outcomes of the research with regards to the quality of juvenile fish produced, an International NGO (CARE International) mainstreamed the approach within large-scale development projects and promoted it in over 9000 households throughout NWB. Further research by the group assessed the outcomes and further refined the approach before it was scaled up and out through local NGOs to more than 20,000 households. The key research finding leading to this wider interest among development agencies was that of the households participating in the trials, exclusively drawn from the poorest rice-growers, most (70%), were able to produce large Nile tilapia fingerlings on a scale that met a range of different needs including selling for cash, restocking into their own food fish systems or direct consumption. The research showed that households using either a single, small rice plot or small fine mesh cages *(hapas),* suspended in ponds achieved efficiencies of production that exceeded those from many conventional hatcheries (Haque et al. 2010). Monitoring of juvenile production and marketing confirmed that the system almost perfectly matched supply with demand at the onset of the rains and water availability for stocking in seasonal systems. Research from Stirling identified that the main marketing channels through which juveniles were sold were local and that, in addition to pond owners purchasing directly, actors such as fingerling traders and fishers (among the poorest in the communities) were important for local distribution (Haque et al. 2010). The scale of the original research (two trials based on a total of 65 households), allowed for variability in outcomes to be assessed and informed later research into secondary adoption, adaptation and impacts.

3. References to the research

Key papers:

1. Barman, B.K. and Little, D.C. 2011. Use of *hapas* to produce Nile tilapia (*Oreochromis niloticus* L.) seed in household foodfish ponds: a participatory trial with small-scale farming households in Northwest Bangladesh. *Aquaculture* 317: 214-222.
2. Haque, M.M., Little D.C., Barman' B.K., Wahab, M.A. 2010. The adoption process of ricefield based juvenile fish production in Northwest Bangladesh: an understanding through quantitative and qualitative investigation. *Journal of Agricultural Education and Extension* 16: 161-177.
3. Little, D.C., B.K. Barman, M.M. Haque and M.A. Wahab. 2007. Decentralised Nile tilapia seed production. In Fishponds in Farming Systems, 2007. Editors: Zijpp A.J. van der, J.A.J. Verreth, Le Quang Tri, M.E.F. van Mensvoort, R.H. Bosma, M.C.M. Beveridge; Proceedings of a symposium held in Can Tho City, 28-30 April 2006, organised by Can Tho University, Vietnam and Wageningen University, Netherlands. Wageningen Publishers.pp 49-58.
4. Little, D.C., Nietes-Satapornvanit, A. and Barman B.K. 2007. Seed Networks and entrepreneurship. *In* M Bondad Reantaosa, ed. *Assessment of freshwater fish seed resources for sustainable aquaculture* pp.549-561. FAO Fisheries Technical Paper 501, FAO, Rome.
5. Barman, B.K. and Little, D.C. 2006. Nile tilapia (*Oreochromis niloticus)* seed production in irrigated ricefields in Northwest Bangladesh-an approach appropriate to poorer farmers? *Aquaculture* 261:72-79.
6. MacNiven, A.M. and Little, D.C. 2001. Development and evaluation of a stress challenge testing methodology for assessment of Nile tilapia (*Oreochromis niloticus* L.) fry quality. *Aquaculture Research* 32: 671-679.

Associated grants:

1. Promoting decentralised fish seed Innovation challenge fund. Research Into Use Programme, DFID £400,000 (2008-2011); Rangpur Dinajpur Rural Service (RDRS), Bangladesh Coalition partners: Bangladesh Agricultural University (BAU) University of Stirling, Institute of Aquaculture, UK International Development Enterprises, Bangladesh (IDE) Practical Action, Department of Fisheries (DOF) People's Resource Oriented Voluntary Association (PROVA), SACHETAN
2. Association for Community Development (ACD), Tribhuvan University, Institute of Agriculture and Animal Science, Nepal, WorldFish Center, Bangladesh and South Asia Office, One-stop Aqua Shop, West Bengal, India.
3. Developing strategies for sustaining fry quality through decentralised seed supply systems: £197,898 August 2003-March 2005. AFGRP Programme development David Little, Stirling; Elizabeth Harrison, Sussex; Graham Mair, UOW; M.A Wahab, BAU; N.C. Dan, RIA 1.
4. Improving freshwater fish seed supply and performance in small-holder aquaculture systems in Asia. £257, 889. November 1997-September 2002. DFID. RNRRS Aquaculture Research Programme, David Little, Stirling and Peter Edwards, AIT.

4. Details of the impact

A rapid assessment of the impact of the introduction and testing of decentralised seed production (DSP) was initiated 3 years after the initial field work conducted in 1999. A radial study to assess secondary adoption within 3 km of one of the research communities, in which 4 households had originally participated, found that a total of 120 households in more than 20 communities were now engaged in the practice. On the strength of the early success, an International non-governmental organisation (CARE) mainstreamed the inclusion of tilapia as a component of a project (commencing in 2001) working to promote innovations in rice field management based in 150 communities over 3 seasons in a different area of NWB.

The main societal impacts, however, have occurred more recently through further scaling up (e.g. 5.1) and after recommendations arising from this work were incorporated into curricula for Farmer Field Schools promoting the practice. A subsequent analysis of adoption in 20 communities sampled from this broader group found that although the area of the ricefield used and access to tilapia broodfish were critical, a large range of ecological and complex socio-cultural factors were responsible for its adoption or rejection by farming households (5.2). Key differences were found between primary and secondary adoption; primary adopters (i.e. those to whom DSP has been directly extended) tended to be poorer and the benefits invested in immediate consumption (purchase of food, education etc), whereas secondary adopters tended to invest in longer term assets (e.g. land). More than 80% of households found that the technology supported the basic food needs of household members, particularly women, children and the elderly. There was an important temporal aspect of the benefits delivered by the approach, since fish consumed and income provided for households occurred during the 'hungry gap'; DSP can be regarded as a coping mechanism for households' seasonal vulnerability. An important impact was the development of networks among seed producers and fry traders that reinforced the adoption process. It was also found that adoption was not constrained by illiteracy of the household head, the size or ownership status of ponds, or lack of ownership of land or an irrigation pump. Poorer and intermediate households had smaller ricefield (RF) plots and lower production of fingerlings (kg/household) compared to the better-off, however, their production efficiency (kg/ha) was higher. Restocking of RF-produced fingerlings increased household pond productivity by 60% over non-RF households. As a result, better-off RF households increased their fish consumption (by 50%) compared to non-RF. Poorer households reduced dependence on the market for meeting their fish consumption, particularly during months of low availability of wild fish. The importance of income flows from fingerling sales were also linked to seasonality, especially for poor households. Complementarity of DSP to the core household activity was demonstrated; the production of rice in the irrigated season and income in both seasons was much higher in seed producing ricefields compared to other ricefields (RF and non-RF). Breeding and nursing tilapia in *hapas* has also been promoted by follow-on extension projects among ethnic minority groups marginalized from mainstream society that are particularly dependent on fish as food. Research on impact (5.3) found that beneficiaries, mainly women, gained in terms of income and food security through cage culture and roles trading fish generated through promotion of DSP.

On the basis of these demonstrated key improvements of poor livelihoods, DSP was established as an effective pro-poor innovation that could be established in rural areas. It then spread organically, and an extension programme, designed and funded to support further scaling up, resulted in the inclusion of 20,000 households in different contexts throughout NWB in partnership with a range of local partners (5.4). The key demonstrated outcomes of this initiative broadly mirrored the findings of the detailed assessment of impacts presented above. A more detailed understanding of upstream and downstream impacts emerged in this larger project where chains of micro-entrepreneurs were established as an outcome of the programme leading to more diversified and sustainable impacts on livelihoods. It was found that the use of satellite broodstock-rearers, established to support sustained and productive DSP adopters, was an effective strategy and niche for better off farmers with perennial water sources. The impacts on one of poorest groups in NWB communities (i.e. seasonal, often land-less fingerling traders) were also positive with their involvement in marketing juvenile tilapia increasing throughout the project period (5.5).

The beneficial socio-economic impacts on poor people have been established but a further study identified important and positive environmental impacts. Biswas (5.6) identified reductions in reported use of pesticides not only among rice fish adopters but also non-adopters in the same community. Across the NWB region this would constitute an important environmental benefit.

There has been institutional take up by a wide range of Government and Non-Government field-level implementers in the NWB and mainstreaming of DS into their regular field-level programmes . These organisations include the Department of Fisheries 5.7), and non-governmental organisations Caritas and Practical Action (5.1). WorldFish, a member of the Consultative Group on International Agricultural Research has mainstreamed the approach in Bangladesh and in other countries in Asia and Africa for contexts that have similar agro-ecosystems through published manuals (5.8) and incorporation into other projects such as the Adivashi Project focusing on marginalised tribal communities (5.3, 5.9, 5.10).

5. Sources to corroborate the impact

1. **Factual statement** from Head of Policy Practice and Programme Development, Practical Action Bangladesh (NGO promoting DSP).
2. **Publication**: Haque M.M., Little, D.C., Barman, B.K., Wahab, M.A. and Telfer, T.C. 2012. Impacts of decentralized fish fingerling production in irrigated rice fields in Northwest Bangladesh. *Aquaculture Research* 1-20.
3. **Publication:** Pant, J., Barman, B. Kumar, Murshed-E-Jahan, K., Belton, B & Beveridge, M. (2014). Can aquaculture benefit the extreme poor? A case study of landless and socially marginalized Adivasi (ethnic) communities in Bangladesh, *Aquaculture* doi: 10.1016/j.aquaculture.2013.09.027 (early view available).
4. **Project report**: Barman, B.K., Mitra, B., Belton, B., Rahman , M and Shrestha, S (2011) Enhancing the Impacts of Decentralised (fish) Seed Production (RIU-DSP) Project End of project report 25pp Putting agricultural research into use.
5. **Working paper**: Reddy, V., Hall, A. & Sulaiman, R. 2011. The when and where of research in agricultural innovation trajectories: evidence and implications from RIU's South Asia projects. Working paper Series 024. Maastricht Economic and Social Research Institute on Innovation and Technology (UNU-MERIT). Available at: http://www.merit.unu.edu/publications/wppdf /2011/wp2011-024.pdf (case study 2, pages 20-25)
6. **MSc Dissertation**: Biswas, N.J. 2008 *Impacts of rice-fish integration on pesticide use at a community level in Northwest Bangladesh*. University of Stirling, 100pp.
7. **Factual statement** from Principal Scientific Officer, Fish Inspection & Quality Control, Department of Fisheries, Bangladesh
8. **Manual**: Barman, B.K, Roy S., Haque, M.Mitra, B; Belton, B. (2010). Fish Seed Production in Ricefields Participatory Training and Extension Manual. Available at: http://www.worldfishcenter.org /resource_centre/WF_2781.pdf
9. **Factual statement** from Director, Worldfish, Bangladesh and South Asia
10. **Project report** Aquaculture Options for Alternative Livelihoods: The experience of the Adivasi Fisheries Project in Bangladesh. Available at: http://www.worldfishcenter.org /resource_centre/WF_2484.pdf