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Investing in carp seed quality improvements in homestead aquaculture: lessons from Bangladesh

Manjurul Karim [a,*], Hendrik Jan Keus [a], Md. Hadayet Ullah [a], Laila Kassam [c], Michael Phillips [b], Malcolm Beveridge [d]

[a] WorldFish, House no-22B, Road no-7, Block no-F, Banani, Dhaka 1213, Bangladesh
[b] WorldFish, Jalan Batu Maung, 11960 Bayan Lepas, Penang, Malaysia
[c] Amaranth Sustainable Development LLP
[d] WorldFish, Katima Mulilo Rd, Plot 37417 Olympic Park, Lusaka, Zambia

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ABSTRACT

Lack of quality seed and technical knowhow are considered major constraints to improving aquaculture productivity and profitability in Bangladesh. This paper assesses the outcomes of investments in improving carp seed quality and farmer training, targeting poor and women fish farmers, on the productivity and profitability of homestead aquaculture systems in Southwest Bangladesh. The paper also assesses the effect of factors such as stocking density, use of fertilizer and feed, farmers' characteristics and location on fish yields and determines the major driving factors influencing adoption of improved practices. The results show that farmers who used improved carp seed and received training had higher yield and profit from homestead aquaculture than farmers who received training but did not use improved seed. Both of these farmer categories had higher homestead pond yields and profit than those who did not receive training but used improved seed and all three categories were found to have higher yield and profit than the control group. These results suggest that using improved seed without technical advice is unlikely to have a significant impact on aquaculture productivity and profitability while training without using improved quality seed is likely to have a positive impact on these outcomes. These results are supported by a multiple regression model which shows that, when controlling for other factors, farmers who had been trained and used improved seed were 52% more productive than the control group, while those who had been trained and did not use improved seed were 15% more productive. There was no significant difference ($P<0.05$) in productivity between farmers who had not received training but used improved quality seed and the control group. Location, stocking density, pond water area and experience were also found to significantly influence homestead pond productivity. The additional net return generated by farmers as a result of investments in improved seed and training is estimated to be approximately US$ 470,000 and US$ 210,000 for training alone, representing a return on investment (ROI) of 285% and 394% respectively. Despite the high ROI, the modest absolute increases in income and production estimated for participating households, due mostly to the low base from which growth is taking place, suggests the need for future investments to bring about relatively higher rates of productivity increases if they are to have meaningful impacts on household production and income. Overall, these results suggest that it is not enough for aquaculture development interventions to focus only on the technical fix of improved seed, rather capacity building of farmers is also crucial if aquaculture productivity and profitability are to be successfully improved.

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1. Introduction

A continuous and dramatic growth in global aquaculture production has been observed since the 1950s, and is expected to continue in the new millennium. The requirement for animal source foods will continue to rise in the coming decades due to increased population and economic development driving increased future demand for fish products. This demand will only be fulfilled if aquaculture makes an increasing contribution to the volume and stability of global fish supplies (Merino et al., 2012).

Bangladesh is the world's fifth largest aquaculture producer (FAO, 2014) accounting for just over 2% of global production. Aquaculture contributes approximately 55% of inland fish production in the country and produced a total of 1.85 million mt in 2013 (DOF, 2014). Inland aquaculture production in Bangladesh has shown a remarkable increase

* Corresponding author.
E-mail address: m.karim@cgiar.org (M. Karim).

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between 2006 and 2014 with an average annual growth rate of nearly 12% (DOF, 2014). This impressive growth has been possible due to the recent rapid expansion and intensification of pond aquaculture, which is the predominant aquaculture production system in Bangladesh. Pond aquaculture accounts for approximately 86% of total production and 58% of the area under culture (DOF, 2010). A recent study showed that around 4.27 million households in Bangladesh (20% of rural inhabitants) operate a homestead pond, covering a total water area of 265,000 ha and producing around 400,000 mt of fish and other aquatic products (Belton et al., 2011).

Income diversification (on or off-farm) is considered one of the most important pathways out of poverty (Krishna, 2006), including in Bangladesh (Sen, 2003). Aquaculture is one potential pathway for poverty alleviation and social and economic development (Belton et al., 2011; Haque, 2007; Karim et al., 2011; Little et al., 2012). Bangladesh is one of the seven countries that accounts for about two-thirds of the total number of undernourished people in the world. Nevertheless, fish is estimated to contribute 50% of total animal protein intake of the country (FAO, 2014). This contribution could be substantially higher and could potentially meet domestic fish demand if aquaculture productivity was increased. Currently, the level of annual aquaculture production from ponds and ditches is around 2,839 kg/ha/year (FRSS, 2009), which is relatively low compared to many other leading aquaculture producing countries. Thus, increased productivity of pond aquaculture represents one possible route to address fish demand and contribute to social and economic development.

Successful pond aquaculture depends mainly on proper pond preparation/conditioning, seed quality, stocking density, feeding, fertilization, water management, pond maintenance, and harvesting (Baluyut, 1989). Belton et al. (2011) noted that the growth of aquaculture in Bangladesh is particularly related to the production and supply of seed and feed, but highlight the quality of both inputs as a major concern. The importance of freshwater fish seed quality in Asia was documented by Little et al. (2002).

While the importance of quality seed in successful aquaculture farming is assumed and raised by several authors (Barman et al., 2002; Belton et al., 2011; Little, 1999; Sarder, 2007), and is commonly incorporated in various aquaculture development interventions, no empirical study has been carried out to investigate the effect of investments in seed quality improvements on farm level pond production and economic performance in Bangladesh. Understanding the different aspects of fish seed quality and its impact on household fish production is important if investments into aquaculture development are to be effective (Barman et al., 2002). Therefore, the overall objectives of this paper are to assess the impact of improved seed quality and understand the influence of associated factors such as training on aquaculture productivity and profitability. Through this analysis, the paper seeks to learn from present investments in seed quality to provide valuable insights for future investments in aquaculture development initiatives.

2. Fish seed improvement interventions in Bangladesh

Innovation in seed production by farmers in Asia started in 1882: farmers in West Bengal (India) developed a method of fish breeding called “bundh breeding” for Indian major carps by artificial simulation of the natural breeding environment of a river that eventually produced good quality seed for carp polyculture (Mondal et al., 2005). In Bangladesh, seed production by farmers started with production of common carp and tilapia seed in the rice-field based systems of the north-west region of Bangladesh in 1992 (Costa et al., 2006). Seed production in irrigated spring (Boro) rice-fields through the stocking of fertilized eggs thus became a well-accepted ‘decentralized’ seed production system among the farmers in north-west Bangladesh (Barman et al., 2004). Seed production and supply through decentralized systems, compared to hatchery based centralized systems, may result in greater benefits to rural poor farmers involved in aquaculture. Seed production in these decentralized systems could include several approaches such as breeding and nursing of fry to fingerlings in ponds and in rice fields using hapas, or nursing of fry in cages and in small seasonal ponds (Barman et al., 2007). Two participatory approaches to produce Nile tilapia (*Oreochromis niloticus*) seed in household food fish ponds, rice field-based tilapia seed production and hapas (Barman and Little, 2011), demonstrated farmers’ capabilities to produce seed through decentralized approaches. Rice-field based fish seed production has also been found to be a coping mechanism for households’ seasonal vulnerability (Haque et al., 2010).

Fish seed supply has grown substantially since the early 2000s with the growth of aquaculture in Bangladesh. Currently, 878 carp hatcheries (112 public and 756 private) have been established in the country, and more than 98% of the carp seed for aquaculture is being supplied by these hatcheries (Sarder, 2007; Belton et al., 2011). Although a good network of hatcheries and a reasonable supply of cheap seed has supported growth of aquaculture in Bangladesh, a common and emerging concern is that of poor seed quality (Barman et al., 2002; Belton et al., 2011). The quality of seed in hatcheries has been deteriorating due to various factors, including inbreeding, inter-specific hybridization, negative selection, and improper broodstock management resulting in a low growth rate, high mortality, disease susceptibility and deformities (Barman et al., 2002; Sarder, 2007; Siriwardena, 2007). Since management of broodstock has critical impacts on the health status and subsequent performance of seed (Muir, 2003), husbandry of broodstock is considered to be very important in the production of quality seed. Therefore, collection of quality broodstock from diversified sources (wild and domesticated) to produce good quality seed which is supplied to household pond farmers for nursing and farming could help improve the situation. Research has showed that low-cost household hatcheries, particularly for carp and tilapia, with just a little training, were able to raise good quality fish fingerlings and subsequently stock their own ponds in north-west Bangladesh (DFID, 2007). The high price of seed is also a constraint and Karim et al. (2005) reported that fish seed cost more than any other input/variables in pond-based aquaculture in and around the major fish producing area of Mymensingh, Bangladesh.

Indian major carps (*Labeo rohita*, *Catla catla* and *Cirrhinus mrigala*) are the most commonly cultured species in pond aquaculture in Bangladesh, accounting for over 37% of production (FRSS, 2014). The popularity of carps is high due to its good taste, rapid growth and high market value and it is thus considered one of the major sources of animal protein in the country. Most carp seed is produced and supplied by private hatcheries using inferior quality broodstock which has resulted in high mortality rates (up to 60% in the case of semi–intensive production in nursery ponds) and a limited supply of quality fingerlings (Haque and Barman, 2004). The increasing supply of poor quality seed from hatcheries during recent years demands alternative options to ensure fish farming households have access to better quality seed. Hence, adopting improved management practices at hatcheries using better quality broodstock could be a crucial option to ensure the production of better quality seed and promote homestead pond aquaculture in rural Bangladesh.

Approximately US$ 165,500 was invested between April 2012 and March 2013 in fish seed quality improvements and farmer training by the USAID funded Aquaculture for Income and Nutrition (AIN) project. This investment focused primarily on building the capacity of 38 carp hatcheries to provide improved quality seed through: (a) research to develop high quality broodstock, including expenditure on biomarkers, fish tags and other accessories and on costs related to broodstock management and growth trials; (b) provision of hatchery equipment (c) distribution of improved quality broodstock to hatcheries; and (d) provision of training to hatchery operators. Investment was also made in training fish seed traders and staff from 254 nurseries and approximately 20,000 fish farmers in improved management practices (AIN, 2014).