Aquaculture 428–429 (2014) 61–70

Contents lists available at ScienceDirect

Aquaculture

journal homepage: www.elsevier.com/locate/aqua-online

Profitability and adoption of improved shrimp farming technologies in the aquatic agricultural systems of southwestern Bangladesh

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ARTICLE INFO

Article history:
Received 1 August 2012
Received in revised form 28 December 2013
Accepted 25 February 2014
Available online 5 March 2014

Keywords:
Shrimp
Southwest Bangladesh
White spot syndrome virus
Adoption
Profitability
Aquatic agricultural systems

ABSTRACT

This paper assesses factors influencing adoption of new shrimp aquaculture technologies within aquatic-agricultural farming systems in southwestern Bangladesh. The impacts of three new technologies were assessed: two Modified Traditional Technologies (MTT 1 and MTT 2) and a Closed System Technology (CST). A total of 789 farmers from 10 sub-districts in Khulna Division were surveyed randomly, including a control group of 350 farmers using traditional technologies. Farmers gained significantly higher ($P < 0.05$) net returns when practicing improved shrimp farming systems as compared to traditional farms. The profitability of CST farms was more than double that of MTT farms, and the profitability of MTT farms was more than that of traditional farms. Similar ($P > 0.05$) financial benefit was derived from adoption of MTT1 and MTT2 technologies. Feed use, stocking density, *gher* size and white spot syndrome virus incidence were key factors associated with the economic returns of CST farms, while various supplementary feed inputs made a significant positive contribution towards increased return for the MTT farms. Lime was an important input for increased return both for MTTs and traditional farms. Farmer age and access to training influenced adoption of both technologies, and gher size and access to financing were significant for the more intensive Closed System Technology (CST).

1. Introduction

Black tiger shrimp (*Penaeus monodon*) contributes significantly to the national economy of Bangladesh, with shrimp exports being the second highest export income earner in the country (Bangladesh Bureau of Statistics, 2008), worth over US$ 457 million (DOF, 2012). In 2008–2009, Bangladesh farmed just under 98,000 tonnes of shrimp and prawn, of which the majority was black tiger shrimp, and exported more than 54,000 tonnes (processed including both head-on and head-off) (DOF, 2012). More than 244,000 ha of land in southern Bangladesh is now reported by the Department of Fisheries as registered for shrimp or prawn culture (Belton et al., 2011) and the sub-sector supports the livelihoods of more than 600,000 people, including farmers and service providers such as traders and processors (USAID, 2006). (See Fig. 1.)

Farming in Southwest Bangladesh has undergone rapid growth and change since the 1980s as a result of a strong global market for shrimp and prawn and high profits to producers of these crops, the development of hatcheries and expansion of the area under production (Alam and Phillips, 2004; BFFEA, 2007; Islam et al., 2003). Land and waterscapes in Southwest Bangladesh are profoundly interconnected. These coastal and freshwater agro-ecosystems, in which aquatic productivity contributes significantly to household food security, nutrition and income, are collectively referred to as 'Aquatic Agricultural Systems' (AAS) (WorldFish Center, 2011).

Shrimp and prawn production in Bangladesh takes place in ghers — modified low-lying rice fields with raised dykes, used for seasonal production of shrimp, fish and other aquatic products. Shrimp (mainly *Penaeus monodon*) farming takes place primarily in saline areas, whereas freshwater prawn (*Macrobrachium rosenbergii*) farming takes place primarily in freshwater areas. Because salinities vary seasonally and the salinity range of the two species is partially overlapping, farmers often stock shrimp, prawn in the same system, either sequentially or concurrently (Ahmed et al., 2002; Barmon et al., 2004). However, farms surveyed for this paper were located mainly in brackish water or mixed salinity areas, and their production was dominated by shrimp. Thus, in the remainder of the paper we refer to them as shrimp farming systems.

Shrimp farming in Bangladesh can be broadly categorized into three types, according to the level of inputs used:

- Extensive culture, where shrimp depend entirely on naturally occurring organisms in the ponds for their growth
- Improved extensive culture, which utilizes both natural productivity, application of fertilizer and occasional supplementary feeding to enhance growth

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http://dx.doi.org/10.1016/j.aquaculture.2014.02.029
0044-8486/

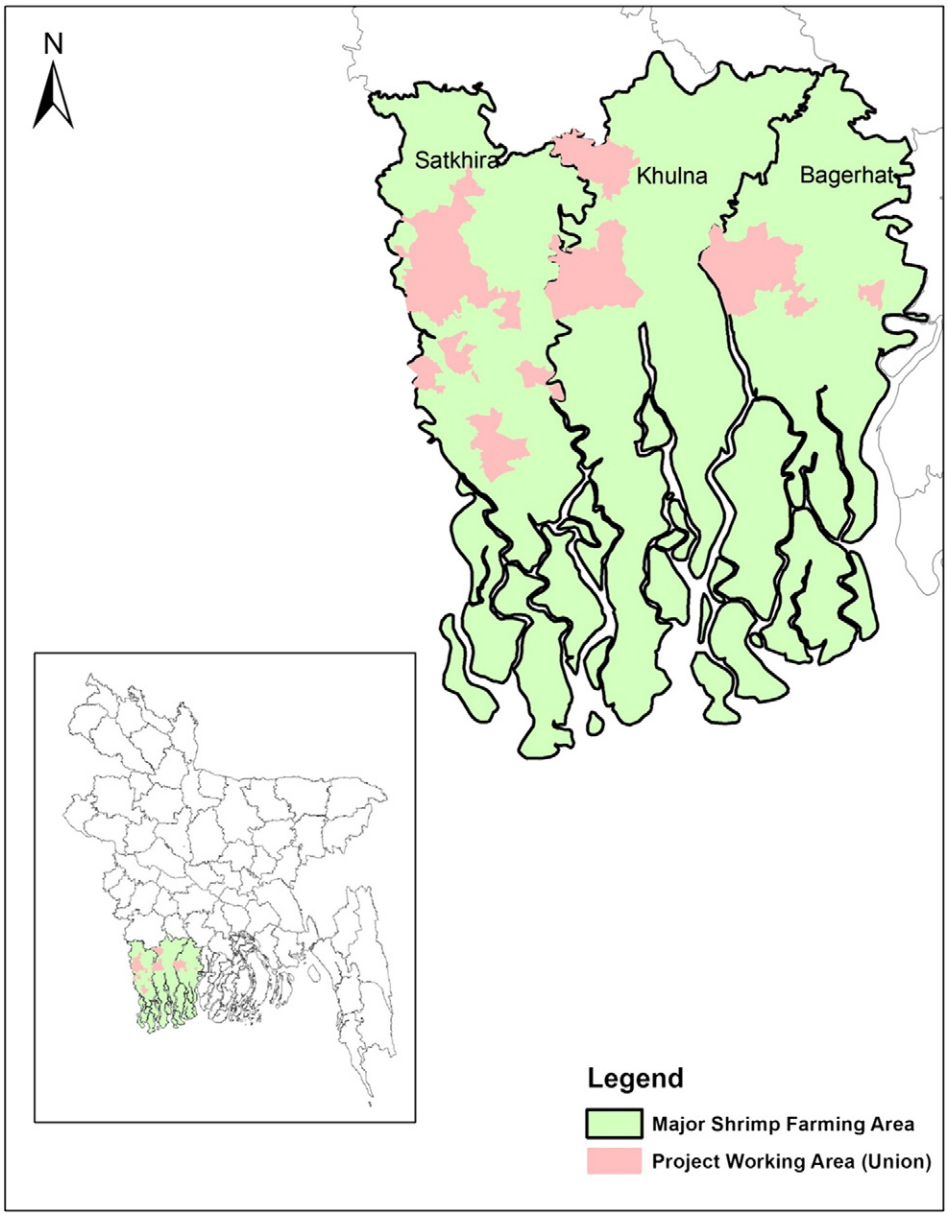

Fig. 1. Map showing major shrimp farming and sampled farmers/project working locations.

- Semi-intensive culture, in which shrimp obtain nutrients primarily from artificial feeds and are stocked at higher densities, necessitating management practices such as aeration and pond drainage to maintain water quality employed.

Numerous factors have shaped the development of shrimp farming in Bangladesh. These include shrimp disease, changes in salinity, trade-related shocks, social conflicts and rising input prices, but farming has remained based largely on traditional practices with a low per unit area productivity of 160–230 kg/ha/year (Belton et al., 2011). Productivity is low compared to most neighboring shrimp-producing countries in Asia (Alday-Sanz, 2010; Gammage et al., 2006; Karim et al., 2012; Nguyen and Ford, 2010). Attempts to intensification of shrimp farming were not quite successful due to high risk of crop losses due to White Spot Disease (WSD) caused by white spot syndrome virus (54% crop loss reported by Karim et al., 2012), requirement of high investment, and no insurance provision on shrimp farming in Bangladesh. In response, government and non-government organizations have implemented various programs to improve the productivity and sustainability of shrimp culture in southern Bangladesh (Shrimp Foundation, 2012).

WorldFish's Shrimp Quality Support Program (SQSP), funded by USAID and launched in December 2005, was one such program. SQSP aimed to 'improve the quality and quantity of Bangladesh's shrimp export in socially and environmentally acceptable ways' (SQSP, 2006). This was attempted by providing assistance to shrimp farmers in Bagerhat, Khulna and Shatkhira districts to facilitate the adoption of improved production technologies. Most farmers selected by the project were small-scale, typically owning or operating less than 2 ha of *ghers*. In order to achieve its goals, the project promoted two alternative systems: a 'Modified Traditional Technology' (MTT), which, as the name suggests, was based on improvements to the widely used traditional culture system, and a semi-intensive 'Closed System Technology' (CST) (See Table 1.). A key aim of both systems, alongside increasing productivity, was to reduce the incidence of White Spot Disease (WSD), caused by the White Spot Syndrome Virus (WSSV). Better management practices, including the use of Polymerase Chain Reaction