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Change and diversity in smallholder rice–fish systems: Recent evidence and policy lessons from Bangladesh

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ABSTRACT

Efforts to unlock the genetic potential of both rice and fish, when combined with improvements in the management of rice–fish systems, can potentially increase agricultural productivity and food security in some of the poorest and most populous countries in Asia. In Bangladesh, estimates suggest that the country's potential rice–fish production system encompasses 2–3 million hectares of land. But despite three decades of research on biophysical and technical aspects of rice–fish systems, this potential has not been fully realized due to insufficient attention given to the social, economic, and policy dimensions of rice–fish system improvement. This paper provides a characterization of the diverse and changing nature of rice–fish systems in Bangladesh to shed new light on the economic viability of different rice–fish systems and recommend policy and investment options to accelerate the development of appropriate rice–fish technologies. Data are drawn from a novel subdistrict-level survey of fishery officers, a household/enterprise survey, focus group discussions, and a meta-review of the literature on aquaculture in the country, all of which were conducted in 2010–2011. Findings indicate that concurrent rice–fish systems, alternating rice–fish systems, and collectively managed systems offer considerable potential for increasing productivity and farm incomes in Bangladesh. Findings also suggest that while innovation in these rice–fish systems is being driven by households and communities, there is need for more supportive government policies and investments to enable further innovation. Policymakers need to develop effective regulations to promote feed and fish quality and quantity, for example. More rigorous analysis of the intended and unintended impacts of these policies and investments is also necessary.

Introduction

Many Asian countries are described as "rice–fish" societies because household consumption is largely dependent on rice as the staple food and fish (including finfish and crustaceans) as the main source of animal protein (Dey et al., 2005a; Kawarazuka and Béné, 2010). In these countries, food security and prosperity have long been associated with the availability and diversity of both rice and fish. The rice and fish production systems on which these societies depend are quite varied and greatly influenced by seasonal rainfall and flood inundation patterns, particularly in river floodplains and delta lowlands.

Efforts to improve rice–fish systems through improvements in genetic potential and management practices can potentially contribute to increasing agricultural productivity and food security. This is particularly relevant in Bangladesh, where the importance of both rice and fish in Bangladeshi life is captured in the popular saying "*Mache bhate Bangali*," which roughly translates into "Rice and fish make a Bengali." Estimates suggest that the country's potential rice–fish production system encompasses between 2 and 3 million hectares of land (ADB, 2005; Ahmed and Garnett, 2010; Dey and Prein, 2006). But with average operational holdings of only 0.5 ha (Joshi et al., 2007) and limited historical investment in the social, economic, and policy dimensions of rice–fish system improvement, this potential is not being met.

Broadly speaking, there are a number of inland or freshwater fish culturing systems in Bangladesh ranging from (1) permanent (that is, year-long) fish ponds, (2) permanent and seasonal prawn and shrimp ponds, (3) traditional culturing of fish within the same plot as the standing rice crop, which is commonly referred to as the "concurrent" rice–fish system, and (4) seasonal rotations between rice and fish ponds, or the "alternating" system (Dey et al., 2008).

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Systems (3) and (4) are the main methods of culturing fish in rice fields in Bangladesh and are the focus of this paper.

Concurrent culturing is practiced in the rainy season (typically July to December) because rains and flooding provide a favorable environment for *amon* rice varieties and both endemic and exotic fish breeds. In alternating systems (also referred to in the literature as "alternate," "rotating," or "rotational" rice–fish systems), *boro* rice is cultivated during the dry season (typically January to June) and fish is cultured during the rainy season. As in the concurrent systems, the alternating systems may stock endemic and exotic fish breeds.

Traditionally, many Bangladeshi farmers catch large quantities of fish from their rice fields, primarily from stocks of naturally occurring small indigenous species (SIS) used mainly for their own consumption. But the intensification of rice cultivation in Bangladesh over the past three decades has transformed many of Bangladesh's traditional rice–fish systems. Since the mid-1980s, farmers in the medium highlands, medium lowlands, and shallow flooded areas of Bangladesh have shifted into intensive cultivation of high-yielding *boro* rice varieties during the dry season with the help of modern inputs and irrigation from shallow/deep tubewells, while also continuing to cultivate *amon* rice during the rainy season (see Hossain, 2010). Farmers in the lowlands and deep flooded areas have also shifted into *boro* rice cultivation during this period, but tend to leave their fields fallow during the rainy season.

As a result of the intensification of *boro* rice production, critical dry-season fish habitats have diminished and traditional SIS fish catches have declined (Halls et al., 1998; Hoggarth et al., 1999; Shankar et al., 2004), thereby reducing the availability of an important source of both nutrition and income for many small-scale farmers.

In an effort to address the changes brought about by *boro* rice intensification, Bangladesh's agricultural research and extension system has explored a variety of alternative rice–fish farming practices since the mid-1980s. The Bangladesh Fisheries Research Institute (BFRI), Bangladesh Rice Research Institute (BRRI), Bangladesh Agricultural University (BAU), Department of Fisheries of the Government of Bangladesh (DOF), and the WorldFish Center have all conducted extensive research on the topic. Various nongovernmental organizations (NGOs), private companies, and rural entrepreneurs have also invested in innovative approaches to culturing in Bangladesh's rice–fish systems. Many of the improved fish-culturing practices introduced by these actors in recent decades rely on the deliberate stocking of fish, either concurrently with, or subsequent to, rice cultivation. Thousands of Bangladeshi farmers have since experimented with various forms of rice–fish culturing and have developed practices to suit their farming environments and resource endowments (Halwart and Gupta, 2004).

But apart from studies reviewed in greater detail in Section 3, the social and economic research on rice–fish systems is relatively limited given the magnitude of the system's traditional importance in rural Bangladeshi livelihoods and given its potential importance as a means of improving agricultural production.[1] Further, policy research on rice–fish systems—research on the public policies and investments needed to foster more substantive growth in Bangladeshi aquaculture, especially for small-scale, resource-poor farmer-fishers—is largely absent.

In an effort to address this knowledge gap, this paper examines the diverse and changing nature of rice–fish systems in Bangladesh and policy options that might support greater pro-poor development of the country's rice–fish systems. Specifically, by combining primary and secondary data from several sources, this paper (1) characterizes the diverse nature of rice–fish systems in freshwater areas of Bangladesh, (2) examines the economic viability of alternative systems, and (3) recommends policy and investment options to further improve the development and delivery of rice–fish technologies.

Importantly, the methods, analysis and recommendations set forth in this paper provide a framework for examining similar systems and systemic challenges in other Asian "rice–fish" societies. By examining rice–fish systems in an integrated manner, the paper aims to move beyond agricultural-product-specific approaches (such as studying only rice or only fish) or technology-driven approaches (such as studying improved genetics or management practices) to address the complex interactions among agroecological diversity, smallholder farming systems, and public policy.

Material and methods

This paper draws on a study of rice–fish systems conducted in 2010–2011 in Bangladesh. The study was a joint undertaking of the DOF, BAU, and the International Food Policy Research Institute (IFPRI). The first source of data is a nationwide *upazilla* (subdistrict)-level survey conducted in 2011 jointly by DOF, BAU and IFPRI (referred to hereafter as the "2011 DOF/BAU/IFPRI Survey"). The survey aimed to better understand which types of rice–fish culture systems were being used across Bangladesh. The 2011 DOF/BAU/IFPRI Survey queried DOF officers in 475 *upazillas* about the primary crop cultivation and fish-culturing practices by farmers in their respective *upazillas*. No other survey or statistical gazette provides this information at a national level, making the survey a unique contribution to our understanding of farming and fishing practices in Bangladesh.

Primary data were also collected from a series of focus group discussions and household/enterprise surveys conducted in two key freshwater rice–fish producing districts, Mymensingh and Comilla. The former was chosen due to the prevalence and growth of fish culturing in permanent fish ponds and anecdotal reports of poorer households giving up fish culturing and disinvesting in these ponds because of high input costs, credit constraints, and risks associated with both production and markets. The latter district was chosen because of the well-documented and innovative interventions of Shishuk, an NGO, in promoting collectively managed aquaculture in seasonal floodplain areas (Belton et al., 2011; Sultana, 2012; Toufique and Gregory, 2008).

The main purpose of the household/enterprise surveys in Comilla and Mymensingh (referred to hereafter as the "2011 DOF/BAU/IFPRI Comilla Survey" and "2011 DOF/BAU/IFPRI Mymensingh Survey," respectively), was to collect data on costs and returns of various rice–fish enterprises. For these surveys, information from DOF and NGO officials were used to develop a sampling frame around the nature and extent of fish and rice–fish culture. A total of 108 community-based fish culture operations/enterprises were identified in Comilla district, from which 30 community-based operations were selected from two *upazillas* (Daudkandi and Titas) using a stratified random sampling approach, and key informants involved in these enterprises were interviewed. In Mymensingh district, four villages in Muktagacha *upazilla* were selected based on the concentration of fish culturing, and a total of 30 households were randomly sampled for the survey.

In both sites, interviews were conducted from March to November 2011 by trained enumerators, with help from local DOF and NGO officials, using two location-specific questionnaires. Follow-up focus group discussions were held in both sites with separate

[1] See also Kumar and Quisumbing (2011) for a study of the long-term impacts of early adoption of pond-based fish polyculture in Bangladesh; Islam (2008) for a study on governance and certification of the shrimp value chain in Bangladesh; Alam and Thomson (2001) for an earlier review of aquaculture and fisheries policies in Bangladesh; and Hishamunda et al. (2009) for a review of commercial aquaculture in other Asian countries..