DEVELOPMENT ECONOMICS AND POLICY

Series edited by Joachim von Braun, Ulrike Grote and Manfred Zeller

76

Impact of Technological Innovation on the Poor

Integrated Aquaculture-Agriculture in Bangladesh

Abu Hayat Md. Saiful Islam

PL ACADEMIC RESEARCH

Chapter 1: Introduction

1.1 Background

Rice and fish are integral to society in many Asian countries where they provide the basis of food security and well-being. Integrated rice–fish farming systems (IRFSS) in this region are quite varied. A broad spectrum of integrated aquaculture-agriculture (IAA) systems have been practiced for centuries in Asia, particularly in Bangladesh, China, India, Indonesia, Malaysia, Thailand, and Vietnam (Prein, 2002; Dey et al., 2013). Many of these IAA systems, especially rice–fish based IAA systems, have been transformed during the course of the green revolution (GR) in Asia due to the unsustainable intensification of rice production through intensive use of fertilisers, pesticides, and irrigation. With respect to renewed interest in sustainable intensification under a paradigm of a 'doubly green revolution,' IAA systems can be a potential intensification strategy. Through participatory research and extension systems, different national and international governmental and non-governmental organisations (NGOs) together with innovative farmers are making an effort to address the unintended consequences of GR intensification efforts. Many actors have introduced improved IAA systems in recent decades that are suited to the geographically specific farming environments and resource endowments of local farmers. One recent estimate indicates that about 0.18 million hectares of land are currently under rice–fish based IAA systems in Bangladesh, which is much lower than the potentially suitable area of 2 to 3 million hectares (ADB, 2005; Dey et al., 2013). This raises the question of whether or not the adoption and impacts of IAA systems have been adequately examined. A recent meta-review of rice–fish based IAA systems in Bangladesh also indicates that relevant socio-economic research is relatively scarce considering the potential of these systems for improving agricultural production and rural livelihoods in Bangladesh (Dey et al., 2013). Troell et al. (2014; 13257) stated that "interconnections between the aquaculture, crop, livestock, and fisheries sectors can act as an opportunity for, enhanced resilience in the global food system given the increased resource scarcity and climate change and if government policies provide adequate incentives for resource efficiency, equity, and environmental protection."

Given this backdrop we used the value chain conceptual framework as the basis to investigate the financial performance of IAA value chain actors and the dynamics and determinants of IAA value chain participation, and the welfare and environmental impacts among extremely poor and marginalized indigenous[1] populations in Bangladesh. The intent of the research presented here was to better understand how the current nature of IAA system development acts as either an impediment to, or an opportunity for, the enhancement of smallholder welfare given their typically limited resource endowments and numerous constraints. To accomplish this we considered all of the IAA value chain actors and system level research methods in an integrated manner rather than using commodity specific (e.g. only rice or only fish) or technology specific approaches (e.g. improved seed, fertiliser, irrigation). In doing so the research effort is expected to contribute to the on-going debate on sustainable intensification policy and practices within the agricultural sector, and to be relevant to researchers on these systems and related systemic challenges in other sectors and regions.

1.2 Problem Statement

Despite immense progress in poverty reduction in the developing world there will continue to be around one billion people living below the international poverty level of US$1.25 per person per day in 2015 and 162 million people who live in 'ultra-poverty' (less than US$0.50 per person per day). Many people living under the US$1.25 poverty line are vulnerable to poverty and food insecurity (Ahmed et al., 2007; Chen and Ravallion, 2012). Similarly, more than one billion people in the world are chronically undernourished and most of these live in Asia and the Pacific (FAO, 2010a). The common characteristics of the world's poorest and most hunger prone people are that they typically reside in rural areas that are remote with respect to access to roads, markets, schools, and health services, and they are less likely to be educated and more likely to belong to socio-ethnic minorities and other marginalised groups (Ahmed et al., 2007). Food security and poverty reduction continue to be daunting challenges for most developing countries, however, the pressing question is how can both food insecurity and poverty be reduced?

Many of the poor and vulnerable rely heavily on the agricultural sector. Although the GDP share of agriculture is declining in most countries, it continues to be the backbone of the economies of most of the least developed countries (LDCs). It is the largest and most significant source of livelihoods in terms of providing food, income, and employment in LDCs. It produces a multiplier effect through strong forward and backward linkages with other sectors and an added stimulus for growth and income generation (Mellor, 1998). Agriculture is also one of the

1 The terms 'indigenous,' '*adivasi*,' 'aboriginal,' 'ethnic minority,' and 'tribal' are used synonymously throughout the dissertation.

major sources of economic development and recovery. Agricultural growth has powerful impacts on poverty via its broad effects on poor people, which may not be the case for growth in the manufacturing and service sectors. Thus, sustaining the productivity and efficiency of the agricultural sector is the central emphasis for 'pro-poor' growth with respect to economic planning (Thirtle et al., 2003; Koroma, 2007).

Agriculture sector is typically dominated by crop production, especially of rice in Asia. Although rice production has increased substantially since the onset of the GR, due to rising food demand it is estimated that production needs to increase by more than 50% over the next few decades (Spielman and Pandya-Lorch, 2009; Mishra and Salokhe, 2010). Moreover, current concerns about the environment and food security, including food safety, are gaining momentum, which feed the debate about the sustainability of GR approaches in developing countries (Redclift, 1989; Alauddin and Tisdell, 1991; Shiva, 1991; Singh, 2000; Kunio, 2002). Simultaneously, increases in global commodity prices due to new drivers like increases in the demand for feed, food, and biofuels are putting significant pressure on agricultural systems (von Braun, 2007). An important concern with respect to feeding growing populations is whether or not existing rice research systems will be able to sustain the growth of rice production or if new solutions are required to sustainably meet the demand for rice by a growing world population (Surridge, 2004).

Horizontal expansion of arable land is not possible in many areas and in some cases it is declining, so the only possible way to increase the productivity of land, labour and water resources is vertical intensification through the integration of different agricultural enterprises or by changing management practices and efficiency through sustainable intensification and resource reallocation. Such integration efforts could reduce poverty and malnutrition. Accordingly, 'doubly green revolution'[2] perspectives call for innovative strategies that are both 'pro-poor' and technically feasible, addressing livelihoods in an economically, socially, and environmentally acceptable way, which has gained much attention in recent literature

2 'Doubly green revolution' not only signifies productive, but also stable, resilient, and equitable means of providing benefits to everyone. This signifies that it should be equitable, sustainable, and environmentally benign (Conway, 2011). Conway argues for a 'doubly green revolution' that is characterised by sustainable productivity and conservation. He proposes to emphasise the design or development (or rediscovery) of improved crop and livestock varieties, alternatives to inorganic fertilisers and pesticides, improvements to soil and water management practices, and enhancement of earning opportunities for the poor, especially women, through interaction between researchers and farmers (Conway, 1999).

in the context of poverty reduction and sustainable agricultural development in developing countries (Conway, 1999; Noltze et al., 2011). IAA farming systems could provide such a tool for increasing carbohydrate and protein production more sustainably by using scarce land and water resources in an intensive and complementary way (Meaden and Kapetsky, 1991). IAA offers the prospect of higher rice yields with more efficient agricultural land use with limited negative impacts on natural resources at affordable costs for poor smallholder farmers (Khoo and Tan, 1980; Ruddle, 1982; Lightfoot et al., 1992; Frei and Becker, 2005a). Edwards (2000) mentioned that there is significant potential for increased involvement of poor farming households in rice–fish production with respect to both rain fed and irrigated systems, and mentioned that there are many successful examples in Bangladesh, Madagascar, and Thailand. Several studies in different countries have identified the advantages of IAA in terms of more efficient use of land and water resources, increased food production, greater food and nutritional security, improved farmer income (Mukherjee, 1995; Gupta et al., 1996, 1998; Purba, 1998; Horstkotte-Wesseler, 1999; Berg, 2002; Ahmed et al., 2008; Nahar, 2010; Ahmed and Garnett, 2011; Rahman et al., 2011), and for the control of rice weeds, pests, and mosquitoes (Neng et al., 1995; Rothuis et al., 1998a; Vromant et al., 1998; Berg, 2001; Ichinose et al., 2002; Frei and Becker, 2005b). In spite of these immense benefits and the research and promotional efforts of many international and national organisations, IAA farming has not been widely adopted in Asia (Rothuis, 1998a; Ahmed et al., 2008). This issue elicits the question of whether or not the adoption of IAA and its impacts are adequately understood.

Most of the published and unpublished research on IAA farming is incomplete. There is a general lack of high quality detailed field research using scientific and proper econometric methods. To date there is only limited published research on the economics of rice–fish-prawn culture (Ali and Mateo, 2007). There is a lack of applied research using proper econometric methods and theory on adoption patterns and intensity, and of the impacts of IAA on poverty, food security, gender, and land, labour, credit markets, the environment, income diversification, and equity, especially in terms of extremely poor and marginalised populations. Research on rice–fish based IAA has focused primarily on biological and technical issues that are location and season specific rather than at the system level or across entire annual agricultural cycles. Socio-economic, policy, and institutional dimensions of rice–fish based IAA system research is generally lacking (Dey et al., 2013).

So there is a need to systematically examine the above mentioned issues before widespread diffusion of IAA farming in potential implementation areas of the world, including Bangladesh. For more widespread diffusion and poverty reducing policy intervention it is necessary to have a better understanding of adoption patterns, as well as of the impacts of the adoption of new technologies in terms of household welfare (Becerril and Abdulai, 2010; Noltze et al., 2012). Similarly, Feder and Umali (1993) mentioned that for the determination of cost-effective policy options and their optimal intensity and duration it is necessary to know whether or not technology is adopted in packages, individually, in combination with other factors, or following a sequence. Feder et al. (1985) (in Doss, 2006; 208) mentioned that future technology adoption research is primarily needed in the following five areas: (i) the intensity of adoption (not just dichotomous choices); (ii) the simultaneity of adoption of different components of a technology package; (iii) the impacts of incomplete markets and policies on adoption decisions; (iv) the contextualization of adoption decisions within social, cultural and institutional environments; and (v) the dynamic patterns of land tenure and wealth accumulation among early and late stage IAA adopters. Doss (2006; 208) mentioned that, 20 years after Feder et al. technology adoption studies have made substantial progress, especially in the first two areas and that "[t]he issues of how institutional and policy environments affect the adoption of new technologies and how the dynamic patterns of adoption affect the distribution of wealth and income remain unanswered." Given this backdrop, this study attempted to fill research gaps mentioned above by using more sophisticated analytical approaches based on an integrated framework under a broader range of geographical and institutional conditions in marginalised, extreme poverty settings in Bangladesh. Thus it is expected that the study will facilitate the ability of policy-makers and international development organisations to make more nuanced decisions about the optimal entry point for addressing rural poverty and assessing approaches to rural development and their effectiveness in reducing rural poverty in developing countries.

1.3 Research Objectives and Questions

The study examined causality among factors that affect IAA value chain participation and its impacts in terms of welfare and the environment. Externalities of system changes were explicitly modelled (i.e. welfare benefits, environmental benefits or costs). Specifically, the study sought to:

1. Evaluate the overall performance of IAA value chain development in Bangladesh,
2. Determine the factors that influence the dynamics of participation in IAA value chains,

3. Assess the welfare impacts of IAA value chain participation dynamics,
4. Analyse the competitiveness and environmental impacts of rice–fish based IAA relative to rice monoculture farming systems.

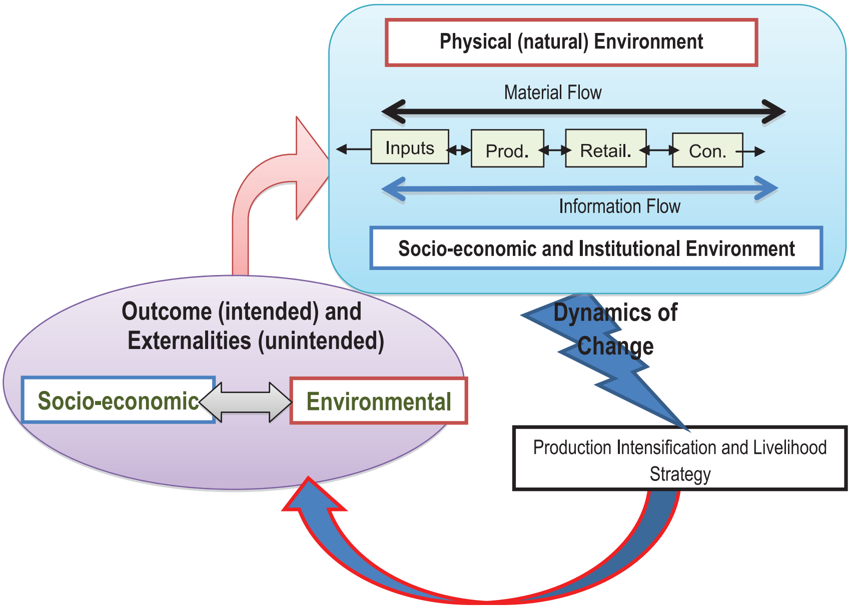
Based on the stated objectives and research problems, the study sought to answer the following research questions:

1. Is participation in IAA value chains a profitable option and how can overall performance be improved?
2. What are the factors affecting the decision of whether or not to participate in IAA value chains and how do these factors differ among the participator categories?
3. How do IAA value chain participation dynamics affect the welfare of the marginalized rural poor?
4. How do farmers perceive the environmental effects of rice–fish based IAA diffusion relative to rice monoculture and the factors determining such perceptions?

1.4 Conceptual Framework

The conceptual framework briefly summarizes the key assumptions, hypotheses and research questions of the study on three levels of analysis (Figure 1.1). The first level is the individual value chain analysis, which indicates the key actors in a chain, estimates the value added at each stage, establishes the chain dynamics and governance, as well as financial performance of each actor. The second level is the value chain participation dynamics. This level focuses mainly on socio-economic, institutional, and physical/natural environmental contexts. The aim at this level is to observe how these arrangements facilitate or hinder participation and performance of the different value chain actors. The third level concerns the impacts of value chain participation dynamics through production intensification, livelihood strategy, and change over time. Here the emphasis was to reveal two levels of impact; the intended impact (i.e. socio-economic welfare impacts) and unintended (externality) impacts (i.e. environmental impacts). In addition, these impacts, along with physical, socio-economic and institutional factors, may work as a feedback mechanism that helps to explain participation dynamics. The impacts of this system can act equally as an incentive or a disincentive to drive or divert further livelihood strategies through IAA value chain participation. These three levels of analysis will provide greater insight, not only to what is happening with respect to IAA in Bangladesh, but why it is happening and what needs to be done to improve the situation. The conceptual framework is reflected by the study objective to take into account the socio-economic and environmental impacts (including positive and negative externalities) associated with system change (i.e. from rice/fish monoculture to IAA system). To capture all the positive and negative externalities, a comprehensive social and economic assessment is required, but we capture some part of it and the rest needs further research (see further research need details in Chapter 6, section 6.3).

Figure 1.1: Conceptual framework of the study



The conceptual framework highlights IAA as the key element of this study. At this stage it is necessary to conceptualise IAA, as it will be featured throughout the dissertation. Asia is commonly considered to be the origin of IAA systems, which were initially developed in China as a means of increasing food production on small-scale subsistence farms with limited resources (Edwards, 2003; Little and Muir, 2003). IAA is based on the concept of integrated resource management where "an output from one sub-system in an integrated farming system which may otherwise may have been wasted becomes an input to another sub-system resulting in a greater efficiency of output of desired products from the land/water area under the farmer's control" (Edwards et al., 1988; 5). Similarly Prein (2002; 128) defined this system as "concurrent or sequential linkages between two or more human activity systems, one or more of which is aquaculture, directly on-site, or indirectly through off-site needs and opportunities, or both." More broadly it is the linkages between two or more farming activities, of which at least one is aquaculture (Edwards, 1987). Generally there are two forms of IAA, one of which is pond-based IAA, in which a pond enterprise is added to a farm system (i.e. appropriate fish species stocked in a pond and available input materials from the farm such as crop and livestock residues are used as fish feed) (Brummett and Noble, 1995; Prein, 2002). The other form is where an aquaculture system is physically integrated into another system through redesign and re-operationalization of the latter, (e.g. rice–fish based IAA) (Prein, 2002). Both types of IAA systems and other value chain actors were considered in this study.

In IAA synergies between farming systems increase productivity, efficiency, diversification,[3] and sustainability (Talpaz and Tsur, 1982; Edwards et al., 1988; Edwards, 1989, 1998; Alsagoff et al., 1990; Dalsgaard and Oficial, 1997; Gomiero et al., 1999; DSAP, 2005; Berg, 2002; Jamu and Piedrahita, 2002; Frei and Becker, 2005a; Pant et al., 2005; Nhan et al., 2007; Tipraqsa et al., 2007; Jahan et al., 2008; Blythe, 2013), reduce environmental pollution by recycling aquaculture wastes (solids, organics and nutrients) and farm nutrient loss as well as by utilizing wastes produced from agriculture as feeds or fertilisers for aquaculture (Little and Muir, 1987; Edwards, 1998, 1993; Costa-Pierce, 2002; Devendra and Thomas, 2002; Prein, 2002; Primavera 2006), increase food and income security (Edwards et al., 1988; Gupta et al., 1996; Edwards, 1998; Prein and Ahmed, 2000; Devendra and Thomas, 2002; Tipraqsa et al., 2007; Kremen and Miles, 2012), reduce vulnerability to the effects of climate change, and protect biodiversity (Gurung, 2012).

1.5 Research Methods

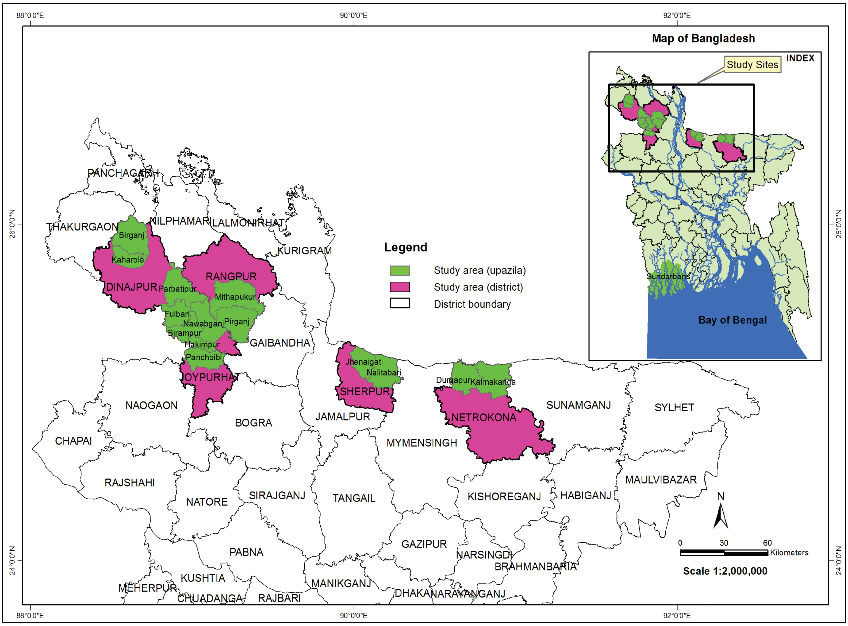
1.5.1 Study Area

The data were collected from indigenous households in the plains of northern and northwestern Bangladesh (Figure 1.2). The study area included three districts (Dinajpur, Rangpur, and Jaypurhat) in the north and two districts (Netrokona and Sherpur) in the northwest. The study sites included ten sub-districts/*upazilas*/*thanas* (Pirganj, Mithapukur, Panchbibi, Birampur, Birganj, Hakimpur, Kaharole, Fulbari, Parbatipur, Nawabganj) in the northern districts and four sub-districts/*upazilas*/*thanas* (Kalmakanda, Durgapur, Jhenaighati, Nalitabari) in the

3 Rice or fish monocultures may be subject to alternative risks (Naylor et al., 2000).

northwestern districts. Most of the study area is near the border and rural, where normally the indigenous people of Bangladesh reside.

Figure 1.2: Map of the study area indicating the geopolitical districts (purple) and sub-districts (green) in Bangladesh



The mean household size among the study sites ranges from three to four members. Literacy rate varies between 35 and 60%. Literacy levels were higher in the northern region relative to the northwest. Households in the northwest own a higher number of ponds than households in the north. The main crop in the study areas is rice (paddy) and agriculture is the main income source for 60% to 70% of the households studied. Thus there is considerable potential for the integration of aquaculture into existing ponds and rice cultivation areas. Mean annual temperatures range from 10°C to 22°C among the study sites. Rainfall is relatively higher in the northwest relative to the northern region. Irrigation coverage varies widely among sites and average cropping intensity ranges from 150% to 210%, some are very close to the national mean of 191%, and others fall above and below the national average (BBS, 2011, 2013). Thus there is potential for increasing irrigation coverage and for integrating aquaculture, and subsequently these efforts would increase cropping intensity in sustainable manner. All of the districts in the study area have large water bodies that are well stocked with fish species such as: ruhi (*Labeo rohita*), mrigel (*Cirrhinus mrigala*), kalbaush (*Labeo calbasu*), katla (*Katla katla*), and indigenous fish species like shoil (*Channa striatus*), shing (*Heteropneustes fossilis*), and koi (*Anabas testudineus*) (BBS, 2013; Banglapedia, 2014).

1.5.2 Data: Sampling Technique, Sample Size, and Survey Effort

The study used household-level three-wave panel data and cross-sectional survey data from the study area (Figure 1.2). The first and second survey rounds were conducted in 2007 and 2009 under the supervision of WorldFish (WF), Bangladesh researchers. The third survey round (re-visited) was conducted from July 2011 to January 2012 by the author himself with the assistance of trained enumerators. The study sites were deliberately sampled from the *Adivasi* Fisheries Project (AFP) sites.[4] A multistage sampling procedure was applied for the survey effort. At the beginning of the AFP in 2007, WF conducted a census of 5337 *Adivasi* households across five districts in northern and northwestern Bangladesh. Out of the total sample, 3594 extremely poor households (based on wealth ranking) were selected from 120 communities for intervention by the project. A total of seven suitable livelihood intervention options within IAA value chains were disseminated among the selected households according to their resource base, and social and economic characteristics such as income, land holding size, and food security status. Among the selected households, those that were relatively wealthier and that own or have access to suitable assets for fish culture (i.e. ponds, rice fields, community aquatic resources) were engaged in IAA production related value chain interventions. The relatively poorer households, such as those that were landless or that lacked significant physical or economic resources, were selected for inclusion within upstream and downstream IAA value chain activities such as fingerling or fish traders and fishermen (netting). Entire sample households received technical training through a 'farmer field school' (FFS) and initial financial support (AFP, 2010; Pant et al., 2014).

To assess the nature and extent of changes resulting from IAA value chain participation WF, Bangladesh conducted a random survey with 510 of the participating households and 147 non-participating households (control) in 2007 (first round of survey). That survey effort employed a structured questionnaire

4 The project was implemented by WorldFish and its partner organisations from 2007 until 2009 to increase food security and dietary nutrition by diversifying livelihood options among resource-poor, marginalized *adivasi* (indigenous) communities (see Pant et al., 2014).

featuring information about the asset base and livelihood portfolios of the households surveyed. WF conducted a follow-up survey (the second round of survey) with the same households in 2009 using the same questionnaire to monitor impacts at the household level. The author revisited the same households in 2012 (the third round) and surveyed a subset of 450 participating households and 121 non-participating households. Table 1.1 describes the sample and dynamics over time. Based on data from the third survey round it is evident that the IAA value chain participating households split-up into two groups, those that continued participation in IAA value chain activities (234 households) and those that had abandoned participation in IAA value chain activities (216 households). This reflects the dynamics of IAA value chain participation. In this study we explored the factors that determine participation dynamics and welfare impacts. This appears to be the first analysis of long-term panel data on IAA systems that considers all value chain actors. Between the first and second survey rounds there was no sample attrition, but between second and third rounds there was some sample attrition, which is normal for long-term panel surveys. The sample attrition in the third survey round was 13.1%. We tested for attrition bias and found that it was random (see the attrition bias test results in the appendix in Table A.1.1). Due to migration, death, and regular absence from the home, some sample households from the first and second survey rounds could not be included in the third round survey. Throughout the dissertation we treat IAA participation as 'technology adoption,' and in accordance with the treatment of technology adoption categories in the literature (as either 'adopters,' 'dis-adopters,' or 'non-adopters') we describe members of IAA participation categories as 'participators,' 'dis-participators,' or 'non-participators'.

Table 1.1: Sample size of the panel survey of integrated aquaculture-agriculture participation among study area households in Bangladesh

Survey round	Year	IAA value chain non-participators	IAA value chain participators	IAA value chain dis-participators	Total	Attrition (%)
1st Wave	2007	147	510	–	657	–
2nd Wave	2009	148	509	–	657	–
3rd Wave	2012–2013	121	234	216	571	13.09

For the third survey round recent agricultural and fisheries graduates were hired and trained as survey enumerators, and interviews were conducted in the local languages under the supervision of the author. In addition to the questions asked in the first two survey rounds, we included detailed questions on production, revenues, and the costs of IAA value chain activities. In the third survey effort we also included questions on perceptions of the social and environmental impacts of rice–fish based IAA and rice monoculture systems. The sample for the third survey round included an additional 133 non-indigenous rice monoculture farmers (see the third survey questionnaires Table A.1.2 in the Appendix). The analyses of the data derived from the additional questions and sample households are discussed in chapters 2 and 5.

1.5.3 Indigenous People of Bangladesh

Bangladesh occupies the Ganges River delta and is one of the poorest and most densely populated (1203 ind./km^2) countries in the world. The amount of arable land per capita is only 0.05 ha with a population of over 156 million and an area of 147570 km^2 (Badiuzzaman et al., 2013; BER, 2014; WDI, 2014). Of the total population, around 2% (more than two million) are indigenous people living in the border areas of the Northwest and Northeast Chittagong Hill Tracts (CHT). There are more than 49 indigenous communities with distinct cultural, ethnic, religious, and linguistic identities. Broadly, they can be classified as belonging to two groups, one inhabits the plains of the northern and northeastern Bangladesh and the other is the '*Pahari*' or '*Jumma*' (hill tribes) concentrated in the CHT (Barkat et al., 2009; Roy, 2012). The former indigenous group is featured in this study.

Although there is a commonly accepted definition of indigenous people, in Asia and particularly Bangladesh prespective, the Asian Development Bank (ADB) working definition of indigenous people seems more appropriate. According to the ADB working definition, indigenous peoples are those that display two significant characteristics: "(i) descent from population groups present in a given area, most often before modern states or territories were created and before modern borders were defined; and (ii) maintenance of cultural and social identities; and social, economic, cultural, and political institutions separate from mainstream or dominant societies and cultures" (Plant, 2002; 7). In Bangladesh the indigenous people originally lived in sparsely populated areas and had ready access to natural resources, mostly in the border areas. Like many other countries, in Bangladesh indigenous people have been historically subjugated and discriminated against, and are the most marginalized social group in the country (Pant et al., 2014).

The socio-economic status of Bangladesh's indigenous is typically marginalized and very poor, with a higher frequency of health problems, nutritionally poor diets, and poor hygiene relative to the rest of the country. In general the socio-economic status of the plains indigenous group is relatively worse than that of the CHT indigenous group (Roy, 2012). Indigenous people in Asia and many other parts of the world are often geographically, politically, socio-culturally, and psychologically marginalized (PRSP, 2008; Tauli-Corpuz and Malanes, 2010). Originally the indigenous groups engaged in diversified livelihood strategies that included crop and livestock farming, fishing (and the harvest of other aquatic animals such as crustaceans and molluscs) in wetlands, and hunting in forests (of small terrestrial animals and birds), but in recent times traditional livelihood strategies are under threat due to a combination of social, economic, and ecological factors, such as land grabbing, declines in the productivity of natural fisheries and forests, socio-economic marginalization, and exclusion from development programmes and policies (e.g. social safety net programmes). WF and its partners implemented the AFP in the north and northwest of Bangladesh ('plains' indigenous group areas) during 2007–2009 in order to diversify livelihood options, reduce the vulnerability of households, and increase resilience through the development of IAA value chain activities in indigenous communities (Pant et al., 2014).

1.6 Outline of the Dissertation

The introductory chapter presents the overall problem statement, research questions, conceptual framework, study area, survey data, and an overview of the indigenous people in Bangladesh. The history and characteristic features of the indigenous people of Bangladesh and how they differ from the rest of society in terms of social, ecological, economic, and cultural aspects and the general socio-economic status in Bangladesh are also described in this chapter. The chapter also includes a broad discussion of the data and study sites to give an overview of the data collection and planning process of the entire study.

Rice–fish based IAA value chains are addressed explicitly in Chapter 2 along with a discussion about the financial performance of different value chain actors, the value addition process and function, and gender disaggregated employment along value chains. The chapter includes a discussion of the factors that contribute to success or impose barriers with respect to IAA value chain development within a broader discourse on sustainable agricultural development. In Chapter 3 we explore the value chain participation dynamics in greater depth. In this chapter we identify the determinants that distinguish among IAA value chain participators, non-participators, and dis-participators (those who discontinue participation over time), the latter of which is very often overlooked in technology adoption research.

Chapter 4 features analyses on the welfare impacts of IAA value chain participation. This includes a description of the linkages between IAA value chain participation and the welfare of indigenous households. The discussion also highlights the distributional effects of IAA value chain participation based on impacts on all value chain actors.

Chapter 5 presents the evaluation of rice–fish based IAA socio-environmental impacts and the differences relative to rice monoculture systems that have dominated rice production and received significant policy support in Bangladesh since independence. The analyses presented in this chapter examined the competitiveness of rice–fish IAA relative to rice monoculture systems by considering environmental impacts. Throughout the dissertation emphasis is placed on the application of quantitative research methods in the analyses of data generated by structured surveys to better understand the casual effects of IAA in Bangladesh. The conclusions presented in Chapter 6 summarize the major research findings, attempt to formulate a new research agenda for sustainable development through IAA value chain development in light of these research findings, and identify potentially effective policy options.