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Organic shrimp aquaculture for sustainable household livelihoods in Bangladesh

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ABSTRACT

Black tiger shrimp (*Penaeus monodon*) cultivation in *gher* (modified rice fields or ponds located beside canals or rivers) is widespread in southwestern Bangladesh. Shrimp farming plays an important role in the economy of the country, as it earns foreign exchange and provides employment opportunities. Organic shrimp aquaculture has emerged as an alternative farming enterprise for farmers, especially in the southwestern districts of Bangladesh. In this study, an asset-based conceptual framework known as the sustainable livelihoods approach (SLA) is applied to evaluate the impact of organic shrimp farming on livelihood. Data were collected in 2009 in the Kaligonj and Shyamnagar subdistricts through questionnaire interviews, transect walks, and focus group discussions with 144 organic shrimp farmers. Shrimp farming experience and size of *gher* have been found to influence the income from organic shrimp aquaculture. In this region, all farmers are highly vulnerable to natural phenomena like cyclones, floods, diseases, as well as contamination of saline water from untreated water sources, and market and price fluctuations that directly hinder the economic growth. The study concludes that more options for shaping livelihoods can be achieved if the farmers' capacity in coping with uncertain phenomena is increased. The adoption of organic shrimp farming has increased farmers' assets and has mitigated their vulnerability in ways that make livelihoods sustainable.

1. Introduction

Shrimp derived from open capture fisheries and aquaculture is an important seafood commodity. Global shrimp production increased from approximately 4.3 to 6.5 million tonnes between the years 2002 and 2008 (FAO, 2010a). In the same time, the global production of aquaculture shrimp doubled from 1.5 to 3.4 million tonnes. Aquaculture is mainly found in the Asia-Pacific region, which contributes about 89% of world production in terms of quantity (FAO, 2010b). Bangladesh, eighth in the world in terms of shrimp aquaculture, contributes approximately 2% of the total global production (FAO, 2010a). The annual production of shrimp from aquaculture in Bangladesh increased from 63 to 94 thousand tonnes between the years 1999 and 2008; aquaculture accounts for 42.2% of the total shrimp production in the country (DoF, 2009a). Sales to international markets contribute about 4.04% to the total export earnings and 3.74% to the GDP of Bangladesh (DoF, 2009b). Approximately 1.2 million people in Bangladesh are employed in shrimp production, processing, and marketing activities and the well being of 4.8 million household members relies on this sector (USAID, 2006).

Shrimp aquaculture engenders considerable environmental costs in terms of destruction of natural habitats and displacement of traditional livelihoods. Environmental and social scientists around the world criticize the often unplanned, unsustainable expansion and industrial development of shrimp farms (Primavera, 1997, 2006; Lebel et al., 2002, 2010; Bene, 2005; Paul and Vogl, 2011). Shrimp experts propose that good aquaculture practices (GAP), best management practices (BMP), and ecohydrology-based shrimp farming (ESF) will enhance the sustainable development of shrimp/prawn farming (FAO/NACA/UNFP/WB/WWF, 2006; Wahab et al., 2012; Sohel and Ullah, 2012). The sustainable development of aquaculture requires adequate consideration of environmental, social, and economic factors, e.g., comprehensive policies and regulations, good ecology, excellent breeding, appropriate technology, and governance (Goodland and Daly, 1996; Caffey et al., 2000; Biao and Kaijin, 2007; Costa-Pierce, 2008). As a reaction to the negative publicity, the first organic aquaculture initiatives were developed in the mid-1990s as an alternative and innovative culture system (Bergleiter et al., 2009). The organic movement throughout the world is continuously growing with 35 million

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hectares of agricultural land being presently farmed. In contrast, only 0.43 million hectares of aquacultural land are managed organically (Willer and Kilcher, 2010). Organic aquaculture has attracted attention due to consumers' awareness of overfishing, environmental degradation, health risks, sustainability, and animal welfare issues associated with conventional aquaculture (Lien and Anthony, 2007; Biao, 2008). It is predicted that the production of organic aquaculture will increase 240-fold by 2030, i.e., to 0.6% of total aquaculture production (FAO, 2002). In the year 2005, an organic shrimp project (OSP) was initiated in Bangladesh by the Swiss Import Promotion Program (SIPPO). Currently, the Germany-based importing organization WAB Trading International has taken over the OSP which was certified by Naturland, a German private organic farmers' association that runs an aquaculture scheme. The OSP comprises approximately 4000 ha of the 167,877 ha of coastal land involved in shrimp farming in Bangladesh (DoF, 2009b) and is managed by 3379 individual farmers who have converted from conventional to organic shrimp aquaculture.

According to the IFOAM, organic production dramatically reduces external inputs by prohibiting the use of chemosynthetic fertilizers, pesticides, pharmaceuticals, and feed additives, while encouraging natural ecological processes, biodiversity, and the use of locally available resources (IFOAM, 2008). Recent studies argue that organic farming can reduce poverty and promote sustainable livelihoods in developing countries (Parrot and Marsden, 2002; Giovannucci, 2005). Nevertheless, conversion to organic farming entails a complex change of system (Padel, 2001). Whether organic farming can produce sufficient yields to meet the demand of the world's growing population is also in question (Trewavas, 2001; Goklany, 2002). While economic and ecological aspects of organic farming systems have been extensively studied in western countries (Stolze et al., 2000; Offermann and Nieberg, 2001; Mäder et al., 2002; Lotter, 2003), little research has focused on organic farming practices in developing countries. Likewise, livelihood analyses of organic shrimp aquaculture have so far not been addressed.

We hypothesize that the adoption of organic shrimp farming can reduce economic vulnerability compared to nonorganic shrimp farming and achieve expected livelihood goals better than nonorganic shrimp farming. First, the study seeks to understand how the organic shrimp farmers' assets influence their livelihoods. Second, the article provides an overview of the factors that challenge the conversion to and subsequent operation of an organic shrimp farm—factors that might challenge the diffusion of organic shrimp farming. Third, the article discusses the impact of organic shrimp farming adoption on the livelihood of the farmers and the sustainability of their businesses. Finally, we suggest conditions that can help organic shrimp farmers to meet sustainable livelihood goals.

2. Conceptual framework: a sustainable livelihood approach

Capabilities, assets (both material and social), activities, and access to resources (mediated by institutions and social relations) together determine the living gained by the individual or household (Chambers and Conway, 1992; Carney, 1998; Scoones, 1998; Ellis, 2000). A livelihood is considered to be sustainable when it can cope with and recover from shocks and stresses, and maintain and enhance its capabilities and assets both now and in the future, while not undermining the natural resource base (Chambers and Conway, 1992). The sustainable livelihoods approach (SLA) has become popular in development thinking as a way of conceptualising rural development, poverty reduction, and environmental management (Scoones, 1998; Ashley and Carney, 1999; Udayakumara and Shrestha, 2011). The SLA is an asset-based conceptual framework that has been widely tested and adapted during research and policy analyses (DFID, 1999; Shankland, 2000). The SLA has been applied in developing countries in small-scale aquaculture and aquatic resources management (Allison and Ellis, 2001; Neiland and Bene, 2004; Ahmed, 2009). In 1997, the Department for International Development (DFID) adopted an SLA framework to address the underlying causes of poverty and to assess the importance to poor people of certain structural and institutional issues (Ashley and Carney, 1999; DFID, 1999). The five key indicators for assessing the outcomes of a sustainable livelihood are (i) creation of working days; (ii) poverty reduction; (iii) well-being and capabilities; (iv) livelihood adaptation, vulnerability, and resilience; and (v) natural resource-based sustainability (Scoones, 1998). The SLA has been used by a number of organizations for designing projects and programmes, for assessing existing activities, and for research (Ashley and Carney, 1999).

The sustainable livelihoods framework (Fig. 1) encompasses the forces and factors that affect livelihoods; it addresses various influences (constraints and opportunities) on livelihoods and ensures that important factors are not neglected (Ashley and Carney, 1999). The framework recognises that households may be vulnerable to trends, shocks, seasonality, and other factors beyond their control that affect livelihood sustainability. Households maintain their livelihoods according to the availability of assets which may be owned, controlled, claimed, or in some other means accessed by the household.

The framework identifies five main capital asset categories: human, natural, social, financial, and physical. Access to these forms of capital is enabled or hindered by transforming structures and processes (policies, institutions, organizations). The determination of appropriate livelihood strategies and the achievement of livelihood outcomes depend on access to these assets. A livelihood is sustainable if people are able to maintain or improve their standard of living related to well-being and income or other human

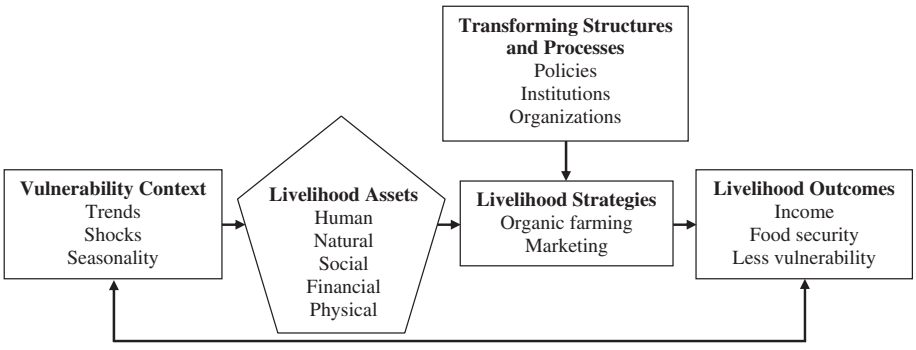

Fig. 1. The sustainable livelihoods framework (adapted from DFID, 1999; Rabbani et al., 2006; Ahmed et al., 2009).

development goals, reduce their vulnerability to unpredictable events, improve food security, and ensure their activities are compatible with maintaining the natural resource base (Allison and Horemans, 2006).

3. Methods

Research for this article was conducted in the Satkhira district, a salinity-affected coastal area of the Bay of Bengal, situated in the southwestern part of Bangladesh (Fig. 2). The SW regions of Bangladesh (Khulna, Bagerhat, and Satkhira Districts) operate 80% of the country's shrimp farms (Alam et al., 2005; Pokrant, 2006). Satkhira has been identified as the most promising area for brackish water shrimp culture due to year-round moderate to high water salinity (Alam and Phillips, 2004). Shrimp is cultivated in this area mostly between February and November when the water of the surrounding rivers becomes saline. According to WAB biweekly routine sampling in the year 2009, the salinity range of the surrounding rivers/coastal waters varied from 2–12 ppt during the culture season (Feb–Nov). The dry season from November to February is hardly suitable for shrimp cultivation due to scarcity of water and its very high salinity. During the summer monsoon from July to October, some farmers grow rain-fed transplanted rice as the overall water salinity becomes low (Ali, 2006). The Satkhira district is divided into seven subdistricts. Among them, only Kaliganj and Shyamnagar subdistricts have been considered in this study, because the available saline water and the closeness to the river channels allow them to operate a large number of shrimp farms. Both subdistricts are located close to the world's largest continuous mangrove forest and an OSP is implemented here by WAB Trading International. The 200 staff members of the OSP are mainly farmers but a few are well educated. The OSP works according to an internal control system; that is, quality management procedures, training, and inspections are performed by OSP staff to prepare for independent third party inspection and certification by the Institute of Market Ecology. An internal trainer in the OSP cannot be an inspector and vice versa. The external inspection and certification are based on current legislation for organic farming and organic aquaculture in the countries of import.

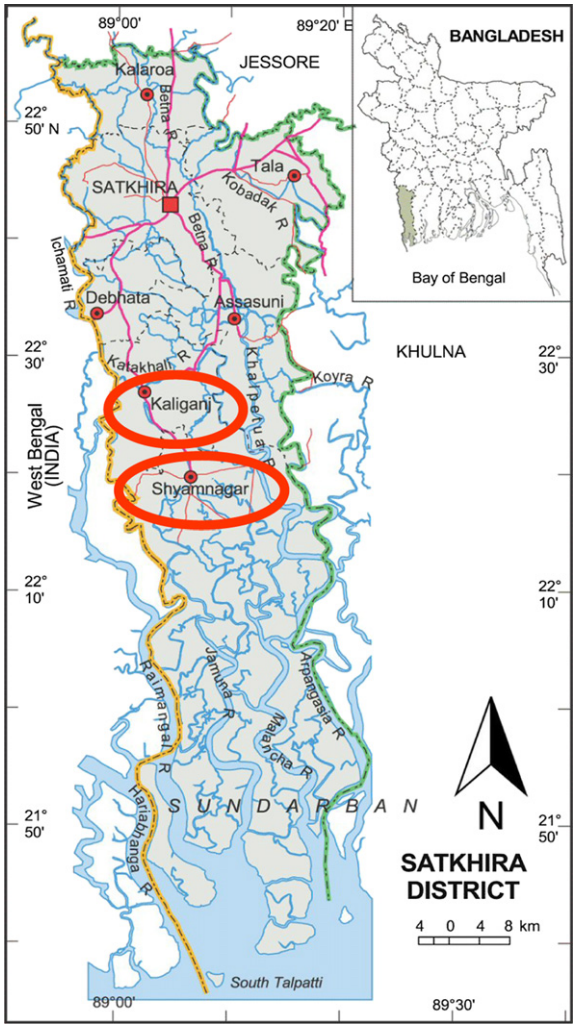

Fig. 2. The study areas (red circles) of Kaliganj and Shyamnagar in SW Bangladesh (Sathkira district) (Banglapedia, 2006).

Data were collected between October and December 2009 during the late harvesting season of shrimp farming. This study applied the quantitative and qualitative data collection methods reported in Ahmed et al. (2010). These are described here briefly. WAB cooperates with 160 organic farmers' groups (15–40 farmers per group) in Kaliganj and Shymnagar subdistricts and 3379 individual organic farmers. From these 160 groups, 12 per subdistrict (a total of 24 groups from both subdistricts, that is, 15% of the 160 groups) were selected through a stratified random sample (stratum = subdistrict). In every group, farmers were again selected through stratified purposive random sampling based on the strata *gher* size (small, medium, and large) (Table 1). A total of 144 organic shrimp farmers (4.3% of all the organic shrimp farmers associated with WAB), 72 in each stratum from each subdistrict, 24 in each stratum from each farmer's category, were sampled.

At the beginning of the study, 10 transect walks (Chambers, 1992) were performed systematically with shrimp farmers by walking across the *gher* sites to build rapport. Transect walks allow researchers to speak with farmers and observe directly the sites relevant to the research (Chambers, 1994). This method of direct interaction with the farmers generated on-the-spot questions that gleaned informal information on resource use patterns and helped the researchers to understand the farming practices and daily livelihood activities of the farmers. The transect walks were also used to validate farmers' answers in the questionnaires.

Primary data were collected during a face-to-face field survey using a pretested, finalized questionnaire that contained both precoded and open-ended questions. Pretests were done with six nonsampled shrimp farmers. The pretested questionnaire (a brief list of questions is included in the Appendix) contained both precoded and open-ended questions. The questionnaire was developed in English and then translated into Bengali by the first author to ensure efficient communication with farmers during interviews. All respondents were male and were actively involved in *gher* farming. Each respondent was given a brief introduction about the nature and purpose of the study before the interview

Table 1
Farm categories and sample size of shrimp farms based on *gher* size with their distribution in the study areas Kaliganj and Shyamnagar (Bangladesh).

Farms category	*Gher* size	Sample size (farms)	
		Kaliganj (12 groups)	Shyamnagar (12 groups)
Small farms	≤0.67 ha (≤5 bighas[a])	24	24
Medium farms	0.68–2.00 ha (5.1–15 bighas)	24	24
Large farms	≥2.01 ha (≥15.1 bighas)	24	24
Total farms		72	72

[a] The *bigha* is a unit of measurement of area of a land in Bangladesh (1 ha = 7.48 bighas).

commenced. During the ~40-min interview, questions were asked in sequence, with replies being recorded directly in the questionnaire.

As a means of triangulating the data derived from questionnaires, several topics relevant to the study, such as farmer's views and experiences in shrimp culture activities, were presented and discussed in focus groups (Morgan, 1997; Krueger and Casey, 2009). Eight focus group discussions were conducted in Kaliganj and Shyamnagar subdistricts (four in each). Each focus group session comprised 8–12 individuals and the duration of each discussion was approximately an hour. Focus group discussions were conducted only with organic shrimp farmers. The discussions were recorded with a digital voice recorder, and organized with the help of WAB staff members. Focus group discussions were held inside collection centres of WAB and in farmers' residences with the first author acting as moderator of the sessions. WAB staffs were not present at focus group meetings.

Questionnaire interview data were coded and entered into a database using MS-Access (Microsoft 2003). The statistical package for social science (SPSS™15.0 for Windows) was used to produce descriptive statistics. Data were analysed in accordance with the sustainable livelihood framework that seeks to understand why farmers adopt organic farming and what factors impact rural livelihoods. Factors that influence the income from organic shrimp aquaculture were determined through multiple regression analysis (Field, 2005) using the formula:

$$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + \varepsilon', \qquad (1)$$

where Y is the dependent variable (here, income from organic shrimp production); b_0 is the intercept and b_1, b_2, b_3, b_4, b_5 and b_6 are the slope parameters of the model. X_1 is the age in years of the organic shrimp farmer, X_2 is the number of persons in the household, X_3 is the number of years of school attendance, X_4 is the number of years of experience with shrimp farming, X_5 is the number of labour including family and wage, X_6 is the total *gher* area in hectares, and ε is an error term.

The term "farmer" hereafter refers to organic shrimp farmer. The conversion of taka (Bangladesh currency) to U.S. dollars ($) was calculated based on the rates on December 2009 ($US1 = 70 taka).

4. Results

4.1. Shrimp production systems

The 144 farms investigated—Kalindi, Uzirpur, Chuna, Ghoalghashia, Khaksihali, and Boyar beel—are in the intertidal range of the local river. The farms (the edge nearest the river) are mostly rectangular or irregular with irregular bottom topography. All the farms are within three kilometres of the river in the subdistricts Shymnagar and Kaligonj. The average size of *gher* under organic shrimp production of the studied farmers is 2.32 ha (median of 1.07 ha). The largest *gher* size is 26.72 ha and the smallest is 0.069 ha. Organic shrimp farming takes place predominantly from February to November (Fig. 3). The water level is maintained between 0.305 and 1.829 m during the whole production period. All farmers exchange water fortnightly during full and new moons. Farmers estimated an exchange of 20–30% of the total volume of water from the *gher* during each lunar cycle. During rainy seasons farmers drain excess water. Farmers exchange water through wood or concrete sluice gates controlled by wooden shutters. The same gate is used for drainage and for flushing purposes; few farmers have separate inlets and outlets. All farmers stock shrimp post-larvae between mid January and February for the first time. Restocking takes place continuously more than eight times until September. The stocking density is reduced after the first-time stocking. Harvesting and marketing take place between April and December (Fig. 3).

The farmers follow a polyculture system, that is, shrimp are housed together with a range of finfish (different species of tilapia,

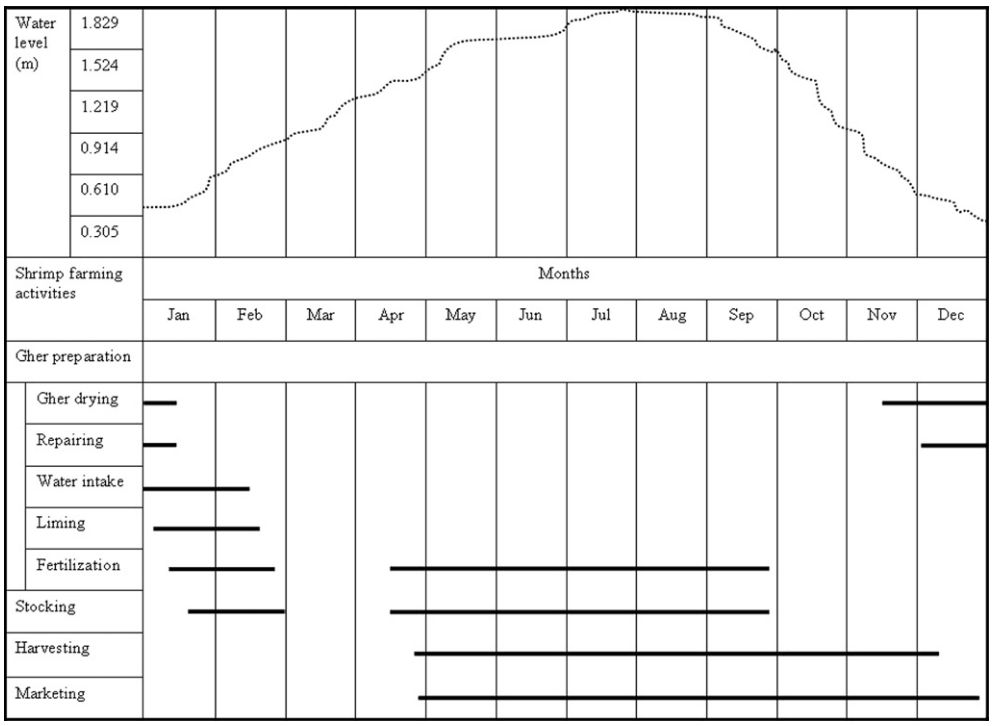

Fig. 3. Time schedule of organic shrimp farming activities in Bangladesh (Source: present study: questionnaire responses of 144 organic shrimp farmers).

Mugil parsia, *Lates calcarifer*, and the catfish *Mystus gulio*). Tilapia and *Mugil parsia* are stocked from outside but other finfish naturally enter the *gher* during saline water exchange. Farmers allow natural vegetation to grow on approximately 70% of the total dyke surrounding the *gher*. The average stocking density is 8128 post-larvae ha^{-1} ranging from 3750 to 15,000 post-larvae ha^{-1} $month^{-1}$. Farmers are not allowed to stock wild catches of post-larvae, instead they release native shrimp post-larvae from nurseries nominated by WAB. The nurseries collect hatchlings from hatcheries located in Cox's Bazar in the southeastern part of Bangladesh. However, various species of shrimp and finfish enter the *gher* from the wild via water exchange, although this is controlled strictly using fine sieves in the pipe inlets. The shrimp are nourished by natural food produced from processed cow dung or compost. No additional feeding and chemical fertilizers are used by the farmers. The shrimps are grown following traditional management, which uses the tides to control the water quality and to harvest the *ghers*. There are small ditches inside the *gher* to acclimatize post-larvae before they are released to the main *gher*. Eighty percent of the organic farmers reported that the yield of organic shrimp has increased compared with their past experience as conventional aquaculturists. Ninety-one percent of the organic farmers stated that production cost has decreased since they do not use fertilizers, additives, supplementary feeds, or vitamins in the organic shrimp farm.

4.2. Livelihood asset portfolios

4.2.1. Human capital

The age of the studied organic shrimp farmers ranged from 19 to 82 years; 34% were over 45 years old and only 19% were under 30 years old. The mean household size of the organic shrimp farmer was 5.6 persons and 62% of the households consisted of 5 or less than 5 members. The mean household size was slightly higher than the national average of 4.9 persons (DoF, 2009a). Among the total organic shrimp farmers, 15% were illiterate. Eighty-five percent of the organic shrimp farmers had a formal education but only 10% of the organic farmers held a bachelor or higher academic degree. Each organic farmer built up skills employing his knowledge from past shrimp culture. Farmers had an average of 14.4 years of shrimp farming experience and 55% of the organic shrimp farmers had more than 12-year experience.

Only 5.6% of the organic shrimp farmers lived close to the subdistrict health complex. Eighty-six percent stated that the health facility was "okay" but not easily accessible; 7.6% of the farmers did not have access to a health facility because of its remoteness or their financial insolvency. The shrimp farmers studied did not visit doctors in preliminary stages of disease and mostly depended on local pharmacies, untrained village doctors or paramedics, and traditional treatments such as *kabiraj*, *ojha*, *boidya*.

Shrimp farming requires a combination of family and wage labour. The family members of all organic shrimp farmers are involved in shrimp farming activities but family labour is not recognized as having monetary value by the prevailing social structure in Bangladesh. Family labour is mostly used for activities such as releasing post-larvae, harvesting, guarding farms, transport, and year-round marketing. The use of family labour depends on the individual farmer's financial situation. Among the organic shrimp farmers studied, 69.7% of the family labour was assigned to physical work. Shrimp farms recruit both permanent and seasonal labour (Table 2). Fifty-nine percent of organic shrimp farmers did not recruit permanent wage labour whereas 24% and 13% recruited one and two permanent workers, respectively. However, 93.7% of the farmers employed seasonal wage labour with a mean recruitment of 4.51 persons (Table 2). Seventy-nine percent of the farmers recruited three people or more as seasonal wage labourers. Forty-one percent of the farmers employed permanent wage labour for maintaining daily activity (Table 2). Seasonal labour was contracted on a daily basis and wages varied between $US1.2 and 1.8 without food. Permanent labour contracts ranged from US 21.5 to 43.5 per month without food and from $US71.5 to 171.5 per year with food. Permanent wage labourers contracted without food were employed mainly for guarding the farms.

Table 2
Distribution of labour (number of persons working) in organic shrimp farms.

Type of labour	Activity	Arithmetic mean	Standard deviation	Percentage ($n = 144$)
		Number of persons working		
Family labour	Dyke maintenance, land levelling, *gher* preparation	1.38	1.33	69.7
Wage labour (seasonal)	Dyke maintenance, land levelling, weeding, carrying post-larvae	4.51	2.65	93.7
Wage labour (permanent)	Guarding, water exchange, carrying, harvesting, transporting, marketing	0.69	1.14	41.0

4.2.2. Natural capital

On average, organic shrimp farmers owned 1.24 ha of land, almost half of the land under *gher* operation (2.31 ha) by organic farmers. Of the totally owned land, 70% was used for organic shrimp production and 19% was used for agricultural activities. Traditionally, agriculture is the main occupation of the rural population of Bangladesh. Only 8% of the land is used for homestead purposes where human habitats are constructed. Surrounding homestead land is used for producing rice and vegetables due to a deficit in agricultural land. Three percent of the land was used as ponds for producing finfish. Ninety-three percent of the farmers collected saline water from rivers or canals for shrimp production. Only 7% of farmers collected saline water using pumps or obtained saline water from a neighbour's *gher*, because their *ghers* were not situated close to canals or rivers.

According to focus group discussion participants, organic shrimp cultivation relies fully on natural sea water exchange, so several aquatic fauna and flora, fishes, and different shrimp species enter the *gher*. The abundance of those species can increase in the *gher* due to the ban on pesticides. Organic shrimp aquaculture depends on the availability of post-larvae. Two types of post-larvae are available in Bangladesh, natural post-larvae and hatchery post-larvae. Seventy-nine percent of the farmers reported that natural post-larvae are hardly available (often not found due to scarcity), and 14% claimed moderate availability (often found, but not in high enough quantities). On the other hand, 94% of the farmers stated that hatcheries post-larvae are sufficiently available for shrimp cultivation. Ninety-nine percent of the organic shrimp farmers studied stocked hatchery-produced post-larvae.

4.2.3. Social capital

All surveyed farmers had received training in organic shrimp farming at least three times for 2–3 h each from WAB. Organic shrimp production is monitored by WAB, and all organic farmers have an identification number supplied by WAB. No farmer can sell shrimp to WAB-established collection centres without showing an identification number.

Traditionally, large landowners in Bangladesh have offered employment to the rural poor. Nowadays, 100% of the large and medium shrimp farmers, and 91% of the smaller farmers employ rural poor because organic farmers have become more financially capable. OSPs generate a substantial amount of employment and diversified work opportunities for educated people in Bangladesh.

Focus group discussion participants reported that shrimp farmers donate cash to local mosques and temples from their substantial earnings after good harvests. Due to the expansion of shrimp farming, farmers compete for positions on governing bodies in local schools, colleges, *madrassas*, local markets, and committees. Membership in such organizations gives the farmers political influence and is thus helpful in maintaining sluice gates, accessing water resources, settling land related disputes, and obtaining credit from government banks and NGOs.

4.2.4. Financial capital

The mean annual household income of an organic shrimp farmer was calculated as $US 5,733 based on all income generating activities and including all household members' incomes. The mean annual income of an individual was $US 1,126. Calculation of the household income considered only earnings and did not take into account expenditures such as post-larvae, labour, leasing, and input costs. Aquaculture activities of the interviewed farmers generated more than 75% of their total annual income, and shrimp alone generated about 63.3%. Farmers earned 10.2% of their income from fish and other shrimp species (Table 3). Income from agriculture was 3.8% of the total income. Of the total incomes, 12.1% of earnings came from multiple sources including remittances, pensions, wage labour, and driver services, and 7.7% came from business sectors including shop keeping, petty trading, and shrimp purchasing and selling.

Twenty-six percent of the organic shrimp farmers did not use credit for costs involved in their business; the remaining 74% received loans from sources such as NGOs, money lenders, shrimp traders, and banks. Forty-two percent of the farmers received loans from NGOs at 12–15% yearly interest at a flat rate. Seventeen percent of the farmers received loans from local branches of the local government and private banks at a 12% yearly interest rate. Traditional money lenders provided loans to 6% of the organic farmers at an interest rate of 10–15% per month. Focus group discussion participants reported that they intended to pay back loans through the continuous selling of shrimp.

4.2.5. Physical capital

Transport, irrigation machines, power tillers, shelters, markets, electricity, drinking water sources, health, and sanitary facilities enable farmers to pursue their livelihood strategies. According to the organic shrimp farmers, physical capital has increased over the last 10–15 years (Table 4). Eighty-nine percent of the farmers report improvements in the condition of their dwellings. Nearly 97% of the farmers now have safe and hygienic latrines. Forty-eight percent of the farmers now have electricity compared to 3% 10–15 years ago. About 92% of the farmers now have access to the government health complex and 89% of the farmers now travel on bitumen-layered roads compared to the unpaved roads of the past. Vehicles used in shrimp cultivating areas are mainly bicycles, van, auto-rickshaws and motorbikes. Fifty-three percent of the farmers' drinking water sources are ponds and 43% of the farmers depend on either tube wells or rain for drinking water. Only 17% of the farmers have installed tube wells at their own expense.

Table 3
Sources of household annual income of organic farmers in Shymnagar and Kaligonj subdistricts of Satkhira district (Bangladesh).

Source of income	Mean annual household income ($US)	Standard deviation	Percentage of annual income ($n = 144$)
Shrimp	3628	5996	63.3
Prawn	64	171	1.1
Fish and others	587	1003	10.2
Agriculture	217	872	3.8
Livestock	30	101	0.5
Business	442	825	7.7
Job	73	425	1.3
Other	692	963	12.1
Total	5733	7636	100.0

4.3. Vulnerability context

Organic shrimp farmers identified several problems that increased their vulnerability as conventional farmers in past years (Table 5). Farmers identified shrimp diseases as the most important problem in conventional farming (96%), followed by the high price of inputs (85%). Eighty-five percent of the farmers reported that the quality post-larvae is not a problem for conventional shrimp farming.

Table 6 lists shocks, trends, and seasonality that can impact the livelihood of organic shrimp farming communities.

Shocks affecting farmers refer to sudden events that undermine household livelihoods. Natural disasters such as cyclones, floods, and heavy rains are unpredictable and beyond the control of the farmer. They can affect both organic and conventional shrimp farming. Diseases have not yet been found in organic shrimp production but farmers felt uncertain about the future development of this topic. Production may fail due to disease occurrence. No organic farmer has installed a saline water treatment system. Hence, contamination of saline water may occur due to the sudden entry of untreated saline water during water exchange. There are no local markets for organic shrimp in Bangladesh. The commercialization of organic shrimp is a big concern of the farmers as a ban imposed by a buyer or a decline of demand for organic shrimp on the global market would negatively affect the livelihoods of shrimp farmers in Bangladesh. Farmers also cited conflicts that have emerged between large and small *gher* owners over the control of water and land resources. These conflicts can erupt suddenly, for example, upon provision of leasing money.

Trends refer to changes over time in natural resources stocks and quality, or in other factors unrelated to aquaculture that impact an organic farming household. A major change, reported by the farmers, has taken place in the use of land in the study area. All *ghers* have been converted from agricultural lands previously used for crop cultivation. This conversion has mainly taken place due to poor crop yields and soil fertility deterioration due to saline water seepage from surrounding *ghers*. Livestock resources have decreased due to salt water intrusion in the study area. As most of the lands are now used for shrimp cultivation, production of rice and vegetables has decreased. Farmers stated that cooking fuel is going to disappear as rice production and livestock production has decreased. Most of the farmers used to employ straw and cowdung for cooking fuel. Now they depend on wood from the neighbouring mangrove forest, Sundarban.

Seasonality refers to seasonal changes that constrain the livelihood choices of people. Seasonal shifts in sources for post-larvae are an important factor mentioned by the surveyed farmers. In Bangladesh, there are more than 60 shrimp hatcheries, but none is situated in the southwestern region. Farmers face the problem of stocking post-larvae in their *gher* due to an increase in the price of post-larvae during the early season. Hence, the price and quality of post-larvae fully depend on the hatchery. Farmers often lose

Table 4
Conditions of physical assets of organic shrimp farmers now and 10–15 years ago.

Physical assets	Situation	Material/type/accessibility/position	Present condition (%) ($n = 144$)	Condition 10–15 years ago (%) ($n = 144$)
Dwelling	Good	Brick wall and tin roof or better	45	9
	Ok	Tin wall with wooden pillars and frames with tin roof	44	19
	Not good	Earthen or bamboo fence wall and tin roof	11	72
Sanitation facility	Good	Brick with good drainage	53	4
	Ok	Wood/galvanized metal with inadequate drainage	44	15
	Not good	Bamboo with leaf shelter and inadequate drainage	3	81
Electrical facility	Good	Electric lighting, fans	45	2
	Ok	Electric lighting	3	1
	Not good	No electrical connection	52	97
Medical facility	Good	Close to govt. health complex	5	0
	Ok	Far from govt. health complex but access possible	87	3
	Not good	No access to govt. health complex	8	97
Transportation	Good	Wide bitumen layered road	39	0
	Ok	Narrow bitumen layered or brick road	50	3
	Not good	Earthen road	11	97

income when there is a decrease in buyer demand. In Bangladesh, 142 processing plants have been established. Among them, only 62 hold a licence from the European Commission to export their products. The remaining plants are idle because of insufficient raw material. Only one processing plant is responsible for buying organic shrimp from WAB-governed farmers.

In addition, although shrimp farming is a year-round activity, employment opportunities for the local population face seasonal variations and are especially scarce in lean seasons.

4.4. Factors that influence income from organic shrimp aquaculture production

Livelihood strategies are likely to focus on activities that generate income. The occupational pattern shows that all farmers have more than one livelihood activity. Of the total farmers, 82.6% considered shrimp farming to be their main activity and primary source of income, followed by 7.6% that saw business, and 3.5% that saw agriculture as their main activity. Shrimp farming as a secondary activity and secondary source of income was reported by 17.4% of the farmers.

The income from shrimp production relies on different factors. The coefficient of multiple determinations (R^2) for income from organic shrimp production is 0.717, indicating that 71.7% of the total variation can be explained by the six independent variables included in the model in Eq. (1). The organic shrimp industry income depends mainly on the *gher* area under operation and the aquaculture experience of the farmers (Table 7). This implies that the income of organic farmers has increased due to the operation of larger *ghers*. The larger the *gher* area in operation, the larger is the possibility to increase income. Past experience with shrimp farming increases farmer skills and improves the management efficiency of organic cultivation. Labour plays a significant role in generating income from organic shrimp aquaculture, that is, cultivation of organic shrimp is labour intensive. The independent variables age, household size, and education do not have a statistically significant impact on income from organic shrimp farming.

Table 5
Problems faced by the organic shrimp farmers during earlier conventional shrimp farming.

Problems	Response (%) ($n = 144$)	
	Yes	No
Shrimp diseases	96	4
High price of inputs/production cost	85	15
Natural disasters (cyclone, flood)	84	16
Heavy rain	81	19
Salt water intrusion in rice field[a]	81	9
Productivity of soils	75	25
Wastewater	70	30
Oxygen deficiency	68	32
pH fluctuations	68	32
Salinity increase in *gher*	66	34
Organic matter (black soil)	63	37
Turbidity	50	50
Irrigation due to saline water[b]	42	25
Quality post-larvae	15	85

[a] 10% of the farmers did not comment on this issue.
[b] 33% of the farmers did not comment on this issue.

Table 6
Vulnerability contexts such as shocks, trends, and seasonality faced by organic shrimp farmers (Qualitative data from focus group discussions; $n = 80$).

Vulnerability context	Examples of shocks, trends, and seasonality faced by organic shrimp farmers
Shocks	Occurrence of natural disaster (cyclones, floods, heavy rain)
	Uncertain shrimp diseases
	Production failure
	Contamination of saline water
	Ban on marketing
	Demand fluctuation
	Conflicts involving control of water and land resources
Trends	Inadequate saline water supply
	Land use change
	Decrease in livestock resources
	Decrease in vegetable production
	Shortage of cooking fuel
Seasonality	Sources of post-larvae
	Dependency on hatchery
	Dependency on processing plant
	Alteration in employment opportunities

Table 7
Multiple regression analysis on income from organic shrimp production ($n = 144$).

Dependent variable	Independent variables	Coefficients	*t*-ratio	*p*-value
Income from organic shrimp	Age in years	0.000	−0.139	0.890
	Household size in persons	−0.016	−1.776	0.078
	Years of school attendance	0.008	1.608	0.110
	Shrimp farming experience	0.019	5.341	0.000**
	Labour	0.018	2.550	0.012*
	Total *gher* area	0.082	13.769	0.000**
Y-Intercept		2.723	26.381	0.000**
$R^2 = 0.717$, Adj. $R^2 = 0.705$, $F = 57.866$, *P*-value = 0.000, $n = 144$				

*, **Significant at 0.05 and 0.01 levels of probability, respectively.

5. Discussion

5.1. Organic shrimp farming can be integrated into a livelihood strategy

Environmental and socioeconomic impacts limit conventional shrimp farming (Paul and Vogl, 2011). Organic shrimp farming might mitigate some of these impacts and thus be integrated into the conventional farmers' livelihood system. However, little is known about the impact organic farming will have on a conventional shrimp farmer's livelihood. As assets play a leading role in developing and understanding the livelihood strategies which may cause an improved livelihood situation (Rakodi, 1999; Ellis, 2000), farmers can combine human, natural, social, financial, and physical capital assets in a livelihood asset portfolio to assess livelihood outcomes (Carney, 1998; Farrington et al., 1999; Ellis, 2000). Organic farming relies on these five capital assets, which contribute to agricultural sustainability over time (UNCTAD/UNEP, 2008).

Human capital is increasingly vital in organic farming, particularly for individuals and communities in Africa, as increased human knowledge and skills increase food yields and improve access to food (UNCTAD/UNEP, 2008). Greater age, higher level of education, and past aquaculture experience can increase the efficiency of organic shrimp farms (Paul and Vogl, 2012). The livelihoods of organic shrimp farmers depend mainly on the utilization of land and water resources and the protection of other natural capital. Organic shrimp farmers must consider stocking density, soil quality, water quality, post-larvae quality, and polyculture techniques. Organic farmers seek to maintain a healthy soil quality and a sustainable use of water resources (Willer and Kilcher, 2010). The dependency on hatchery post-larvae protects natural stocks of post-larvae from overexploitation, allowing the natural production of shrimp and fish to increase. Increased shrimp production from capture fisheries can provide a livelihood to poor people not involved in aquaculture. Social capital accumulates when organic shrimp farmers donate cash to institutions. Donors not only establish themselves as influential individuals, they help to create social bonds and networks within the community. The working strategy of an OSP is the formation of farmers' groups for the sharing of knowledge and experience that increase shrimp production and lower the costs of working (Paul and Vogl, 2012). Social capital can facilitate access to resources and transform them into income (Ellis, 2000; Pretty, 2003).

According to DFID (1999), available financial capital provides people with different livelihood options. The organic shrimp farming option has expanded because of the availability of financial capital. This capital facilitates the financing of working capital. The mean income of an individual organic shrimp farmer was higher than the per capita gross national income of $US 690 in the financial year of 2008–2009 (BBS, 2009), and aquaculture activities comprised an average of 75% of the total income. The percentage distribution of income indicates that organic shrimp farming has a positive impact on household livelihoods in the study area. It is also assumed that the land under shrimp cultivation is only suitable for *gher* activities as the high the salinity does not favour rice cultivation. While some organic shrimp farmers use their own financial resources to operate their business, the majority receives loans from various sources. Focus group discussion participants suggested that it is difficult to acquire loans from government banks, especially for small farms and poor farmers. A few participants applied for loans but failed, discouraged by the documentation required by government banks. Local NGOs sometimes refused to lend money to small farmers because of repayment uncertainty. Small farmers that obtain loans to finance *gher* operations are usually subjected to the higher interest rates of money lenders. However, organic farming can increase household income and has a positive impact on poverty in a variety of ways, including cash savings and additional income gained by selling surplus produce and value added products (UNCTAD/UNEP, 2008).

Physical capital endowments are an important means of accelerating growth in household incomes (DFID, 1999). The influx of road networks and the advent of electricity have enabled farmers to carry their harvested shrimp to collection centres which can protect the shrimp from deterioration in quality. New and better transportation systems have also created employment opportunities beyond shrimp farming for local people. Improvement of sanitation and medical facilities has reduced the number of farmers suffering from diseases. However, about half of the farmers depend on ponds for drinking water and have no good access to safe drinking water resources. Farmers now access up-to-date market information using their motorbikes and mobile phones. Current market information enables the farmer to earn premium prices from organic produce.

Agriculture is a primary livelihood strategy in Bangladesh (Hallman et al., 2003). Organic shrimp farming is a primary livelihood activity in the study area but provides neither full-time employment nor food security; organic shrimp farmers must rely on multiple sources of income to feed their families. Multiple livelihood activities provide a safety net to organic shrimp farmers to cope with production failure and price shock due to demand fluctuation in international markets. Livelihood strategies are the range and combination of activities and choices that people make in order to achieve their livelihood goals (Carloni and Crowley, 2005). A few years ago, many of the organic shrimp farmers interviewed converted to shrimp farming for employment and adapt new cultivation techniques. Organic farming generated employment while promoting local resources and locally adapted production methods (Buck et al., 1997; Kilcher, 2007). New industries have been generated by the shrimp industry in Bangladesh, including production of bamboo-made screens, traps and baskets, net making, sluice gate building, cock-sheet box supplying, post-larvae trading, and van pulling. Hatcheries, nurseries, ice plants and processing plants have been established to accommodate shrimp cultivation (BSFF, 2008). Marketing of organic shrimp is a viable livelihood activity for people in this area. Shrimp purchased from the farm can be carried to the processing plant applying quality control measures. This marketing occupation is a niche that could be further developed by providing adequate training to prospective candidates. Shrimp marketing is a year-round activity that could augment the income of seasonal workers.

Income diversification according to occupation is the best indicator of the socioeconomic position of a household (Ellis, 2000). Organic shrimp farmers commonly use their land for shrimp farming because it generates multiple employments (post-larvae trading, bamboo-made screens, traps and baskets, net making, sluice gate building, cock-sheet box supplying and van pulling) and

therefore more opportunity to achieve higher income diversification. Distribution of landholdings and size of land under *gher* operation in the organic shrimp sector play a significant role in Bangladesh (Paul and Vogl, 2012). Shrimp farming experience and *gher* size influence income level and in turn the livelihood of local people who are inspired to convert their farms to organic shrimp cultivation. In Bangladesh, the mean yield from organic shrimp farming is higher (320 kg ha^{-1} yr^{-1}) than from conventional farming because of improved husbandry conditions and the use of multitrophic aquaculture (Paul and Vogl, 2012). The multitrophic aquaculture concept is now used in different parts of the world as it enhances ecosystem functions by allowing biological and chemical processes to balance each other. That is, the by-products, including waste, from one aquatic species are used as nutrient inputs (fertilizers, food) for another species (Chopin, 2006). As organic shrimp farming is polyculture based and is dependent on the natural food cycle, multitrophic aquaculture can achieve higher yields in Bangladesh. Yields from conventional shrimp farming in Bangladesh have been reported to be 260 kg ha^{-1} yr^{-1} (Alam, 2009), 146 kg ha^{-1} yr^{-1} (Alam et al., 2007), and 80–200 kg ha^{-1} yr^{-1} (Islam et al., 2005). Apparently, agricultural yields remain stable when a farmer converts to organic from conventional systems (UNCTAD/UNEP, 2008).

5.2. Adopting organic shrimp farming can decrease vulnerability to risks

Organic shrimp farmers are vulnerable to events over which they have no control and that can cause negative effects to their livelihood. It is therefore important to identify means by which the negative effects of the vulnerability can be minimized, including building greater resilience and improving overall livelihood security (Ahmed et al., 2008). For instance, planting mangroves can protect and stabilize coastal land from natural disasters such as cyclones and storm surges (Saenger and Siddiqi, 1993; Islam and Wahab, 2005; Iftekhar and Takama, 2008), and potentially conserves fisheries resources (Islam and Haque, 2004). Organic aquaculturists are not allowed to damage mangrove forests to construct or expand shrimp farms (Naturland, 2011) as mangroves hold the soil in place, preventing erosion. In order to stabilise and enhance the ecological system, 50% of the total dyke surface is covered by plants (Naturland, 2011). This dyke can also be used for vegetable production. Farmers can also grow grass for rearing livestock. The increments of livestock resources directly contribute to solve the lack of cooking fuel.

The occurrences of shrimp diseases have the potential to reduce economic returns in Bangladesh (Alam et al., 2007). Adequate management and limited stocking density in organic farming minimize the extent of shrimp loss due to disease (Paul and Vogl, 2012). Management practices in organic aquaculture can achieve a high level of disease resistance and prevention of infections (Tacon and Brister, 2002). Safe saline water is an important factor in shrimp health; the health of all shrimp is vulnerable to pollution and degraded water quality (Islam, 2003; Islam et al., 2004a).

Farmers tend to sell their shrimp to WAB-established collection centres where processing companies offer premium prices after weighing. The studied farmers reported that the prices for organic shrimp were higher than those for conventional shrimp. The average price of shrimp from conventional aquaculture in local markets varied from $US 5 to $US 7 kg^{-1}, while organic farmers received close to one dollar more. This market chain has eliminated a number of intermediate stakeholders and delivers organic shrimp immediately to the processing plant. Organic farmers argued that they incur a financial loss when the shrimp are not available for purchase by international buyers. Despite the advantage of being free from middlemen, farmers can be negatively affected by limited marketing opportunities. Bans imposed without prior notice by international buyers can cause economic loss to farmers. Organic shrimp farmers and conventional farmers are equally affected by price declines. A ban imposed by the EU in 1997 for shrimp export from Bangladesh hurt the country's economy as well as individual farmers (Yunus, 2009). The Fair Trade agreement (FairTrade, 2011) ensures that buyers guarantee a minimum price for the shrimp harvest; price premiums are set on the basis of the current market price. The OSP can implement the concept of Fair Trade minimum price and organic premiums for farmers in Bangladesh. Continuous marketing, buyers at collection centres (farm gate), and price premiums help organic farmers to reduce their vulnerability to loss of income.

Farmers in the OSP are organized as an independent group. Organic production is under internal control and audits are provided by an external body (Institute of Market Ecology). The group format helps farmers to make business and social connections and take initiatives to manage conflicts. Low-level conflicts have arisen in shrimp farming areas in India's fragile Sundarbans archipelago due to the farmers being locals, the low-intensity cultivation practice, and the small area of land under operation (Knowler et al., 2009). Group organization plays an important role in creating trust, reciprocity, and cohesion within the society as members follow local norms and share values and attitudes (Pretty and Ward, 2001; Pretty, 2003). WAB training helps farmers to optimize cultivation practices and provides opportunities to share unexpected incidents and conflicts. Group meetings build good relations within the OSP, which can then help to build social capital. Access to social capital helps organic farmers to reduce vulnerability to assorted risks. Social capital can facilitate access to resources, create household livelihood capabilities, and play a significant role in sustainable rural development (Woolcock, 1998; Bebbington, 1999; Lin, 1999; Ellis, 2000; Pretty, 2003).

Organic farmers are fully dependent on hatchery sources for post-larvae (Paul and Vogl, 2012). Collections of post-larvae from natural sources are strictly prohibited by the Bangladesh government. Organic shrimp farming preserves the natural biodiversity by not stocking natural post-larvae in *ghers*. An estimated 60–75% of shrimp post-larvae are produced in hatcheries, although current data for Bangladesh do not exist (Islam et al., 2004b). Post-larvae collection from natural sources causes huge mortality of shrimp and other aquatic species incurring a biodiversity loss (Naylor et al., 2000; Hoq et al., 2001). In Bangladesh, export organizations and the processing industry are the most important transforming structures. The choices for selling organic shrimp are limited for farmers in Bangladesh. The markets for certified organic shrimp depend mainly on demand of western countries (Biao, 2008). The Government of Bangladesh has amended several policies, laws, rules, acts, and ordinances such as saline water take-up, seasonal ban on post-larvae collection from natural sources and ban on post-larvae import. To obtain licences, farms must be registered with the Department of Fisheries. The use of chemicals and drugs is now regulated, directly encouraging organic farming practices. WAB has developed an internal control system as prescribed by European Commission regulations that can help organic farmers to reduce their vulnerability. Hence, the conversion to organic shrimp farming can be recognized as a strategy to cope with the past vulnerability experienced by the farmers when they practiced conventional shrimp farming.

5.3. Organic shrimp farming can be an innovation

In Bangladesh, the conversion to organic shrimp farming is relatively new and under development. The development of

organic shrimp farming in Bangladesh is mainly driven by the farmers with the involvement of international importing organizations. According to Padel (2001), conversion to organic farming is a typical example of the diffusion of an innovation. Organic shrimp farmers can be considered innovators or early adopters. According to the adoption model, innovators are venturesome, interested in developing cosmopolitan social relationships, and communicate with a clique of other innovators, often not considering geographical distance (Rogers, 2003). Innovators must be able to cope with a high degree of uncertainty and have an ability to understand as well as apply complex technical knowledge. Adopters usually have a degree of opinion leadership and have potential communication with information sources. The role of early adopters in the diffusion process is to help trigger the innovation to an acceptable critical mass (Rogers, 2003).

The adoption model accommodates socioeconomic characteristics such as age, education, income level, farm size, personality, and communication behaviour as well as innovativeness (Rogers, 2003). Likewise, studies on the conversion to organic farming have looked at socioeconomic characteristics (Tovey, 1997; Duram, 1999; Rigby et al., 2001; Koesling et al., 2008; Kallas et al., 2010). The adoption of organic shrimp farming requires initial investment that can be supplied from multiple income options. Higher household income gave organic farmers an opportunity to make contact with WAB officials frequently, to acquire the necessary know-how, and to upgrade their skills for managing their farms organically. By adopting organic shrimp farming, farmers can reduce the negative effects of vulnerability and livelihood goals may be achieved. The conversion to organic shrimp farming may lead to the adoption of a different set of activities such as using hatchery post-larvae; applying polyculture techniques; applying compost; and may facilitate the greening of the area surrounding the *gher*. If organic farming is successfully adopted in the study area, it can diffuse very quickly to neighbours. Organic technology will be more readily diffused if social bonds are developed within the communities. In this connection, organic farmers can improve their living standards, can enhance their purchasing power, and can increase their capability to access the natural resource base.

6. Conclusion

Organic shrimp farming has a potential to improve the livelihoods of Bangladesh farmers through increased export earnings and improved social status. Because the practice is gentle to the environment, these improvements are sustainable. Currently, a single buyer exports organic shrimp in Bangladesh, but development of the OSP can inspire international buyers and a domestic market will emerge in the future. Organic shrimp farming can be a source of sustainable household livelihood; it offers positive social and economic benefits, and the risk of shrimp disease is manageable. The income gained from organic shrimp farming has enabled farmers to diversify their income opportunities. This study has opened up a range of questions for further research. As policy becomes more sophisticated, interventions to minimize the vulnerability of organic farmers and improve their living conditions will naturally follow.

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Appendix

Brief list of questions:

1 Briefly describe the demographics of organic shrimp farmers.
2 How much land (*bigha*) of the various types does your household own or have access to?
3 Briefly describe the number, size, age, history, and culture system of *gher* cultivation.
4 What are the main sources of water and their distances from the *gher*?
5 What are the main sources of water for different purposes and their distances?
6 Could you describe the ownership and accessibility of the water sources?
7 What problems are faced during shrimp farming? How would you rate them?
8 How many labourers were used for 1 *bigha* shrimp and rice production in the last year?
9 Could you give information about the shrimp post-larvae (PL)?
10 Have you obtained a licence from the Government to do shrimp production?
11 Describe the type of inputs, their frequency, and their quantity that you apply in your shrimp pond.
12 What is your source of income? What were the shrimp production and shrimp price last year?
13 Please indicate the livestock resources you own.
14 Please indicate the condition of your physical assets due to shrimp aquaculture.
15 Have you ever received credit? If so, from whom did you take credit?
16 Have you ever received any training for organic shrimp farming? If so, please indicate the name of the organization and the duration of the training.
17 How did you first hear about organic shrimp farming?
18 What was the reason you decided to take up organic shrimp farming?

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