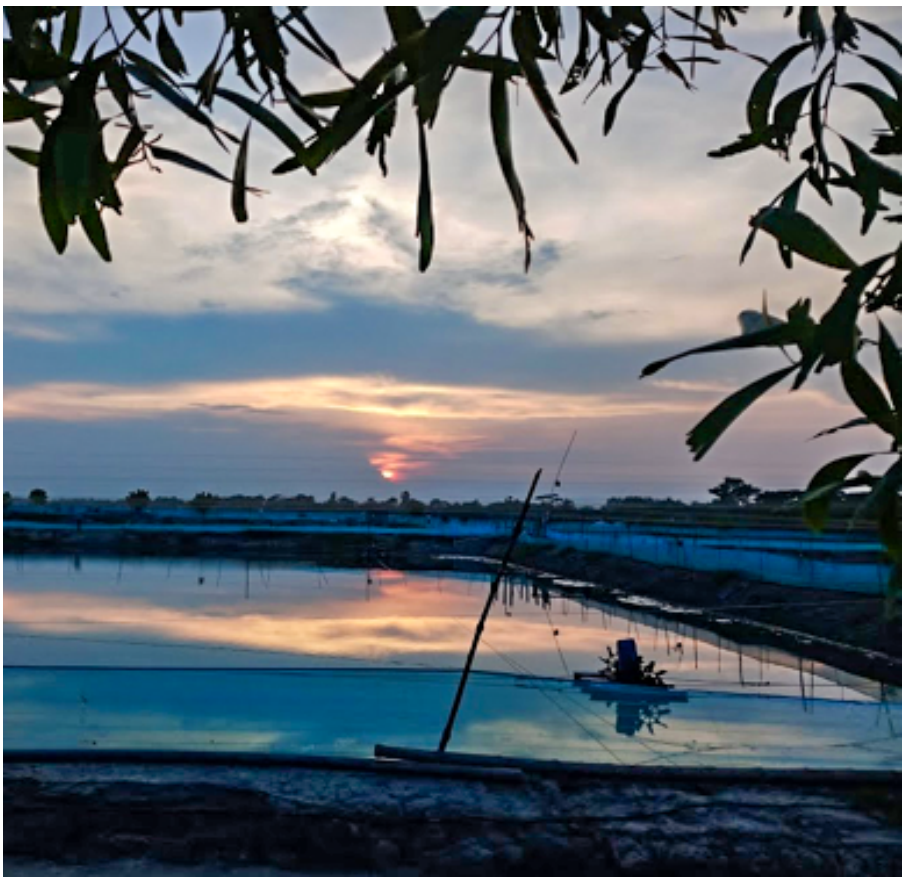

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An AgriFoSe2030 Final Report from Theme 1 - Social and economic dimensions of smallholder based agriculture and food security

Commercial shrimp-farming in south-west Bangladesh:

Challenges and Opportunities for Policy Interventions

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AgriFoSe2030

Agriculture for Food Security 2030
- Translating science into policy and practice

Today more than 800 million people around the world suffer from chronic hunger and about 2 billion from under-nutrition.

This failure by humanity is challenged in UN Sustainable Development Goal (SDG) 2: “End hunger, achieve food security and improve nutrition and promote sustainable agriculture”.

The AgriFoSe2030 program directly targets SDG 2 in low-income countries by translating state-of-the-art science into clear, relevant insights that can be used to inform better practices and policies for smallholders.

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Front picture: Shrimp farm in Bangladesh. Photo: Srilata Sircar

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Summary

Since the mid-1980s commercial shrimp-farming has expanded exponentially in coastal Bangladesh, with a focus on the south-western districts of Khulna, Satkhira, and Bagerhaat. Majority of these farms cultivate saline-water shrimps while some also cultivate fresh-water prawns. These products have come to be known as 'white gold' in the popular discourse because of their high profitability and capacity to bring in foreign exchange. The shrimp sector has been highly promoted by both the national government and the international lending agencies. It constitutes one of the largest exports from Bangladesh, alongside garments and textiles.

However, since the early 1990s there have also been recurrent concerns regarding the environmental and socio-economic impacts of this large-scale commercial shrimp-farming. While on one hand the sector has undoubtedly generated high incomes for a certain segment of shrimp-farmers, it has also in parallel led to decreasing mangrove cover, loss of biodiversity, increasing soil-salinity, and disruptions in the agricultural resource-dependent traditional way of life. This study provides a synthesis of the existing literature surrounding these themes. It further attempts to highlight the opportunities for policy interventions that can be beneficial for the core stakeholders of the AgriFoSe 2030 project i.e. smallholders and women farmers.

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This study was carried out during my stint as a guest researcher at the Centre for Integrated Study of the Sundarbans (CISS), Khulna University, Bangladesh. During this time I received support and guidance from the faculty members of the Department of Environmental Sciences, Department of Forestry, and Department of Fisheries. In particular I would like to thank Dr Dilip Dutta for facilitating these interactions. I would also like to thank the local NGO Sushilan for allowing me to accompany them on their field visits, where they facilitated focus group discussions. These played an important role to help me understand the context of the study. Finally, I would like to thank the reviewers for their comments and feedback.

1. Introduction

As of 2017, the total area under shrimp-farming in Bangladesh was estimated to be over 250,000 hectares with an annual production of more than 100,000 tons. There has been extensive expansion in area under cultivation: from 52,000 ha in 1983-84 to 140,000 ha by 1995-96 and a little over 275,000 ha in 2016-17. The horizontal expansion of farming areas can be reflected in the trend of total shrimp production of the country for the same period. Starting from a mere 2,220 MT in 1982-83 production from culture of shrimp and prawn jumped to 46,000 MT in 1995-96 and to over 130,000 MT in 2015-16. Of all the shrimp farms in the country, about three-quarters are located in the south-western coast in the districts of Khulna, Satkhira, and Bagerhat. The sector has grown exponentially over the past two decades and currently constitutes the second largest export industry in Bangladesh, as well as a significant contributor of foreign exchange in the economy. This growth has been largely made possible by the huge demand for shrimp products in the global market, dominated by the European Union and the USA. The boom in this market and its resultant profitability are testified to by the fact that shrimps have come to be referred to as "white gold" in Bangladesh (Ahmed & Diana 2015).

However, in the recent years a number of concerns have ailed the shrimp economy of Bangladesh. Foremost among these are questions of climate change and environmental degradation. A number of issues such as rising sea-levels, frequent cyclones, increased soil-salinity, and loss of mangrove forests are seen to be threatening the quality and quantity of shrimp production. Since the vast majority of shrimp-producers are small and marginal farmers, with a high representation of women among them, the challenges faced by this sector are likely to have far-reaching

social consequences. Primary among these are concerns of food-security, protection of livelihoods, and diversified household incomes.

With these implications in mind, the aim of this report is to present an overview of the sector and synthesize the existing research on shrimp-cultivation in South-western Bangladesh. This will be done with a focus on socio-economic and environmental sustainability. The report will also attempt to throw light on the opportunities for policy interventions within the current scenario.

The majority of sources used in the writing of this report consist of academic articles published in peer-reviewed journals, policy documents and review reports published by various state actors in Bangladesh, and reports prepared by international organizations such as the UN. This is supplemented by primary observations and analysis carried out during a visit to the Department of Environmental Sciences at Khulna University during July-August 2017. In doing so, the report will rely on testimonies and narratives collected through focus-group discussion and stakeholder meetings with a cross-section of shrimp-cultivators. The aforementioned host department plays a key role as the facilitator and liaising partner for dialogue and discussion between various stakeholders within the shrimp-sector. As such the visit proved to be a valuable opportunity to gain first-hand insights into the ongoing developments within the sector.

One of the first tasks of the report will be to understand the genesis of shrimp-cultivation in the region and locate it within the global context of commercial shrimp-farming as a sub-set of the fisheries sector. This will be followed by a description of the particular farming practices prevalent in the region and the nature of supply chains integral to the process. The report will then undertake a review of the documented challenges and critiques within the sector such as its environmental impacts, relationship to food security, and social-structural factors affecting the production process. This discussion will be carried out within the context of the existing policy framework and its various blind spots. The report will then conclude by pointing to the knowledge gaps and potential for future research and policy interventions.

Traditional shrimp-farms created by inundating paddy fields with saline water. Photo: Srilata Sircar.

2. Methodology

The study was conducted primarily as a review of academic literature, grey literature and policy documents. The grey literature includes reports and earlier studies conducted by INGOs, advocacy groups, and media briefings. The policy documents are mainly sourced from relevant ministries and state actors based in Bangladesh. A database of these sources was created on NVivo and thematic coding was used as a tool to understand and organize the main themes dominating the literature.

Apart from these secondary sources, some primary data was also taken into account during the writing of this report. I attended a stakeholder meeting with key actors of the shrimp sector in Bangladesh. This meeting had representatives from farmers' co-operatives including both big and small farmers. It also had representatives from owners of large cold storages – a key factors in the profitability of the shrimp sector. The observations and notes from this meeting and the summary of the discussions that took place have also been used in the writing of this report.

Additionally, during my stint as a guest researcher at Khulna University in south-western Bangladesh, I accompanied the students and lecturers of the university to their fieldwork sites where they conducted focus group discussions with stakeholder groups. These groups included all-women groups of small-scale farmers and mixed-gender groups of small farmers who were trying to diversify from shrimp monocrop to rice and shrimp cultivation. I was a silent observer at these FGDs and did not directly intervene or participate in the proceedings. However I was later given access to the recordings and in combination with my own notes, these helped me to supplement the secondary literature used in the writing of this report.

3. Commercial Shrimp-farming: Why, Where, and How?

Until the 1970s, nearly all commercially sold shrimp were captured from the oceans. By the mid-1980s, capture of wild ocean shrimp became more seasonal and unpredictable. At the same time, in several Asian coastal zones, shrimp were also cultivated for local consumption in traditional "bheri" – inland inundated shrimp farms. Brackish water from deltaic estuaries was allowed to flow into croplands bringing with it crustacean and fish fry which would feed and grow on naturally available plankton and other vegetation. Also, traditional salt makers often used their ponds to cultivate fish and prawns during the rainy season (Sultana 1994, Baraclough & Finger-Stich 1996). By the mid-1990s, close to 30 per cent of world shrimp production had become dependent on monocropping extensive, semi-intensive and intensive aquaculture. By the mid-2000s cultured shrimp had surpassed harvested shrimp production (Swapan & Gavin 2010).
In this section we will review the emergence and spread of commercial shrimp-farming at a global scale before returning to a focus on Bangladesh.

3.1 Why Commercial Shrimp-farming?

Commercial shrimp-farming has been heavily promoted and subsidized by international and national lending agencies that often cite global food security needs as a justification (Baraclough & Finger-Stich 1996). The shrimp industry has become a main beneficiary of subsidies and institutional support. Countries which have important parts of their population in need of food, such as India and Bangladesh, have been the main areas of expanding coastal shrimp aquaculture. The industry has been promoted in less developed areas with the support of the host governments and transnational companies that are often from higher income Asian countries such as Thailand or Taiwan Province of China. At the same time, aquaculture primarily meeting local food requirements has received little support compared to commercial aquaculture, including shrimp farming (FAO, 2003).

Shrimp are almost exclusively produced for export to meet the demands of high purchasing power consumers in Japan, the United States and western Europe. Consumption in these countries almost trebled during the decade of 1985-95, but with many fluctuations in demand, supply and price. Furthermore, shrimp consumption among high income groups in rapidly growing Asian countries also increasing considerably. Shrimp aquaculture is, however, a rather inefficient way to produce food calories and proteins as it relies on pellet feeds derived from captured fish. For instance, shrimp from intensive farms are fed about three times their harvested weight. But of the total amount of food provided, only about 17 per cent is converted into consumable produce (Primavera 1997).

Estimates of the monetary values generated by farmed shrimp production have varied widely depending on the prices and volumes assumed and the link in the production chain at which they are calculated. In its 1996 report on the socio-economic and environmental impacts of commercial shrimp-farming, the UN made the following estimates. Assuming an average producer price of US$ 4 per kilogram, 1994 production of 733,000 tons had a monetary value at the farm level of about US$ 3 billion. Firms in the USA importing these shrimps in 1994 paid some US$ 5.50 per pound or about US$ 11 per kilogram of shrimp (Filose, 1995). Thus the value of shrimp importing countries became almost double the production value. A large share of value added within the importing countries goes to distributors, retailers and food industries. These estimates do not account for price variations of imported shrimp between different shrimp-importing countries and exclude importers in Asia. Nonetheless, based on these rough estimates, the UN placed the value of commercially cultivated shrimp at well over US$ 8 billion in 1994. Since then the volume and scale (and therefore the value) of the commercial shrimp sector has only grown.

This makes it clear that the main reason behind the flourishing of commercial shrimp-farming is the enormous profitability attached to the sector, enabled and maintained by international financial and political support.

3.2 Where and how does Commercial Shrimp-farming take place?

About 80 per cent of world's cultured shrimp come from Asia. Between 1993 and 1994 Asia increased its production from 477,000 metric tons to 585,000 metric tons, with an increase in area of about 170,000 hectares to reach a total exceeding one million hectares. During the same time period, the number of shrimp hatcheries across Asia increased from about 2800 to more than 4000 (Rosenberry 2003, 2004). The installation of these hatcheries took place through governmental support.

In Bangladesh in 1993, for example, the government owned two of the country's four hatcheries. In order to facilitate further development of the shrimp industry, the government of Bangladesh decided to sell its hatcheries to the private sector. It also provided US$ 50 million in credit to encourage the installation of new shrimp farms.

Fisheries on the whole is central to the socio-economic life of Bangladesh. Fish supplements about 60% of Bangladeshi people's daily animal protein intake (DoF, 2016). More than 17 million people depend on the fisheries sector for their livelihoods through fishing, farming, fish handling, and processing. More than 80% of laborers engaged in the fish processing industries were women (DoF 2015). The fisheries can broadly be classified into three categories: inland capture fisheries, inland aquaculture and marine fisheries, of which the inland aquaculture sector is contributing more than 55% of the total production. The fisheries sector plays a very important role in the national economy, contributing 3.69% to the Gross Domestic Product (GDP) of the country and 22.60% to the agricultural GDP. Over the last 10 years (2004-2005 to 2013-2014 FY), the fisheries growth was fairly steady and at an average of 5.38% per year (MoFL, 2015). This sector experienced a more-or-less consistent growth rate, ranging from 7.32% growth in 2009-2010 to 4.04% growth in 2013-2014 (Bangladesh Economic Review, 2014). The sector has maintained an average contribution of 4-7% to the national GDP and within agriculture, the contribution of fisheries has increased significantly from 7% in 1975-76 to over 23% in 2015-16.

The mechanisms of shrimp-farming in Bangladesh and elsewhere, have been divided into the following categories – traditional, extensive, semi-intensive, and intensive (Swapan & Gavin 2010). The traditional form of shrimp-cultivation is the simplest with close to no additional inputs and very low yields. Several combinations are observed within this form of cultivation- (a) shrimp and fish culture throughout year, (b) salt production in dry season (December—April) using solar energy followed by shrimp and fish culture in rest of the year, specially seen in the south-east and (c) shrimp/fish culture followed by paddy culture (August to December). To make paddy cultivation possible, repeated flushing is required to reduce the soil salinity. The extensive form of cultivation is a slight improvement on this traditional form, in terms of the management practices and engineering aspects. For instance it can involve intentional stocking and feeding as opposed to complete dependence on the stock brought in by tidal waters.

In the semi-intensive form of cultivation, the biogenic capacity of the ponds is improved through supplemental feeding and improved culture practice, selective stocking, planned post-harvest and marketing. The intensive format represents the highest density, almost absolute management control, high quality complete feed, prophylactic

treatment, etc. leading to the highest production potential. The water in intensive ponds has to be changed more frequently, in order to supply clean water and dissolved oxygen necessary for the growth of the shrimp.

Extensive farms can flood over 100 hectares although they are often much smaller. Intensive and semi-intensive ponds vary from less than 0.5 hectares to about 5 hectares. Semi-intensive farms for the most part use minimal external inputs and rely on the capture of wild shrimp fry and only occasional feeding. Intensive ones use hatchery raised post larvae, pellets of mixed feeds, chemical fertilizers, medication, etc. Feed costs average 50 per cent of production costs for intensive and semi-intensive farms reaching over two thirds of current operating costs for some intensive farms. Shrimp are fed four to five times per day. In 1994 feed mills worldwide produced one million metric tons of shrimp feed. Feed manufacture requires considerable inputs of commercial energy and sophisticated technology to produce nutritious and physically stable pellets (Paul & Vogl 2010).

While labour input is relatively low, the energy costs of more intensive forms of shrimp production are high. Commercial energy inputs include the production of nutrients, feed, veterinary and sanitary products; the pumping and aeration of water; the production and use of automated feeding and harvesting devices; the raising of shrimp larvae in hatcheries; the freezing, packaging, storing and transporting the product to distant consumers (Swapan & Gavin 2010).

3.3 The Coastal Embankment Project (CEP) and inception of Commercial Shrimp-farming in Bangladesh

A number of historical events were associated with the emergence of commercial shrimp-farming in Bangladesh. It was first tested by the local farmers in 1960s, when a government project ended up creating a permanent water logging with saltwater in coastal cultivable lands. Leaving no options for rice productions in the saline fields, local farmers were permanently involved into small-scale shrimp cultivation after this man-made hazard (Foxon 2005, Fleming 2004). Then, the practice attracted a vast number of external people as soon as the shrimp price increased dramatically in the international market and turned it into a large-scale commercial industry. Due to increasing global demand of shrimp products, the industry expanded in an unplanned manner. It was further pushed through favorable policies of the government of Bangladesh in terms of getting loans, easy transportation and exporting facilities (Ahmed et al. 2002).

In the 1960s, the government felt the need to enhance the country's domestic rice production to accommodate the growing population of Bangladesh (Foxon 2005, Fleming 2004, Tutu 2001). The price of rice in the external market had risen, and consequently it was necessary for Bang-ladesh to become self sufficient in grain supply. This also coincided with the development of High Yielding Varieties (HYV) of grain. The government planned a conversion of the south-western coastal tidal plains into permanent freshwater areas for increased rice production. The aim was to create a "Green Revolution" in the agricultural sector. With this aim in mind, the government implemented a project called "the Coastal Embankment Project (CEP)" in south-west Bangladesh assisted by the World Bank. As a part of the project, 1556 km of embankments with 282 sluice gates and regulators were constructed in the south-west coastal areas of Bang-ladesh, creating a huge system of lowered sections (known as polders) separated by high em-bankments (Islam 2005).

The polders were designed to cut off all natural tidal inflow into the plains from the rivers or canals, maintaining a salinity free zone for agricultural production. Naturally, the silts carried by the tide from upstream were deposited onto the plains. This led to a rapid rise in the river-bed level and sea-water began to flow over the high embankments submerging the low-lying agri-cultural lands within the polders. The sluice gates eventually came to be blocked with silt and created areas of saline water-logged land (Tutu 2001). As there was no mechanism to drain out the water through the blocked sluice gates, the agricultural lands became permanently saltwa-ter-logged. With no agricultural alternative, a few farmers experimented with small scale shrimp cultivation in their saltwater-logged plots. Their success encouraged others and the practice began to spread gradually. As a result, salinity increased in the surrounding areas due to the intensive use of saline water in shrimp ponds, and large areas of agricultural lands lost their fertility.

The CEP brought an end to the traditional small-scale shrimp farming and encouraged farmers to turn to large-scale commercial shrimp farming in the south-west region of Bangladesh. As men-tioned earlier, a strong international market and high prices were the prime factors for increas-ing shrimp farming. Equally important was the fact that it was no longer financially viable to cultivate rice because the agricultural lands were already affected by salinity. These two factors together provided a catalyst for the process of accelerated shrimp farming (Alauddin & Hamid 1999). In the 1980s and 90s, the practice of saltwater shrimp farming expanded very quickly and with cheap land, cheap labour, and availability of wild shrimp fry, the industry expanded phenomenally (Fleming 2004).

Apart from CEP, which formally ran from 1961 to 1979, other projects involved in embankment construction in coastal districts include the Delta Development Project during the 1980s and most recently completed Asian Development Bank-funded Coastal Rehabilitation Project. As a result, by the 1980s, polders became integrated into the natural setting of coastal Bangladesh with a network of nearly 5,700 km long embankments in 139 polders (Islam 2004).

3.4 The Supply Chain in Commercial Shrimp-farming

The life-cycle of a present-day commercially farmed shrimp usually starts in a hatchery. A hatch-ery is where the shrimp eggs are grown to the post-larvae (PL) stage. They have a system of tanks for water treatment, and raise the eggs in aerated tanks, where algae and plankton are encouraged to grow to feed them. These are then moved to different ponds for the later stages of their growth. While many of the PL used to be caught in the rivers, today wild fry collection is prohibited to protect the local ecosystems. Now 80% of the shrimp originate in hatcheries and only 20% are caught in the wild (Hensler 2013).

Once transported to the nurseries in the cultivation areas in the south-west of Bangladesh, the shrimp is allowed a few days to recover from the journey and become familiar with the local water. It is then released into the ponds at the shrimp farms, locally known as “gher”. The shrimp grows until it is about 4 months old, when it has the urge to travel back to the sea to breed. When the moon is in the correct phase and the tides are high, the shrimps begin to swim around the pond to find its way out. In this process it gets trapped into the nets set up within the pond. It is then harvested in the early hours of the morning and taken to the local market to be sold to the middle-men (Ahmed 2013).

As soon as it is sold, the weight and price are documented and the shrimp are stored in a box with ice. The owner of the ‘Set’ – a local makeshift storage provider- gets a commission of 2-3%. Farmers are known have informal credit arrangements with these middle-men and set-owners who adjust the loans against the price of the shrimp. From here the shrimp are taken to a ‘de-pot’. A ‘depot’ is the next level of local, make-shift storage where the shrimp is again weighed and stored in ice-boxes. From here it is transported by trucks to one of 145 processing plants which have a combined capacity of about 265,000 million tons. At the processing plants, the shrimp is washed and sorted by an automatic machine, its head is removed by the processing workers (mainly female), gutted and cleaned inside, frozen, packed and prepared for export. (Focus Group Discussions, 2017)

The processing plants are monitored by the National Fish Inspection and Quality Control Service who are responsible for approving exports. When the shrimp arrives in the importing countries it enters the retail or foodservice chain and is sold to a supermarket from where it enters pri-vate and commercial kitchens (Hensler 2013).

4. Socio-economic and Environmental Impacts

The detrimental socio-economic impacts of shrimp-cultivation in general and that specifically in Bangladesh have been documented for a long time. In fact, as early as 1996 - more than two and a half decades ago, the United Nations Research Institute for Social Development (UNRISD) published a report on the socio-economic implications of the shrimp-cultivation sector. The findings of the report led to a ban on shrimp imports in the USA from several Asian countries (UNRISD 1996). Although the ban was primarily seen as a conservation effort to save turtles, it generated a global concern about the shrimp-farming sector on the whole.

The regional repercussions of this were felt in India most strongly. The Supreme Court of India took into account five major studies conducted by various NGOs and advocacy groups and decided to ban all commercial shrimp farms within a 500 meter radius of high-tide zones. While the immediate legal reasoning for this was a technical violation of

the Coastal Zone Regulation laws, the court observed in its judgment that commercial shrimp-farming as a sector was bringing more harm than good on a larger socio-economic and environmental scale.

These interventions were of course met with resistance from the shrimp industry which was both economically and politically influential. As we already know, in the ensuing 25 years the shrimp-farming sector not only flourished but also continued to be challenged and critiqued for its detrimental impacts. This anecdote illustrates that the history of commercial shrimp-farming on a global scale has been ridden with both fantastic success stories and premonitions of gloom and doom. With this background in mind, we now turn our attention to some of the specific challenges and critique that are of the most pressing nature.

4.1 Loss and Degradation of Mangrove Cover

Most shrimp farms are found along the periphery of the Sundarbans mangrove reserve forest area. This has led to clearing of forest cover to reclaim wetland area for expansion of shrimp-farming. This process started two decades ago and the exact rate of mangrove destruction due to the construction of ponds in the south-western parts of Bangladesh is not yet known. A lot of literature also points to the fact that the biodiversity within the mangrove forests has degraded (Iftekhar 2006, Hoq 2007, Iftekhar and Takama 2008).

A 2013 study conducted by Sustaining Ethical Aquaculture Trade (SEAT) notes that in most farms that were surveyed there was a high biodiversity in the pond. The larger, edible species of fish contributed to about half of a farmer's income from the 'gher' through sale on the local market. It also augmented the households' own consumption. The smaller pond life serves as natural feed to the shrimp. What is notable, however, is that the biodiversity of vegetation on the banks of the ponds is reduced, because only salt tolerant plants can grow. In recent times regulations have been introduced to protect these mangrove forests. Section 5.3.5 of the 2014 National Shrimp Policy prohibits the expansion of the shrimp industry by clearing mangrove forests and prevents any shrimp-related activities that make the forest vulnerable. However, it has also been critiqued as an adequate intervention. The policy emphasizes the building of a sustainable and eco-friendly shrimp culture but encourages a large number of people to engage in semi-intensive shrimp-farming, emboldening private investment. Currently, in the Sundarban mangrove region, 70% of shrimp-pond areas are under semi-intensive farming. Semi-intensive farming does not require extensive land use but needs a reliable supply of shrimp fry from hatcheries or from wild sources. Thus, unlike traditional or extensive techniques, semi-intensive or intensive farming have higher environmental impacts. It is unclear how the government seeks to address this in the absence of any concrete plans (Ishtiaque & Chhetri 2016).

In a comparative perspective, regions like south-east Asia have undergone more extensive loss of mangroves. In Bangladesh less than 2% of total mangrove forest cover has been converted to shrimp farms from 1975 to 1990 coinciding with the period when the expansion of commercial shrimp farming took place (Shahid et al. 1992). A large part of this was contributed by the clearing off of an entire 7,500 ha mangrove forest in the south-eastern Chakaria coast of Bangladesh (Hossain et al. 2001).

4.2 Changing nature of resource use

Rice was the main agricultural production in all villages before the arrival of shrimp farming. Prior to shrimp farming, rice was cultivated on 80% of the cultivable land and harvested twice a year (February-March and July-August). The yearly agricultural production was also supplemented by other vegetables and fruits. Increased salinity due to shrimp cultivation declined this production. The FGD participants stated that it was not possible to grow banana trees in the saline soil any more even though prior to the advent of shrimp-farming, banana had been one of the main cash crops in their locality. The fishes were a natural supply of protein to the daily meals of the communities. Intrusion of saline water into the wetlands has destroyed the habitat of freshwater species and, in turn, removed a protein source from the household diets.

Through the FGDs and the stakeholder discussions it emerged that the biggest sense of loss that shrimp-farmers felt was attached to the loss of homestead produce such as fruits and vegetables that could be grown within the homestead plot. These included seasonal fruits like mangoes and papayas and tropical vegetables that were integral

to the local diet. These plants are no longer able to survive the high salinity in the soil which spreads from the shrimp-farming ponds to all surrounding land. These were not only crucial in protecting the food security of the households but also contributed to a sense of identity and community.

At present there are some attempts to grow saline tolerant and resistant varieties of rice. However similar strains have not been developed for other fruits and vegetables.

4.3 Rural Livelihoods

There are over two million people involved in prawn and shrimp production, marketing, processing and export in Bangladesh (WorldFish 2013). The livelihoods of around 400,000 people, many of them women and children depend on wild fry fishing in coastal Bangladesh (Ahmed et al. 2010). Catching shrimp post-larvae is unsustainable and extremely damaging to marine biodiversity and causes health problems for those involved. Collecting post-larvae was banned or restricted in selected areas in 2000 and development agencies, government departments and NGOs are attempting to promote livelihoods diversification for those engaged in this activity (Ahmed et al 2010). Many people continue to catch post-larvae, as they have the equipment, knowledge and experience to make money. Many may not have the required assets or opportunities to pursue alternative livelihoods. There also continues to be a market for wild shrimp seed. Thus those engaged in this unsustainable and outlawed activity require proper rehabilitation into other means of livelihood.

The focus groups in the selected villages argued that the shrimp farms had provided jobs for less than 10% of the unemployed people, who had lost their jobs in the paddy field. Most of the farmers were landless and sharecroppers. Paddy fields employ around 8-10 people throughout the year whereas a large shrimp pond can be run by only 1 or 2 staff members. As a result, affected villagers changed their previous profession or migrated to other places in search of new jobs. The respondents and the key informants identified sharecroppers as the most vulnerable group in the village.

Swapan and Gavin (2010) in a participatory rural appraisal (PRA) found that 20% of the total households left their village in the last ten years due to poverty, unemployment, food scarcity and losses incurred in the shrimp business and associated debt incurred as a result of loans from local money lenders. While prices between retailers and the processing plants are negotiated, at the lower end of the value-chain among fry collectors and middlemen bargaining was found to be very limited. Small farmers depend very often on larger, dominant buyers and have very little ability to influence the price. Beside the fact that the farmers are mainly price takers, they face some other disadvantages. Apart from instability of the prices and payments made to middlemen, farmers also need to wait between 2 weeks to 3 months for payment. The payment is usually not documented, and all transactions are carried out through informal verbal agreements. This reportedly has led to stress, anxiety, and general uncertainty over being able to plan for the household's future expenses. This in turn has led to high levels on indebtedness. It is only the richer farmers with bigger tracts of land who have been able to continue farming rice on a part of their lands. The rest are entirely dependent on the market for rice and other essential food commodities. This has resulted in a precarious situation for the household level food security of shrimp-farmers.

Some employment associated with shrimp aquaculture has been created in both on- and off-farm activities in coastal areas, including jobs supplying inputs and processing production for export (Alauddin & Hamid 1999). Emerging industries based on converting seafood processing waste into value added products (Yan and Chen 2015) could create significant new income and employment opportunities. Concerning on-farm work and employment in processing plants it has been speculated that operators bring in workers from outside the community owing to mistrust and concerns over losing control to local groups (Alauddin & Hamid 1999).

Overall the literature is divided on the socio-economic impacts of commercial shrimp-farming in south-west Bangladesh. While big land-owners, including richer rice farmers, have been affected; there has been a much more significant impact on the landless labourers and marginal small-scale farmers. Some research suggests that there has been a general decline in working opportunities in shrimp farming compared to rice farming. There also exist conflicting evidence that suggests that shrimp-farming has generated greater incomes on an average.

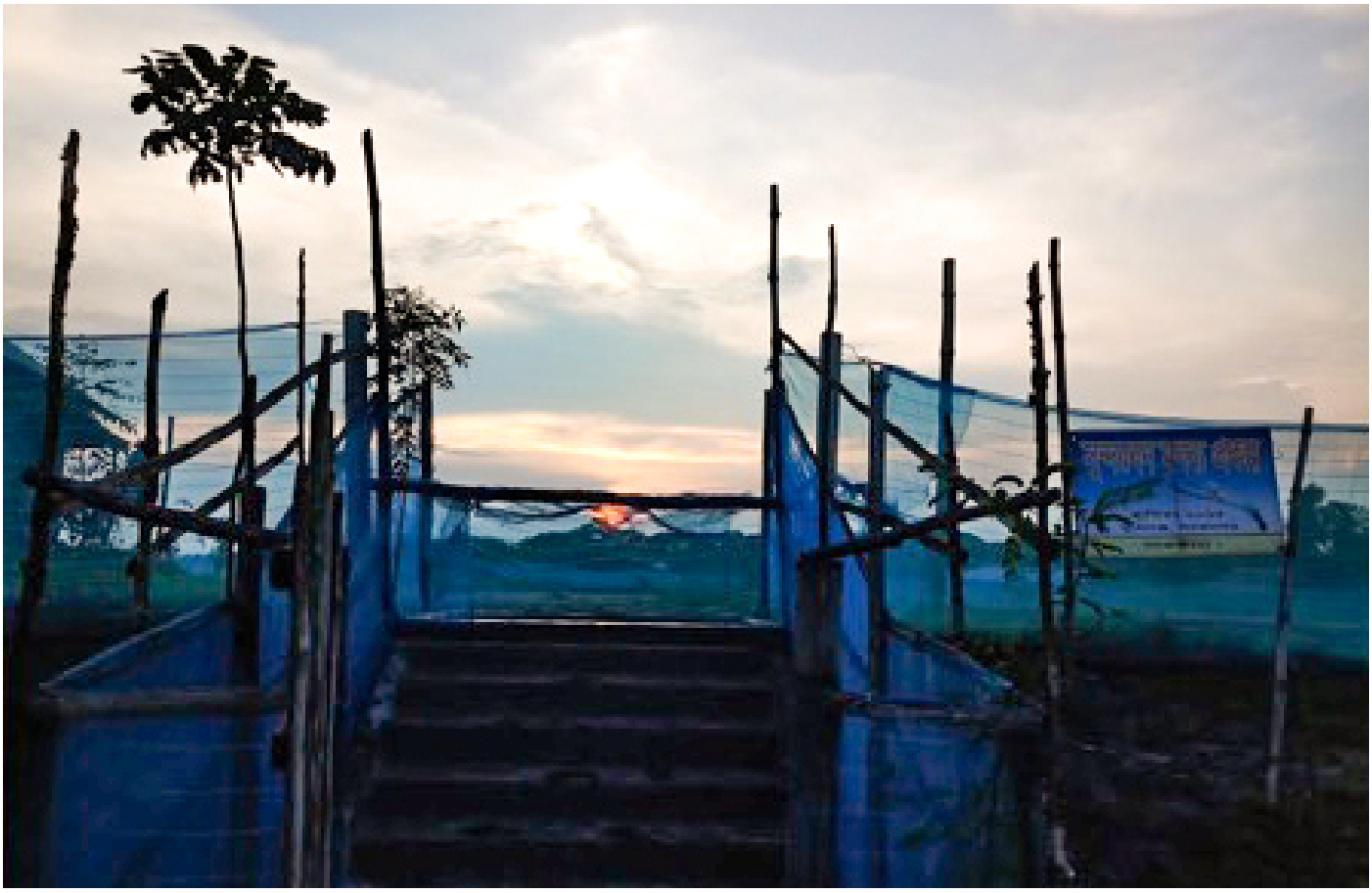
There is however consensus on the claim that it is the landless and income-poor women who have been most adversely affected by this shift from rice to shrimp cultivation. This was also validated in the focus group discussions. As women traditionally worked in paddy fields, there is now less work for them. Some women also stated that they preferred the work in the rice fields, because the casual labour on the shrimp farms is more physically demanding. Employ-ment along the shrimp supply-chain is usually characterized by insecure and seasonal casual labour in farming, processing and fry catching. Moreover, there is widespread gender discrimi-nation along the shrimp supply-chain, with women getting only about 60% of the wages men earn (Swapan & Gavin 2010) particularly in the processing plants where 60-80% of workers are female. The selling and auctioning, as well as farming is almost exclusively done by men.

There is less conflict within the existing literature on the environmental impacts of commercial shrimp-farming. The consensus is that it has had an adverse impact on mangrove cover and bio-diversity while also resulting in decreased soil quality in the region.

5. Climate Change and Expected Impacts

Bangladesh is subject to seasonal changes in climatic conditions. It also faces risks from a combination of climatic variables such as rainfall, flooding, droughts, cyclones, sea-level rise, levels of salinity, and sea surface temperature. Annual rainfall in Bangladesh varies from 1400 mm in the west to 4300 mm in the east, with 80% occurring between May and September (Shahid 2010). Climate change has profound impacts on rainfall intensity and variability in Bangladesh, and it is predicted that monsoon rainfall will increase about 10-15% by 2030 (ibid).

Increased surface temperature of the Bay of Bengal might also change wind patterns leading to increased rainfall in Bangladesh (Shahid 2010). Bangladesh is flood prone and 20% of the country is normally flooded each year. Even in drought years, 10% of the country experiences floods during the monsoon. Saline water intrusion is an increasing



Intensive farming being carried out in enclosed and protected ‘ghers’. Photo: Srilata Sircar.

problem in coastal Bangladesh, which consists of 19 districts out of 64 (about one third of the country). Saline water from the Bay of Bengal has entered in coastal Bangladesh over 100 km upstream through estuaries and rivers. Soil and groundwater salinity in coastal Bangladesh is predicted to affect two million hectares of land by 2050 (Conway and Waage 2010). Sea-level rise and cyclones with tidal surges are likely to play a critical role in increasing salinity of coastal Bangladesh. Cyclones push highly saline seawater from the deep-water layers onto the shelf and then to coastal areas (Dasgupta et al. 2011).

In a mixed-methods study conducted among shrimp-farmers in south-west Bangaladesh, Ahmed and Diana (2015) found that rising sea-levels and coastal flooding were the most commonly an-ticipated climate change impacts in this community. The fear of climate-change led adverse outcomes was found to be slightly higher among farmers who combined rice and shrimp culti-vation on their plots or were planning to diversify into resuming rice cultivation on some part of their land. This may be attributed to the fact that shrimp-farming is more resilient to in-creased salinity than the rice crop. However shrimps thrive within a narrow margin of salinity and beyond that range they face a high risk of getting infected by various diseases. The shrimp-only farms were also found to be closer to the coastline and was therefore susceptible to cy-clonic storms.

Farmers' accounts of recent cyclonic storms revealed that the production process hit a wall in the short term as the availability of wild post-larvae declined. Cyclones also result in road blockages, destruction of crucial infrastructure, disruptions in electricity supply, and obstruction of storage facilities. In the aftermath of cyclones, farming households are faced with the high costs of rebuilding damaged homes and reconstructing essential infrastructure. This also impacts their ability to make the investments necessary for the production cycle. Even outside of Bangladesh cyclones are one of the most common climatic factors impacting the shrimp industry. In 2013 for instance, cyclone Phailin caused an estimated damage of US$57 million to shrimp farms in the state of Odisha, India (Business Standard, 2013).

In recent times there have also been occurrences of droughts in the region, a clear marker of climate change. In April 2014, shrimp farmers in southwest Bangladesh faced extreme drought which destroyed US$25 million worth of shrimp and fish fry (Financial Express 2014). Drought is one of the most common causes of food shortages in shrimp farming communities. Many farmers reported that drought reduced the amount of staple food consumption, including rice, fish, vegetables, and fruits. Several farmers reported that drought has adverse impacts on income from shrimp production which in turn affected their ability to purchase food in markets. Moreover, food prices increase as drought has an impact on food supply to coastal markets. Surviving drought has always been hard as severe droughts often cause famine in shrimp farming communities.

6. Opportunities for Policy Interventions

In 2014 the Ministry of Fisheries and Livestock of Bangladesh came out with a National Shrimp Policy. The policy recognizes that much of the expansion of the commercial shrimp-farming sector in Bangladesh has taken place in an unplanned manner since the mid-1980s. It further claims that there is a need for planning and adoption of technology within the sector to make the production process more environmentally sustainable while also increasing productivity per hectare. The policy has high ambitions of mobilizing this sector to reduce poverty and make households food secure. To this end, the policy highlights both crop-rotation and crop-diversification as possible strategies.

From the FGDs and stakeholder meetings it was noted that a number of shrimp-farmers, especially those who moved to shrimp-farmer by diverting land and resources from rice farming, were eager to bring back rice cultivation in some way or form. Bunting et al (2015) have carried out an evaluation of diversified shrimp-rice agroecosystems. The authors found that combined culture of shrimp with rice presents challenges that need to be overcome through technological innovation.

Integration of giant freshwater prawn with rice farming in Bangladesh has been described extensively and the benefits of 'gher' systems (fishponds with shallow central areas for rice cultivation) are well-known and evaluated (Belton and Azad 2012, Ahmed and Garnett 2010, Ahmed et al. 2008, 2010). However due to the already increased soil salinity,

fresh water prawn cultivation is not an option available to all farmers. Systems for the integration of salt-water shrimp and rice culture have been described to a lesser extent.

These accounts point to several important techniques and innovations that make such systems interesting to evaluate from the perspective of social-ecological resilience encompassing food security and climate change adaptation. Resilience in this context was described by Adger et al. (2005) as the ability of a socioecological system to recover from natural disasters and retain essential linkages between ecosystems and society. The main obstacles faced by farmers in this process is the long time it takes for the accumulated salt to be washed away from the land and for the land to regain its chemical properties that can sustain rice cultivation. To be able to attain this, farmers would need to leave the plots fallow for several cultivation cycles to give enough time for the monsoon showers to cleanse the land. This is of course unimaginable for many farmers whose households are entirely dependent on the income from the land. The government proposes periodical monitoring and evaluation of soil quality in shrimp-farms as one of the measures to combat this. However there are no concrete plans in place for this.

The policy also refers to conservation of biodiversity and protection of mangrove forests. To this end it proposes the conservation of the naturally occurring species of fresh-water prawns and saline-water shrimps. The natural life-cycles of the species need to be protected and their migration paths, habitats, and necessary ecological conditions need to be preserved. One of the steps suggested by the government in this regard is to create switch-gates on the existing coastal embankments to control the flow of deltaic and saline water. This would enable the farmers to artificially control the salinity levels in the ponds and the surrounding natural habitat according to the life-cycle stage of the shrimps.

Another issue addressed in the new policy is that of mangrove protection and conservation of biodiversity. Historically, the Sundarbans mangrove forest provided an important habitat for shrimp. Channels and low-lying depressions in the Sundarbans, earlier used by poor fishers, have been turned into shrimp farms (Islam and Wahab 2005). Developments in the neighbouring Sundarbans in West Bengal, India followed a similar trajectory. Coastal areas in southwest and south-central Bangladesh have been brought under aquaculture production through the construction of ‘bheris’ or large impoundments. With areas ranging from 1 hectare up to 100 hectare and located in low-lying coastal areas they are filled with the incoming tide. This water carries a diverse array of juvenile marine animals into the ponds where they are retained by closing gates in the seaward embankments. Traditional management practices consist of regulating water exchange, with no supplementary stocking of juveniles, feeding or fertilisation. The ghers developed in an uncoordinated manner in the southwest, with shared dikes restricting options for water management (Azad et al. 2009). Thus an effort towards conserving biodiversity would entail rethinking the mechanism of the ‘ghers’ and ‘bheris’.

Community based adaptation (CBA) strategies have been suggested as one such alternative for shrimp farming in changing climate. The construction of earthen dams may help to protect shrimp farms. These embankments could help to protect inundation in shrimp farming communities. Fencing and netting around shrimp farms may also keep shrimp from escaping as well as predator and wild fish from entering during flood. The construction of higher dikes around shrimp farms is also a key strategy for flood management. Community based irrigation facilities with proper drainage systems may also help for rice and shrimp cultivation in the dry season. A community based integrated system for culture of prawn, shrimp, and fish could be incorporated to cope with saltwater intrusion into rice fields (Ahmed, 2013). CBA strategies have been suggested for integrated prawn-fish-rice farming in southwest Bangladesh to promote social-ecological resilience (Ahmed et al., 2014). Moreover, the introduction of salt-tolerant and drought-resistant rice varieties may substantially increase rice production. Dike cropping including fruits (e.g., banana, coconut, guava, lemon, and papaya) and vegetables (e.g., bean, cucumber, and gourd) plantation can help to protect shrimp farms from soil erosion.

Another idea that has been cited in the literature as well as promoted by local organizations is that of Integrated Coastal Zone Management (ICZM) is needed for sustainable shrimp farming in the context of climate change. The construction of large coastal embankments would help to reduce the effects of cyclones and sea-level rise in shrimp farming communities. Afforestation of greenbelt and mangrove plantation would also help to address the problem of receding mangrove cover and assist in protecting against coastal flooding, cyclones, and shoreline erosion (Alongi, 2008; Duarte et al., 2013). The construction of adequate cyclone shelters with comprehensive disaster management plan may reduce the vulnerability of climate change in shrimp farming communities. In order to effective ICZM,

however, institutional support including coordination among government organizations, NGOs, community based organizations, and local communities are essential for disaster management.

Based on the above discussion the following areas emerge as opportune spaces for policy interventions:

1. Income protection, social insurance and technical support to shrimp-farmers who are willing to shift to a diversified crop base such as combined shrimp-rice cultivation or prawn-fish-rice cultivation, but are unable to make the transition due to fear of lost incomes.
2. A community-based approach towards making investments into constructing physical infrastructure that can assist in controlling levels of salinity. This should be accompanied by technical support for monitoring soil salinity and agricultural extension on matching crop varieties to the condition of the soil.
3. Integrating approaches towards tackling climate change, protecting mangrove forest cover, and conserving biodiversity in the form of Integrated Coastal Zone Management programs that are tailored to the particular needs of local communities.
4. The social conflicts that occur in the shrimp culture area are mostly related to ac-cess to, and ownership of land, that determines the livelihood of the landless and marginal farmers. Land reforms encompassing secure lease arrangement, individual and collective tenure regimes and secure land title for the landless or land poor are central to address community related social issues.
5. To preserve biodiversity in the rivers and estuaries, use of wild fry in shrimp farms should be discouraged. However, since the wild fry catchers' livelihoods depend on this activity and since majority of them are resource poor women and children, it should be implemented in phases over a period that is realistic within the framework of new projects and programmes to ensure alternative livelihood opportunity for them. In this regard, there could be a welfare fund established through revenues generated through license fee, taxation of big farmers (producing a certain volume of shrimp), depot owners, feed manufacturers and exporters. The certification scheme should make sure that the farm in question complies with any such measure through which shrimp PL collectors can be rehabilitated
6. Consumer organizations and social justice groups, in addition to exposing the vul-nerable work and gender situation of the shrimp industry, should also explore the price exploitative behaviours of intermediaries in the shrimp global value chain that are often the reasons for such vulnerability.

7. Conclusion

There can be little doubt about the importance of commercial shrimp-farming in the national economy of Bangladesh and especially the local socio-economic life of south-west Bangladesh. The story of expansion of commercial shrimp-farming in the region is one of both great prosperity and great destruction. On one hand the incomes of farmers across the spectrum have grown exponentially while the country has benefitted from the inflow of foreign exchange through exports. On the other, the shift to commercial shrimp cultivation has taken place at the cost of converting fertile paddy fields into salt-water inundated ponds. This in turn had led to various unforeseen outcomes such as loss of mangrove forest cover, loss of biodiversity, loss of homestead fruits and vegetables, and fall in rice production which is directly linked to household level food security.

There is also ample documented evidence that commercial shrimp-farming has overwhelmingly benefitted the rich farmers and big landlords. With the transition from traditional and extensive forms of cultivation to semi-intensive and intensive forms, the cost of inputs and technology have increased making it inaccessible to small and marginal farmers. There have also been recorded cases of land grabbing for commercial shrimp-farming with the rise of middle men. The sector involves a vast range of actors in the value chain from wild-fry catchers and hatchery managers, to local storage owners and transporters. This has generated work opportunities of different kinds. But studies show that overall the shift from rice to shrimp cultivation has led to a fall in the rate of employment. This has especially hit landless labourers and women agricultural workers. Since the nature of work on the shrimp-farms is less labour intensive and not conventionally seen as women's work, it has led to displacement of women from agricultural work. Some of this has been compensated by work opportunities in the processing chain, but this comes with its own share of issues around informality and exploitation.

The main environmental impact of commercial shrimp-farming in south-west Bangladesh has been felt on the mangrove forests. The exact extent of loss of forest cover is not definitively known, but it is widely estimated to be significant. This has been accompanied by loss of biodiversity and consequent ecological disruptions. The inflow of saline water into inland farms has resulted in higher salinity of soil and ground water. This has been disruptive of species habitats while also hindering the growth of other food crops. Apart from the fall in rice production, households have also faced the loss of homestead produce such as seasonal plants and vegetables. This has had negative consequences for household level food security.

In view of these socio-economic and environmental impacts, there has been a growing enthusiasm among farmers to resume rice cultivation through rice-shrimp combined agricultural systems and diversified fresh-water-prawn, fish, and rice cultivation. However, there are several obstacles to making this transition smooth. This also presents an opportunity for well-planned policy interventions to make the sector more sustainable. In this paper I have suggested three concrete policy interventions that can be seen as opportunities for making commercial shrimp-farming more in the region more resilient. These include i) income protection and technical support for farmers looking to diversify and resume rice cultivation ii) investments into physical and technological infrastructures for monitoring and controlling soil salinity and adopting salinity-resilient varieties of seeds and iii) Integrated Coastal Zone Management with a plan that combines climate change resilience, disaster preparedness, and sustainable commercial shrimp-farming.

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