International Food and Agribusiness Management Review
Volume 23, Issue 3, 2020; DOI: 10.22434/IFAMR2019.0201

Received: 28 December 2018 / Accepted: 24 March 2020

Value chain impact of the increased hilsa shad (*Tenualosa ilisha*) harvest in Bangladesh

RESEARCH ARTICLE

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Abstract

Hilsa shad is the largest single fish species, contributing 12% of the total fish production in Bangladesh. Since the rapid decline of its harvest in early 2000, the government of Bangladesh took various initiatives to accelerate the hilsa production and introduced the hilsa fisheries management action plan in 2005. Under WorldFish led enhanced coastal fisheries project, implemented in partnership with the Department of Fisheries, the hilsa fishery reversed and experienced record harvest in 2016. Therefore, this study was undertaken to explore the contributions and benefits of this increased hilsa shad production among value chain actors. The results revealed that increased catches have significant impacts on the volumes of hilsa that were handled by the value chain actors, which depressed market price along the value chain. However, the increased amounts of hilsa harvested compensated for the reduced price and led to increased profits, increased household incomes of the value chain actors, and enhanced fish consumption at the household levels. The increased hilsa catch also had positive and significant impacts on credit repayment. Therefore, the incentive-based co-management system deserves continuation to improve the livelihood of the poor hilsa fishers, to increase the income of the value chain actors and to ensure a sustainable hilsa fishery for Bangladesh.

Keywords: hilsa shad, value chain actors, economics benefits, loan repayment
JEL code: A11, Q13, Q22, Q33

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1. Introduction

Hilsa shad (*Tenualosa ilisha* V. 1847) is the national fish of Bangladesh, contributing about 12% of the country's total fish production and 60% of the global hilsa production (DoF, 2018). Almost all hilsa is consumed domestically, with a tiny proportion (~1%) exported annually to the Middle East, Europe, and the USA, where the primary consumers are expatriate Bangladeshis (DoF, 2018; Kleih *et al.*, 2003). Approximately half a million fishers are directly involved in hilsa fishing, and 2.5 million more are indirectly involved in the hilsa fishery value chain (BOBLME, 2012; Halder, 2004; Mohammed and Wahab, 2013; Mohammed *et al.,* 2016).

Hilsa is an anadromous fish that breeds in freshwater while the juvenile hilsa migrate to the Bay of Bengal where they grow before returning to the rivers as adults to complete the cycle. Fishers catch them in the Gangetic river system (Padma, Jamuna, and Meghna) and at sea (Puvanendran, 2013). The total hilsa catch of Bangladesh started dropping in the 1990s, falling to a minimum of only 199,032 tons in 2002 (DoF, 2004). This sharp decline triggered the implementation of conservation and management programs by the government of Bangladesh assisted by donor-funded development projects, including the Global Environmental Facility/ UK Department for International Development supported fourth fisheries project (Dewhurst-Richman *et al.,* 2016; Haldar, 2003). A hilsa fisheries management action plan was introduced in 2003, through which seasonal fishing bans were imposed on five sanctuaries in the main rivers and four breeding grounds totaling 7,000 km^2 in the estuarine lower Meghna river.

These measures aimed to allow increased reproduction and recruitment in the fishery (Haldar, 2003). Fishers were banned from catching juvenile hilsa (*jatka*) from November to June, from fishing in sanctuaries in March and April, and from catching mature hilsa for 22 days in September-October around the full moon. Other management measures included the prohibition of fishing by monofilament gill nets (*current jal*), set bag nets (*behundi jal*) and other illegal gear. A compensation package was provided to fishers during seasonal fishing bans, including food and support for income-generating activities. These initiatives halted the decline, and hilsa catches started to increase at an average annual growth rate of around 5%. (Milton, 2010; Rahman *et al.,* 2012). Figure 1 shows yearly catch statistics for hilsa in Bangladesh, demonstrating rapid growth in catches from 199,032 tons in the year July 2002 to June 2003 to 517,000 t/yr in 2017/2018. These increases are attributed to hilsa stock management measures implemented by the Government of Bangladesh in recent decades resulting in increased recruitment and survival of young hilsa (jatka) which were consolidated through the enhanced coastal fisheries project (ECOFISH) (Dutton *et al.,* 2018).

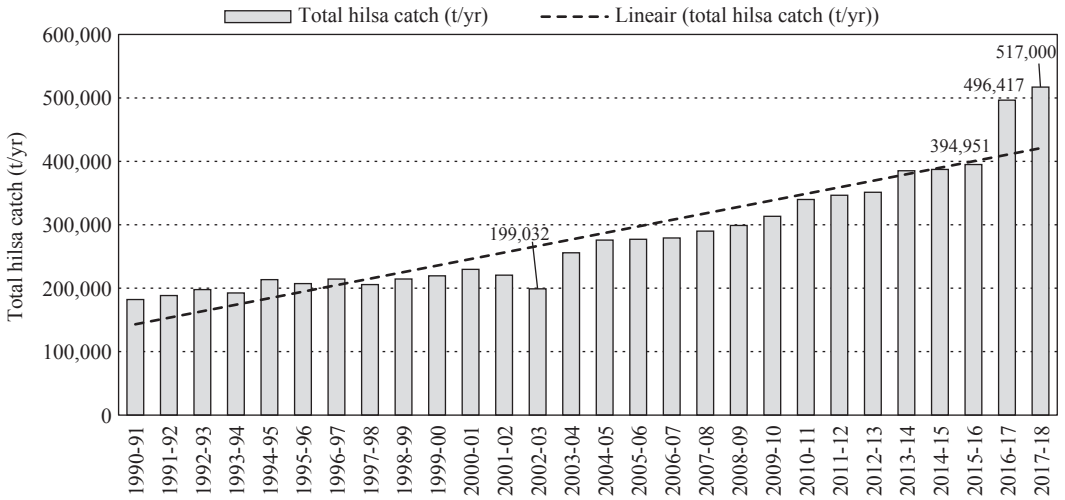

Figure 1. Hilsa catch trend in Bangladesh.

In 2014 a new 5-year initiative focused on improved management of the hilsa fishery was launched. The USAID-funded ECOFISH project was designed to enhance the resilience of the Meghna River system and improve the livelihoods of the fishers reliant on coastal fisheries. ECOFISH is jointly implemented by WorldFish and the Department of Fisheries. The project established Hilsa Conservation Groups, Hilsa *Ghat* (landing center) Groups, fisher women's Community Savings Groups, and Community Fish Guards in locations close to sanctuaries, breeding grounds, and migration routes. These community groups acted as the building blocks for the deployment of adaptive co-management approaches, including awareness building programs and livelihood support to fisher households. By 2016/17, official statistics indicated that hilsa catches had grown to around 500,000 t/yr, and these high catches have been sustained in subsequent years (Figure 1).

Though hilsa is of great economic importance with a high domestic and export demand, its marketing system is still traditional, albeit complex (Ahmed, 2007). The value chain of hilsa fishery consists of the actors – fishers, wholesalers (*aratder)*, buyers (*paikar*), retailers and consumers. Fishers often feel that they are exploited by the *mohajan*, and *aratder,* the non-formal money lenders, and boats and gears owners. Bumper production of hilsa in 2016 with an increase of 28% from the previous year (DoF, 2016) may have financial gain at different levels of stakeholders from fishers to consumers. But how the benefits were distributed among the value chain actors is a crucial indicator of an efficient market system. Besides, hilsa shad fishing is capital-intensive due to the high costs required for boats and nets, more so than other artisanal fisheries. Therefore, in most cases, fishers take loans from *mohajan* and other NGOs. *Paiker* (local wholesaler) also receives credit from *aratder* (commission agent). But the characteristics of this form of credit system are different from institutional loans.

Therefore, this study tried to answer: (1) how the different market actors shared the incremental benefits of bumper hilsa production; and (2) whether there was any positive effect on fishermen's economic emancipation, fish consumption and loan repayment? Therefore, this study aimed to determine the impacts of increased hilsa harvests on the value chain by mapping the hilsa value chain, carrying out value chain analysis on key nodes of the value chain, comparing value chain performance between two seasons with different catch levels and documenting the responses of value chain actors to increased hilsa catches.

The study took place at the end of 2015 and 2016 over a period when there was a 25% increase in recorded hilsa catches. Subsequent statistics and observations by fishers appear to show that the higher level of catches has since been sustained. At an average consumer selling price of US$ 7.95/kg in 2016, the overall value of the hilsa catch is now worth some US$ 3.9 billion per year to the Bangladesh economy. The main market channel for hilsa is from fisher to local wholesaler (*paiker*), then to regional wholesaler, then to the retailer and to the consumer with the assistance of commission agents (*aratder*) between the fisher and local wholesalers and from the local to the regional wholesaler. Due to higher fish production in 2016, the unit purchase and sale prices were lower than in the previous year, as were marketing margins and marketing profits at each level of the value chain. Despite the lower values per kg in 2016, the higher quantities handled by each value chain actor meant that total values traded were significantly higher in 2016 than the previous year. Hilsa consumption and incomes in fishing households increased significantly after bumper production. It was also found that the loan repayment rate was significantly higher after the increased production of hilsa due to higher income.

The rest of the paper is organized as follows. The next section introduces the hilsa fishery of Bangladesh. Then the data collection and analytical method is described, followed by the presentation of the results and a discussion of these. Finally, a conclusion is made and policy suggestions are put forward.

2. Hilsa fishery of Bangladesh

Bangladesh is fortunate in having an extensive inland water resource and extensive coastal line which is very productive. The soil, water and climate of Bangladesh are very favorable for inland fisheries, both open and closed water. Bangladesh is the second largest inland capture fish producing country after China and 11th in marine fish production in the world (FAO, 2018).

Among about 250 fish species, hilsa is the national fish of Bangladesh which has economic and cultural importance in Bangladesh. Year-round, this species is caught from ocean and river systems, and marketed and consumed all over Bangladesh. Before 1972, the hilsa fishery was restricted to the upstream rivers, mainly the rivers Padma, Meghna, Krakatoa, Rupsa, Shibsa and Payra. Consequently, it has sharply declined in the upstream areas and now Hilsa fishing intensity has been increasing in downstream areas and especially the inshore waters where sufficient concentrations of hilsa are now found (Hossain, 2014). Low water discharge from the river Ganga at the Farraka barrage in India located 10 km from the border with Bangladesh disrupts the migration route and contributes to the loss of spawning and nursery ground of the species and indiscriminate exploitation of juveniles (Halder, 2002; Hossain, 2014). In addition, hilsa fish are being harvested at a higher level than the available stock can sustain, varieties of fishing gear and fishing boats (both mechanized and non-mechanized) are used throughout the year which led to overexploitation (Amin *et al.*, 2002, 2008; Khan, 2012; Miah *et al.*, 1997). This overuse of fishing effort has reduced the fish stock and the rate of catch per unit of effort. Consequently, concern has been expressed that the hilsa stock may collapse near future due to an increased rate of exploitation (Amin *et al.*, 2008; Halder, 2004),

About 3 million (2%) of the country's total population are directly or indirectly involved in the hilsa fishery for their livelihoods. Almost half a million people are directly involved in hilsa fishing which belonging to 184,000 families. 68% are full time, and 32% are part-time in different areas of Bangladesh (DoF, 2014; Halder, 2004). From 1987 to 2018, with an increase of boats and gears, the numbers of hilsa fishers have increased in this sector. Most of these fishers are very poor, illiterate and do not possess any land for crop cultivation. Therefore, hilsa fishers earn their livelihood by catching and selling hilsa even if they have no other sources of income. Most of the hilsa fishers live below the poverty level; largely they are economically weak in terms of earning and availability of work (Pal *et al.,* 2011; Siddique, 2009).

Most fishers (80%) do not own their boats. They borrow money from boat-owners and payback with 50% of the net return of catch sales. Usually, three types of fishers make up a crew, i.e. head *mazhi*, assistant head *mazhi* and *bhagi*/fishers. The number of *bhagi* depends on the size of the boat and the fishing net (Mome, 2007). Revenue distribution is complex among the fishers. For example, if a fishing boat is operated by five fishers (1 head *mazhi*, 1 assistant head *mazhi* and 3 fishers), initially 50% of net return goes to the owner of the boat. The remainder is divided into six shares. The head *mazhi* gets 2 shares, the assistant head *mazhi* gets 1.5 shares (he also gets half a single share's worth from the boat owner), and each *bhagi*/fisher gets 1.25 shares, with an additional quarter share's worth from the boat owner). Boat owners donate about a share and a quarter to four fishers as welfare support or a symbol of generosity. Table 1 shows the per trip income distribution among the boat owner and fisher from this study. It was observed that the average total and net returns were US$ 187.54 and US$ 117.71 per trip, respectively, of which half was paid to the boat owner and the remaining amount was distributed among five fishers (Table 1).

Hilsa marketing systems are traditional and complex run chiefly by a small organization at local level. Fish marker is generally divided into primary, secondary and tertiary. It also can be divided into local market, distance market and overseas market based on the consumer. Usually, fishers, local agent, wholesaler and retailer are the main marketing actors of hilsa fish but a larger number of people such as fishermen, commission agent, wholesalers, processor, transporters, day laborer including women and children, and retailers are involved in the value chain. Fishers generally sell fish to the local commission agent (locally known as *aratders*) from where they have received loan. But fishermen have rights to sell their fish to another market or commission agents if they get a higher price. Once the fishermen land the fish in the local or primary

Table 1. Per trip income distribution among fishers and boat owner.

Fishing team	Share distribution	Net income/person (US$)	Income/trip (US$)	Costs/trip (US$)	Net income/trip (US$)
Boat owner	50% of total revenue	58.85	187.54	69.83	117.70
Head *mazhi*	2 shares	19.61			
Assistant head *mazhi*	1 share + 0.5 of share from boat owner	14.70			
Each fisher/laborer	1 share + 0.25 share from boat owner	12.26			

market, the sale agent takes care of landing, handling, sorting and auctioning where local day laborer and women are involved. To ensure a higher price for the fishermen, the agent follows the auctioning system where auctioneer calls out the bid loudly in the presence of several buyers and the highest bidder wins. Here, local agent (*aratders*) get commission at a specific rate which varies from 3 to 8% of auction price depending on location and volume of fish. Afterwards, local suppliers (who purchase fish through biding system) store fish on ice and communicate with the distance wholesalers especially in the secondary market. Suppliers commonly use boats, trawlers, track, buses and trains to transport hilsa from landing areas to the distance wholesalers at urban fish markets. Subsequently, hilsa reach to tertiary or retail market through two to three intermediaries. The price of hilsa is very high compared to other aquaculture or capture fish species. Therefore, poor or middle-income people cannot buy this species except in the peak season. Hilsa price at the village market is higher compared to divisional market because of transportation cost. According to the Bangladesh Department of Agricultural Marketing, hilsa price has increased 20-fold during the last three decades (DAM, 2018).

3. Data and methods

The study was conducted along the hilsa market chain from fishers to consumers. Data was collected from the landing centers of three hilsa sanctuaries of Chandpur, Bhola and Barisal (Figure 2) in 2015 and 2016 during peak and lean seasons. A baseline survey was conducted during November-December 2015 and a final survey during November-December 2016. In each sanctuary, interviews were conducted at two major fish landing centers (*mach ghat*) and in the fishing communities residing adjacent to the sanctuaries. These fishing communities are directly dependent on fishing inside the sanctuaries for their livelihood. Simple random sampling procedure was used at this stage. Finally, other value chain actors, i.e. from *aratder* to consumers were selected through the 'snowball sampling' technique, where a diverse group of people engaged in hilsa fisheries activities were selected to identify the potential value chain actors of hilsa shad (Bernard, 2006). A total of 420 value chain actors were selected, of which 240 were hilsa fishermen, and 180 were other value chain actors, including the consumers. Figure 2 shows the major spawning areas for hilsa in Bangladesh and the study area.

Value chain mapping was then carried out to identify the key actors from harvesting through to consumption. Structured questionnaires with quantitative and qualitative questions were prepared for each group of value chain actors: fishers, wholesalers, traders, retailers and consumers. Questionnaires were pretested before final data collection. The questions included respondents' demographic characteristics, their respective activities and perceptions on government and ECOFISH initiatives.

Fishers from landing centers in three hilsa sanctuaries (Chandpur, Bhola and Barisal) were interviewed either in the marketplace after selling fish, or at their boat or at home following random sampling. The surveys took place in November/December 2015 and November/December 2016. Wholesalers, buyers and retailers were interviewed in wholesale or retail markets in Dhaka, Jessore and Khulna using 'snowball sampling', where value chain actors identify other actors in the value chain. Consumer data was collected from people

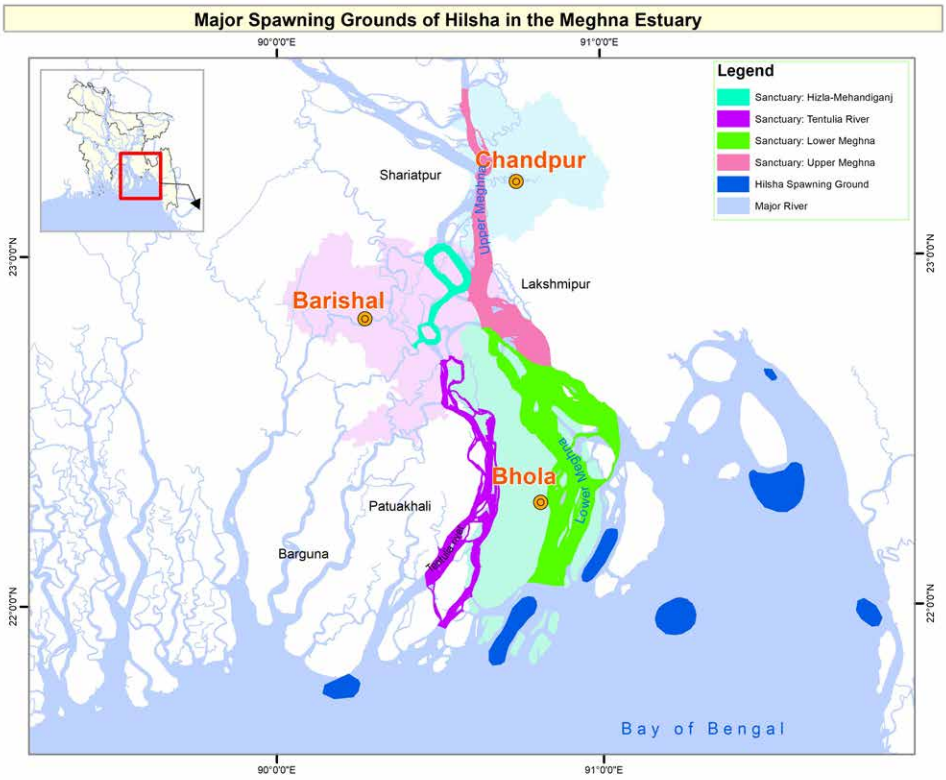

Figure 2. Map showing the study sites within the Meghna River system.

buying hilsa in these markets. Several Focus Group Discussions were also conducted with different value chain actors for data validation. A total of 240 hilsa fishers and 180 other value chain actors were interviewed in each year.

Initially, hilsa value chain mapping and main marketing channels were identified to estimate the actual benefits. Afterwards, different performance indicators, such as marketing cost, marketing margin (Equation 1), marketing profit (Equation 2), marketing efficiency and the average net share of the final selling price (Equation 3) were estimated on the basis of actors' activities for 2015 and 2016.

The following performance indicators were estimated as follows:

$$\text{Marketing margin} = \text{Sale price} - \text{Purchase price} \quad (1)$$

$$\text{Marketing profit} = \text{Sale price} - (\text{Purchase price} + \text{Marketing costs}) \quad (2)$$

$$\text{Average net share of consumer's price received by actors in value chain} = (\text{Purchase price} / \text{Consumer's price}) \times 100 \quad (3)$$

Costs and profits from hilsa catches and sale were calculated for all actors of the value chain based on the interviews carried out at the end of 2015 and 2016. The results were used to estimate average quantities and value of hilsa traded by the value chain actors. The welfare of women was estimated through household consumption and income. Two-sample *t*-tests were used to determine whether any significant change took place in sale volumes, benefits and credit received between the two years.

4. Results

There are about nine actors involved in the whole hilsa value chain process. Therefore, the consumer level price is much higher than that at the producer level. The main market channel for hilsa is from fisher to local wholesaler (*paiker*), to regional wholesaler to retailer and retailer to consumer with the assistance of commission agents (*aratder*) between the fisher and local wholesaler and from the local to regional wholesalers. A small proportion of the catch (5%) is sold by floating *aratder* who pass fish directly from fishers in the river to local or regional agents while some of the fish from local wholesalers are sold to local retailers or directly to consumers (Figure 3). Fishers bring their fish to a collection center where fish is sold by auction to wholesalers. Fishers usually have a credit relationship with a specific commission agent. However, they may use another agent if a higher price can be obtained elsewhere. Commissions vary according to location and market conditions but are in the range 5-12% of the selling price. Regional commission agents perform the same function in larger markets where again the fish is sold through a bidding process. Wholesalers have extra costs associated with sorting, icing and storing fish either at the local or regional level. Regional wholesalers may operate a shop and store hilsa for some time. Retailers buy fish from wholesalers and have a shop in markets where they incur costs for icing, storing and selling fish to consumers.

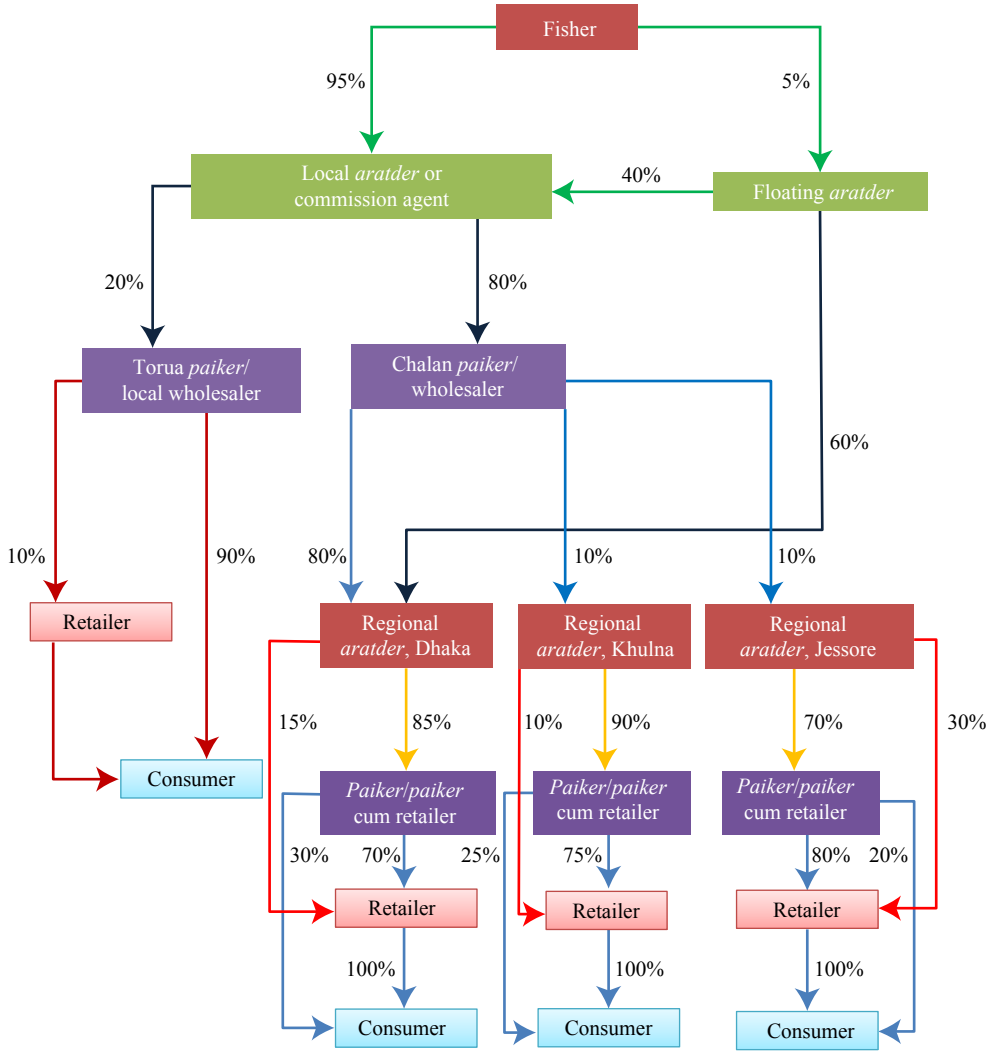

Figure 3. Value chain mapping with the percentage of hilsa fish in selected areas surveyed.

The approximate distribution of value and profits between value chain actors is shown in Table 2 for 2015 and 2016. Due to higher fish production in 2016, the unit purchase and sale prices were lower than in 2015, as were marketing margins and marketing profits at each level of the value chain. The marketing profit for fishers (distributed among all fishers who operate as a team on a fishing boat) was US$ 3.85/kg in 2015 compared to that of US$ 3.23/kg in 2016. The average marketing profit gained by a local commission agent was US$ 0.51/kg in 2015 compared to only US$ 0.39/kg in 2016. Local wholesalers also incurred higher marketing costs for storing, grading, icing and transportation of fish, resulting in average marketing profits of US$ 0.50 /kg in 2016, compared to US$ 0.81/kg in 2015. Marketing profits for regional wholesalers were US$ 0.52/kg in 2015 and US$ 0.47/kg in 2016 while marketing profits for retailers dropped from US$ 0.49/kg in 2015 to US$ 0.36/kg in 2016. In spite of the lower marketing margins and profits in 2016, total benefits for all value chain actors were much higher than that of 2015. Besides, hilsa market became more efficient and vibrant due to increased availability of hilsa in 2016 owing to bumper production.

Despite the lower values per kg in 2016, the higher quantities handled by each value chain actor meant that total values traded were significantly higher in 2016 than in 2015, as shown in Table 3. The total sale volumes per fisher increased by 70% (from 3,677 kg in 2015 to 6,238 kg in 2016), and by 142% for local

Table 2. Costs, marketing margin, and marketing profits for different value chain actors.[1]

Value chain actor	Category	2015 (US$/kg)	2016 (US$/kg)
Fisher	Fishing cost	2.20	2.09
	Commission cost	0.38	0.31
	Selling price	7.00	5.63
	Marketing profit	4.41	3.23
	Share of consumer price (%)	69.09	70.76
Local agent	Commission cost	0.63	0.51
	Marketing cost	0.12	0.12
	Net profit	0.51	0.39
Local wholesaler	Purchase price	7.00	5.63
	Marketing cost	0.34	0.32
	Commission cost	0.31	0.23
	Selling price	8.62	6.67
	Marketing margin	1.34	1.04
	Marketing profit	0.81	0.50
	Share of consumer price (%)	85.18	83.83
Regional agent	Commission cost	0.31	0.27
	Marketing cost	0.11	0.09
	Net profit	0.19	0.18
Regional wholesaler	Purchase price	8.62	6.67
	Marketing cost	0.26	0.09
	Selling price	9.40	7.62
	Marketing margin	0.78	0.58
	Marketing profit	0.52	0.47
	Share of consumer price (%)	92.86	95.74
Retailer	Purchase price	9.40	7.35
	Marketing cost	0.11	0.11
	Selling price	10.00	7.95
	Marketing margin	0.60	0.50
	Marketing profit	0.49	0.36
Consumer price		10.00	7.95

[1] 1 US$ = BDT 82.

Table 3. Average quantity (t/yr) and value (US$/yr) of hilsa traded by value chain actors.[1]

Value chain actor	Unit	2015	2016	% increase (*P*-value)[2]
Fishers	quantity (t/yr)	3.67	6.24	70 (0.00)
	value (US$/yr)	25,719	35,110	37 (0.00)
Local agent	quantity (t/yr)	34.67	83.85	142 (0.00)
	value (US$/yr)	242,536	471,390	94 (0.00)
Local wholesaler	quantity (t/yr)	23.02	51.38	123 (0.00)
	value (US$/yr)	200,768	361,366	80 (0.00)
Regional agent	quantity (t/yr)	123.57	187.86	52 (0.00)
	value (US$/yr)	1,077,780	1,321,365	23 (0.01)
Regional wholesaler	quantity (t/yr)	5.30	12.95	144 (0.00)
	value (US$/yr)	49,829	98,622	98 (0.00)
Retailers	quantity (t/yr)	2.65	4.23	59 (0.00)
	value (US$/yr)	26,817	34,170	27 (0.01)

[1] 1 US$ = BDT 82.

[2] Significant difference between the 2015 and 2016 volumes and values; *P*-value in parentheses (Students *t*-test).

agents (*aratder)*. Sale volumes for other value chain actors also increased by approximately 123, 52, 144 and 59% for local wholesaler (*chalan paiker)*, regional agent, regional wholesaler and retailers, respectively leading to significantly higher income at all levels of the value chain.

Hilsa consumption and incomes in fishing households increased significantly between 2015 and 2016 (Table 4). Average hilsa consumption by all households interviewed increased from 1.42 kg/person/month in 2015 to 2.55 kg/person/month in 2016, demonstrating that lower prices and greater availability had a significant impact. The average monthly income per fisher household has increased 67.23% from US$ 178.64 in 2015 to US$ 298.72 in 2016. Because the effects of bumper production in 2016 outweighed the effects of price reduction.

Both institutional and non-institutional credit systems exist in the hilsa fishing industry. Informal credit known as *dadon* exists at every stage, whereby fishers take loans from agents (*aratder)* as well as NGOs. Each *aratder* usually distributes loans to 100 to 125 fishers and the amount of loans varies between US$ 122 to US$ 1,220. Since the fishers are obliged to supply hilsa to the *aratder,* they enter into a chronic debt cycle and lose the freedom to selling fish at a fair price. *Aratder* find it easier to access loans from financial institutions such as different public and private banks that fishers cannot access due to lack of collateral. Increased hilsa harvests had a positive impact on credit repayments. It was found that while fishers received around the same amount of credit for fishing in 2015 and 2016, the loan repayment rate 2016 was 71.35%, which was significantly higher than the 2015 repayment rate of 43% (Table 5).

All members of the fishing households are involved in the fisheries activities (Hasan, 2012), women's participation in hilsa fishery value chain is, however, largely invisible. Traditionally, at the village level, women always do sacrifice for the family members regarding food, i.e. women serve food to their husband and children first and then she eats the rest of the food (Sheema *et al.,* 2016). Therefore, in poor households,

Table 4. Hilsa consumption and household income in fishing communities.

Items	Unit	2015	2016	Increase (%)
Amount of hilsa consumption	kg/month	6.98	13.84	98.13 (0.00)[1]
Average income/fisher household	US$/month	178.64	298.72	67.23 (0.00)

[1] Figures in parentheses indicate the *P*-value difference between the 2015 and 2016 volumes and values.

Table 5. Credit received and repayment rates before and after bumper production.

Credit amount and repayment rate	2015	2016	*P*-value
Average credit received for hilsa fishing (US$)	807.67	859.83	0.25
Repayment rate (%)	43.84	71.35	0.00
Average credit received for family purposes (US$)	151.99	166.84	0.336
Repayment rate (%)	52.66	78.97	0.001

women consume less food, especially fish and meat, compared to the men in the household. It was observed that overall, per household hilsa consumption of women has increased from 22.35 kg/year in 2015 to 36.77 kg/year in 2016 (Figure 4), which was due to bumper production. All women interviewed agreed that hilsa production was significantly much higher in 2016 compared to the previous. Furthermore, they reported that average household incomes in fisher households had increased by about 2.5 times in 2016 compared to 2015. The increased income was spent on loan repayments, buying clothes, supporting children's education, repairing houses and visiting relatives. The increased access to resources led to the creation of saving schemes through the formation of 123 community savings groups under the ECOFISH project (Naznin personal communication Gender Specialist, WorldFish). Therefore, enhanced hilsa production had multi-dimensional positive effects on fish consumption (Figure 4), income and overall welfare of women in fishing households.

5. Discussion

This study argues that the increases in hilsa harvests in recent years can be attributed to the long-term efforts of the Department of Fisheries, Bangladesh and the recent interventions implemented by WorldFish and the Department of Fisheries through the USAID funded ECOFISH project to protect brood hilsa for breeding and improve survival of juvenile hilsa. Project interventions accelerated the consolidation of increasingly well-enforced seasonal restrictions on fishing for brood hilsa and *jatka* (juvenile hilsa) while supporting AIGAs to encourage compliance with fishing bans and thus increase the resilience of the river ecosystems. According to official statistics, there was a 25% increase in catches between 2015 and 2016 and elevated catch rates have been sustained in the years since then. This study confirmed that increased catches had significant impacts on the volumes of hilsa being handled by value chain actors which depressed prices along the value chain. Nevertheless, increased volumes more than compensated for the reduced prices leading to increased profits for value chain actors and consumption by consumers. Besides, price spread was low in 2016 compared to 2015 indicates higher market efficiency due to increased hilsa catch. Bladon *et al.* (2016) reported that about 91% of respondents stated that government regulations such as current net ban, the *jatka*-fishing ban, and the 15-day hilsa-fishing ban for brood fish have had positive impacts on hilsa abundance. They also reported that the household income of fisher has increased significantly due to the hilsa ban regulations. In

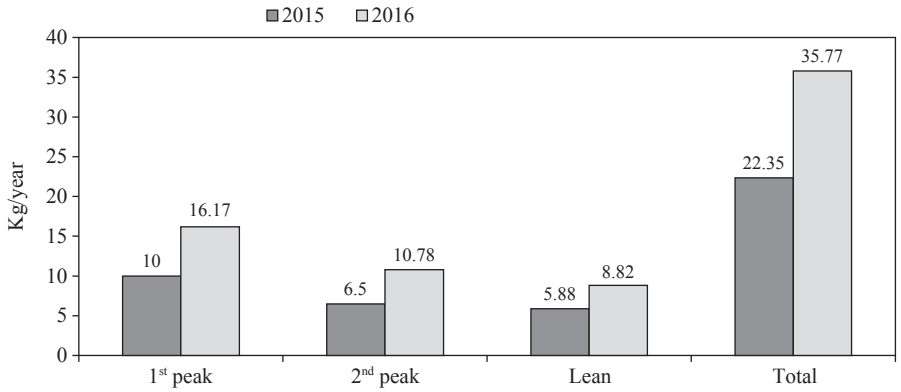

Figure 4. Women's hilsa consumption increased due to bumper production.

another study, Hossain and Hossain (2019) showed that increased production of shrimp has positive effects on value chain actor's livelihood. Uddin *et al.* (2018) showed efficiency in marketing system is low in the case of the aquaculture value chain.

Findings of this research also shows that bumper hilsa catches has positive and significant effects on consumption of fisher's household. Mostly, poor fisher consumes higher hilsa fish when they catch more. Hilsa fish consumption can vary substantially depending on income, season and location. Since hilsa is a natural sourced fish and produced in a particular season, therefore, there is a seasonality pattern in hilsa consumption. The average per capita hilsa consumption was 1.27 kg/person/year and the most hilsa is consumed fresh (Nowsad *et al.,* 2012; Toufique, 2015) after applying different cooking methods. Among different fish species consumptions, the major share was occupied by assorted small fish (29%), Indian carp (22%), and exotic carp (21%). The shares of the other species are 9% for hilsa followed by live fish, tilapia, shrimp, and prawn (Nowsad *et al.*, 2012). Bangladeshi women are often considered underprivileged compared to men with regard to productive assets (Quisumbing and Maluccio, 2003; Quisumbing *et al.*, 2013; Sraboni *et al.,* 2014). About 30% of women are directly or indirectly involved in the fisheries sector in Bangladesh. While all members of fishing households are involved in some way in fisheries activities (Hasan, 2012), women's participation in the hilsa fishery value chain is largely invisible. In poor households, this usually means that women consume less food, especially fish and meat, compared to other members of the family. It was observed, in this study, that hilsa consumption per woman increased from 22.35 kg in 2015 to 35.77 kg in 2016.

Credit works as power for any business, but nature of credit and its terms and conditions is very much essential to be succeed in any business. Informal credit (known as *dadon*) exists in all stage of hilsa value chain but contracts is different than the usual informal credit. Usually, fisher takes *dadon* from the commission agent (*aratder*) which has no interest rate and repayment date. But fisher is obliged to sale fish to that *commission agent* from where he took *dadon*. It was found that each *aratder* distributed *dadon* among at least among 100 to 125 fishers and the amount varies from US$. 121.95 to US$. 1,219.51. Total amount of *dadon* has increased year by year, which skewed the freedom the fisher of selling fish in the market. Besides, local wholesaler receives *dadon* from regional commission agent and amount depends on the quantity of transaction. This research confirmed that increased hilsa catch had a positive significant impact on repayment of *dadon* as well as other credits. Dewhurst-Richman *et al.* (2016) found that 84% of respondents reported being in debt and 86% reported selling their catch via middlemen, who tend to keep fishers perpetually in debt.

6. Concluding remarks

The attribution to the cumulative efforts of a decade long *jatka* conservation of the Department of Fisheries, where ECOFISH project added a holistic impetus that accelerated the hilsa production. The hilsa value chain of Bangladesh from fishers to ultimate consumers through various intermediaries is complex and exploitative in nature. All intermediaries perform their job creating different types of utilities and move the harvested hilsa fish from fishers to consumers as well as reap benefits as per their roles and contributions to the market channel. This study, therefore examined whether there were any positive effects of increased hilsa production on the value of fish as well as the wellbeing of the value chain actors. The results revealed that the incremental benefit to all actors of the value chain was eventually higher during bumper production of hilsa, which was observed in 2016, when higher sale volume resulted in higher transaction profits than the previous years. Fishers' average monthly income increased by about 67.23% and the change was highly significant; this clearly highlighted the fact that increased hilsa production improved the average income of the fishers and other stakeholders in the value chain. The bumper production also increased the access of fish at all levels at an affordable price, and helped vast fishing communities repay their loans to the non-formal moneylenders as well as to the micro-finance institutions. Besides, the fish consumption and family welfare have increased due to higher hilsa production in the Meghna river-estuarine systems of Bangladesh.

The programs jointly implemented by WorldFish and Department of Fisheries indeed appears to have benefited the fishers and the other value chain actors, despite some management challenges and visible inequality in the distribution of benefits. The fishing communities have accepted the present ECOFISH co-management approach, and they are gaining higher levels of welfare now than before which implies that the system has been working and should continue in the capture fisheries sector in Bangladesh. Besides, government officials and policy makers are optimistic about the current co-management system, and hilsa production has increased significantly after almost one and half a decade. Therefore, there is a need for a greater level of investment for the welfare of the fishing communities, so that all fishing households are covered under various kinds of compensation during ban period. In this regard, the government should continue to supply sufficient food grains for the entire fishing ban periods and should provide some cash subsidies for purchasing fishing equipment such as boats and nets in order to get rid of the informal exploitative loans from the moneylender.

While hilsa production increased during the recent years, there is still a need for confirmation, if this increase in hilsa production is a sustainable one or a temporary phenomenon caused by any external factor, such as the increased flow of water in the Gangetic river systems in 2016. Much more works are necessary to understand the dynamics of this complex hilsa fishery, including further studies to define the spawning areas, determining whether hilsa has several distinct stocks that return to their natal spawning areas, understanding the migration routes between spawning areas and the Bay of Bengal, stock assessments and growth studies to estimate overall population size. An in-depth understanding of the impacts of different fishing gears used in hilsa fishery may contribute towards establishing a sustainable and resilient fisheries management plan for hilsa fishery in Bangladesh and the region.

Acknowledgements

The study was funded by USAID for implementation of Enhanced Coastal Fisheries in Bangladesh (ECOFISH-Bangladesh) and contribution of CGIAR Research Program on FISH. The cooperation of the coastal fishers, various stakeholders and fishers' women of the coastal fishing villages are gratefully acknowledged. The authors thankfully acknowledge the contribution of Drs. Philippa Cohen and Alexander Tilley, WorldFish, Head Quarter, Penang for their initial revision to the draft manuscript. We are thankful to Dr. Malcolm W. Dickson, Country Director, WorldFish, Bangladesh Office for his support and encouragement.

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