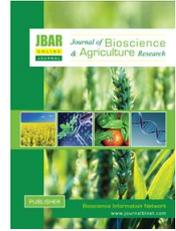


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## Current status and chronological development of fisheries and aquaculture in Bangladesh

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### ABSTRACT

While many parts of the world face water scarcity, Bangladesh is fortunate to have an abundance of the resource. The economic health of the country depends heavily on the fishing industry. Both capture fisheries and culture fisheries are common types of fisheries. Unlike culture fisheries, which is farming aquatic organisms in closed waters under controlled conditions, capture fisheries typically means harvesting fish and other aquatic organisms from open waters. This article examines Bangladesh's fisheries and aquaculture sectors using data from the Bangladesh Department of Fisheries and a few other relevant organizations and articles. Bangladesh is one of the world's major fish producers, with a total output of 4.62 million metric tons (MT) in the fiscal year 2020-2021. The majority (57.10%) of the country's fish and shrimp come from aquaculture, while 28.16 and 14.74 percent come from inland capture and marine capture, respectively. Bangladesh ranks only fifth in aquaculture production and third in inland open-water capture production whereas it stands first in hilsa production in the world. One of the most productive fish species is the major carp. There has been a modest increase in the country's inland aquaculture output over the past few decades, but the country also gets fish from inland capture and marine fisheries. The most recent ten years have seen significant contributions to inland capture fisheries and inland aquaculture from floodplains and ponds, respectively. The most common fisheries exports are frozen raw shrimp in blocks, individually quick frozen (IQF) shrimp and white fish, chilled and frozen Hilsa, crab, etc. In 2020-21, the country has earned BDT 4088.96 crore, or 1.24% of total export revenues, from exporting 76.59 metric tons of fish, shrimp, and other fishery products. However, over the past decade, the value of exported fish and fishery products has shown a nearly erratic trend. In contrast, annual production of the national fish hilsa has increased on a rising trend over the past decade. The number of carp seeds produced from both natural and artificial sources has followed an erratic increasing trend with some deviations during the past decennium. As the country's fisheries and aquaculture industries continue to grow, many cutting-edge technologies are making significant contributions that are helping to improve the quality of life for all involved. This has helped Bangladesh's economy expand over the past decade, particularly in fishing and aquaculture sectors.

**Key Words:** Status, Chronological development, Fisheries, Aquaculture and Technologies.

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## I. Introduction

Bangladesh is blessed with vast water resources. There is excellent fish culture potential in this country. The fisheries sector plays a significant role in Bangladesh's economy in terms of nutrition, income, employment and foreign exchange earnings. This is one of the significant export-earning sectors, which contributes about 3.57% to the national GDP and about 1.24% of the foreign exchange earnings of the country (DoF, 2022). The sector includes two main parts- capture fisheries and culture fisheries. Capture fisheries are generally considered fisheries or wild fisheries, which refers to all kinds of harvesting from wild sources. It is divided into inland capture and marine capture. But Fisheries can broadly be defined as a multidisciplinary science, which draws on the disciplines of biology, conservation, ecology, population dynamics, economics and management of aquatic environment. Culture fisheries mean inland culture or aquaculture, that is, the farming of aquatic organisms under controlled conditions. In other words, aquaculture "means farming aquatic organisms including fish, molluscs, crustaceans and aquatic plants. Farming implies some forms of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc. Farming also implies individual or corporate ownership of the stock being cultivated".

The share of aquaculture in total fish and shrimp production of Bangladesh is increasing tremendously daily, whereas the share of fisheries production is showing a decreasing rate during the last two and half decades. For example, in the financial year of 2001-02, capture fisheries contributed 58.39% and aquaculture contributed 41.61% to total fish and shrimp production (DoF, 2003), whereas in the financial year of 2020-21, capture fisheries contributed 42.90% and aquaculture contributed 57.10% to total fish and shrimp production. Though the closed water area is only 17.93% of the total inland waterbodies, 57.10% of the total yield comes from inland aquaculture (DoF, 2022). Many researchers in Bangladesh have studied the fisheries status of different regions of Bangladesh separately. However, there is no literature containing organized information related to the present status as well as the chronological development of overall fisheries and aquaculture of Bangladesh to evaluate the prevailing situation of fisheries and aquaculture sector in Bangladesh. Therefore, a comprehensive study of fisheries and aquaculture of the country seems to be of timely value and immense necessity. The present study is aimed to provide an overview of existing status of fish culture and harvest, chronological development of fisheries and aquaculture region-wise and year-wise, on-going technologies in aquaculture sector and socio-economic development of the stakeholders. This study is very significant to highlight Bangladesh's position in the fisheries sector worldwide and to save the fisheries biodiversity through proper management.

## II. Materials and Methods

The study was conducted based on the information through review of literature, field survey and searching related websites. The necessary data were collected from Bangladesh Department of Fisheries, National Fish week compendiums, related books, visiting Bangladesh Fisheries Research Institute, different hatcheries, fish farms, and consulting with different consultants and researchers.

## III. History of aquaculture in Bangladesh

The origin and development of aquaculture practices in Bangladesh are not well documented; historically the country's natural water bodies were stocked during the monsoon season through natural spawning. Dr. Nazir Ahmed (1947–1960), the then Director of Fisheries in East Pakistan laid the formal foundation for fish culture in ponds and lakes within Bangladesh. He worked keenly on the development of large-scale carp culture in ponds and lakes and by the late sixties and early seventies some progress had been made in this area. In the late sixties, Ali (1967) successfully conducted induced breeding of Indian major carp species using carp pituitary gland extracts. Thus, fish culture was extended gradually all over the country.

## IV. Present status of fisheries and aquaculture in Bangladesh

Bangladesh is a small country with an area of 1,47,610 sq. km. The country is blessed with about 3.86 million ha open inland waterbody, 0.84 million ha closed inland waterbody and marine waters cover an area of 1.18 sq. km. These waterbodies are very rich in fisheries resources (DOF, 2022).

## Fisheries resources in Bangladesh

Fisheries in Bangladesh are diverse, there are about 795 native species of fish and shrimp in the freshwater and marine waters of Bangladesh of which 260 freshwater species, 475 marine water species, 36 marine shrimp species, 24 freshwater prawn species and also 12 exotic species have been introduced (National fish week compendium, 2022). IUCN Bangladesh (2015a) and (2015b) reported that among 260 freshwater fish species, nearly one-fourth (64 species) of the species are under threat. Among them, 9 are critically endangered, 30 are endangered and 25 are vulnerable. In addition, there are 10 species of pearl-bearing bivalves, 27 species of edible tortoise and turtle (Banglapedia, 2021), 16 species of crab and 6 species of lobster (BdFish, 2012).

## Mostly cultured aquatic species

Indigenous freshwater carps (22 percent) and exotic carps (10 percent) from the farming and capture sectors are the primary contributors to total fish production. Brackishwater species, giant tiger prawn (*Penaeus monodon*) and giant river prawn (*Macrobrachium rosenbergii*) are the primary cultured species in coastal areas of Bangladesh (Azim et al., 2002). Moreover, brown shrimp, white shrimp, mud crab, giant sea perch and yellow tail mullet are also cultured.

## Fisheries and aquaculture production

Bangladesh is one of the world's leading fish producing countries with a total production of 4.62 million metric ton (MT) in the financial year of 2020-21, where aquaculture produces 2.64 million MT, inland capture contributes 1.3 million MT and marine capture contributes to 0.68 million MT fish and shrimp. This year, aquaculture, inland capture and marine capture share 57.10%, 28.16% and 14.74% of total fish and shrimp production, respectively (Figure 01). The country has exceeded the projected production target of 4.55 million MT of fish by 2021. Now Bangladesh has become self-sufficient fish producing country and thereby the country supplements about 60% (with per capita of 62.58 g/day against targeted 60 g/day) of daily animal protein intake of its people (DoF, 2022). FAO (2020) ranked Bangladesh as 3<sup>rd</sup> in inland open-water capture production and 5<sup>th</sup> in world aquaculture production. In tilapia production, Bangladesh positioned 4<sup>th</sup> in the world and 3<sup>rd</sup> in Asia. Besides, among 11 hilsa producing countries in the world, Bangladesh ranked 1<sup>st</sup> position. Geographical Indication Registration Certificate was also achieved for our national fish hilsa named as 'Bangladesh ilish' (DoF, 2022).

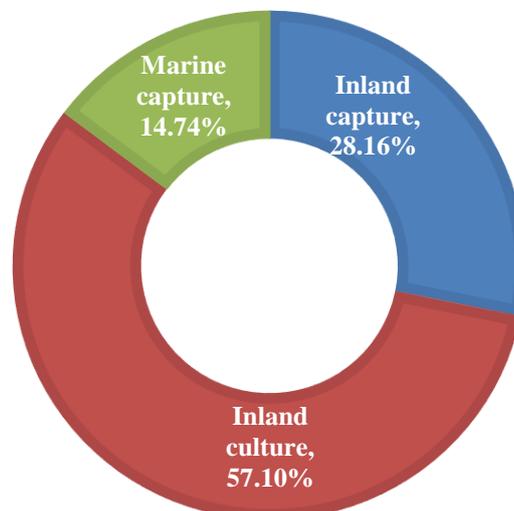


Figure 01. Sector-wise fish production of Bangladesh in 2020-21.

Among eight divisions of Bangladesh, Chittagong division contributed maximum fish production and Rangpur division contributed minimum fish production in financial year of 2020-21 (Table 01). This year, Mymensingh district of Mymensingh division contributed the highest production (341378 MT) and Bandarban district of Chittagong division contributed the lowest production (2049 MT) in the total production (DOF, 2022).

Table 01. Division-wise annual fish production in inland water in 2020-21

Division	Dhaka	Mymensingh	Khulna	Barisal	Rangpur	Rajshahi	Chittagong	Sylhet
Total Production (MT)	501735	498980	731160	358624	277776	510131	779703	281886

The per capita annual fish consumption in Bangladesh stands at about 23 kg/year against a recommended minimum requirement of 21.90 kg/year, indicating that Bangladesh is now self-contained in fish production (National fish week Compendium, 2022). Among all the species, major carp have the highest contribution to total fisheries production, whereas chuchia, pomfret and sharks cover a small portion of total fisheries yield (Table 02).

**Table 02. Species/Group-wise annual fish production in inland and marine fisheries in 2020-21 (DOF, 2022)**

Species/Group	Inland fisheries (MT)	Marine fisheries (MT)	Total (MT)	%
Major Carp	975531	0	975531	21.11
Other Carp	129237	0	129237	2.80
Exotic Carp	516969	0	516969	11.19
Pangas (Cat Fish)	402298	0	402298	8.71
Other Cat Fish	73180	0	73180	1.58
Snake Head	78468	0	78468	1.70
Live Fish	166204	0	166204	3.60
Tilapia	392095	0	392095	8.48
Other Inland fish	625286	0	625286	13.53
Hilsha/Ilish ( <i>Tenualosa ilisha</i> )	251590	313593	565183	12.23
Shrimp/Prawn	205667	46297	251964	5.45
Crab ( <i>Scylla serrata</i> & <i>Scylla olivacea</i> )	12337	0	12337	0.27
Sarpunti ( <i>Puntius sarana</i> )	101932	0	101932	2.20
Cuchia	9195	0	9195	0.20
Sardine ( <i>Sardinella finibriata</i> )	0	34519	34519	0.75
Bombay Duck ( <i>Harpondon nehereus</i> )	0	71922	71922	1.56
Indian Salmon ( <i>Polydactylus indices</i> )	0	163	163	0.00
Pomfret(Rip/Hail/Foli Chanda)	0	9214	9214	0.20
Jew Fish (Poa, Lambo, Kala datina etc.)	0	48665	48665	1.05
Sea Cat Fish ( <i>Tachysurus spp.</i> )	0	12199	12199	0.26
Shark/ Skate / Ray	0	8228	8228	0.18
Tuna & Tuna like fish	0	22130	22130	0.48
Other marine fish	0	114309	114309	2.47
Production (Metric Ton)	3939989	681239	4621228	100
%	85.26	14.74	100	

**Note:**

1. Major Carp - Rui, Catla, Mrigal
2. Other Carp - Kalibaus, Bata, Ghania
3. Exotic Carp - Silver Carp, Grass Carp, Common Carp, Mirror Carp, Big Head Carp, Black Carp
4. Other Cat Fish - Boal, Air, Silon, Rita
5. Snake Head - Shol, Gazar, Taki
6. Live Fish - Koi, Singhi, Magur
7. Prawn - GaIda and Other Inland Chingri
8. Shrimp - Bagda and Other Coastal/ Marine Chingri
9. Other Fish (Inland and Marine) – Includes all other fishes except those mentioned above

**Main organizations involved in fisheries and aquaculture sector**

The Ministry of Fisheries and Livestock (MoFL), Department of Fisheries (DoF), Bangladesh Fisheries Development Corporation (BFDC) and the Bangladesh Fisheries Research Institute (BFRI) are the main organizations responsible for aquaculture and its development. Universities, Bangladesh Rural Development Board, Export Promotion Bureau, organizations within other ministries and local as well as international NGOs are also involved in this area. In addition, Bangladesh Krishi (Agriculture) Bank, Bangladesh Somobay (Co-operative) Bank and some other commercial banks are responsible for issuing credit to the aquaculture sector. Youth Development Training Centers under the Ministry of Youth deal with extension and training of unemployed young people and fish farmers.

**Contribution to the economy**

Both Fisheries and aquaculture play a significant role in nutrition, employment and foreign exchange earnings. More than 12% of the total population of Bangladesh is directly or indirectly involved in this sector on full-time and part time basis for their livelihoods. About 1 million and 0.5 million people are fishing from inland and marine waters, respectively. In 2020-21, the fisheries sector contributed about

3.57% to the national GDP and more than one-fourth (26.50%) to the agricultural GDP. Bangladesh has earned a considerable amount of foreign currencies by exporting fish, shrimps and other fishery products, contributing 1.24% of the total national export earnings. The country has earned BDT 4088.96 crore by exporting almost 76.59 thousand MT of fish and fishery products by overcoming the financial crisis in the corona situation around the world (DoF, 2022).

### Export of fish and fish Products

About 98% of total fish products are exported to European countries (48.51%), USA (30.06%) and Japan (9.32%) (Hossain, 2003). Major export items of fishery products are raw shrimp block frozen, IQF shrimp and white fish, PUD and P&D shrimp block frozen, consumer pack of raw frozen shrimp, chilled & frozen Hilsa, dry, salted and dehydrated fish, live fish, eel fish, crab and a little quantity of value-added fish and shrimp products. However, mud crabs are the second most exported crustacean product from Bangladesh. Total earnings from mud crab export in 2007-08 were US\$ 7,068,000. From 2009-10 to 2013-14, an increasing trend was found in crab export earnings. Crab from Bangladesh is exported to various countries such as China, Taiwan, Thailand, Singapore, Malaysia, Japan, Hong Kong, South Korea, Japan, America and other European countries (Islam et al., 2015).

### Collection of fish seeds/hatchlings

In Bangladesh, fish seeds are obtained from natural sources and artificial or hatcheries. The main natural sources for fish seed collection are Halda, Jamuna, Padma, Arial khan, Brahmaputra, Garai River. In 2020-21, 2152 kg hatchlings were produced from natural sources, contributing only 0.32% of total hatchlings. Both govt. and private hatcheries produce hatchlings and sell them at 4-5 days old. About 1056 fish hatcheries are producing 668801 kg hatchlings in 2020-21 and 33 Galda (*Macrobrachium rosenbergii*) hatcheries and 44 Bagda (*Penaeus monodon*) hatcheries in Bangladesh. Galda hatcheries produce 2.37 crore Galda PL and Bagda hatcheries produced 721.04 crore Bagda PL in the same year (DOF, 2022).

**Table 03. Year-wise inland capture, culture and marine fisheries production and their individual share in total fish and shrimp production of Bangladesh from 2001-02 to 2020-21**

Year	Total production (MT)	Sector-wise production (MT)			Share in total production (%)		
		Inland capture	Inland culture	Marine fisheries	Inland capture	Inland culture	Marine fisheries
2001-02	1890459	688435	786604	415420	36.42	41.61	21.97
2002-03	1998197	709333	856956	431908	35.5	42.89	21.61
2003-04	2102026	732067	914752	455207	34.83	43.52	21.66
2004-05	2215957	859269	882091	474597	38.8	39.8	21.4
2005-06	2328545	956686	892049	479810	41.1	38.3	20.6
2006-07	2440011	1006761	945812	487438	41	39	20
2007-08	2563296	1060181	1005542	497573	41.36	39.23	19.41
2008-09	2701370	1123925	1062801	514644	41.61	39.34	19.05
2009-10	2899198	1029937	1351979	517282	35.53	46.63	17.84
2010-11	3061687	1054585	1460769	546333	34.45	47.71	17.84
2011-12	3261782	957095	1726067	578620	29.34	52.92	17.74
2012-13	3410254	961458	1859808	588988	28.19	54.54	17.27
2013-14	3548115	995805	1956925	595385	28.07	55.15	16.78
2014-15	3684245	1023991	2060408	599846	27.79	55.93	16.28
2015-16	3878324	1048242	2203554	626528	27.03	56.82	16.15
2016-17	4134434	1163606	2333352	637476	28	56	16
2017-18	4276641	1216539	2405415	654687	29	56	15
2018-19	4384221	1235709	2488601	659911	28.19	56.76	15.05
2019-20	4503370	1248401	2583866	671104	27.72	57.38	14.9
2020-21	4621228	1301244	2638745	681239	28	57	15

## V. Chronological development

Bangladesh is enriched with huge water resources. According to available statistics, it was found that the total fish production of the country showed a consistently increasing trend during the last 20 years (Figure 02). The overall growth performance from inland aquaculture showed a moderately increased trend due to dissemination of improved technology packages and supportive extension services at

farmer's level. A slight growth in the fisheries production obtained from both inland capture and marine fisheries was also noticed during the last two decades, with some exceptions (Figure 03).

But the share of inland capture fisheries has been reduced remarkably during the two decades due to mainly decline and degradation of the vast open water resources. In 2001-02, the contribution of inland capture and culture fisheries to total fish production was 36.42% and 41.61%, respectively (DoF, 2003), whereas, in 2020-21, inland capture fisheries contributed only 28% and inland culture fisheries contributed 57% to total production (DoF, 2022) (Table 03).

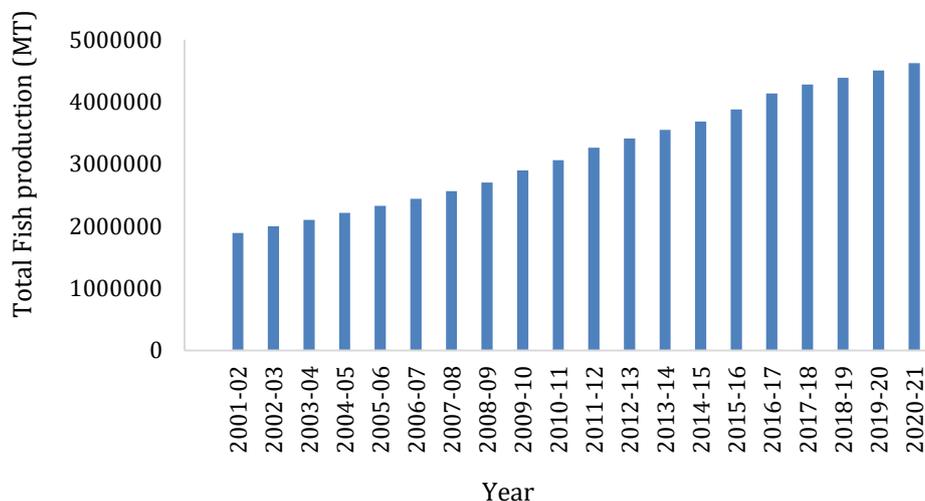


Figure 02. Upward trend of annual total fish production in Bangladesh during last two decades.

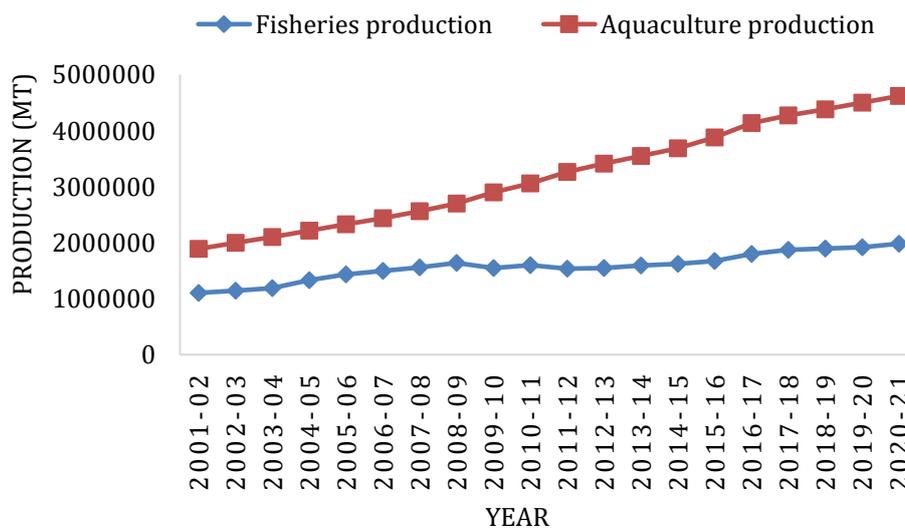
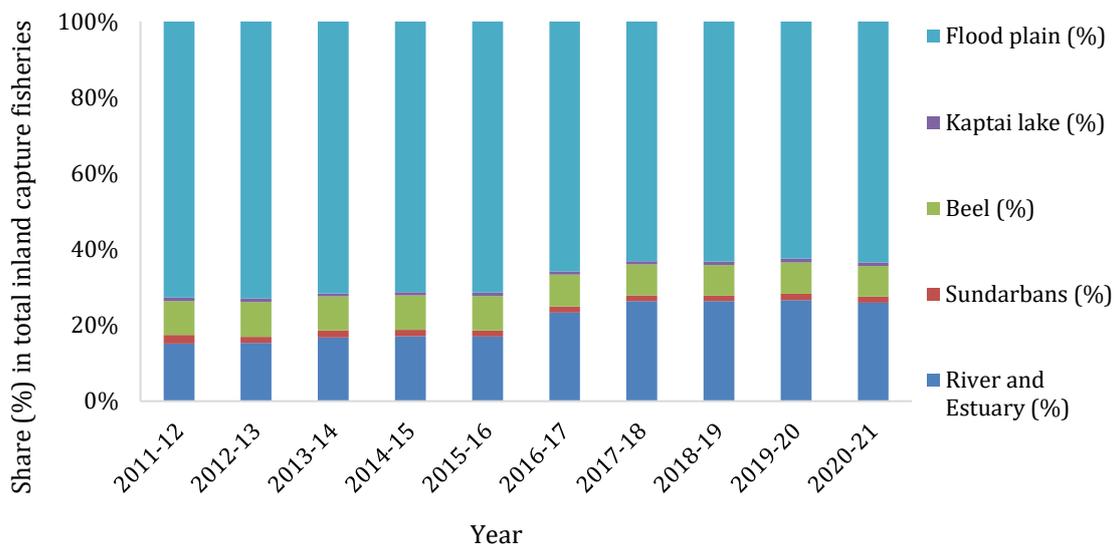


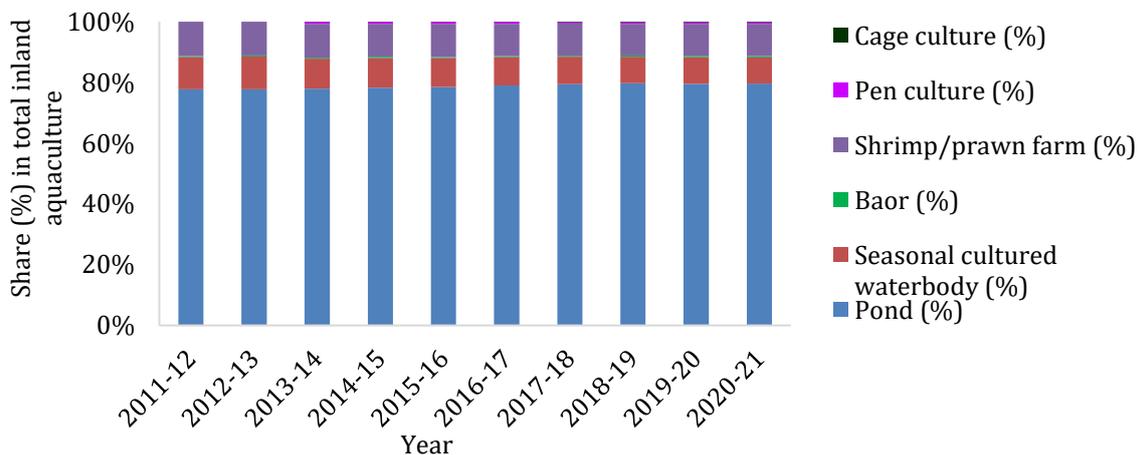
Figure 03. Last 20 years' fisheries and aquaculture production trend in Bangladesh.

In our country, inland open waters include River and estuary, Sundarbans, beel, Kaptai lake, floodplain and inland closed waters include Pond, seasonal cultured water body, baor, Shrimp/Prawn farm, pen culture, cage culture.

According to available statistics, it was found that during the last decade, the floodplain had the highest contribution to inland capture fisheries, whereas Kaptai lake contributed little. But the fish and shrimp production in floodplain showed a gradually decreasing trend from 2011-12 to 2020-21, although river and estuary followed the opposite trend (Figure 04). In the case of inland aquaculture production, the largest contribution was found from ponds and smaller contribution came from baor, pen, and cage culture over the last 10 years. The pen and cage cultures were included in inland aquaculture production from 2013-14. However, the cage culture had a very minor contribution to inland aquaculture, although its sharing to inland aquaculture production showed a moderately increasing trend from 2013-14 to 2020-21 (Figure 05).

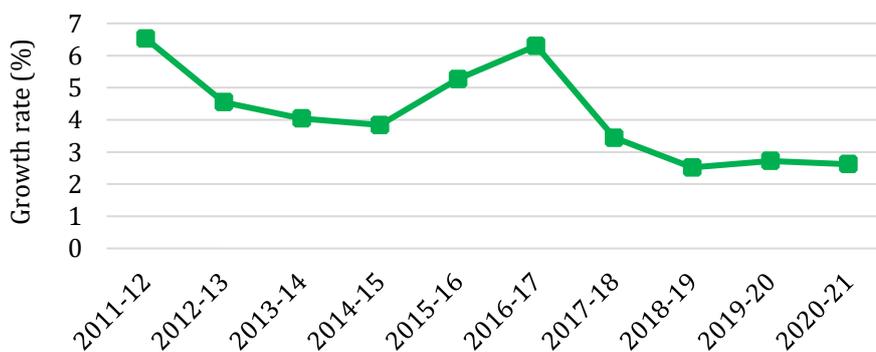


**Figure 04. Year-wise the share (%) of different sectors in total inland capture fisheries production during last decade.**



**Figure 05. Yearly contribution (%) of different sectors to total inland aquaculture production over last 10 years.**

Over the last 10 years, the growth rate of fisheries and aquaculture sector in Bangladesh varied from 2.62 to 6.53 percent, with an average 4.18%. However, the growth rate over the last decade showed a downward trend with deviations in 2015-16 and 2016-17 (Figure 06).



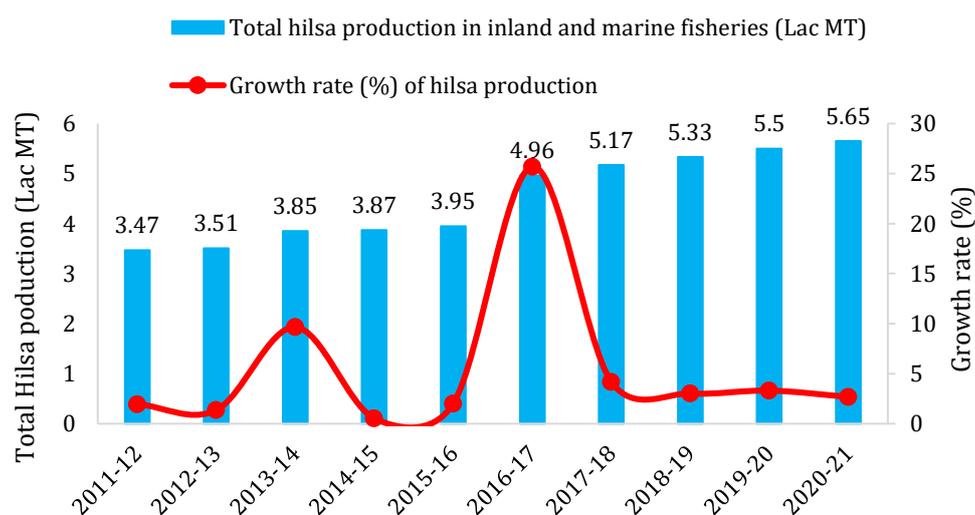
**Figure 06. Last 10 years' trend of annual growth rate of fisheries and aquaculture sector in Bangladesh.**

Shrimp is one of the major export items in Bangladesh. During the last decennium, the shrimp/prawn farm area ranged from 2.58 lac hectares to 2.75 lac. However, the area was constant from 2011-12 to 2015-16, after that it started to reduce. Similarly, total shrimp and prawn production over the last 10 years also exhibited descending trend with some exceptions and retrieved its steadiness in 2020-21. Shrimp/prawn were obtained from open as well as closed inland waters and marine waters. The shrimp/prawn cultured in closed inland waterbody contributed more than 50% to total shrimp/prawn production every year of the last decade (Table 04). However, different programs and development projects are being implemented to increase the production and promotion of shrimp aquaculture.

The national fish hilsa is the most significant single-species fishery accounting for about 12.23% of annual fish production by volume in 2020-21, and contributed one percent to the country's GDP (DoF, 2022). Through implementing several protection and conservation measures to protect jatka and hilsa brood, hilsa production increased from 3.47 lac metric ton in 2011-12 to 5.65 lac metric ton in 2020-21. In addition, year-wise hilsa production showed a moderate increasing trend during the last 10 years. However, the annual growth rate of hilsa production varied from 0.54% (in 2014-15) to 25.69% (in 2016-17) over the last decennary (Figure 07).

**Table 04. Year-wise shrimp/prawn farm area and production in Bangladesh from 2011-12 to 2020-21**

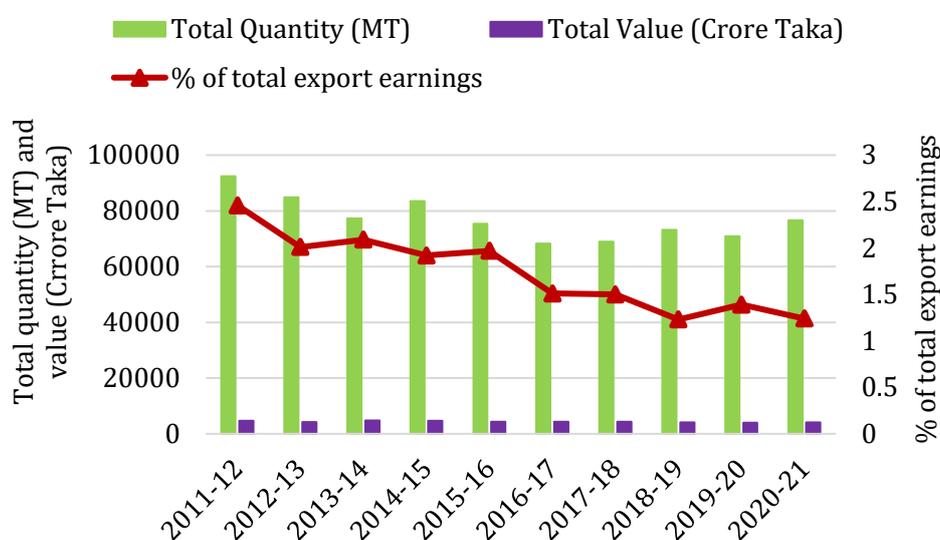
Year	Shrimp/prawn farm area (Lac hectre)	Total shrimp/prawn production in inland and marine waters (Lac MT)	Percentage (%) of cultured shrimp/prawn in total production of Shrimp/prawn
2011-12	2.75	2.53	54.32
2012-13	2.75	2.32	60.5
2013-14	2.75	2.24	57.34
2014-15	2.75	2.3	57.68
2015-16	2.75	2.34	56.67
2016-17	2.73	2.45	56.09
2017-18	2.59	2.47	52.91
2018-19	2.59	2.4	55.76
2019-20	2.58	2.41	56.03
2020-21	2.63	2.52	55.34



**Figure 07. Ascending trend of yearly hilsa production with its annual growth rate during the last decade.**

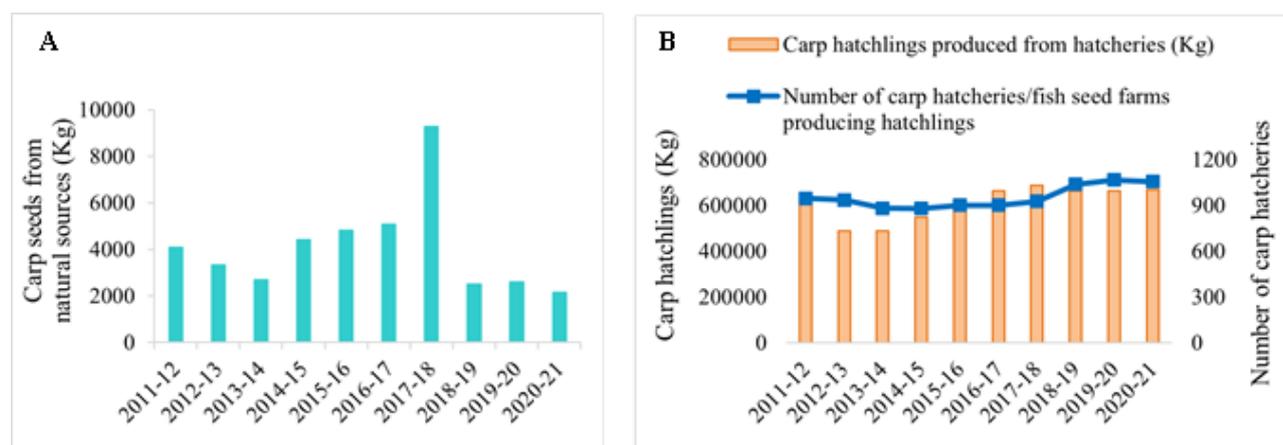
Every year export of fish and fishery products plays a vital role in the economy of Bangladesh. It was found that the value of fish and fishery products exported showed a nearly waving trend during the last 10 years. In addition, the share of fish, shrimp and prawn to total export earnings reduced remarkably during the last decade with some exceptions due to tremendous development of other

sectors of the country (e. g. readymade garments, jute manufacturing etc.) than fisheries sector. In 2011-12, the country earned BDT 4703.94 crore by exporting almost 92.47 thousand metric tons of fish, shrimp and other fishery products that contributed 2.46% to total national export earnings, whereas in 2020-21 BDT 4088.96 crore was achieved from 76.59 thousand metric ton of fishery products exported and it shared 1.24% to total export earnings (Figure 08).



**Figure 08. Annual fish and fishery products quantity and value trend in Bangladesh during last 10 years.**

In our country, fish seeds are collected both from natural sources and hatcheries, where the contribution of natural sources is very little. The quantity of carp seeds produced from both natural and artificial sources showed an inconsistent upward trend during last decade with some exceptions in 2012-13, 2013-14 and 2018-19. In the number of carp hatcheries, it was found that in 2011-12, there were 947, which followed a slight descending trend till 2014-15. After that, the carp hatcheries started to increase in number and showed a moderate rising pattern to date. Consequently, in 2020-21, 1066 carp hatcheries are available in the country, producing good quality hatchlings (Figure 09).



**Figure 09. Changing trend of A) Yearly amount of carp seeds collected from natural sources and B) Annual quantity of carp hatchlings produced from hatcheries as well as number of carp hatcheries during the last decade.**

## VI. Various technologies developed in fisheries and aquaculture sector of Bangladesh

Fisheries and aquaculture production is increasing day by day. There is an excellent contribution of many modern technologies beyond this higher production. Many new technologies are being introduced gradually from which the farmers are benefiting. In aquaculture system in Bangladesh, various technologies such as mixed culture of carps (Frei et al., 2007), integrated fish culture (e. g. paddy-cum-fish culture, fish-cum-poultry farming, fish-cum-horticulture etc.) (Oehme et al., 2007),

composite culture of carps and freshwater prawn (Salam et al., 2003), cage culture of fish (Moniruzzaman et al., 2015), pen culture of fish (Chakraborty et al., 2018), mono-sex tilapia culture (Kunda et al., 2021), fish culture in aquaponics (Azad et al., 2016; Azad et al., 2018), IFCAS (Haque et al., 2015), IMTA (Kibria and Haque, 2018) and RAS systems (Begum et al., 2022), induced breeding technique or hatchery technology (Biswas et al., 2021), mixed culture of carps and mola (*Amblypharyngodon mola*) (Roos et al., 2002), development of black soldier fly larvae production technique for fish feed supplement (Rana et al., 2015), fish culture in bioflok system (Nahar et al., 2015) etc. have been introduced, which are playing important role in developing aquaculture sector in Bangladesh.

In addition, in case of other than aquaculture system, different techniques or apparatus like low-cost icebox for fish transportation (Nowasad et al., 2008), sperm cryopreservation to reserve sperm for selective breeding of fish and to avoid ageing of sperm (Hossain et al., 2011), ring tunnel used for pesticide-free dried fish (Alam, 2015), solar tunnel fish dryer for drying fish in hygienic condition (Reza et al., 2009), improved earthen oven used for facilitating shrimp drying or preventing huge amount of shrimp from rotting (Alam, 2005), digital kit-box for identification of formalin in fish (Uddin et al., 2011), molecular techniques used for identification of virus in Bagda chingri (Islam et al., 2007), gene banking to protect the endangered fish species (Bart, 2002), fiber glass boat for safely fish harvesting (Chokesanguan et al., 2010), fish forecasting through GIS, RS, GPS and field data (Zaman, 2012), remote sensing and machine learning to improve the speed, cost and effectiveness of aquaculture data collection (Khan et al., 2021) etc. have been developed to enhance fisheries along with aquaculture production in the country.

## VII. Socio-economic development of the stakeholders

The stakeholders related to fisheries and aquaculture sector are the persons involved directly or indirectly in culture, harvesting, processing, marketing or exporting of fish and other fishery products, such as fishermen, fish farmers, fish processors, fisheries scientists etc. At present, the socio-economic condition of the fisheries stakeholders of Bangladesh is developing day by day with the increase in fish and shellfish production. In Bangladesh, more than 12% of total population is directly or indirectly involved in this sector (DoF, 2022). Many people are involved in the fish marketing chain, including farmers, processors, traders, intermediaries, day labourers and transporters (DFID, 1997; Kleih, 2001). The fishermen are getting training facilities for better culture techniques and bank loan facilities as necessary. However, women involvement and empowerment in this sector is also a remarkable matter in the country. About 10% of total fisheries stakeholders are women, which is again 1% of total population of Bangladesh. Moreover, more than 80% of the labourers involved in fish processing industries are women. In general, a fish farmer receives 56 percent of the price paid by the final consumer, in other words, 44 percent of the retail price is taken by the various intermediaries (Alam, 2002). Due to the increase of fisheries and aquaculture production, the stakeholders' income, nutritional status and savings are increasing daily. As a result, their living standards are developing and poverty alleviates gradually. Their literacy rate, housing and health facilities, and safe drinking facilities are also improving (Azad et al., 2020).

## VIII. Conclusion

In terms of fish production, Bangladesh is among the world's top countries. Since its independence in 1971, it has made remarkable advancements in the fisheries and aquaculture sectors. A moderate upward trend in the country's aquaculture output can be traced to the proliferation of cutting-edge farming techniques over the past few decades. Although there were fluctuations, overall, fisheries output went up slightly as a result of declining and degrading wild resources. Various technical interventions, such as the creation of fish refuges and the restoration of fish habitats, have been implemented over the past few years to preserve fish and other aquatic species diversity in open waters. This has led to increased fish production and the number of endangered species found in these areas. By adhering to international food safety regulations throughout the entire supply chain, Bangladesh can export frozen shrimp and other fish and fisheries products to a few developed countries. Finally, it's worth noting that Bangladesh's fisheries have a great deal of untapped potential that could significantly boost the country's economy. By increasing fish production, quality fish seed

and fry production, training on various adaptive technologies, and disseminating aquaculture technologies among farmers, concerned government departments, development partners, researchers, and non-government organizations can play an important role in the extensive development of the fisheries sector to improve the socio-economic condition of the poor village people.

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