



Can Countries Learn from each Other? Navigating Change in Fisheries and Gleaning Lessons from Growth Stories of Bangladesh, India and Thailand

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Abstract

The fisheries play a vital role in the economy and food security of many Asian nations, especially Bangladesh, India and Thailand. This study analyses the growth of fisheries GDP, fish production, fish yield and export and import dynamics of the fisheries sector in Bangladesh, India and Thailand from 1991 to 2020. Developing economies witnessed a transformation in their GDP composition with steady decline of agricultural sector share. During 1991-2020, the agriculture sector's contribution to overall GDP declined from 34%, 32% and 15% in 1991 to 12%, 18% and 9% in 2020 in Bangladesh, India and Thailand, respectively. Within the agricultural sector, fisheries contribution increased gradually in Bangladesh and India, while it halved in Thailand from 2% to 1% due to a decline in fish production since 2001. One-way ANOVA revealed significant differences ($p < 0.05$) in fisheries GDP, production, exports and imports across the selected countries. Aquaculture production outpaced capture fisheries, with India exhibiting the highest marine fish yield growth but lagging in inland fish yield. Thailand initially led fisheries exports but experienced a decline after 2016, necessitating greater reliance on importing raw materials for value-added re-exports. Unlike Thailand and Bangladesh, India has lagged in improving per-capita fish consumption during the period in spite of higher growth in fish production. Gleaning evidence and insights from the cross-country comparison, this study underscores the economic significance of fisheries and suggests key interventions to prioritize and reorient fisheries development policies to make them more sustainable and fastrack the attainment of SDG 2030 targets.

Keywords:

Growth, Fisheries GDP, Fish Export and Import, India, Bangladesh, Thailand

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Introduction

The global economy has seen robust growth over the past three decades, and notable shifts have been observed in the composition of the country's Gross Domestic Products (GDPs). The upward shift in the contribution of industry and the service sector to the nation's economy shows the impact of industrialization in past decades. Developing countries like Bangladesh, India, and Thailand majorly depend on the agricultural sector, as they have vast potential and resources. However, the agricultural sector's contribution to countries' GDPs shows a declining trend. Many studies focused on agriculture sector's growth and its contribution to economic growth (Chirwa *et al.*, 2008; Pingali, 2010; Jatuporn *et al.*, 2011; Ahsan and Warner, 2014; Oyakhilomen and Zibah, 2014; Rahman, 2017; Bathla *et al.*, 2020; Sampantamit *et al.*, 2020a; Agboola *et al.*, 2022; Ansari *et al.*, 2022; Manik, 2023), but very few studies looked at the sub sectors of agriculture (Herrero *et al.*, 2013; Kumar *et al.*, 2015; Sulistijowati *et al.*, 2023). When the literature says agriculture growth or development, it often refers to the crop sector (Kydd *et al.*, 2004; Loizou *et al.*, 2019). There is a notion that the fisheries is a neglected sector, often overshadowed by the crop and

livestock sector, but the contribution it makes to a Nation's economy is significant. Considering the unique trend and demand for the produce, it is necessary to study the sub sectors of agriculture for overall development of the sector. To gain a comprehensive understanding, individual sub-sectors like fisheries warrant focused analysis.

As we step on the decade of action to achieve Sustainable Development Goals (SDGs), the challenge of feeding an increasing population without exhausting the existing natural resources continues to grow. In this context, fisheries sector is increasingly in the spotlight for its huge potential to meet out a larger population's nutritional food requirements (FAO, 2022). In 2022, the FAO launched an initiative called Blue Transformation, with the main objective of promoting innovative approaches to expand the contribution of blue foods to food security and nutrition. This would ensure affordable, healthy diets for all (FAO, 2022). The fisheries industry holds immense global importance due to its multifaceted impact on economies, societies, and ecosystems. As a vital source of protein and nutrition, it plays a critical role in addressing food security for millions worldwide (Ahmed and Lorica, 2002; Lauria *et al.*, 2018; Eegunjobi and Ngpeah, 2022), with the total production of 218 million tonnes in 2021 (FAO, 2023). Beyond providing sustenance, the industry serves as a major economic driver, generating employment opportunities and contributing significantly to national economies through exports and trade. This sector plays a pivotal role in supporting the livelihoods of a substantial portion of the economically disadvantaged population in the country (Allison, 2004). However, the sustainability of fisheries faces challenges such as overfishing and environmental degradation, necessitating thorough analysis of various metrics.

This article aims to compare the fisheries sector's growth in terms of fish production, contribution to GDP, and the export and import of fishery products across three Asian countries namely Bangladesh, India and Thailand over a period of 30 years from 1990-2020. Together these three countries contributed nearly 10% world's total fish production in the year 2021 (FAO, 2023). It is essential to understand the sector's significance and its impact on national economies. Comparing these metrics for Bangladesh, India and Thailand can shed light on similarities and differences between the countries. While we wished to study as many developing countries of Asia as one can, long term (30 years) time series data availability constrained the analysis to be restricted to only three countries for now namely Bangladesh, India, and Thailand.

A comprehensive analysis of fisheries across these nations contributes to the formulation of informed policies regarding resource management, trade policies, and investment strategies, the enhancement of resource management practices and the advancement of sustainable fisheries on both regional and global scales. Crop sector received much attention in the past from policy makers to address the food security issues, which paved way to the green revolution, now there is a need to shift the focus to other subsectors of agriculture to meet the nutritional requirements of the growing population. This paper aims to demonstrate the growth trajectories of fisheries, a sub-sector of agriculture, to emphasize the importance of more focused policy attention on this sector's potential.

Materials and Methods

Three developing countries from the Asian continent namely Bangladesh, India and Thailand (Fig. 1) were selected for this study, considering their growth history and significant contribution of fisheries sector in the nation's economy, and the implicit assumption about the co-existence of similarities and dissimilarities among them. The three countries selected for this study rely on the fisheries industry for economic growth. Bangladesh heavily depends on fisheries for food security and employment (Shamsuzzaman *et al.*, 2020). India has a vast coastline and abundant marine resources that support its fishing industry (Kumar *et al.*, 2015). Thailand has a well-developed seafood processing sector and is one of the world's leading exporters of fish products (Kehoe *et al.*, 2016; USDA, 2018). The progression of fishing / fisheries industry, however, has been unique to each country. Comparing their strategies and outcomes enables the identification of successful practices and potential areas for improvement. Additionally, their roles in the global market as exporters of fish and seafood products bring attention to their responses to international demand and supply fluctuations.

The study was conducted using data and information from various secondary sources. Fisheries GDP was collected from official websites of respective countries. To maintain the uniformity and minimize the variations, fish production data and official currency exchange rate were collected from the World Bank database. Fisheries export and import data collected from the software called FishStatJ developed by FAO specially for fisheries and aquaculture (Table 1). For analyzing and visualizing the collected data MS Excel has been used. Recently, the term Gross Value Added (GVA) is widely used in India, instead of GDP. In this study we used the term GDP to indicate the sum of value of all the finished goods and services produced by a country or by a particular sector.

¹The word Agriculture/agricultural is used to indicate the agriculture and allied sectors, including crop, livestock, fishing and forestry.

²The word fishery and fisheries are synonymously used.

³The term fish production or fish import/export used in the study indicates all the aquatic food and non-food produce from the fisheries sector including finfish, shellfish and other aquatic animals and plants.

Table 1: Data sources

Data	Sources
Fisheries GDP	CSO (2022), BBS (2020), NESDC (2022)
Fisheries production	World bank (2022)
Fisheries export and import data	FAO (2023)

As this is a cross country comparison, the fisheries GDP in local currency was converted into US dollars by multiplying official exchange rate for the year with current GDP (Miles and Scott, 2008). Official exchange rate of local currency to US dollar partially accounts inflation of the local currency. Compounded Annual Growth Rate (CAGR) measure was used to compare the growth in fish production, GDP and fish export / fish import across the countries and across the decades within the country.

Compounded Annual Growth Rate (CAGR) calculated using following formula

$$CAGR = \text{Logest}(T_1 - T_n) - 1 \times 100$$

Fisheries GDP per capita calculated using following formula

$$\text{Fisheries GDP Per Capita} = \frac{\text{Fisheries GDP of the country}}{\text{Total Population of the country}}$$

Per capita fisheries GDP accounts for differences in total population by normalizing the total GDP contribution by population size. This enables direct comparison between countries. Overall GDP does not control for population differences. The combination of

total and per capita GDP provides comprehensive economic comparison and insights.

Notional fish yield calculated by dividing the inland fish production with total inland water spread area of the country, which is used to compare the inland fish production per ha of available inland water spread area in the selected countries. Same has been applied for marine fisheries, Km of coastal length in the country used instead of available inland water spread area in hectare.

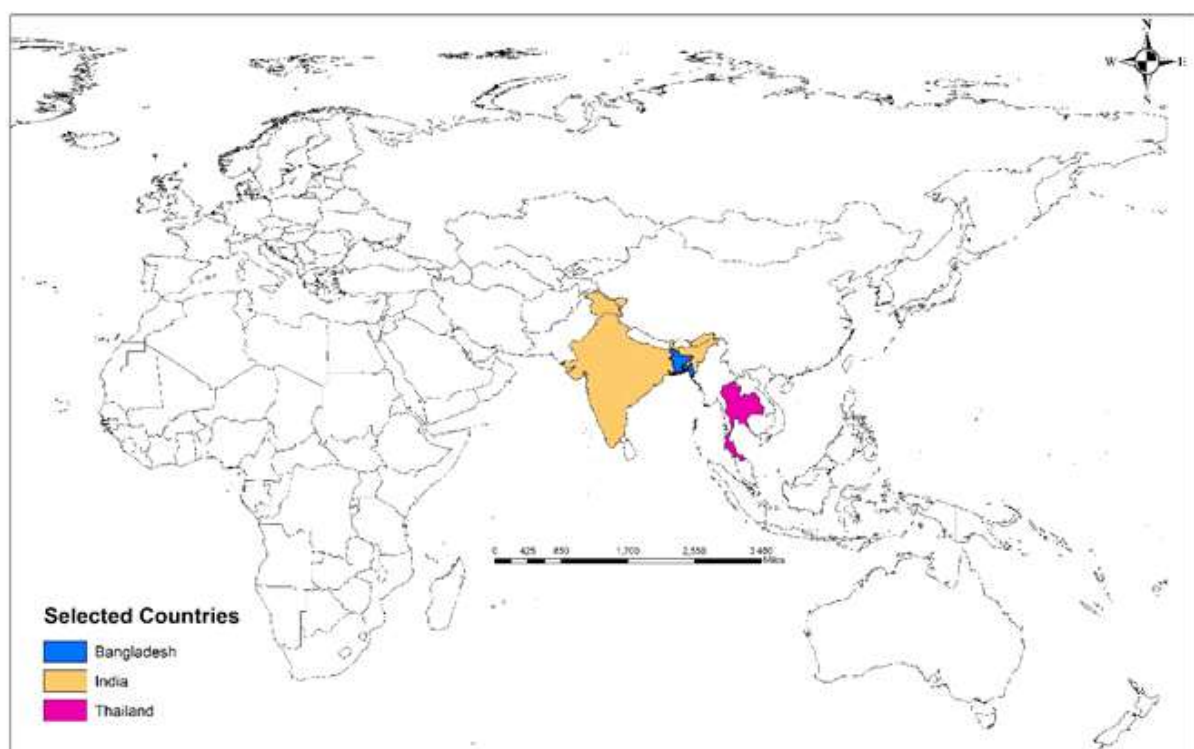
Notional Fish Yield (Inland)

$$= \frac{\text{Inland (Capture + Culture) Fisheries Production in Kg}}{\text{Inland Water Spread Area in Km}^2}$$

Notional Fish Yield (Marine)

$$= \frac{\text{Marine (Capture + Culture) Fisheries Production in Kg}}{\text{Coastal Length in Km}}$$

Total fish production volumes are not directly comparable between countries due to large differences in size and population. Notional fish yield per Km² provides a production efficiency comparison controlling for resource availability. It accounts for the differences in total inland water resource area between the countries. While not all water areas may be suitable for capture fisheries or aquaculture, the proportion of unusable area is assumed to be similar across the countries. Calculating yield on the total available inland water resource base gives an indicative benchmark for potential fish production. The analysis accounts for the fact that actual harvestable yields will be lower than notional yields per Km² due to unusable areas. But it still provides a standardized useful comparison.

**Fig. 1** Map showing location of countries selected for the study

Bar graphs and line graphs have been used to show the trend and growth patterns in fish production, GDP, export and import values of selected countries over the period of thirty years from 1990 to 2020. One-Way ANOVA has been performed to test whether there is significant difference between these countries in their fisheries GDP, export and import values. Net export value calculated by subtracting the import from export of the country.

Results and discussion

Fisheries GDP Growth and Contribution

The analysis of fisheries GDP and growth trends over 30 years (1991-2020) revealed considerable differences between Bangladesh, India and Thailand (Fig. 2). Bangladesh's overall GDP was USD 415 billion in the year 2020-21, out of which the agriculture contributed 12%, and the fisheries sector contribution to the agricultural sector was 22%. Over the 30 years of period (1991-2020), the compound annual growth rate (CAGR) of overall GDP of the economy was 9%, while the agricultural GDP grew at a relatively lower CAGR of 6%. The growth rate of fisheries GDP and livestock GDP was same as that of overall agricultural GDP, but the crop sector GDP grew at a slightly lower

rate (5%) during the period 1991-2020. While agriculture's contribution to Bangladesh's GDP decreased nearly two-third from 34% in 1991 to 12% in 2020, the fisheries subsector's contribution within agriculture rose from 17% to 22% and the crop sector contribution reduced i.e., 61% in 1991 to 49% in 2020. The fisheries GDP of Bangladesh has increased six fold, in absolute terms, during last 30 years (1991-2020) and is expected to grow further.

India's GDP grew 12 times from USD 200 billion in the year 1991 to USD 2400 billion in 2020. The CAGR of overall GDP of the Indian economy was 9%, while the agricultural and fisheries sector growth rate was 7% and 9% respectively. Agriculture sector contributed 32% to India's overall GDP in 1991, which gradually reduced to 20% in 2020, which is very similar to the case of Bangladesh. Within the agriculture sector, the contribution of fisheries doubled from 3% to 6% during the last 30 years, while the crop sector contribution reduced from 72% to 55%. The decade wise CAGR of fisheries GDP showed a steady growth i.e., 9% in 1991-00; 10% in 2001-10; 11% in 2011-20. Meanwhile the agricultural sector as well as overall GDP growth rate were found highest for the decade 2001-10.

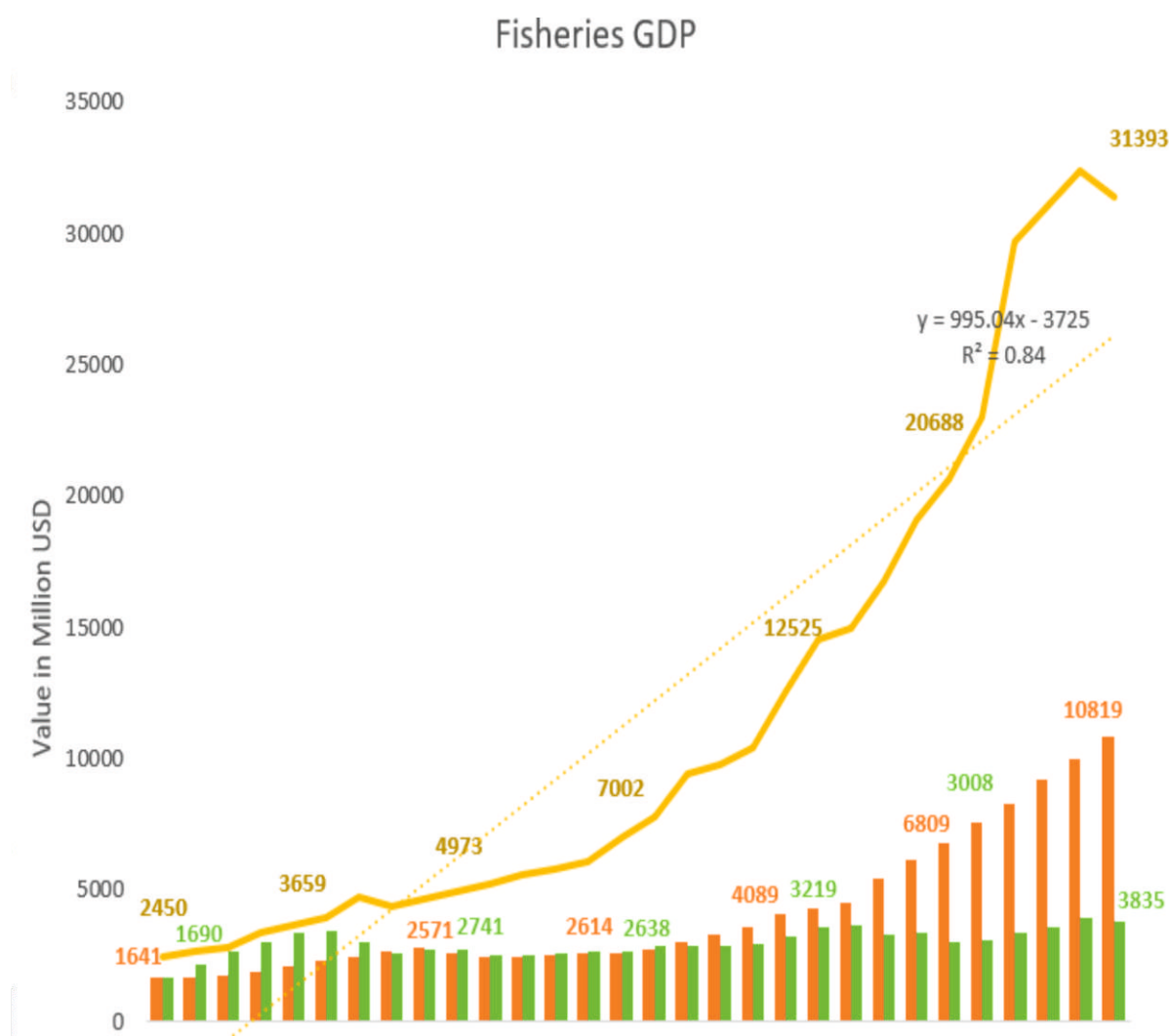


Fig. 2. Fisheries GDP of Bangladesh, India, Thailand (1991-2020)

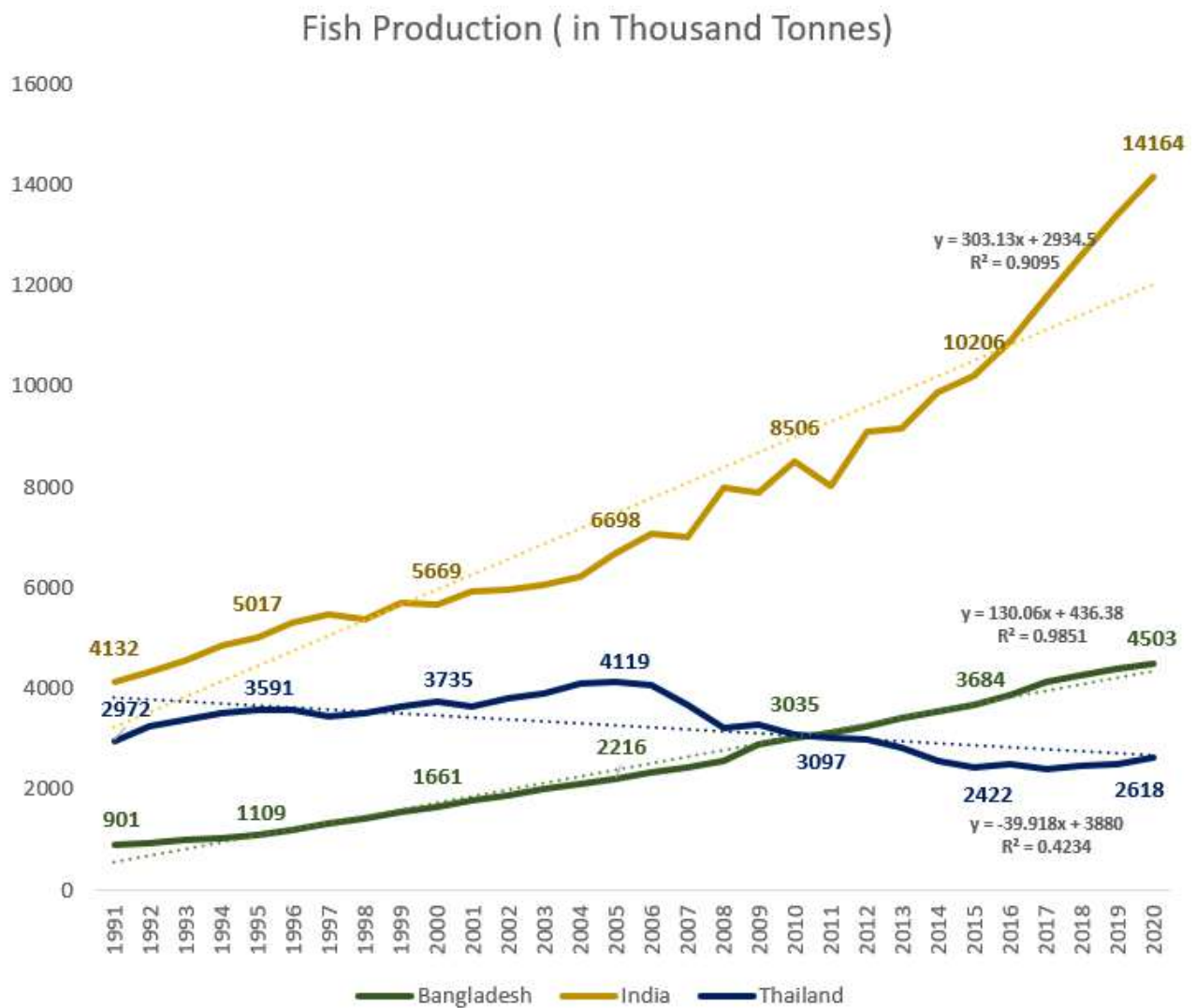


Fig. 3 Fish production trend over the period of thirty years (1991-2020)

A contrary trend could be seen in Thailand's agricultural GDP growth story during the same period. Its overall economy grew from USD 85 billion in 1991 to USD 500 billion in 2020. The fisheries sector GDP, which was USD 1690 million in 1991, increased gradually to more than double by 2020 to become USD 3835 million, with a CAGR of 1%, which was significantly lower than the CAGR of the agriculture sector (5%). Thailand's fisheries GDP growth rate was also much lower than those of Bangladesh and India. As a result, the crop sector contribution to agriculture increased from 57% to 79%, while the fisheries sector contribution reduced from 2% to 1% between 1991 and 2020, the opposite of what was witnessed in Bangladesh and India. As expected, one way ANOVA test revealed significant differences ($p < 0.05$) in the fisheries GDP values of the three countries. The significantly higher fisheries GDP growth in India and Bangladesh compared to Thailand underscores the rising prominence of fisheries in the former two countries. The sector expanded rapidly in Bangladesh and India to meet nutritional demands of growing populations and for export earnings. In contrast,

Thailand's slowing fisheries growth indicates a plateauing as well as maturation of the sector that also underlies possible structural differences in development stages of the fisheries economy of three countries.

Bangladesh's fishery industry has been experiencing consistent growth in recent years, contributing significantly to the country's economy (FRSS, 2017). A six-fold increase in Bangladesh's fisheries GDP was witnessed between 1991 and 2020, driven by consistent growth in aquaculture production, specifically inland freshwater fish production, which aligns with the findings of Hernandez *et al.* (2018) as well. The marine fisheries sector of Bangladesh is dominated by small-scale fisheries, with 93% of the marine catch coming from artisanal fisheries (DoF, 2010). The country needs to explore new opportunities in marine aquaculture (mariculture, including cage culture and seaweed cultivation) to increase fish production and reduce the crowding effect in capture fisheries, as the culture fisheries of Bangladesh depend only on inland fish culture (LightCastle Analytics Wing, 2021).

India has experienced consistent growth in fish production, both from marine and inland fisheries, leading to a surge in export volumes and values (Anantharaju *et al.*, 2016; FAO, 2023; Kumar *et al.*, 2010; Lakra and Gopalakrishnan, 2021). Aquaculture has become a major driver of growth in the fisheries sector (Katiha *et al.*, 2005; Garlock *et al.*, 2020; Lakra and Gopalakrishnan, 2021), and it was estimated that 80% of the total fish production must come from aquaculture by 2050 (CIFA, 2050).

Growth of Fish Production

Over the period of 30 years from 1991 to 2020, Bangladesh, India, and Thailand exhibited varying trends in fish production. Among these three countries, India consistently displayed the highest fish production, ranging from 4132 thousand tonnes in 1991-92 to a maximum of 14164 thousand tonnes in 2020-21 (Fig 3). Of world's fish production, 6% comes from India, while nearly 2% and 1% contribution are by Bangladesh and Thailand respectively. Bangladesh demonstrated a steady increase in fish production, with figures ranging from 901 thousand tonnes to 4503 thousand tonnes. Thailand, on the other hand, witnessed fluctuations in production, ranging from 2422 thousand tonnes in 2015-16 to 4119 thousand tonnes in 2005-06. The production increased during 1991-2005, but thereafter began to decline from 2006. The overall mean fish production was highest for India, followed by Thailand and Bangladesh. Notably, while India sustained its leadership in fish production, Bangladesh's upward trajectory and Thailand's intermittent fluctuations highlight the complex interplay of factors shaping the fisheries industry across these three countries. One-way ANOVA test revealed significant differences ($p < 0.05$) in the fish production of the selected countries.

Table. 2 presents the decade wise CAGR of fisheries production of three countries. Invariably across the three countries during each of the three decades, production from culture fisheries grew faster than the capture fisheries. The growth of culture fisheries sector was highest in 1991-2000 in Bangladesh (15.2%) followed by Thailand (7.9%). India's focus towards aquaculture is evident from its consistent increase in the growth rate of culture fisheries

production, from 5.8% in 1991-00 to 9.7% in 2011-20. The growth of fisheries production in Thailand showed a negative trend from 2001, which is completely different from other two countries. Mainly in the last decade (2011-20), capture as well as culture production considerably decreased in Thailand. In Bangladesh and India, fish production grew steadily during which the capture fisheries contribution to total production witnessed a steady decline. This was mainly due to expansion, intensification and species diversification in culture fisheries. Thailand's fisheries sector has experienced a mix of growth, fluctuations, and challenges over the past three decades. The decline in production in recent years emphasizes the need for strategic interventions to ensure the long-term sustainability of the fisheries sector.

Notional fish yield

Notional fish yield calculation and comparison gives insights into the country with high potential for further development and growth. Table 3 provides the data on the notional fish yield of inland fisheries in kilograms per hectare inland water spread area (Kg/Km^2) for the years 1991-92, 2001-02, 2011-12, and 2020-21 for selected countries. In 1991-1992, the notional fish yield in Bangladesh was 38.63 Kg/Km^2 . This yield increased over the years and reached 80.65 Kg/Km^2 in 2001-02, 146.70 Kg/Km^2 in 2011-12, and 226.44 Kg/Km^2 in 2020-21. Bangladesh shows a consistent and significant increase in fish yield over the decades. In 1991-92, India had a notional fish yield of 5.44 Kg/Km^2 . This yield gradually increased to 16.86 Kg/Km^2 in 2011-12, by 2020-21, it had doubled to 35.82 Kg/Km^2 .

Thailand had a relatively high notional fish yield of 115.78 Kg/Km^2 in 1991-1992, this yield increased significantly over the years, reaching 296.52 Kg/Km^2 in 2020-2021. It has also experienced notable growth in fish yield, although the rate of increase slowed down in recent years. Thailand consistently had the highest notional fish yield among the three countries in all the years from 1991-2020; its yield was threefold higher than that of Bangladesh in 1991-92. But the gap was reduced by 2020-21, with both two countries having nearly the same yield.

Table 2: CAGR of capture and culture fish production

Fisheries Production CAGR	1991-2000			2001-2010			2011-2020			1991-2020		
	BLD	IND	THL	BLD	IND	THL	BLD	IND	THL	BLD	IND	THL
Capture	3.8	2.7	0.8	6.3	2.0	-5.7	2.7	2.5	-1.7	3.8	2.1	-2.8
Culture	15.2	5.8	7.9	5.3	7.6	5.1	5.7	9.7	-2.6	9.1	6.4	3.3
Total	7.3	3.7	1.8	5.9	4.3	-2.3	4.3	6.3	-2.1	6.0	4.0	-1.3

Source: Author's Calculation

*Note: BAN – Bangladesh, IND – India, THL – Thailand

Table. 3 Notional fish yield of inland fisheries in selected countries

Notional Fish yield - Inland (Kg / Km ²)	1991-92	2001-02	2011-12	2020-21
Bangladesh	38.63	80.65	146.70	226.44
India	5.44	9.95	16.86	35.82
Thailand	115.78	215.96	273.14	296.52

Source: Author's Calculation

Table 4 provides data on the notional fish yield of marine fisheries in kilograms per kilometer coastal length (Kg/Km) for the years 1991-92, 2001-02, 2011-12, and 2020-21. In 1991-92, Thailand had the highest notional fish yield of 860.71 Kg/Km, followed by Bangladesh with 345.74 Kg/Km and India with 325.54 Kg/Km for marine fisheries. This yield also increased over the years, with significant growth was observed. By 2001-02, Bangladesh, India and Thailand's notional fish yield had increased to 585.10 Kg/Km, 376.50 Kg/Km and 1005.98 Kg/Km, respectively.

In 2011-12, Bangladesh's and India's notional fish yield had increased continuously. But marine notional fish yield of Thailand had decreased to 771.73 Kg/Km in the same period. And by 2020-21, Bangladesh had the highest notional fish yield of 959.50 Kg/Km, followed by Thailand and India. India's notional fish yield in the marine sector has consistently increased over the years, while Thailand's has decreased. Bangladesh's marine fish yield exhibited remarkable growth, and it had the highest yield among the three countries in the most recent year. Thailand started with a high fish yield

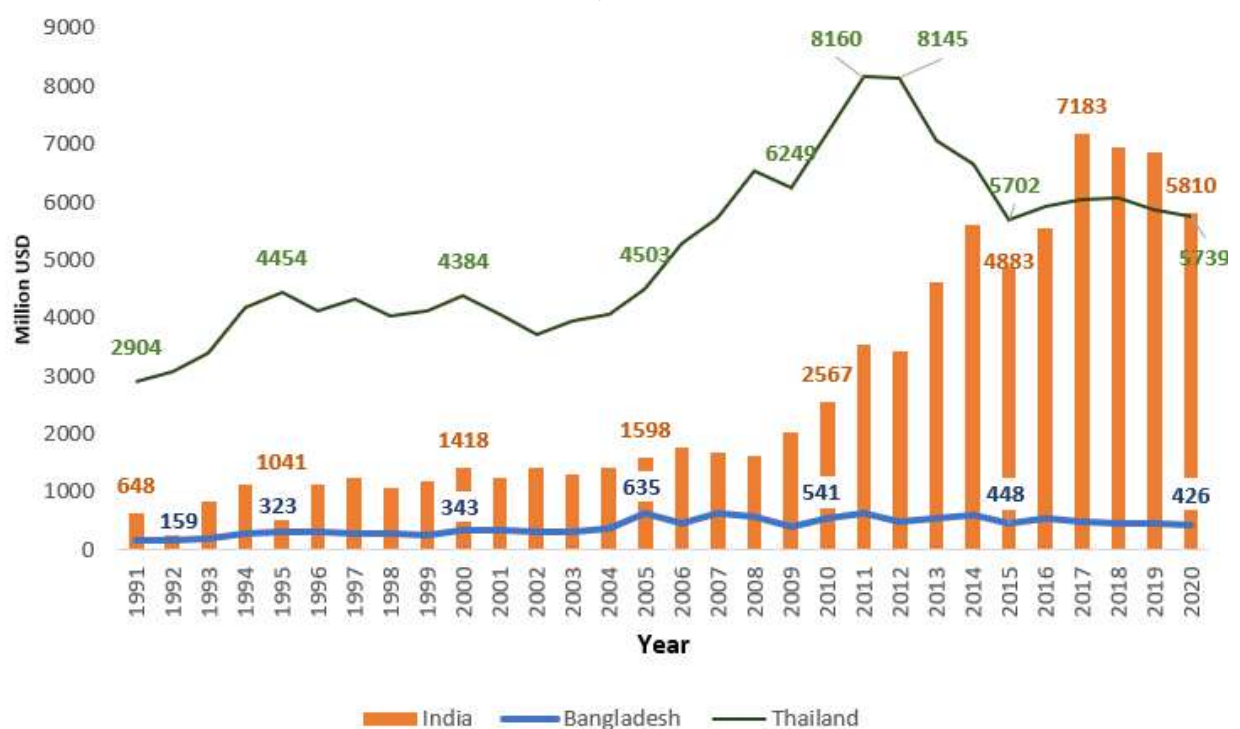
of 860.71 Kg/Km in 1991-92 for marine fisheries. However, this yield decreased significantly over the years, dropped to 623.48 Kg/Km in 2020-21 after reaching a peak in 2001-02.

Table 4: Notional fish yield of marine fisheries in selected countries

Notional Fish yield—Marine (Kg/Km)	1991-92	2001-02	2011-12	2020-21
Bangladesh	345.74	585.10	814.96	959.50
India	325.54	376.50	448.61	462.44
Thailand	860.71	1005.98	771.73	623.48

Source: Author's Calculation

Thailand started with a significantly higher notional fish yield in 1991-92 compared to Bangladesh and India but experienced a noticeable decline over the years. Possible factors contributing to this decline include overfishing, environmental degradation, or changes in fishing practices (Derrick *et al.*, 2017; Sampantamit *et al.*, 2020b). Thailand has faced challenges related to labor practices and human rights issues in its fishing industry (Chantavanich *et al.*, 2016; Marschke and Vandergeest, 2016). Though the inland fish yield (productivity) of India was less than that of Bangladesh and Thailand, the notional unit fish yield from the marine sector was highest in India compared to Bangladesh and Thailand over the decades, though sustainability concerns remain. This disparity underscores the need for sustainable aquaculture/mariculture intensification, as suggested by Puthucherril (2016), Boyd *et al.* (2020), Das (2022), Mamun *et al.* (2023), and Parappurathu *et al.* (2023).

**Fig. 4** Fisheries export values of selected countries (1991-2020)

Fisheries Export and Import

The fish and fishery product export value of Bangladesh fluctuated over the years, started at USD 161 million in 1991, peaked at USD 635 million in 2005 and reached USD 426 million in 2020 (Fig. 4). From 1991 to 2020, the fisheries export value has grown with the CAGR of 3%. Decade wise CAGR showed that the growth rate was reducing from 1991-00 (7%) and attained a negative growth during 2011-20 (-3 %). Meanwhile India has shown a tremendous growth in fisheries product export, with the CAGR of 8.5% during 1991 to 2020 which is more than the growth rate of Bangladesh (3.5 %) and Thailand (2.6 %). India's fishery exports value was USD 648 million in 1991-92. Exports continued to increase over the years, with some fluctuations. Highest growth rate in India's fisheries export was observed in the first decade of the study period (1991-00).

From 1991 to 2016, the Thailand was leading in fishery export among the selected three countries. In 2011, the Thailand fishery export reached its peak with the value of USD 8160 million, which was nearly two times more than fishery export value of India (USD 3551 million) in the same year. Thereafter Thailand's export value began to decline and reached nearly USD 5739 in 2020, which is nearly equal to the export value of India and the country faced challenges related to changing global demand, environmental concerns, and labour issues, in the year 2017 India has overtaken Thailand's fishery export in terms of both quantity and value.

India's remarkable growth in fishery exports reflects its success in expanding its seafood industry and gaining a strong presence in international markets. In the year 1991, value added fishery product export value of India was USD 1 million (excluding simple value addition like

salted, dried and smoked), which was less than 1% of total fishery product exports. This figure has grown drastically and reached USD 594 million in the year 2020-21, with a CAGR of 25%. Additionally, the quantity of the exported product and the type of product exported would provide a more comprehensive understanding of the current state of these countries' fishery export industries. A similar trend has been observed in the quantity-wise fishery export from these three countries (Fig. 5). Both value-wise and quantity-wise fishery product export values are comparatively less in Bangladesh. The growth rate calculation revealed that in Bangladesh the fishery product export quantity and value has grown nearly at the same rate (3%). But in Thailand and India, the value has grown faster than the quantity exported. These trends underscore the dynamic nature of fisheries exports and highlight the divergent trajectories of Bangladesh and India in the evolving global fishery market.

Meanwhile, the fishery import figures showed that the Thailand was importing more products than Bangladesh and India in terms of value as well as quantity (Fig. 6). In 1991, Bangladesh's fishery product imports were relatively low, with an import value of USD 0.05 million and a quantity of 17 tonnes. By 2020, the import value had increased up to USD 123 million, and the quantity reached 143 thousand tonnes. Bangladesh's low initial imports reflect domestic self-sufficiency in fish production historically. The rise in imports indicates increasing domestic demand exceeding domestic supply capabilities currently. During the period 1991-2020 the fishery imports value and quantity had grown at the rate of 14% and 9% respectively. One-way ANOVA revealed that there is a significant difference ($p < 0.05$)

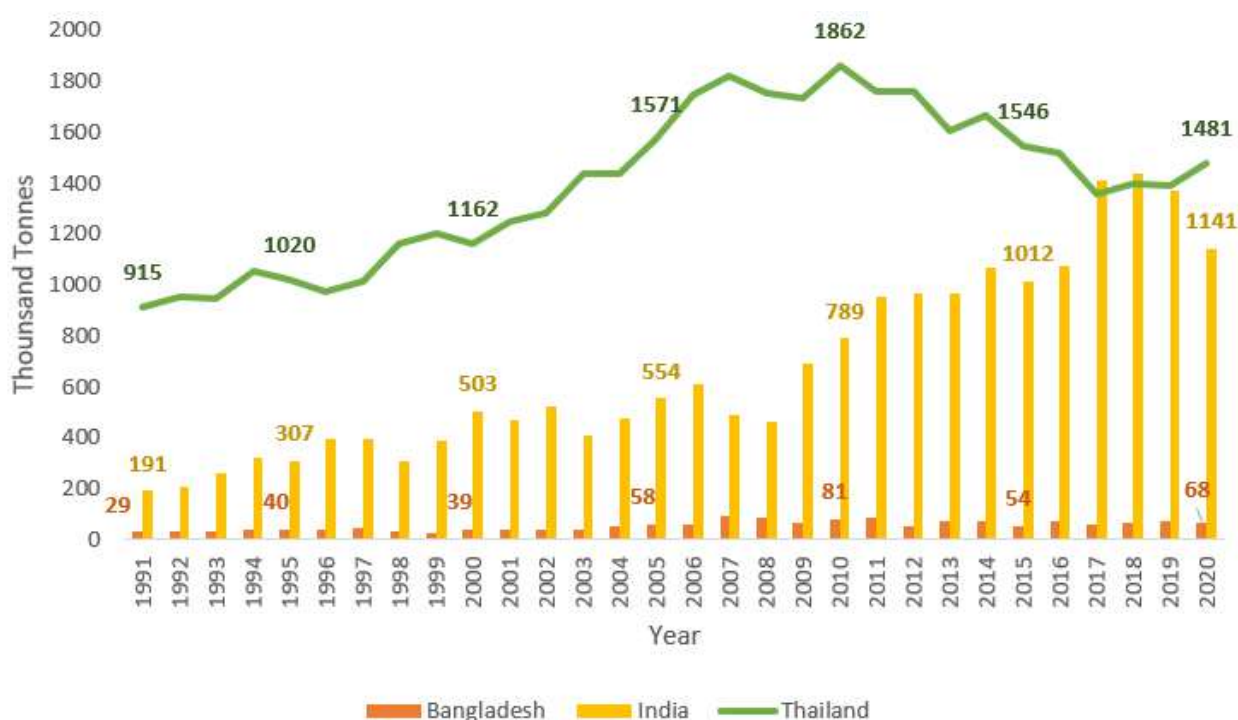


Fig. 5 Fisheries product export quantities of selected countries (1991-2020)

in the fish export and import quantities of Bangladesh, India, and Thailand.

The fisher product import value of India was USD 234 million in 2020, which is nearly two times the value of Bangladesh in the same year. For India, fishery imports are also rising faster than exports, indicating growing domestic consumption levels and demand for species not abundantly available domestically. In 1991-92, Thailand imported 723 thousand tonnes fishery products worth USD 1063 million from other countries. The quantity of imported products has almost tripled in 30 years, and reached 2153 thousand tonnes in 2020, this is almost 9 times higher than that of India. And the value of imported products during the year 2020-21 was USD 3743 million. Bangladesh's almost equal export-import growth rates indicate it is still at a nascent stage as a fish exporting nation unlike India and Thailand. India and Bangladesh have greater scope for expanding exports by boosting domestic production through sustainable aquaculture while managing wild fisheries scientifically. Resource sustainability issues in Thailand are highlighted by its falling exports and rising imports over time.

Bangladesh's fishery exports were dominated by frozen shrimp and prawn, frozen fish, chilled fish, dry fish, shark fins, live crabs, and live eel (FAO, 2021). During 2021-22, Bangladesh generated a total revenue of USD 533 million from the export of fish, shrimp, and other fishery products, accounting for more than 1% of the country's overall export earnings (Lahiri et al., 2023). The country has invested in aquaculture, particularly shrimp and prawn farming, which has boosted export volumes (Golub and Varma, 2014). Bangladesh has also improved processing facilities and developed a few value-added seafood products to meet international market demands

(Hernandez et al., 2018). However, since 2014, Bangladesh's net export in terms of quantity has been negative, while it remains positive in terms of value. For instance, in 2020-21, Bangladesh exported 68,000 tons of fish valued at \$426 million, while its imports were more than double at 142,000 tons but cost only \$123 million. Bangladesh's strategy of exporting high-value species to earn foreign exchange while importing low-value, nutritious fish for domestic consumption has helped meet GDP growth and food security needs.

India's fishery exports have shown significant growth over the years. Increased fish production, diversification of seafood products, and investment in processing and cold chain infrastructure have contributed to this success (Sharma and Burark, 2019; Fayaz and Ahmed, 2020; Kumar, 2020; Emam et al., 2021; Rajeev and Bhandarkar, 2022). Unlike Bangladesh, India exports both high- and low-value fish and fish products to earn foreign exchange, while importing only high-value fish and value-added products to cater to niche high-end consumers and hotel segments. Consequently, India has maintained a positive net export balance throughout the study period.

Thailand's fishing industry has been one of the world's leading exporters of fishery goods, contributing 20% of the country's total food exports. However, after reaching its peak in 1991-92, fishery exports exhibited a declining trend in subsequent years due to overfishing, unsustainable practices, and shifting international market demands (Jensen, 2006; Sampantamit et al., 2020b). Despite declining production, Thailand has maintained a stable fisheries GDP by strategically importing raw fish, adding value through processing, and re-exporting at a premium. In 2020, value-added products (excluding dried, salted,

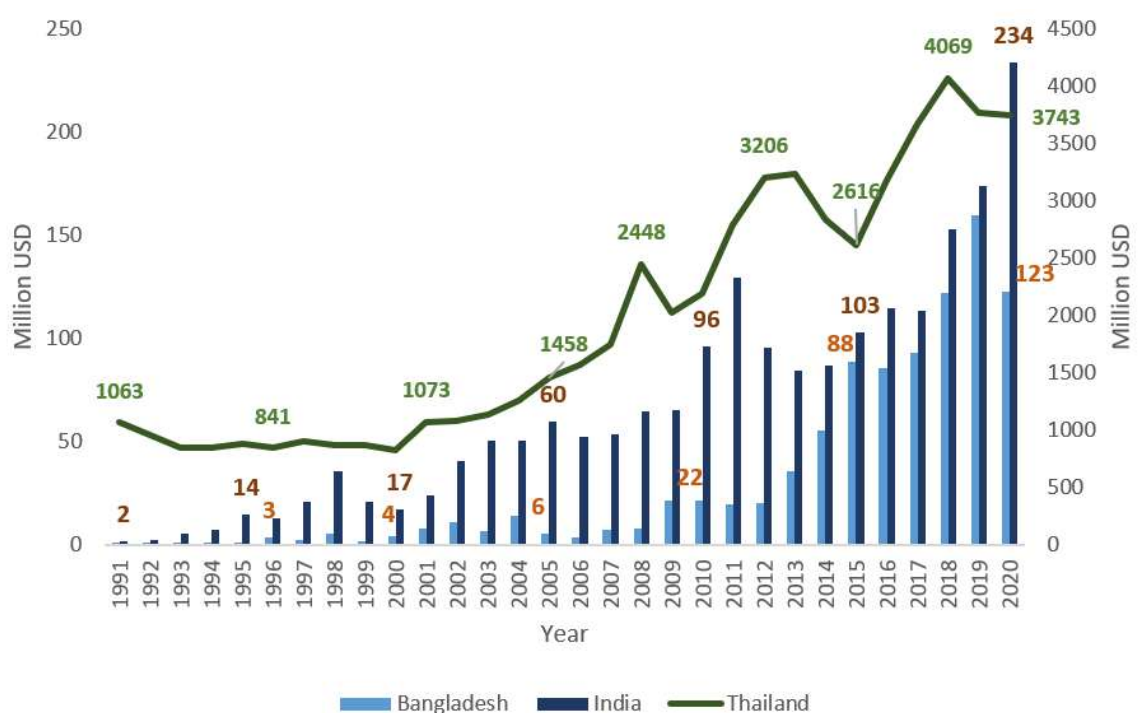


Fig. 6 Fish and fishery product import values of selected countries (1991-2020)

and smoked fish) accounted for 64% of Thailand's total fishery exports, compared to only 6% for India and 2% for Bangladesh (FAO, 2022). Nearly 89% of Thailand's seafood imports were fresh, chilled, or frozen fish, whereas this proportion was around 50% in Bangladesh and India. A detailed study of Thailand's value addition-driven seafood export model could provide useful insights for other developing Asian countries like India and Bangladesh, which are struggling to move up the seafood export value chain.

- Gleaning evidence and insights from the comparative study and the foregoing discussion, following key interventions are suggested to strengthen fisheries development in Bangladesh, India and Thailand: Bangladesh's fisheries exports, both in terms of value and quantity, are comparatively lower than India and Thailand. However, it has got the right export-import fish product mix that earns forex as well as ensures nutritional security. The contribution of value-added fishery products to Bangladesh's total exports is quite low (2%), and its footprint in intensive aquaculture systems and mariculture is almost non-existent. Among others, Bangladesh's development strategy shall focus on promotion of semi-intensive and intensive aquaculture production systems and invest in development of both small-scale and commercial scale mariculture to ramp up fish production in future. On trade front, while continuing and fortifying the present exim strategy, it shall invest heavily in processing and value addition, drawing inspiration from Thailand's success. Furthermore, promoting product diversification by exploring new species and product forms catering to global consumer preferences is advisable.
- India's yield levels in freshwater aquaculture and inland fisheries are the least among the three countries, though her fish production growth rate outpaced Thailand and is comparable to Bangladesh. While the average yield levels in the major aquaculture hub in India, Andhra Pradesh, is amongst the highest globally due to semi-intensive and intensive production systems, concerted efforts shall focus on attaining similar yield levels in rest of India through education and adoption of scientific better management practices, system intensification and species diversification. India and Bangladesh shall both invest and leverage the opportunities to increase their foot print in mariculture including seaweed culture. On trade front, India has to critically revisit the present policy regime that encourages exports of low value-high volume fishes which deprives the domestic population of cheap sources of protein. Strengthening domestic fish market and promotional strategies to increase per capita fish consumption closer to those seen in Bangladesh and Thailand or the global average shall become a central part of the development strategy.

- Thailand's fish production, from both culture and capture, has either declined or fluctuated since 2006, while it has managed to sustain the export of processed seafood exports. The study argues in favour of further strengthening the initiatives to reform and transform both her marine fisheries management as well as coastal aquaculture towards the path of sustainability. Its larger gains in future lie in moving up the value chain ladder further, leveraging on the market advantages offered by implementation of traceability systems and MCS measures in both fish production and trade. This will position Thailand as a model for both small and large Asian neighbours to emulate and replicate.
- All three countries can benefit from improving traceability systems to ensure transparency in the seafood supply chain (Andre, 2018; Egunjobi and Ngepah, 2022). This would enhance consumer confidence and compliance with international standards. Strengthening disease management and environmental sustainability practices in aquaculture can be a shared goal for all three countries (Bondad-Reantaso *et al.*, 2005; Hine, 2010; Salin and Arome Ataguba, 2018).

Conclusion

The comparative analysis of the fisheries production and contribution to countries GDP across Bangladesh, India, and Thailand over last three decades reveals valuable insights and lessons for sustaining development of this vital economic engine. While agriculture's overall contribution to national GDP declined in all three countries due to industrialization, the trajectories within the fisheries sub-sector diverged considerably. Prioritizing investments in processing infrastructure, adoption of intensive aquaculture production systems and exploration of mariculture can unlock Bangladesh's potential for higher export revenues and domestic nutritional security. Strengthening cold chain infrastructure, promoting fisher collective-driven value addition and supporting domestic distribution channels can enhance India's export competitiveness while export policy tweak can improve access of Indian consumers to low value fish for nutritional security. Thailand has successfully leveraged its processing capabilities for value-added seafood exports, an over-reliance on imports raises concerns about long-term resource sustainability. Moving forward, all three countries must prioritise responsible resource management, community-based conservation approaches, and climate-resilient practices to safeguard their fisheries wealth. Regional cooperation, knowledge sharing and collaborative research can drive innovations across various aspects of fisheries. Ultimately, coherent national policies aligned with SDGs are crucial for nurturing the fisheries sector's role as an economic catalyst and a nutritional linchpin. By learning from each other's strengths and addressing shared challenges, Bangladesh, India and Thailand can lead

the way towards "Blue Transformation" - harnessing the power of aquatic foods to support livelihoods, foreign exchange earnings and food and nutritional security for their populations.

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