Opportunities and strategies to achieve potential growth of fish farming in North-East Bangladesh

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Abstract

This review article delves into the opportunities and challenges of fish farming in the northeastern region of Bangladesh, aiming to identify strategies for potential growth and development in the aquaculture sector. Through comprehensive analysis and examination of fish farming trends, challenges, and opportunities, the study compiles and analyses reputed articles and data spanning mostly from 2000 to 2023. Key findings of the study highlight the significant role of pond culture in driving fish production trends in the region. Despite challenges such as limited seed production and infrastructural constraints, the study underscores the importance of targeted interventions, including pond-based aquaculture development, fish seed production, training programs, credit support, infrastructure development, and market linkages, in unlocking the full potential of fish farming in the northeastern part of Bangladesh. The findings provide valuable insights for policymakers, researchers, NGOs, and other stakeholders to collaborate on implementing sustainable strategies for the growth and prosperity of the aquaculture sector in the region.

Keywords: Fish farming; Fish production; Challenges; Strategies; Pond-based aquaculture; Technology advancement

Introduction

Vast inland water bodies and river systems of Bangladesh provide tremendous fishing and aquaculture possibilities (Islam et al., 2016). It is fortunate with geographic location attracts a huge number of aquatic species and offers enough resources to sustain fisheries potential (Halim et al., 2021). Fish is a common accompaniment to rice in the national cuisine, saying "Maache-Bhate Bangali" in Bangladesh (Kumar et al., 2022). The fisheries are essentially categorized into three categories: inland capture fisheries, inland aquaculture, and sea fisheries, with the inland aquaculture sector accounting for more than 55% of total output (DoF, 2016). The fisheries industry is significantly important to the national economy, accounting for 3.52% of the country's GDP and export earnings 1.39% (DoF, 2019). Over the previous decade (2004-2005 to 2013-2014 Fiscal Year), fisheries growth has been rather consistent, averaging 5.38% per year (Barman, 2015). This sector's growth rate was rather stable, ranging from 7.32% in 2009-2010 to 4.04% in 2013-2014 (Rashid et al., 2015). Inland fisheries account for more than 1.39% of Bangladesh's total export value. In the northeastern region of Bangladesh, there are 411 haors, spanning approximately 8000 square kilometers, and hosting a population of around 19.37 million individuals (Shamsuzzaman et al., 2020). Given enough government assistance, the fisheries industry has enormous potential for developing different sorts of auxiliary enterprises in rural regions, which often have a high rate of economic return. Fish accounts for around 60% daily animal protein consumption of Bangladesh (DoF, 2016). Fish farming, fish handling, and processing provide a living for more than 17 million people, including around 1.4 million women (Shamsuzzaman et al., 2017). According to multiple assessments, more than 80% of workers in the fish processing industry are women (DoF, 2016).

Aquaculture stands out globally as one of the most rapidly expanding sectors in food production, playing a crucial role in meeting nutritional needs and combating poverty (Hasan & Jahan, 2022), The global aquaculture production totalled 80 million tons, constituting 47% of the world's total fisheries production and catch (DOF, 2016). Global fish production had surged to approximately 179 million tonnes, with record highs in both capture fisheries (96.4 million tonnes) and aquaculture (82.1 million tonnes) (FAO, 2020). The efforts to increase the productivity of fish breeding in the closed reservoirs or ponds with different feed additives like active charcoal and increased fat content have yielded encouraging results (Osepchuk et al 2021; Ostrenko et al 2021).

Aquaculture now contributes close to half of the world's fish production and ranks among the swiftest growing industries in protein food production (Singha & Chandan, 2023). Notably, Asian developing nations such as China, India, Bangladesh, Myanmar, Indonesia, and Cambodia lead in harnessing their inland water bodies for aquaculture (FAO, 2020). In Bangladesh, aquaculture has witnessed significant evolution, boasting numerous practices, techniques, and cultured fish species. In the fiscal year 2017-18, aquaculture production reached 2.4 million metric tons, accounting for 56.24% of the country's total fisheries production (Sarker & Alam, 2023). Over the past decade, the fishing industry has exhibited steady growth, registering a 5.3% increase from 2009 to 2019. Enclosed water sources contributed significantly, with 56.76% (2.49 million metric tons) of farmed fish originating from such sources in the fiscal year 2018-2019 (Hasan & Jahan, 2022). Bangladesh has achieved self-sufficiency in fish production, with an anticipated output of 4.621 million metric tons in 2020–21(Deb et al., 2021). Aquaculture, primarily conducted in earthen ponds, constitutes 57% of total fish production, aligning with projected targets for fish production (Type & Haroon, 2024).

The northeastern region of Bangladesh, particularly the Sylhet basin, encompasses some of the most economically and ecologically significant wetlands, including Hakaluki Haor and Tanguar Haor, recognized as ecologically critical areas since 1999 (Kumar et al., 2022). These wetlands, spanning approximately 40,000 hectares across Sunamganj, Moulvibazar, and Sylhet districts, play pivotal roles in the country's economic, industrial, ecological, social, and cultural spheres (Tamim et al., 2022). They serve as vital sources of livelihood for millions, offering employment opportunities, irrigation, sustenance, fuel, fodder, and transportation. Hakaluki and Tanguar Haors are hailed for their biodiversity and natural abundance, making them focal points of the region's wetland systems. In terms of seed production, the greater Sylhet area yielded approximately 12,179±690.86 kilograms, distributed across its constituent districts in 2014. Fish production in this region is substantial, reaching around 0.26 million metric tons, with an additional 55.85 thousand metric tons available for exploitation (Sarker & Alam, 2023). The region's freshwater aquatic biodiversity flourishes within its expansive freshwater basin, primarily comprised of haors and floodplain lands. Despite this natural wealth, aquaculture production witnessed a decline in the fiscal year 2021-2022 (DoF, 2022). Efforts to revitalize and optimize aquaculture practices in this region are imperative to harness its full potential and ensure sustained economic and ecological benefits for its inhabitants. But in the northeastern region of Bangladesh, a burgeoning tendency among its youth to seek opportunities abroad, coupled with the aspirations of many parents to send their children overseas, stands as a significant barrier to the advancement of aquaculture production (Ghose, 2017). This trend not only impacts the retention of skilled individuals crucial for the industry's growth but also hampers the potential expansion of aquaculture endeavours. The region of Sylhet boasts numerous barren fields, yet unfortunately, many farmers are grappling with inadequate techniques in fish cultivation. The prevailing acidic soil conditions,

combined with a dearth of technical expertise among farmers, contribute to suboptimal aquaculture outputs (Daily star, 2024).

Therefore, the aim of the study was to explore several key objectives, including the current trends in fisheries production, opportunities and potential growth of fish farming, and comprehensive strategies to improve fisheries production in the northeastern region of Bangladesh.

Methodology

Study area

The study meticulously gathered and analysed a substantial corpus of articles focused on the fish farming within the northeastern region of Bangladesh. This region, characterized by its geographical coordinates spanning between 23°58′ and 25°12′ north latitude and 90°56′ and 92°30′ east longitude, serves as a potential hub for aquaculture activities, covering four districts, including Sylhet, Sunamganj, Habiganj, and Moulvibazar. The area is visualized using ArcMap 10.8, respectively (Fig 1).
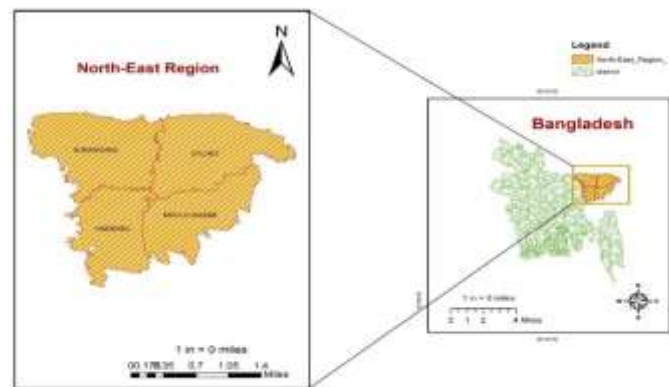

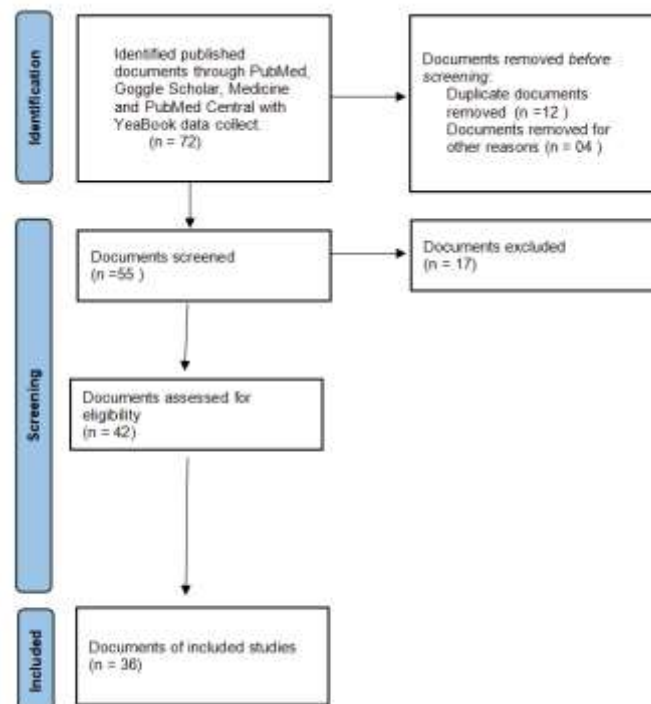**Fig 1:** Northeast region of Bangladesh.

Fig 2: A flow diagram shows the procedure for selecting the publications for this review

Data collection methods

   The study conducted by compiling data from various reputable sources, including yearbook of fisheries statistics from the Department of Fisheries (DoF), peer-reviewed journals, the divisional fisheries office, Sylhet, and reports from governmental and private organizations covering the years 2000-2023. This diverse pool of data ensured a comprehensive understanding of the subject matter. This resulted in 36 publications. The remaining publications' whole texts were then read through. Publications that contained the search terms but lacked sufficient detail on the subject were not chosen for this review. The articles that meet the following requirements are included in the final data set. The selection process for the articles used in this research is shown in the flow diagram (Fig 2).

Data analysis and visualization

   The collected data underwent analysis using R statistics. The findings were visualized using RStudio 4.3.2. Additionally, OriginPro 2024 was used to generate graphs and charts, enhancing the clarity of our findings.
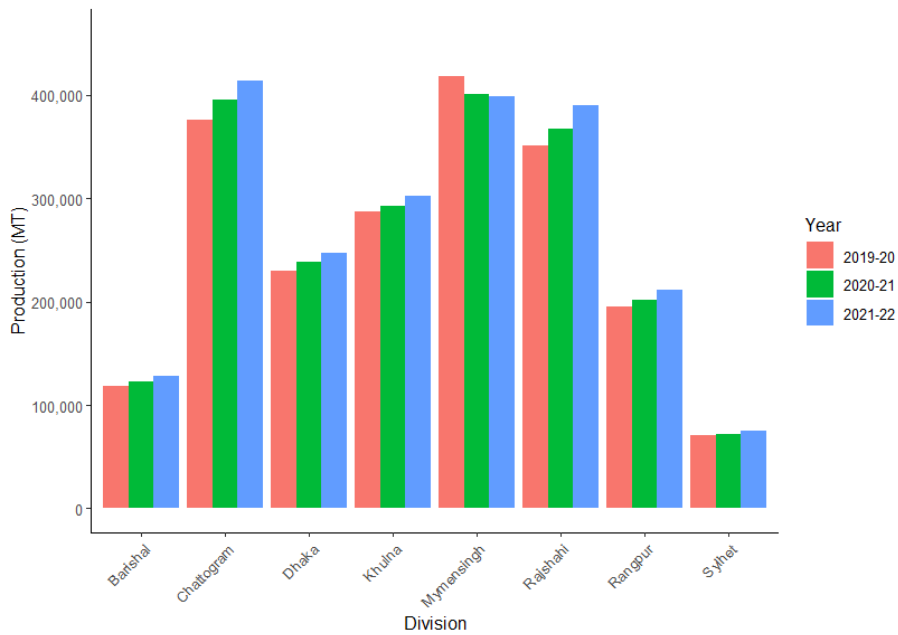
Annual Fish Production

   Bangladesh stands out as a prominent player in global fish production, with its fisheries sector categorized into three main segments: inland capture, inland culture, and marine fisheries. In the fiscal year 2021-22, the total fish production reached 47.59 lakh MT, with aquaculture contributing significantly at 57.39% (DoF, 2022). In recent decades, agricultural practices in Bangladesh, primarily cantered around paddy cultivation, have gradually transitioned towards aquaculture (Ahmed et al., 2011; Dey et al., 2013; Mondal, 2008). This shift has been accompanied by a steady growth rate in the aquaculture sector, ranging from 7.32% in 2009-2010 to 4.04% in 2013-2014, as reported in the Bangladesh Economic Review of 2014. In the fiscal year 2021-22, the fisheries sector experienced a GDP growth of 2.08%, while its share within the broader agricultural sector stood at 21.83% (BER, 2022). Over 12% of the population derive their livelihood directly or indirectly from the diverse activities within the fisheries sector. Notably, Bangladesh secured the 3rd position globally for inland open water capture production and ranked 5th in aquaculture production worldwide. In tilapia production, Bangladesh stood 4th globally and 3rd in Asia. Additionally, among the 11 nations producing hilsa fish, Bangladesh claimed the top spot (FAO, 2020). Furthermore, the national fish of Bangladesh, Hilsa (Tenulosa ilisha), holds significant importance, contributing 11.91% to the total fish production, and has even obtained Geographical Indication Registration Certificate under the name 'Bangladesh ilish' (DoF, 2022). The scenario of fish production from 1990 to 2022 is shown in Figure 3.
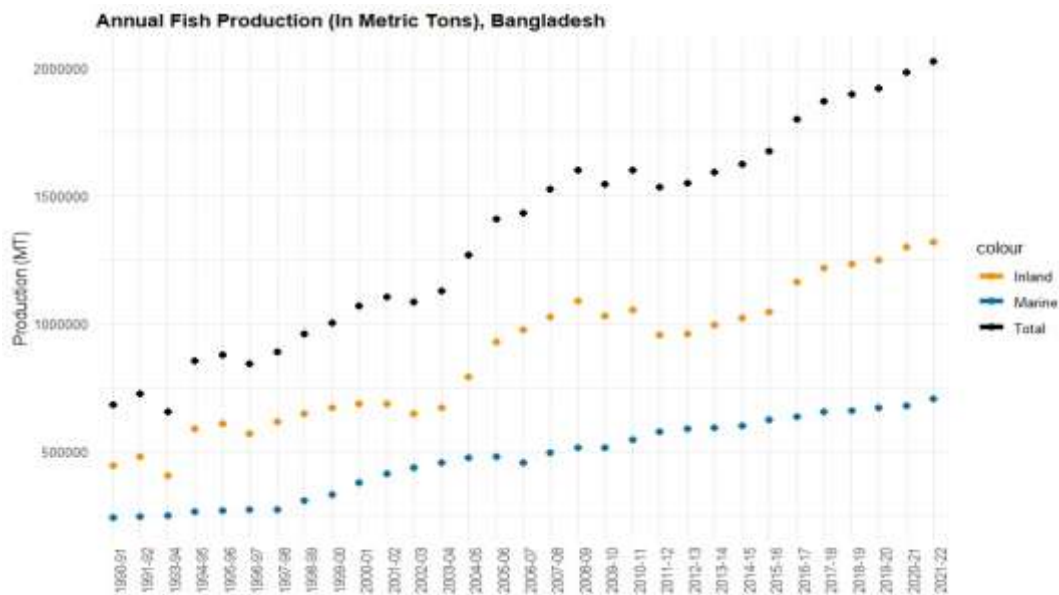

Fig 3: Fish production status (Metric Tons), Bangladesh (DoF, 2022)

**Division wise Annual fish production status of pond-based aquaculture**

Figure 4 compares the fish production of pond-based aquaculture among the divisions of Bangladesh, specifically focusing on the Sylhet division, i.e., the northeastern region. The data indicate that fish production from pond-based aquaculture in the last three years is significantly lower compared to other divisions of Bangladesh. Although there is a slight increasing trend in pond-based aquaculture production in the northeastern region, suggesting a positive trajectory, the amount of production observed in the last three years is comparatively low. The positive trend in pond-based fish production (Fig 4) indicates a potential for future increases in per hectare fish production in the respective area. Figure 5 illustrates the fish production (MT) from inland water bodies, river systems, beels, and ponds over the last seven years in Sylhet division.
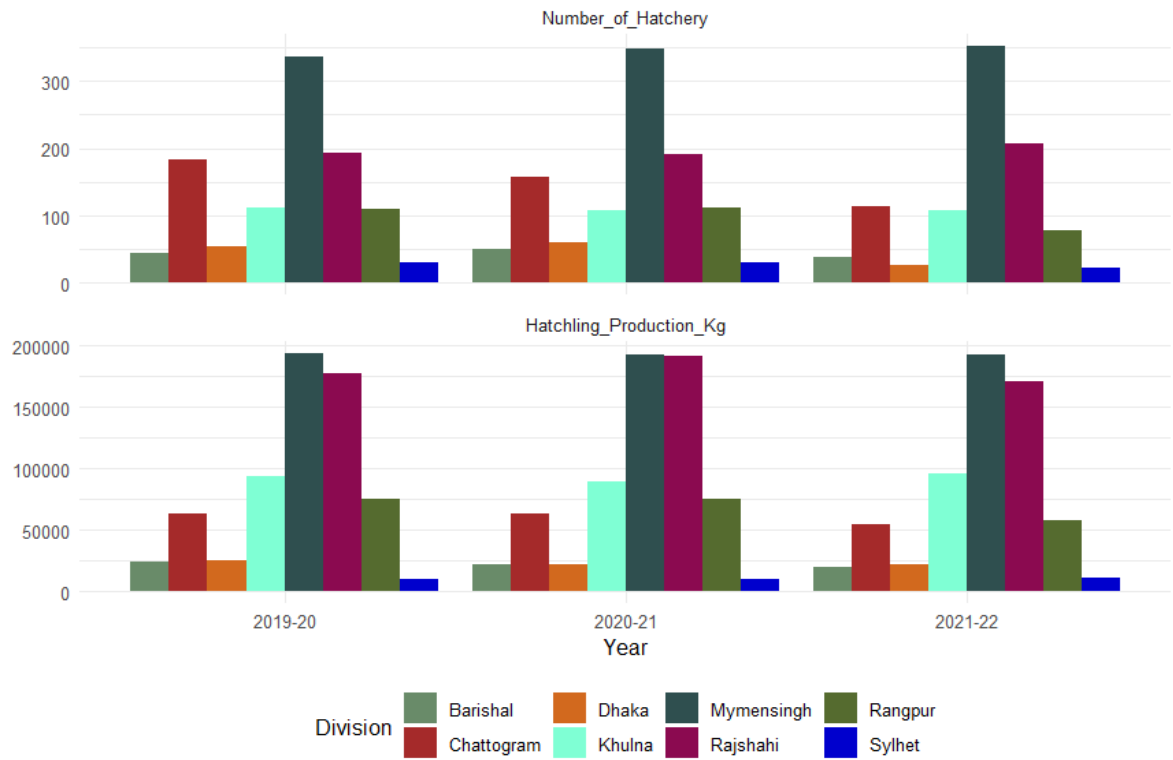

Fig 4: Division wise Annual fish production status (DoF, 2019-2022)
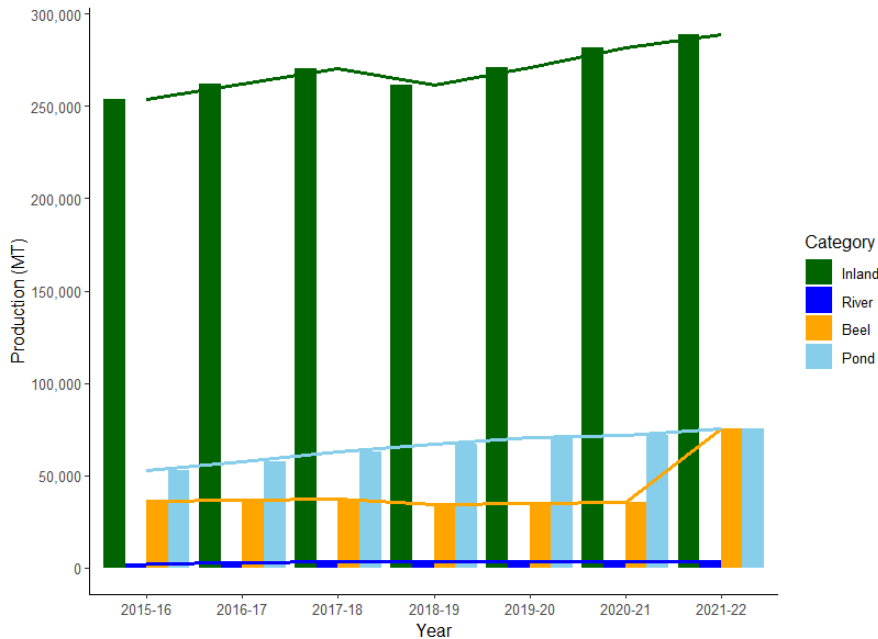
Fig 5: Fish production (MT) over the last seven years in Sylhet Division (DoF, 2015-2022)
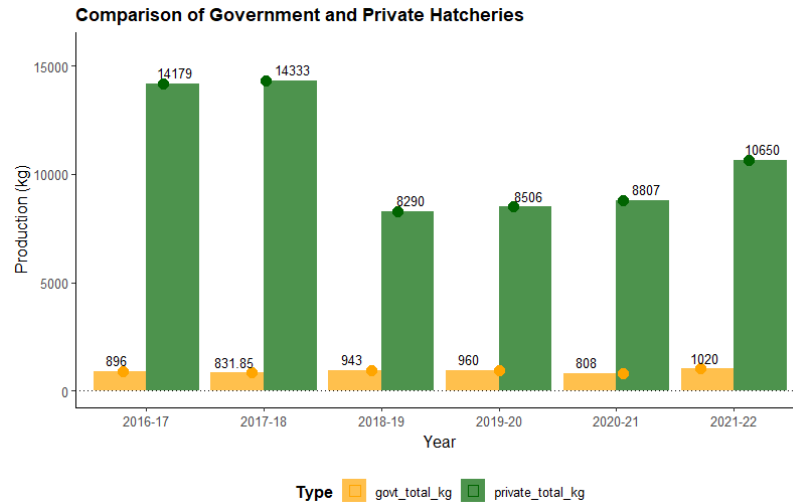
Fig 6: Government and private hatcheries production (DoF, 2016-2022)

Fig 7: Division wise hatchery and hatchling production status (DoF, 2019-2022)

Division wise hatchery and hatchling production status

Figure 7 depicted data from the last three years (from 2019 to 2022). Through our analysis, a notable trend has emerged in the context of North East Bangladesh, where both hatchery numbers and production status exhibit a significant decline compared to other divisions within the region. This observed phenomenon holds implications for aquaculture-based fish production, albeit indirectly. The reduced hatchery numbers signify a potential bottleneck in the aquaculture supply chain within North East Bangladesh. Limited availability of hatcheries may impede the replenishment of fish stocks, consequently affecting the overall productivity of aquaculture operations. This shortage not only impacts the quantity but also the diversity of fish species cultivated in the region, potentially limiting economic opportunities for local fish farmers.
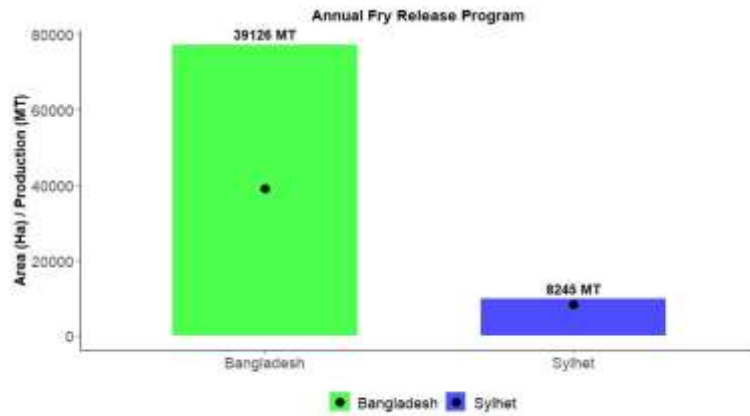
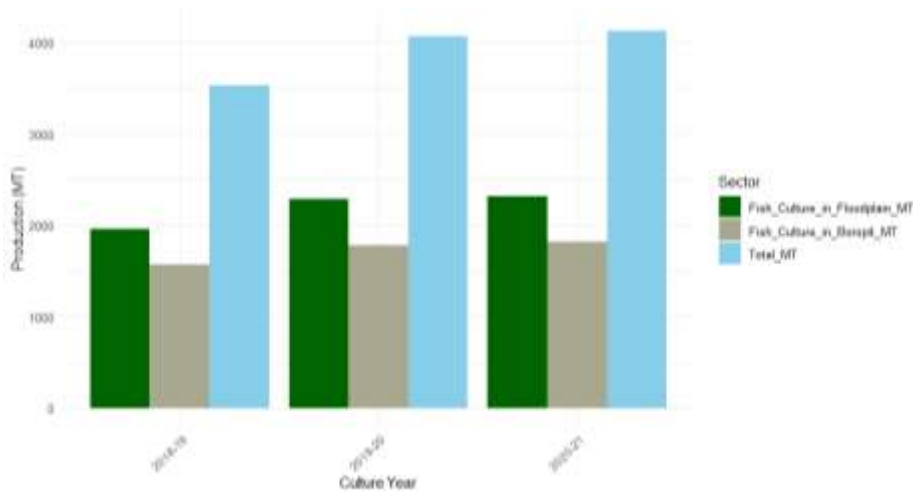**Fig 8**: Annual fry release status (DoF, 2022)

Fig 9: Fish production of seasonal cultured waterbodies (DoF, 2018-2021)

Annual Fry Release

In Figure 8, fish fry release in Bangladesh and its northeastern part during the 2020-21 year is depicted. The fry release occurred in Bangladesh, amounting to 77,356 MT, while only 9,845 MT was released in Sylhet, which accounts for 12.73% of the total fry releasing. Despite its smaller scale, the allocation in Sylhet plays a crucial role in maintaining fish production and environmental balance within the region.

Last three years production status in northeastern region

Over the past three years, there has been a notable upward trend in fish production within the Northeastern region. This increase is particularly evident in the practices of floodplain culture and Boropit fish culture, which have seen significant expansion compared to traditional pond aquaculture methods (Halim et al., 2020). The comprehensive data spanning from 2018 to 2021 reveals a consistent rise in both floodplain and Boropit fish cultures, contributing substantially to the overall boost in fish production across the region in figure 9. This positive trajectory underscores the effectiveness and growing popularity of these alternative aquaculture methods in meeting the increasing demand for fish while utilizing the region's natural resources efficiently.

Aquaculture Potentiality in Northeastern Bangladesh

The agro-ecological zone in northeastern Bangladesh has 60,000 km² of water area, including 9,084 ha of ponds (Alam et al., 2000). There are several small ponds in this region, but they cannot contribute much to fulfilling the household need for fish (Rashid et al., 2015). Pond-based fish culture in the northeastern part of the country is not as advanced as in other districts of Bangladesh. Two significant issues restrict pond aquaculture in this region: the acidic character of the soil (Rahman et al., 2020) and the abundant fish production in the natural environment (Alam et al., 2000). However, because of its diversified topography, abundant water resources, and favourable climatic conditions, this area provides great aquaculture potential. Because of the abundance of open

water bodies, this area has the potential for large-scale aquaculture production (Aziz et al., 2022). Another factor is that the contamination rate of the Haor, river and waterbody is lower than in other regions of Bangladesh owing to a lack of industrial activity, making it a prime culturable location for fish, despite abundant natural production (Abdullah et al., 2022; Deb et al., 2021; Type & Haroon, 2024). However, the location may support a variety of semi-intensive cultures, including cage culture, pen culture, pond culture, and so on. All open floodplains and low-lying flood areas in the northeastern region that naturally hold at least 60 cm of monsoon water for at least three months can be converted to aquaculture using pen culture and cage culture (Halim et al., 2021). Cage culture may provide a significant contribution to the country's overall fish production, and this region can be the ideal site for cage culture (Singha & Chandan, 2023). There is a vast barren land in this region, and according to the BFRSS (1993-94), the total area of ponds in Sylhet district is around 2,502 hectares, with just 552 hectares being cultivated (BRFSS,1993). This whole pond area has the potential to significantly contribute to addressing people's fish demands. However, many pond owners incorporate fish culture into their ponds and adhere to conventional fish culture procedures. Giving them basic information about fish farming and taking appropriate measures to exploit this area may result in a significant increase in productivity.
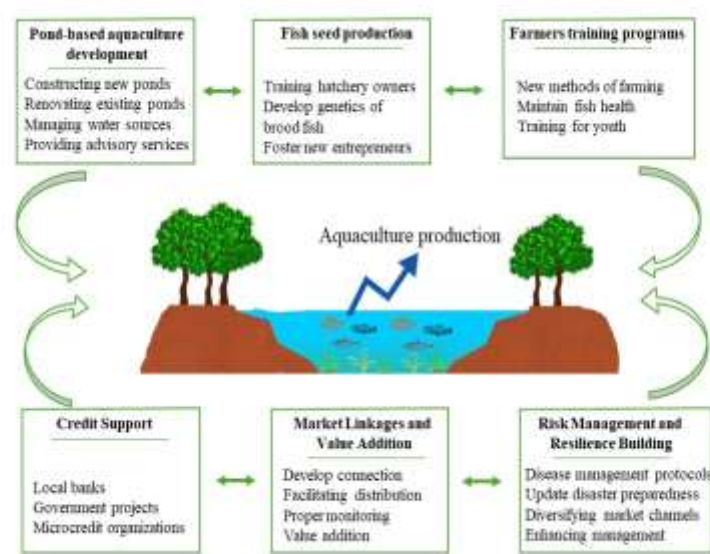
Fig 10: Possible strategic framework to advance aquaculture in northeastern region

Possible strategies to advance aquaculture in northeastern region of Bangladesh

Many people in the northeast region live abroad (Gardner, 2008), and a significant portion of them, especially the youths, are not interested in this field, resulting in low production of agricultural crops, fisheries, and livestock. To address this issue, several efforts (Fig 10) are needed to ensure the livelihood and food security of the residents of the region. Some key strategies that can boost the aquaculture sector in the northeast region of Bangladesh are described below.

Pond-based aquaculture development: This plan focuses on pond-based fish production in northeastern Bangladesh. It includes tasks such as constructing new ponds, renovating existing ponds, managing available water sources, and providing advisory services from government union service providers to new and existing fish farmers through government projects.

Fish seed production: Seed production is essential for sustainable fish production. Sylhet division lags behind in seed production compared to other divisions, necessitating a focus on increasing seed production to ensure timely availability for farmers. The government needs to take initiatives to provide training for hatchery owners to enhance seed production, develop genetics of brood fish, and foster new entrepreneurs. Several NGOs can play a vital role in this case by providing training, demonstrating projects, and offering direct services.

Farmers training programs: These classes or demonstrations aim to teach fish farmers new methods of fish farming, how to maintain fish health, and how to farm fish in an environmentally friendly manner. Government organizations, specifically local fisheries offices, youth development centres, and several NGOs working in this sector, need to organize training sessions for youth and existing fish farmers. Some people are professionally vulnerable, while others wish to change their profession and could benefit from engaging in this sector, which offers a variety of opportunities.

Credit Support for Fish Farmers: Credit support by local banks, government projects, microcredit organizations play a crucial role in bolstering the livelihoods of fish farmers in the northeastern region of Bangladesh. With tailored financial assistance, these farmers can enhance their aquaculture ventures, invest in modern equipment, and expand their operations. Accessible credit facilities empower them to overcome financial barriers, ensuring sustainable growth and contributing to the region's economic development. By providing targeted credit support, stakeholders can catalyze the growth of the aquaculture sector in the northeastern part of Bangladesh, uplifting the lives of fish farmers and fostering prosperity in the region.

Infrastructure development: By investing in modern infrastructure such as roads in haor areas, transportation networks, cold storage facilities, and processing plants, the region can overcome logistical challenges and improve the efficiency of fish farming operations. Enhanced infrastructure will facilitate the timely transportation of fish from farms to markets, reducing post-harvest losses and ensuring fresher products for consumers. Moreover, the establishment of modern processing facilities will enable value addition and increase the competitiveness of this area's fish products in domestic and international markets. Through strategic infrastructure development, stakeholders can pave the way for sustainable growth and prosperity in the region's aquaculture sector.

Market Linkages and Value Addition: Establishing strong market linkages and implementing value addition initiatives are essential strategies to augment fish production in the northeastern part of Bangladesh. By fostering connections between fish farmers and local markets, as well as facilitating access to broader distribution channels, the region can capitalize on its fish farming potential. Moreover, investing in value addition processes such as processing, packaging, and branding can elevate the quality and perceived value of the fish products, enabling them to command higher prices in domestic and international markets. Through concerted efforts to strengthen market linkages and integrate value addition practices, stakeholders can unlock new opportunities for growth and prosperity in the northeastern fish farming industry.

Risk Management and Resilience Building: In the pursuit of sustainable fish production in northeastern Bangladesh, it is imperative to address various risks and build resilience within aquaculture systems. This region, while rich in aquaculture potential, confronts various challenges ranging from environmental hazards to market fluctuations. Implementing rigorous disease management protocols, fortifying natural disaster preparedness measures, diversifying market channels, and enhancing financial risk management mechanisms are crucial steps towards mitigating risks and ensuring the resilience of fish farming operations. Moreover, adapting to climate change, investing in capacity building initiatives, and fostering collaboration among stakeholders are essential components of a comprehensive strategy to safeguard livelihoods, promote economic development, and foster long-term sustainability in the aquaculture sector of northeastern Bangladesh.

Conclusion

The northeastern region of Bangladesh holds immense potential for the growth and development of the aquaculture sector. Through comprehensive analysis and examination of fish farming trends, challenges, and opportunities, this review paper has shed light on the critical role that aquaculture plays in the socioeconomic development of the region. Despite facing challenges such as limited seed production, infrastructural constraints, and environmental factors, the region has shown remarkable resilience and adaptability in enhancing fish production. Moving forward, it is imperative for policymakers, researchers, NGOs, and other stakeholders to collaborate closely and implement targeted strategies to address the identified challenges and leverage the available opportunities. By fostering innovation, promoting sustainable practices, and empowering local communities, the aquaculture sector in the northeastern region can thrive, contributing significantly to food security, economic growth, and livelihood enhancement. With concerted efforts and collective action, the vision of a vibrant and sustainable aquaculture industry in the northeastern part of Bangladesh can be realized, ensuring prosperity and well-being for generations to come.

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