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Analogical viewpoint of fisheries and aquaculture between Bangladesh and Nigeria: potential of knowledge transferability

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Abstract

The inland fisheries and aquaculture of Bangladesh and Nigeria were critically examined with a view to comparing their fish production and farming systems, nature of seed supply, contribution to country's Gross Domestic Product (GDP) and the transferability of experiences towards development of the fisheries sector. A review-based study was conducted based on the available information in journals articles, reports, Bangladesh and Nigeria Departments of Fisheries Statistical Year Books, text books, thesis and web documents. There are considerable similarities between Bangladesh and Nigeria in terms of geographical position, agro-ecology, fisheries resources and the socio-economic condition, fish eating tradition and domestic demand for fish consumption of the people. Bangladesh aquaculture systems though mainly semi-intensive but more developed than that of Nigeria in terms of fish seed and feed supply while Nigeria, though adopts the intensive culture technique but experiences lower production and higher import of fish. From the findings of this review, it could be argued that Bangladesh needs to fully harness its abundant resources such as seeds, ponds, water, so as to achieve self-sufficiency in fish supply and develop export market. Alternatively, Nigeria needs to adopt, diversify and invest more in aquaculture and fisheries receiving learning from an aquaculture growing country, like Bangladesh, so as to increase production and reduce import.

Keywords:

Bangladesh; Nigeria; Aquaculture;

Inland fisheries; Knowledge

transferability

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Introduction

Fisheries and aquaculture make critical contributions to development in the areas of employment, food security and nutrition for the over 41 million people worldwide engaged in fishing and fish farming, the vast majority of whom live in developing countries (Finegold, 2006). According to FAO (2016), the world average per capita consumption of fish stands at 20 kg per annum. Fish is a vital source of food for people and it is man's most important single source of high-quality protein by providing ~17% of the animal protein consumed by about one billion of the world's population (FAO 2014). However, in 2010 – 2012, about 870 million people - or one in eighth of the people in the world – did not consume enough food to cover their minimum dietary energy requirement and of these people, 852 million were in developing countries (FAO, 2013a).

Bangladesh and Nigeria are two developing countries in different continents (Asia and Africa), far apart from each other (8772km) but resemble in many common attributes. Bangladesh and Nigeria's population as at July 1 2014 is estimated at 158 512 570 and 178 516 904 people and rank 8 and 7, respectively, in the list of countries by population (Worldometers, 2012).

The current world is undergoing the globalization shift which refers to the interchange of world views, products,

technologies, ideas and mutual sharing, and other aspects of culture. In this milieu, the role of technology adoption has been recurrently described in the growing economic literature. The developing countries do not adopt new technology equally and per capita income of those countries would not change positively even if the distribution of technology adoption is constant over time Mayer (2000). To reduce the gap between developed and developing countries, developing countries will need to upgrade their level of technology faster than the advanced countries (Mayer, 2013). In agricultural export trade, the developed countries import various food items (e.g. fish) from developing countries that influence the production systems at the producer level in different ways, therefore learning and sharing of advanced knowledge of fisheries and aquaculture among the developing countries is inevitable. As with amongst other developing countries, Bangladesh and Nigeria are undergoing the globalization shift, therefore, technological sharing and upgrading is the unique opportunity to raise per capita income (Mayer, 2000).

In the area of aquaculture, cross-country technological transfer between African and Asian countries has shown positive impacts in various domains. Researchers and experts of different continents worked together to transfer and share aquaculture technologies between Asian and African countries. Under SARNIASSA, the

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Analogical perspective between Bangladesh and Nigeria Fisheries and Aquaculture

WorldFish having the Asian experience transferred various aquaculture technologies in Cameroon, Southern Africa and Democratic Republic of Congo. Asian Institute of Technology (AIT) has provided huge information of aquaculture technologies the platform of the project. The information communication technology (email group, website, etc.) based platform developed by SARNISSA created the avenue of sharing technical information, ideas of problem solution, trade of aquaculture equipment, etc (SARNISSA, 2013). Through this platform, African partners have been able to tackle the disease problem of marine shrimp in Mozambique. These all indicate that cross country technology sharing and transfer has a great potential to uphold fish production and national economy. Knowledge transfer and capacity building can cross cultures and political jurisdictions and cooperation can occur between distant ecosystems experiencing common challenges (Liu *et al.*, 2013; Abigail *et al.*, 2016). Though some comparative studies between Bangladesh and Nigeria have been conducted (Islam, 2006; Lola, 2009), they were basically centered on bureaucracy, globalization and poverty. There is dearth of linkage of existing aquaculture practices and knowledge between these two developing countries. Gaining knowledge on such potential as part of doctoral study by a PhD fellow (first author) from African country in Bangladesh would have multiplier impacts by having broader understanding on existing knowledge base. In this

context, reviewing available literature from various sources, this paper attempts to examine the contribution of fisheries and aquaculture sectors, the role played by government, and the potentials of transferability of aquaculture experiences between Bangladesh and Nigeria.

Geographical positions

By virtue of the geographical location of Bangladesh and Nigeria, they fall in the north latitude of this planet (Fig. 1). The physical geography of Bangladesh is slightly variable characterized by two distinctive features: a broad deltaic plain subject to frequent flooding, and a small hilly region crossed by swiftly flowing rivers. Due to this physiographic feature, about 80% of the landmass is made up of fertile alluvial lowland. The Tropic of Cancer passes through Bangladesh having a monsoon climate characterized by wide seasonal variations in rainfall, high temperatures, and high humidity. Three distinct seasons are generally recognized: a hot, muggy summer from March to June; a hot, humid and rainy monsoon season from June to November; and a warm-hot, dry winter from December to February. In general, maximum summer temperatures range between 38 and 41°C. April and January are the hottest and coolest months, respectively, in most parts of the country which receive at least 2,300 mm of rainfall per year, except for the relatively dry western region of Rajshahi where the annual rainfall is about 1,600 mm.

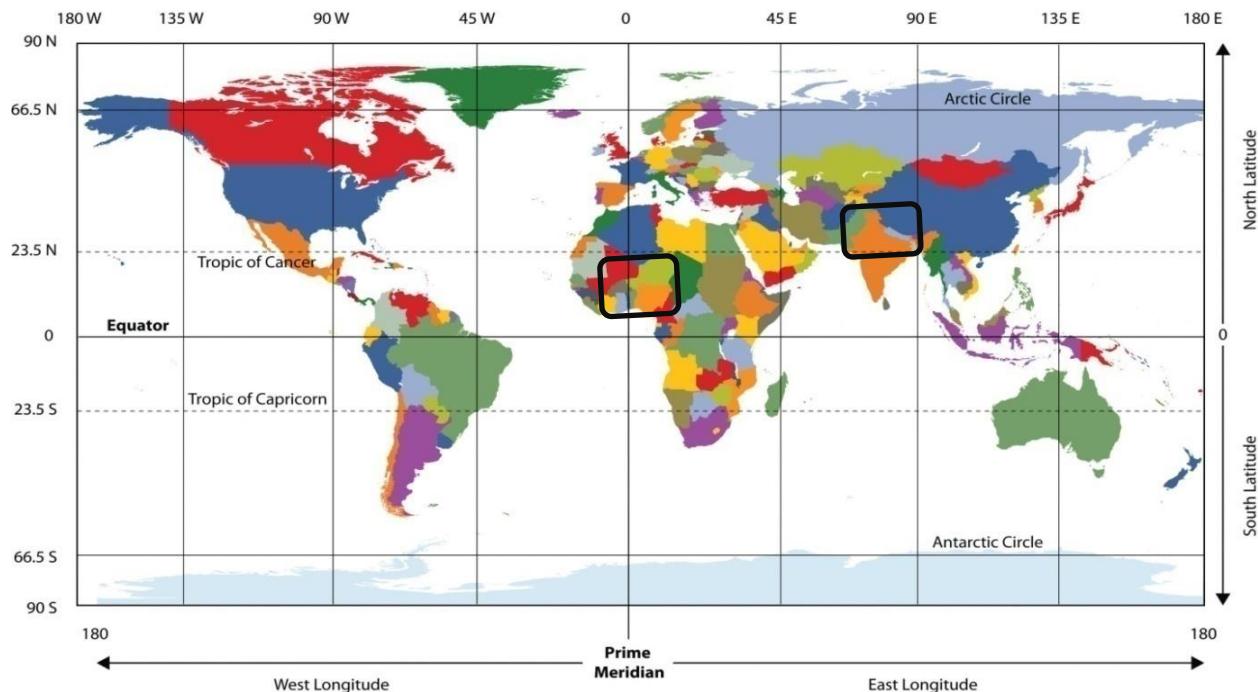


Fig. 1. Geographical Position of Nigeria (encircled left) and Bangladesh (encircled right) in North Latitude of World Map.

Nigeria locates within the Equator and the Tropic of Cancer. The arid plains in the north give way to savannah in the central hills and plateau, merging into tropical rain forests in the southern lowlands and mountains to the southeast. The tropical climate in Nigeria exhibits a well marked rainy and dry season with a single peak known as the summer maximum due to its distance from the equator. Temperatures are above 18°C throughout the year. The central Nigeria has a temperature range of 18.45°C to 36.9°C, and an annual rainfall of about 1,500 mm with single rainfall maxima in September.

The similarities between Bangladesh and Nigeria in terms of geographical position, tropical weather and soil types to a greater extent indicates the potential of corresponding aquaculture systems adopted. While the earthen ponds predominates in Bangladesh due to the higher water holding capacity of the soil, in Nigeria, the use of earthen ponds is possible in the southern part and along flooded plains and coastal flats.

Inland water resources

Both countries are endowed with vast inland fisheries and aquaculture potentials and contribute significantly to their continents share of fish production and consumption. Bangladesh is ranked as the 5th largest aquaculture producing country and 4th largest producer for inland fisheries with estimated total production of 1 726 066 tons and 957 095 tons in 2012 for aquaculture and inland fisheries respectively (FAO, 2014). Both sectors have recorded remarkable increase in production, 1023991 and 2061057MT, for capture and aquaculture, respectively, (DoF, 2015; FAO, 2016). Inland capture fisheries production per unit area of a country (tons/km²) is an indication of the importance of inland fisheries in a country. Bangladesh (4.7 tons/km²) stand out 1st among the 20 countries in inland capture fisheries production per unit area followed by Cambodia (2.0 tons/km²) and Uganda (0.9 tons/km²) while the remaining 17 range from 0.5 to 0.2 tons/km² (FAO 2003a). The ponds constitute the 2nd in terms of water area (377968ha) but account for the highest aquaculture (43.72%) in Bangladesh. This is followed by the floodplains which constitute the highest amount of inland water area (2692964 ha) with 20.09% capture fish production (DoF, 2015).

Nigeria is another country in which inland catches have been growing very rapidly in recent years: about 100 000 tons were reported in 1997 while over 354466 tons were reported in 2012, ranked 8th, mostly from river Niger and Benue (FAO, 2014; Bartley *et al.*, 2015; FAO, 2016). However, as a result of obnoxious fishing methods such as use of beach seine nets, over fishing and inefficiency of fisheries management policies, the status of the inland waters have deteriorated whereby most of the fishes have suffered depletion and are now in danger of extinction (Chilaka *et al.*, 2014; Jamabo and Hart, 2015). Though the growing aquaculture industry has attempted to fill the gap between demand and supply

as the global appetite for fish continues to increase, its capacity might be enhanced by collaboration and cooperation with countries having better track record in fisheries and aquaculture.

Nigeria is blessed with a vast expanse of inland freshwater and brackish ecosystems and the bulk of which constitutes the rivers, lakes, reservoirs and floodplains (capture) while fish ponds constitute only about 5 500 ha (Ita, 1993). This clearly demonstrates to the low aquaculture production in Nigeria compared to Bangladesh. Nigeria was not listed among the 20 countries with annual production of 200 535 tons despite the immense quantity of freshwater. Some of the constraints leading to low productivity include inadequate supply of input and lack of capital to artisanal fishermen, the changing nature of the seasonal streams/rivers as a result of climate change, and poor management of the rivers by the authorities. Moreover, the promotion of pond based aquaculture was not strengthened scientifically by the government and developers, which has got tremendous attention in Bangladesh as with many other developing countries in Asia.

Due to the declining trend of open water fisheries production, cage culture is being promoted in different parts of Bangladesh. Cage culture was experimented with poor households in 80s and 90s to improve the level of protein rich food consumption however in last decade; it has been commercialized by the large entrepreneurs in rivers in southern Bangladesh (Sarker, 2009). Cage culture enterprises created various segments in its upstream and downstream value-chain in terms of local and international trading of cage materials, seed production and supply chain, feed production and supply networks, drugs and chemical supply and fish marketing which further created huge employment opportunities in the rural and peri-urban areas of Bangladesh (Sarker, 2009). A recent study has supplemented some technical values to cage to produce fish and vegetables in an integrated system which is acronymed as IFCAS (Integrated Fish Cage Aquaponics System) technology (Haque *et al.*, 2015). Nigeria, with relatively less fish ponds, may increase fish production through the utilization of her vast inland water resources for cage culture especially for the vast majority of the rural fisher folks in the north where there is low rainfall and construction cost of concrete tank is very high. In the same vein, for areas in the riverine and southern part, with vast water bodies, most of the inhabitants are relatively poor. There is therefore the need to utilize available waters effectively for food fish production without necessarily exerting more demands on land use for such purposes. Cage fish farming may be encouraged as an alternative livelihoods and income generation avenue which may result in high returns relatively quickly compared to other agricultural investments in Nigeria. In addition to that cage aquaculture enterprises can generate employment opportunities for the people of poor neighboring countries of Nigeria that is evident in Thailand where many migrants from Myanmar working in aquaculture farms (ILO, 2015).

Fisheries Sector

Fisheries play an important role in Bangladesh national economy which account for 4.7% of GDP, 9.1% of the export earnings and 6% of the supply of protein (DoF, 2015). Aquaculture is perceived as an embedded part of fisheries in Bangladesh. The capture fisheries are declining due to various anthropogenic and environmental causes. The fisheries sector as a whole including aquaculture is being promoted by the considerable government and foreign investments to improve fish production, nutrition and income and employment generation of poor and marginal people.

Based on the GDP per capita of the two countries (Table 1), Nigeria appears to be richer than Bangladesh, though their population is slightly different. The Nigerian food basket reflects the diverse culture of more

than 500 different tribes and languages that reside in Nigeria (The Nigerian Foods, 2016). However, as with other developing countries the people of Nigeria are suffering from malnutrition, particularly protein rich foods, with 29% of Nigerian children reported to be underweight (NDHS, 2013). As a source of animal protein, fish and fish products locally provide nearly per capita consumption of 13.9kg of fish per capita per annum as compared to recommended rate of 21kg per capita per year (Belton and Thilsted, 2014); an equivalent of 40% of all animal protein consumed in the country while the contribution of the fisheries sub-sector to national development include such activities as employment generation, income generation and household food security (Sikoki, 2013).

Table 1. Comparison of the Fisheries Sector of Bangladesh and Nigeria

Particulars	Bangladesh	Nigeria	Source
Area (sq.km)	147 570	923 768	
Water area (sq.km)	45 757	286 200	Shimang (2005)
Inland water bodies (reservoirs, lakes, rivers, ponds) (ha)	4708193	19958100	DoF (2015);Ita (1993)
Brackish waters (ha)	3169800	741 509	Rahman and Akhter (2015); Sikoki (2013)
Length of continental coastline (km)	714	853	
Exclusive Economic Zone (sq.km)	166 000	25 900	
Population (million)	158 512 570	178 516 904	Worldometers (2012)
Per capita GDP (US \$ billion)	1 096.6	3 184.6	NBSN (2015)
Agriculture GDP (US \$ billion)	67 467	17 514.10	
Fisheries GDP (US\$ billion)	10 042(4.7%)	210.17(1.2%)	Banglapedia (2009)
Population of fisher people (million)	5.2	2.0	FAO (2013b)
Fish consumption per capita (kg)	18.7.	13.9	Belton and Thilsted (2014))
Fish contribution to total animal protein intake (%)	56.2	43.1	FAO (2010)
Government cash expenditures on agriculture, forestry, fishing and hunting 2009-2011(million US\$)	8.9	0.9	FAO (2013b)
Fishery share of official development assistance (2010) (%)	0.2	0.0	FAO (2013b)
Fish import (tons)	3950	500 000	The Fishsite (2014)

Despite that, the government of Bangladesh is committing more funds to the agricultural sector, including fisheries and aquaculture and more people are engaged in fisheries and aquaculture. Aquaculture production has become more international either through foreign direct investment (directly by setting up aquaculture installations or through the purchase of existing companies) or through subcontracting parts of the aquaculture process to other companies (OECD, 2010). For effective development of aquaculture and fisheries in Nigeria, there is need for more government investment and infrastructural improvement in such areas as power supply to support not only residential but also commercial farming.

Aquaculture systems

In Bangladesh, aquaculture production systems have become mainly semi – intensive and in few cases intensive systems (FRSS, 2015), depending on the level of management inputs, especially in stocking and feeding. Indian major carps, some exotic Carps and catfishes are the main aquaculture species in Bangladesh (Table 2). In Nigeria, with most of the cultured fish produced from commercial farms, the intensive culture system is more common with fertilizers and pellet feeds applied, however, extensive and semi-intensive culture

systems can be practiced within wetland ecosystems which can provide a consistent food supply for both partly marine and mainly for freshwater species (Bolorundoro, 1999; Miller *et al.*, 2006; Dauda, 2014). The major aquaculture species in Nigeria are catfish and tilapia (Table 3).

Table 2. List of Cultured Fish Species in Bangladesh

Common name	Scientific name
Catla	<i>Gibelion catla</i>
Rui	<i>Labeo rohita</i>
Mrigal	<i>Cirrihinus cirrhonus</i>
Kalbaush	<i>Labeo calbasu</i>
Silver carp	<i>Hypophthalmichthys molitrix</i>
Common carp	<i>Cyprinus carpio</i>
Grass carp	<i>Ctenopharyngodon idella</i>
Bighead carp	<i>Aristichthys nobili</i>
Silver barb	<i>Barbodes gonionotus</i>
Thai pangas	<i>Pangasius sutchi</i>
Nile tilapia	<i>Oreochromis niloticus</i>
Ilsha bata	<i>Labeo bata</i>
Kurio labeo	<i>Labeo gonia</i>
Walking catfish	<i>Clarias batrachus</i>
Stinging catfish	<i>Heteropneustes fossilis</i>

Source: FRSS (2014)

Table 3. Commonly cultured fish species in freshwater fish ponds in Nigeria

Common name	Scientific name
Tilapia	<i>Oreochromis niloticus</i>
	<i>Tilapia guinensis</i>
	<i>T. melanopleura</i>
	<i>Sarotherodon galilaeus</i>
Mud catfish	<i>Clarias gariepinus</i>
Spotted catfish	<i>Synodontis filamentosus</i>
Red mud catfish	<i>Heterobranchus bidorsalis</i>
Grey catfish	<i>Chrysichthys nigrodigitatus</i>
Catfish	<i>Citharinus citerus</i>
Nile perch	<i>Lates niloticus</i>
African bony tongue	<i>Heterotis niloticus</i>
Common carp	<i>Cyprinus carpio</i>
African carp	<i>Bagrus bayad</i>
Indian carps	<i>Catla catla</i>
	<i>Labeo rohita</i>
	<i>Cirrhinus mirgala</i>
Moon fish	<i>Labeo coubie</i>
Trunk fish	<i>Gymnarchus niloticus</i>

Source: Ita (1989)

Pond aquaculture

Fish is produced in a variety of production systems in Bangladesh but ponds are by far the most important (Haque *et al.*, 2015), mainly as a result of advanced aquaculture technologies and markets, availability of fish seed, fish feed and other necessary production inputs.

Fish pond aquaculture production in Nigeria is currently very low, estimated at below 10,000 MT/year from a total water surface area of about 5,500 hectares (Miller *et al.*, 2006). Fish production technique adopted varies according to agro-ecological zones. Fish pond system is the commonest technique in the Niger Delta Region of Nigeria. Earthen ponds are preferred in this region (Southern Nigeria) because of cheap source of underground water from inundated swamps and clay soil that retains water. Fish farming is majorly carried out in outdoor or indoor concrete or plastic tanks in other parts of Nigeria. According to Adeogun *et al.* (2014), 58.3% of fish farmers used concrete tanks in rearing fish, 16.5% used earthen (Dug-out) ponds, 23.3% plastic while 2.8% used fibre - glass tanks. Other types of rearing facilities include wooden tanks, collapsible tarpaulin tanks, etc. Production tanks vary in sizes and shapes, however, round tanks between 5000 to 10000 litres are most commonly used (Mirzoyan *et al.*, 2010). One of the constraints to the development of pond aquaculture in Nigeria is the lack of enthusiasm to adopt aquaculture technologies due to poor aquaculture extension services, despite the comparative advantage of earthen ponds over concrete tanks in terms of cost, production and income (Egware and Erewa, 2014). Nigerian investors are mostly interested in quick business for protein supply rather than in developing a technology (Miller *et al.*, 2006). Pond based aquaculture in Bangladesh created double opportunities for fish and horticulture production, which can be replicated with

Nigerian poor where applicable. For instance integration of fish production with grain and vegetable farming will supplement the income from fish farming and by producing grain, vegetables, fruits and fish, the community becomes self-sufficient with regards to food. The dominance of pond aquaculture production in Bangladesh may be attributed to its agro-ecological disposition. Due to the increasing size of population thereby increasing buying and leasing value of land/pond, pond aquaculture would be inaccessible for poor and marginal people in Bangladesh. Therefore, tank based aquaculture being practiced by Nigerian people using plastic, wooden and collapsible tanks may be adopted by the resource poor farmers both in rural and urban areas of Bangladesh.

Cage culture

Cage culture started in Bangladesh since 80s, however, in the last decade it has got commercial entrepreneurial shape particularly in the slow flowing rivers in southern Bangladesh. Cages are used as a form of farming in their own right within flowing or large bodies of water and can also be used in small pond fish culture to protect fingerlings in the initial stages of development (Bot *et al.*, 2011).

Nigeria is not recognized as one of the prominent cage culture practicing countries (FAO, 2007a). Main constraints to the development of competitive cage culture in Nigeria and Africa as a whole include the unavailability of locally produced, high quality extruded feeds at competitive prices using local raw materials. Other constraints include a lack of training in cage culture, a lack of processing and routes to developed markets in some countries, traditionally low prices and quality of wild caught fish in the region, lack of potential investors willing to take a long- term investment risk in Nigeria and lack of expertise in disease identification and management (Blow and Leonard, 2007).

However, considering the availability of vast rivers, lakes and reservoirs, adoption of cage culture, along with partnership of Nigeria with Bangladesh, may serve as panacea for the slow growth of aquaculture in Nigeria. This entails bilateral cooperation between the two governments to facilitate interaction and brainstorming between agencies, aquaculturists and fisheries managers, other academicians and international organizations.

Aquaculture practices

Fish feeding: The growth of commercial aquaculture and commercial feed production in the last ten years in Bangladesh has been extremely increasing. With the intensification and commercialization of aquaculture, commercial pellet feeds have substantially replaced home-made and raw unformulated feeds (Apu, 2014). Most of the fish feed for commercial aquaculture in

Bangladesh is produced within the country using fish and fishery by products (tail, bones, visceral). This makes fish feed easily accessible and somewhat affordable. Low-cost pellet feed production machine was manufactured locally and being used by fish farmers. It also created enterprise and employment for the farmers.

Fish feed technology is one of the least developed sectors in Africa (Gabriel *et al.*, 2007). Fish farmers depend largely on imported fish feed from Europe thereby increasing the total cost of production (AIFP, 2004). Nigeria is blessed with abundant shrimp from the coastal region. Its utilization along with other source for feed manufacture within the country may cushion the cost of feed usually imported into the country. Low cost feed production device technology can be disseminated in Nigeria where applicable, i.e. aquaculture is not simply a technology to produce food fish but to produce multiple value chain segments for employment generation.

Breeding (Seed production)

Aquaculture practices in Bangladesh started with seed collected from rivers, but now it is almost entirely (99.55%) replaced by hatchery-produced seed (FRSS, 2013). The main sources of fish fry in Bangladesh are produced in government and private hatcheries, and some collected from rivers. At present the total number of fish hatcheries are 936 of which government fish farms are 77, other government hatcheries 7 and private fish hatcheries are 852 (DoF, 2013). In the year 2013, the total fry production from hatcheries in Bangladesh was 487453 kg of which 9890 kg was from public hatcheries and 477563 kg was from private hatcheries (Table 4).

Table 4. Production of hatchlings in Government and Private sector hatcheries in Bangladesh in 2013

Source	Number of hatcheries	Percentage	Quantity of hatchling produced (kg)
Government hatcheries	84	8.97	9890
Private hatcheries	852	91.03	477 563
Total	936	100	487 453

Source: FRSS (2013)

The seed industry in Nigeria may be classified for convenience into small-scale, medium and large scale producers. The small-scale producers are those who produce more than 20 000 fingerlings during a production season; medium-scale producers usually produce and sell more than 20 000 fingerlings during a production season. They account for 60% of all the fish seed supply in the country, numbering 200, situated in the south-south and south-west zone; large-scale producers: they produce and supply to the market in excess of 100 000 seeds every season and though few in number (about 30), cumulatively supply about 20% of

all the fingerlings available in the market (Atanda, 2007).

More than 80% of cultured fish in Nigeria is catfish, mainly *Clarias* spp, *Heterobranchus* spp and their hybrids followed by the tilapias (Table 4). Unfortunately, however, the required quantity and quality of fish seed have never been available. Total production and supply from all these sources amounts to 55 million fingerlings (Table 5), which is far less than the requirement of about 500 million per annum to satisfy the immediate market need (Atanda, 2007).

Table 5. Freshwater Fish Seed Supply in Nigeria

Source	Percentage	Seed production (million)
Private sector (ponds, hatcheries)	80	44
Public sector (government fish farms, hatcheries, universities, research institutions)	10	5.5
Wild collection	9	4.55
Importation and other sources	1	0.55
Total	100	54.60

Source: Atanda (2007)

Progress made in increased aquaculture production in Bangladesh over the last decade, may not be unconnected to the tremendous success achieved in hatchery production of several fish species such as *Labeo rohita*, *Gibelion catla*, *Cirrhinus cirrhus*, *Clarias batrachus*, *Ompak pabda*, etc. There exist over 230 indigenous fish species recorded in Nigerian inland waterbodies (Ita, 1993) which resulting indiscriminate fishing and lack of management strategies, are gradually becoming endangered such as *Protopterus annectens*, *Heterotis niloticus*, *Oreochromis niloticus*, etc. Seed production of these culturable endemic species may enhance the aquaculture production in Nigeria. The government could also facilitate the conservation of these valuable species through technological development by research and general management.

Shrimp farming

The shrimp production unit in Bangladesh is locally called “gher” farming, which is combined form of aquaculture and agriculture. This industry diversified the shrimp value-chain with various upstream and downstream segments having very high economic importance of domestic and international seafood trade (DoF, 2015).

Nigeria is a maritime state with a coastline of approximately 853 km. Use of beach seines drastically reduces the shrimp abundance because the net lands everything that is swept by the ground rope. This hampers recruitment, thus, shrimp farming is a robust option to improve production as shrimp is the most

important agricultural export of Nigeria worth US\$ 49 million (FAO, 2007b).

Basic legislation and institutional setup

In Bangladesh, the basic act regulating inland fisheries is the Protection and Conservation of Fish Rules (1983) and the Marine Fisheries Rules (1983). Other legislations include the Tanks Improvement Act (1939), the Shrimp Culture Users Tax Ordinance (1992) and Bangladesh Fisheries Development Cooperation Act (1973). Nigeria has no specific legislation on aquaculture at national level, nor is this activity mentioned in the decree and regulation of marine sector. However, the Inland Fisheries Decree (1992) empowered the Minister in charge of fisheries matters to determine whether the set up of enclosures such as pens and cages, should be subject to a license fee (FAO, 2005-2015). However, while Bangladesh have developed a highly pluralistic fisheries and aquaculture extension service system as they include a host of organizations and international entities up to the grassroot level carrying out diverse projects along with international Non-Governmental Organizations (NGOs) and farmer associations (GFRAS, 2016), in Nigeria, the real field extension work is carried by Fisheries Superintendents and Fisheries Assistants with limited contact with the fishermen. Their work is limited to obtaining catch statistics of the fishers but not for aquaculture extension (FAO, 1993).

The institutional setup of both countries is quite similar, but the diversity of extension services with particular focus on aquaculture extension has to be improved. In this regard, a closer collaboration between the countries for sharing and learning various aspects of fisheries and aquaculture may be built through the supports of donor agencies.

Fish import and export

Experts said Bangladesh is almost self-reliant in fish production and consumption as it now produces 3.2 million tons annually against its annual demand of 3.5 million tons (Dhaka Tribune, 2013). The per capita demand and supply gap of fish in Bangladesh is very poor. While demand was estimated as 37.92 million MT per year, the fish supply was 34.10 million MT (DoF, 2015).

Nwafili and Tianxiang (2007) reported that out of the estimated 120 million people in Nigeria in 2000, about 1% of them engage in fishing and over 24 million depend on fisheries for their livelihoods yet Nigeria imports over 600 000 tons of fish annually.

Despite the tremendous progress made in aquaculture development in Bangladesh, more than 40% of fish supply comes from capture fisheries. Nigeria may drastically reduce fish import by producing more fish internally through proper fisheries management and

adoption of improved cage culture techniques. Bangladesh and Nigeria have expressed mutual interest to expand the bilateral trade and investment. The existing bilateral relation between the two countries could facilitate smooth transfer of technological advancement between the two countries. Nigeria has urged Bangladeshi businessmen to invest in Agriculture, food processing, pharmaceuticals, Information and Communication Technology (ICT) and the educational sector (FE, 2012). Transferring aquaculture technology from Bangladesh to Nigeria might open-up other avenues for investment between the two countries such as in the booming garment industry (Bangladesh) and the ailing textile industry in Nigeria.

Fisheries and aquaculture has emerged as the second largest export industry of Bangladesh (Ghose, 2014). Of the total fish production of the country, approximately 97% is marketed internally for domestic consumption while the remaining 3% is exported (EPB, 2013). The shrimp industry in Bangladesh accounts for 66.5% of annual fish exports in terms of volume and 84.6% in value in 2010 (BBS, 2010). Shrimp exports reached a peak of 53361MT in 2006 but recent figures in 2010 showed shrimp exports totaling 51599MT (BBS, 2010). Nigeria exported USD 83,824 of fishery commodities in 2011 but increased to USD 323,881 in 2012. With a production capacity of 12,000MT annually, Nigeria's shrimps are at present entirely wild caught from the Niger Delta. The production of young prawn species under controlled condition was attempted in Nigeria without success. As with Bangladesh, Nigeria has the potential of promoting shrimp farming by establishing shrimp hatcheries and farms taking the initiatives of research and development that might further increase the volume of shrimp export. Smoked fish of *Clarias*, *Oreochromis* spp and *Heterotis* spp., largely from Calabar and Lake Chad, are exported to the United Kingdom by airfreight (FAO, 2003b). Nigeria currently exports approximately 5 MT of smoked fish per month. In Bangladesh smoked fish is recent addition to the fishery products (Latifa et al., 2014), however, Bangladesh could diversify her sources of foreign currency by giving more emphasis on smoked fish processing and export.

Aquaculture and social development

Considering the fact that gender norms and relations constitute the most important socio-cultural constraints on individual's ability to pursue aquaculture efficiently (AFSPAN, 2014), Bangladesh government, Non-Governmental Organisations (NGOs) and donor agencies took aquaculture as an important driver for gender and social development. Agencies like International Fund for Agricultural Development (IFAD), United Nations Development Programme (UNDP), Islamic Development Bank (IDB), are working to improve women's status by including them in the projects main activity of pond aquaculture and by

supporting them in other income-generating activities (Boto *et al.*, 2013).

In Nigeria, with the exception of catfish, aquaculture has been slow to develop because of low social acceptance despite huge unmet demand for fish because of inappropriate technology, limited value chain development and a focus on household nutrition rather than income generation (AFSPAN, 2014). Although women are actively involved in various sectors of agriculture and fisheries, government has not shown sufficient concern to improve their contribution. However, IFAD, Economic Community of West African States (ECOWAS) Fund and UNDP together assist with gender sensitive components in projects for aquaculture and fisheries development. Such kind of bilateral programme between Asia and Africa needs to be initiated to exchange and share of learning between the regions for broader social development centering aquaculture.

Conclusion

The transferability of technological knowledge in the field of fisheries and aquaculture between Bangladesh and Nigeria is an important issue of research and development. Unlike Nigeria where laterite soils predominate, presence of alluvial soils across Bangladesh permits diverse use of ponds for aquaculture. However, due the high population density, other non-conventional aquaculture systems – plastic, wooden and collapsible tanks might be ideal for the land-locked and resource poor Bangladesh farmers. Emphasis on smoked fish processing and export could also diversify the country's foreign revenue. Availability of vast rivers and lakes in Nigeria suggest the adoption of cage culture for increased fish production. Nigeria needs to broaden her fisheries and aquaculture system and encourage international participation at the grassroots level. The political will of the two governments is critical for a fruitful and sustainable knowledge transfer. Nigerian government need to invest more towards aquaculture development. Partnership in the aspect of personnel, training and inter-agency cooperation between Bangladesh and Nigeria is necessary for sharing of research experiences. Most significantly, the substantial progress made in Bangladesh in the hatchery production of some indigenous fish species, if similar trend is followed in Nigeria, diversifying the number of fish cultured through domestication, breeding and culture of wild species, may greatly boost fish production and reduce imports. Though proper adoption of new aquaculture technologies – feed, seed, etc, may require increased capital outlay by the Nigerian government, this might be the ideal option for such a mono economic country seeking for diversification. Incorporation of social, cultural and economic development aspects of fishermen need to be adequately considered in future fisheries development plans in Nigeria.

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Conflict of interest

The authors wish to declare that there is no conflict of interest with any person or organization.

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