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A Strategy on Increase Production and Marketing of Mola and Other Small Indigenous Species of Fish (SIS) in Bangladesh

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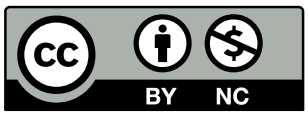

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Some parts of the study which highlighted the activities and projects of relevant stakeholders are excerpts from the website or communications materials of those respective companies. It was not possible to verify all information the companies claim to have done or can do.

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Abstract

Small indigenous species (SIS) of fish occupied large numbers in the fish diversity of Bangladesh and which about more than 150 species. To overcome the undernutrition in Bangladesh, SIS are considered the most important source of macro and micronutrients. Considering the importance of SIS, current strategies of small fish production were reviewed and developed strategies for increasing small fish production and marketing in Bangladesh under the project 'Aquaculture: increasing income, diversifying diets, and empowering women in Bangladesh and Nigeria' in 2020. Among the small fishes in Bangladesh, mola, extremely rich in micronutrients could be play a vital role in the aquaculture. Various research finding showed the effectiveness of mola culture technology along with carp polyculture. The production technology of mola and other SIS have promoted in many projects of WorldFish (e.g. IFAD funded Small Fish and Nutrition Project, CSISA-BD project, AIN project, CBRMP-LGED project, ANEP, Odisha-WorldFish Project and Assam APART Project in India) and found greater success in mola production. Based on the research findings and experience of different project of WorldFish, the followings are the key strategies for the promotion of SIS particularly mola (i) production and supply of broodstock of mola and other SIS, (ii) incorporate mola broodfish in the fish seed supply chain, (iii) mola nursery, based on hatchery-produced spawn, (iv) farming of mola with carp polyculture. Under this project, mola and other SIS scaling strategies are (i) awareness meeting, workshop and seminar on importance of culture on mola-SIS with carps and identify LSPs, (ii) organize ToT program, (iii) develop communication products, (iv) establish source of mola broodstock, (v) mola in the project models on polyculture in ponds (vi) criteria of farmer selection, (vii) involvement of LSPs, (viii) embedded service by LSPs, (ix) mola processing and cooking demonstration and (x) setup research trials to incorporate mola broodfish in fish seed supply chain and to establish commercially viable induced breeding and nursing technology in hatchery.

I. Introduction

1.1. Background

In the natural resources (*beels*, floodplains, open water ponds, ditches, rivers, canals and rice fields) there were presence of diversity of small indigenous species fish along with other fish. With abundance of small indigenous species of fish (SIS) in natural resources most of the households in rural areas in earlier days consume fish regularly (Roos, 2001) which made up to 50-80% of total fish consumed by households (Hels, 2002; Roos *et al*., 2003; Islam, 2007).

Although, the availability of fish in natural waterbodies reduced significantly large number of people especially the poor in wet months depend on inundated rice fields, *beels*/floodplains, canals and other water resources on harvesting of natural fish to use for household consumption.

During the monsoon season in Bangladesh, water are available in inundated rice fields for 3-4 months (July-October). Rural people/farmers harvest the fish from the rice fields during that period. Those do not have any pond; they also get the opportunity to harvest fish from the inundated rice fields. Different types of fishing gears are used like fish trap, gill net, cast net, lift net, pull net (Figure-1). No specific species-wise production data are available from the floodplain or inundated rice fields. However, most the catches are small indigenous fish species (SIS) and the most common SIS harvested from the rice fields are punti (*Puntius spp*), darkina (*Esomus danricus*), mola (*Amblypharyngodon mola*), chanda (*Chanda nama*, *Parambassis ranga*), koi (*Anabas testudineus*), kholisha (*Colisa spp*), taki (*Channa Punctata*), cheng (*Channa gachua*), tengra (*Mystus tengara*), gochi (*Macrognathus pancalus*), poya/gutum (*Lepidocephalichthys spp*), bele (*Glossogobius giuris*), small chingri (*Macrobrachium spp*), shing (*Heteropneustes fossilis*) and magur (*Clarias batrachus*).

Many people partly or fully maintain their livelihoods through harvesting and selling of fish most importantly the SIS by harvesting from the natural resources.

Figure-1: Different gears used for fishing in inundated rice field and an woman catching fish using gill net in rice field.

Case Study: Mr. Abu Siddique is residing with five family members at Rasulpur, Harirampur, Parbatipur, Dinajpur and living his livelihood by caretaking road side forestry and own agriculture. He harvests fish from inundated rice field for 2-3 months during monsoon season (Jul-Sep) in every year. About 15-20 days per month, he harvests fish from rice field and harvested amount is average 500g of fish per day (**Figure-2**). Most interesting things is that all the harvested fish are small indigenous fish species (SIS). They are using the harvested fish only for their household consumption. They used the gill net and fish trap (*Darki*) for catching the fish and they set the fishing gear at night and catch the fish at morning. About 20-30 kg SIS are harvested each year and the market price of the fish is 120-150 BDT/kg. The harvested fish species are:

Sl.	Local Name	Scientific Name	Gill Net	Fish Trap
1.	Kholisha	*Colisa fasciata*	✓	✓
2.	Gochi	*Macrognathus pancalus*	✓	✓
3.	Poya	*Lepidocephalichthys spp.*	✓	✓
4.	Punti	*Puntius spp.*	✓	✓
5.	Shing	*Heteropneustes fossilis*	✓	
6.	Taki	*Channa Punctata*	✓	✓
7.	Cheng	*Channa gachua*	✓	✓
8.	Bele	*Glossogobius giuris*	✓	
9.	Darking	*Esomus danricus*		✓
10.	Small Chingri	*Macrobrachium spp.*		✓

Figure-2: Fishes of one day catch from rice field and the fisherman with his gill nets using for catching fish from rice field.

Bangladesh has a very diverse small indigenous species of fish and more than 150 species are generally found (Annex-1). The greater availability of small indigenous species of fish in inundated rice fields, *beels*/floodplains are due to reason that these resources are used as suitable breeding and nursing ground for many of the SIS, due to greater availability of natural food, space and favorable environment. The SIS in most cases are self-recruiting species (SRS[1]), the fish breed in a confined and even in shallow waterbodies especially during the wet months when it rains; which is an advantage for the rapid spreading of SIS in natural waterbodies immediately after the rains started. It is useful get production from pond based system after its initial introduction provided necessary amount of broodstock of the SIS is conserved in ponds useful to get the production through breeding and self-recruitment.

1.2. Nutrient composition of important fish species in Bangladesh

Inland capture – 30 samples of small indigenous species of fish, 7 samples of large species fish. Inland aquaculture – 3 indigenous species of major carps, 8 samples of exotic species of fish. Marine capture - 8 samples of marine fish. Highlighted the presence of vitamins and micronutrients contents and proximate composition of mola, darkina, dhela (high content) in comparison to other SIS and major carps. In general, fish are one of the important sources of animal protein cover almost 60% of animal protein for people in Bangladesh. In Bangladesh, fish contribute 60% of animal protein, in addition to fat, minerals and vitamins useful for healthy diets.

[1] **Self-recruiting species (SRS)**: The aquatic animals that do not require repeated stocking in farmer managed aquatic systems and can be of indigenous or exotic origin.

The results of the analysis of the nutrient compositions of different species of fish collected from inland open waters, inland culture, coastal and marine sources by Bogard *et al*. 2015; brought lot of valuable insights: (a) There are diversity in nutrient content of fish species, the nutrient composition of small indigenous species is rich, should guide policy and programmes to improve food and nutrition security in Bangladesh (b) Among the small indigenous species of fish some of those are very rich with major micronutrients (iron, calcium, zinc, iodine, magnesium, potassium and vitamin A). Small indigenous species of fish rich with minerals and vitamins are; mola, darkina, dhela, chapila, bele, kholisa, chanda, ekthute, jat punti, gutum.

SIS have been considered as important source of essential macro and micro-nutrients, which can play the vital role to eradication of malnutrition in Bangladesh. Most of the small fish species are rich in micronutrients than large fish species (Table-2). Small fishes are eaten whole with bones, head and eyes are rich in micronutrients.

Shakuntala *et al*. (2014), mentioned the carp-mola polyculture in household ponds is an entry point and building on the framework and guiding principles of nutrition-sensitive agriculture, which will not only increase the small fish production but also enhance the consumption of micro-nutrient rich small fish by the household members especially in the first 1000 days of life, behavior change communication for improving knowledge and practices of essential nutrition. Preliminary results from a three years' project of WorldFish with 1,500 households in north-west Bangladesh showed promising results with respect to fish production and productivity, as well as mola consumption in women and young children.

One of the small fish, mola (*Amblypharyngodon mola*), which is extremely rich in micronutrients, can contribute half of the vitamin A and a quarter of the iron intake recommended for a family of four annually (Castein *et al*., 2017). Considering their nutritional importance (Table-1), more emphasis should be given to increase production of small fish along with large fish from different production system.

Table-1: The micronutrient content of fish and other foods (per 100 g, raw, edible parts[2]) (Roos, 2001; USDA, 2005)

Category	Name	Calcium	Iron	Zinc	Vitamin A
	Units	mg	mg	mg	RAE[3]
Small indigenous fish	Mola (*Amblypharyngodon mola*)	776	5.7	3.2	>2680
	Dhela (*Ostreobrama cotio cotio*)	1300	-[4]	-	937
	Chanda (*Chanda baculis)*	379	0.8	1.8	>1500
	Darkina (*Esomus danricus*)	775	12	4	890
	Chapila (*Gudusia chapra*)	786	7.6	2.1	<100
	Tengra (*Mystus vittatus*)	481	4	3.1	-
	Puti (*Puntius sophore*)	698	2.2	2.9	<100
	Tit Puti (*Puntius ticto*)	992	3	3.1	500-1500
Large fish	Hilsa (*Tenualosa ilisha*)	0	-	-	69
	Mrigal (*Cirrhinus mrigala*)	0	2.5	1.5	<100
	Rui (*Labeo rohita*)	317	-	-	27
	Silver carp (*Hypophthalmichthys molitrix*)	4	4.4	1.4	<100
	Tilapia (*Oreochromis niloticus*)	10	0.56	0.33	0
Other animal source food	Chicken egg	171	3.23	1.11	140
	Chicken liver	8	8.99	2.67	3292
	Cow milk	119	0.05	0.37	33
Plant source food	Carrot	33	0.3	0.24	835
	Spinach	99	2.71	0.53	469
	Rice	10	1.2	0.49	0

[2] Edible parts = Not included gut content, scale and incase of large fish gill cover and fins
[3]RAE = Retinol Activity Equivalent
[4] Not measured

1.3. Problems for lowering production of SIS

Over the year's production of fish from natural resources were significantly reduced. Due to pressure of increased population, indiscriminate fishing from open waters, unplanned construction of roads and flood protection embankments caused destruction of breeding and nursery grounds of fish and other aquatic animals. The other factors related to reduction in production and supply of SIS and other fish from natural resources are; (a) removal of the fish from ponds under fish culture by complete drying or poisoning due to major emphasis on promotion of intensive aquaculture production (b) use of surface water from natural resources for irrigation of crops causing drying up of natural resources resulting damages of natural fish (c) siltation of natural waterbodies due to deforestation of upland areas and deposition of silt in canals and waterways in low land areas (d) alteration of waterbodies into cropland by changing the physical features (e) killing of fish using excessive pesticides into agricultural land and (f) water pollution due to agricultural or industrial source. Lack of awareness on nutritional values of SIS, lack of knowledge about the biology, limited availability of seed, land and water use conflicts, use of agro-chemical crop fields, weakness in the implementation of fish acts, lack of alternative income generation for the fishers, lack of awareness and uncertainty of climate changes are the major challenges for the sustainable production of SIS in Bangladesh (Wahab, 2014). These gradual decline of fish from natural resources and increase in demand of fish due to increase in population over the years has prompted aquaculture development to get higher fish production in the country. Much emphasis was given for production of large size fish at the cost of SIS or other species of fish available in the natural resources.

1.4. Changes in production of SIS over the years in Bangladesh

The timeline developed based on the assumptions about the changes in production of SIS from different types of waterbodies in Bangladesh. It showed very high production of SIS and other natural fish in open waters with rapid decrease in production especially from river, canal and *beel* or floodplains as well as from culture system (**Table-2**).

Table-2: Timeline on availability and potential of small indigenous fish species in different resources of Bangladesh

Time line	Pond[5]	Inundated rice field [6]	River	Canal[7]	*Beel*[8]/Flood plain[9]
1951-1960	++	++++	+++	+++	++++
1961-1970	++	++++	+++	+++	++++
19071-1980	++	++++	++	++	++++
1981-1990	+	+++	++	++	+++
1991-2000	+	++	+	+	++
2001-2010	+	++	+	+	+
2011-2020	++	++	+	+	++
Potential for promotion	**+++**	**+++**	**+**	**+**	**+++**

++++ very high, +++ high, ++ medium and + less availability

It showed that due to implementation of activities on culture of SIS in ponds fish production of both SIS and others species use for culture increasing. Similarly, due to application of enhanced fisheries management and conservation measures the production and diversity of SIS and other species of fish is increasing. There is high potential to increase production of SIS in pond, ricefields and *beels* and floodplains provided necessary measures need to be undertaken in use of effective technologies on culture of SIS with other species in ponds, in ricefields and use of enhanced stocking, conservation and regulatory measures in production of SIS with other indigenous fish in *beels* and floodplains.

[5] **Ponds:** Purposefully dug out pits for fish aggregation, aquaculture and/or for other purposes.
[6] **Inundated rice field:** Rice fields that are flooded in the monsoon seasons.
[7] **Canals:** Narrower water channels connecting rivers and floodplains, and act as both feeding and draining channels of floodplains.
[8] ***Beels*:** Saucer shaped perennial water bodies in between the river leaves and constitute a major fish production habitat in the country.
[9] **Floodplains*:*** Flat lands that are alternately exposed and inundated depending on the monsoon wet and dry seasons.

1.5. Success in production of mola and other SIS in ponds and in wetlands

Under the IFAD funded Small Fish and Nutrition Project, production of small fish was found as 722 kg/ha/year in Rangpur District and 967 kg/ha/year in Dinajpur District, whereas mola production was 476 kg/ha (Rangpur) and 671 kg/ha/year (Dinajpur) and the total fish production was 2808 kg/ha/year in Rangpur and 2974 kg/ha/year in Dinajpur (Barman *et al*., 2013). Results obtained under small fish and nutrition project, the CSISA-BD, AIN project, the projects of other organizations (NGOs), the papers (nutrition journal – reflecting the outcomes of small fish and nutrition project, the CSISA-BD and AIN project) culture in pond based system.

There are more examples about production of mola in ponds (open and closed) in production of mola and SIS in the Dhalua *Beel*. In Dhalua *Beel* about 60% (28 species) are SIS. Dhulia *beel* in Nilphamri was found to be highly productive area for mola (800-1000 kg/ha) (Saha, 2019).

In addition, under the small fish and nutrition project there are successful evidences about increased in fish production from open waters. Soma Nadi Jalmahal production in open water using enhanced stocking of mola and darkina in ditches, the use of conservation and regulatory measures by the CBOs useful to increase productivity and biodiversity in fish production. Measures undertaken in production of mola in backyard ponds, community tanks and in small irrigation reservoirs. The update results of the initiatives and plan to take potential measures to increase the production.

The national statistics on fish production data are deficient. In a statistics of DoF, 2005, about 67% inland fish production comes from small indigenous fish species in the country, whereas, only 22% were major carp. In recent years, through induced breeding great success have been achieved in making availability fry/fingerlings some SIS making enormous contribution in aquaculture production (e.g. *Clarias batrachus*, *Heteropneustes fossilis*, *Anabas testudineus*, *Mystus cavasius, Mystus vittatus, Ompok pabda, Notopterus notopterus, Labeo bata*).

However, there are lot of SIS important for which the breeding technology for mass seed production not yet developed such as Mola (*Amblypharyngodon mola*), Dhela (*Osteobrama cotio*), Darkina (*Esomus danricus*), Chela (*Salmostoma bacaila*), Punti (*Puntius sophore*), small Chingri (*Macrobrachium spp.*), Gochi (*Macrognathus pancalus*), Khalisa (*Colisa fasciata*), Batashi (*Pseudeutropius atherinoides*), Kajali (*Ailia coila*).

1.6. Advantages of mola in fish production

Mola is very rich in micronutrients and highly potential for polyculture with carp. It is compatible for production in all type of ponds, inundated waterbodies, rice field connected ponds, *beels*. It breeds in ponds and other waterbodies, it is highly fecund fish species (1,000- 20,000), breed several times per year and matured at three months of age. It is not required further stocking if once stocked and conserved it properly. Mola enhances other SIS production as waterbody managed by BMP of mola has the favorable environment for other SIS. The possible for regular/frequent harvesting for consumption and sale. Household consumption is possible at any time during the culture period, while in carp culture the harvest is generally done at the end of culture.

Farmers could able to receive regular cash return through partial harvesting, there is high market demand and comparatively higher market price of mola. It is highly profitable with carp polyculture system (contribution of mola in total production about 20% and economic 30%). It is also poor friendly fish, because small amount of fish can be purchased by the poor in case of high price of fish because of small in nature.

II. Research findings on Production of SIS

2.1. Culture of SIS in pond aquaculture

In Bangladesh, several research trials were conducted for increasing the small fish production due to gradually scarcity of SIS and its nutritional benefits and that was started in 1980s (Roos *et. al*., 2007b, Thilsted *et al*., 2014). To develop the production technology of SIS, mola (*Amblypharyngodon mola*) was predominant species used in the research trials for its extreme value of vitamin A to combat the high prevalence of vitamin A deficiency in Bangladesh; however, some other SIS were also used such as dhela (*Osteobrama cotio cotio*), chapila (*Gudusia chapra*), chela (*Chela cachius*), puti (*Puntius sophore*), darkina (*Esomus danricus*), etc. (Castein *et al*., 2017). Compare to mola, chela is less productive (Roy *et al*., 2002). WorldFish Bangladesh implemented three major projects found that one of the small fish, mola (*Amblypharyngodon mola*) contributed significantly to the micronutrients produced from all fish in the homestead ponds. While the mola production was 15% of the total production; however, it contributed 98%, 56% and 35% of the total vitamin A, iron and zinc produced, respectively (Castein *et al*., 2017). Now a days, some of small fishes such as bata (*Labeo bata*), magur (*Clarias batrachus*), shing (*Heteropneustes fossilis*), pabda (*Ompok bimaculatus*), gulsha (*Mystus cavasius*), tengra (*Mystus tengara*) cultured as major species or commercially in allover Bangladesh; however, those are not so rich with micronutrients like mola, dhela and according to recent classification (Hossain *et al*., 2012), most of them are medium fish, not small fish.

Stocking and conservation of mola, removing of predatory fish, feeding with finely minced feed, fertilization, no or selective netting during peak spawning season and partial harvesting of mola are the special management practices in mola farming (Saha, 2019). Mola showed various favorable characteristics for suitability of culture like; a prolonged breeding season during March to December, high fecundity (relative fecundity about 2000/g), partial breeding nature.

Induced breeding in research trial was found to be successful for mola and it showed rapid embryonic and larval development and very fast growth, which might be the great potential for initiating its commercial culture in near future as well.

Inclusion of mola does not show any competition with carp (Kadir *et al*., 2006; Kunda *et al*., 2009; Kunda *et al*., 2010; Wahab *et al*., 2011; Karn *et al*., 2018), potential to increase total pond productivity in many cases (Castein *et al*., 2017). The introduction of mola in the polycultures has no negative effect over the other carp species production. Introduction of mola with the combination of *Hypophthalmichthys molitrix, Aristichthys nobilis, Labeo rohita* and *Cirrhinus mrigala* showed positive effects (Karn *et al*., 2018). Inclusion of mola provides better production and the suitable combination of carps with mola is suggested as silver carp, bighead carp, rohu and mrigal. The competition for food does not occur between silver carp and mola and that might be sharing into different feeding niche. Though the feeding habit of silver carp and mola are similar, both are herbivores, there is no effect of silver carp production due to inclusion of mola (Roy 2004; Kadir *et al*., 2007; Kunda *et al*., 2009). However, mola production can be increased up to three times through reducing the silver in the carp-mola polyculture system (Kadir *et al*., 2006; Kunda *et al*., 2009). Mola production was higher in ponds where mola stocked with large fish after poisoned the ponds with rotenone compared to non-poisonous ponds (Roos *et al*., 2002b). Inclusion of mola and other SIS in polyculture systems is an important strategy to increase the quantity and diversity of SIS consumption (Ahmmed *et al*., 2008). The consumption of SIS is much higher in that geographical areas closed to inland capture fisheries, where there is a scope of access the SIS in polyculture; where people consumed 48.5 - 50.4 g per capita per d of SIS compared to 5.9 - 7.1 g per capita per d, in other areas. Higher mola productivity can be frequent through harvesting (bi-weekly) mola to sustain a healthy brood stock and over-population (Rajts *et al*., 1997; Roos *et al*., 2007b).

2.2. Culture of SIS in rice field based system

Mondal *et al*. (2018) studied effect of small fish mola and darkina in carp polyculture concurrently with rice field connected ditches/ponds in northwest Bangladesh and found as 37- 38% of total production through stocking of small fish at 150 g/decimal ditch area basis. Ponds adjacent to the *beels*, seasonally flooded low lying areas, *haors* and canals are the most suitable habitat for mola (Saha 2019). Mass mola production including other small fish are continued in a pocket area namely, Dhulia *beel* in northwest Bangladesh (Nilphamari District). More than 15 MT of mola are produced

every year in the Dhulia *beel*. Two different systems of small fish production are there in Dhulia *beel* (i) closed waterbodies: *gher* like ponds and (ii) open ditches inside *beel*, where mola are produced simultaneously with all other fish species. Rice and fish are cultured in closed water bodies followed by alternative method. Stocking and conservation of mola including small fish, management and creating favorable environment for small fish are the key factors for mass mola production.

2.3. Small fish production in open waterbodies

Small fish production in open waterbodies like *haor* can easily be enhanced through small fish stock enhancement and some regulation management by the community people (Barman *et al*., 2013). Small fish mola stocked in *haor* which increased the production of mola from un-noticed to 5th positon in within one year and 2nd position in 2nd year among the total harvest. The Community Based Resource Management Project (CBRMP-LGED) with the support of WorldFish promoted the innovative new technology to enhance the productivity and bio- diversity in *haor*. Mola (343 kg) was introduced in 14 waterbodies in *haor* basis before flooding along with some fisheries management practices in the *haor* and after two years, the partial harvesting showed 4036 kg mola production (Mohsin and Khan, 2014). Stocking of mola not only enhanced productivity in the *haor* area but also provided knowledge on the micro-nutrient requirements for the family members specially the pregnant women, lactating mother and minor children (first 1000 days) through coordination and awareness meetings.

Over the years, floodplains and *beels* (natural depressions) (occupied 72% of inland open water in Bangladesh) were adapted for fish culture using different approaches; making them closed water bodies by putting in permanent structures or by using devices/fences in the inlets and outlets (Benoy and Golder, 2014). However, the use of open waters for aquaculture has some negative impacts on production of natural fish of which a large proportion are small fish (including many micronutrient-rich fish) and aquatic biodiversity, though it is increasing fish production (mostly carps) and earnings. To overcome these negative impacts and to increase use of open waters (especially *beels*, seasonal floodplains), stocking of micronutrient-rich small fish ‘mola’ and ‘darkina’ and others small fish brood and their conservation and regulation measures through creation of sanctuaries, habitats could be the most effective way.

III. Promotion of carp-mola polyculture

3.1. Promotion of carp-mola polyculture in Bangladesh

WorldFish Bangladesh and South Asia conducted an IFAD funded project “Small fish and nutrition” (Barman *et al*., 2013). In the project area (two districts of northwest Bangladesh), carp-SIS polyculture was promoted among 1500 households (HH). Mola broodfish was supplied to HHs as 100g/decimal for stocking into their ponds with carp polyculture. it was found that the mola production 671 kg/ha and its contribution to total fish production increased from almost 0% to 21% by 2 years and at the same time, the economic contribution was 31% to the total income from fish production. Several farmer-friendly techniques were innovated and fine-tuned such as mola transportation, techniques of handling, hardening and separation of mola (Saha *et al*., 2014). For stocking the mola broodfish in the homestead ponds, high survival during transportation was found with conditioned fish properly. Hardening before transportation, separation of mola from large fish using grading net and soft handling of mola broodfish during collection and transportation are the key measures to successful of mola broodfish transportation for stocking into culture pond.

WorldFish through Agriculture and Nutrition Extension Project (ANEP) promoted carp-mola polyculture in Bangladesh and Nepal. In Barisal District, southern part of Bangladesh, the mola broodfish was stocked in every selected demo and non-demo ponds through the support of local fish seed traders after establishment of mola brood pond in the community level (Ali *et al*., 2016). The mola stocking density was 988 to 15200/ha (mean: 6354/ha). The mean productivity of mola 0.05 to 0.68 t/ha/y (mean: 0.26 t/ha) and 20 kg/household and the consumption of mola was 55% by the farm households. The mola production varies between areas due to water availability in ponds and careful stocking techniques. Mola production can be successful without close monitoring as they found no significant difference in mola production between demo and non-demo farms. There is good potential to increase production of mola in polyculture with carps in Bangladesh by applying greater quantities of specific inputs. Because, results from the Cobb-Douglas (C-D) production function imply that input variables (viz., stocking, seed weight, feeding, organic and inorganic fertilization, MOC

fertilization, labor, pond depth, water retention month and pond age) increased by 1%, mola production would increase by 1.22%. Access to brood mola for stocking into pond is the main pre-requisite for the promotion of mola production system, which requires developing economically viable systems to sustainable supply mola broodfish at the farmer level.

A three years project of WorldFish, in north-west Bangladesh showed promising result on mola production in the homesteads ponds; where engagement of local women as lead farmers and field staff and focusing on strong motivation, supervision and follow-up of staff were the key factors (Shakuntala *et al*., 2014).

WorldFish Bangladesh and South Asia promoted carp-mola polyculture through another two projects in Bangladesh namely, Aquaculture for Income and Nutrition (AIN) project and Cereal Systems Initiative for South Asia (CSISA) project. AIN project was more focused on dissemination of the carp-SIS technology in homestead ponds, predominantly to women farmers (Keus *et al*., 2017). The project distributed 4700 kg of mola to 9,100 household for stocking with other fish in household ponds during 2012 and 2015. The farmers shared their produced mola broodfish (5600 kg) to the fellow farmers (37,500 farmers). Training with practical session was provided to all farmers to increase fish production and improve the nutrition. As a result, all farmers significantly increased their homestead pond production and learned not to remove the heads of mola and its other nutritional benefits. CSISA project conducted adaptive research trial on carp-mola polyculture with limited numbers of farmers, where farmers received 30-40% input costs from the project (Castein *et al*., 2017). About 150 g mola brood stock per decimal along with the training support for the farmers. As a result, farmers got 12.3 kg mola per households and which was much higher than AIN project farmers production (6.7 kg mola per households).

3.2. Carp-mola-SIS-Production in Odisha in India

Based on the success on production of mola in Bangladesh the program has been included for promotion in small homestead ponds, community tanks and minor irrigation reservoirs under the WorldFish and F&ARD in Odisha. For this at the beginning ToT was provided to the DoF staff provided, awareness building works on importance of mola has been highlighted. Mola broodstock were stocked in the backyard ponds of several farmers in selected districts and the farmers started to get the production of mola from their ponds to use for household consumption. At least 3 mirror irrigation reservoir were included under the program on stocking of mola to get higher production. However, due to rapid changes in the preferences to promote fish culture in the community tanks with WSHG (the decision of the Secretary) by the project rather than the small homestead ponds and difficulties in collection and purchase of mola the program on carp-mola-SIS has been reduced in terms of importance. The program on promotion of mola however, confined only with self-recruitments and as subsistence based production system. However, in recent years the culture of fish in small ponds have been emphasizing and the issue of use the homestead ponds as important sources of fish for regular household consumption is growing. So, there could be scope to regenerate the interest of promotion of mola in Odisha in small homestead ponds along with large tanks of women self- help groups.

In Odisha, the major emphasis given on culture of fish through the project in community tanks with WSHG is an important model to improve the socio-economic condition of the members of the groups. With carps, the promotion of mola were suggested. However, several constraints were observed in carrying out the production of mola and other SIS in the tanks. Problem in stocking of broodstock of mola as needed, therefore, in most cases no stocking of mola broodstock was done. However, even without stocking of mola it was possible to received mola and SIS production in almost 67% of total ponds under project intervention and the contribution of mola and SIS was around 10% of total fish production. Problem in harvest of mola from the pond were raised, however, it was not clear. The following issues arise in this case: If the productivity of mola is successful by the WSHG and if the netting in tanks provide good harvest, then why it could not be carried out by hiring of the netting team (say from the tank if the harvest is at least 50kg per time, if the price Rs. 200/kg, the total sell could be Rs.

10,000, if even they charge of netting Rs. 2000 at least the WSHG could get Rs. 8000/time and even Rs. 16000 per month. Another, point important here is how they keep the broodstock needed for stocking by keeping in small separately prepared pond and if after final harvest this fish (mola and others) restocked it will be useful to get very high productivity and ensure the stock sufficient enough to ensure the production.

In Odisha, it has been tried to establish breeding and seed production system of mola like other major species of fish in hatcheries, although, it has been tried to explain that unlike the major species of fish the use of natural based production system using broodstock for stocking in many reasons more useful techniques (related to low price of seed, the fish stocked breed, multiple breeding takes place in a season, the offspring become mature within few months useful to reproduce in the same season. The system in various ways are useful to get higher productivity and regular income in addition to use it regularly for household consumption.

Due to less emphasis on the activity to small irrigation reservoirs changed, the stocking of mola and the management will create lot of opportunities to get higher production from the system (semi-closed waters the *beels* in Bangladesh) not completely explored. Although, in some of the communities huge potential have been observed during the intervention.

3.3. Carp-mola-SIS-Production in Assam in India

Mola and SIS with carp in large size ponds (area min 0.25 ha to max 0.8 ha) in 2019-20 total 67 ponds mola stocked (provide ToT to the TEF and the staff of DoF) in addition to the training by College of Fisheries under Assam Agricultural University to the staff for capacity building. This include the practical demonstration, field visit and mentoring of the field staff about the method of collection of mola broodstock as live and stocking in the ponds of the beneficiaries of the project. The staff received training than applied this in their working areas and in 2019- 20 made success in stocking of mola in their ponds.

By this time it has been reported that the 67 farmers who have produced mola in their ponds majority of them used it regularly for household consumption, sold in the market as foodfish and received premium price and some of them sold the mola as live to non-

project farmers (the ponds size is less than the project farmers), the non-project farmers within the community by seeing the good results motivated and adopted the technology with their own initiatives (own investment), the technology of production of carp-mola-SIS thus dominated to large numbers of farmers in the project areas even in one year. The success brought lot of motivation among DoF, the APART team, other high officials and beneficiaries' within the project areas. In order to scale-out the technologies to large areas with more beneficiaries including the non-project farmers and in ponds, *beel* fisheries it is important big initiatives are going to undertake in 2020-21 year in Assam.

IV. Marketing system of small fish in Bangladesh

Forward market linkage approach is needed to be applied for scaling of mola production in Northwest Bangladesh. These include (i) establishment of the mola broodfish supply chain and
(ii) farming mola with carp polyculture system (iii) marketing of mola as foodfish to get premium price. Identify sources of mola broodstock for collection as live located within or nearby the community for stocking in ponds. Build up capacity of farmers engaged in polyculture of mola and other SIS with other species in polyculture in ponds to sell the mola and other SIS as live to stock ponds of other farmers in addition to sell as foodfish in the market.

Applying method to keep as stock sufficient quantity of mola and other SIS in ponds useful to use as broodstock to continue the production in the following years. It could be good to keep mola and other SIS in well prepared small ponds and use supplementary feeds with high quality protein. This will be useful to do uniform size mola and also good for stocking in the grow-out ponds after pre-stocking management of the ponds - selling of fish and preparation of pond), also useful farmer to get estimate about the amount of fish sold. This could be used as useful strategy to make availability of broodstock of mola within the community to make self- sufficient community for supplying of mola broodstock in other ponds.

It is important to incorporate mola broodfish value chain - fish seed value chain linking with fish seed traders with mola producers, sell mola like fry/fingerlings of other species of fish could be important. For this necessary support will be needed on collection and transportation of mola as live and the understanding about the benefits on production of mola and other SIS with carp in polyculture.

It has been tried to produce mola fry production through induced breeding in hatcheries to sell nurseries, the technology found not yet technically and economically viable and limited scope to promote mola using this hatchery produced seed as compared use of mola broodstock directly in ponds.

V. Strategy on promotion of carp-mola-SIS in the Project

5.1. Production and supply of broodstock of mola and other SIS

Farmers can transport the mola broodfish from one pond to another pond for stocking as per their requirement. Basically, in a community, farmers will be self-sufficient for supplying the mola broodfish for continuing the mola production system**.** It is the best way for mola broodfish supply for their own. Farmer can conserve the mola broodfish at the end of production cycle in each year for sustainability of mola production system. Considerable amount of mola broodfish should be kept in their pond during the final harvesting of fish for continuing the next crop.

Mola can be collected from ponds of grow-out farmers in communities who have established very successfully carp-mola-SIS polyculture with other fish in their ponds. The grow-out farmers will be trained about the know-how of collection and selling of mola broodstock as live in addition to those sold in the market as foodfish. The mola broodfish supplier can collect mola may be from nearby sources initially (old ponds, *beels*, inundated water bodies, rice field connected ponds) but later on it the grow-out farmers could be the very viable sources for them to get the supply of mola broodstock. The mola broodfish operators can be treated as mola broodfish supplier and sell their product (mola broodfish) to the selected project farmers in the community and any interested farmer in their contact.

Mola breeders collected from wild or from ponds frequently mixed with other undesirable species. As mola breeders are relatively small, generally (2-5 g size) the elimination of mixed other species from breeders to be stocked in ponds is difficult, particularly that of chanda (*Chanda nama*). Chanda is predominantly carnivorous in nature and disturbing for carps, reproducing in pond, feeding on fish scale and mola juveniles and prevent establishment of appropriate mola population in the pond. In order to avoid this it is good if the farmers collect the mola from the large ponds and then stock in a small size ponds where he could able to remove all these unwanted small fish other thank mola.

5.2. Incorporate mola broodfish in the fish seed supply chain

If the mola broodfish incorporated in the fish seed supply chain then farmers can get easily the mola broodfish for stocking into their pond to culture with carp polyculture. Mola broodfish supplier from the established mola brood pond or any recognized mola sources can bring the mola broodfish to the fish seed market. For example, mola broodfish can be transported from Dhulia *beel,* Nilphamari, a recognized mola broodfish source to fish seed market at Kakina, Lalmonirhat, an established fish seed market. A trial need to be conducted on 'incorporating mola broodfish at Kakina fish seed market from Dhulia *beel* to see how the fish seed traders react on mola broodfish in the fish seed supply chain'. Fingerling traders can collect the mola broodfish from the mola brood pond or from any recognized sources and sell the mola broodfish separately or along with carp fingerlings to the farmers.

5.3. Mola nursery, based on hatchery-produced spawn

Nursing of hatchery-produced mola spawn would be the best alternative to breeder supply. Nursery operator can collect mola spawn from the hatchery and nursing the mola for 50-60 days to produce mola juvenile and then they can sell their product (mola seed) to the fingerling traders or farmers in the community. Nursery operators can produce mola broodfish also through rearing it for 3-4 months. Nursery operators can mix the mola broodfish with the carp fingerlings for supplying to fingerling traders or farmers. However, presently no hatchery is producing mola seed; though there are some hatcheries (eg. Dolphin Hatchery in Rangpur, Brahmaputra Hatchery in Mymensingh, Mattri hatchery in Jashore) succeeded of producing mola spawn.

5.4. Farming of mola with carp polyculture

Farming of mola with carp polyculture can be done in the following ways:

A. Training and motivation on carp-mola polyculture technology
B. Culture of mola with carp

Importance of mola culture can the promoted through organizing training and awareness campaign and other extension materials like billboard, posters, leaflet etc. The farmers can receive the knowledge and skill on carp-mola production technology from the training and learn from the experienced neighboring farmers. Govt. and other organization and local service providers (LSP) can lead the promotional activities for the carp-mola polyculture technology at the community level.

Stocking of mola broodfish and following some better management practices for mola are the key factors for culture of mola with carp polyculture. For stocking mola broodfish with carp, farmers can collect mola broodfish from the mola brood pond in their community, mola broodfish supplier, fish seed market, neighboring mola farmer or wild sources. Farmers will produce mola along with carp in their pond. Smallholder farmers will harvest mola partially in regular basis (once per week or twice per month) for their household consumption. They can sell the excessive amount of harvested mola (once in two months or quarterly) to the local market to earn money. In general, smallholder farmers can sell about 50% of the produced mola and make profit from selling the mola. Generally, mola contributes about 20% of whole production and 30% of economic return in the carp-mola production system.

5.5. Mola and other SIS Scaling Strategies in the project

The BMGF funded project (Aquaculture: increasing income, diversifying diets, and empowering women in Bangladesh and Nigeria (Bangladesh Component)) of WorldFish and its partners will take the following measures for scaling mola in the ponds of farmers in Rajshahi and Rangpur Divisions in the northwest region of Bangladesh.

- **Awareness meeting, workshop and seminar on importance of culture on mola-SIS with carps and identify LSPs:** The project will organize awareness meeting, workshop and seminar on importance of culture on mola-SIS with carps at community levels. Posters, leaflets, other communication products, relevant messages on carp-mola-other SIS develop and disseminate in the social media. The project of WorldFish and its partners will identify the local service providers (LSPs) – the traders, the Lead Farmers (LF) with ponds having mola broodstock

located within or in nearby communities to develop the supply chain of mola and other SIS in each of selected communities.

- **Organize ToT program:** The project organize training of trainers (ToT) for the LSP, the traders and mola broodfish supplier to enhance the technical knowledge and skill to collect and transport mola as live and rearing technology. LSPs and the partners will organize the training on carp-mola polyculture production technology, income and nutrition of farming households.

- **Develop communication products:** The project will develop communication products (e.g. poster, leaflet, and billboard) and messages in social media on carp-mola and SIS production technology, income and nutritional benefits on use of mola and other SIS. A Training of Trainers Module and 'farmers guide book' on fish culture in pond and vegetable production in dykes developed the carp-mola-SIS included.

- **Establish source of mola broodstock:** In the Project working in collaboration with partners TMSS and BRAC with 76 Local Service Providers (LSPs). Forty of them are nursery operators located in 40 Unions. To all the LSPs, ToT were provided about fish culture technology, household nutrition and gender. The 76 LSPs having linkages with around 20,000 farmers in seven districts in Rangpur and Rajshahi Divisions. In Rangpur District the partner BRAC is working with 10 LSPs, and the WorldFish project staff working directly with 5 LSPs. In Gaibandha district BRAC is working with 10 LSPs, the WorldFish project working directly with 7 LSPs. In Bagura the partner TMSS working with 10 LSPs and the WorldFish project directly with 6. LSPs. In Rajshahi and Natore, WorldFish project is working directly with 18. LSPs and in Naogaon district TMSS is working with 10 LSPs. Total 76 LSPs, by partners 40 LSPs and direct 36 LSPs received training as ToT to work with the farmers in the project areas.

- **Mola in the project models on polyculture in ponds:** Several models based on the for fish culture in ponds are designed for the Project Farmers (Zahura *et al*., 2020). Of these the following models are assigned for stocking of mola with carps.

- **For Perennial pond**:
    - (i) Model – 1: Silver carp 8-10, Catla/Bighead 4-6, Rohu 8-10, Grass carp 2- 3, Mrigal 4-8, common carp 2-4, (total carp 28-41) and Mola 100
    - (ii) Model – 4: Silver carp 10, Catla/Bighead 6, Rohu 8, Grass carp 3, Mrigal 4, Common carp 4, (total carp 35) and Mola 150
- **For seasonal pond:**
    - Model – 8: Silver carp 10-12, Catla/Bighead 2-3, Rohu 8-10, Grass carp 1-2, Mrigal/Common carp 4-6, (total carp 25-33) mola, 150

- **Criteria of farmer selection:** Land holding up to 2 ha or productivity not more than 4 metric tons/ha/year or 50% of fish consumed by owners
- **Involvement of LSPs directly by project staff and through staff of partners**
    - LSPs are providing training to farmers in total 214 groups consisting 5344 farmers directly. One LSP of WorldFish project staff trained 1-3 groups of 25 farmers in each group (36 LSP, 54 groups and 1344 farmers) and 1 LSP of partner NGO (BRAC and TMSS) trained 4 groups of 25 farmer in each group (40 LSP, 160 groups and 4000 farmers).
    - LSP are providing 3 sessions of training for each farmers group in different days; pre- stocking, stocking and post-stocking. Each session is about 2 and half hours. For organizing and conducting farmers training, LSPs are getting honorarium from the project (for one training session, LSP honorarium is BDT 500 for BRAC and BDT 1000 for WorldFish and TMSS). Farmers are getting snacks during training sessions. LSP are equipped with banner and festoon from WorldFish. It is assuming that one LSP has about 300 outreach farmers and proving embedded services to them.
    - New LSPs – about 2000 LSPs are going to onboard (WorldFish directly - 500, BRAC - 500, TMSS - 500 and 500 by other partners (like hatchery, TRK, Light Castle, Bank Asia), 4 LSPs in one union (feed dealer/retailer and nursery operator).
    - LSP – the nursery operators with connectivity – fingerlings traders could be the participants in the training fingerlings traders useful to connect to pond owners with mola.

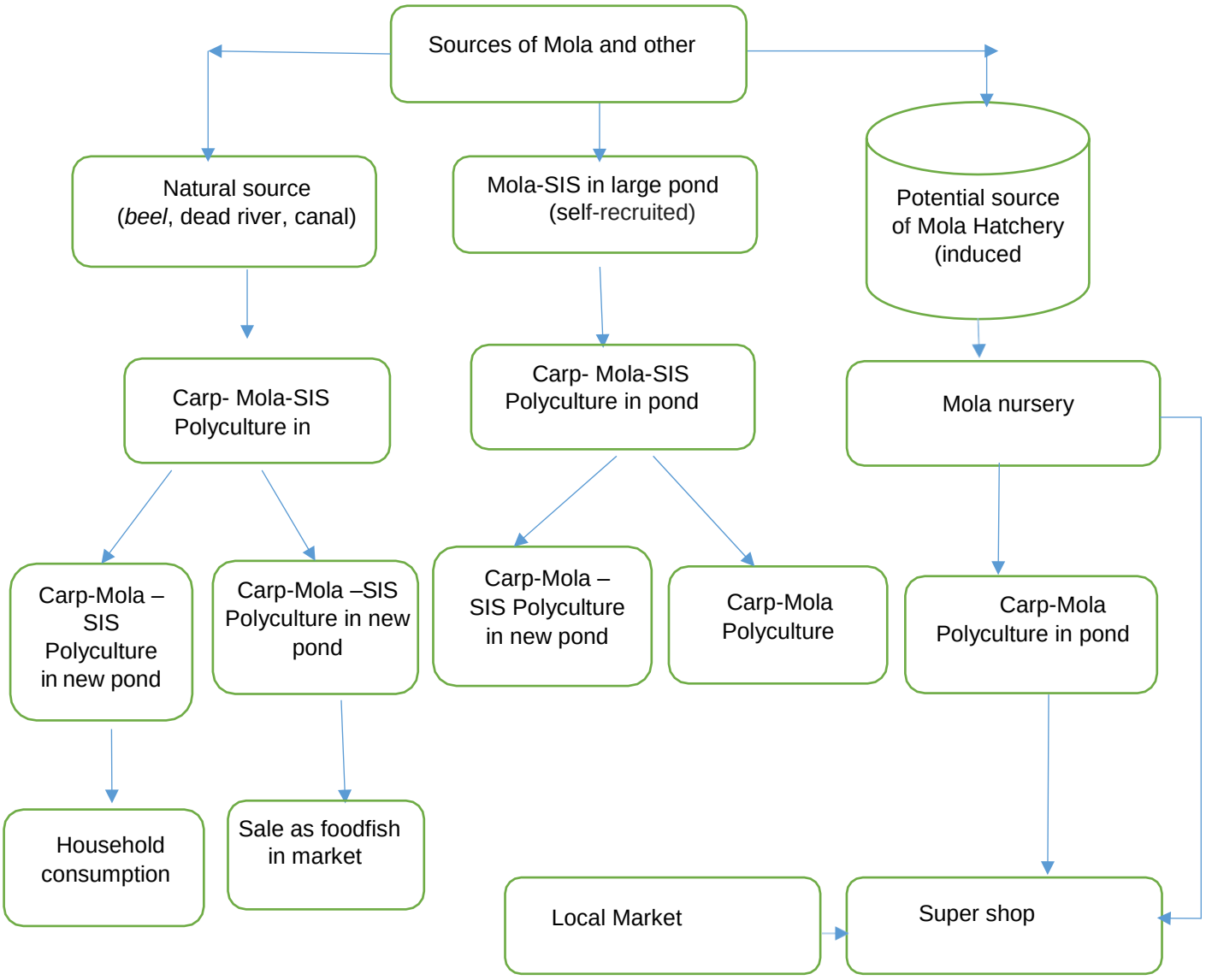
- **Embedded service by LSPs**

  Probable sources of mola broodfish in the locality or region will be identified through the support of LSP, partner and other stakeholders. Initial stage, Project can provide the mola seed as support to establishment of mola brood pond at community level. Once the mola broodfish supply chain develops at the community level, then farmers can get the mola broodfish easily within the community and it will continues for years. It will be a profitable venture for the mola broodfish supplier and nursery operator. In addition, mola broodfish supplier and nursery operator can also sell their produced mola to the local mark*et* also. As they will produce mola exclusively, they can supply mola to the super shops (Swapno, Agora, Meena Bazar etc.). Selected smallholder farmers of the project can purchase the mola broodfish from the mola broodfish supplier or from nursery operator and stock into the carp polyculture pond.

  - **Mola processing and cooking demonstration:** For enhancing the knowledge and practice on essential nutrition, mola processing and cooking demonstration program should be organized at community level by the project support. This mola processing and cooking demonstration, will improve the farmers attitude regarding mola consumption in the households especially in early life of first 1000 days. **Linkage development:** WorldFish and its partner can assist to develop the linkage between producers to super shop. WorldFish can try to develop a supply chain system in the forward market.

  - **Setup research trials:** Some of adaptive research trials can organized by WorldFish by the support of other organizations or private sectors engagement. These might be (i) trial on incorporating mola broodfish at Kakina fish seed market from Dhulia beel to see how the fish seed traders react on mola broodfish in the fish seed supply chain and (ii) trial on establishing commercially viable induced breeding and nursing technology in hatchery.

5.6. Flow Chart of Mola and Other SIS



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Annex-1: Small Indigenous Fish Species (SIS) in Bangladesh (excluding tiny fish, size <5 cm) (Hossain *et al*., 2012; Hossain 2013; FishBase, 2020; BdFish, 2020)

Sl.	Family	Species	English Name	Bengali Name	Habitat
Order: Osteoglossiformes					
1	Notopteridae	*Notopterus notopterus*	Bronze Featherback	Foli	E-R
2	Clupeidae	*Gonialosa manmina*	Ganges River Gizzard Shad	Chapila	E-R
3		*Gudusia chapra*	Indian River Shad	Chapila	R
4	Engraulidae	*Coilia dussumieri*	Gold-spotted Anchovy	Olua	E-R
5		*Coilia ramacarati*	Ramcarat Anchovy	Olua	E-R
6		*Thryssa puruva*	Oblique-jaw Thryssa	Ram Phasa	E-R
7		*Pellona ditchela*	Indian Pellona	Choukkha	E-R
Order: Cypriniformes					
8	Balitoridae	*Acanthocobitis botia*	Mottled Loach	Bilturi	R
9		*Acanthocobitis zonalterans*	River Loach		R
10		*Balitora brucei*	Grays Stone Loach		R
11		*Nemacheilus sikmaiensis*			R
12		*Schistura beavani*	Creek Loach		R
13		*Sehisthuara dayi*			R
14	Cobitidae	*Botia dario*	Queen Loach	Bou Machh	R
15		*Botia dayi*	Hora Loach	Rani Machh	R
16		*Botia lohachata*	Reticulated Loach	Rani Machh	R
17		*Botia rostrata*	Gangetic Loach	Rani Machh	R
18		*Lepidocephalichthys berdmorei*	Burmese Loach	Puiya	R
19		*Lepidocephalichthys guntea*	Pcppered Loach	Gutum	R-E
20		*Lepidocephalichthys irrorata*	Loktak Loach	Puiya	R
21		*Pangio oblonga*	Java Loach	Panga	R
22		*Pangio pangia*	Cinnamon Loach	Panga	R
23		*Somileptus gongota*	Gongota Loach	Cheng Gutum	R

Sl.	Family	Species	English Name	Bengali Name	Habitat
24	Cyprinidae	*Amblypharyngodon mola*	Mola Carplet	Mola	R
25		*Amblypharyngodon microlepis*	Indian Carplet	Mola	R
26		*Aspidoparia jaya*		Joya	R
27		*Aspidoparia morar*		Morari	R
28		*Barulius barila*	Barna Baril	Baril	R
29		*Barulius barna*	Ozola Barb	Koksa	R
30		*Barulius shacra*	Shacra Baril	Koksa	R
31		*Barulius bendelisis*	Hamilton's Barila	Joiya	R
32		*Barulius tileo*	Tileo Baril	Pathorchata	R
33		*Barulius vagra*	Vagra Baril	Koksa	R
34		*Bengala elonga*	Megarasbora	Along	R
35		*Chagunius chagunio*		Chaguni	R
36		*Chela cachius*	Silver Hatchet Barb	Chhep Chela	R-E
37		*Chela laubuca*	Indian Glass Barb	Chhep Chela	R-E
38		*Laubuca brahmaputraensis*		Chhep Chela	R
39		*Salmostoma acinaces*	Silver Razorbelly Minnow	Chela	R
40		*Salmostoma bacaila*	Large Razorbelly Minnow	Katari	R-E
41		*Salmostoma phulo*	Finescale Razorbelly Minnow	Phul Chela	R
42		*Salmostoma sardinalla*	Sardinalla Razorbelly Minnow		R
43		*Crossochelius latius*	Gangetic Latia	Kalabata	R-E
44		*Danio dangila*	Moustached Danio	Nipati	R
45		*Devario aequipinnatus*	Giant Danio	Chhebli	R
46		*Devario anomalus*			R
47		*Devario devario*	Sind Danio	Debari	R
48		*Esomus danricus*	Flying Barb	Darkina	R-E
49		*Rasbora daniconius*	Slender Rasbora	Darkina	R-E
50		*Rasbora rasbora*	Gangatic Scissortail Rasbora	Luizza Darkina	R-E
51		*Garra gotyla*	Sucker Head	Ghorpoiya	R
52		*Cirrhinus reba*	Reba carp	Raek	R
53		*Labeo bata*	Bata	Bata	R
54		*Oreichthys cosuatis*	Kosuati Barb	Kosuati	R

Sl.	Family	Species	English Name	Bengali Name	Habitat
55		*Osteobrama cotio*		Dhela	R
56		*Puntius chola*	Swamp Barb	Chela Punti	R
57		*Puntius conchonius*	Rosy Barb	Kancho n Punti	R
58		*Puntius guganio*	Glass Barb	Mola Punti	R
59		*Puntius phutunio*	Spotted Tail Barb	Phutani Punti	R
60		*Puntius puntio*	Puntio Barb	Punti	R
61		*Puntius sarana*	Olive Barb	Shar Paunti	R
62		*Puntius sophore*	Pool Barb	Bhadi Punti	R
63		*Puntius terio*	One Spot Barb	Teri Punti	R
64		*Puntius ticto*	Ticto Barb	Tit Punti	R
65	Psilorhynchidae	*Psilorhynchus balitora*	Balitora Minnow	Balitora	R
66		*Psilorhynchus gracilis*	Rainbow Minnow	Balitora	R
67		*Psilorhynchus rahmani*			R
68		*Psilorhynchus sucatio*	River Stone Carp	Titari	R
Order: Siluriformes					
69	Amblycipitidae	*Amblyceps laticeps*	Indian Torrent Catfish		R
70		*Amblyceps mangois*	Indian Torrent Catfish		R
71	Bagridae	*Batasio batasio*		Tengra	R
72		*Batasio tengana*		Tengra	R
73		*Mystus bleekery*	Day's Mystus	Golsa Tengra	R
74		*Mystus cavasius*	Gangatic Mystus	Kabasi Tengra	R
75		*Mystus vittatus*	Striped Dwarf Catfish	Tengra	R
76		*Mystus tengara*	Pyjama Catfish	Bujuri Tengra	R
77		*Rama chandramara*	Hummingbird Catfish	Gura Tengra	R
78	Clariidae	*Clarias batrachus*	Walking Catfish	Magur	R-E
79	Erethistidae	*Conta conta*	Conta Catfish	Kutakanti	R
80		*Laguvia ribeiroi*	Paited Catfish	Kani Tengra	R
81	Heteropneustidae	*Heteropneustes fossilis*	Stinging Catfish	Shing	R-E
82	Schilbeidae	*Ailia coila*	Gangetic Ailia	Kajilo	R-E
83		*Ailia punctata*	Jamuna Ailia	Kajilo	R-E
84		*Pseudeutropius atherinoides*	Indian Potasi	Batasi	R-E
85	Siluridae	*Ompok pabda*	Pabdah Catfish	Pabda	R
86		*Ompok pabo*	Pabo Catfish	Modhu Pabda	R
87	Sisoridae	*Gagata cenia*	Clown Catfish	Gang Tengra	R-E
88		*Gagata gagata*	Yellow Spotted Trevally	Gang Tengra	R-E

Sl.	Family	Species	English Name	Bengali Name	Habitat
89		*Gangata youssoufi*	Indian Gangata	Gang Tengra	R-E
90		*Gangara viridescens*	Huddah Nangra	Gang Tengra	R-E
91		*Glyptothorax cavia*	Sisorid Torrent Caatfish	Kani Tengra	R
92		*Glyptothorax telchitta*	Sisorid Torrent Catfish	Dhal Magur	R
93		*Glyptothorax sp.* (Kollia Khal)			R
94		*Glyptothorax sp.* (Jagat River)			R
95		*Hara hara*	Moth Catfish	Kutakanti	R
96		*Sisor rabdophorus*	Whiptail Catfish	Chenua	R
Order: Syngnathiformes					
97	Syngnathidae	*Ichthyocampus carce*	Freshwater Pipefish	Kumirer Khil	R-E
98		*Microphis cuncalus*	Crocodile-tooth Pipefish	Kumirer Khil	R-E
99		*Microphis deocata*	Deocata Pipefish	Kumirer Khil	R-E
Order: Synbranchiformes					
100	Mastacembelidae	*Macrognathus aculatus*	Lesser Spiny Eel	Tara Baim	R-E
101		*Macrognathus aral*	One-Stripe Spiny Eel	Tara Baim	R-E
102		*Macrognathus pancalus*	Barred Spiny Eel	Guchi	R-E
Order: Perciformes					
103	Ambassidae	*Ambassis nalua*	Scalloped Perchlet	Nalua Chanda	R-E
104		*Chanda nama*	Blogata Glass Perchlet	Chanda	R-E
105		*Parambassis ranga*	Indian Glassy Fish	Ranga Chanda	R-E
106	Anabantidae	*Anabas cobjius*	Gangetic Koi	Koi	R
107		*Anabas testudineus*	Climbing Perch	Koi	R
108	Channidae	*Channa gachua*	Dwarf Snakehead	Chneg	R
109		*Channa orientalis*	Walking Snakehead	Rega	E-R
110		*Channa punctata*	Spotted Snakehead	Taki	E-R
111	Eleotridae	*Butis butis*	Duckbill Sleeper	Kuli	E-R
112		*Butis melanostigma*	Black-spotted Gudgeon	Kalo Baila	E-R
113		*Eleotris fusca*	Dusky Sleeper	Bhut Baila	E-R

Sl.	Family	Species	English Name	Bengali Name	Habitat
114		*Eleotris lutea*	Lutea Sleeper	Kuli	E-R
115	Gobiidae	*Acentrogobius Caninus*	Tropical Sand Goby	Nuna Baila	E-R
116		*Acentrogobius cyanomos*		Nuna Baila	E-R
117		*Acentrogobius viridipunctatus*	Spotted Green Goby	Nuna Baila	E-R
118		*Apocryptes bato*		Dali Chewa	E-R
119		*Awaous grammepomus*	Scribbled Goby	Bele	E-R
120		*Awaous guamensis*	Pacific River Goby	Baila	E-R
121		*Boleophthalmus boddarti*	Boddarts Goggle- eyed	Dahuk	E-R
122		*Glossogobius giuris*	Tank Goby	Bele	E-R
123		*Gobiopsis macrostoma*	Longjaw Goby	Chuna Bele	E-R
124		*Odontamblyopus rubicundus*	Rubicundus Eelgoby	Nuna Baila	E-R
125		*Oxyurichthys microlepis*	Maned Goby	Dali Chewa	E-R
126		*Parapocruptes batoides*		Dahuk	E-R
127		*Periophthalmodon schlosseri*		Dahuk Chewa	E-R
128		*Periopthalmus barbarus*	Atlantic Mudskipper	Dahuk	E-R
129		*Pseudapocryptes elongatus*	Pointed Tail Goby	Raja Chewa	
130		*Scartelaos histophorus*	Waliking Goby	Saba Chewa	
131		*Stingmarogobius sadanundia*	Spooted Goby	Deto Chanda	
132		*Taenioides buchanani*	Burmeses Goby Eel	Tak Chanda	
133		*Taenioides cirratus*	Beared Eel Goby	Thutni Chanda	
134		*Trypauchen vagina*	Burrowing Goby	Tak Chanda	
135	Lenognathidae	*Gazza minuta*	Toothed Ponyfish	Tak Chanda	
136		*Secutor ruconius*	Pignsed Ponyfish	Samundra Koi	
137		*Secutor insidiatoe*	Slenderbarred Ponyfish	Bata	
138		*Leiognathus bindus*	Orangefinned Ponyfish	Bata	
139		*Leiognathus equulus*	Greater Ponyfish	Bata	
140	Mugilidae	*Liza parmata*	Broad-mouthed Mullet	Parse	
141		*Liza parsia*	Gold-spot Mullet	Parse	E-R
142		*Sicamugil cascasia*	Yellow Tail Mullet	Kachki Bata	R

Sl.	Family	Species	English Name	Bengali Name	Habitat
143	Nandidae	*Nandus nandus*	Gangetic Leaffish	Meni/Bheda	R-E
144	Osphronemidae	*Colisa fasiciata*	Banded Gourami	Kholisa	R
145		*Colisa labiosa*	Thick-lipped Gourami	Kholisa	R
146		*Colisa lalia*	Dawrf Gourami	Lal Kholisa	R
147		*Ctenops nobilis*	Frail Gourami	Neftani	R-E
148		*Pseudosphromenus cupanus*	Spiketail Paradisefish	Koi	R-E
149		*Trichopsis vittata*	Croaking Gourami		R
150	Polynemidae	*Polynemus paradiseus*	Paradise Threadfin	Taposhi	E-R
151	Sctophagidae	*Scatophagus argus*	Spotted Scat	Bistara	E-R
152	Sciaenidae	*Dendrophysa russelii*	Goatee Croaker	Goti Poa	E-R
153		*Johnius coitor*	Coitor Croaker	Koitor	E-R
154		*Johnius gangeticus*	Gangetic Bola	Bata	E-R
155		*Johnius vogleri*	Sharpnose Hammer Groaker	Poa	E-R
156		*Panna microndon*	Panna Kroaker	Poa	E-R
Order: Pleuronectiformes					
162	Cynoglossdae	*Cynoglossus cynoglossus*	Bengal Toguesole	Kukurjib	E-R
163	Soleidaea	*Brachirus pan*	Pan sole	Kathalpata	E-R
Order: Tetraodontiformes					
164	Tetraodontidae	*Chelondon Patoca*	Milkspotted Puffer	Potka	R-E
165		*Tetraodon cutcutia*	Ocellated Pufferfish	Tapa	R-E
166		*Tetraodon fluviatilis*	Green Pufferfish	Potka	R-E

R: River (freshwater)
R-E: Major habitat is river (freshwater) but also available in estuaries
E-R: Major habitat is estuaries but also available in river (freshwater)

About WorldFish

WorldFish is an international, not-for-profit research organization that works to reduce hunger and poverty by improving aquatic food systems, including fisheries and aquaculture. It collaborates with numerous international, regional and national partners to deliver transformational impacts to millions of people who depend on fish for food, nutrition and income in the developing world. Headquartered in Penang, Malaysia and with regional offices across Africa, Asia and the Pacific. WorldFish is a member of the CGIAR, the world's largest research partnership for a food secure future dedicated to reducing poverty, enhancing food and nutrition security, and improving natural resources.

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