Securing Nutrition for Rural India through Culture and Enhancement of Small Indigenous Freshwater Fish Species

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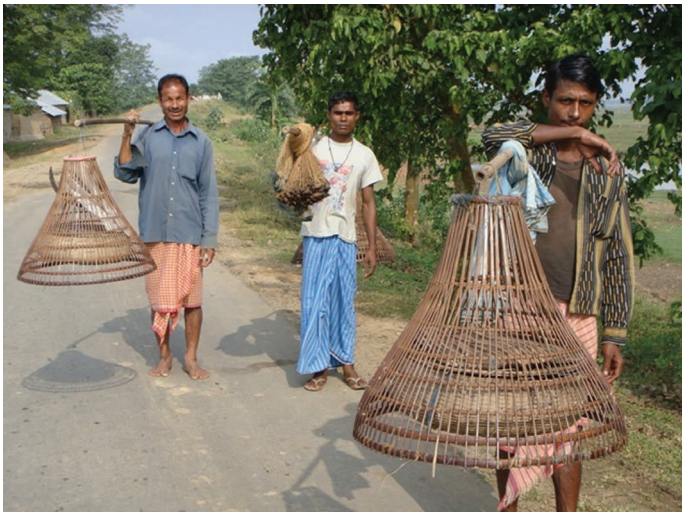
India, the world's second most populous country with more than 1.34 billion people, is a developing country with a hunger severity considered "serious" by the Global Hunger Index (IFPRI 2014). India ranks 103 of 119 countries in the 2018 Global Hunger Index, as assessed on the basis of indicators such as inadequate food supply, child mortality and child undernutrition. In India, 38 percent of children under five years are stunted, 15 percent of the population is undernourished, and the under-five mortality rate is around 5 percent. Fighting hunger remains a major challenge in the country.

The importance of fisheries and aquaculture in securing nutrition and livelihoods is globally recognized and extensively demonstrated. FAO (2009) forecasts the need to increase food production by around 40 percent by 2030 from the available resources to feed the growing world population and fish is one of the most important food items. The demand for fish and fish products has been increasing due to population growth and factors like the growing awareness of the health benefits of eating fish, taste preferences and increasing purchasing capacity of growing middle classes in countries like India and China.



FIGURES 1 & 2. *Catching SIFFS in natural resources using traditional traps and gears in Assam.*

The estimated demand for fish in India in 2020 is around 13 million t, much more than the current production of 9 million t (2012-13). The target fixed for the XII Five-Year Plan is to increase inland fish production from 5.4 million t to 7.9 million t. The silver lining is that the global fish production has grown steadily in the last five decades with food fish supply increasing at an average annual rate of 3.2 percent, outpacing world population growth (1.6 percent) and this growth is attributable to growth in aquaculture (FAO 2014). It is expected that aquaculture alone will provide around two-thirds of global fish consumption by 2030 (FAO 2014).

Aquaculture can play an increasing role in poverty alleviation, livelihood creation, food security and generating income and employment opportunities. As the onus of providing fish for the burgeoning population of the world is on the shoulders of the aquaculture sector, it needs to become more vibrant with adoption of efficient and effective fish farming technologies, diversification of species that would ensure higher production and affordable and secure nutrition for the resource poor, judicious resource utilization, economic viability and ecological sustainability.

Small Indigenous Freshwater Fish Species

India, the second largest aquaculture producer in the world, is known as a carp cultivating country because its aquaculture is primarily based on culture of a few indigenous and exotic carp species. The country has been undertaking programs and developing strategies for a second blue revolution in the eastern region through technologies, species diversification and utilization of resources. The country has 2,844 fish species, representing almost 12 percent of global fish biodiversity. Of these, 877 are indigenous freshwater species, 113 are brackishwater species, 1,563 are marine species and 291 are exotic species, as per the Annual Report, ICAR-National Bureau of Fish Genetic Resources, 2012-13. Of the indigenous freshwater species, around 450 are included in a group commonly referred to as Small Indigenous Freshwater Fish Species (SIFFS).

Some define SIFFS as those that grow to a maximum length of 5-25 cm at maturity (Felts *et al*. 1996). However, Sarkar and Lakra (2010) defined SIFFS as those that grow to a maximum size of 25-30 cm as mature adults. These SIFFS inhabit widely diverse natural and human-made aquatic ecosystems that include rivers, tributaries, streams, floodplains, wetlands, lakes, low-lying paddy fields, swamps

and seasonally inundated low-lying areas. The maximum diversity of SIFFS occurs in the North Eastern Region of India, followed by Western Ghats and Central India. Based on the assessment of NBFGR, about 23 percent of SIFFS (104 species) are important as food fish (62 species) and ornamental fish (42 species).

Small Indigenous Freshwater Fish Species are valuable sources of essential nutrients (Table 1). As these fishes are generally consumed whole, with the head, bones and viscera, they serve as an easily available source for vitamins, calcium, iron, other minerals and micronutrients (Majumdar *et al*. 2008). The role of SIFFS in nutritional and livelihood security is quite significant for a considerable section of the Indian population, especially for the population of the North Eastern Region, where these species are abundant in natural water bodies. The SIFFS are preferred by the ethnic populations of the region for their unique taste and food value and are consumed fresh, dried and fermented. Different products are prepared traditionally by the more than 220 ethnic groups through different techniques. Catching wild SIFFS with traditional traps and gears in natural habitats such as swamps or beels is a common scenario in rural areas of the North Eastern Region (Fig. 1-2).

The North Eastern Region of India, comprised of eight states (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim), is a global hotspot of freshwater fish biodiversity (Kottlelat and Whitten 1996). The region is bestowed with vast and varied water resources that are inhabited by 296 fish species, of which 160 are endemic to the region (Sarkar *et al*. 2010). Around 250 species are identified as potential ornamental fish species, of which 157 species are exported, mostly through collection from wild resources (Mahapatra *et al*. 2005). There is high demand for indigenous fish in the North Eastern Region as nearly all people of the states in the region are fish eaters. Fish production from this region has increased from 241,000 t in 2004-2005 to 372,000 t in 2013-2014. The trend belies a paradoxical picture as domestic fish production is lagging far behind the demand for fish to feed the growing population. The per capita consumption of fish in this region is much below the level recommended by the WHO as well as the national average. Therefore, judicious utilization of the available water resources for fish production is the need of the hour for nutritional uplifting of rural farm families and meeting market demand.

Homestead Pond Aquaculture in the North Eastern Region

The major share of fish production in the region is contributed by Assam (72 percent) followed by Tripura (16 percent). Because fish production from natural resources is declining for various reasons, the onus of securing a fish supply for the population of the region is on the shoulders of the culture sector. As such, emphasis in recent years has

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TABLE 1. Nutrient content (dry weight) per 100 g raw edible parts of common SIFFS (Source: Bogard *et al.* 2015).

SIS	*Energy (kcal)*	*Protein (g)*	*Fat(g)*	*Moisture (g)*	*Ash (g)*
Mastacembelus armatus	381	17.9	1.7	78.6	1.0
Glossogobius giuris	292	16.6	0.4	80.3	3.1
Collisa fasciata	354	15.2	2.5	77.0	5.2
Pseudambasis ranga	400	15.5	3.8	76.2	4.7
Gudusia chapra	385	15.5	3.8	78.4	3.4
Chela cachius	349	15.2	2.4	79.4	2.9
Esomus danricus	384	15.5	3.2	77.1	4.2
Osteobrama cotio cotio	387	14.7	3.8	78.1	3.7
Notopterus notopterus	384	20.5	0.6	76.7	1.4
Mystus cavasius	479	16.8	5.1	76.8	1.0
Mastacembelus pancalus	394	17.9	2.6	77.7	2.2
Puntius sophore	541	15.7	7.2	73.2	3.5
Ailia coila	751	17.1	12.6	70.0	0.7
Xenentodon cancila	329	17.1	1.2	80.2	1.8
Anabas testudineus	737	15.5	12.8	70.5	1.0
Clarias batrachus	326	16.5	1.3	81.3	1.1
Nandus nandus	338	16.7	1.7	78.5	3.6
Ompok pabda	619	16.2	9.5	73.9	0.9
Amblypharyngodon mola	445	17.3	4.5	75.6	3.5
Botia dario	654	14.9	10.6	70.8	3.2
Heteropneustes fossilis	374	19.1	1.9	79.2	1.0
Channa punctatus	306	18.3	0.6	80.7	2.1
Macrognathus aculeatus	387	17.2	2.6	79.4	2.3
Mystus vittatus (Tengra)	428	15.1	4.6	76.6	3.7
Puntius ticto	385	15.4	3.4	77.5	3.8

FIGURE 3 – 6. *SIFFS at a roadside market in Assam.*

been placed on development of the aquaculture sector, particularly in Assam and Tripura, where vast plains are available for expansion of the culture area.

Although the region has the unique distinction of having a rich biodiversity of indigenous freshwater fish species, including a plethora of highly nutritious and commercially important SIFFS, only a few species of carps are popular as cultivated species. A good number of species with culture potential in the region have been identified that can be incorporated into culture systems to boost production, meeting consumer demand and taking advantage of the diverse water resources available in the region. However, very few studies have been conducted on the culture prospects, propagation and enhancement of these species. Here we review the importance of SIFFS and highlight their potential for aquaculture, discuss propagation techniques and provide suggestions for ensuring nutritional and livelihood security.

Assam has the unique distinction of having traditionally managed family farms, locally known as *bari*. This family farming system generally includes different horticultural crops, plantation crops, livestock, birds, in addition to a multipurpose small pond to support sustenance and secure needed fish protein for the farm family. While the diversified cropping system makes judicious use of land, a pond in the homestead acts as a water reserve for the family, harvesting rainwater for irrigation and other domestic use as well as use for fish production (Figs. 3-6).

Almost every rural household of Assam has a pond on their homestead that is generally used for various domestic activities. Most ponds are small (< 500 m^2) and shallow (<1 m) and hence not suitable for culture of large carps. Although these homestead ponds are potential resources, they are not utilized properly for fish production mostly due to the gap of scientific information on suitable culture species and breeding and culture technology (Fig. 7).

Breeding and Production of SIFFS in Assam

The research project "Utilization of homestead ponds for culture of small fish species," funded by the World Bank under the Assam Agricultural Competitiveness Project (AACP) at the Fisheries Research Centre, AAU, Jorhat, identified three popular and commercially important SIFFS – *Mystus vittatus*, *Notopterus notopterus* and *Amblypharyngodon mola* – that are suitable for culture under small homestead pond conditions in the state. These ponds (Figs. 8-10) can be utilized for culture of SIFFS to secure fish protein for farm families (Chetia Borah *et al*. 2013).

Trials to propagate these species indicated that *A. mola* is a prolific breeder, spawning three times per year under small-pond conditions (Chetia Borah *et al*. 2010). *Notopterus notopterus* also naturally breeds in ponds with moderate weed infestation, with a breeding season from the last part of April to July and a peak breeding period during May and June (Chetia Borah *et al*. 2015).

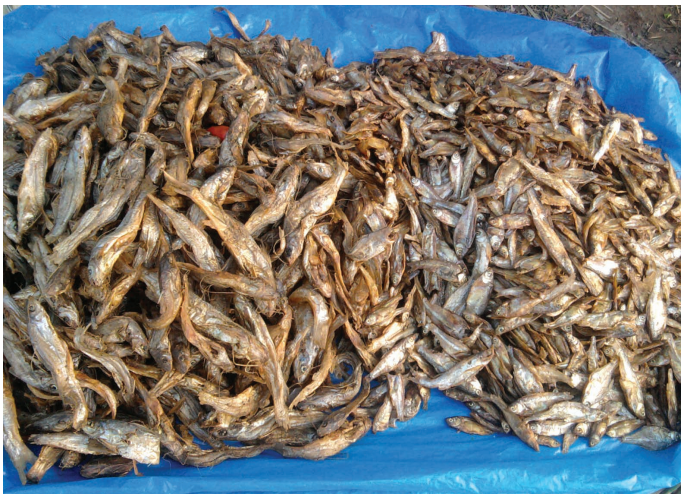

FIGURE 7. *Value-added products prepared using SIFFS.*

Induced breeding and seed raising of *Mystus vittatus* was successful with administration of synthetic hormone (Chetia Borah *et al*. 2009). Successful technology for breeding has been reported for other small fish species like *C. batrachus*, *Anabas*, several murrels, *Mastacembelus* spp., *Heteropneustes fossilis*, *Ompok pabda*, *Trichogaster fasciata*, *Macrognathus* spp. and *Danio* spp. (Das 2004, 2006, Sarkar *et al*. 2005 Mahapatra 2004, Abujam *et al*. 2015). Conventional magur breeding technology that requires sacrificing male broodfish has been improved wherein males are kept alive by using the self-healing capacity of the fish (Chetia Borah and Gogoi 2014).

Development of breeding and culture technology of SIFFS contributes to enhancing nutritional and livelihood security and conserves dwindling SIFFS biodiversity. Propagation and production enhancement of these species will help in development of enterprises based on indigenous technical knowledge. SIFFS are suitable for preparation of varieties of dried and fermented products preferred by the ethnic population of the region. Additionally, culture of these species may contribute to control of mosquito and other aquatic insect populations as some of these species are larvivorous in food habit, thereby reducing the incidence of malaria and other diseases prevalent in the region.

The development of culture fisheries for SIFFS depends on participatory management. Fishers who are the poorest of the poor are dependent on these resources for their livelihoods. To achieve maximum benefit, there is a need for active participation and involvement of the community. This can be done by creating awareness and education of the value and importance of SIFFS among different stakeholders and solicit their commitment to culture, propagate, conserve and use wisely. There is also a need for greater coordination and policy support to popularize these untapped resources though collaborative ventures at a national level.

Notes

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FIGURE 8. *SIFFS suitable for culture in small ponds:* A. mola.

FIGURE 9. *SIFFS suitable for culture in small ponds:* M. vittatus.

FIGURE 10. *SIFFS suitable for culture in small ponds:* N. notopterus.

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