

Potential, prospects and strategies to increase inland open water fish production in different regions of India

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Fisheries play a vital role in the food and nutritional security of people especially in the rural areas. In many developing countries, aquaculture has been given high priority to improve the availability of protective food for their under nourished peoples and also to cater to the overseas trade. However, the irrational growth of fisheries and aquaculture, ventures, impervious to environmental norms, can open up a floodgate of new concerns, as evident from the recent Asian experience of prawn culture boom. Most of the inland water-bodies in recent years showed clear signs of over-exploitation of important fish stocks, modification of ecosystems causing significant economic losses. This could threaten the long-term sustainability of fisheries and contribution of fisheries to food supply. It has now been realized that living aquatic resources, although renewable, are not infinite and need to be properly managed, if their contribution to the nutritional, economic and social well being of the growing worlds' population is to be sustained.

Key words: Fish, Inland, Potential, Production, Prospects, Strategies

INLAND fisheries resources in India are diverse, comprising rivers, floodplains, estuaries, mangroves, estuarine impoundments, lagoons, upland lakes, reservoirs and ponds. In India, inland fisheries is classified into freshwater aquaculture, including the pond culture of carp; brackishwater aquaculture, involving mostly shrimp culture; and capture fisheries in rivers, estuaries, lakes, reservoirs etc. The inland water-bodies in Andhra Pradesh, Karnataka, Telengana and Tamil Nadu along with West Bengal, Rajasthan and Uttar Pradesh, account for 62 % of total area in the country. As far as reservoirs are concerned, Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Odisha, Rajasthan and Uttar Pradesh account for larger portion of area under reservoirs. More than 77% of area under beels, oxbow, lakes and derelict water lies in West Bengal, Odisha, Uttar Pradesh, Bihar and Asom.

The eastern region of India is endowed with enormous natural resources in the form of reservoirs,

wetlands, oxbow lakes, beels etc. and having huge potential for fish production. These resources are underutilized due to multitude of factors. Regardless of various inhibiting factors, it is evident that sustainable development of the inland water-bodies of eastern region of India would help in increasing fish production of the country and achieving second Blue Revolution.

Fishes in Indian states

Bihar is endowed with rich aquatic and fisheries resources in the form of rivers, flood plains, wetlands (chaurs), ox-bow lakes (mauns), reservoirs, tanks and ponds. The main culture fishery resources of Bihar lie in over 43,000 ponds and tanks of variable sizes covering a total area of about 65,000 ha. Flood plains and other wetlands locally known as chaurs are other major fisheries resources and measure about 45,978 ha which are found mainly in the basins of Kosi-Gandak river systems of north Bihar. Present fish production from Jharkhand is 96,000

metric tonne; however, the annual demand is more than 1.15 lakh metric tonne. Besides, current fish seed requirement in Jharkhand is 600 million whereas availability is only 350 million.

Uttar Pradesh has vast and varied inland fisheries and aquaculture resources which are at various levels of utilization. Fisheries resources are in the form of network of rivers and rivulets, reservoirs, network of irrigation canals and extensive floodplain wetland.

Chhattisgarh is blessed with vast inland water resources including productive waters in the form of rivers, tanks and reservoirs etc. The State has 80,760 ha of area under reservoirs out of which 75,726 ha is under fish culture operation whereas area covered by tanks is in 63,498 ha out of which 49,824 ha is under fish culture.

Asom is endowed with vast fishery resources in the form of rivers, ponds, derelict water-bodies, beels in addition to the two major river system viz. the Brahmaputra and the

Barak with their tributaries. Fish occupies an important place in the lives of the people of the Asom and fish farming has been one of the common activities in the rural areas and fishery sector is considered as an important economic activity in the socio-economic context of Asom.

West Bengal is enriched with significant wealth of fishery resources like lakes, reservoirs, wetlands, rivers, streams, canals, ponds and tanks. Fish production from these open and confined waters have enhanced considerably in recent years. The floodplains are primarily continuum of rivers and exist in the form of beels, boars or oxbow lakes in the districts of North 24 Parganas, Nadia, Murshidabad, Malda, Dakshin Dinjapur and Uttar Dinjapur.

Odisha is one of the major maritime states, offering vast scope for development of inland, brackish-water and marine fisheries. Freshwater resources of the State are estimated to be 6.76 lakh ha comprising 1.25 lakh ha of tanks or ponds, 2 lakh ha of reservoirs, 1.80 lakh ha of lakes, swamps and *jheels* and 4,500 km of rivers and canals (Table 1).

Strategies to increase fish production

Strategies for sustainable increase of open water fish production through enhancements and environment management approach includes: (a) culture-based fisheries, (b) stock enhancement, (c) cage culture, and (d) pen culture.

Culture-based fisheries in ox-bow lakes (Mauns), floodplains (Chauras) and small-and medium-reservoirs

Culture-based fisheries (CBF) is an effective management tool in increasing fish yields when recruitment of desired fish species is lower than the carrying capacity of the waterbody (Table 2). The basic strategy for fish yield enhancement through CBF is stocking and recapture. Floodplain wetlands can be brought under this management mode as recapture of the stock is easy in such water-bodies. The growth of fishes in floodplains will be faster compared to that of reservoirs due to availability of huge reserve of food niches. The success of culture based

Table 1. Inland fishery resources of different regions of India.

States	Rivers and canals (km)	Reservoirs (lakh ha)	Floodplains and derelict water (lakh ha)	Brackish water (lakh ha)
Bihar	3,200	0.25	0.5	-
Jharkhand	4,200	1.15	-	-
Uttar Pradesh	28,500	1.38	1.33	-
Chhattisgarh	3,573	0.80	-	-
Asom	4,820	0.02	1.1	-
West Bengal	2,526	0.27	0.42	2.1
Odisha	4,500	2.00	1.8	4.18

Table 2. Fish production through culture-based fisheries from seasonally flooded open water-body.

Species	Stocking (No./ha)		Production (kg)	Yield (kg/ha)
	2008-09	2009-10		
<i>Catla catla</i>	2,000	2,400	34,962.3	1,059
<i>Labeo rohita</i>	1, 500	1,800	42,917.4	1,301
<i>Cirrhinus mrigala</i>	1, 500	1,800	28,171.35	854
Others			30,227	916
Total	5, 000	6,000	136, 278	4,130

Table 3. Fish production through culture-based in different reservoirs.

States	Reservoirs	Before (kg/ha)	After (kg/ha)
Uttar Pradesh	Gularia	33	100
	Bachhra	40	139
	Pahuj	33	52
Madhya Pradesh	Dahod	50	125
Tamil Nadu	Aliyar	27	202
Kerala	Chulliar	80	316
Karnataka	Markonahalli	6	75

fisheries depends on the parameters such as size at stocking, stocking density, fishing effort, size at capture, selection of species and selection of fishing gear (Table 3).

Culture-based fisheries management in wetlands lead to increase in total fish production from wetlands, e.g., 400 kg/ha/year to 1,500 kg/ha/year (West Bengal), 150 kg/ha/year to 900 kg/ha/year (Asom), and 180 kg/ha/year to 1,100 kg/ha/year (Bihar). Production level of 1,000-1,500 kg/ha/year have been achieved in floodplain wetlands. The adoption of culture-based fisheries technology developed by the CIFRI for small reservoirs, has demonstrated that the fish production from this resource can be increased up to 350 kg/ha/year. The unit cost of fish production achieved was ₹ 8.2/kg with a benefit cost ratio of 3:8.

Fingerling stocking and stock enhancement in large reservoirs

Stock enhancement augments the stock of desired fish species through stocking or encouraging natural

recruitment. In open water-bodies, which have lost riverine connection due to construction of embankments and siltation, natural fish stocks of commercially important fish species have been depleted due to disruption of the auto-stocking process from the rivers. The basic purpose of stock enhancement is establishing a breeding population of desired species. The main aspects of stock enhancement are selection of species for stocking, determination of stocking rate and the size at stocking. The success of stock enhancement depends on the knowledge on population structure including recruitment, growth and mortality of the stock.

The CIFRI has provided technological backstopping to reservoir fisheries management in 21 states which resulted in substantial increase in average reservoir fish production in the country. The mean post-stocking yield is ranged from 5.3 to 889 kg/ha when compared with the pre-stocking yield range of 1.5 kg/ha to 310 kg/ha (Table 4).



Fig. 1. Cage culture in Indian reservoirs



Fig. 2. Pen culture in wetlands

The overall impact in the 2,300 reservoirs was enhancement of average fish production from 20 kg/ha/year to 110 kg/ha/year benefiting livelihoods and income of thousands of poor fishers. The details of production achieved from different categories of reservoirs through application of CIFRI technologies are as follows:

- Small reservoir = Average 174 kg/ha from 50 kg/ha
- Medium reservoir = Average 94 kg/ha from 30 kg/ha
- Large reservoir = Average 33 kg/ha from 12 kg/ha

Cage-culture in medium and large reservoirs

Cage culture technology for fingerling raising and table size fish production in cages made up of low-cost locally available materials have been developed for reservoirs and floodplain wetlands. The technology can ease the problem of non-availability of quality stocking material for these waters as stocking material is pre-requisite in enhancement of fish production through culture-based fisheries. Adoption of the technology can tap

the high fish production potential of the open waters.

Cage culture has been adopted by more than 16 states and production level of 5-7 tonnes per cage (96 m³ volume) has been achieved. The CIFRI successfully demonstrated the cage fish culture technology in different states in a co-management mode and fish production of 4 to 5 tonnes /cage (75 m³ volume) has been achieved. In West Bengal, 4 tonne of fish/cage was produced from Maithon reservoir. In Jharkhand, a production of 5 to 7 tonne of fish/cage has been achieved from Hatia reservoir.

Pen culture in ox-bow lakes and floodplains

Technologies for seed raising and rearing of table size carps and giant freshwater prawn in pen enclosures in floodplain wetlands and reservoirs was developed. Derelict and weed choked water-bodies, where aquaculture and fishing is difficult, can be utilized for fish production through this technology. A production of 3,000 to 5,000 kg table size Indian major carps in 8 months with 80% survival; table size giant freshwater prawn of 1,500 to

2,000 kg in 4-5 months with 70% survival and carp fingerlings of 600 kg in 3 months with 70% survival could be achieved per ha of pen. Adopted widely by Indian states, Bihar, West Bengal etc. and production level of 3,000-5,000kg/ha/8 months was achieved by stocking IMC fingerlings.

SUMMARY

The reservoirs and wetlands of different region of India can produce more fish than current production levels. The present average fish yields of small-, medium- and large-reservoir is far behind the production potential. Large-scale adoption and diffusion of culture based fisheries, stock enhancement and enclosure culture technology through the Public Private Partnership (PPP) mode in these reservoirs and wetlands can boost and bridge the gap between the current production and production potential, which can contribute to substantial increase in the overall fish production of the country. Apart from reservoirs and wetlands there are large number of inland water resource in Bihar, Jharkhand, West Bengal and Odisha in form open coal mine pits, which can be utilized for culture of fish culture. Moreover, studies are required to improve the existing technologies of culture-based fisheries, stock enhancement, cage culture and pen culture, in collaboration with respective state fisheries department and other stakeholders for development of state specific technology packages.

Table 4. Mean fish yield shift in reservoirs under culture-based fisheries in various states and under corporations after implementation of CIFRI technologies.

States/Corporations	Reservoirs considered (No.)	Mean stocking (No./ha)	Yield (kg/ha)	
			Pre-stocking	Post-stocking
Andhra Pradesh	12	955	129.2	235.0
Arunachal Pradesh	1	1,000	1.5	5.3
Chhattisgarh	28	617	265.9	824.8
DVC	4	1,000	5.0	56.2
Jharkhand	1	250	310.0	889.0
Karnataka	158	866	78.0	102.0
Kerala	1	2,000	1.9	45.0
Maharashtra	9	1,741	17.7	36.1
Punjab	7	1,000	17.5	95.0
Karnataka	2	1,014	78.0	100.5
Madhya Pradesh	1	345	50.0	126.0
Uttar Pradesh	1	386	33.0	52.0

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