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Canals in Indian Sundarbans:

Opportunities towards livelihood improvement through fisheries intervention

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Canals in Indian Sundarbans are still underutilized in terms of sustainable fish production. Erection of barriers in these canals is a common practice for catching fishes. This may lead to intensive fishing of innate fishes and also barring natural recruitment into the canal. To rejuvenate and augment fish productions from canals, a degree of management is required for these resources. ICAR-CIFRI has initiated the staggered stocking of IMC in six freshwater canals of Sundarbans. It was reported that the practice of simple release of Indian Major Carps (IMC) in these canals produced 800 kg/ha/year of table sized fish without supplementary feeding. Similarly, in net partitions the maximum size recorded for catla, rohu and mrigal was 1.2, 1.0 and 0.80 kg respectively after six months of culture period. Stock enhancement in canals may be one of the noble options for sustainable fish production as well as support of the livelihood of rural poor fishers in Sundarbans. Attention has to be given to this pre-existing habitat to save water needed for farming and conservation of sustainable fish production.

Keywords: Canal, Fisheries, Sundarbans

CANALS are the second most important (26%) source of irrigation covering 17.0 million ha in India. Major States under canal irrigation are Andhra Pradesh, Assam, Haryana, Jammu & Kashmir, West Bengal, Punjab, Rajasthan, Bihar, Karnataka, Tamil Nadu and Uttar Pradesh. The plains of North India are canal irrigated including some parts of peninsular India where two types of canal exist *viz*., inundation canals and perennial canals. In inundation canals, water is taken from large rivers when water level is high enough, especially during monsoon. On the other hand, perennial canals are connected with dams and barrages for providing water round the year for irrigation. The total length of the canal in India is 1,26,334 km which can support various levels of fish productions practices at a time, these are hitherto not scientifically utilized for fisheries.

World scenario on canal fisheries

Literatures revealed that various countries are producing fish from irrigations canals. It is estimated that almost 16% of the freshwater fishery production comes from Nile and its irrigation canals in Egypt. while in Sudan, the fish biomass in minor canals of Geizira irrigation system is on an average 660 kg/ha/year. The practice of simple release of species *Oreochromis* spp., *Channa striata* and *Puntius gonionotus* into irrigation canals resulted in reproduction of 350 kg/ha/year without supplementary feeding in Thailand. It is reported that channelization or irrigation canals exhibit lower species diversity than nearby static water bodies which is influenced by temperature and low primary producers. Fish biomass is 31% lower compared to an unchannelized stream and that reduced 78% in macro-invertebrate biomass. In Thailand, extensive culture of bighead carp, grass carp and Nile tilapia in irrigation canals used for vegetable crops has been successful. In Myanmar, the rearing of snakeheads and climbing perch in irrigation channels is practicing by *Chan myaung* (irrigation canal, locally known as) owners in

Table 1. Canal resources in South 24 Paragans district

Name of block	Area in acres
Sagar	59
Patharpratima	287.87
Kakdwip	35.83
Namkhana	16.39
Mathurapur I	9.40
Mathurapur II	215.46
Kultali	112.39
Joynagar	214.69
Canning I	20.55
Canning II	7.0
Basanti	161.05
Gosaba	1,055.99
Bhangore II	15.20
Kulpi	30.05

Source: Adapted from Mukharjee (2016).

Ayeyarwady Delta, assistance provided by the World Fish.

Canal resources in Sundarbans

Indian Sundarbans, an important mangrove chunk in the world and an extremely fragile ecosystem inhabits considerable amount of threatened and vulnerable fish species. An area of 4,200 sq km of reserve forest located in India is a tide dominated low lying coastal wetland. The area experiences annual rainfall between 1,600-1,800 mm and severe cyclonic storms. The biodiversity of Sundarbans includes numerous species of phytoplankton, zooplankton, micro-organisms, benthic invertebrates, mollusks, amphibians and mammals. It has been inscribed as a World heritage site by International Union for Conservation and Nature (1987) and included as Biosphere Reserved under United Nations Educational, Scientific and Cultural Organization (UNESCO) Man and the Biosphere (MAB) programme list (2001). Recently, in February 2019, the Indian Sundarbans have also been designated as 'Wetland of International Importance'. Indian Sundarbans are rich in canal systems which covers an area 907.33 ha (Table 1&2) and exist highest at Gosaba block (427.34 ha). The natural forms of these resources are excavated for freshwater by erection/ setting up of sluice gate in the connecting channel of the parent river. Human settlements are prominent in both the banks of these canals in Indian Sundarbans. Industrialization and consequent urbanization in this era has brought environmental degradation and stress on coastal ecosystems of India, which adversely impact their inherent biota, physico-chemical profile of water and productivity. Sundarbans is not an exception from these anthropogenic pressures thereof. Large numbers of canals in Indian Sundarbans are fed by the tidal water through connecting channels (Fig. 1). Naturally, fish enter into these canals and some fish species form natural populations. Yet, information on trophic status of canal habitat, biotic community structure and hydrographical characters are lacking. Hence, ICAR-CIFRI initiated the investigation on trophic status of canal habitat, biotic community structure on three canals; *Bhetkimari* (21°44'29.7"N 88°15'06.7"E) and *Bherua* canal, (21°36'38.0" N 88°15'21.1"E) in Namkhana and *Bishalakhi* canal (21°46'47.3"N 88°05'30.6"E) in Sagar Island of Indian Sundarbans.

Table 2. Total Inland water resource and area under culture of West Bengal

Resources	Area (in lakh ha)	Area under culture (in lakh ha)
Open water systems		
Rivers	1.64	-
Canals	0.80	-
Reservoirs	0.28	0.13
Estuaries	1.50	-
Enclosed water bodies		
Tanks and ponds	2.88	2.61
Floodplain lakes/ derelict water bodies	0.42	-
Beels and Boar	0.42	0.21
Sewage fed fisheries	0.04	0.04
Brackish water fishery	0.60	0.59

Source: Adapted from Mahapatra *et al.* (2015)

Physico-chemical properties of soil and water in selected canals of Sundarbans

The preliminary investigations of ICAR-CIFRI in selected canals (Namkhana and Sagar Island) of Sundarbans revealed that canals are generally experienced with 8-10 feet

Fig. 1. A typical view of a canal in Sundarbans

depth during peak monsoon season (Fig. 2). Salinity is one of the important criteria in these canals where it fluctuates from 0.02 ‰ (monsoon season) to 18.76 ‰ (pre-monsoon season). The salinity levels are highest during pre-monsoon due to high rate of evaporation and lowest during monsoon season owing to high precipitation. Concurrently, low level of tidal influx is also a cause of increased salinity in some of the canals in Sundarbans. It is imperative to mention that the freshwater dominated canals are reaching maximum salinity up to 6.0% during pre-monsoon season (e.g. *Bherua* canal, *Shivpur*) which may be favorable for carp culture practice. Water temperature of the investigated canals ranged from 25.8-34.2°C round the year. Water pH found to be neutral to alkaline (7.60-8.35) with optimum range of dissolved oxygen (5.7- 6.23 mg/l) which is the most critical limiting factor for normal growth and survivability of fishes. Total alkalinity (107-188 mg/l) indicated productive nature of the canals. Water transparency (Secchi disc) in the canals recorded lowest during monsoon (28.8 cm) and highest during pre-monsoon season (45.2 cm) with average phytoplankton production 145.0 mgC/m³/hr in the selected canals.

Soil quality is an important factor in aquaculture productivity as it maintains the bottom stability. Soil texture of the Sundarbans canal is sandy-loam (67.33%). Soil pH was alkaline in nature. Organic carbon acts as source of energy for microbes that release nutrients through biochemical processes. It was low to medium (0.38-0.60%), which indicated there was no organic matter accumulation at the bottom of the canals. In general, soils under brackish water contain good amount of available phosphorous which is beneficial to the growth of fish food organisms. Accumulation of good quantity of available nitrogen and phosphorus in canal soils are considered to be productive environment.

Fig. 2. Field visit of trainees/ fishers to ICAR-CIFRI experimental site, Bherua Canal, Shivpur

Biotic communities

The assemblage of biotic community indicates the productivity of water body. Phytoplankton population, the biological wealth of an aquatic ecosystem, responsible for wide assemblage of biotic community and regulate the food web. Zooplankton, being the primary consumer in food chain, plays an important role in transfer of energy to the higher trophic level. Zooplankton is also fed upon by many juvenile and adult zooplanktivorous fish species and hence it can be termed a key factor in the control of fish stock sizes. The occurrence of these organisms largely depends on the seasonal variations of physico-chemical parameters, physiographic factors and flow characteristics of the water body.

Phytoplankton and zooplankton populations in the selected canals exhibited significant variations in abundance in seasons. Cyanophyceae excelled as a major microfloral component (>35%) followed by Bacillariophyceae (>28%) and Chlorophyceae (>17%). Other algal groups (Coscinodiscophyceae, Euglenophyceaea, Trebouxiophyceae, Mediophyceae, Xanthophyceae, Conjugatophyceae, Synurophyceae) contributed partially and fluctuated much in seasons. Dinophyceae contributed least (<1%) contribution to the algal community. Diatoms were the most diverse group across the seasons in these canals. Compositions of zooplankton represented; Crustacean nauplius> Rotifera> Copepoda> Copepod eggs > Cladocera> Ostracoda in the stated order. Richness and Shannon-Weiner diversity index with a calculated value >2.95 in the studied canals indicated moderately rich phytoplankton diversity in the systems. Similarly, Pielou's evenness index also calculated with a mean value 0.88 showed the evenly spatial distributions of phytoplankton in the studied canals.

Periphyton is the heterogeneous group of community assemblage that attached in plants, woods, stones and various other substrates. It has great importance as primary producers together with phytoplankton and macrophytes which provides foods to many aquatic organisms. The periphytic associations in the selected canals of Sundarbans showed the dominance of six groups which represented as Bacillariophyceae > Cyanophyceae > Coscinodisco-phyceae > Chlorophyceae > Conjugatophyceae > Nematoda. Diatoms invariably constituted the bulk of the population (> 66%) of the total periphytic community attached in the natural substrates. Macrobenthos; *Pila virens, Bellamya bengalensis, Pila globossa, Meiniplotica scabra, Tarebia granifera, Thiara lineata* were very common irrespective of seasons in the canals.

Small indigenous fishes (SIFs) are the major catch in these canals contributing >75% (showed percentage on the basis of studied canals) of the total catch. *Amblypharyngodon mola, Puntius*

sophore, Pethia ticto, Parambassis ranga, Chanda nama, Trichogaster spp., *Anabas testudineus, Macrognathus pancalus, Glossogobius giuris, Channa punctata, C. marulius, Salmophasia bacaila, Notopterus notopterus, Mystus gulio, Mystus* spp. *Chelon parsia, C. tade* were the major catch. Penaied and non-penaied prawns also contributed a good amount of share (<10.0%) to the total fish catch.

Canal fisheries development in Sundarbans

A degree of management stocks to be required to maintain a more productive sustainable fishery. With this view, since 2017, ICAR-CIFRI associated in staggered stocking of Indian major carps in various fresh water canals of (Bali and Gosaba block) Sundarbans with local village development team in a participatory approach. Need-based capacity building programmes are being organized in selected areas to promote canal fisheries as a livelihood options. Interventions are made by simply release of Indian major carp fingerlings in 6 canals of Sundarabans (Bali and Kalitala area) where fish production was obtained up to the tune of 800 kg/ha/year of table sized fish without supplementary feeding. Fish production can further be increased by following proper management strategies. Stocking of right size fish seed at right time and maintaining of water depth/ volume are the two major crucial factors for the fish production/ enhancement in these canals.

Recently, ICAR-CIFRI has initiated trial in 'net partition systems' for 'carp polyculture' in selected freshwater canals of Sundarbans (Bherua and Bishalakhi canal) where stocked IMCs are resulting good growth (ongoing). It was reported that after 6 months of culture period, the maximum size recorded for catla, rohu and mrigal was 1.2 kg., 1.0 kg and 0.80 kg respectively; which may encourage the local community to culture fish in canals. Experiment on culture practices with diversified fish species is urged to do on these canals and perennial irrigation canals in particular existed in various states. Systematic net partition systems covering large area with suitable low-investment fish culture practice/ enhancements in canals is one of the noble option for enabling fish productions and livelihood support of local people.

Lessons learned

- Advanced fingerlings (more than 80 mm) to be stocked in the canals to escape themselves from the predatory wild stocks available in the resources.
- A small portion can be utilized for *in-situ* raising of advanced fingerlings as stocking material for enhancement in canals.
- As canals are long stretch of water body, poaching is a major issue and need to be addressed. Creation of ownership among stakeholders for the canal fisheries is important.
- The inlets and outlets of the canals need to be covered with nets to prevent escape of fish from the canal and *vice-versa*.
- Capacity building of the stakeholders on canal fisheries is necessary to increase fish production.
- Governance is the prime issue as canals are common property resource.

SUMMARY

The study discussed about the potential culture practice/ enhancement in canals of Indian Sundarbans. It is understood that the canals or modified irrigation systems can supply additional livelihood support through fisheries to rural poor provided attention is given to this pre-existing habitat. Restoration of productive fisheries in canals needs management regimes to save water needed for farming and conserve sustainable fish stocks. Governance of canals is the major issues due to the conflict of interest between agriculture and fisheries as these are common property resource. At the same time, the probable impact on biodiversity and ecological integrity are concern, which needs more cutting-edge research on these resources. For successful management and development in this sector, it is essential to have the appropriate understanding of these ecosystems with site-specific suitable methodologies/ enhancement practices for fish production and also plausible guidelines which can maintain the role of canal fisheries as a social "safety net" along with promotion of fishers in the locality.

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