

Fisheries enhancement through stocking of fingerlings in Indian reservoirs

for doubling fisher's income and livelihood security

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Fingerling stocking and culture-based fisheries (CBF) is one of the major fisheries enhancement strategies practiced in reservoirs. In the recent years, the reservoir productivity in the country has improved through adoption of culture based fisheries coupled with financial assistance from National Fisheries Development Board (NFDB), Govt. of India and technical guidance from ICAR-CIFRI. The present study deals with the assessment of impact of fingerlings stocking on the major carp production in selected reservoirs in three different states. Successful adoption of CBF in 83 small reservoirs of Odisha led to the increase of fish yield to 204-323 kg/ha/yr. Similarly in Chhattisgarh the fish yield increased significantly from 48-160 kg/ha/year after scientific stocking of fingerlings in 34 reservoirs. The fish yield increased from 1.1 kg/ha/yr in 2004-05 to 43.46 kg/ha/yr in 2017-18 due to adoption of fish stock enhancement strategy in large reservoir of Madhya Pradesh. Stocking and management of fingerlings in these reservoirs resulted in increased availability of fish, enhanced food security, livelihood opportunities and increased farmer's income.

Keywords: Fingerling stocking, Fisheries enhancement, Livelihood, Small reservoir

IN India, the area under reservoir was estimated at about 3.5 million ha having enormous potential for inland fisheries development. Presently, stocking of fish in reservoir or culture based fishery is the most important strategy for sustainable enhancement of fish production. Enhancement of fish production through stocking was recorded in many reservoirs of India and other parts of the globe. Scientific assessment of the actual impact of stocking on the fish yield is lacking which is essential for fixing of the optimum stocking density and refining the stocking management for sustainable enhancement of fish production from the reservoirs.

The reservoirs of India are situated in tropical region with high nutrient turnover favouring natural productivity. The fish production in

India is low due to poor adoption of scientific stocking strategy and agro-climatic factors. Initially, in absence of scientific guidelines, the Indian reservoirs were stocked arbitrarily. Fish seed Committee of Government of India (1966) recommended stocking rate of 500 fingerlings/ha (40-150 mm). Despite of the recommendations, reservoirs were understocked owing to unavailability of quality seed and inadequate fund availability. After the boost in fish seed production in the country through induced breeding of carps coupled with financial assistance from National Fisheries Development Board (NFDB) after its formation in 2006, the stocking rate has increased over the years which has reflected in the increased fish yield from these water bodies. The stocking recommendations were later revised

to 500 fingerlings/ha, 1,000 fingerlings/ha and 2,000 fingerlings / ha for small, medium and large reservoirs, respectively.

The information on impact of stocking on fish yield in reservoir of India is sparsely and irregularly available. Although different states have their own stocking program but no recent systematic assessment has been carried out and documented properly in the recent years. Impact assessment of stocking was carried out only for selected reservoirs of India. As information on the impact of stocking is needed for development of stocking strategies for enhancing fish production in reservoir, an attempt for updating the information is highly needed. The Government of India is emphasizing on second blue revolution from eastern India particularly from the

inland open waters. In this background, the present study attempted to assess the impact of stocking on the fish yield i.e. the fish catch per unit area per unit time (kg/ha/yr) from selected reservoirs of India and discusses issues and suggests management measures and way forward for sustainable fisheries enhancement and livelihood security of fishers.

Methodology for assessment of impact of stocking

The data on stocking and production of Indian reservoirs were collected from respective state department of fisheries to assess the impact of stocking of Indian Major Carp (IMC) i.e. *Catla catla*, *Labeo rohita* and *Cirrhinus mrigala* fingerlings. Impact of stocking were statistically assessed by comparing the change in fish production between the initial year of stocking and the year after stocking of fish using suitable statistical tools such as student t-test. The pattern of stocking and fish yield and their relationship were shown using suitable graphs.

Impact of stocking of fingerlings on fish yield in Indian reservoirs

In India, NFDB and other organizations in collaboration with state fisheries department, stocking of fingerlings of IMCs was executed in reservoirs of different states of India. However the impact of stocking on fish yield was not properly assessed. The impact of this stocking programme on fish yield was highly necessary to find the optimum stocking density for maximum sustainable production. The fish yield has increased from 11.4, 12.3 and 49.9 to 33, 94, and 174 kg/ha/yr from large, medium, and small reservoirs respectively as a result of adoption of culture based fisheries and management practices through NFDB (Fig. 1 and 2).

Success stories of culture based fisheries in small reservoirs of Odisha

The basic data on reservoirs, fish stocking details and fish catch information were collected for the year 2012-13 and 2013-14 from

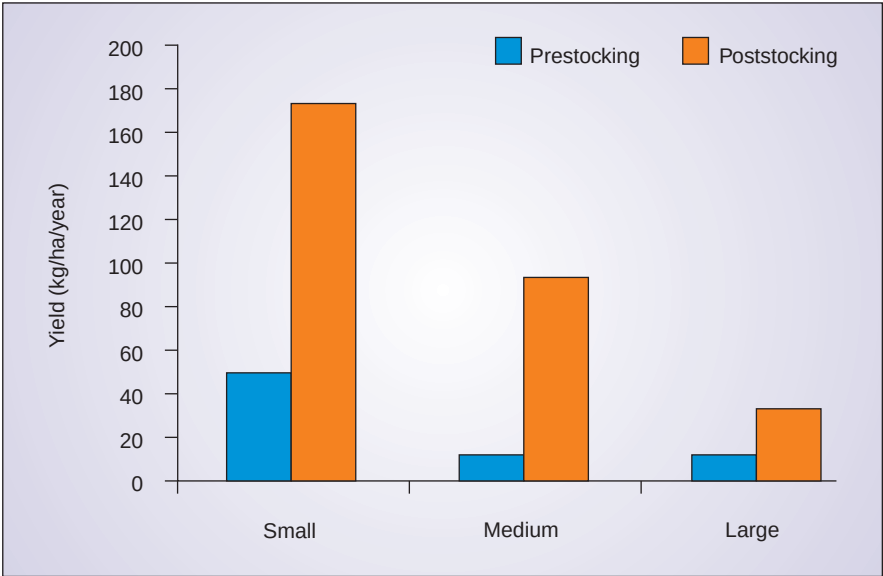


Fig. 1. Impact of stocking on small, medium and large reservoirs of India. Source: Adapted from Sarkar et al. 2018.

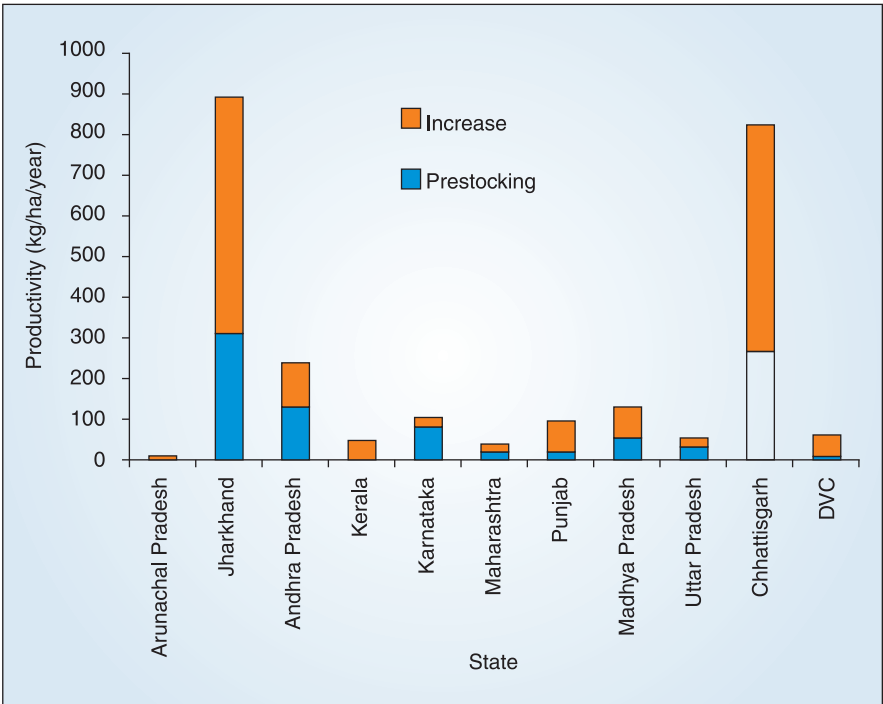


Fig. 2. Impact of stocking in reservoirs of different states of India. Source: Adapted from Sarkar et al. 2018.

Department of Fisheries, Odisha, India to assess the impact of stocking of Indian Major Carp (IMC) i.e. *C. catla*, *L. rohita* and *C. mrigala* fingerlings stocked in 83 small reservoirs from 19 districts during 2012-13 and 2013-14. The stocking programme was implemented with the financial assistance from ST & SC Development Department, Government of Odisha.

The mean production level of small reservoirs of Odisha increased significantly ($P < 0.05$, t-test) from

32.46 MT during 2012-13 (initial year of stocking) to 48.69 MT (after stocking) during 2013-14. It was observed that the fish yield of small reservoirs under this program was increased significantly ($P < 0.05$, t-test) from 204 kg/ha/yr during the 2012-13 to 323 kg/ha/yr during 2013-14. The per capita fish production was increased from 398 kg/fisher/year during 2012-13 to 702 kg/fisher/year during 2013-14. The visible change in per capita fish production was noticed in



Fig. 3. Fish harvest using gill net from reservoir

Mayurbhanj district.

Culture based fisheries/stock enhancement in Chhattisgarh

A total of 34 reservoirs of Chhattisgarh have been assessed for assessing impact of fingerling stocking. Highest fish yield of more than 300 kg/ha/year was recorded in Kirna reservoir. Fish yield increased significantly ($P < 0.05$) from 48 to 160 kg/ha/year after scientific

stocking of fish seed in reservoirs of Chhattisgarh (Fig. 3, 4 and 5).

Impact of fish fingerling stocking in Indirasagar reservoir, Madhya Pradesh

Indirasagar reservoir is located in Khandwa district at the heartland of India, Madhya Pradesh. The reservoir of Indirasagar Dam a multipurpose key project was built on the holy Narmada river near Punasa village. Indirasagar reservoir is the largest

water reservoir with an area of 91,348 ha at full reservoir level (FRL). Impact of stocking was assessed for 14 years (2004- 2018) based on the data of fish stocking and yield. The fish yield increased from 1.1 kg/ha/yr (Stocking Density: 86 fingerlings/ha/yr) in 2004-05 to 43.46 kg/ha/yr (Stocking Density: 304 fingerlings/ha/yr) in 2017-18 due to adoption of fish stock enhancement strategy (Fig. 6).

Recommendations and way forward

- The carrying capacity of the water body must be considered while formulating stocking strategy as the fish yield potential varies from reservoir to reservoir and region to region.
- Stocking of advanced fingerling (~120 mm) would ensure better survival especially in reservoirs dominated by the large predatory fishes. Also, efforts should be made to remove large predatory fishes through repeated netting or with hook and line.
- Some reservoirs covered under the study were struggling with low



Fig. 4. Fish catch from reservoirs for marketing

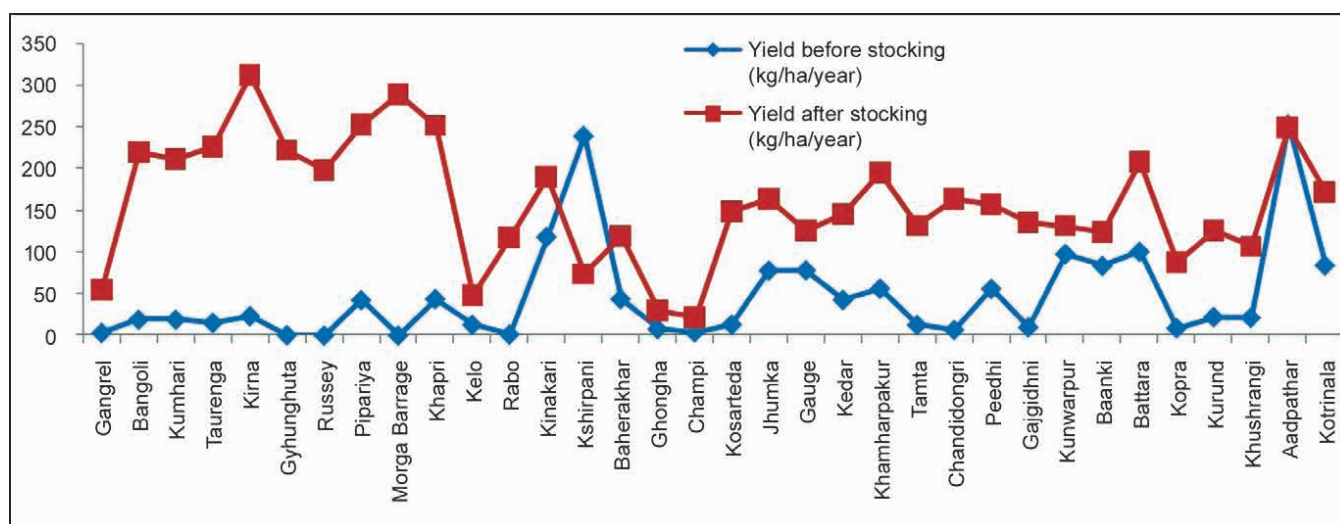


Fig. 5. Impact of fish stocking and yield of 34 reservoirs of Chhattisgarh

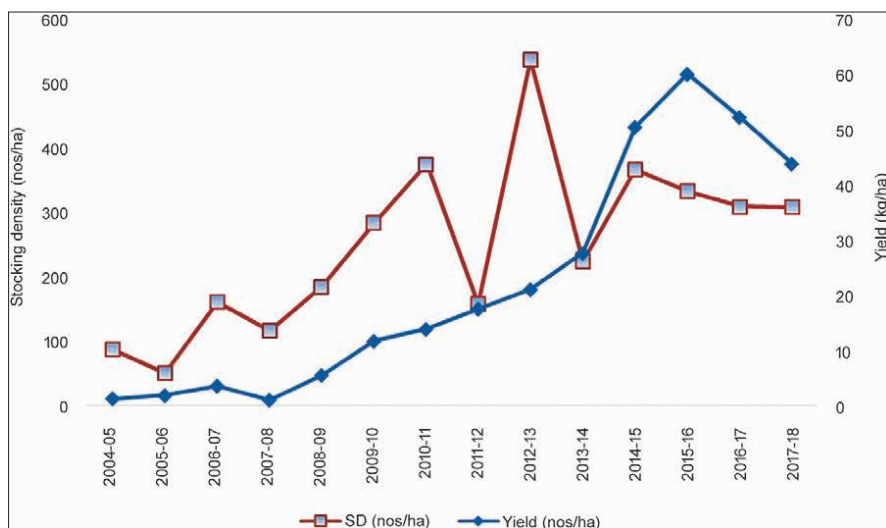


Fig. 6. Trends of fish stocking and yield in Indirasagar reservoir, Madhya Pradesh



Fig. 7. Sensitization of culture based fisheries to the fishers of reservoirs

water level during summer and were frequently affected by the extreme climatic events like flood and drought. Hence, reducing water diversion, adoption of deep pool refuge, late stocking, early harvesting etc. can be used as adaptive management strategies.

- Onsite nursery rearing in cutoff pools, cages, pens etc. by the Primary Fishermen Cooperative Society (PFCS) should be promoted and replicated to the other reservoirs, where adequate quantity and optimum sized fingerlings are not available for stocking.
- Systematic records on stocking, harvesting, gear operated, catch per unit effort (CPUE), fisher's income etc. should be maintained by DoF to quantify the impact of the

launched developmental schemes. Moreover, time series data on stocking, environmental and climatic conditions prevailing will help in estimation of weather pattern influences on fish yield.

- Application of remote sensing for delineating the effective water area will optimize the stocking rate as fluctuating water levels may cause massive mortality of the stocked species.
- Impact assessment of climate variability and extreme climatic events on culture based fishery of reservoirs should be done to devise appropriate strategies to mitigate negative impacts in future and to ensure livelihood of fishers (Fig. 7).
- For sustenance of the CBF in small reservoirs, the PFCS should be strengthened to take up such kind

of enhancement programs independently in respective reservoirs with no or minimal financial assistance in future.

- Ecosystem based model for estimation of optimum density for sustainable fish production in reservoirs.
- Understanding of ecosystem functioning of the tropical reservoirs for development of climate resilient reservoir fisheries.
- Knowledge based management practices with adequate budgetary support in participatory mode.
- Development of region specific management protocol by utilizing the information of ecological status and fisheries information.

Conclusion

CBF is a stock enhancement practice suitable for water bodies that do not support sustainable fisheries through self-recruiting fish populations. The present findings clearly indicated that stocking rate (1,000 nos./ha/yr) recommended by National Fisheries Development Board, India enhanced the fish yield, however, the impact on fish yield depends on habitat quality, natural productivity, size and management. Estimation of the potential fish yield and generation of basic data on fisheries and ecology are needed for each reservoir for optimising the stocking density and adopting reservoir specific management strategies. Scientific record of stocking and yield data is extremely important as time series data on stocking and production are needed for generating optimum stocking density. Awareness and training for the fishers and cooperative society members are recommended for the better fisheries management of reservoirs in terms of stocking, harvesting, marketing and profit sharing etc. to support the livelihood of fishers living in and around the catchment of the reservoirs.

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