AgriCos e-Newsletter
ISSN: 2582-7049
AgriCos e-Newsletter
Open Access Multidisciplinary Monthly Online Magazine
Volume: 05 Issue: 07 July 2024 Article No: 12

Harnessing India's Reservoirs: Advancing Inland Fish Production through Sustainable Cage Culture

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SUMMARY

Indian reservoirs, often dubbed "sleeping giants," hold significant potential for boosting inland fish production through cage culture. Despite India's leading role in global aquaculture, its freshwater fish production remains predominantly pond-based. Cage culture, which involves cultivating fish in enclosures within natural water bodies, presents a viable solution to enhance productivity without expanding land-based farms. This article explores the evolution and current status of aquaculture in India, particularly focusing on the innovative approaches under the Pradhan Mantri Matsya Sampada Yojana (PMMSY) aimed at promoting inland cage culture. The analysis covers economic models, social relevance, and the environmental impacts of cage culture, highlighting both the opportunities and the challenges faced in the sustainable development of this sector.

INTRODUCTION

Indian reservoirs, often termed "sleeping giants," possess immense potential for cage culture, yet their contribution to inland fish production remains disproportionately low as freshwater aquaculture in India is largely a pond-based system. Culture of fish in enclosures such as cages installed in open water bodies offers scope for increasing production, obviating the need for more land-based fish farms. Among the new methods in the discipline of aquacultural engineering, the cage culture system is used for the commercial culture of aquatic species, particularly fish, in various aquatic habitats

What do you mean by aquaculture?

Aquaculture usually defined as farming of aquatic organisms such as fish, crustaceans, molluscs, and aquatic plants, under controlled conditions which involves the cultivation of both freshwater and marine species in various types of enclosures or facilities such as ponds, tanks, cages, and raceways. It is also known as “Underwater Agriculture”

India's position in aquaculture:

India’s stance in aquaculture started from a meagre of 7.5 lakh tons in 1950–51, the country's overall fish production reached a record 162.48 lakh tons annually in 2021–22, growing by 10.34% from 2020–21. With an approximate 8% share of the world's fish production, India is currently the third-largest fish-producing nation. According to him, it is the nation that produces the most cultivated shrimp globally and ranks second in aquaculture production. While in the case of inland fish production which was primarily driven by aquaculture had a startling 400 percent growth occurred in the inland fish production from just 28.23 lakh tons annually in 2000–01 to 121.21 lakh tons annually in 2021–22.

	Total production	2010 Cage production (thousand tonnes)	Contribution (%)	Total production	2015 Cage production (thousand tonnes)	Contribution (%)	Total production	2020 Cage production (thousand tonnes)	Contribution (%)
China	19913	1131	5.7	24642	1379	5.6	25684	321	1.2
Indonesia	1332	121	9.1	2955	191	6.5	3390	650	19.2
Bangladesh	1147	---	---	1831	2	0.1	2294	5	0.2
Egypt	920	160	17.4	1175	173	14.7	1592	201	12.6
Thailand	404	40	9.9	391	33	8.4	369	32	8.7
Philippines	308	103	33.3	303	95	31.2	285	74	26.0
Russian federation	115	25	21.6	138	30	21.6	189	59	31.2
Colombia	68	23	33.5	93	19	20.8	173	30	17.5
Turkey	79	---	---	101	70	69.0	128	100	78.0

Cage Culture in Indian Reservoirs:

Reservoirs in India are commonly referred to as "sleeping giants" since they produce around 3.81% of all inland fish production through cage culture. As a result, the Department wants to utilize 3.54 million Ha of reservoir potential. In order to maximize production through culture-based fisheries in small and medium reservoirs, numerous steps have been made to promote cage culture in reservoirs in a sustainable manner. The Department has concentrated on raising the present fish production through cage culture from 2.44 lakh MT to 6.29 lakh MT by FY 2024–2025 in order to fully use its potential. This will be accomplished by tapping at least 60% of the reservoirs and increasing the productivity of all types of cages (small, medium, and large). It is estimated that to achieve that goal, 750 crore fingerlings will be required annually. In order to fully use reservoirs, the Department will concentrate on implementing an integrated strategy that includes building strong post-harvest management, marketing connections, and other supporting infrastructure. Furthermore, increased stocking density, high-quality feed, better disease control, and species diversification to include pangasius, tilapia, minor, medium and exotic carps are all contributing factors to the attainment of high fish yields.

PMMSY Schemes for inland cage culture:

The scheme "Pradhan Mantri Matsya Sampada Yojana (PMMSY)" was launched by the Department of Fisheries; Ministry of Fisheries, Animal Husbandry, and Dairying in 2019 to bring about ecologically healthy, economically viable, and socially inclusive development of the fisheries sector of India.

Under PMMSY for inland cage culture:

For Installation of Cages in Reservoirs – Per Unit cost 3 lakhs

Government Assistance (Rs. lakhs) - General (40%) SC/ST& Women (60%)

(i) The Beneficiary will obtain necessary prior permissions from the concerned State/UT Government and other Competent Authorities for installation of cages in reservoirs. Allotment of water area by the State/UT Government for cage culture would be as per the prevailing leasing policy/guidelines of the State/UT

(ii) The reservoir identified for cage culture should contain water throughout the year with an approximate depth of 8 meters at the cage installation area.

(iii) Beneficiaries will submit Detailed Project Report(DPR) with justification, capital cost, recurring cost involved, source of funds for meeting the beneficiary contribution including bank consent for providing loan, undertaking of beneficiary to the effect that no other governmental assistance is availed for the proposed project, anticipated direct & indirect employment generation to local population, enhancement of fish production and specific time lines for implementation of project etc.

(iv) The Governmental financial assistance will be restricted to a maximum of 5 numbers of cages for individual farmer/beneficiary and a maximum of 20 Nos of cages at a particular location for a group such as cooperative societies/SHGs/JLGs etc., having minimum 10 members. As far as FFPOs/Cs are concerned, the modalities of implementation and upper ceiling on the total units eligible for support would be decided by the CAC.

(v) In case of Exotic Fish Species, permission from Govt. is mandatory.

Who are all the eligible burrowers?

The following category of borrowers are eligible to avail credit for inland cage culture.

• An Individual

• FPOs / A company
• A Partnership firms
• A co-operative society
• A group of fish farmers.

Training in fish farming will be provided by the State Fisheries Departments to the eligible borrowers and it is essential that the borrower has prior knowledge of cage fish farming before availment of bank loan.

Economic analysis for inland cage culture under PMMSY:

Model 1:(Battery of 4 cages Each cage dimension - 6m x 4m x 4m (Ix b x h) Volume - 96 CuM each cage

S.No	Particulars	Nos	Amount (₹)	Unit cost as per PMMSY, * GoI (₹)
A	Capital cost			
1	GI Cage including construction of 6m x 4m x 4m, Floating Materials and Other Accessories	4	4,82,100	
	Subtotal of A		4,82,100	
B	Recurring cost			
1	Fingerlings - Pangasius / Monosex Tilapia / other suitable species) (Total 16000 nos. @ 4000 seeds in each cage i.e. 2.50 Rs. per seed) (600 seeds per kg)	4	40,000	@ 3,00,000 per cage
2	Formulated Floating Feed (15000 Kg.@ 45 Rs. /Kg) (size 1mm to 4 mm)	4	6,75,000	
3	Medicine Cost		4000	
4	Miscellaneous Cost		6000	
	Subtotal of B		6,89,000	
	Total Cost (A+B)		12,07,100	12,00,000

Income and Expenditure:

1	Culture period (Months	10
2	Stocking Density of Seeds (Nos)	16,000
3	Average Survival rate of seeds (80% survival)	12,800
4	Average annual growth rate of fish (kg) in 1st year	0.75
5	Average annual growth rate of fish (kg) in 2nd year	0.90
6	Fish Production in 1st year (kg)	9600
7	Fish Production from 2nd year onwards (kg)	11,520
8	Farms gate price (Rs/Kg)	110
9	Gross annual income in 1st year	10,56,000
10	Annual recurring cost in 1st year	6,89,000
11	Annual net income in 1st year	3,67,000
12	Annual income from 2nd year onwards	12,67,000
13	Annual recurring cost in 2nd year	6,89,000
14	Annual net income in 2nd year	5,78,200

Model 2:
(Battery of 2 cages) Each cage dimension - 6m x 4m x 4m (Ix b x h)
Volume - 240 CuM each cage

SNo	Particulars	Nos	Amount (₹)	Unit cost as per PMMSY, * GoI (₹)
A	Capital cost			
1	GI Cage including construction of 6m x 4m x 4m, Floating Materials and Other Accessories	4	2,41,100	
	Subtotal of A		2,41,100	
B	Recurring cost			
1	Fingerlings - Pangasius / Monosex Tilapia / other	4	20,000	@ 3,00,000 per cage

	suitable species) (Total 16000 nos. @ 4000 seeds in each cage i.e. 2.50 Rs. per seed) (600 seeds per kg)			
2	Formulated Floating Feed (15000 Kg.@ 45 Rs. /Kg) (size 1mm to 4 mm)	4	3,60,000	
3	Medicine Cost		4000	
4	Miscellaneous Cost		6000	
	Subtotal of B		3,90,000	
	Total Cost (A+B)		6,31,100	6,00,000

Income and Expenditure:

1	Culture period (Months	10
2	Stocking Density of Seeds (Nos)	8,000
3	Average Survival rate of seeds (80% survival)	12,800
4	Average annual growth rate of fish (kg) in 1st year	0.75
5	Average annual growth rate of fish (kg) in 2nd year	0.90
6	Fish Production in 1st year (kg)	4800
7	Fish Production from 2nd year onwards (kg)	5760
8	Farms gate price (Rs/Kg)	110
9	Gross annual income in 1st year	5,28,000
10	Annual recurring cost in 1st year	3,90,000
11	Annual net income in 1st year	1,38,000
12	Annual income from 2nd year onwards	6,33,600
13	Annual recurring cost in 2nd year	3,90,000
14	Annual net income in 2nd year	2,43,600

Who are all the owner of these cages?

Cage culture is carried out on resources owned by the community, as opposed to land-based aquaculture, which is conducted on private property. Therefore, it is crucial to give careful thought to the ownership of the cages that are placed in reservoirs. The following information must be taken into account before responding to the question.

- The government or government agencies own nearly all of the nation's big and medium reservoirs, and fishermen have free or nearly unrestricted access to these bodies of water as common property resources.
- Fisheries communities, both traditional and local, possess the "natural primary rights" to fish derived from the reservoirs, as it is fundamentally a natural resource.
- Fishing from reservoirs provides a living for a large number of the impoverished.
- Fishing in reservoirs is occasionally utilized as a rehabilitation strategy for those evicted from dam construction sites.

If cage culture diminishes the water body's natural productivity, local fishermen may lose access to fishing sites, have their routes obstructed, and see a decrease in fish harvest. Utilizing the enhanced fish production potential through cage culture is equally vital at the same time. Empowering the fishermen to take up this task collectively without conflict is the best strategy to accomplish the goal, given the requirement to avoid conflicts. Allowing individual investors and corporate entities to engage in cage culture as part of a strictly profit-driven strategy will go against the spirit of inclusive growth and may cause societal unrest. Thus, the community (or a group of members of the community) should own the cages as a common property and they should be the beneficiaries of this technology.

Cage Culture Challenges and Solutions in Indian context:

Despite its potential benefits, cage culture in India faces several challenges that need to be addressed for sustainable growth. Regulatory constraints, such as licensing requirements and environmental regulations, can hinder the expansion of cage culture operations. Additionally, concerns related to water quality management, disease outbreaks, and feed sourcing pose technical challenges for fish farmers. To overcome these challenges, stakeholders must work together to develop and implement appropriate solutions, including the adoption of best management practices, improved infrastructure, and capacity building initiatives.

Social Relevance:

Cage culture has significant socio-economic impacts in India, particularly in coastal and rural areas where aquaculture activities are concentrated. By providing employment opportunities, income diversification, and poverty alleviation, cage culture contributes to the socio-economic development of these communities. Fish farmers, especially small-scale producers, benefit from increased income and improved living standards through cage culture. Moreover, the expansion of cage culture can stimulate economic growth in related industries such as feed manufacturing, equipment supply, and fish processing, thereby creating a ripple effect throughout the economy. Overall, cage culture plays a vital role in supporting livelihoods and fostering economic resilience in Indian coastal regions

Environmental impact assessment of inland cage culture:

The effects of cage culture on the environment are not entirely known because it is a relatively new method of producing fish in India. Models for evaluating the effects of nutrient loading on the environment have been established in various nations. However, because of the different environmental regimes in which they were developed—particularly the differences in temperature and trophic status—these models are not immediately relevant in India. India is working on developing these models, but the findings won't be accessible anytime soon. However, the rapid expansion of cage culture operations is raising concerns, particularly in light of our negative experience with uncontrolled growth in coastal aquaculture throughout the 1980s and 1990s. Ecosystems have suffered greatly as a result of not addressing environmental challenges. Our approach to the EIA of cage culture should be based on caution, as per the FAO-CCRF standards for handling data-deficient systems... Therefore, the following actions must be taken for initiatives involving cage culture:

- The discharge of excessive nutrients that build up in water and sediments is one of the main environmental risks associated with cage aquaculture.
- Before going for cage culture projects, an environmental impact assessment is required in order to safeguard aquaculture operations from excessive nutrient loading in water and sediments as well as to safeguard the environment from the negative effects of cage culture (eutrophication and chemical/pharmaceutical inputs). Competent authorities and/or organizations will handle this and follow established procedure. States ought to have more authority over cage aquaculture operations through appropriate governing procedures.
- Using the trophic characteristics and other site selection criteria state governments should identify, list, and notify water bodies that are suitable for cage culture. With the assistance of relevant institutions, they should then upload the list of water bodies and their suitability on a GIS platform.
- With an eye on long-term environmental impact, cage culture operators will be required to document water quality metrics such as pH, CO2, total alkalinity, and dissolved oxygen both within and outside of the cages starting on the first day of operation. Any rise in nutrient levels outside of the cage area ought to be interpreted as a warning sign.
- In order to analyse the effects in terms of nutrient loading, cage culture operators will be required to gather data on the trophic status in and around the cages as well as the areas away from the cages on a regular basis and report to the authorities. According to the perceived danger, research on other chemical and physical quality indices of water and sediments will also be conducted.
- The NFDB and Central Organizations will strengthen the ability of States to analyse and draw conclusions from such data.

CONCLUSION

Cage culture in Indian reservoirs offers a promising avenue for enhancing inland fish production, contributing to economic growth and social development, particularly in rural and coastal areas. The government's initiatives, such as the PMMSY, provide crucial support for expanding cage culture sustainably. However, the success of these initiatives hinges on addressing regulatory, environmental, and technical challenges. Implementing robust environmental impact assessments, fostering community ownership, and enhancing training and infrastructure are essential steps toward realizing the full potential of cage culture in India. With careful planning and execution, cage culture can significantly bolster India's aquaculture sector, ensuring ecological balance and socio-economic benefits for the fishing communities.

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