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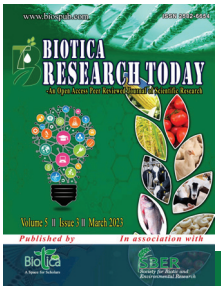

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Scope of Cage Aquaculture System in Bihar: Way towards Unlocking the Potential of Inland Open Water Bodies

Abhilipsa Biswal[1*], Ravindra Kumar Tiwari[1], Shivendra Kumar[2], Anupama Kumari[3], Bharati Upadhaya[1], Sanchita Ghosh[1], Sumit Kumar Singh[1] and Pankaj Kumar[4]

[1]Krishi Vigyan Kendra, Birauli, Dr. Rajendra Prasad Central Agricultural University, Bihar (848 115), India

[2]College of Fisheries, Dholi, Dr. Rajendra Prasad Central Agricultural University, Bihar (848 125), India

[3]Directorate of Extension Education, Dr. Rajendra Prasad Central Agricultural University, Bihar (848 125), India

[4]Krishi Vigyan Kendra, Saraiya, Dr. Rajendra Prasad Central Agricultural University, Bihar (843 126), India

Corresponding Author

Abhilipsa Biswal

✉: abhilipsa@rpcau.ac.in

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Abstract

Several estimates proclaim that the demand for fish will be manifold incoming years and the inland fishery sector has to play a significant role in meeting this upsurging demand. The Cage aquaculture system is expected to play a significant role in fulfilling the vision of blue revolution in the country through incorporation of enclosure aquaculture in inland open waters. Bihar being the land of vast inland aquatic resource, where most of the large water bodies are in underutilized condition, adoption of cage aquaculture will effectively utilize the water bodies and will contribute towards enhancing the socio-economic status, increasing the employment generation as well as providing nutritional security to the people.

Keywords: Bihar, Cage Aquaculture, Inland Water, NFDB

Introduction

The grim reality of hunger crisis and child malnutrition has cannonaded India very hard with its rank in the Global Hunger Index for the year 2022 being 107 out of 121 countries. With the exponential growth of the ever-growing population, the undernourishment crisis is expected to be more menacing in the coming years. Bihar being the third most populated state of India, has struggled with high rates of hunger and malnutrition for years. According to National Family Health Survey (2015-16) about 38% children under 5 years age in Bihar are found to be stunted and 21% are found to be wasted (too thin for their age), which is quite higher than the national average. In this scenario, the availability of inexpensive protein source will enable people to come out of the perilous situation of malnutrition. Fish is being considered as the super food and the cheapest source of animal protein. Fish possessing of all indispensable sources of amino acids with high digestibility will serve as armour to contend against the problem of malnutrition. Currently, Fisheries sector exists as the fastest growing food production industry in the world. Considering the enormous potential of fisheries sector, it is targeted to enhance the total fishery production of the country from 14.16 million metric tons (2019-20) to 22 million metric tons by the year of 2025 through PMMSY. The aforementioned Yojana is aiming towards fulfilling the SDG goal of "Zero Hunger". Such an ambitious target on fish production, can only be achieved by focusing on various components of the Blue Revolution. Among the various components of blue revolution, one such component is "improving the productivity of existing water bodies". Bihar being the land to a vast stretch of untapped open inland water resources (Table 1), there exists a high scope to enhance fish production from these water bodies through adoption of new technical interventions such as enclosure aquaculture systems such as cage and pen culture systems.

In cage culture system fishes are cultured intensively in the enclosed net cage, allowing free circulation of water, which acquiesce the efficient utilisation of natural productivity and maintenance of good water quality condition throughout the culture period by removal of debris passively. Recently, there are more than 6000 floating cages present in India, which

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are constructed of different materials such as Galvanised Iron, Bamboo, High Density Polyethylene (Sugunan, 2015). Adoption and success of cage aquaculture in more than fifteen states through NMPS (National Mission on Protein Supplementation) and RKVY (Rastriya Krishi Vikas Yojana scheme), has convinced the scientific community with the possibility of enhancing the inland fish production in India through the propagation of cage aquaculture technique. This article is focused on elucidating the scope, benefits and drawbacks for development of the cage aquaculture system in Bihar.

Present Status of Fisheries in Bihar

Although there is a presence of vast inundated water bodies in Bihar, the consumption rate of fish is only 8.82 kg per capita annum^{-1} (2019-20) which is still lower than the recommendation for amount of fish consumption as per Indian Council of Medical Research (12 kg per capita annum^{-1}). Bihar being a landlocked state, marine and brackish water fish production is totally absent here. However, due to the abundance of freshwater aquatic resource it occupies 5th position in the country in inland fish production sector (including both culture and capture fishery production) with the total fish production of 6.41 lakh tonnes for the year of 2019-20. Although vast aquatic resources present in this state, it has been estimated that there still exists a huge gap between the demand and supply for fish consumption, which is approximately 43% (Kumar *et al.*, 2019). In this scenario cage aquaculture will not only contribute to curtail the demand and supply gap, but also will provide a mean for raising specific species, which is having high market potential for the specific region.

Table 1: Aquatic Resources of Bihar

Water Resources	Area
River	3,200 km
Reservoir	26,304 ha
Tank and Pond	93,218 ha
Oxbow lake and Derelict water body	9,000 ha
Chaurs and floodplain wetlands	9,41,000 ha

Feed and seed are major inputs in the aquaculture system. Although the annual fish seed production is 13727.18 lakh fry for the state of Bihar (2019-20), non-availability of fish seed of appropriate size (fingerling, advanced fingerling, yearling) for the different culture system in appropriate time, is the major constraint for culture fisheries sector in Bihar. This situation is making the state dependent on neighbouring states to cater its demand. Therefore, in order to make the availability of quality fish seeds throughout the year the cages can be utilised for the rearing of fish fry for production of advanced fingerlings and yearlings, thus this will establish the state as a self-dependent land in the fisheries sector.

Scope of Utilization of Existing Underused Water Body for Cage Aquaculture in Bihar

Cage aquaculture is a type of enclosure aquaculture system which exists as a net enclosure structure either floating at the surface of the water body or totally submerged where the fishes are held captive and grown in a high-density condition (Figure 1). In areas having unproductive flood plain wetlands, where yield from capture fisheries sector is low, cage aquaculture exists there as a suitable culture option to utilize the vast water resource for fish cultivation purpose. North Bihar regions have 30 rivers flowing through it, therefore the continuous action of river meandering is responsible for the formation of a series of oxbow lakes or flood plain lakes in the river plains of Bihar. Flood plain wetlands of Bihar constitute as high as 22.88% of total flood plain lakes of the Country. The north-east part of Bihar has a vast area of flood plain wetlands in the Gandak and the Koshi river Basin. However, a major portion of these kind of waterbodies are weed infested therefore the fish yield lies only in the range of 100-200 kg ha^{-1}, against the production potential of 1000-2000 kg ha^{-1}. An estimated water spread area of 9,000 ha exists in the form of Oxbow lakes providing immense potential for cage aquaculture in the state. Apart from flood plain wetland and oxbow lakes, Bihar is bestowed with more than 37 numbers of reservoirs which are mainly dependent on capture based fishery. The productivity of the reservoir is too less (2.5 kg ha^{-1} year^{-1}) as compared to the national average of 15 kg ha^{-1} year^{-1} signifying a huge scope for enhancement of productivity from reservoirs. Considering the oligotrophic nature of medium and large reservoirs in Bihar, there exists copious scope in enhancement of fish production potential through feed based intensive fish production system, such as cage aquaculture (Table 2).

Figure 1: Demonstration of intensive aquaculture operation in the cage at KVK, Birauli Maun, Birauli, Samastipur, Bihar

Benefits of Cage Aquaculture

Operational Ease

Fish feeds can be effectively utilized in the cage aquaculture system with minimum loss unlike pond based culture system. Close observation of feed intake and fish behaviour makes it easy for anticipating the occurrence of disease or abnormality in water quality. As sampling of fish is very simple and easy in cages, in time approach can be taken in the presence of any abnormalities.

Less Predation Pressures

Because the cage is meshed, the fish inside are less likely to be attacked by the predators, unlike pond-based aquaculture system where the rate of predation pressure is comparatively high.

Table 2: NFDB Guidelines for Cage Culture

Parameters	Guidelines
Shape of the Cage	Rectangular shape or square shape.
Size of the Cage	6 m × 4 m × 4 m.
Materials to be used	High Density Polyethylene, Galvanized Iron.
Water body selection	Surface area 1,000 ha or more at FRL (Full Reservoir Level).
Depth	At least 10 meter.
Cage maintenance	Should be painted with anti-corrosive paint and in order to remove bio-fouling should be scrubbed at the 15-days interval.
Species Cultured	Sutchi catfish (*Pangasianodon hypothalamus*).
Stocking density	For *P. hypophthalamus* 500-700 Nos. m^{-3} of 20 mm size fry for fingerling rearing and 60-100 Nos. m^{-3} of 50-60 mm size fish seed for grow out culture.
Health monitoring of fish	Provision of optimum stocking density, the application of prophylactic treatment before stocking, application of good quality feed and intermittent sanitation and cleaning of cage are the necessary measures to be undertaken for keeping the cultured fishes disease free. Apart from that a record should be maintained for indicating the occurrence of disease and medicines used for controlling the outbreak of disease.
Safety measures	Sufficient amount of life saving equipment, such as life buoys and life-jackets should be present for the safety of the workers. In order to prevent poaching and vandalizing, an efficient watchman should be employed for the protection of the cages.
Harvesting	Multiple harvesting should take place according to the market requirement and harvesting should be done in phased manner.
Environmental impact assessment	Environmental impact assessment should be done my measuring the alteration in physiochemical characteristics of water.
Carrying capacity of cages in the reservoir	A reservoir having area > 10,000 ha area maximum number of cages that can be installed is 5,000.
Ownership beneficiaries and governance	Cages should be owned by a group of members of the community and culture practice can be done collectively.

Simplified Harvesting & Less Labour Requirement

Partial lifting of the cage is done in order to harvest the fishes out of the water. By crowding the fishes to a small area or by simply dipping a net, the fishes are harvested out from the cage. Comparatively a lower labour charge is required than pond harvesting. However, unit area fish biomass productivity $cage^{-1}$ is higher than unit area productivity of Pond.

In comparison to the pond culture system treatment of disease becomes much simpler in the cage aquaculture system, thus survival rate is higher in this system. Installation of the cage is easy and can easily transfer the cage from one place to another place in case of any kind of emergency situation. Manpower requirement is also less in case of cage aquaculture. Considering all these benefits, the effective utilization of different kinds of untapped water resource could be done for fish production through the cage aquaculture system.

Constraints of Cage Aquaculture

Higher Feeding Practices

Complete dependency on artificial feed is one of the major problems associated with cage aquaculture. As fishes are reared in higher density, high dependency on artificial feed might increase the operational cost.

Susceptibility to Degradation of Physio-Chemical Characteristics of Water

Complete dependency on artificial feed degrades the water quality parameter by increasing the ammonia concentration. Chocking of nets by biofouling impedes the movement of water across the net enclosure to the reservoir. The selection of appropriate net size according to fish seed size, removal of biofouling, stocking of fish seed in appropriate number and monitoring of feeding according to the optimum requirement will help in maintaining the physio-chemical characteristics of water.

Susceptibility to Disease Occurrence

Crowding stress in cages usually promote disease in fish. Wild fishes around the cage could also transmit disease to the cultured fishes. Over-wintering of warm water fishes in cages might lead to bacterial and fungal disease and can cause high mortality. Therefore, overwintering should be avoided in cages. In addition to that if fry is being stocked in cages, the size above 25 mm will be suitable for rearing. A size below 25 mm will make the fishes prone to disease attack. The chances of disease infestation can be also diminished by stocking of advanced fingerlings, regular clearing of biofouling and cleaning of nets.

Vandalism and Poaching Problem

Usually, cages are easy target for poachers and Vandals. In cages the poaching problem is generally associated with growing out culture systems. Fries and fingerlings culture systems are not generally associated with the poaching problem. Cages should be placed in zones easy access of poachers and vandalisers can be controlled.

Cage culture not only increases the economic benefits of farmers but also decreases the occupational migration. This technology will contribute towards fulfilling the vision of the second Blue Revolution of India.

Along with *Pangasianodon hypopthalamus*, GIFT tilapia species can be recommended for culture in cages. Apart from these two species no other exotic species are recommended to culture in the Indian reservoir yet.

Conclusion

Through awareness programmes, the genesis of Self-help groups, creation of farmer producer organizations and by providing training to people on scientific management of the cage aquaculture system, the adoption and propagation of the cage aquaculture system can be accelerated in Bihar. As the market demand exotic species vary from place to place, appropriate researches need to be conducted to formulate the culture strategy for locally demanded indigenous species such as *Labeo bata*, *Labeo rohita* (Jayanti rohu), murrels (*Channa striata*, *C. marulius*), *Puntius sarana.* The potential of the cage aquaculture system for enhancement of the water productivity, new entrepreneurship and employment genesis, calls the urgent need of attention for Bihar fisheries department for focusing toward establishing the cage aquaculture system in various open water bodies.

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