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An extensive investigation on the current state of freshwater cage aquaculture in India

Ekta Kumari & Arun Kumar*

University Department of Zoology, B.N.M. University, Madhepura, Bihar, India

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Abstract- About 13% of the world's population gets their animal protein cheaply from aquaculture, which also employs an estimated 24 million people. By 2024, the sector is expected to have filled the worldwide fish protein gap as a result of static marine fish catches. Cage culture has been identified as one of the most effective methods to utilise underutilised water resources, notwithstanding the sector's diversity in terms of the species cultivated and farming techniques. The earliest attempts were made in India utilising Indian big carps in the Ganga and Yamuna rivers and air-breathing catfish in marshes. Later, the Powai, Govindsagar, Halali, Tandula, and Dimbe reservoirs were used by the Central Institute of Fisheries Education to conduct cage culture for the development of fingerlings and table-sized fish. The last ten years have seen a considerable success in cage culture after numerous attempts with average success. The National Mission for Protein Supplements and other state government programmes have supported this method, which has become well-established in Tamil Nadu and Jharkhand. A decision was made to expand fish production through cage culture.

Key words: Cage Culture, Fish Production, underutilised water resources,

INTRODUCTION

A brief description of cage culture

Due to the presence of over 2.25 million hectares of ponds and tanks, 3.0 million hectares of reservoirs, and 0.78 million hectares of beels, swamps, and other water bodies, India has a large potential market for cage culture, particularly in freshwaters. Cyprinids, perches, snakeheads, and catfish have all been successfully bred in cages thus far. In some aquatic bodies, cage culture can be carried out in extended, semi-intensive, and intensive ways. As a thorough method, cage culture uses phytoplankton and zooplankton from the water bodies rather than supplemental feed.[1] As a semi-intensive practice, cage culture calls for a low protein supplementary food (30%), and if the feed's protein concentration rises above that threshold, the approach can be viewed as being intensive. Farmers need to be trained in cage culture because it is a relatively new aquaculture method in India. Unplanned growth in cage culture can have negative environmental effects, thus it's important to establish appropriate rules to ensure this industry grows sustainably without having any negative effects on the environment.

Choosing a location for cages

One of the most crucial aspects of cage aquaculture practices is site selection, which takes into account parameters like water quality, water depth, and currents needed for the cage culture units. Important water quality parameters like dissolved oxygen, temperature, pH, and ammonia should be periodically checked when cultivating.

Since photosynthesis and wind action are the main sources of dissolved oxygen, a location with better wind and wave action will ensure that proper oxygen levels are maintained for the cultured animals. Dissolved oxygen

*Corresponding author :
Phone : 9006991000
E-mail : prf.arunkumar@gmail.com

should not go below 5 mg/l. Less than 4 mg/l of dissolved oxygen may result in low survival rates, poor growth, and fatality. A key physical factor governing molecular dynamics and biological processes is temperature. Unfavourable temperatures have an impact on the health, feeding habits, and rate of reproduction of fish. The ideal temperature range for the majority of warm water species is between 24 and 30°C. Another crucial factor is pH, which can change as a result of CO_2 absorption and release during photosynthesis, respiration, and decomposition. An ideal pH range of 6 to 9 is required for improved fish growth, while high pH can cause water bodies' ammonia levels to rise.[2] Ionised and unionised ammonia are the two types of ammonia. Ammonia with ions is more harmful to fish. Ammonia concentrations above their optimal (maximum) range of 0.02 to 0.05 mg/l can be influenced by temperature and pH.

About 6 metres of water is the ideal depth for successful cage aquaculture. The bottom of a cage must be at least 1 m away from the water's surface in order to prevent negative environmental effects, according to earlier cage culture experiences. To maintain appropriate water quality conditions inside the cages, the chosen area should have water current speeds between 20 and 30 cm/second. When the flow rate is more than 40 cm per second, feed may leak from the cages into the ecosystem, and the shape of the cage may alter, potentially stressing the fish and lowering yield.[3] As a result, careful consideration of the water current's speed and pattern is also crucial while placing cages. The location should be free from strong winds and waves because these factors might make it difficult to maintain the cages and, in the case of severe weather, even cause the cage system to collapse. Avoid areas that are prone to flooding, fish breeding grounds, local fishing areas, areas that receive industrial effluent, and areas where there are large concentrations of fish.

Benefits and Drawbacks

Compared to traditional pond culture, cage aquaculture techniques are simple to master and take up a lot less room. Cage culture enables the effective use of large quantities of water, such as lakes and reservoirs. Fish health monitoring, disease detection, and health management are made simple in cages. Individual cages also offer the potential for an efficient and thorough harvest, making it more economically viable than other extensive fish growing techniques.[4] There are certain restrictions, though. Natural disasters might bring the culture system to a halt, and the high density of the fish could cause disease to spread more quickly than in more broad culture systems. Problems with cages can arise with other stakeholder groups, such fishermen.

Construction of Cages

It is possible to practice with four different types of cages: surface floating, fixed, submersible, and submerged cages. The floating cage is the most popular, practical, and environment-friendly of these, especially in India. The location of the cage in the water can be simply changed depending on the water level. Aluminium, galvanised iron, stiff PVC, and HDPP pipes are examples of building materials.[5] The cages are floated using empty barrels, HDPP jerry cans, airtight PVC pipes, and fibreglass. Materials for netting and cages should be sturdy, resilient, lightweight, weather- and corrosion-resistant, fouling-resistant, easily repairable, affordable, and widely accessible.

Cage grouping and mesh size

Similar to the spacing between the cages, cage grouping is another crucial element. Perhaps 20 to 24 units, grouped in two rows of 10 to 12 cages each, can make up a cage battery. To enable water exchange and sustain dissolved oxygen levels, a certain distance must be kept between the cages. The cage culture units must be at least 20 to 25 metres apart.

The mesh size can be decided taking into account size of ûsh stocked. Generally maintaining larger mesh is better for ûsh stock as it allows for improved water exchange and dissolved oxygen levels and less fouling. Knotless mesh is recommended, as it allows better water exchange than normal knotted mesh. A mesh size of 4 – 6 mm^2 for fry rearing and 16 – 20 mm^2 for grow out are recommended.[6]

A net should be placed over cages to stop fish from jumping out or being eaten by birds. Due to consistent water quality that is less easily impacted by fish waste, larger water bodies are better suited for cage culture than smaller ones. Cages can also be installed in ponds that are between 0.5 and 2.5 hectares in size.

Species selection

The species chosen for cage culture depends on consumer demand, high market value, and seed availability on the local and regional markets. As a result, species with a higher market value can bring in more money. Poor species selection by the fish producer might result in poor marketability and loss because the most popular species in one market may be the least popular in another market.[7] Another crucial factor is seed availability; if there are no hatcheries for a species in the area, it is best to avoid using that species because it can force you to rely solely on wild gathering or suffer high shipping costs if you buy it from elsewhere.

The chosen species should be able to tolerate overcrowding, have good flesh, exhibit rapid growth, higher survival rates, lower food conversion ratios, ready acceptance of feed, rapid adoption of artificial diets, and exhibit higher disease resistance. The species that have been determined to be the best candidates for cage culture are the air-breathing fish, Indian major carps, *Tilapia*, *Pangasius*, etc.

***Pangasius*:-** The ideal *Pangasius* stocking density for fry (20 mm) and fingerlings (50 mm) is 500 to 600 individuals/m^3 and 80 to 100 individuals/m^3, respectively. In order to evaluate the fish's growth rate and overall health, periodic sampling is necessary. The average length of cage cultivation is six to eight months.

Indian major Carps:- With a minimum suggested stocking size of 15g, the ideal stocking density for Indian major carps is approximately 80 fish/m^3. Indian major carp fingerlings and advanced fry up to 25mm in size are suitable for harvesting. Minor carps (*Labeo catla*, *Labeo rohita*, *Labeo calbasu*, *Labeo gonius*, *Labeo bata*, and *Cirrhinus mrigala*) have a stocking size of roughly 1.3 to 2.6 g (40 - 65 mm) and can be harvested for about 15 to 36 g with a survival rate of about 70%.

Transportation and seed supply

To achieve excellent survival and development rates, seed should be purchased from a reputable fish hatchery after being quality-checked. Farmers should therefore observe aggressive swimming and quick acceptance of natural or artificial feed when buying seeds to determine the quality of the seed. The seed should be conveyed using the shortest route possible and in the morning or late afternoon. The seed should be placed in plastic bags with 1/3 water and 2/3 oxygen. When you get to the cage location, float the plastic bags in a water-filled container there for 15 to 20 minutes. To equalize the water temperature in the bag and the container, open the plastic bags, slowly splash small amounts of water into each, and then let the fish swim out on their own. Then, before releasing the seed into the cages, give it a dip treatment with salt (5%) or potassium permanganate (3-5%) to get rid of ectoparasites.

Stocking Density

The quantity of fish stocked per cubic metre in cages is referred to as stocking density, which affects fish development and survival as well as the water's quality and overall health. The carrying capacity, fish feeding habits, and stocking size all affect stocking density. Additionally, it is advised to stock animals of an even size to facilitate handling, prevent predation and cannibalism, and ease harvesting challenges. In order to achieve good development and survival, an ideal stocking density is necessary. Fish size and stocking density are inversely correlated. Higher stocking densities make it difficult for feed to be accessed; however this problem can be solved by evenly distributing feed around the cage. When managed according to optimum management practices, 15g fish with an ideal stocking density of 80 fish/m^3 can guarantee a survival rate of 98 to 100%.

Feed and feeding

In the shape of granules or pellets, feed supplies the fish with the balanced nutrients they require. For cage culture, floating pellets are preferable to sinking pellets. Farmers can also examine how fish respond to feeding and their general health thanks to floating pellets. When using sinking feed, extra care must be taken to prevent waste and maximise use. To prevent feed waste while using automatic feeders, floating feed is advised. The right nutritional elements must be included in fish feed to meet the needs of the fish. In semi-intensive cage culture, larger fish require just 20–30% of the total protein, though this varies depending on the species. However, for little tilapia and catfish (1 to 25g size), 32–36% of protein is required. Additionally, the feeding must last for at least 6 to 8 hours, and two feedings a day are sufficient.

To reduce feed wastes, it is necessary to maintain good feeding practices. Feeding should not be more than 3 to 5% of body weight. Through sampling, the feeding ration must be changed a few times every month. While the amount of the meal grew with the number of fish culture days, the percentage of feeding could be decreased. Mash-type feed should not be used because it can be dropped out of the cage, go uneaten, and affect the water's quality.

Management practices

Water samples from inside the cages should be taken routinely to assess the water quality parameters such dissolved oxygen, ammonia, and phosphate, and periodic records should be kept to track changes and alter management as necessary. In order to prevent excessive algal growth, which could restrict water exchange, cages should be cleaned as needed. Fish that have been stocked should have their health checked on a regular basis; if an illness is found, it must be quarantined and treated in accordance with the symptoms.

Harvest and marketing

Feeding should be discontinued one or two days prior to harvest. Harvesting should be done in stages, with larger fish being sold first and then smaller fish. This guarantees the crop's highest possible returns. The ability to harvest the appropriate quantity with minimal labour and keep the remaining animals alive at a minimal cost is cage culture's advantage.

In contrast to the current production of 16.24 Million Tonnes, India's expected demand for fish in 2022 is 19 million tonnes. The National Fisheries Development Board has implemented several programmes, including the fish brood bank, aquaculture intensification in ponds and tanks, reservoir fisheries development, cage and pen culture, infrastructure for post-harvest, modern fish markets, and a disease surveillance programme, with the goal of tripling the country's current fish production. The most effective method to fulfill the rising need for fish production, though, has been found to be cage culture.

CONCLUSION

The use of water resources is essential for cage cultivation. About 43,000 ponds and tanks of various sizes, covering a total of about 65,000 acres, are where the majority of Bihar's culture fisheries resources can be found. If cage culture is implemented in around 70% of the current reservoirs, tanks, and ponds, fish production is projected to increase by over 94,000 tonnes. This demonstrates unequivocally that cage culture is a successful method for raising fish productivity and that it also provides rural areas with economic opportunities.

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