Enclosure culture technologies for openwaters of Northeast

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Fish species selected for pen culture should be based on the availability of seed, market demand and the environmental conditions required by the species.

Introduction

Reservoir and wetland ecosystems of the country, despite having high fish production potential (1000-1500 kg ha-1 y-1) are producing sub-optimal fish yields. In order to realize potential from these resources, enclosure culture (pen and cage) technologies and adoption of fisheries enhancement options are important. Pen aquaculture is one of the low-cost with high economic return aquaculture practices that can be practiced at various management levels. The technology is suitable for open waterbodies such as floodplain wetlands, reservoirs, lakes and even in riverine pool zones having mild water currents. This technology is suitable for production of seed and table fish of Indian major carps, exotic carps, minor carps (Labeo bata, L. gonius, Osteobrama belangeri) and also small indigenous fishes (SIFs) such as Amblypharyngodon mola, Puntius spp. and Gudusia chapra. In Northeast India, cage aquaculture of major carps (Labeo rohita, Cirrhinus mrigala mainly for seed raising), minor carps (L. bata, L. gonius), exotic carps (Ctenopharyngodon idella, Cyprinus carpio) is being carried out on experimental basis with moderate success in certain floodplain wetlands (beels) of Assam and Arunachal

Pradesh, Loktak lake of Manipur, reservoirs of Manipur, Mizoram, Nagaland, Tripura and Meghalaya. Enclosure culture technologies were also proven to be climate resilient in wetlands of Assam and Manipur. Cages, pens with increased height before onset of monsoon and floating pens (using macrophyte mass called phumdi) were able to withstand flood condition. It is necessary to standardize package-of-practice for locally-preferred fish species and popularize the technology in NE India. Large-scale demonstration and adoption of the technology are required for the realization of optimal fish yield from inland waterbodies of the Northeast, thereby contributing to making this region self-sufficient in fish production.

Open waters of Northeast India

The Northeast India has about 8% of the country's geographical area and 4% of country's population, but possesses 44.85% of derelict water, 31.53% of wetlands, 10.36% of rivers and canals and 0.80% of reservoirs of the country. Northeast India is having a total of 3.84 lakh ha water resources in terms of reservoirs, tanks and ponds, beels, oxbow lakes and other derelict waters, except the rivers and canals which are extending to a length of 20,875 km in all the NE states of India taken together. Among capture fisheries resources, the floodplain wetlands reservoirs have high potential for fisheries development in NE India.

Pen aquaculture

A pen is defined as a fixed enclosure in which the bottom is the bed of the waterbody and the sides are enclosed with the bamboo screen or nylon net. Pens can be completely enclosed on all four sides in the middle of the waterbody with no foreshore, a shore enclosure with a foreshore extending to deep water surrounding by a net structure or a bay enclosure with an embankment or net structure only at the entrance. Pen culture is a low-cost and simple culture technology for enhancement of fish production from inland openwaters, especially wetlands. In the past, pens were used for purposes like short-term rearing of fin and shellfish, holding of fish temporarily for a short-period before transferring to the other places, but raising of fish in pens constructed in large waterbodies is gaining importance day-by-day, because survival and growth of carp fingerlings in pens is encouraging.

Pen aquaculture technology has been developed by CIFRI as an avenue for additional fish production in beels parallel to the enhancement of their capture fisheries/ stock enhancement, where a manageable part of marginal areas of the beel is encircled with net-lined split-bamboo screens (bana) for rearing of carp fingerlings/table fish. The technology is a good management option for macrophyte-choked shallow waterbodies where netting and catching fish is very difficult. Studies in Assam and Manipur showed that in situ raising of fingerlings as well as table fish production in pens is technologically and economically feasible in the floodplain wetlands.

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Pen culture trials for production of table fish in NE Region showed benefit cost ratio ranging from 1.3 to 3.2 and net production of 4125 to 6312 kg ha-1 y-1.

Advantages of pen aquaculture

Pen aquaculture is one of the most economical land-based culture systems offering many advantages. Pen culture technology (a) is a high-density culture practice with very high productivity potential, (b) is suitable for rearing compatible species together to fully utilize different ecological niches, (c) saves reared fish from predators, (d) is most useful for weed-choked unproductive water areas, where netting and catching of fish are highly difficult, (e) does not disturb the capture fisheries in a large waterbody, because pens are normally constructed in the marginal areas of the waterbody, (f) offers easy, rapid and complete harvesting of fish with lesser efforts, (g) offers exchange of water encouraging growth of natural fish food organisms inside the pens reducing cost of feeding fish to a certain extent, (h) offers easy monitoring of growth and health condition of stocked fish. However, pen aquaculturists should be aware of the fact that the site with strong water current, turbulence, wind and wave action is not suitable for pen culture because they may damage the pen structure. Entry of non-target small fishes is almost unavoidable inside the pens; these fishes will compete for food and space with the target species. One of the most important constraints in pen culture systems is the risk of theft, because fishes in the pens may be easily poached.

Fish species for pen aquaculture

Fish species selected for pen culture should be based on the availability of seed, market demand and the environmental conditions required by the species. The desirable characteristics in the candidate species for pen culture are fast growth rate, high survival rate, adaptability

to overcrowding, easy acceptance of supplemental feed, high feed conversion ratio and disease resistance. The Indians and Chinese carps (Catla catla, Labeo rohita, L. calbasu, L. bata, Cirrhinus mrigala, Cyprinus carpio, Hypophthalmichthys molitrix and Ctenopharyngodon idella), air breathing fish (Clarias magur, Heteropneutes fossilis), climbing perch (Anabas testudineus), snakeheads (Channa striatus, C. marulius) and freshwater prawn (Macrobrachium rosenbergii) satisfy most of the above characteristics for pen culture in India. Polyculture of carps in pens with 40% surface feeders (catla Catla catla & silver carp Hypophthalmichthys molitrix), 20% column feeder (rohu Labeo rohita), 30% bottom feeders (mrigal Cirrhinus mrigala & common carp Cyprinus carpio) and 10% macrophyte feeder (grass carp Ctenopharyngodon idella) is normally practiced. Fish species of local importance such as Osteobrama belangeri (pengba) and Labeo gonius (kuri) performed well when stocked in net pens in Takmu pat of Manipur. Labeo bata, Barbonymus gonionotus and other small indigenous fishes like Puntius sarana, Amblypharyngodon mola and Gudusia chapra can also be stocked along with carps for additional income from the pens.

Cage aquaculture

Cage aquaculture can be defined as rearing of aquatic organisms in a volume of water enclosed on all sides with cage netting materials including bottom, while permitting free circulation of water through the mesh of cages. The technology is suitable for almost all kinds of waterbodies provided there is sufficient water depth so that the bottom cage net is at least 2 m above the bottom of the waterbody. In India, cage culture was attempted for the first time in case of air-breathing fishes like Heteropneustes fossilis and Anabas testudineus in swamps during the 80s. Trials on cage culture carried out at Darbhanga (Bihar) and Guwahati (Assam) under Coordinated Research Project on Air-

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breathing fish culture demonstrated production level of 0.3, 0.7, 1.0, 1.7, 1.5 and 1.3 kg/m3/month in Anabas testudineus, Heteropneustes fossilis, Clarias magur, Channa striatus, C. punctatus, respectively. The optimum stocking density of Cirrhinus mrigala fry and Labeo rohita fry in net cages for stock enhancement purpose was standardized at 300 and 200 fry/ m3, respectively in beels of Assam.

Experiments were carried out in floodplain wetlands (beels) of Assam to optimize stocking density of commercially important minor carps. Considering the fish yield and economics of cage aquaculture system, a stocking density of 75 fingerlings m-3 was recommended as optimum for rearing L. bata up to advanced fingerlings during winter months and a stocking density of 30 fingerlings m-3 for producing table sized fish of L. bata. In case of L. gonius, a stocking density of 40 fingerlings m-3 was recommended as optimum for table fish production. Cage culture of the endemic minor carp Osteobrama belangeri was tried for the first time in Takmu pat of Manipur. A stocking density of 20 fingerlings m-3 was found to give economic production considering the high cost of seed. In spite of small and large-scale demonstrations and experiments conducted in wetlands of Assam, Manipur and Arunachal Pradesh and some reservoirs of the region, cage culture is yet to make an impact, mostly because of limited adoption and low-level of management. However, it has been recommended to expand cage aquaculture only up to 1% of the total water area of beels so that there is no problem of eutrophication in years to come.

Advantages of cage aquaculture

Rearing and raising of fishes in cages is gaining importance all over the world because of its increasing technical, ecological, social and economic advantages over capture fisheries and conventional aquaculture. Cage culture technology is (a) compatible and not competitive with other fish production systems and complementary to some, (b) applicable to almost all aquaculture species, (c) ideally applicable in openwaters where low fish yield and other fishery development is impractical, such as inland reservoirs and large rivers, (d) basically developed and ready for practical application in freshwater environments, (e) technologically simple, (f) not capital intensive, (g) economically and technologically available to all sectors of society including uneducated and poor, small-holder farmers, (h) more adaptable than conventional aquaculture to matching production to market demand. It also has social advantages in that landless people can find habitation and employment in cage aquaculture. Small-scale cage aquaculture is a flexible technology adaptable to the needs of poor people by placing only the cages under the ownership of the landless.

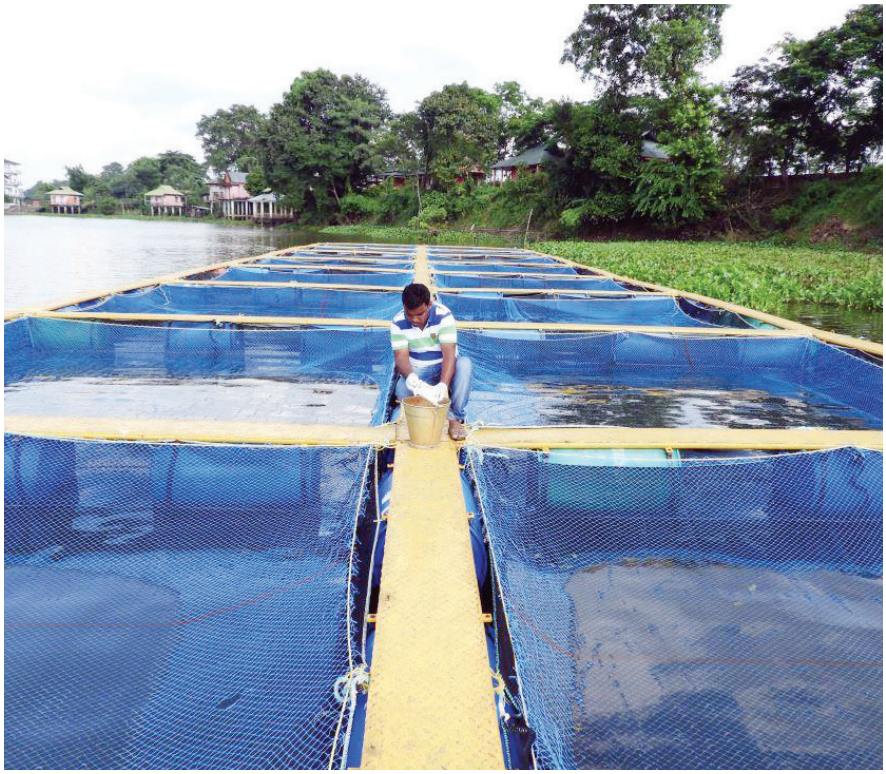
Stock enhancement through enclosure culture

Fish stock enhancement (i.e., augmenting the stock of desirable fish species) is one of the most common and effective management

measures followed in the beels of Assam, which can also be practiced in many of the reservoirs. However, the major constraints of practicing stock enhancement in open waterbodies at large-scale are (i) non-availability of carp fingerlings of desired size i.e., about 10 mm or above in required quantities at the beel site, (ii) high cost of carp fingerlings and (iii) associated high mortality during transportation. All these constraints can be overcome by in-situ rearing of fingerlings in pens/ cage within the beels. Enclosure culture, especially for raising stocking material offers a great scope for the effective utilization of available floodplain wetland resources for fisheries enhancement that will lead to significant improvement in the socio-economic status of fishers. Cage aquaculture is especially effective in raising carp seeds in seasonally open beels of the region where practicing pen aquaculture is a difficult proposition during the south-west monsoon season (June-September). Moreover, floating nature of cage enclosures makes them most suitable for waterbodies which are affected by occasional flood and drought-like situations.

Enclosure culture as a climate resilient technology

Main threat of climate change on the numerous floodplain wetlands of river systems are floods due to irregular and excessive precipitation during the southwest monsoon (June-September) and drought during pre-monsoon seasons (Jan to April). Experiments and demonstrations conducted in the region showed that enclosures installed in inland waters are resilient to climate change impact. In dry seasons when the water level reduces, temporary pens erected around the deepest part of a wetland can be used to culture fish. On the other hand, height of the pen enclosures are increased using netting before the onset of monsoon to prevent escapement of cultured fish due to flood. If cage enclosures



are considered, floating nature of the cages makes it resilient to flood. However, in dry seasons, cages can be moved to deeper areas provided there is at least minimum permissible water depth prevailing in the waterbody.

Conclusion

Inland openwater resources like floodplain wetlands and reservoirs are the vital resources and must be utilized sustainably for fish production. Enclosure culture technologies create an avenue for additional fish production from such waterbodies. Pen culture also serves as a good management option for macrophyte-choked shallow and unproductive wetlands that solves the problems created by gear restrictions and catchability. Pens can be used for raising fingerlings or table fish. Fish species with local importance such as O. belangeri (pengba) and L. gonius (kuri) performed well when stocked in net pens. Economically important small indigenous fishes can be stocked in pens, which would reproduce in them and become a self-recruiting population providing nutritional securities to the fishers. Cage culture technology has been successfully field tested in several beels/ wetlands of Northeastern India with special emphasis on Assam. The technology is also being demonstrated and tested (using CIFRI GI Cage as well as Modular cages) in Umiam lake of Meghalaya, Loktak lake, Khuga and Mapithel reservoirs of Manipur, Serlui reservoir of Mizoram, Borbeel of Arunachal Pradesh, Dumbur reservoir of Tripura and Doyong reservoir of Nagaland. Research and development in enclosure culture are needed to standardize package-of-practice including the size of stocking and harvesting, stocking density, species ratio of compatible species, feeding rate and culture duration of new candidate species. Large-scale demonstration and adoption of the technology is essential for realization of optimal fish production from the beels/ pats, reservoirs and natural lakes of the Northeast thereby contributing substantially to making this region self-sufficient in fish production. By adopting enclosure culture technology in large openwater resources of the Northeast, the region can produce significant quantities of fish reducing the demand-supply gap.

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Fisheries and Aquaculture Potential in Northeast India

The Northeastern region of India comprising of eight landlocked states viz., Arunachal Pradesh, Assam, Manipur, Meghalaya, Nagaland, Sikkim and Tripura is one of India's richest regions in terms of natural resources and biodiversity. The region has vast and varied fisheries resources in the form of reservoirs, tanks and ponds, beels, oxbow lakes and other derelict waters covering 4.18 lakh ha water-spread area, excluding rivers and streams which is estimated at 20,875 km.

The two main river systems in the region are the Brahmaputra in the north and the Barak, running through the southern edges, together with their numerous tributaries. The region is rich in freshwater fish species and is regarded as one of the world's hotspots for freshwater fish biodiversity. As many as 422 fish species from northeast India, belonging to 133 genera and 38 families, including indigenous and exotic species, have been reported. These beautiful resources make tremendous contributions towards overall fish production in the region.

Fisheries and Aquaculture sub-sector has immense potential for providing employment opportunities to youth, livelihood to rural masses and economic development as a whole for the region. There is a growing demand for fish and fishery products in the region due to increasing population, per capita income, urbanization and changes in food habits. There is a tremendous scope for development of fisheries and aquaculture in the region, but lags behind the rest of the country in fully harnessing its potential.

The region is deficient in fish production; it depends on others to fulfil its demand. Hence, there is an urgent need to increase fish production from these available resources to fill the gap. To achieve this goal, there is a need to utilize these fisheries resources of the region in a sustainable manner.

The articles in this special issue of the magazine cover different aspects of fisheries and aquaculture development in the North Eastern Region.

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