JUST AGRICULTURE
multidisciplinary e-Newsletter

Composite Fish Culture: A Proven Technology for Aquaculture Enhancement in Northeast India

Chandan Debnath
Senior Scientist, Division of Animal and Fisheries Sciences, ICAR Research Complex for NEH Region, Umiam, Meghalaya

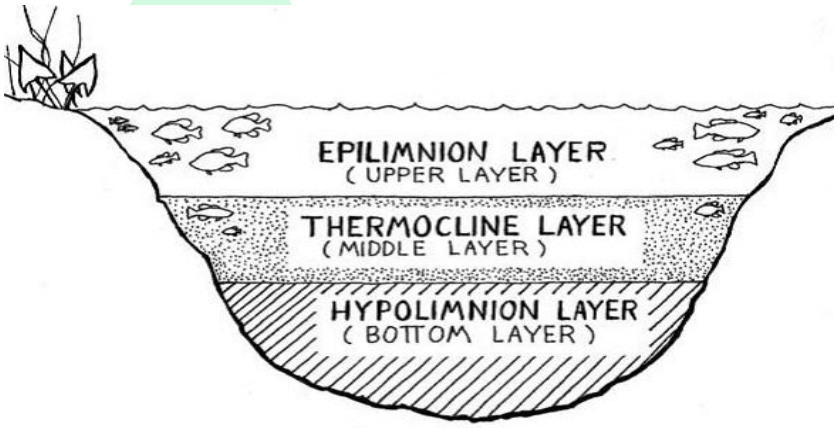
ARTICLE ID: 19

Aquaculture is a major source of income and employment for thousands of people in Northeast (NE) India. Ponds and tanks are the main water resources where this aquaculture is in practice. As per the latest data published by the Handbook of Fishery Statistics (2020), Ministry of Agriculture and Farmers Welfare, total resources available under ponds/tanks in NE India are 150422.5 ha. Majority of these ponds are small and backyard in nature with an average size 0.08 ha and depth 1 m. Based on decomposed layer and plankton productivity, these ponds can be broadly classified into three types, such as type A (bottom decomposed layer is 15-30 cm, optimum plankton turbidity and other parameters; ideal pond for fish culture), type B (almost absent decomposed bottom layer with low plankton turbidity and low organic carbon level) and type C (high organic load; >30 cm plankton turbidity, low pH, high eutrophication/ algal bloom formation). Most of these water bodies are very fertile and yet to reach final fertility stage however, their average fish productivity (1.5 MT/ha/year) is far below the national average estimated to be 3 MT/ha/year. A number of factors could be made responsible for it but one of the major factors is not targeting the water bodies with appropriate or proven technologies.

Fish production through composite fish culture (a trial in Tripura)

JUST AGRICULTURE
multidisciplinary e-Newsletter

Composite fish culture (CFC) is a proven aquaculture technology. Here, culture of fish is done utilizing the natural foods and living space available at three niches of pond ecosystem such as upper layer, middle layer, and bottom layer. It is an ecosystem approach to aquaculture (EAA) and a scientifically valid and economically viable method. CFC is a highly productive and remunerative production method. Here, main attention is paid over receiving maximum benefit out of three niches of the pond ecosystem by stocking fishes of dissimilar feeding habits at certain composition.. CFC is a capital-intensive approach due to requirement of high amount of concentrated feed, however, that can be downsized through keeping proper tab on resources critical for farming.



Three niches of pond ecosystems

The species of fishes mostly recommended in CFC are *Catla catla* (Catla), *Labeo rohita* (Rohu), *Cirrhinus mrigala* (Mrigal) [together they are called Indian major carps-IMCs), *Hypophthalmichthys molitrix* (Silver carp), *Ctenopharyngodon idella* (Grass carp) and *Cyprinus carpio* (Common carp) [together they are called Chinese carps- CC]. Out of these six fishes, Catla and Silver carp inhabit at the surface layer in pond ecosystem, Rohu and Grass Carp inhabit at the middle layer in pond ecosystem and Mrigal and Common Carp inhabit at the middle layer in pond ecosystem. Kalbasu (*L. calbasu*), (Reba *C. reba*), Gonia (*L. gonius*), Bata (*L. bata*), fringed-lipped Rohu (*L. fimbriatus*), Java Puthi (*Puntius gonionotus*), Pengba (*Osteobrama beelangeri*) are some minor species gaining importance in aquaculture diversification process over the years. A production of 3 to 5 MT fish/ha/year is possible through CFC. Fish productivity can be improved by another 10 to 15% with the incorporation of self-recruiting (SR) small indigenous species (SIS) such as Mola, Sophore barb, Flying barbs, Bronze featherbacks, etc.

JUST AGRICULTURE
multidisciplinary e-Newsletter

	
***Catla catla* (Catla)**	***Labeo rohita* (Rohu)**
	
***Cirrhinus mrigala* (Mrigal)**	***Hypophthalmichthys molitrix* (Silver Carp)**
	
***Ctenopharyngodon idella* (Grass Carp)**	***Cyprinus carpio* (Common Carp)**

Candidate fish species of CFC

Scientific protocols recommended in CFC are described below.

- **Pond preparation:** Remove aquatic weeds because it creates hurdles for sunlight penetration and photosynthesis, competes with fish for food, living space and dissolved oxygen, absorbs nutrients from water and reduces primary productivity, provides shelter for aquatic insects, frogs, tadpoles, snakes, etc, impairs oxygen production-consumption rate at night, creates problem in netting operation, causes siltation, reduce the aesthetic value of the water body, etc. Manual eradication of weeds using sickle or performing repeated netting is the easiest and cheapest method. A number of commercial weedicides

JUST AGRICULTURE
multidisciplinary e-Newsletter

are available but their use is not recommended as they leave residual effects on fish and other non-target organisms and minimizes the pond productivity in the long run. Weeds can be kept under control using herbivorous fishes such as Grass Carp (*Ctenopharyngodon idella*), Goramy (*Osphronemus goramy*), Silver barb (*Puntius gonionotus*), etc. Suggested stocking rate for grass carp is 200-300 numbers (500-600g)/ha. Shaded plants and leaves, falling plantation on pond dikes, hanging tree branches, etc should be removed. If the pond is high on organic matter, their soil should be regularly raked with a soil raking device (could be made indigenously) or exposed to sunlight until it cracked.

Grass carp, a aquatic weed-controlling fish

- **Removal of predatory and weed fishes:** The predatory fishes such as Magur, Singhi, Murrels, etc. and weed fishes such as minnows, barbs, etc should be eradicated from the pond well in advance of fish seed stocking. Repeated netting or drying of pond is a low-cost technique for removal of predatory and weed fishes but it is not effective. For effective removal of predatory and weed fishes, mahua oil cake (with 4-6% saponin) @ 2000-2500 kg/ha-m delivers excellent result; it also acts as a manure besides killing fish. However, it is not easily available in NE States. In that situation, bleaching powder @ 350 kg/ha-m or bleaching powder @ 175 kg/ha-m in combination with urea @ 100 kg-ha (after a gap of 18-24 hrs) or anhydrous ammonia @ 200-250 liters/ha-m can be used.

JUST AGRICULTURE
multidisciplinary e-Newsletter

After 15 days of application of bleaching powder, the ponds can be stocked for seed stocking.

- **Application of lime:** Fish prefers a pH in the range of 6.5 to 7.5, but in most of the cases, particularly in the states of NE India, the pH of pond water or soil remains far below that. Low pH is associated with low productivity, thus, liming is must for pH correction. Lime should be applied based on the pH of water/ soil. The dose of the lime could be varied from 250 to 1000 kg/ha/year; 1/3rd of it should be applied before seed stocking and rest 2/3rd after seed stocking on monthly/bi-monthly basis. Avoid direct application of lime as it warms up the water and cause fish succumbs to death. Soak lime overnight in water before apply.

Table 1: Recommended dosed of lime dose for fish culture

pH	Dose of lime (kg/ha-m)
4-4.5	1000
4.5-5.5	700
5.5-6.5	500
6.5-7.5	250

- **Application of fertilizers in pond:** Application of manures/fertilizers is needed to maintain the plankton production in pond. Plankton are called 'living capsules of nutrition' and 'natural fish food organisms' of fish. The combined application of organic and inorganic fertilizers (N, P, K) delivers 20-23% higher fish production when compared to application of only organic manure. Potassium is not a limiting factor in most of the freshwater water bodies, so its application can be skipped. The recommended dose of cattle manure is 10-20 MT/ha/year, poultry manure is 4-8 MT/ha/year, urea is 100 kg N/ha/year and SSP is 50 kg P/ha/year. One-third of the fertilizers should be applied before seed stocking and rest 2/3rd after seed stocking on monthly/bi-monthly instalment.

Table 2: Recommended doses of organic manures (kg/ha) for pond fertilization (based on a study by ICAR, Tripura Centre)

Manures	Monsoon	Post-monsoon	Winter	Pre-monsoon	Total
Cattle manure	3000	2500	1000	3500	10000

JUST AGRICULTURE
multidisciplinary e-Newsletter

Pig manure	1500	1000	500	2000	5000
Poultry manure	1000	1000	500	1500	4000

Table 3: Recommended fertilizer doses for different pond types

Nutrient	Low	Medium	High
Organic Carbon (%)	0.5-1.5	1.5-2.5	>2.5
Avail. N (mg %)	25-50	50-75	>75
Avail. P (mg %)	<3	3-6	>6
Recommended dose of fertilizers			
RCD (MT)	20	15	10
Urea (46% N) (kg)	150 kg N (322 kg urea)	100 kg N (218 kg urea)	50 kg N (104 kg urea)
SSP (16%) (kg)	75 kg P (470 kg SSP)	50 kg P (310 kg SSP)	25 kg P (155 kg SSP)

- **Fish stocking:** After 10-15 days of pond fertilization, when water colour becomes green and plankton turbidity is estimated to be 20-30 cm (one foot), quality fish fingerlings (size: 5-10g/40-100 mm) should be stocked at certain composition. Morning is the best time for fish seed stocking. Seeds are 'the heart of aquaculture; hence, the better the seed quality, higher fish production. The recommended fish stocking density is 10000 numbers/ha. The fishes of surface layer (Catla, Silver Carp) are recommended @ 30-40%, middle layer (Rohu) @ 30-35% and bottom layer (Mrigal, Common carp)- 30-40%. Grass carp is recommended @ 5-10%. Medium carps are recommended @ 5-15% in substitution of major carps. For minimizing inter-specific competition between Catla and Silver carp, Catla should be stocked 1-2 months after stocking Silver carp. Some recommended species composition for attaining higher fish production in CFC under the agro-climatic conditions of NE India are- Common carp 50% & Gonia 50% (2-species combination), Catla 40%, Rohu 30%, Mrigal 30% (3-species combination), Catla 30%, Rohu 40%, Mrigal 20% & Common carp 10% (4-species combination), Catla 20%, Silver Carp 10%, Rohu 40%, Mrigal 20% & Common carp 10% (5-species combination)

JUST AGRICULTURE
multidisciplinary e-Newsletter

- **Supplementary feeding:** Feed is a critical factor of fish production. It contributes ca. 50-60% in the total operational cost of aquaculture. The success of aquaculture is greatly dependent upon how judiciously feed cost is managed. Feed are of two types such as natural foods (planktons, benthos, etc) and supplementary/artificial feeds. Natural feeds such as phytoplankton and zooplanktons automatically get produced in ponds. 30-40% of fish growth comes from natural food while 60-70% from external feeding. Pond fertilization is must to keep pond optimum in primary productivity. For external feeding, rice polish and mustard oil cake can be used @ 1:1. In the initial 2 months of culture, recommended feeding rate is 4-5% of fish biomass, in the next 2 months, it is 3% and then 2% and 1%. Winter feeding may be avoided if fish are low in response. When fish grows to ≥800 gm, harvest them, because after that, fish growth is not proportionate to feed consumed by them.
- **Water and soil quality management:** A pond with clayey loam soil with 15-30 cm decomposed clayey layer at pond bottom is ideal for fish culture. Optimum level of organic carbon is soil is 0.5 to 1.5 %. Suitable water depth (1.5-2 m) and plankton turbidity (20-30 cm) may be maintained for better fish growth and survival. Chemical parameters such as water pH (7.5-8.5), dissolved oxygen (4-5 ppm), total alkalinity (>75 ppm) and ammonia-nitrogen (<1 ppm) are the four important parameters that influence fish to a great extent.
- **Fish health management:** Fish are prone to many diseases, thus fish health management is essential. Epizootic Ulcerative Disease Syndrome (EUS) of fish is classical example of how devastating a fish disease could be. Fish diseases could be broadly classified as parasitic infections, bacterial infections, fungal infections and viral infections. Parasitic infections are visible in naked eyes; among the parasitic infections, infections by *Argulus*, *Ergasilus* and *Lernia* are common in fish. To control them, fish can be bathed for a minute (once a week) in melathion (0.25 mg/L) or ethyl parathion (0.125 mg/L) or formalin (20-25 mg/L) for consecutive four weeks or simply in 10% salt solution for 10 minutes. For dropsy a bacterial infection, use tetracycline @ 50-70 mg/kg feed for 10 days. For fin and tail rot, apply CuSO4 (@500 mg/L) on the affected areas. For ulcer diseases, apply lime at regular intervals or add tetracycline in feed (@25 mg/kg feed) for seven days. EUS is the most common among fungal infections of fish. This disease

JUST AGRICULTURE
multidisciplinary e-Newsletter

generally occurs in winter season, and Carps are highly susceptible. To control it, CIFAX can be applied (@ 0.1 mg/L). Feeding root powder of Ashwagandha (0.1-0.22% of feed) and turmeric powder (0.2 to 0.44% of feed) improves immunity of fish against EUS. Another important fungal disease is cotton wool disease (caused by *Saprolegnia parasitica*). To control it, formalin can be used (50-150 mg/L). The works well against the disease. Viral infections are less reported in fish.

- **Fish harvesting and marketing:** To achieve high fish production and high economic return, partial harvesting is recommended based upon the market demand/ preference of fish. Through single stocking and single harvesting (SSSH) technique, 3 to 5 MT fish production/ha/year is possible and through multiple stocking and multiple harvesting (MSMH) technique, 5 to 8 MT fish production/ha/year is possible. Income from fisheries can be increased through intelligent marketing. There is huge demand for live/ fresh fish; they fetches 1.5-2 times higher price when compared with fishes stored in ices. Thus selling fishes in live/fresh condition, can add more benefit. Selling fish during the festive seasons such as New Year, Durga puja, Bihu, Ningol Chakouba, Christmas, etc. and family occasions/ rituals such as marriage, birthday, etc, is another strategy to be followed for earning more income from fisheries.

Table 4: Economic appraisal of a model 3-species composite fish culture project

Particulars	Unit	Unit Rate (Rs.)	Quantity	Amount (Rs.)
Capital cost				
1. Land				Own
2. Site development	LS			10000.00
3. Construction of pond	Rs./ha	70000	1	70000.00
4. Store room	Sq.ft.	150	100	15000.00
5. Diesel pump set (3HP)	LS			20000.00
6. Inlet/Outlet sluices	LS			10000.00
7. Nets and other implements	LS			10000.00
8. Unforeseen expenses	%	5		6750.00
Total (A)				141750.00
Operational cost				
1. Fish seed (Catla, Rohu and Mrigal)	Fingerlings	5	10000	50000.00
2. Fish feed	Kg	30	10000	300000.00
3. Lime	Kg	15	500	7500.00
4. SSP	Kg	5	500	2500.00
5. Urea	Kg	5	1000	5000.00

JUST AGRICULTURE
multidisciplinary e-Newsletter

6. Cattle manure	Kg	1	10000	10000.00
7. Harvesting charges	Kg	5	5000	25000.00
8. Pond reclamation	LS			5000.00
9. Security of pond, watch and ward, etc	LS			10000.00
Total (B)				415000.00
Total cost of the project (A+B)				556750.00
Income (C)				
Table fish	Kg	7500	150	**1125000.00**
Net benefit (C-B)				**568250.00**
Benefit-cost ratio (C/A+B)				**>2.0**

In conclusion, it could be said that composite fish culture is an ideal technology for enhancing the fish production from pond and tank resources available with us. Through CFC, we can produce 3-5 MT fish/ha/year or even higher and increase the income of fish farmers. The added advantage of fish production in NE India is that here people are extremely fond of eating fish and after COVID pandemic they demand more of fresh or live fish and reluctant to take fish comes from Andhra Pradesh or Bangladesh. In this situation, if we can increase fish productivity through proven technologies like CFC, it can bring sea changes in the improvement of regional fisheries and people associated with the sector for food and livelihood security.

References

Debnath, C., Das, S.K. and Mahanta, P. 2022. Scientific pond fish farming technique, ICAR Research Complex for NEH Region, Umiam, Meghalaya- 799103

Debnath, C., S.K. Das & V.K. Mishra.2022. Present Status of Fisheries in Northeast India and Strategies for Inclusive Development. In Souvenir on "International Conference on "Responsible Aquaculture and Sustainable fisheries Interact" (RASHI) ((13-16, December, 2022), p. 13-19.

Debnath C., Das, S.K., Sahoo, L., Mahanta, P. 2022. Opting aquaculture as a lucrative business enterprise: scopes and opportunities in North-East India. Souvenir, AGRIPACTS, May 26-27, 2022, Gangtok, Sikkim, page no. 106-110

Debnath, C. 2022. The prospects and potentials of Fisheries in Northeast India: strengths, weaknesses, opportunities and threats. Just Agriculture (multidisciplinary e-newsletter) 2 (11): 1-23.

JUST AGRICULTURE
multidisciplinary e-Newsletter

Handbook of Fishery Statistics. 2020. Department of Fisheries Ministry of Fisheries, Animal Husbandry & Dairying, Government of India, New Delhi