

# Aquaculture and fisheries perspectives in Arunachal Pradesh

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*Integrated fish farming system in Lower Subansiri District.*

Fish is an essential source of protein for the people of Arunachal Pradesh. This hill state is inhabited by a population of 1.38 million people, the majority of whom relish fish. In terms of fish biodiversity, the varying altitudinal regimes ranging from 100-4,000 m play a dominant role in the distribution of species. The foothill regions to an elevation of 300 m are hot and humid and are suitable for culture of warm freshwater fish species viz., Indian major carps, catfishes, feather backs, eels, mahseers and the exotic carps. The sub-tropical mid altitude zone, up to 1,200 m, provides a suitable climate for a mixture of cold and warm water species. The high-altitude alpine zone, above 1,200 m, features cold, fast flowing streams and lakes, which are a suitable habitat for exotic rainbow and brown trout along with indigenous snow trout *Garra* spp., *Noemacheilus* spp., *Glyptothorax* spp., *Psilorhynchus* spp., and occasionally *Barilius* spp.

Arunachal Pradesh has freshwater resources in the form of around 11,000 km of rivers, 226 ha of small reservoirs, 2,300 ha of tanks and ponds, 3,300 hectares of wetlands and derelict water bodies and 56,000 ha of other forms of aquatic resources<sup>1,2</sup> that are home to 259 species of fish.<sup>3</sup> Inland fish production from the state has increased to 5,284 metric

tonnes during 2022-23, with the advent of new technologies in the region followed adoption of scientific fish farming practices by farming communities. Furthermore, 20 million fry and 11 million fingerlings were produced during 2022-23 from government and private fish hatcheries. There are around 24,000 fishers in the state is with an average of 961 per district engaged in inland fishery activities. However, the region needs to catch up the rest of the country in developing its water resources to meet the gap between the production and demand. The per capita availability of fish in the state was 3.65 kg/year against the WHO recommended level<sup>1</sup> of 12kg/year during 2020-21. This article reflects on aquaculture and fisheries perspectives in Arunachal Pradesh, based on survey and research activities undertaken by the author over the last two decades.

## Aquaculture systems

Aquaculture in Arunachal Pradesh is mainly based on carp, and mostly practiced in the warmer foothill regions where six recommended species namely *Labeo catla*, *L. rohita*, *Cirrhinus mrigala*, *Hypophthalmichthys molitrix*,



Harvesting of Chinese carps in mid elevation fish ponds.

*Ctenopharyngodon idella* and *Cyprinus carpio* are cultivated under polyculture. Fish are cultivated using extensive methods in earthen ponds and tanks of size varying from 100 m<sup>2</sup> to 1.2 ha. Small to medium sized earthen ponds are mostly prevalent due to the hilly terrain. Cattle manure, pig dung, and poultry waste are applied at the rate of 5-10 tonnes/ha to enhance the plankton growth in the water. Periodically lime @ 400-600 kg/ha/year is applied to neutralise the acidic water (pH 5.0-6.0) typical of the region. The stocking of ponds is done at the rate of 1-2 fishes/m<sup>2</sup>. Feeding is done with rice bran and mustard oil cake in the ratio of 1:1 or 2:1. Maize flour, cooked and fermented rice, puffed rice, millet flours etc are also applied in ponds on traditional lines. In recent times, pellet feeds with 20-25% protein composition are fed to the fishes resulting into growth of 0.9-1.0 kg/fish/year.

However, Indian major carps do not grow well in the cooler (< 22°C) high altitudinal ponds and tanks. Therefore, Chinese carps, namely silver carp, bighead carp *Hypophthalmichthys nobilis*, grass carp and common carp are taken as the candidate species for culture in pond fisheries at high altitudes. It has been possible to achieve a production of 0.4-0.6 kg/m<sup>2</sup> under low temperature conditions based on a stocking density range of 3-4 fishes/m<sup>2</sup> with recommended supplementary diet. Monoculture of common carp in ponds and tanks at mid to high altitudes is also prevalent due to its wide thermal adaptability from 5-30°C, robust nature, better food conversion ratio, high fecundity and easy accessibility of seeds.

Integrated fish farming is another successful system adopted by the farmers of Arunachal Pradesh resulting in a 3-4 fold increase in farm production as well as income through multi-

cropping. Over the years several components have been integrated with fish farming to evaluate their compatibility. Some of the important integration models are fish-poultry, fish-duck, fish-pig, fish-paddy and fish-horticulture. Large White Yorkshire, Middle White Yorkshire, Berkshire, Hampshire, Land-race, Large Black, and Duroc are some of the exotic breeds of pig commercially cultivated in the region. Kamrupa, Vanaraja, Kadaknath are a few poultry breeds whereas Khaki Campbell, Indian Runner, Charra Chambelli are duck breeds in use. Fish production levels up to 0.6-0.8 kg/m<sup>2</sup> can be achieved without provision of supplementary feeding to fish under this type of integration. The fish integrated with live-stock and poultry helps in recycling of farm-based resources



Common carp raised in rice-fish farming systems in Ziro Valley.

and substantial reduction of risk factors through diversification of food commodities. The farm products are easily marketed as most of the populace are non-vegetarians.

The culture of common carp with local rice cultivars viz. eamo, ampu, mipya, pyapu, pyaping and eylang in terraces of the Apatani Plateau at 1,500 m altitude of Lower Subansiri District has become popular in the recent times. Apart from the common carp, species such as grass carp, silver carp, *Puntius* spp. catfishes, murels and *Labeo* species are also occasionally stocked in the plots. The dykes of rice-fish plots are used for raising vegetables such as cucumber, radish, brinjal, tomato, pumpkin, chillies, beans and crops such as finger millets, buckwheat, barley and maize to gain additional income. Similar integrated farming practices could be possibly adopted by the farmers in other districts as a self-supporting system. The integrated rice-fish farming in the state produces 150-200 kg fish/ha/3 months and rice production accounting to 10 tonnes/ha/season<sup>4</sup>.

The low temperature regime in uplands of Arunachal Pradesh offers tremendous scope for exotic trout farming in raceways. Rainbow trout *Oncorhynchus mykiss* is the most suitable candidate species for upland fisheries due to the favourable water temperature ranging from below freezing point to as high as 20°C. Three trout farms cum hatcheries have been established in Arunachal Pradesh viz., Nuranang stream at 3,660 m altitude and Chuje trout farm at 3,030 m in Tawang District, and Shergaon in West Kameng District, located at an altitude of about 1,954 m. All these hatcheries are

producing from 50,000 to 100,000 eyed ova. Menchukha is another potential area in the Shi Yomi District of Arunachal Pradesh for rainbow trout farming. Concerted efforts have been made by the state Fisheries Department, research institutes and entrepreneurs in developing this place as a hub for trout, inviting tourists across the globe. At present, the trout production is at a low stake and the fish produced in the raceways is seldom sold in markets and are consumed in local households.

Ornamental fish keeping has become an important commercial component of aquaculture for many, generating income for unemployed youth and farmers in the country. The concept of entrepreneurship development has led more and more people to enter this lucrative business. The Eastern Himalayan region has been identified as one of the 18 mega biodiversity hotspot regions of the world<sup>5</sup> with 259 species of fishes including loaches, barbs, minnows, catfishes, and murels. The region has the advantage of having a mild climate, abundant natural waters and export facilities for expansion of the ornamental fish trade to overseas markets. However, little information is available on the ornamental fisheries in the state and the aquarium shops are dependent on exotic varieties such as koi, goldfish, angels, platy, molly, oscar, arowana and so on imported from other states.

Commercial culture of catfish and air-breathing fish has not yet been taken up in the state although such fishes are abundant in natural water bodies. These fishes have a better market price with high consumer preference. The



Fish ponds in Arunachal Pradesh.



*Trout farm at Shergaon, Arunachal Pradesh.*

most commonly preferred catfishes in the region are *Clarias magur* and *Heteropneustes fossilis*, which can be of great potential for commercial cultivation in the foothills of the district considering the availability of huge resources in the form of ponds, swamps and derelict water bodies. Freshwater eels, pangasius, red-bellied pacu, murrel, tilapia and koi are other potential fish varieties of high consumer preference and candidates for local aquaculture. The recent advances in bio-floc technology and re-circulating aquaculture systems can further enhance the fish production in the hill locked region.

## Inland capture fisheries

The inland fisheries in Arunachal Pradesh provide ample opportunities for fish-based ecotourism perspectives, where travellers can experience pristine destinations relatively untouched by human intervention. The undulating terrains, river valleys, upland lakes and green lush vegetation provides opportunities for leisure, knowledge sharing on the environment, ethnicity and in turn sustaining the well-being of the local people with viable income-generating options. Sport fishing or angling, fish watching, river rafting, trekking, and hiking, bird watching, river side camping, local fish cuisine etc are some of the most sought-after adventure tourism activities in the hills and present booming international business opportunities.

Fish groups such as mahseer; the goonch and brown trout are the flagship species of considerable economic, recreational and conservation interest in the state. Mahseer, large bodied potamodromous freshwater fish belong to three



*Young rainbow trout for raceway culture.*

genera *Tor*, *Neolissochilus* and *Naziritor*. Mahseer are recognised as the 'state fish' in seven states of India due to their superlative sporting quality. Golden mahseer (*Tor putitora*) and chocolate mahseer (*Neolissochilus hexagonolepis*) are the dominant species in the northeastern part of India. This group of mahseer are mostly concentrated in the rivers Kameng, Subansiri, Siang, Dibang, Lohit, and Pare, all flowing through the vast wilderness and finally terminating in the mighty Brahmaputra River. Anglers among these sparsely inhabited areas travel along the river valleys as adventure enthusiasts amongst the picturesque mountains of Arunachal Pradesh, with crystal clear pre and post monsoon waters coursing through them and home to the big fighting fishes. Fish watching platforms on natural and manmade lakes have gained much attention due to their multiple positive benefits to human health. Keeping fish in lakes, tanks and ponds also facilitates in-situ conservation of endangered fish. Concerted efforts are being made for their captive rearing and maturation, breeding and seed production by artificial processes. Trials have been made at Iduli in Lower Dibang valley for the commercial seed production of mahseer. A similar effort is being made to establish another mahseer hatchery along the banks of river Subansiri River along the dam site of a 2,000 MW hydropower plant. The seed will usually be used for ranching in the river systems or for aquaculture purposes in the hill regions.

The goonch or the giant devil catfish *Bagarius bagarius* and *B. yarelli* are fish of high sports value and sought by anglers worldwide. These fish are occasionally encountered in the river Dibang and Siang of Arunachal Pradesh. The species is categorised as vulnerable on the IUCN Red List due to over exploitation of wild populations.

The brown trout (*Salmo trutta fario* Linnaeus, 1758) is regarded as the best coldwater sporting fish in the country. The Yargyap Chu River, flowing through the township of Menchukha at 1,829 m in West Siang District, is home for exotic brown trout. A sizable catch of brown trout weighing up to 12 kg has been reported from this water. The adaptation of the imported trout fishes during 1990s in these cold water provides an excellent opportunity for game fishing in this mesmerising northeastern part of the country. It is also interesting to know and report herewith that the skin of the brown trout is also utilised in preparing dhoor, a musical instrument used during the rituals of the Buddhist communities. The instrument is a goblet shaped hand drum comprised of a light wood coated with fish skin at the either side.

Apart from the fish groups mentioned above, the other game fishes encountered are the cyprinids *Raiamas bola*, *Labeo dyocheilus*, *L. pangusia*, *Bangana dero*, *Opsarius* spp., Schizothoracines and a few catfishes. These groups of fish are occasional catches in search of the major game fishes.

Snow trout is an important group of fishes from taxonomic, evolutionary and zoogeographical view point as their distribution is mainly restricted to mountain regions of Asia. The important Schizothoracine fishes occurring in Indian uplands embrace seventeen species belonging to eight genera<sup>6</sup>. *Schizothorax richadsonii* and *S. plagiostomus* and *S. progastus* are the indigenous snow trout found in abundance in the region. Unlike carps, these species have a very slow growth rate in capacity (30-40 g/year) and thus are not recommended for culture in ponds and tanks. Snow trout are also important from a recreational point of view as these fishes are caught



A tilapia from the culture tanks in Papumpare District.



A species of mahseer raised in aquaculture system at Siang District.



A catch of snow trout in Dirang Valley.



*Seeh Lak: A recently developed water body situated 110 kms from the state capital Itanagar.*

by a selective gear noose on line method developed indigenously by the local fishers of Dirang region in West Kameng District<sup>7</sup>. Success has been achieved in captive maturation and breeding of this fish group in the country which enhances its chances of propagation in natural upland water bodies for recreation and food to the mountain dwellers.

for fish and people dependant on them. Responsible fishing and supplementary stock enhancement may generate revenues through fish-based ecotourism in the sector. Further intensifying research in feed development, genetic improvement, and water budgeting can lead to success in developing strategies sustainable for fish production and productivity and in securing fish as

a protein rich food to the mountain dwellers in this eastern most part of the country.

## Conclusion

There lies a huge potential in generating fish-based revenues in terms of aquaculture and capture fisheries by tapping unutilised or underutilised aquatic resources of the hills of Arunachal Pradesh. Emphasis must be given in identifying and preparing a digital database on water bodies and developing repositories in fish and fisheries of the region. Measures should emphasise the development of breeding protocols of the indigenous and endemic fish species for aquaculture system diversification, human resource development for technology transfer and adoption, framing suitable policies on fish conservation and retaining inhabitable environments



*A haul of brown trout from Menchukha Valley.*



*The giant devil catfish (goonch).*

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*Avid anglers in search of brown trout in coldwater resources.*