Fisheries Resources of Nagaland: Status and Perspectives

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Introduction

Nagaland, with a geographical area of about 16,579 sq.km in the northeast of India is part of the Eastern Himalayan hotspot. The Eastern Himalayan hotspot is known for its freshwater fish biodiversity in the world (Kottelat and Whitten, 1996). The state is part of the three major riverine systems of the region; Brahmaputra, Barak (India) and Irrawaddy (Myanmar) rivers. Nagaland shares its fish genetic resources with that of the Indo-Gangetic plains and to a lesser extent with the Myanmar and South Chinese fauna. A large number of fish species inhabit both the lotic and lentic water bodies with climatic conditions ranging from temperate of the mountains to sub-tropical of the foothill plains. The topographic and climatic diversity coupled with intriguing network of drainage systems support commercial species groups like carps, barils, loaches, rasboras, barbs, minnows, catfishes, perches, spiny eels and snakeheads. Nagaland is predominantly an agrarian state where about 60% of the population depends on agriculture and other allied activities for their livelihood.

Fishery resources and their present utilisation

Riverine Fisheries

ICAR-CIFRI Regional Centre, Guwahati conducted the first ever extensive field study on the ecology and fisheries of selected rivers in Nagaland during 1998-2002. The rivers in Nagaland flow either into the Brahmaputra river in Assam or the Chindwin river in Myanmar. The largest river in the state that flows into River Brahmaputra is River Doyang, formed by confluence of Dzuu and Sidzu rivers. The total length of the major rivers in the state is 1600 km.

Reservoir Fisheries

Doyang reservoir (26° 13' 10" N and 94° 17' 90" E) located in Wokha district, occupies a waterspread area of 2,258 ha and has the potential to increase fish production in the state. Fish catch in the reservoir is mainly contributed by stocked fish species (80- 90%) like *Labeo catla, L. rohita, Cirrhinus mrigala, Cyprinius carpio, Hypophthalmichthys molitrix* and natural fish species like *L. dyochelius, L. dero, Neolissocheilus hexagonolepis, Tor tor, T. putitora, T. progenius, Anguilla bengalensis, Barilius sp., Mastacembelus armatus. Cyprinion semiplotum, Chagunius sp.* and *Garra sp.* reportedly contributes to only 10-20% of the total catch from the reservoir partly because fish are caught using only surface gill nets. Among the fishing gears, gill nets contribute to the maximum (80%) followed by hooks and line, cast nets and traps (Odyuo, 2010). The Department of Fisheries, Nagaland has been stocking the reservoir almost every year. The Department has been carrying out diverse activities in the reservoir like post-harvest programmes, organisation of villagers (from 23 displaced villages) into co-operatives/SHGs etc. to facilitate better fisheries activities and marketing. Fish yield rate in the reservoir ranged from 157.2 kg/ha/yr to 158.5 kg/ha/yr during the past 5 years. During 2016-17 the total production from Doyang stood at 358 tonnes.

Ponds and Tanks

Pond culture system of fish dominates aquaculture activities in the foothill plains of the state, and on higher altitudes paddy-cum-fish culture is widely practiced where paddy is cultivated along terraced fields. The estimated potential area under ponds and tanks in the state stands at 30,000 ha out of which 3298 ha (11% of the total available area) has been utilised during 2016-17. The average productivity level of fish from ponds and tanks was about 1800 kg/ha/yr during 2009-10 which has increased to 2150 kg/ha/yr during 2016-17. The total production from ponds and tanks during 2015-16 stands at 6758.50 MT which increased to 7090.70 MT during 2016-17.

Integrated farming systems

The local tribes of the state not only need supplements of animal protein in their diet but also new sources of gainful employment and sustained income. As their land

Table 1: Fishery Resource of Nagaland

Sl.No.	Resource	Resource potential			Percentage of Area utilised till date	Total average productivity level (kg/ha/yr)
		Estimated potential total area	Utilised area till 2016-17 (ha)	Unutilised area (ha)		
A			Inland Culture Fisheries			
	(a) Ponds/Tanks	30,000 ha	3298	26,702	10.99%	2150
	(b) Integrated Fish culture					
	(i) Paddy-cum-Fish culture	82,500 ha	3230	79,270	-3.91%	335-500
	(ii)Livestock-cum-Fish culture	-	-	-	-	-
B			Inland Capture Fisheries			
	(a) Reservoir	2258 ha	2258	-	100%	158
	(b) Rivers/Streams Fisheries	1600 km	-	-	-	-
	(c) Lakes/weirs/ swamps	1700 ha	1000	700	58.82%	-

Table 2: Statistics of Fish Production (Resource-wise) during 2015-16 & 2016-17

Sl. No.	Type of Resources	2015-16		2016-17	
		Volume (MT)	Area (ha)	Volume (MT)	Area (ha)
1.	Ponds and Tanks	6758.50	3218.50	7090.70	3298.00
2.	Paddy-cum-Fish culture	1094.60	3120.00	1146.65	3230.00
3.	Doyang Reservoir	358.00	2258.00	358.63	2258.00
4.	Rivers/Streams etc.	2.98	-	3.04	-
5.	Lakes/Weirs/Swamps etc.	5.92	960.00	5.98	1000.00
	Total	8220.00	9556.50	8605.00	9786.00

holdings are small and fragmented, the modern large scale production technologies with high input requirements does not offer a practical solution to their problems of low income and productivity. Taking this into account, the state department is now making efforts to develop low cost farming systems suitable for local conditions based on the principle of productive re-cycling of farm waste and optimum utilisation of available resources and manpower. Integrated farming systems are being encouraged amongst the farmers because it is economical and sustainable at the same time. The tribal communities of the state traditionally raise livestock such as pigs, poultry, cattle, etc. They can be motivated to integrate their skills of raising different components together such as fisheries with livestock and agriculture.

Recently, the department has endeavoured to generate interest among local entrepreneurs to venture into ornamental fish trade taking into consideration, the vast resources of indigenous fish species that can be introduced to the ornamental fish market.

a) *Paddy-cum-fish Culture:* Rearing of fish in terraced paddy fields is an age-old practice among some tribes in the state, especially in Kohima and Phek. This practice has gained popularity in some other districts too, in recent times. The state is endowed with 82,500 ha of wet terraced paddy fields and another 3,120 ha could be harnessed. An area of 2820 ha is developed as earthen embankment and the remaining 300 ha as semi-permanent embankment. A total of 1,094.60 MT of fish was produced during 2015-16. During this period, an additional fish production of 944.80 MT and 149.80 MT was obtained from earthen and semi-permanent embankments at an average fish production rate of 335 and 500 kg/ha/yr respectively, with substantial increase over the last 5 years. During 2016-17 the total area under paddy cum fish culture increased marginally to 3230 ha (3.91% of the total available area) and a production of 1146.65 tonnes was achieved.

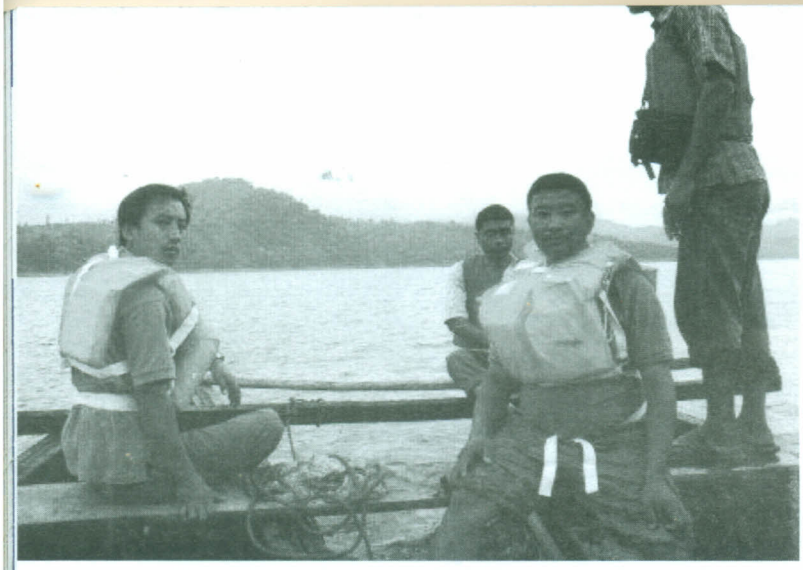


Fig. 1: Doyang Reservoir, Wokha, Nagaland

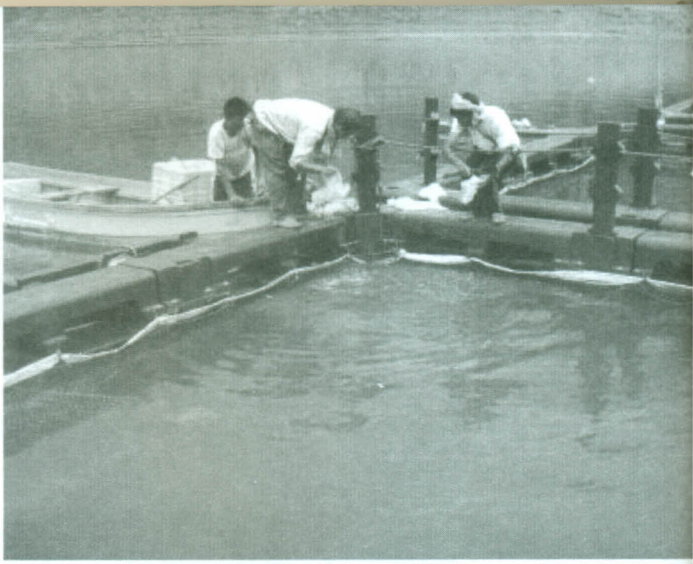
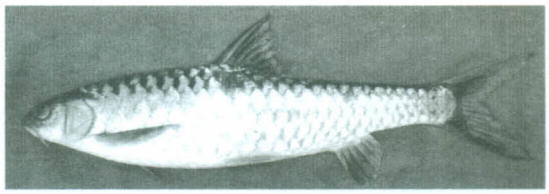


Fig. 2: Cage culture at Doyang reservoir



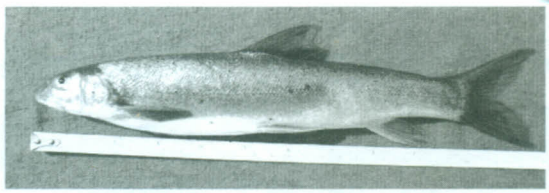


Fig. 3: Indigenous fish of Nagaland comprising Mahseer , Snow Trout and SIFs

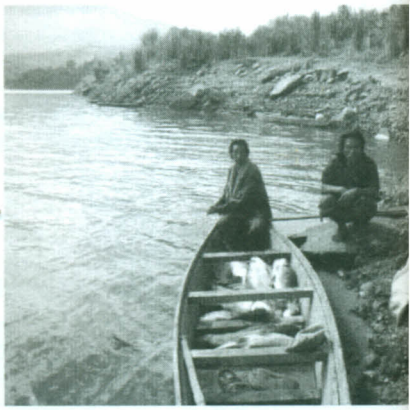


Fig. 4: Fish catch from natural wate bodies

b) *Livestock cum Fish culture:* Rearing of pigs, ducks, and poultry near the embankment/vicinity of fish ponds by allowing excreta and waste as fish feeds (directly or indirectly) supplements to more fish production. This practice reduces expenditure on fish feeds and can be easily adopted by local fish farmers. The Department of Fisheries, Nagaland implemented an ambitious scheme by rearing of piglets at 20 piglets/unit i.e. 1.00 ha water area at a total cost of Rs 2.00 lakh/ unit.

Fish Resources

The most important indigenous commercial fish species of Nagaland are *mahseers* (*Tor putitora* and *Neolissochilus hexagonolepis*), cyprinids (e.g., *Labeo dero*, *L. dyocheilus*, *Garra sp., Barilius sp.*), and catfishes (*Glyptothorax sp., Bagarius sp.*). Snow trout (*Schizothorax richarsonii*) is also available in hill streams at higher altitudes. So far, 118 fish species belonging to 68 genera under 24 families and 8 orders have been recorded and reported from Nagaland (Anon., 2005). This is approximately 44.36% of total fish species reported from the northeast (Sen, 2000). The topography of the state is mostly of hilly terrains breaking into wide spaces and ridges dissected by a number of seasonal and perennial rivers, which support rich ichthyo-fauna.

The state has to increase pond area and improve total yield from rivers (320 T) and beels (538 T), apart from bringing 5,000 ha under paddy-cum-fish culture (3,000 T).

Potential for Fisheries Development

The state has considerable resources for significant improvement both in terms of production and yield of fish from its water bodies. It only requires management intervention and an effective strategy to realise its potential. The steps that can be taken for this are:

- Efficient management of the natural water bodies such as rivers, beels and lakes
- Development of culture-based fisheries in the beels and reservoirs
- Extension of the proven aquaculture technologies to all the ponds
- Integration of more areas under paddy-cum fish culture

By following such a combined strategy, it will be possible

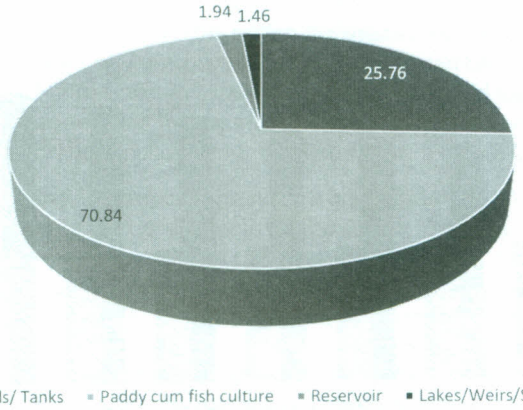


Fig. 5: Percentage contribution of different fishery resources of Nagaland (excluding rivers/streams) to the total potential water spread area

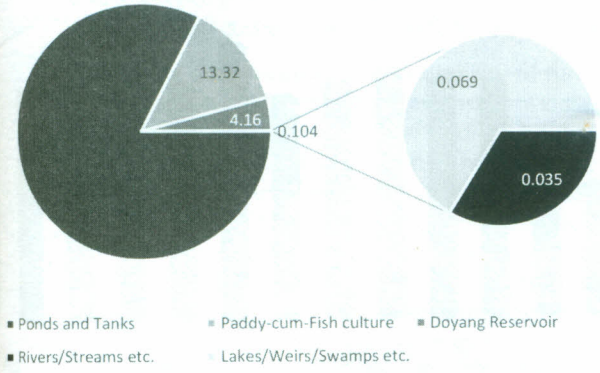


Fig. 6: Percentage contribution of different resources to the total fish production of Nagaland during 2016-17

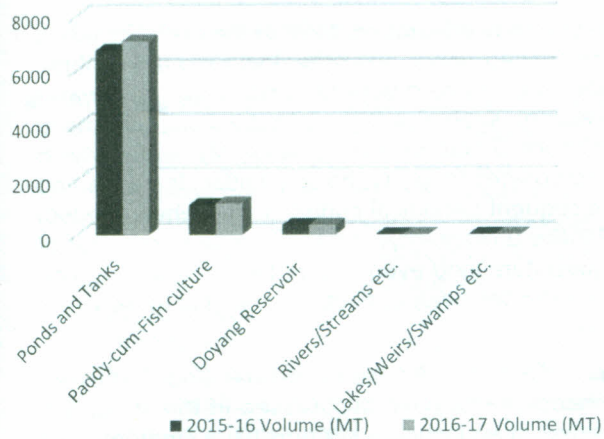


Fig. 7: Resource-wise fish production of Nagaland during 2015-16 and 2016-17

The total fish production from different water bodies in the state was 6358 MT during 2009-10. During the year 2015-16, the state's fish production had increased to 8220 MT and in 2016-17, it was 8605 MT with the district of Dimapur contributing the most.

to raise the state's fish production substantially (target-11,568 MT), thereby narrowing the deficit down to modest levels. For this, the state has to increase pond area and improve total yield from rivers (320 T) and beels (538 T), apart from bringing 5,000 ha under paddy-cum-fish culture (3,000 T). The prevailing aquaculture practices are pond and tank aquaculture, integrated fish farming and reservoir fisheries.

- **Fish Production and Demand:** The total fish production from different water bodies in the state was 6358 MT during 2009-10 (Anon.,2010). This accounts to only 4 kg per capita consumption considering that fish is the staple food for the majority of the population. However, the demand for fish during this period was about 22,000 MT which had to be met through imports from other states such as Andhra Pradesh, Odisha, West Bengal, Assam, etc. During the year 2015-16, the state's fish production had increased to 8220 MT and in 2016-17, it was 8605 MT with the district of Dimapur contributing the most. In addition to this, around 3800-3850 MT of fish (around 44% of the state's total production) was imported from other states to supplement the demand. The current average per capita consumption of fish is 6.23 kg whereas the nutritional requirement according to WHO's recommendation is 11 kg per capita. Taking into account, the population of the state and per capita requirement, the target production has to be approximately 21,874.9 MT, which is likely to grow further. Thus there is a net deficit of over 9800 MT and also a huge demand-supply gap in the state's fish production.

- **Fish Seed Production and Infrastructure:** The total fish seed production of the state during 2015-16 stands at 478 lakh fry. There are 2 carp hatcheries, 1 Freshwater prawn hatchery, 6 demonstration fish farms, 5 Training centres and 8 FFDA units in the state. A few more hatcheries are being planned to make it self-sufficient in fish seed supply.

- **Development of Natural Water Resources:** To augment fish production in the state, it is necessary to systematically utilise the naturally available resources such as streams, rivers, swamps etc, and effectively manage them to their Maximum Sustainable Yield (MSY). Development of rivers/ streams for fishery activities is expected to conserve the natural habitats of rare/endangered species. It will also generate awareness about preservation of natural resources and the need to ban use of hazardous chemicals/ gears in the river systems.

- **Development of Community-Based Fisheries and Water Bodies:** The fisheries department introduced a new scheme entitled "Development of Community-Based Fisheries and Water Bodies" in Annual Plan 2009-2010

onwards, which brought under its purview, sizeable water bodies that can fetch sustainable income for rural communities through fish production. This ambitious project is earmarked for the foothills and low lying areas of potential districts. Through this scheme, a waterspread area of 1.00 ha/unit will be developed to adopt composite fish culture technology. The scheme would be assisted by a loan amounting to 100 lakhs, from RIDF, NABARD. An area of 20 ha has been targeted which is expected to contribute 38 MT to the total fish production.

- **Socio-Economic Status of Fish Farmers:** The total number of fish farmers (including full-time, part-time, occasional and unspecified) in the state till 2008 was 6228 (Anon., 2009). Although the socio-economic condition of the fish farmers has seen a gradual improvement over the years, but it still lags behind the other agri-allied sectors. There is much to be done to improve and uplift their socio-economic conditions.

- **Preferred fish species and prevailing retail prices:** Fish species from openwater bodies like rivers, reservoirs and lakes fetch considerably higher prices than that from pond aquaculture. The most preferred group of fish species in Nagaland are the major catfishes followed by the Indian major carps, exotic carps and other small sized fish.

- The retail price range are Rs 110-250 for major catfishes, Rs 110-140 for IMC and Rs 120-140 for exotic carps (Anon., 2009).

Constraints for Fisheries Development

Even though the state has considerable potential for increasing its fish production, a number of constraints hindering fisheries development are yet to be tackled. Some of these are briefly discussed.

- **Non-professional attitude:** In the past, casual attitude of the farmers towards scientific/ commercial fish farming was a major constraint in the developmental activities of the fisheries sector (Anon., 2009). Majority of the fish farmers in the state take up fish farming as an occasional or part time occupation and thus lack professionalism in fish culture. As a result a huge gap still exists in the supply and demand of fish. However, with much effort and awareness, aquaculture has begun to be assumed as a major activity in the state in recent years even though optimum utilisation of all the potential fisheries resources is yet to be achieved.

- **Non-availability of quality fish seed:** Non-availability of quality fish seed in adequate amounts has always been a constraint in the northeast region (Sugunan, 2003) and Nagaland is no exception. Considerable quantities of fish seed is brought into the state from Assam, but they remain unspecified. The problem is further confounded by the low temperatures at higher altitudes that make it difficult to breed or rear fish (Sugunan, 2003). Adequate facilities are also not available for growing fish fry into fingerling stage to stock the lakes/ reservoirs.

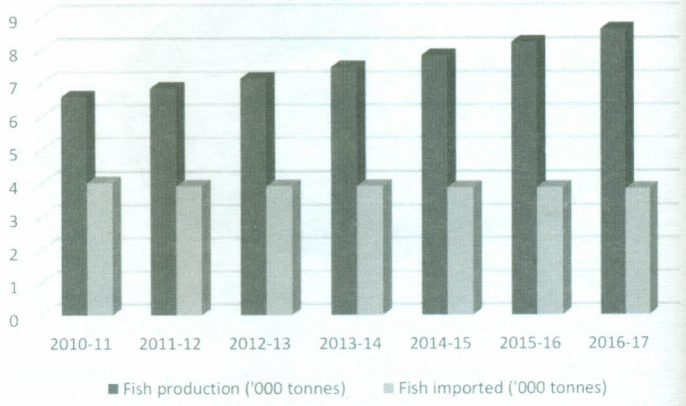


Fig. 8: Quantity of fish produced in and imported to the state over the last six years

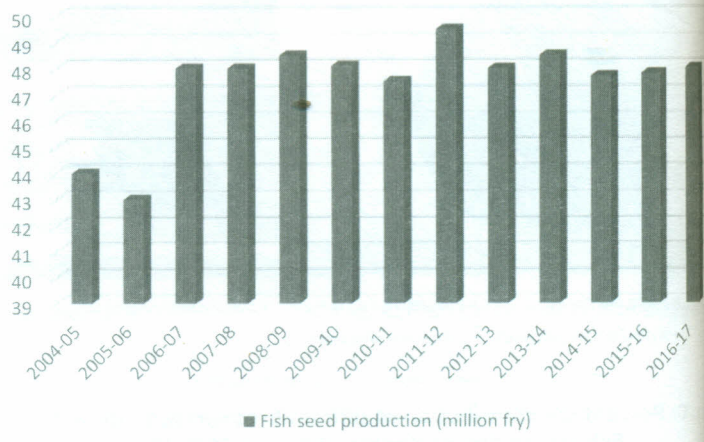


Fig. 9: Fish Seed Production (million fry) in the state over the last thirteen years

- **Macrophyte infestation:** Most of the wetlands/lakes, unmanaged ponds and other low-lying areas of the state are infested with floating (especially water hyacinth), submerged (e.g., Hydrilla sp., Vallisnaria sp.), rooted emergent (e. g., water lily) and marginal macrophytes (e. g., Typha sp.). Initial clearance and subsequent periodical control (if and when needed) of these unwanted vegetation increases the cost of aquaculture (and even culture-based fisheries since macrophytes hinder effective fishing) in these water bodies.

- **Fish disease:** As aquaculture and fisheries enhancements have progressed in the state, fish disease in aquaculture systems have emerged as a significant problem. Fortunately, this is not very acute except for the occasional outbreaks of the Epizootic

Ulcerative Syndrome. However, there is no disease laboratory in the entire northeast region where the aetiology of a particular fish disease can be diagnosed. Further, non-availability of prophylactic and therapeutic agents for treatment of common fish diseases also creates problem for the fish farmers of the state.

- **Bio-fouling of cage nets:** It was reported that the cage nets of the cages installed in the Doyang reservoir were choked with periphyton and organic debris after a couple of months. Bio-fouling severely reduces water exchange, thereby leading to deterioration of water quality inside the pens/cages. In extreme cases, this may result in mortality of stocked fish. Therefore, cage nets have to be periodically cleaned off the accumulated debris. After harvesting, thorough cleaning of the cages is a must before reusing the same netting for another crop.

- **Other technical constraints:** Shortage of other critical inputs like fish feed as well as prevailing low temperatures and acidic conditions also hinder aquaculture development in the state. In addition, limited availability of plain lands, difficult terrains and aquatic pollution also come in the way of fishery development.

- **Economic constraints:** Low availability of funds is a serious constraint for fisheries development in the state especially in its large openwater bodies. A substantial part of the resources in the northeast comprises capture or culture-based fisheries. The development and management of these require high initial costs, compared to pond aquaculture. Financial institutions are often reluctant to advance loans to resource-poor fishers for capture fishery operations due to catch uncertainties and failure to fulfil the set criteria of collaterals, sureties, etc (Sugunan, 2003). Even in the case of privately owned ponds, institutional financing is not satisfactory owing to a number of reasons like complicated procedures in loan sanctions, fear of land mortgages and low recovery of old aquacultural loans. Development of natural resources for fish production involves very high costs, which often has to be borne by the government. Most of the northeastern states face financial crunch, that affects fisheries development. In addition to that, there are also problems like poor post-harvest infrastructure and exploitation of fishers/fish farmers by middlemen.

- **Shrinking area of openwater bodies:** Floodplain wetlands, reservoirs, mini-barrages and low-lying areas of the state receive a lot of silt from the rivers and/or surface run-off from their catchment areas especially during the rainy season. The state's hills and mountains are geologically unstable and therefore, soil erosion and landslides are common. The problem is aggravated by agricultural activities in the catchment areas, which loosens the top soil. Siltation is a serious problem faced by the beels/pats, swamps and low-lying areas. Infestation of aquatic macrophytes causes additional auto-siltation in these water bodies.

- **Consequences of siltation include:** Shrinking water area, reduced water levels, and reduced water renewal/auto-stocking from rivers due to siltation of the connecting channels, faster ageing of swamps/paddy fields and diversion for agriculture/other uses. Siltation is a natural process and cannot be prevented. However, the rate of siltation can be reduced by enforcement of strict laws to prevent deforestation, planting trees around the water body to prevent soil erosion and controlling aquatic macrophytes. Periodical de-siltation of the water body is required for maintaining its productive area but is a costly proposition. Openwater bodies like beels, lakes, swamps and reservoirs of the region face the threat of shrinkage in their water spread area over the years due to siltation and subsequent diversion for other uses. The silted areas are gradually encroached by the local inhabitants and converted to private patta lands in due course with the connivance of revenue officials. A number of beels/pats have either dried up completely or are diverted to other uses like agriculture, pond construction, housing, etc. Encroachment/diversion of these water bodies is abetted by a number of factors like the absence of clear demarcation of boundaries, increased pressure on land resources for agriculture/housing, lack of effective government control, lack of awareness among the riparian communities about conservation of the wetlands for maintaining ecological balance, lack of participation of the local communities in the development/management process, economic benefits from the resource used by only a handful of individuals (lessees/fishers' cooperative society members), non-cooperation of revenue officials, etc. Probable solutions to this issue include prevention and control of siltation, formulation and enforcement of strict laws to prevent reclamation/encroachment, spreading mass awareness about the need for conservation of wetlands/swamps and demarcation of boundaries.

- **River regulation:** Construction of embankments along the banks of rivers for flood control has resulted in negligible auto-stocking of riverine fish species and annual flushing of water in many beels/pats, lakes and swamps. Further, since most riverine fish species use the open beels as spawning and nursery ground, river regulation also adversely affects the fish stocks of the parent rivers (Bhattacharjya, 2004). The harmful effects of dams on the ecology and fisheries of rivers have been well known (Jhingran, 1991) especially on the migratory species. However, even though river regulation has harmful effects on the fisheries of openwater bodies, it is irreversible since flood control is given more importance over fisheries. Thus, construction and effective operation of sluice gates appears to be a practicable option.

- **Conflicts between different users of openwaters:** In most openwater fisheries, conflicts arise between lessees/fishers and agriculturists/local residents over the use of marginal land and water for cultivation, irrigation, jute retting, navigation and other uses. Such conflicts are common in openwater bodies because they are multiple-use resources. However, conflicts often interfere with development and management of openwater fisheries and may create other social

These destructive fishing methods indiscriminately kill the juveniles and the brooders leading to decline in riverine fish species.

Hence serious efforts should be made to conserve these riverine fishery resources. The following conservation approaches can be considered:

A. Deforestation and overgrazing activities along the sloppy catchments need to be checked immediately.

B. Soil and water conservation measures need to be intensified.

C. Enforcement of fishery legislation (Indian Fishery Act/ Nagaland Fisheries Act) in streams, rivers and lakes to be effectively monitored.

D. Specific gear and mesh size need to be regulated to protect the juveniles.

E. Observation of closed season during breeding seasons.

F. Breeding and feeding grounds of fish should be declared as reserves/sanctuaries.

G. Electric -fishing and use of poison, bleaching powder, dynamite should be banned.

H. Seed ranching and protection of the declining stocks.

I. Mass awareness through extension activities and voluntary agencies about the need for conservation of fish stocks and their ecosystem.

Conclusion

The per capita availability of fish in Nagaland was only 3.22 kg up to 2009-2010 (Anon, 2010) which is far below the nutritional requirement of 11 kg. The Department of Fisheries aims at self sufficiency in fish production through creation of self-employment opportunities and upliftment of socio-economic status of the rural people. But due to land pressure, the plan envisages on using the readily available water bodies, reclamation of old ponds/ tanks, utilisation of wet terrace paddy fields for fish rearing, adoption of modern scientific technology, development and upgradation of hatchery units, strengthening technical manpower and upgrading traditional fish farming to semi intensive and intensive farming methods.

Agricultural development including fisheries would have to play a pivotal role in the socio-economic development of the region. The availability of rich fisheries resources, high demand and price of fish creates a congenial environment for fisheries development. Despite the hindrances, it is heartening to note that the state has made considerable progress in recent years; for example setting up of a public aquarium which is a first, in the northeast. Fisheries institutes of the region under the Indian Council of Agricultural Research have initiated research efforts to develop suitable aquaculture technologies for the medium altitude areas (700-1400 metre AMSL). This would enable proper utilisation of locally available resources.

Also, the government departments and financial institutions will have to play an important role in setting up capital intensive fisheries enterprises like commercial feed plants, seed farms, net making plants, etc. The development of capture and culture-based fisheries would provide means of livelihood to the resource-poor fishers of the northeast. The openwater fisheries being a community-based development process, has a direct bearing on the rural populace of this socio-economically sensitive region of the country. Fisheries development often comes into conflict with environmental conservation norms and, therefore, careful planning is required in achieving fish yield enhancement while accommodating the environmental concerns. This is particularly important in the northeast, because of its pristine aquatic environments and precious endemic fish species to be preserved for the future. Thus, concerted efforts are needed on the part of all concerned to realise the fish production potential, thereby contributing to the overall socio-economic development of the region.

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