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Status and future of aquaculture development in Mizoram, India

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Abstract

The state Mizoram witnessed good growth in aquaculture in recent years and has potential for improvement in production of fish with its endowed resources. The present paper is an attempt to analyze the status of aquaculture in the state of Mizoram and draw future strategies for improvement. The state has 5400 ha of water area under fish culture, and about 14500 ha of open water resources. Aquaculture contributed more than 90% of the total fish production of 7630 MT during 2016-17. During the last eight years the total aquaculture production in the state has enhanced to 91% with a growth rate hovering around 10%, mainly due to horizontal expansion of culture fisheries resources that almost doubled in last 10 years. Productivity of fish culture in ponds in the state though increased from 961 kg/ha/year in 2007-08 to 1280 kg/ha/year in 2016-17; it is still far below the national average of 2900 kg/ha/annum. In addition to that the per capita fish availability in the state is only about 6 kg at present which is also lower compared with other neighbouring states like Assam (9.35 kg), Manipur (10.95 kg) and Tripura (17.30 kg). The state falls short of about 25% of fish seed against the total requirement of about 41 million seed. Carps are predominantly cultured though the state has vast diversity of about 160 fish species. The state has an ample scope for fisheries development through horizontal expansion as 17,500 ha area is available aiming at a higher productivity and diversification of species. Kolasib and Mamit are the districts, with maximum plain lands which dominate in all aspects of fisheries in the state and has potential to play the lead role in state's mission of achieving self-sufficiency.

Keywords: Mizoram, fisheries resources, fish seed production, fish production

1. Introduction

Fisheries as a whole provide livelihood supports to about 60 million people ^[1] with notable contribution to GDP, foreign exchange earnings, food and nutritional security of India. Aquaculture, the key component of fisheries, has evolved in India as a viable commercial farming practice from the level of traditionally backyard activity over last three decades with considerable diversification in terms of species and systems, and has been showing an impressive annual growth rate of 5-7 percent ^[2]. The North East India (NEI) covering eight states viz., Assam, Arunachal Pradesh, Meghalaya, Manipur, Mizoram, Nagaland, Sikkim and Tripura is one of the richest regions in terms of natural resources and considered as one of the hot spots of freshwater fish biodiversity in the world ^[3]. It is estimated that 267 fish species belonging to 114 genera under 38 families and 10 orders have been reported so far from this region ^[4], which represents about 33% of the Indian total freshwater fish species. The region is blessed with as many as 58 notable rivers/tributaries besides numerous rivulets/hill streams, floodplain wetlands, lakes, reservoirs, ponds and mini barrages. Representing about 8% of the geographical area and about 4% of the whole population of the country, this region has immense demand for fishes with more than 85% of population being fish eaters ^[5]. Fish has been associated with the life of the people of the region from time immemorial ^[6] and is also linked with the culture, religion, and traditions of the region ^[7]. In North East more than 50% of fish produced are from aquaculture. In some of the states, fish production is only from aquaculture as in the state of Nagaland. In Mizoram, nearly 91% and in Tripura, more than 95% of production comes from aquaculture. This reflects not only the growing importance of aquaculture, but also the great urgency and need to focus on aquaculture to meet the growing demand for fish in the region.

The state of Mizoram located at the southern part of North-East India covering an area of

21,087 sq km has rich wealth of fishery resources and considered as a storehouse of indigenous fishes. Though the terrain of the state is mostly hilly, it has considerable stretches of plain areas bordering Assam and Tripura in its national boundary and Bangladesh and Myanmar as its international border besides various flat lands in certain pockets. Improvised impoundments created by blocking the streams, locally called mini-barrages, are a popular type of aquaculture resource in Mizoram where there is a dearth of plain land for digging ponds. It is estimated that about 24,000 hectare area of the state are suitable for culture fisheries development, but so far only about 23% of the available resource has been developed for fish farming which at present supplies about 55% of the table size fish requirement of the state leaving a gap of about 45%. The state has further 6000 hectare of water area in the form of rivers and streams [21]. Despite having large freshwater resources, fisheries is observed to be underdeveloped in Mizoram compared to other neighbouring states. Aquaculture production though escalated over the last few years, productivity per hectare water area is not yet attained at its optimum. The Fisheries contributed 1% of total GSDP (Gross State Domestic Product) of State of Mizoram and 14% within the Agriculture and allied sector in 2015-16. Though there have been few studies on the fish diversity, fishing practices in rivers of Mizoram, comprehensive literature on the present status of fisheries or aquaculture development of the state is lacking. With this background the present study was conducted to

- i) Map out the fisheries and related resources of the state
 - ii) Elicit the status of fish production and productivity, and
 - iii) Draw out future strategies based on the need of the sector
- The study was conducted by a team of scientists of ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar, Odisha in the year 2017-18 with the support of Indian Council of Agricultural Research, New Delhi.

2. Materials and Methods

The present study is based on the primary and secondary data

collected from different sources. Primary data were collected using key informant technique. The key informants selected for the study were from Department of Fisheries (DoF), Govt. of Mizoram through personal interactions. The secondary data were collected from the annual reports and other documents published by the DoF, Govt. of Mizoram; Planning and Programme Implementation Department, Mizoram; Department of Animal Husbandry Dairying and Fisheries (DAHDF), Govt. of India and scientific communications and websites of DoF, Govt. of Mizoram. Secondary data were collected from October to December, 2017. Adding to that a cross section data of the year 2016-17 upto district level was analyzed to understand the status of fisheries sector. Time series data related to fish production and productivity were collected for last one decade. Tabulation, percentage analysis and graphical representation of data were used for analyzing and presenting the findings of the study.

3. Results and Discussion

3.1 Fishery resources of the state and People’s involvement

Rivers, reservoirs, ponds and mini barrages are the fisheries resources of the state (Table 1). The state has about 7400 ha of water or paddy-cum water area available for fish culture and about 14500 ha of open water resources contributing notably to capture fisheries. There are 22 rivers in the state along with their tributaries accounts to 1700 km and comprising of three drainages namely, Barak (Ganga-Brahmaputra basin), Karnaphuli and Kolodyne basin [8]. River Tlawng (Dhaleshwar) is the longest spanning to 102 km and the river Kolodyne (Chhintuipui), which originates in Myanmar, is the largest by volume. The state also has other riverine resources contributing to fish production. Besides this the state has two large reservoir and three small reservoirs covering about 8400 ha. Other lentic open water bodies of the state include Tum Dil lake near Saitual, Palak Dil lake near Tuipang, Rih Dil lake near Champhai and Rengtlang Dil lake near Parva.

Table 1: Fisheries resources and fish production of Mizoram

S. No.	Type of water	Area at the end of 2016-2017	Production at the end of 2016-2017
1.	Ponds, tanks and mini-barrages	5450 ha	6980 MT
2.	Rivers and canals	6000 ha (1100 km)	180 MT
3.	Reservoir fisheries Serlui Tuirial Teirei Maicham Kawahiva	4000 ha 4000 ha 400 ha	250 MT
4.	Paddy-cum-Fish Culture	2000 ha	
5.	Lakes	100 ha	20 MT
	TOTAL	20850 ha	7630 MT

(Source: Department of Fisheries, Govt. of Mizoram)

The area under pond aquaculture has increased from 2875.80 ha in 2007-08 to 5450 ha by 2016-17 against an observed potential of 24000 ha. This indicates that, though resources of the state have expanded very rapidly within last few years (Fig. 1), there is still scope to expand the area under fish culture. Kolasib, Mamit and Lawngtlai are the districts with maximum area of culture fisheries resources (Fig 2). It has been noted that the expansion of aquaculture resources and the involvement of fishers in the sector also has doubled in the last 10 years (Fig. 3). It is estimated that about 18904 fishers are involved in both culture and capture sector for their livelihood in the state (Fig. 4).

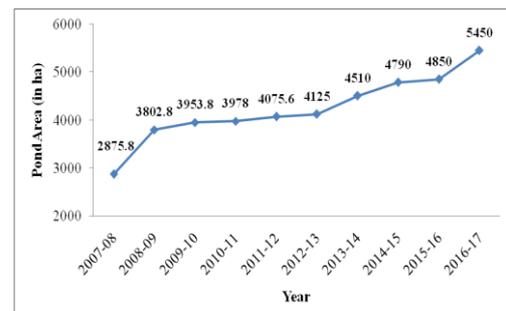


Fig 1: Trends in horizontal expansion of culture fisheries of Mizoram

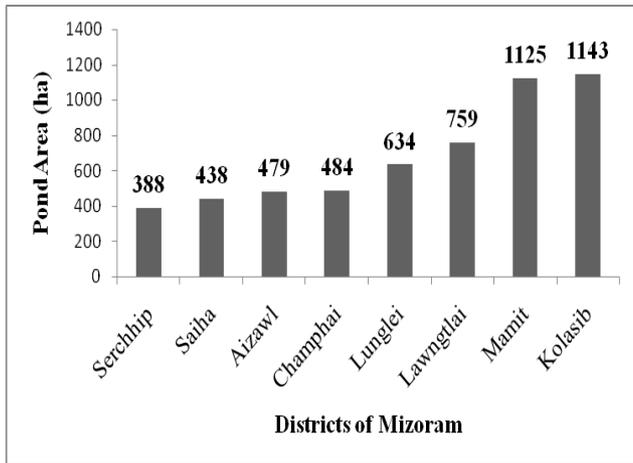


Fig 2: District-wise culture fisheries resources of Mizoram in 2016-17

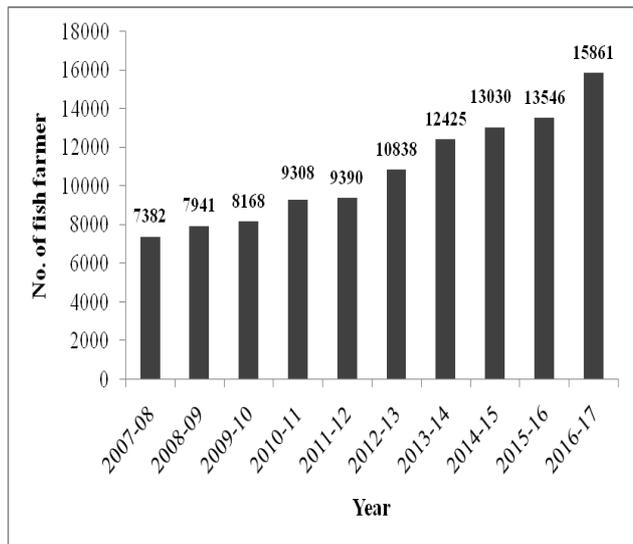


Fig 3: Increasing trends of farmers involvement in culture fisheries sector of Mizoram

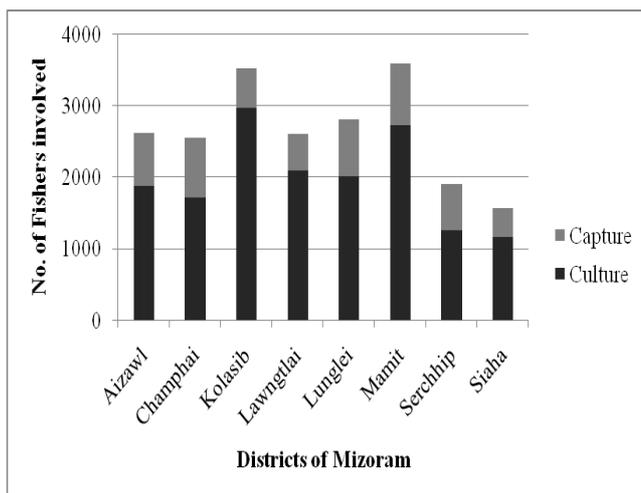


Fig 4: District-wise total no. of fishers involved with culture & capture fisheries sector of Mizoram in 2016-17

3.2 Fish species diversity of the state

The state harbours 156 species of fish belonging to 9 orders, 26 families and 72 genera from different resources like rivers, lakes and other water bodies [9]. The fish diversity of the state is dominated by the order Cypriniformes with 78 species, followed by Siluriformes with 50 species, Perciformes with 15 species and Synbranchiformes with 5 species. The genus

Glyptothorax is the most dominant genus with 15 species, followed by *Schistura* with 12 species, and *Garra* with 11 species [9]. But till fish diversity of Mizoram is believed to be highly underestimated. During the last decade more than 40 new species of freshwater fishes have been indexed from the rivers of Mizoram including fishes like *Schistura aizawlensis*, *Garra dampansensis*, *Schistura mizoramensis*, *Pethia rutila* [10-13]. Many of the species described from Mizoram are not yet reported from outside Mizoram, particularly species within the family Nemachelidae and Sisoridae like *Schistura* and *Glyptothorax* respectively, are rheophilic species and have a high chance of endemism as they are usually torrential hill forms, and often their distribution remain restricted to the head of water of a particular river basin [14].

3.3 Prevailing culture practices and Culture species diversity

At present, the fish culture is predominantly dominated by Indian major carp (IMC) species such as *Catla catla*, *Labeo rohita* and *Cirrhinus mrigala* along with other exotic carps, such as silver carp (*Hypophthalmichthys molitrix*); grass carp (*Ctenopharyngodon idellus*); and common carp (*Cyprinus carpio*). In the plains of Mizoram the common practice of aquaculture is composite fish culture with Indian major carps (catla, rohu, and mrigal) or composite culture of IMC with exotic carps (common carp, silver carp, and grass carp). In the case of high and medium altitudes monoculture of common carp or culture of common carp mixed with other exotic carps and/or IMC is practiced. Species diversification in the state has not yet gained much attention in the farmer's level, but in recent years the state fisheries department initiated attempts for organized expansion of culture of fishes like *Oreochromis mossambicus/niloticus*, *Macrobrachium rosenbergii* and *Pangasius Sutchi*. The state has vast potential further for diversifying fish species under culture, which will not only open new market avenue in the state, but also play role in catering the demands of the neighbouring states. Paddy-cum-fish culture and integrated fish farming with pig, poultry etc. are also practised in the state in limited scale.

3.4 Fish Seed Production

Production of quality fish seed is vital for the development of aquaculture and culture-based fisheries in inland fishery resources [15]. The total fish seed requirement of Mizoram is estimated to be about 409 lakhs fingerlings considering the available water bodies (Table 5). Six fish seed farm including three hatcheries has been handed over to ZOFISFED (Mizoram Fish Farmers Federation) for a period of 10 years and the DoF, Mizoram is managing 5 fish seed farm with 5 hatcheries from 2008-2009 onwards. The DoF is maintaining fish seed farms at Lengpui, Tamdil, Zobawk and Ngengpui (<https://fisheries.mizoram.gov.in>). Out of the total fish seed requirement nearly 300 lakhs of fingerlings produced in the state both from private and government sector and remaining about 109 lakhs come from the neighbouring states of Assam and Tripura. Among north-eastern states Assam, Manipur, and Tripura produce surplus seed and export to other states, while states such as Arunachal, Pradesh, and Mizoram import large quantities of seed from other states [5]. To augment the fish seed production the state government of Mizoram has taken initiatives through the development agencies and projects like National Fisheries Development Board (NFDB), Rastriya Krishi Vikas Yojana (RKVY) and New Land Use Policy (NLUP) to construct and upgrade existing fish

hatcheries and ponds for fish and fish seed production ^[21]. With the assistance of RKVY in 2015-16 the state has distributed 201.8725 lakh fish seeds to the farmers covering an area of 1300 ha, procured 2000 quintals of fish feeds for selling to the farmers at 75% subsidized rate and established 2 nos. of Matsya Mitra Centre, one each at Champhai and Serchhip ^[22].

3.5 Fish Production and Productivity

The inland aquaculture production of the country is constrained mainly by three problems related to -seed, feed, and extension service ^[16]. In 2015-16, Mizoram was the 5th in fish producing state among the North-Eastern states, accounting only about 2% of the North-East India's total fish production (Table 2). The annual fish production in the state is estimated to be 7630 mt from both capture and culture fisheries during 2016-17. Aquaculture in pond/mini barrage represents the mainstay of fisheries in Mizoram, accounting

more than 90% of the total production of the state. The total aquaculture production in the state enhanced nearly 91% in last eight years with a growth rate of 10.65% in 2016-17 (Table 3). The present unit area production of the state are 1281, 200, 30, 30 and 100 (kg/ha) from the ponds, lakes, reservoirs, rivers and paddy-cum-fisheries, respectively. Though aquaculture productivity from ponds in Mizoram has increased from 961 kg/ha/yr in 2007-08 to 1280 kg/ha/yr in 2016-17 (Fig 5), it is far below the national average. The national mean production levels from still-water ponds has gone up from about 600 kg/ha/yr in 1974 to over 2900 kg/ha/yr at present and several farmers are even demonstrating higher production levels of 8–12 tonnes/hectare/year (Handbook of Fisheries and Aquaculture, 2013). All the districts of Mizoram have shown an improved in fish production over the years and observed to be better in Kolasib and Mamit districts with topography of mostly plain (Table 4).

Table 2: Comparison of Fish production of Mizoram with neighbouring states

State	Fish Production (in MT)		
	2013-14	2014-15	2015-16
Assam	266700	283182	291692
Tripura	61950	65779	63560
Manipur	28541	30305	31266
Nagaland	7465	7926	7835
Mizoram	5940	6307	6536
Meghalaya	5752	6107	6140
Arunachal Pradesh	3625	3849	4410
Sikkim	420	446	443

Source: http://dahd.nic.in/sites/default/files/LS%20136_0

Table 3: Total Production and growth rate of Aquaculture in ponds of Mizoram (2008-09 to 2016-17)

Year	Fish production (MT)	Growth rate (%)
2008-09	3624.41	10.23
2009-10	4136.56	14.13
2010-11	4621.40	11.72
2011-12	4800	3.86
2012-13	5100	6.25
2013-14	5540	8.60
2014-15	5987	8.07
2015-16	6308	5.36
2016-17	6980	10.65

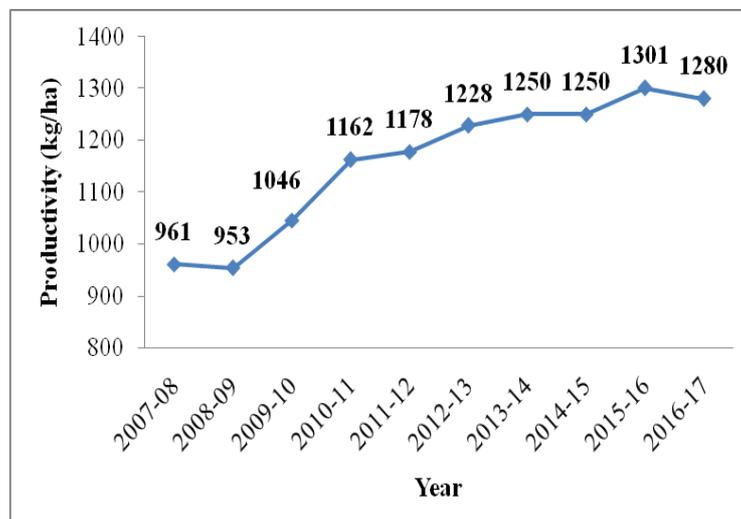


Fig 5: Trends in productivity in pond culture sector of Mizoram

Table 4: District-wise total production (MT) and productivity (kg/ha) of pond culture sector in Mizoram from 2008-09 to 2016-17 (Source: Department of Fisheries, Govt. of Mizoram, 2017)

Year	District-wise total production and productivity															
	Aizawl		Lunglei		Saiha		Kolasib		Mamit		Lawngtlai		Serchhip		Champhai	
	A*	B*	A*	B*	A*	B*	A*	B*	A*	B*	A*	B*	A*	B*	A*	B*
2008-09	133.44	600	289.92	605	227.15	700	1202.5	1250	997.5	1250	358.2	600	184.3	1000	231.4	998
2009-10	142.44	602	297.12	599	237.65	701	1445.65	1450	1200.6	1430	365.6	610	196.3	998	251.4	1002
2010-11	216	900	348.6	700	274.4	800	1550	1549	1289.6	1550	488.8	798	199	990	255	978
2011-12	230	951	365	731	310	898	1532	1527	1394	1528	495	607	215	1064	259	1000
2012-13	215	799	406	801	336	1003	1535	1601	1472	1600	645	997	211	1010	280	952
2013-14	298	949	445	799	358	995	1618	1600	1576	1596	596	900	307	1100	342	993
2014-15	344	942	466	834	386	989	1695	1602	1660	1608	622	926	370	1108	444	1168
2015-16	358	950	505	899	356	898	1813	1699	1719	1649	611	900	443	1302	503	1299
2016-17	478	982	634	930	436	918	1829	1700	1800	1670	758	936	465	1280	580	1263

A* = Total production in MT; B* = Productivity in kg/ha

3.6 Status of exotic fish invasion in natural water bodies of Mizoram

Invasion of exotic species is considered as one of the biggest threat to freshwater fish diversity [17]. Invasive fish species like *Oreochromis mossambicus* has been reported to be occurred in the recent times from rivers of Mizoram, which will plague the highly diverse indigenous freshwater fishes of the state, as *O. mossambicus* is regarded as one of the 100 most invasive species in the world. The species is reported from Lik River (tributary of Tlawng River) and also from Palk Lake, the biggest lake in Mizoram [18]. It is also noted that *Clarias garipinus* also got unauthorized introduction in water bodies of the state. Since exotic fishes are dominant in characters and aggressive in behaviour, they have potential to eliminate the local fish species and considered serious in view of sustainability of local fish diversity. Proper studies

regarding the impact of these exotic fishes on the ecology of the rivers of Mizoram need to be undertaken to control these invasive fish population before facing its larger consequences and impacts.

3.7 Demand and Supply Analysis

The requirement of table size fish in the state by the end of 2016-17 was about 12530 MT at a per capita scale of 11 kg. With a production of 7630 MT at the end of 2016-17, the state faces a shortage of about 40% of the requirement. The per capita fish availability of fish in the state is about 6 kg at present which is also far lower than other neighbouring states of Assam, Manipur and Tripura (Fig 6). The state also has a shortfall of about 25% of the requirement of the fish seed (Table 5).

Table 5: Requirement and supply status of fish and fish seed in Mizoram at the end of 2016-2017

Table Fish			Fish Seed		
Requirement @ 11 kg/ head/yr	Present Production	Deficit	Requirement for pond culture @ 7500 nos./ha	Present production	Deficit
12530 MT	7630 MT	4900 MT	40.87 million	30.00 million	10.87 million

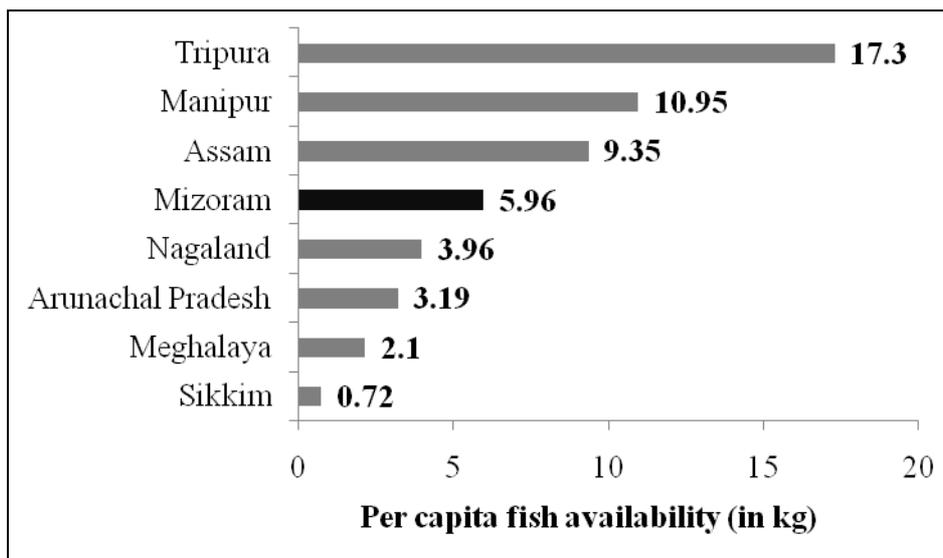


Fig 6: Comparison of per capita fish availability¹ in Mizoram with other North-Eastern States ¹Per capita availability of fish was calculated by dividing the total production of 2015-16 by the total population as per Census 2011.

3.8 Future Strategies and directions towards enhanced aquaculture production:

The state has more than 90% fish eaters which endeavour a market that needs to be satisfied. According to the reports the

possibility of expanding aquaculture is more than 17500 ha which is much higher than the area under aquaculture at present (5450 ha), providing opportunities to increase fish production through lateral expansion. Bringing these water

bodies into the ambit of fisheries will boost fish production. The DoF, Mizoram has targeted to create additional 5000 ha of new ponds and tanks under various Centrally Sponsored Schemes; NFDB (National Fisheries Development Board); NLUP (New Land Use Policy) and other State Plan programmes of Mizoram by the end of 2020 which is an appreciated step. Government of Mizoram has also taken initiatives to utilize two hydroelectricity impoundments offering almost 4000 hectare water areas created by State Power and Electricity Department (PED) for capture based culture fisheries through an MOU between PED and DoF of Mizoram. In addition to that the government has taken up a flagship programme namely NLUP to assist 1,20,000 jhumia families to settle permanently in various trade to do away with shifting cultivation of which 3000 families covering 1500 hectare has been entrusted to the fishery sector ^[21].

Reservoirs, which are largely untapped, have great potential for fisheries development of Mizoram. By promoting technologies like cage culture, the productivity of the reservoirs of the state can be enhanced from the current productivity level of 30 kg/ha/yr, which is far lower than the average fish production potential estimated at 250 kg/ha/yr from reservoirs ^[19]. The DoF, Mizoram targeted to intensify the culture based capture fisheries from medium reservoirs to augment the production to 140 kg/ha through judicious stocking of the reservoirs, improvement of cage culture practices and enforcement of conservation measures in line with Mizoram Fisheries Act 2002. As per DAHDF (2016-17) the production potential of sustainable cage culture for table fish production is about 50 kg/m³ with a possibility for further intensification. DoF, Mizoram also targeted to establish *in situ* seed production facilities in the reservoirs of the state to compensate for insufficient auto stocking due to the failure of natural recruitment and augment open culture in reservoirs.

Paddy-cum-fish integration, believed to be the most appropriate for optimum utilization of available land water resources, has very low productivity in the state (100 kg/ha), which has potential to increase up to 1000 kg/ha/yr by stocking suitable fishes and appropriate management ^[20]. Culture of fast-growing fish such as tilapia (monosex tilapia) and other fishes might be a promising option for fish productivity augmentation from the rice fields. Fish farming can also be well integrated with livestock by products which are considered as wastes. Pond based integrated fish farming using poultry/duck/pig rearing should be explored in Mizoram for accelerating farmer's income especially small-scale farmers. Culture of catfishes or cold water fishes has not attained any mark in the state though there is good possibility. Diversification of aquaculture through utilization of locally available and marketable species of the state need to be promoted which not only helps to supply many fish resources pertaining to regional preferences will also contribute to the conservation of species diversity for the future.

Cold water fisheries also have a good span in the state. Chocolate Mahseer (*Neolissochilus hexagonolepis*) which is abundant in River of Mizoram and *Semiplotus modestus* (locally called as Nghavang), the State fish of Mizoram, which is native fauna in the rivers of Mizoram and presently under threatened status provide good possibility of expansion of cold water aquaculture in the state. DoF, Mizoram now targets to establish two centres for breeding and propagation of Mahseer and other indigenous cold water fish varieties including *Semiplotus modestus* to preserve, proliferate and save them from being extinct.

4. Conclusion

According to dietary guidelines of the National Institute of Nutrition (NIN), India fish can be consumed frequently (at least 100-200g fish in a week) and have to prefer it over than meat and poultry. In the state Mizoram, total fish production was estimated at about 7630 MT during 2016-17 supplying less than 6 kg/capita which is far below as compared to many neighbouring states. But the state has ample scope for fisheries development to meet the requirement and improve the economy. A number of steps have been taken by the DoF, Government of Mizoram for increasing fish production. These steps include increasing total water area under aquaculture, accelerating aquaculture farming, augmenting open water capture fishery, ensuring access of the poor and genuine fishers to fish cultivation, disseminating technologies through strengthening extension services, promoting private sector, improving fish marketing and processing system, quality control etc.

5. Acknowledgement

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