ISSN–0974–0759 | ●●● Popular Article ●●● |Visit us : *www.researchjournal.co.in*|

Freshwater aquaculture of Maharashtra – A review of Vidarbha perspective

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Fisheries is a sunrise sector of our economy. Its role in increasing food supply, generating job opportunities, raising nutritional level and earning foreign exchange has been important. Growing urbanization, globalization and rapidly changing social structures have had a major impact on the fisheries structure in the country. Fisheries and aquaculture has emerged as an important commercial activity from its traditional role as subsistence supplementary activity.

With a long coastline of over 8000 Kms, 2.02 Million Sq. Km. of Exclusive Economic Zone, 0.5 Million Sq. Km of continental shelf area, India is estimated to have exploitable fisheries resources of 3.9 million Metric Tons of which only about 3.0 million Metric Tons are presently exploited. Further, about 1.2 million hectares of potential brackish water area suitable for aquaculture and 5.4 Million hectares of area are available for Freshwater aquaculture in the country. India's with its more than 10 per cent of the global biodiversity in terms of fish and shellfish species offer excellent opportunity for expansion of aquaculture foodfish production. The country has shown continuous and sustained increments in fish production since independence.

Presently India is the second largest fish producing nation in the world. India is also a major producer of fish through aquaculture and ranks second in the world after China. The total fish production during 2018-19 was at 13.70 million metric tonne (MMT). Paradigm shifts in terms of increasing contributions from inland sector and further from aquaculture have been significant over the years. With high growth rates, the different facets, *viz.*, marine fisheries, coastal aquaculture, freshwater aquaculture etc.are contributing to the food basket, exports and employment of the country.

Fish constituted about 10 per cent of total exports from India and almost 20 per cent of agriculture exports in 2017-18. With export earnings of US $ 7 Billion, India is the 4th largest exporter of fish in the world. Apart from exporting marine products worth more than Rs.47,600 crore, the sector also provides employment opportunities to more than 14.5 million people, residing in remote villages of the Indian coast (DADF, 2018). Employment in this sector has grown faster than the world's population. This sector has immense potential and if realized can make a difference in the millions of lives. It is a source not just of health but also of wealth.

Blue revolution through aquaculture: Aquaculture which accounts for 50 per cent of the total fish production has been providing food and nutritional security to millions of people at affordable price as well as contributing to the livelihood support to a large member of rural population in the country. Its growth rate (over 6% a year) is the fastest among all other food production systems. It is also considered as the most efficient form of animal production system. In India, the culture system is based on 3-6 species combination thus maximising productivity (Jayasankar, 2018).

The freshwater aquaculture which began as small scale activities of stocking ponds with fish seed collected from riverine sources during early fifties in rural Bengal has now transformed into a major economic activity in almost all states with the common objective to double the production. Since the last three decades, freshwater aquaculture has also been compensating the loss in the fish production due to decline in the capture fisheries as well as increasing overall fish availability in the country. Aquaculture generates income and employment opportunities

across the chain of seed production, fish culture, fish harvesting, input supply, trading, marketing as well as processing. Globally, aquaculture is being seen as antidote to fight poverty and malnutrition.

Realizing the great scope for the Development of Fisheries, on the occasion of "World Fisheries Day-2015", the Government of India inaugurated the Umbrella scheme on 'Blue Revolution. This umbrella scheme with an outlay of Rs. 3000 crore covers inland fisheries, aquaculture, marine fisheries including deep sea fishing, mari-culture and all activities undertaken by the National Fisheries Development Board (NFDB). A focused approach of this nature would lead to ushering in blue revolution through an integrated development and management of fisheries and aquaculture sector.

Fisheries of Maharashtra: Maharashtra state offers an excellent opportunity particularly in inland fisheries sector because of the vast inland water resources at its disposal. The inland fisheries resources of Maharashtra include 19,456 km rivers and canals and 3,77,905 ha of ponds and reservoirs and 12,445 ha of brackish land area suitable for shrimp culture. The details on the fishery resources in the Maharashtra are provided in the Table 1.

During 2018-19, the total fish production of the state was 5.87 lakh tonnes; of which marine sector contributed 4.74 Lakh tonnes and inland sector contributed 1.13 Lakh tonnes (Fish Production Report, State Fisheries dept., Govt. of Maharashtra). Out of the total inland fish production of the State, the Vidarbha accounts for the approximately 50 per cent (69,756 tonnes) fish production. The high magnitude of inland fish production from Vidarbha is because of the numerous water bodies like village tanks, lakes and reservoirs particularly in the eastern districts of Vidarbha *viz.*, Gondia, Bhandara, Chandrapur and Nagpur. The available water spread area for inland fisheries in Vidarbha region (including Amaravati and Nagpur division) is 128386 ha.

A total of 4.50 Lakh people in Maharashtra are associated with the fisheries trade, out of which 54,901 are active fishermen engaged mostly in marine sector. (Website of State Fisheries Department, Govt. of Maharashtra). The fishermen population of Vidarbha is 2,68,646 of which approximately 85,433 are members of primary fishermen co-operative societies.

Boosting inland fish production of Vidarbha: In Maharashtra inland fisheries have grown in absolute terms. Vidarbha in particular has vast and varied inland fisheries and aquaculture resources which are mostly underutilized. The major fisheries resources are in the form of network of rivers and rivulets, reservoirs, village ponds and tanks,

Table 1: Fishery resources of Maharashtra

Marine fishery resources of Maharashtra			
Continental shelf	1,11,512 sq.km		
Coastline	720 K.M.		
Costal districts	6		
Fishing villages	406		
Fish landing centers	184		
Fishermen population	4.50 Lakhs		
Active fishermen (Full time)	54,901		
Major fish harbours	3		
Fish landing jetties	22		
Ice plant and cold storage	170		
Inland fishery resources of Maharashtra			
State irrigation tank below 200 ha.	2065		1,01,896
Zilla Parishad and other tanks	31425		90,122
Total no of tanks	33740		3,77,905
Length of river		19456 kms	
Government hatcheries, fish seed centres and rearing units			
Fish seed centers	43		
Hatcheries	28		
Rearing units	15		
Freshwater prawn hatchery	1		

malguzari talav and farm ponds. At present, both reservoirs and freshwater aquaculture in ponds and tanks are the two main pillars for future growth of inland fish production of Vidarbha as well as Maharashtra state.

Vidarbha has huge aquaculture potential for development through both expansion and intensification. The fish culture in ponds is being practiced in majority of community tanks, village ponds, government tanks, or privately owned farms. The average fish production from these culture practices is very meager as compared to the national average of 2.9 tonnes/ha/year. This production can be increased to the tune of 4-5 tonnes/ha/year by adopting improved farming practices.

The total inland fish production of the Vidarbha during 2017-18 was 69,756 tonnes which comes mainly from small water bodies such as village ponds, tanks, small reservoirs etc. in the region. Today, both reservoirs and freshwater aquaculture in ponds and tanks are the two main pillars for future growth of inland fish production of vidarbha as well as Maharashtra state. The traditional fisheries in numerous water bodies like village tanks, Malguzari talav, lakes and reservoirs etc. of Vidarbha is the mainstay and the major source of inland fish production in Vidarbha. In Vidarbha reservoirs, offers huge resources and untapped production potential for incremental growth in fish production and overall development in Inland fisheries sector. The available water spread area for fisheries in Vidarbha region including Amravati and Nagpur division is 1,87,249 ha. However, the rate of growth in terms of potential is not yet achieved. This can be attributed to less focus on sustainable development of inland capture fisheries particularly pertaining to reservoirs in the past; increasing pressure on the resources, including habitat degradation; and multiple-use of inland water-bodies with least priority to fisheries requirements. There is huge gap between actual production and potential from reservoirs of Vidarbha.

Further, most of the community tanks, village ponds, government tanks, or privately owned farms for fish culture activity are being utilized in either extensive or semi-intensive manner. The average fish production from these culture practices is very meager as compared to the national average fish production of 20 kg/ha/yr from reservoirs and 2.9 tonnes/ha/yr from ponds. Today, these vast underutilized resources offer enormous potential to boost the fish production and opportunities of livelihood to the unemployed youth and emerging entrepreneur's of this region. Thus, in order to boost the inland fish sector of Vidarbha, it is necessary to address the various issues.

Seed matters: Fish seed is the most critical and prime factor and considered the main lever of the aquaculture development in the country. The species mostly cultured in freshwaters of the region and the seed of which is being produced are catla, rohu, mrigal, silver carp and grass carp etc. The availability of fish seed is an essential prerequisite for fish culture. The main sources of fish seeds in Vidarbha are spawns produced by induced breeding method in State Fisheries Department hatcheries, natural bundh breeding of co-operative societies particularly of Bhandara and Gondia districts and import from other states like West Bengal, Chhattisgarh and Andhra Pradesh etc. Many women co-operative societies in Gondia district of Vidarbha are engaged in dry bund breeding of Indian Major Carps for fulfilling their seed requirement.

The paucity of quality and quantity of fish seed is the most important constraint in the region. Other major concerns are regarding inbreeding depression, inadvertent hybridization and improper size of seed stocked, leading to non-realisation of full potential.The transportation of fish seed from the far distance escalates seed price and also cause mortality of spawn which directly affects the economics of fish culture. Traditionally, the reservoir and ponds of Vidarbha are stocked with seed (spawn) of Catla, Rohu, Mrigal (Indian major carps) for enhancing fish production. In lieu of this, the State Government of Maharashtra had built 15 hatcheries and rearing centres in different regions of vidarbha to increase fish seed production.

The total annual Indian Major Carp fish spawn production capacity of the government fish production centres is 560 million from 15 hatcheries in Vidarbha and 420 million from 9 hatcheries in Marathwada, respectively, against the requirement of 1325 million seed required for Vidarbha and Marathwada region together. On the other hand, the present fish spawn production from all the hatcheries of Maharashtra is 625 million spawn (2017-18). Thus, there is a huge deficit of 1125 million spawn. Today, the seed stocked in most of the reservoirs of Maharashtra is either procured from neighbouring states like Chhattisgarh or Andhra Pradesh or from states like West Bengal. Fish farmers have begun to realize the importance of quality seed (e.g. uniform sized, pathogen-free seed) for success of the crop.

But, most of the times the procured seed does not meet the yield potential due to unscrupulous marketing by agents, adulterated and infected seed, inbreeding in hatcheries and inferior quality of brooders etc. This is

hampering the production potential of the region. Significant enhancement in carp production has been achieved in Andhra Pradesh by stocking with stunted fingerlings (yearlings and "zero point") at the rate of 5000 nos. per hectare (Jayasankar and Das, 2015). This strategy needs to be adopted and replicated. Further, seed of indigenous species as well as newer and economically important high yielding varieties which command high market price such as Magur, Ompok spp., Channa spp., Tilapia spp., Pangassius spp are meagrely available for stocking. Technological interventions by ICAR institutes like Central Institute for Freshwater Aquaculture, Bhubaneshwar have led to development of improved varieties of Rohu, Catla with faster growth rate and higher disease resistance. Similarly seed of mono-sex varieties of Tilapia spp as well as Genetically Improved Farmed Tilapia (GIFT) are available for boosting the productivity in ponds and cages. These technologies are commercialized and are available for adoption at field level.

Production systems: Presently in Vidarbha region, the growout culture is in budding stage and mostly practiced in ponds of varying size of 0.04-1.0 ha in area with 1-1.5 m in water depth. Cattle dung and lime are the most commonly used fertilizers but recommended doses are not followed or fertilization is not done. The seed is stocked at average rate of 4,000-6,000 fingerlings/ha irrespective of type of pond. The supplementary feeding in the form of rice bran and GOC mixture is practiced only in final stage of culture without calculating ration need. Generally, fishes are harvested after a grow-out period of one year during which it reaches to marketable size of 0.6-0.8 kg. However, the fishes even marketed in smaller sizes of over 300 g due to scarcity of water in ponds after monsoon in case of seasonal ponds. The average production 600 – 800 kg/ha which is very low. However, different freshwater aquaculture technologies are available for different categories of fishes, *i.e.* carps and catfishes including air-breathing fishes and prawn. Their catalogue is mentioned below.

The current freshwater grow out technologies may be classified into:

Carp polyculture or composite carp culture: The research and development efforts during last five decades have greatly enhanced average fish yields in the country making carp culture an important economic enterprise. It has grown in geographical coverage, diversification of culture species and methods, besides intensification of farming systems. The three Indian major carps, *viz.*, catla (*Catla catla*), rohu (*Labeo rohita*) and mrigal (*Cirrhinus mrigala*) were the principal species cultured by the farmers in ponds since ages and production from these systems remained significantly low (at 600 kg/ha/year) till the introduction of carp polyculture technology. The introduction of exotic species like silver carp (*Hypophthalmichthys molitrix*), grass carp (*Ctenopharyngodon idella*) and common carp (*Cyprinus carpio*) into the carp polyculture system during early sixties also added new dimension to the aquaculture development of the country. Probably it is the technology of carp polyculture that has virtually revolutionized the freshwater aquaculture sector and brought the country from a level of backyard activity to that of a fast growing and well organized industry and placed the country on the threshold of blue revolution. The average national production from still-water ponds has gone up from 600 kg/ha/year to over 2.4 tonnes/ha/year, with several farmers even demonstrating higher production levels of 8-12 tonnes/ ha/ year.

Culture of air-breathing fishes: Catfishes, Magur and Singhi, both air breathing, could be grown in swamps and ponds and have a higher consumer preference. However, in spite of resources, there large scale seed production and culture is yet to be realised. Technologies have been developed for both seed production and grow out with relevant feed formulations. Non-air breathing catfishes such as Pangas and Ompak spp are potential species for diversification. These fishes attain a marketable size of 100-150g in 7-8 months and production to the tune of 3-4 tonnes can be achieved from one hectare of area. There are potentialities of polyculture of catfishes with carps also.

Mono and polyculture of freshwater prawns: The giant freshwater prawn, *Macrobrachium rosenbergii*, the largest and fastest growing prawn species, which has increased attention in last decade owing to its demand. This species can be cultured along with carps and seed production issue has been adequately addressed through network of hatcheries in coastal states *viz.*, Andhra Pradesh, Tamil Nadu, Gujarat etc. The country produces over 33000 tonnes of freshwater prawns annually with an average productivity of 1000 kg/ha. The prawns feed on algae, insect larvae, molluscs, worms, smaller weed fishes, cereals, slaughter house wastes, oil cakes, etc. Fresh water prawns can tolerate very high range of salinity (upto 28%), but salt concentration upto 5 to 6 per cent is preferred. Rectangular ponds of 0.1-2.0 ha size having unpolluted freshwater, with high concentration of oxygen are considered ideal. According to the intensity of

production systems, an extensive system with low stocking density yields production below 500 kg/ha/year, semi-intensive system with moderate stocking density yields 5000kg/ha/year and intensive system with high stocking density yielding 5000 kg/ha/year.

Cage culture: Intensive culture of fishes through non-conventional system like cage culture is gaining importance owing to higher productivity potentials of the systems and possibilities of higher revenue generation from unit water area. Culture of fish in cages is largely accepted all over the world because of its usefulness in exploitation of large water bodies, which otherwise are under-utilised for fish production, employment and income generation. Various lakes, tanks and coastal waters can be brought under cage culture technique and can be practiced at various management levels. Cage cultures have many advantages, *viz.*, large extent of larger water bodies can be utilized for aquaculture, which otherwise are not fully exploited for fisheries; high production per unit area can be obtained with high stocking density and intensive feeding; feeding and monitoring of stocks for growth and well being is easy; harvesting is simple and cages can be dismantled and reused in other locations as per requirement. Cages can be circular, cubic or basket like, floating or submerged and enclosed at the bottom as well as sides by netting (webbing) material. In the cage of 3m x 3m x 3m, Tilapia and Pangassius stocked @ 50 nos/m^3, the production of 640 kg/cage of Tilapia and 1100 kg/cage of Pangassius can be obtained.

Feed and feeding strategies: Feeding of artificial diet balanced in all nutrients has assumed foremost importance in aquaculture industry. Artificial feeding is an essential practice in an aquaculture operation accounting for over 60 per cent in total input cost. diet in presence of natural food. The feeding strategies adopted by the fish farmers play an important role in maximising the nutrient availability as well as determine the success of the culture economically. Specifically defined feeding strategies have to be adopted to minimise feed wastage, nutrient loss by leaching and to maximise growth.

At present in Vidarbha region fish farming community have not yet realized the importance of feeding practice to increase fish production. The key reasons for non-adoption of feeding practices are lack of knowledge, high cost, irregular feed supply, non availability species specific feed, etc. Most of the fish farmers feed carps with farm made mash feed made up of rice bran and oil cake either in dough or powder form in the ratio 50:50; de-oiled rice bran is mostly preferred over raw bran due to lower price. Among oil cakes, either groundnut oil cake or mustard oil cake or cotton seed cake is utilised depending on their seasonal availability and cost effectiveness.

The fish farmers in neighbouring states of Andhra Pradesh also utilise the same ingredients but apply a ratio they of 70-80 per cent of de-oiled rice bran and 20-30 per cent of oil cake instead, since oil cakes are much costlier when compared to de-oiled rice bran. By adopting such feed management practices they increase their profitability by cutting down the production cost considerably without compromising on the production capacity and FCR. The phenomenon of the protein sparing effect of carbohydrates is exploited by increasing the level of rice bran and reducing the level of oil cake in the feed.

Feeding is generally done at a rate of 7- 10 per cent of the body weight per day initially and later as the fish grows the feeding rate is gradually reduced to 2-5 per cent per day. Now-a-day's commercially available floating pellets are also used in grow-out culture. Feeding is done twice a day, in the morning and evening, respectively.

Feed cost can be substantially reduced by resorting to farm made feeds made from locally available cheap plant materials. Complete replacement of fish meal is possible for carps, which can further reduce the cost. Establishment of low cost feed mill in regions where freshwater aquaculture is prospering is entailed (Jayasankar, 2018).

Today a total estimated feed requirement for Vidarbha and Marathwada would be 2,99,387 tonnes for estimated area of around 21,086 ha under various culture systems. But there are no commercial feed manufactures in the Maharashtra and the presently feed is being brought from the adjoining states of Madhya Pradesh, Andhra Pradesh and Chhattisgarh.There is an urgent need for establishment of commercial fish feed production units to meet this huge and furture requirement as well. With the help of the research and development in fish nutrition sector, it is now possible to increase aquaculture production as high as 15-17 tonnes/ha/year and 4-6 tonnes/ha/crop for prawns.

Marketing and post-harvest management: Fish, as a commodity, is more susceptible to spoilage than certain other animal protein foods, such as meat and eggs. Fish flesh is rapidly invaded, digested and spoiled by the micro-organisms which are abundant on the skin and in the intestine. Keeping the fish as 'fresh' as possible, with minimum losses in flavour, taste, odour, form, nutritive value, weight and digestibility of flesh is of utmost importance. As spoilage of fish starts right from the time it is caught, the proper storage, preservation and prompt

disposal or transport services are essential. Therefore, strengthening of post- harvest infrastructure such as storage facilities, ice plants, cold chains, and transportation, etc., are the key requirements for the development of this sector.

Present market trends, consumer preference to new products, quality and hygiene requirements reflects a rapidly growing demand for ready to cook and ready to eat convenience fish product. Hence, the rationale should be to tap this niche market which presents immense business opportunity for which the post-harvest fisheries which includes processing, product development, transport and marketing needs to be developed.

Today, this post-harvest sector generates more employment than the harvesting sector, which, due to increasing demand and price of fish in both domestic and export markets, keeps growing. While the infrastructure for fish marketing is still principally oriented towards the export market, vast improvements in handling technologies and quick transportation facilities have led to increased market penetration of fresh iced fish to interior markets also. Currently, 50 per cent of fish is consumed fresh in and around producing centres, 43 per cent in centres up to 200 km interior to the coast and 5 per cent beyond 200 km limit.

Development of aquaculture in the Vidarbha in the coming years will increase the fish/prawn production to the tune of 02 lakh tonnes annually. The part of the fish/ prawn harvested will be utilized for domestic consumption but a large chunk of fishes shall be moved to the different consuming centres along the length and breadth of the country. This will require a strong network of cold chain which can be achieved by setting up of ice plants and cold storage units at the various places in and around Vidarbha. Further hygienically processed and packed dried fish for domestic consumption in interior towns and canned fish in cities and defence establishments offer a good scope.

SWOT analysis:

Strength: – Rich freshwater aquaculture resources that could be put to different fish culture practices or even culture-based capture in case of large waterbodies.

– At least 25-30 species of freshwater fish are ready or potentially ready for culture. In addition to Indian major carps, minor and medium carps, air breathing fishes, freshwater prawns and bivalves have strengthened the freshwater aquaculture species base.

– Host of standardized technologies to augment fish production in different water bodies. Mono culture, polyculture and integrated farming systems enable the fish farmer to achieve high production according to system requirements.

Weakness: – Non-availability of proper database in freshwater aquaculture resources and systems,

– Domination of freshwater aquaculture by only a few low-valued fish species,

– Weak linkages and networks between research and development machineries in the freshwater aquaculture sector,

– Weak extension network for transfer of technology and provision of feedback mechanism,

– Social issues hindering the aquaculture development, inadequate infrastructure facilities and input availability.

Opportunities: – The country has the potential to increase fish production from the present level of about 2t/ha/yr to 5t/ha/yr through technology-driven and mission mode approaches and strategies.

– There is great scope for species and system diversification.

– Implementation of selective breeding programmes for increased production efficiency.

– Establishment of brood banks and seed banks in areas where there is acute shortage of quality seed.

Threats: – The nation faces threat from unauthorized introduction of exotic species into culture systems. For example, entry of African catfish, *Clarias gariepinus*, which is known to be highly predatory and also cannibalistic, into our water systems can lead to disastrous consequences on natural biodiversity.

– Inbreeding depression in fish stocks due to faulty hatchery management practices, Emergence of newer diseases.

– Contamination of natural water bodies.

– Habitat destruction and the consequent depletion of natural fish resources.

– Excessive application of antibiotics and chemicals.

– Natural disasters, etc. pose serious threat to aquaculture development in the country.

Future needs: India's future fisheries development plans should aim at making substantial contributions to doubling of food production, improving the welfare of fishers, promoting exports and providing food and livelihood security to its rural population.

Aquaculture is recognized as an important source for meeting future demands for protein food in the country. A number of schemes have been instituted by state and central sectors to augment production from brackish-water and fresh water aquaculture sectors. The private

sector has emerged as a major player in brackish-water aquaculture, particularly in shrimp farming. Responsible aquaculture and prevention and management of aquatic diseases, organic farming, cage farming, quality seed production through induced breeding, prevention of inbreeding in hatcheries and fattening of select species are some of the challenges to be addressed in this sector for improving productivity. Selective breeding of other candidate species like catla and mrigal as well as freshwater prawn, like *Macrobrachium rosenbergii* should be undertaken in similar fashion as that of rohu, Jayanti which has 17 per cent higher growth per generation after seventh generation.

The efforts should involve developing technologies that could be sustained by the rural poor and landless with the meagre resources they have available to them. This means developing simple, low-cost, low-risk technologies that could be adopted and sustained by them. The per capita availability and consumption of fish is to be increased to a level of 11 kg per annum for the fish eating population for which production and distribution has to be scaled up appropriately. All this requires scientific and technological back stopping and capacity building in key areas.

Considering the growing global demand for seafood, developing the export production with due care for food safety and product competitiveness has to be embarked upon. As a backward linkage for improving hygiene and sanitation in fish handling, centrally sponsored schemes have been launched to upgrade the existing infrastructure at fishing harbours and landing centres. Quality up gradation in post harvest and domestic marketing sectors requires concerted efforts. Training, micro credit and increased participative management by the stakeholders need to be ensured.

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Received : *15.01.2020* ***Revised :*** *23.04.2020* ***Accepted :*** *25.05.2020*