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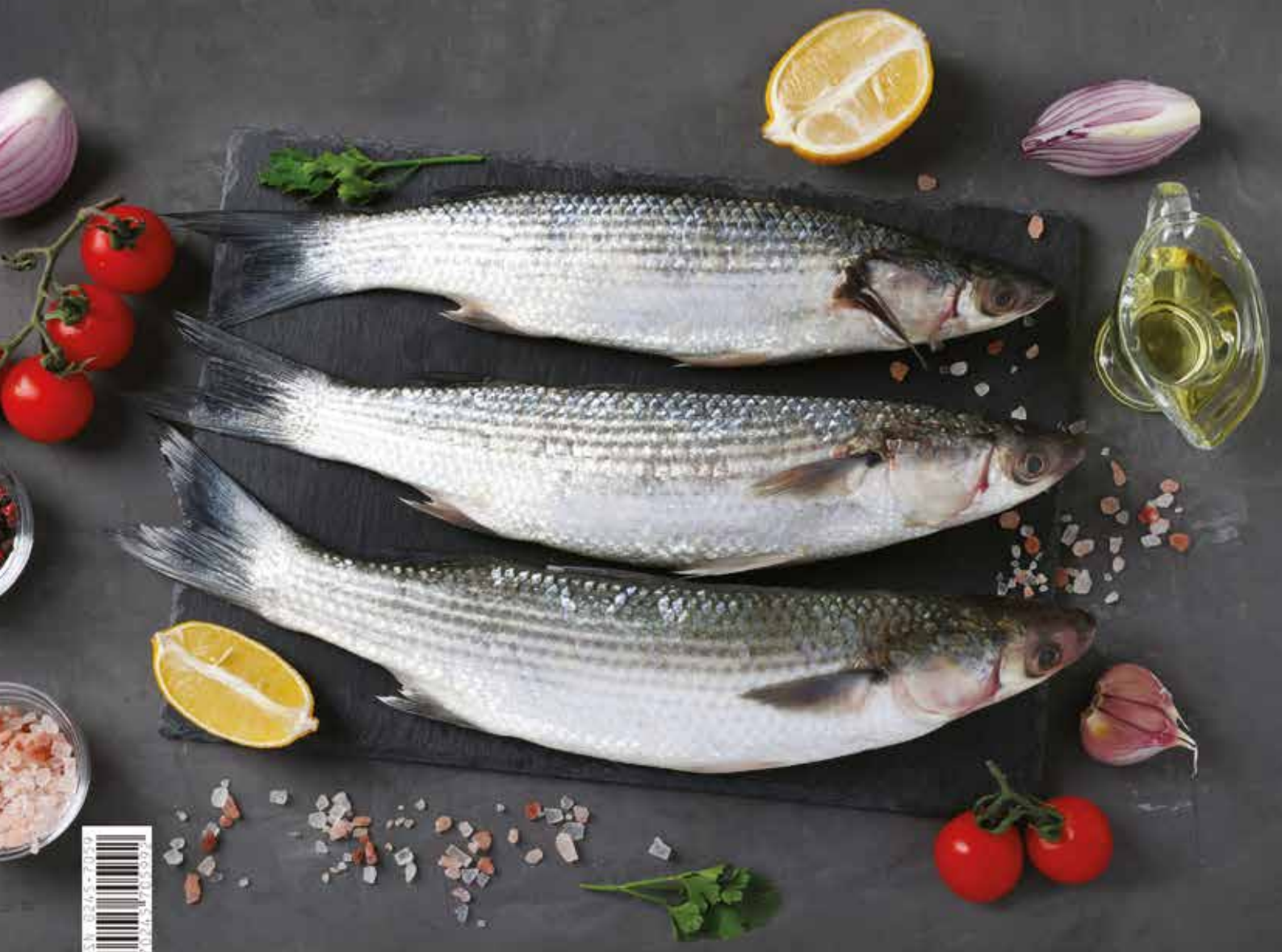

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Grey Mullet aquaculture in India - Challenges and the way ahead

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Introduction

The grey mullet, *Mugil cephalus* belongs to the family Mugilidae, which comprises of 20 genera and 70 species and thirteen species of these are recorded in Indian coasts. Grey mullets are relatively faster growing among the species under the family Mugilidae. Grey mullets are also one of the most economically important cultivable species alongside other mullet species. The consumer demand and the related aquaculture preference of the different mullet species varies in different regions of the world. For example, the thin lip mullet, *Liza ramada* and bluespot mullet, *Valamugil saheli* are widely cultured in Egypt. The goldspot mullet *Liza parsia*, tade mullet *Liza tade* have high market demand in the eastern states as compared to other regions of India. Grey mullet aquaculture is generally carried out as a polyculture practice with other brackishwater fishes and mullet species. It has been an integral part of Indian traditional fish farming systems also. Reports of farming of grey mullet from Kerala, West Bengal and Tamil Nadu exist from the 1940's. This is similar to subsistence farming of grey mullet that has been practised for centuries in the countries around the Mediterranean region, South East Asia, Japan and Hawaii. No recent database exists on the aquaculture production of grey mullets from India. Reports from the 1960's show the average production of mullet species as 1761 t; with Tamil Nadu (Madras) contributing 37%; Gujarat, 31%, Maharashtra 10% as the leading states. The grey mullet continues to remain an important candidate species in our conventional sustainable brackishwater fish culture practices.

Factors influencing geographic distribution of grey mullet aquaculture practice

The natural distribution of grey mullets on the west coast ranges from north-western state of Gujarat to southern state of Kerala and on the east coast it ranges from Tamil Nadu in south to West Bengal in the north-east of India. The traditional pockets where grey mullets are cultured are also aligned along these areas due to the dependence on the wild mullet seed collection for stocking the aquaculture ponds. Over a period of time emergence of more organised collection methods by traders and introduction of temporary seed holding systems like hapas, tanks or small ponds, efficient live fish transportation by a network of distribution agents allowed the grow-out practice to be adopted into semi-intensive polyculture and mono-culture systems especially in the states and areas where grey mullet is a favoured food fish.

Grey mullet occupies a variety of marine, estuarine and freshwater habitats. The adults are catadromous migrating in large schools to the sea for spawning and the larvae are drifted to shallow inter-tidal environments which provide rich feeding grounds. These migratory patterns and scientific research vouch for the euryhaline nature of grey mullet. Hence, grey mullets are easily adaptable to culture systems in different habitats; freshwater, brackishwater or marine. Interestingly over 60% of the global grey mullet aquaculture production is from the fresh water environments. The primary factors favouring grey mullet aquaculture in a region is driven primarily by the consumer preference, seed availability and its prevalence as a traditional culture practice among local farmers.

Feeds and feeding practices to support optimal growth of grey mullet

Grey mullets are benthic feeders exhibiting omnivorous illiophagic feeding habit. They feed on detritus, benthic micro-algae, filamentous algae, diatoms, periphyton small invertebrates and macrophytes. The benthic detrital feeding nature of mullet helps to maintain a

Fig. 1: Broodstock of grey mullet Mugil cephalus in holding tanks at fish hatchery, MES, ICAR-CIBA

healthy pond bottom. Grey mullets feed on periphyton hence these substrates can be utilised to reduce the feed inputs and enhance growth of the animals. This species can be easily adopted to formulated feeds. Studies conducted at CIBA on the grey mullet indicated that the fish requires 27% protein with 9 % lipid for better growth performance and food conversion ratio (FCR). The existing information on the nutrient requirement shows some variation and the crude protein requirement was in the range 30-40% and the crude lipid concentration was 5-10 %. Our experience also revealed that the performance of the fish during the nursery phase was better with high protein feed; CIBA has developed nursery and grow out feeds for this species and named it as Cephalus NurseryPlus and Cephalus GrowoutPlus.

The feeding rate is depending on the body weight; to start with, the formulated feed is fed at 10% during the nursery phase and it is gradually reduced as the fish grows and finally it is fed at the rate of 2-3% in the grow out phase. Growth rates up to 600 g are reported after one year of culture when stocked at initial weight of from 10-15 g. Hatchery produced grey mullets under optimal conditions have been reported to grow up to 1.9 kg in two years when fed nutrient specific feed.

Resolving the challenges in hatchery seed production

Although grey mullet is one of the most desirable species for brackishwater finfish culture, its farming remains limited by constraints with respect to inadequate availability of seed for stocking in pond systems. By far, farmers are largely dependent on wild seed collection for stocking culture systems. The seeds are available from November to February along the east coast and June- July along at west coast at Rs 6-10/unit.

The constraints faced by researchers for developing commercial hatchery production are related to its short annual reproductive period and captivity-related multiple reproductive dysfunctions. Unlike many commercially important brackishwater species that have a protracted reproductive period and are multiple spawners, grey mullet is a group synchronous spawner and usually one clutch of oocytes mature annually. This maturation of oocytes is linked to specific temperature and photoperiod regime, hence the annual reproductive

period of the species is often short. Grey mullets also exhibit high levels of dopaminergic inhibition, which affects the maturity percentage and the success in final oocyte maturation. The captivity-related multiple reproductive dysfunctions observed in grey mullet are also evident in the low percentage of spermiating males and asynchrony in male and female maturation. At ICAR-CIBA some of these key issues related to artificial propagation of mullet are being resolved through exogenous hormone therapy, high quality broodstock feed- Cephalus BroodPlus and broodstock management which has now ensured enhanced captive maturation, expansion of existing narrow reproductive period and synchronisation of maturation.

Being a high value herbivorous species, grey mullet can contribute significantly to the brackishwater aquaculture development. Considering the economic significance of the grey mullet, the major constraints affecting aquaculture development of the species has to be addressed scientifically, especially with respect to seed production. This challenge is a global one. Ever since the pioneering work of Tang (1964), many researchers focussed their efforts on developing technologies towards its captive reproduction and larval rearing especially in Taiwan, Hawaii (USA), Israel, Egypt, United Arab Emirates, Italy and a few countries like Hawaii, Italy, Tunisia and Israel are producing grey mullet fry on an experimental / semi-commercial scale. In India research on induced breeding of grey mullet from wild and captive populations were also initiated in tandem with global efforts (Mohanty, 1971; Sebastian and Nair, 1973; Chaudhuri *et al*., 1977; Rajyalakshmi *et al*., 1991; Krishnan *et al*., 1996; Abraham *et al*., 1999). Yet, it is only in the recent years that hatchery-based seed production could be successfully carried out at fish hatchery, Muttukadu experimental station, ICAR-CIBA. Efforts to scale up the seed production and expansion of its reproductive period are being targeted for which species-specific state of art facilities for breeding and larval rearing is required. Due to the variations in reproductive periods at different locations, hatchery production on a partnership mode will benefit in mullet seed production in different months of the year. Training and sensitisation of officials of fisheries departments and government hatcheries on different aspects of grey mullet reproduction have been one initiative in this direction.

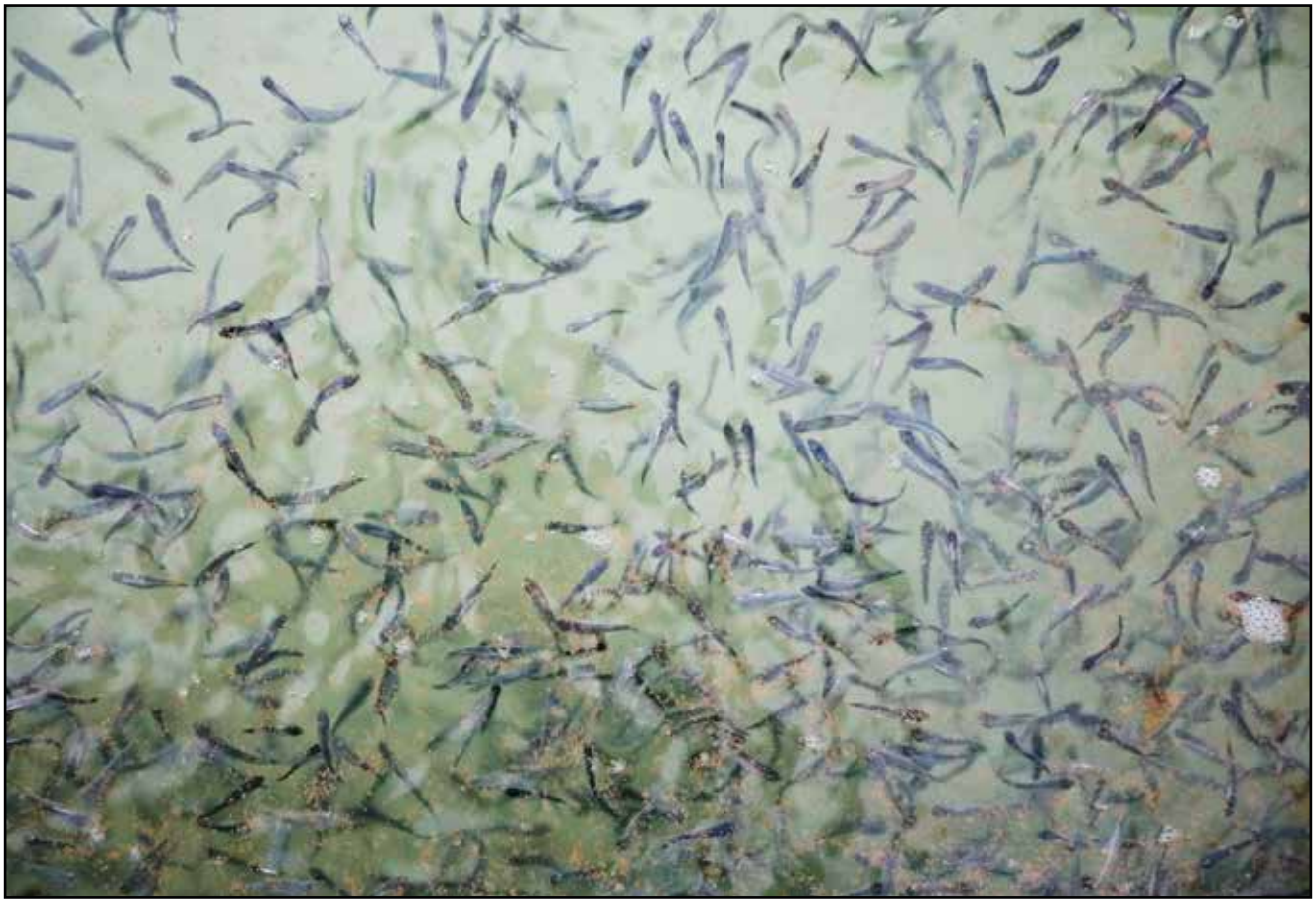

Fig. 2: Hatchery produced fingerlings of grey mullet

Fig. 3: A haul of grey mullet from monoculture pond

Nursery and grow-out aquaculture of grey mullet

Hatchery produced or wild-collected small mullet fry (15-25 mm) are not suitable for stocking in culture ponds and often result in poor production. Therefore, a pre-stocking nursery rearing step is desirable to obtain advanced fingerlings (100–120 mm) that are suitable for grow-out culture. Nursery rearing of grey mullet fry can be conducted in brackishwater tide-fed ponds for production of advanced fingerlings. Among different seed rearing methods such as use of fertilization/ feeding/ compost application/ periphyton systems when tested alone or in combinations, the best performances were obtained in the combined fertilization-feeding and fertilization-periphyton rearing systems.

In pond culture trails of grey mullets, after treatment of pond bottom with lime, water was filled and fertilized with cattle manure, urea and single super phosphate (SSP) at 500, 30 and 30 kg/ha, respectively. After 7 days of fertilization, ponds were stocked with *M. cephalus* fry (0.55 g/ 36.0 mm) at 15000 no./ha.

Formulated feed prepared from locally available ingredients (mustard cake, rice bran, wheat flour, fishmeal etc.) was provided as supplementary feed @ 20 to 5% of body weight. Ponds were fertilized fortnightly with the above-mentioned fertilization materials at the same dose. Liming was done at fortnightly intervals with lime stone powder at 250 kg/ha. After 150 days of rearing, grey mullet attained average body weight (ABW) of 96 g6. Further, higher density rearing of mullets was carried out in ponds after bottom treatment and water intake according to the method mentioned earlier. Fertilisation was done with mustard cake, urea and SSP at 200, 20 and 20 kg/ha, respectively.

After 6 days of fertilization, bamboo poles are erected vertically in the pond to cover 10% of pond surface area as substrate for periphyton growth. After 10 days of bamboo pole fixing, pond was stocked with *M. Cephalus* advanced fry (3.36 g) @ 30000 no./ha. During rearing, all the ponds were fertilized fortnightly with mustard cake at 100 kg/ha. Agricultural lime was applied at 100 kg/ha one day before fertilization. Grey mullet fingerlings attained ABW of 28g in 120 days of rearing. Monoculture of grey mullet depends on availability of suitable seeds as stocking materials.

Various on-station and out-station trials have proven that monoculture of grey mullet can be an economically viable farming option provided that ponds are stocked with seeds reared initially in nursery. The pond for monoculture is prepared first, following eradication of unwanted organisms and application of manures and fertilizers. Advanced fingerlings of >50 g size are stocked at 10000 no. /ha. Fish are fed with supplementary feed. In an 8-month culture, fish attained 500-800 g with total production of 3-5 ton/ ha.

Similarly, polyculture trial can be carried out using combination of fish species at 8000-15,000 no./ha along with tiger shrimp seeds at 15,000-30,000 no./ha and following standard pond preparation procedures.

The stocking density varies with the quantum of seed availability. Natural pond productivity is maintained by fertilization. In addition, supplementary feed prepared from locally available ingredients can be used at 2-5% body weight daily. This kind of system can yield a total production of 2-3 ton/ha in 6-10 months.

The preferred species among fishes are: mullets- *M. cephalus*, *Liza tade* (tade grey mullet), *L. parsia* (goldspot mullet), milkfish- *Chanos chanos*, pearlspot- *Etroplus suratensis* and tiger shrimp- *Penaeus monodon*.

In an out-station trial, 3 ponds (1 ha each) were stocked with *M. cephalus* (40-50 g size) as the major species at 10000 no./ha, L. tade (10 g size) at 2000 no./ha, pearlspot (10 g size) at 1000 no./ha and *P. monodon* at 4500 no./ha. Supplementary feeding was provided with floating feed. After 150 days, shrimp with 45g ABW was harvested and fishes were harvested after 300 days. It resulted in 3.5 ton/ ha production with a net returns of Rs. 2 lakh/ ha.

Way ahead

With the high emphasis on fish meal replacement in fish feeds and consequent increase in production costs for carnivorous fish species, the traditionally farmed grey mullet remains the most promising option among the available herbivorous species for brackishwater aquafarmers of our country. ICAR-CIBA continues its efforts for upscaling hatchery based seed production to support efficient aquaculture practices.

Strategies involving exogenous hormone therapies and environmental manipulation are being attempted to widen the narrow annual reproductive period of the species. Besides the problems of inadequate availability of quality seed for farming, many aquafarmers especially those who adopt species like grey mullet for the first time face challenges during harvest and marketing.

Farmers adopting partial harvesting as in many traditional farming systems are able to efficiently sell their produce at Rs 300-500/kg. First time farmers at new geographic areas find it a challenge to sell large biomass of their produce at prevailing market rates. This problem is true for many species and needs to be addressed through more efficient interventions like introduction of marketing networks and alternative post-harvest options.

Species like grey mullet have high export potential as its roe is a high value product in countries like Italy, France, Taiwan, Spain, the Mediterranean region, United States, where it sold as in form of a premium product the *"Botarga cavier"*. Prices are in the range of 100-150 Euros per 100-150 g sac to 200 euros/ kg depending upon the markets and the product quality. The challenges faced at different levels of production and post-harvest needs to be addressed for diversified species like grey mullet to harness its true aquaculture potential.

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