

Growing tilapia production

and emerging sustainability issues

Atul K. Singh¹

National Bureau of Fish Genetic Resources, Lucknow, Uttar Pradesh 226 002

Today world is teaming with aquaculture of most coveted introduced species tilapia and in India too there are several fish introductions, tilapia being one of them. Tilapia are second most farmed finfish after carp in the world where Asia is contributing about 72%, Africa 19%, America 9% of the total tilapia production. The global production of tilapia has gone up to 6.5 million metric tonnes where, China remains by far the major producer, at 1.8 million metric tons; Bangladesh is producing around 0.285 million metric tonnes while India still has a marginal contribution. In India there is an increased demand for low trophic-farmed tilapia species, in view of food security and employment. A demand-driven expansion of tilapia aquaculture production in India has been taken up to stimulate the local economy and thereby contributing to employment generation. Booming tilapia in India has been possible due to world's cutting edge technology and trade. Present tilapia production in the country is although very limited however, Marine Product Export Development Agency (MPEDA) has got a very ambitious target to produce around 1.2 million tonnes of tilapia in near future. This paper presents an assessment of over-all scenario of prospering tilapia culture into India and focuses on growing issues and concern to be addressed since aquaculturists are enthusiastically excited towards tilapia farming and large scale operations are coming up.

Key words: Culture, Diseases, Management, Regulations, Standards, Tilapia

EARLY tilapia farming was based on extensive production technologies that involved primarily fertilization; low stocking densities, and some supplemental feeding. The initial introduction of Mozambique tilapia (*Oreochromis mossambicus*) met with failure due to early maturation, the lack of control over breeding and, the ensuing slow growth rate resulting in production of small, low-value fish in culture ponds. Large-scale research and development attention began in the late 1990s when the initial success of tilapia farming in its early phase of development was achieved due to technologies. Further, controlling unwanted reproduction

was another issue although manual culling of females was initially the simplest way to ensure selection of faster-growing male tilapias. However, this method was laborious and prone to errors. Thereafter, hybrid production technologies provided an initial impetus for managing early sexual maturation and

the prolific reproduction of tilapias. Introduction of the faster-growing and slowly maturing Nile tilapia (*O. niloticus*) in the early 1990s led to the development of several inter-specific hybrids such as golden tilapia. Captive hybridization and rapid technology dissemination resulted in greater availability of tilapia hybrids later for aquaculture.

In India, there are 5 species of tilapia; the *Oreochromis mossambicus* was the first tilapia species introduced in India during 1952. Due to prolific breeding, it quickly gained the reputation of being a pest. The other species *O. niloticus* or Nile tilapia later became the choice of culture. The Government of India



permitted its aquaculture in 2009, prescribing certain guidelines as a part of diversification of species for increasing overall fish production levels of the country. As the fish represents lower level in food chain, its culture has been considered economical and eco-friendly. As per existing guidelines, farming of only mono-sex male/sterile (through either hormonal manipulation or cross breeding) is permitted and species recommended is Nile tilapia and of late the genetically improved farmed (GIFT) species. The third species existing in India is *O. urolepis honororum*, which is available in Andaman and Nicobar and is cultivated there in ponds and tanks having production potential of over 1,150 kg/ha/culture cycle. The fourth species reported from Chennai is *O. aureus*, which incidentally appeared and was identified. The fifth one being *Tilapia zilli* that is available in large number in the Indira Gandhi canal in Rajasthan and the species is not under aquaculture.

Culture production of tilapia

Aquaculture of tilapia is although an old endeavour, yet it has taken a significant leap in the commercial fish farming in India looking forward to meeting the huge demand for the fish in the domestic as well as international market. Culture of *O. niloticus* has now been gearing up, particularly in Tamil Nadu, Kerala, Andhra Pradesh, Odisha, Maharashtra, Rajasthan and West Bengal. Traditional extensive culture methods were replaced with semi-intensive and intensive production systems. Tilapia are attractive as a co-cultured fish also because of their potential to improve water quality, (especially in penaeid shrimp ponds), by consuming plankton and detritus and by altering pathogenic bacterial populations while increasing marketable production. GIFT tilapia culture has been successfully done in biofloc system as BFT helped improve optimum growth and better immune status of GIFT and possibility of utilization of biofloc-based zero water exchange system to ensure bio security and environmental sustainability in farming and inland



Tilapia farming with natural systems

saline water farming. GIFT strain of Tilapia at higher stocking densities 200–250 m³ has been considered as optimum stocking density whereas higher stocking densities up to 350 m³ can be reared in the biofloc systems without compromising the growth and immunity.

Tilapia culture in ponds and tanks

Culture of Nile tilapia *Oreochromis niloticus* is mostly practiced in tanks, ponds or cages and is clustered in Andhra Pradesh, Tamil Nadu, Karnataka and Kerala states with an estimated production of around 20,000 metric tons while MPEDA has targeted its production close to 22,000 metric tons by 2020. Although, tilapia is primarily produced as monoculture however, tilapia aquaculture has also been adopted as polyculture with compatible local fish species for continuing increased production and improved sustainability. Tilapia has also been incorporated into polyculture with shrimp, providing an additional cash crop and reducing the incidence and severity of viral and bacterial diseases in shrimp. In pond culture, farmers have introduced tilapia as an additional polyculture species into traditional carp ponds. Polyculture of tilapia with carps is available in Andhra Pradesh, Gujarat and Tamil Nadu states. Shrimp and carp polyculture provides 3–5% of national tilapia production.

Tilapia, *Oreochromis mossambicus*

was the first species widely introduced for aquaculture while *O. niloticus* was introduced into India during late 1987. The aquaculture of *O. niloticus* expanded in the entire country, especially by private entrepreneurs. In 1995, Vorion Chemicals Ltd. Chennai claimed high production of hybrid red tilapia, popularly known as golden tilapia. The production of golden tilapia was claimed as 10 tonnes/culture cycle of 6 months. However, production collapsed for unknown reasons or due to continuous availability of seed. Later red tilapia production and sales have grown in some markets due to a greater acceptance of red varieties, as well as the recognition of the value it adds to the final product while GIFT is still an accepted tilapia in the market.

Genetically Improved Farmed Tilapia (GIFT) culture program developed by the World Fish Center, Penang, Malaysia has been now passed on to private industry for further enhancement of the fish in India. MPEDA has introduced GIFT to boost its exports and is planning to produce 12 lakh metric tonnes of GIFT worth 8,000 crores INR in the next few years. Generally, tilapia fry (1 g) is reared in nursery ponds till 20–40 g for 5 to 8 weeks and then restocked into grow-out ponds. Male tilapia generally grows to 300–400 g in 5 to 6 months and reaches nearly 700–800 g in 9 months under mono-sex culture. To produce 400–500 g

fish, common practice is to stock 6,000 to 8,000 males per acre in static water ponds with aeration or 20,000 to 28,000 males per acre where 20% daily water exchange is economically practical. After 6 months of feeding with good quality feeds, such ponds can produce 5 to 7 t/ha.

Tilapia culture in cages

The development of cage and pen culture in India has substantially increased the reservoir fish production (Prabu *et al.*, 2018; Sarkar *et al.*, 2018). Floating cages have become the most popular system for rearing tilapia in India after *Pangasianodon hypophthalmus* in areas with suitable water quality, flushing rates and water depth. This practice has been growing in several countries, including China, Indonesia, Brazil, Bangladesh and India. MPEDA is endeavoring and pursuing hard to raise the tilapia production in cages, because Indian reservoirs and lakes have good potential for cultivating it. There is a plan of private fish exporters to invest over INR 100 crore in rearing tilapia in cages in lakes in Maharashtra and Rajasthan in the next 4 years with the technical support of MPEDA.

Culture of tilapia in cages installed in reservoirs or lakes although offer scope for increasing production, it causes environmental and social concern. The high nutrient inputs that water body receives in the form of unused feed and metabolic wastes may cause some serious environmental problem due to eutrophication and inadvertent release of the fish damage to the ecosystem. At the same time, physical obstruction to the fishing activities of traditional fishers and resultant conflicts may also crop-up as concern due to tilapia invasions. For cage culture, state departments of fisheries have been leasing and licensing procedures allowing cage culture in public waters.

Tilapia in sewage fed fisheries

Thousands of fish farmers had set up *bheris*, or fishponds, across 12,500 ha on the eastern fringes of Kolkata city in West Bengal. The

average yield of tilapia from wetlands/*bheris* is around 750 kg/ha/yr with the individual growth rate of 150-200 g in 3-4 months. This provides living support for some 50,000 cultivators and fish traders. Most of them are small-time private entrepreneurs who earn an income rearing 10,000 tonnes of wastewater-fed fish a year. The Kolkata model of rearing sewage-fed fish is used in a number of Indian cities, including Nagpur, Chennai and Bhopal.

All male monosex tilapia production

One of the key commercial technologies adopted in early 2000 was the production of monosex male tilapia. Tilapia fingerlings are fed with the androgen, 17- α -methyl testosterone in diet, to produce all-male populations. Dissemination of sex-reversal technology led to expansion of tilapia production around the world. However, unpredictable seed quality and concern over use of hormones for sex reversal led to genetics research leading into production of genetically male tilapia (GMT), where YY “super males” tilapia was produced. Super male tilapias have two Y chromosomes instead of the usual Y and X chromosome thus producing only male progeny.

As the male tilapia is well adapted to supplementary feeding and due to its rapid growth, has huge profit in monosex tilapia commercial farming. This fish has a very high demand in local as well as international markets. The currently operating hatcheries use α -methyl-testosterone to sex reverse fry for all-male production. Most tilapia hatcheries are privately owned stand-alone operations that sell to a network of grow out farmers. Of late, a better simple and generic method of monosex production of tilapia was reported from India as the farmers are relying on the monosex production technology from outside the country.

Disease and health management

Tilapia being hardy fish has low frequency of disease occurrence. Nevertheless, many bacterial diseases are ported in tilapia culture particularly in indoor systems. There

is a practice of using antibiotics, prebiotics and probiotics in tilapia culture which is a growing concern. The effects of antibiotics, probiotics, prebiotics and alternative feed ingredients on the intestinal microbiota of tilapia in advanced tilapia culture techniques has been studied and it is proposed that more research is needed into the microbial ecology, alternative feedstuff effects and economic impacts of modulating intestinal microbiota of tilapia so as to develop a sustainable tilapia production technology. Further, antibiotic resistance of isolated bacteria from tilapia farms may concern as zoonotic pathogens.

Beyond this, recently appeared tilapia lake virus disease (TiLVD) has been found as a novel virus disease emerging as a potential threat to the global tilapia industry. The disease was first reported from the freshwater lakes of Israel in 2014 which caused mass mortalities of tilapia. Subsequently, the virus was reported in fresh and brackish waters of Ecuador, Colombia, Egypt, Thailand, and India. The impact of tilapia lake virus disease on wild stocks may also be highly significant, both in economic terms and in relation to biodiversity and ecological effects. Recently, two tilapia cell lines have been developed for strategic control and prevention of TiLV.

Management practices

At present the aquaculturists prefer tilapia culture because basic information and culture techniques are available for them and it is easy to adopt them to be competitive within international markets. Tilapia in Indian conditions can survive in 12-40°C temperature and grows well in 16-35°C temperature. Tilapia is available even in some of the hill states and can be produced twice a year. If modern farming methods and technology are used in tilapia fish farming, then it would generate more income rendering a bright chance to contribute to our economy. Tilapia is the second most farmed fish worldwide and their production has quadrupled over the past decade due to ease of aquaculture, marketability and stable

market prices. Nevertheless, there is still a need for refinement of technologies being practiced, to ensure strong genetic base, final quality of the product, and effective farm management and health management commensurate with government policies and regulations.

Under the existing regulatory framework available in the country, the introduction of improved strains and implementation of quarantine and biosecurity, the tilapia production from pond, tank and cage culture has been promoted significantly, elevating commercial productions. However, compliance with product standards, technical standards, hygiene standards, and other relevant regulations in tilapia farming are yet major concerns. The excessive use of antibiotics and other chemical substances are posing threat to aquaculture sustainability by negatively affecting food safety and environmental conditions. Voluntary sustainability standards and certification schemes have been developed in the recent years to increase value chain transparency and to enable consumers to incorporate sustainability-related aspects in their purchase and consumption decisions. The Aquaculture Stewards Council (ASC) standards for tilapia comprise farm-level standards and regulations

for independent third-party audits. Requirements are for instance related to the conservation of biodiversity, natural habitats and water resources, the responsible use of resources needed for aquaculture, the protection of fish health as well as human health, and socially responsible working conditions.

Suggestions

It is suggested that further improvement of tilapia production in India must include distribution of genetically proven improved stocks of the GIFT, better formulated and floating feeds, deployment of advanced aquaculture production systems, continued quarantine and tighter biosecurity standards along with stringent monitoring. Further, application of tested monosex culture technique will boost up all male tilapia culture production. There is also an important need for refinement of technologies to ensure stock enhancement, final quality of the product, and effective management of tilapia-health risks. Advances in information and communication technology will help fish farmers and other aquaculture stakeholders to adopt better management practices. These advances should range from high-tech modeling and monitoring systems used to improve the

environmental and economic performance of tilapia farming. The available regulatory mechanisms must be strictly followed to ensure sustainable growth of the sector. If needed the existing guideline should be revisited for modifications and amendments with stricter enforcements.

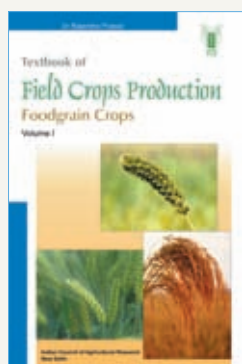
SUMMARY

Pond, tank and cage culture of the introduced improved strains of tilapia has resulted into significantly raised aquaculture productions in India. Today, there is an emphasis on tilapia farming using cages and biofloc technology and aquaculturists are endeavouring to jump into the international market besides catering the domestic need. Looking at the prospects of developing tilapia culture, action point for further improvement of tilapia production in India are suggested for distribution of improved stocks, better formulated and floating feeds, deployment of advanced aquaculture production systems, monosex culture and continued quarantine and tighter biosecurity standards.

¹Former Director ICAR-DCFR and Emeritus Scientist e mail: aksingh56@rediffmail.com

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(Volume I)



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