GIFT TILAPIA

for climate smart aquaculture









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Preface

In changing climatic scenario, frequent occurrence of climate aberrations can cause huge loss to fisheries productivity, predominantly under rainfed conditions. Hence, ensuring food and nutritional security to increasing population has emerged as the biggest challenge. Therefore, abiotic stress resilient fish species can play a crucial role in development of climate smart aquaculture in coming future. In addition to abiotic stress resilience in aquaculture, better management practices can significantly reduce losses due to adverse climate. There is need to add climate resilient fish species in Indian aquaculture basket.

Genetically Improved Farmed Tilapia (GIFT) is the potential candidate's species for climate aquaculture in India. GIFT tilapia is considered the 'Food Fish' of the 21st century and is also popularly known as 'aquatic chicken'. GIFT is one of the surest fish species that can secure its place as an alternative to food security, especially for a growing population and cheap protein. Given the current and potential contribution of GIFT Tilapia in fish production basket, there is no doubt that GIFT Tilapia can truly be a gift for aquaculture and is emerging as a super cultivable fish , even for degraded land owing to its ease of cultivation and several health and medicinal benefits. It has got potential to grow in diversified aquaculture –climatic smart conditions and hence it is also gaining popularity in India as well as in world. Thus, main aim of this bulletin is to present considering the lack of compiled comprehensive information on various aspects of GIFT Tilapia and aquaculture, the institute has taken the lead in publishing the technical bulletin titled ''GIFT tilapia: for climate smart aquaculture''. In this context, all these aspects are covered in this publication. Hence can significantly contribute to sustainable as well as profitable aquaculture and fisheries that can help in improving the economic status of farmers.

Our sincere thanks to the Director, ICAR-NIASM, Baramati for initiating and facilitating research on "GIFT tilapia: for climate smart aquaculture'' and also scientists; technical staff and farmers associated with the programme and those who extended their supports while conducting research work.

This compilation may serve as ready reference for the students, academicians, scientists, teachers and farmers interested in management of abiotic stress in fisheries and aquaculture also in agriculture. This can also help in orientation of research programs aiming at improvement of abiotic stress tolerance fishes under climate smart aquaculture.

August, 2022 **Authors**

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Introduction

Aquaculture is the fastest expanding food production industry, accounting approximately 46% of the global fish production (FAO 2020) and India is a prominent figure in this sector. In India, fish are produced from varied resources like coastal water resources and inland water resources i.e. ponds, cage, reservoirs, lakes, backwarers, farmponds, biofloc, RAS etc (Bhendarkar et al. 2017, 2020). All of these resources are supported by carp farming, which has been practised in the nation for more than a century and is backed by significant contributions from traditional knowledge and science (Bhendarkar 2018a, 2018b; Bhendarkar and Brahmane 2019a).

Climate change and currently witnessing the worst public health crisis with the COVID-19 are seen as a major threat to fisheries and aquaculture sector, both in terms of quality and quantity (Bhendarkar, Gaikawad, et al. 2021; IPCC 2019; Kurade et al. 2022; Myers et al. 2017) and fish production not exempted from this circumstances. Additionally, the sector is recognized as the only way to fulfil the expanding demand for aquatic goods due to the world's rapidly growing human population (FAO 2020). However, climate change impacts on the sustainability of aquaculture are not only present concern but will continue to be so in the future. As a result, diversification of more robust strains and abiotic stress tolerance fishes in aquaculture baskets is needed, which will improve temperature, salinity, dissolve oxygen and disease resistance, is needed. Improved stress tolerance might contribute to survival, and flesh quality ultimately fish production (Bhendarkar, Kumar, and Ramteke 2022; Boraiah et al. 2021; Kumar et al. 2022).

Genetically Improved Farmed Tilapia (GIFT) is the potential candidate's species for abiotic stress resilient aquaculture in India (Bhendarkar and Brahmane 2021a, 2021b). GIFT is an improved strain of Nile Tilapia, *Oreochromis niloticus*, that grows faster than other local varieties commonly known as Super Tilapia. It was first developed by WorldFish and asscociates in 1988 through selective breeding. The GIFT is a significant milestone in fisheries history since it produced the world's first selective breeding programme for tropical fish. GIFT Tilapia is the result of a pioneering selective breeding effort that began in 1988 in order to adapt to a constantly changing and developing environment (Bhendarkar and Brahmane 2021a; WorldFish 2022). After 28 years of selective breeding, GIFT is now producing its twenty-third generation and is being used by 17 nations around the world (FAO 2022a).

After Chinese carps and Indian major carps, tilapia is the third most farmed fish in the world (FAO 2022b). Global tilapia production grew from 3.49 million metric tonnes in 2010 to 6.03 million metric tonnes in 2018, while the share of tilapia in the world's fish supply increased from 8.29% in 2010 to 10.20% in 2018 (FAO, 2020). Tilapia is the common name for several species of chichlid fish that inhabit freshwater streams, ponds, rivers and lakes, and less commonly brackish water. Tilapia is classified an most wide spread invasive fish species (Champneys, Genner, and Ioannou 2021; Gu et al. 2015) due

to its prolific nature of spawning and posed serious ecological consequences especially in open water resources. Monosex GIFT tilapia has been more popular as an aquaculture species in recent years for a number of reasons, especially its ability to tolerate a broad range of environmental extremes and an all-male population. Tilapia is currently the world third largest farmed fish, (FAO 2022b) and it has played an important role in the growth of aquaculture and will continue to do so in the future. In this bulletin, we evaluated the current state, farming guidelines, better culture practices of GIFT tilapia in different culture system, and the ICAR-NIASM research initiative (Bhendarkar, Pawar, et al. 2021).

"The bisecurity guidelines were strictly adhered to at the same time since it rapidly spread in open water. There are now enough detrimental effects of tilapia invasion in open water"

We used Genetically Improved Farm Tilapia (GIF Tilapia) as 'GIFT tilapia' here for better understanding and frequently used term use in many fisheries communities and farmers groups.

Historical trend of Tilapia

It is believed that the tilapia farming of, particularly the natural variety of Nile tilapia, originated more than 4,000 years ago in Egypt. Tilapia is regarded as the St. Peter fish in Christian mythology as because the apostle Peter caught it to feed many people (Thiruvengadam, 2019). Tilapia are now farmed around the world, and in fact, they are more common in Asia than in their homeland in Africa. In India, introduction of tilapias (*Oreochromis mossambicus*) were began in 1952 with a goal to filling up unoccupied niches, such as ponds and reservoirs, and subsequently followed by others species during 1980's (Sugunan, 1995). Due to its prolific breeding and capacity to adapt to a broad range of environmental conditions, the species quickly expanded over the whole country. This had an impact on the fisheries in many reservoirs and lakes.

Then, in 1959, fisheries research committee of India imposed ban on tilapia (GoI, 2020) but it has overrun lakes and reservoirs. In last decades, in the light of fact that *O. niloticus*, is the most widely cultured tilapia species worldwide and in view of the immense aquaculture possibilities and the need for enhancing production in freshwater farming systems in India, The Ministry of Agriculture, Govt of India formally issued for responsible farming of Tilapia particularly Genetically improved tilapia (GIFT) was permitted with certain conditions and guidelines. There are currently about 11 authorized licenced hatcheries in India, five of which produce solely GIFT; the other hatcheries produce red tilapia and Chitralada. More than 25 illegal tilapia hatcheries/seed-rearing facilities exist (Gaikwad et al. 2021), which might lead to quality fraud. As a result, farmers are not obtaining the proper results due to the supply of low-quality seed from unauthorized hatcheries.

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GIFT Position in India

India has a population of 1.35 billion, making it the second-most populated nation in the world after China (United Nations, Department of Economic and Social Affairs, Population Division 2019). It also has the fifth-largest economy, with a GDP of USD 3 trillion. With 13.75 million metric tonnes of fish produced in 2019–2020, India is the third-largest fish producer in the world. According to data from the National Family Health Survey (NFHS-4), 69 percent of Indians eat fish (International Institute for Population Sciences (IIPS) and ICF 2017). It is anticipated that inland aquaculture will have a significant impact on fish production and availability for both domestic and international markets. Indian major carps have been the primary cultivated species in the inland sector for the last few decades, although minor carps, pangasius, and other catfish have also made substantial contributions to the production of farmed fish in India. To boost farm productivity, profitability, farmer resilience, and consumer affordability, the government is determined to diversify cultivated species. And in this context, GIFT farming may significantly improve the accessibility and cost of fresh fish by promoting nutrition outcomes, even for the most vulnerable areas. In India, around 11 licenced and more than 25 unlicensed hatcheries produced 94 million tilapia fry in 2019–20. GIFT, Chitralada, and Golden are the three main strains produced by authorised hatcheries (Gaikwad et al., 2021).

According to WorldFish (pioneer of GIFT technology), by 2024-25 India would be able to produce 1 million metric tonnes of tilapia (Gaikwad et al. 2021). At the Rajiv Gandhi Centre for Aquaculture, India already has a cutting-edge GIFT breeding nucleus. The RGCA has maintained genetic purity by adhering to a pedigree-based breeding programme since the breeding nucleus was created in 2011 with assistance from WorldFish. Therefore, its acceptance and expansion in India might significantly help to the growth of sustainable aquaculture. The GOI's strategy presents a chance to expand GIFT in India when combined with recent policy developments like PMMSY. In 2019-2020, India produced around 10 million GIFT monosex fry and 2000 t of table-size tilapia out of a total 30,000 t farmed tilapia production in the country (Gaikwad et al. 2021).

Commercially Important Tilapia Species

There are about 70 species of tilapias, of which nine species are used in aquaculture worldwide classified into three genera of the Cichlidae family namely Oreochromis, Sarotherodon, and Tilapia are collectively referred to by the common term ‘Tilapia’. It is mostly a native of the Africa and the Middle east (Watanabe et al. 2002) and has emerged as very promising group in aquaculture. *Oreochromis mossambicus* (Mozambique tilapia) was the first tilapia species to be taken up for large scale aquaculture, followed by *Oreochromis niloticus* (Nile tilapia) (see figure 1), *O. aureus*, (Blue tilapia), and *O. zilli* (red belly tilapia). Today, Nile tilapia is the most widely cultured species worldwide, ranking third among the aquaculture species and accounting for 90% of tilapia aquaculture production globally (FAO 2020).



Mozambique tilapia



Nile tilapia

Fig. 1. Commonly found tilapia variety in India

Why GIFT Tilapia?

Nile tilapia is the third largest farmed fish in the world after grass carp and silver carp. The Global market for tilapia is growing at the rate of 10-12% per year (FAO 2020). Fishery professionals referred to tilapia as "aquatic chicken" due to its fast evolution and easy of cultivation, which now has made its farming widespread around the world (Maclean 1984). In our country, Monosex GIFT tilapia has become a more poplar species among fish farmers (Bhendarkar et al. 2017, 2020; Bhendarkar and Brahmane 2021a). The major reasons for its popularity are listed below (See figure 2):

- Suitability for wide range of farming systems
- Wide ranges of feed adaptability
- Low feed conversion and efficiency
- High level of tolerance for changing water quality and extreme events

- Tolerance to salinity and disease resistance
- Fast Growth Rate in comparison to other fish species
- High stocking densities
- Production costs are low
- White flesh; suitable for a wide variety of value added products
- Harvesting time is shorter, and size more than 200 gm may sell out.
- Good market demand, easy to be accepted by consumers.

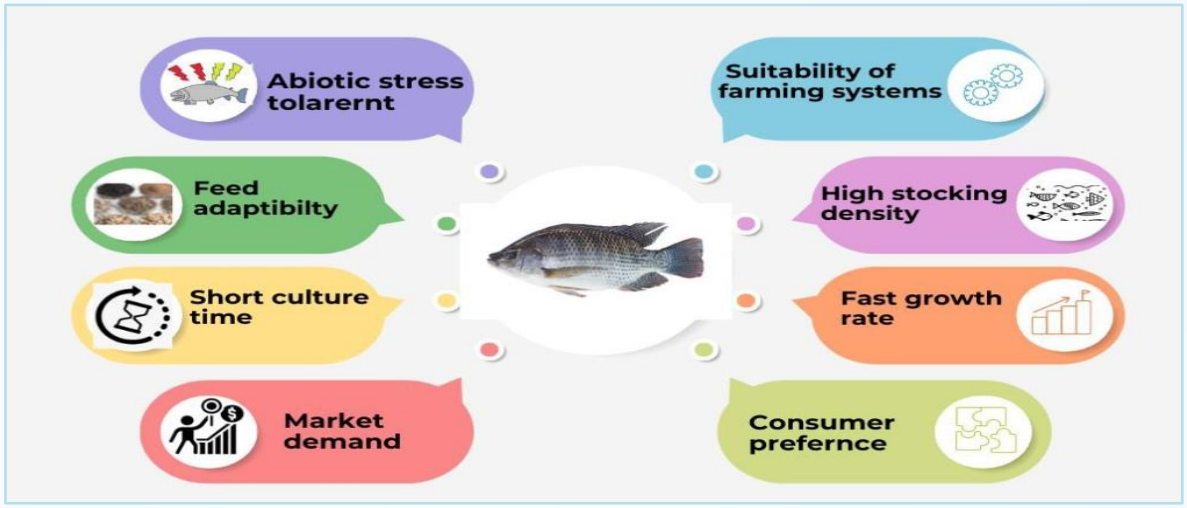


Fig. 2. The major features of GIF tilapia (Sources: Bhendarkar et al., 2021)

Tilapia Farming Guidelines

To enhance the farming and growth of tilapia in that country in a responsible manner, the Department of Fisheries, Ministry of Fisheries, Animal Husbandry and Dairy has framed the guidelines in the year 2015 and subsequently in 2020 for Tilapia culture, Breeding/Seed Production in India. Rajiv Gandhi Centre for Aquaculture (RGCA) is the pioneer body to already has a cutting-edge GIFT breeding nucleus. The RGCA has maintained genetic purity by adhering to a pedigree-based breeding programme since the breeding nucleus was formed in 2011 with assistance from WorldFish. Recently, the Government of India has granted permission to some private to for the breeding and supply of quality seed production (GoI, 2020).

According to the revised guidelines for Responsible Farming of Tilapia in India 2020, it is mandatory to get formal registration for the grow-out farming of GIFT tilapia. The process for obtaining a license is simple (see figure 3) and the terms and condition are as follows (Bhendarkar, et al. 2021; GoI 2020).

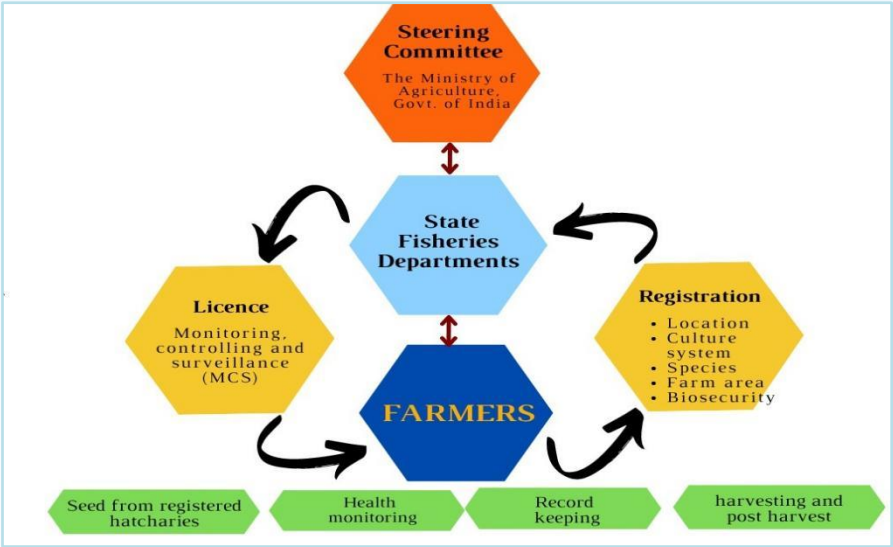


Fig. 3. The process and practices involved in tilapia farming registration

Farming Guideline

A. Registration

The first step, farmers/ entrepreneurs should apply to the State Fisheries Department to register in the prescribed their farm. Farmers that have registered their farm/farm pond with the State Fisheries Department are allowed to culture GIFT tilapia.

B. Location

Cultured pond may be located in areas which are not prone to floods or in a buffer r zone around a declared sanctuary or bio-reserve or other vulnerable areas in or-dear to avoid escape to the open water bodies.

C. Culture type and permitted

Only Nile tilapia (*Oreochromis niloticus)* or its improved strains/hybrids (Monosex male/sterile) shall be allowed/recommended for culture**.**

D. Area of culture system

Farms of any size of pond and culture system viz. Recirculating aquaculture system (RAS), cage culture, pen culture and Biofloc technology (BFT) are allowed to do GIFT tilapia culture.

E. Size of seed to be stocked

Grow-out ponds should be stocked seed of more than 10 g whereas the stocking size in cages and pens, RAS, BFT systems should be at least 30g or above.

F. Stocking Density

5 nos/m^2 or as the diversified system demands.

G. Biosecurity

1. It is mandatory to have a provision of Bird scaring device/fencing around the whole pond.
2. sluice gates must be provided with appropriate mesh size to prevent escape of fish/eggs/fry.
3. Bund height should be high enough to avoid fish escape.
4. Ponds/farms which could maintain bio-security of the farm to ensure no escape of the biological material from the farm to the water source or to any other source even in situations like flooding. Outlet water from culture ponds must be screened and treated before released into drains/canals/rivers during culture practice or subsequent to harvesting in order to prevent escape of eggs into natural water bodies.
5. Outlet water from culture ponds must be screened and treated before released into drains/canals/rivers during culture practice or subsequent to harvesting in order to prevent escape of eggs into natural water bodies
6. It is necessary to have your own system to check the quality of water.
7. It is necessary to keep all the records daily e.g. Feeding rate, water quality, fish weight over a period of time, etc.

H. Sale of seed and Broodstock

Farmers should not be supposed to sale GIFT seed and broodstock from his grow-out ponds/tanks or residual stocks.

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Better Management Practices of GIFT Farming

After receiving the approval, farmers or entrepreneurs can grow GIFT in various culture systems such as earthen ponds, concrete tanks, super-aerated ponds, raceways, recirculating aquaculture systems, cage culture, pen culture and biofloc technology. In the registration farm, the culture system should be specified.

Table 1. GIFT better management practices for aquaculture

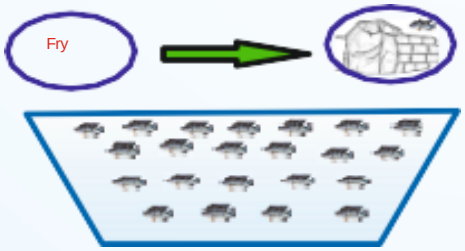
Particulars	Pond culture	Cage culture	RAS	BFT
Area (H)	0.02-0.05	6 x 4 x 4		
Depth (m)	4	1.0 - 1.5		
Stocking weight of fish	10 gm	>30 gm	>30gm	>30 gm
Stocking density (Nos)	5 / m^2	50 / m^3	100/m^3	80-100/m^3
Culture Period(Months)	5-6	4-6	4-6	4-6
				Sources: (M. Bhendarkar & Brahmane, 2021a)

Farming Strategies

Any fish farming that is based on the natural productivity of a pond has steadily grown with the use of basic scientific aquaculture management techniques, ultimately in an increase in quality fish production. The following are the fundamentals of pond management (Bhendarkar, Pawar, et al. 2021; Bhendarkar and Brahmane 2019c, 2019c):

- Pre-Stocking Management (In HDPE polythene pond is not practical)
- Stocking Management

Stocking Management



Nursery phase in Hapa/Pond



Rearing Pond



Stocking Pond

Fig. 4. Better Management practices of GIFT farming

Pre-Stocking Management

Pre-stocking management aims to properly prepare pond to remove the causes of poor survival, unsatisfactory growth, etc., and ensure ready availability of natural food in sufficient quantity and quality for seed/fry/ fingerlings to be stocked. Pre-stocking part of the management involves the following sequential measures (see figures 5-13).

Pond Drying

In the course of harvesting ponds, water is drained; pond bottom should be exposed to bright sun for about 15-20 days till it cracks. It is a general rule that ponds should remain as dry as possible until the next production season.



Fig. 5. Pond drying

Cleaning and cultivation of pond bottom

Removing objects, vegetation and aquatic weeds is the second step of pond preparation. Passing of dry pond bottom with a ploughing will ensure healthier life of benthos.

Eradication of unwanted fish and disinfection of pond bottom

The predatory or invasive fishes like directly pray upon the juveniles (young once of the fish) and compete with GIFT tilapia for food, space and oxygen. Hence, before stocking of desirable species utmost care shall be taken for complete eradication of undesirable species which shall be done by repeated netting of pond or using fish toxicant (Mahua Oil Cake).

Liming

Quick lime at the rate of 200 kg/ha is recommended for accelerating the mineralization of organic matter and act as prophylactic measure. It acts as buffer against pH changes and it increases the availability of carbon for photosynthesis.



Fig. 6. Liming

Inundation of pond

When filing pond, there are recommended intervals of time otherwise water condition become favorable for aquatic plants which will grow with the rising water. Appropriate screening of water during inundation of ponds is the only prevention against the entering unwanted fish and items.



Fig. 7. Inundation of pond

Manuring and Fertilization

It is essential nutrient play a vital role in the productivity of the pond where fish prefer natural fish food is expected. Organic manure i.e. cattle dung @ 1000 kg/ha is generally applied in 4 equal installments. Inorganic fertilizers like Urea @ 25 kg/ha/month and single super phosphate 20 kg/ha/month. Manuring and fertilization should be applied at monthly intervals.



Fig. 8. Manuring and fertilization

Stocking Management

In HDPE lining pond, only stocking and Post-Stocking Management operations may performed. Initially for 20-30 days, it is preferable to stock GIFT seed in small ponds or hapas (net enclosures) so that feeding and survival may be easily monitored (see figure 9).

Hapa

In a nursery pond or in *hapa*, tilapia fish seeds should be kept for a month. The effective implementation of nursery care in it is necessary to achieve optimum fish survival and an improvement in production.



Fig. 9a. Nursery



Fig. 9b. *Hapa*

Quantity of Stocked Fish

According to the Responsible Farming of Tilapia in India 2020 guidelines, the optimum stocking density of GIFT tilapia are 5/m^2 or as the diversified system demands. However, the stocking density is based on culture system in which fish will grow (see table 1).

Execution of Stocking

Fish should pass with least stresses possible. Therefore, fish of all stages must be handled with care and released gently by means of acclimatization. Time invested in this action will achieve better survival of stocked fish.



Fig. 10. Execution of stocking

Acclimatization and Stocking

Before stocking fish for grow-out into a pond, the number of fish, the average individual weight and the total quantity must be estimated. The fish from the polybags / transport tanks are to be gradually acclimatized to the water quality parameters in the pond before release into the open ponds or nursery hapas in the ponds. Initial biomass calculation followed by periodic checks at regular intervals during the culture period will allow reliable projections on biomass and survival rates.



Fig.11. Acclimatization

Post - stocking Management

Post-stocking management involves maintenance of pond environment and harnessing the pond productivity in the form of natural fish food, maintaining supplementary feeding and health care. As per guideline, could maintain bio-security of the farm to ensure no escape of the seed or Broodstock and continuous follow MSC.

Supplementary Feeding

Soon after stocking, the fish start grazing natural food available in the pond irrespective of their stage of life cycle. Seed feeds voraciously on plankton (if available). GIFT tilapia seeds need more food than the naturally available food in the fish pond. Artificial food in floating form is useful for their growth. Tilapia eats almost all types of supplements, but responds very well to artificial foods. Guideline stated that formulated standardized certified floating pellet feed/farm made pellet feed with minimum protein content of 20% should be used. Care should be taken to ensure that the water quality of the pond does not deteriorate due to excessive feeding. However, feeding has to be at the discretion of the pond manager, with feed consumption, the pond conditions and the general environmental conditions be considered before deciding on the quantity of feed to be provided. An indicate feed chart for grow-out farming of Tilapia is shown in Table 2.



Fig. 12a. Regular sampling



Fig.12b. Mass mortality in farm pond

Water Quality Management

Managing water quality in GIFT tilapia culture ponds is crucial for fish growth. It is also necessary to importance and maintenance of parameters at optimum levels is essential to ensure best growth and survival of the stocked fish, photosynthesis, biological factors. Water quality parameters such as dissolved oxygen, temperature, pH, transparency, etc. should be monitored on a daily basis. Ammonia levels should be checked at weekly intervals or during the period if the fish are eating less food. With a controlled and accurate diet, changing the water when needed, and mechanically providing air (aerator) when fish storage density is high or arrange the input water pipe such that water splashing on the surface of the water (Figure 13), all these water components can be kept at a controlled optimal level. The criteria

for favorable water quality for GIFT tilapia conservation are given in the table 3.

Table 2 : Indicative feeding table of GIFT from nursing to grow out farming

Sr. no.	ABW (Gms)	% Body Weight
1	1-5	8
2	6-10	6
3	10-15	5.5
4	15-20	4
5	20-50	4.0-2.5
6	50-100	2.5-1.7
7	100-200	1.7 -1.3
8	200-300	1.3-1.0
9	300-500	1.0-0.9
10	500-700	0.9-0.8
11	>700	0.8-0.6

Regular Sampling and Fish Health Management

Periodic sampling of fish is necessary to observe the growth and health status of the production biomass. Fishes should be sampled once in every 15 days to check the health and growth. The body surface should be checked for presence parasites if any. If there is mass mortality occurred, immediately check the water parameter and other sign of infection (see figures 12). The flow of pesticide-rich water from crop fields or the release of hazardous industrial waste, etc. may cause a mass mortality of fish in a farm pond.





Fig. 13a. Dissolve oxygen maintenance **Fig.13b.** Aerator

Table 3. Optimum water quality parameters to be maintained in Tilapia culture

Waters Parameter	Optimum Level
Dissolved Oxygen	4-6 ppm
Temperature	28-30 ℃
pH	7.5 -8.5
Transparency	20-30 cm
Ammonia	< 0.2 ppm (Total Ammonia)

Harvesting

Tilapia usually weighs 500 to 600 gm in 5-6 months after stocking. The periodical harvesting is done subsequently with dragnet of suitable mesh size and final harvesting is carried out by completely draining the pond.

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GIFT in Inland Saline Water

India is headed towards shrinking agriculture land due to increasing population, urbanization, indicate a food catastrophe in future. In such a circumstance, salinity's impacts on the soil are also degrading it more noticeably. In India, salinity affects over 67.3 lakh hectares (Kumar & Sharma, 2020) i.e. 2.1 % of the country's total land area, and many farmers in the states of Maharashtra, Haryana, Punjab, Rajasthan, and Gujarat are suffering with this challenge.

These inland, salt affected and waterlogged areas where agriculture does not have a prominent role, but water is abundantly available can be potentially utilized for developing aquaculture. Inland saline aquaculture can not only prove to be a good means of fertilizing this unfertile land, but also good as a complement to employment problem. Additionally, the government supports the construction of aquaculture ponds in salinity-affected areas through "Pradhan Mantri Matsya Sampada Yojana" programme, considering the vast potential water resources for the growth of fisheries (PMMSY).

ICAR-NIASM Research Initiatives

Saline groundwater can differ in chemistry compared with coastal seawater and adjusting the chemistry or choosing species that are tolerant to the differences is one of the major challenges for expansion of inland saline aquaculture (See table 4). The ICAR-National Institute of Abiotic Stress Management are engaged in studying and demonstrated the experiment on the response of GIFT Tilapia fish to different salinity stress (Inland saline water) exposed to acute and chronic salinity stress and try to develop reclamation technologies and strategies of inland saline aquaculture on farmer's field. ICAR-NIASM successful demonstrated and transformed barren saline land into model aquaculture farm (1 acre) of farmers name Mr. Suryakant Khalate Baramati, Maharashtra by imparting technical knowledge from site selection, ponds designed to harvesting (See figures 14).

Table 4. Water parameter of inland saline water from Baramati

Sr. No.	Water Parameter	Inland Saline Water
1.	Temperature °C	25.2
2.	pH	9.05
3.	Salinity (ppt)	11.16
4.	Hardness (mg L^{-1})	1140
5.	Ammonia (mg L^{-1})	0
6.	Nitrate (mg)	6.92

7.	Phosphorus (mg/L)	0.119
8.	Potassium ((mg L^{-1})	5.02
9.	Electrical Conductivity	18.52
10.	Total suspended solid (ppt)	8.638



Fig. 14a. Fish ponds construction in saline affected area



Fig. 14b. Pond dike built using clay core and cut-off trench to ensure impermeability

In order to assess the Nile tilapia physiological response to coping with different salinity stresses, an experimental trial was carried out utilizing inland saline groundwater of salinity 0 to 15 ppt. The purpose of this study was to examine the effects of juvenile exposure to varying salinities, from acute to chronic. We examined the effects of cortisol, hematological, histological variations, growth and survival, and other responses to stress to include primary, secondary, and tertiary stress responses. The experiment's results point to the viability of inland saline aquaculture using low salinity subsurface water and provide new directions for further research and development.

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GIFT Farming in Farm Pond

Majority of the Indian population is dependent on agriculture and allied sectors for their livelihood and income. Therefore, the growth and development of these sectors are given a lot of attention. However, inadequate irrigation is one of the important and critical constraints in these sectors particularly in rainfed areas, since approximate 42% of the net sown area in India could only be completely irrigated (GoI 2021). To overcome irrigation problems as well as to boost the agriculture production the Agriculture Department initiated the 'National Horticulture Mission', Maharashtra Rural Employment Guarantee Scheme, Rashtriya Krishi Vikas Yojana (RKVY). Maharashtra State Government took significant step in this direction particularly for rainfed areas and launched a scheme popularly known as "Magel Tyala Shet Tale" (Farm pond on demands) and Jalyukt Shivar (JYS). On similar grounds in Andhra Pradesh, mandal committee has also prepared a plan on 'Neeru-Chettu'. Under NREGA also several farm ponds have been construction. Under 'Panta-Kunta' programme, two to five small farm ponds will be dug in every village. All these farm ponds can also be potentially utilized for aquaculture without affecting the water level in farm pond (Bhendarkar and Brahmane, 2018). Farm ponds based Aquaculture with abiotic stress resilient variety of fish has the ability to boost farmers' surplus income and ensure their long-term sustainability while enhancing the nutrient content of water for use in crops (Bhendarkar and Brahmane 2019b). Thus, a GIFT Fish culture in these water bodies in rainfed areas has potential to increase fish production and economic return per unit area of land.

Keeping in this view, the ICAR-National Institute of Abiotic Stress Management has already developed technology on Farm pond based Aquaculture Model in water stress in Rainfed Areas (Technology Code : 201637570160430). This technology is the methodology for fish farming in farm ponds which makes them the country's important water resource, with huge untapped potential in water stress in Rainfed Areas. These water bodies' uses for agriculture use during the drought period and it can be parallel used for aquaculture by stocking quality of GIFT seed. This model of fish farming results in increasing the farmer's income with their existing water resources. It is also expected that this additional water area will prove a boon to 'Blue revolution' programmes to achieve blue revolution and help to achieve target of fish production to 22 million metric tons by 2024-25 set under Pradhan Mantri Matsya Sampada Yojana (PMMSY). In the light of this perspective, GIFT farming in Farm Pond could take a viable option for doubling farmer income in India.

Farming Strategies

Nowadays, the majority of farmers have farm ponds that they utilise to store water during dry seasons. Now they may make use of this farm pond for GIFT farming and perhaps farm pond based aquaculture model would be the best starting place for new agricultural farmers and fisher to enter the fish farming. Farm ponds are often deeper since they are designed for water storage, making them inappropriate for fish culture. However, by implementing some strategic management the farmer might get the more output of the available resources per

unit area. The different types of strategic management in farm ponds fish farming can be broadly categorised as follows:

Selection of Fish Species

Farm ponds have some limitations when it comes to fish farming compared to ideal fish ponds. Therefore, selecting the right culture species is more crucial when taking into account factors like water depth, pond design, local fish demand, shorter culture times, stress tolerance, and easy maintenance, among others. A farm pond-based aquaculture model that takes into account all of the aforementioned limitations, the GIF tilapia is viable option.

Bird Scaring Device

According to the guidelines for biosecurity, it is necessary to provide fence or a bird frightening device. Perhaps farmers would benefit from reducing the harm done by fish - eating birds. Farmers usually employ bird nets to prevent losses. The important thing to keep in mind is that not all birds are harmful for fish and other aquatic species. Some make use of the aquatic habit without troubling the fishes. However, it's also crucial to prevent harming birds by entangling them in nets by utilizing responsible bird management techniques, such as color nets or Bird scare humming lines.



Bird Scare Humming Lines Bird net

Fig. 15. Bird scaring device

Nursery Care of GIFT

In the farm pond-based aquaculture approach especially in earthen farm pond, emphasis is placed on increasing the primary productivity through manure and fertilizer. By doing this, enough plankton will be available for natural food. Additionally, this nutrient-rich water that contains N, P, and K serves as a liquid fertilizer for agricultural crops.

Hapa and Small Cage

Tilapia fish seeds should be kept for a month in a small pond (or in *hapa*) to ensure

maximum fish survival and an increase in productivity, nursery care procedures must be properly adhered to (see figure 16). After a month, the seed should be weighed, and shift to a farm pond.

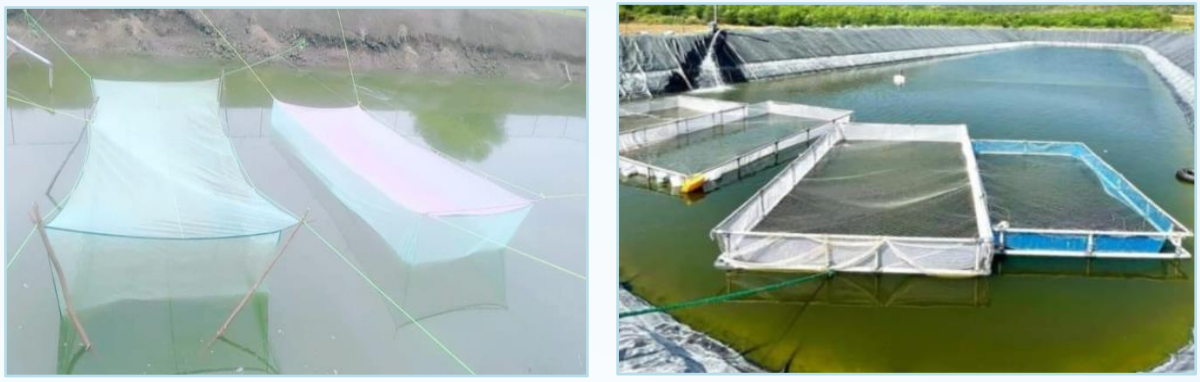


Fig. 16. Nursery rearing in *Hapa* and small cage

Execution of Stocking

Fish should be pass into farm pond with least stresses possible. Therefore, fish seed must handle with care and released gently by means of acclimatization (see figure 11). Time invested in this action will achieve better survival of fish. Execution of stocking should be stocked with seeds usually in the morning hours.

Stocking Rate

The size of the farm pond and the seed size determine the stocking density. In general, it is advised to stock 15000–20000 GIFT per acre, with an average size of 0.20–0.30 gram (Bhendarkar and Brahmane 2021a). However, when stocking density rises, the growth rate slows.

Grout-out Farming Management of GIFT

After nursery management, grow-out farming involves maintenance of pond environment, water quality, supplementary feeding, and health care management.

Supplementary Feeding

The natural food in the fish pond is not enough to feed the GIFT seeds and it is important for development of these fish growth benefits from artificial food. Although GIFT consumes practically all dietary supplements, it reacts quite well to artificial pelleted feed. A feeding chart should be created based on the fish size and stocking density. After fortnightly sampling, modify the chart and adhere to it (see table 2).

Fish Health Management

Under, feeding leads to malnutrition, resulting in growth retardation and low disease resistance. The best way to avoid disease outbreak in the farm ponds during culture is through taking preventive measures which are ensured by proper management of the soil and water quality, following proper feeding schedule, use of balanced feed, periodic sampling for health check, etc. To monitor the health and growth of the fish, samples should be taken once every 15 days. If there are any parasites, they should be examined on the surface of the body.



Fig. 17. Sampling and health and growth observation

Harvesting

When a farm pond is draining the water is being used for crops, harvesting time is often recommended. So that it may easily harvested with a minimal water depth. GIFT usually weights 500 to 600 gm in 5-6 months after stocking. Following that, the periodic harvesting is completed using a net with an appropriate mesh size, and the ultimate harvest is completed by entirely emptying the pond.

Economics

Marketing and economics are crucial components of every farming operation, however GIFT culture in farm ponds is not only economically successful but also effectively utilizes the resources available and gives the farmer surplus income. Perhaps it would improve the fish production system and the economic return per unit area of land (see table 4).

Table 4. Economics of Grow-out Tilapia production/acre in Farm pond.

Sr. no	Particulars	Unit	Rate (₹/Unit)	Quantity/acre (Unit)	Amount (₹)
1	GIF Tilapia	Nos	3	20000	60000
3	Medicine			20000	20000
4	Supplementary feed		50	5000	250000
5	Miscellaneous			50000	50000
6	Total Expenditures			380000	
7	Yield (Kg)	KG	80	7000	560000
8	**Net profit (7-6)**				**₹ 1,80,000**

Conclusion

GIFT is considered the "Food Fish" of the 21st century and popularly known as "aquatic chicken". The world production of tilapia is 4.0 million tons and its estimated value is 3.0 billion. According to the FAO report, global production of tilapia will reach 7.3 million tons by 2030. Tilapia has made significant contributions to food security in China, Egypt, the Philippines, Brazil, Thailand and Bangladesh. Tilapia is one of the surest fish species that can secure its place as an alternative to food security, especially for a growing population and cheap protein. GIFT tilapia has been improving for almost 30 years and is still improving. Given the current and potential contribution of GIFT Tilapia in fish production basket, there is no doubt that GIFT Tilapia can truly be a gift for aquaculture.

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