Guidelines for responsible farming of Tilapia in India

Background

Tilapia is native to Africa and Middle East, and has emerged from mere obscurity to one of the most productive and internationally traded food fish in the world. The farming of tilapias, especially of Nile tilapia (*Oreochromis niloticus*) in its crudest form is believed to have originated more than 4000 years ago from Egypt. The first recorded scientifically oriented culture of tilapia was conducted in Kenya in 1924 and soon spread to many parts of the world.

The uncontrolled breeding of tilapia in ponds, which led to excessive recruitment, stunting and a low percentage of marketable-sized fish, dampened the initial enthusiasm for tilapia as a food fish. However, the development of hormonal sex-reversal techniques in the 1970s, followed with research on nutrition and culture systems, along with market development and processing advances, led to rapid expansion of the industry since the mid-1980s. Though several species of tilapia are cultured commercially Nile tilapia is the predominant cultured species worldwide.

The last three decades have seen significant developments in farming of tilapias worldwide. They are being farmed in about 85 countries worldwide (FAO, 2008) and about 98% of tilapia produced in these countries are grown outside their original habitats (Shelton, 2002). Global tilapia aquaculture production in 2009 was 3.08 million mt, with China, Indonesia, Egypt and the Philippines being the top producers.

Species for aquaculture

Tilapia belongs to the family Cichlidae under order Perciformes. The tilapias have recently been classified into three genera, based on parental incubation of eggs. The species of the genera *Sarotherodon* and *Oreochromis* are mouth brooders, while *Tilapia* incubates eggs in a lake or pond bottom built-in "nest". There are about 70 species of tilapias, of which nine species are used in aquaculture worldwide (FAO 2008). Important commercial species include: the Mozambique tilapia (*Oreochromis mossambicus*), blue tilapia (*O. aureus*), Nile tilapia (*O. niloticus*), Zanzibar tilapia (*O. hornorum*), and the red belly tilapia (*O. zilli*).

Habitat and biology

Nile tilapia is a tropical species that prefers to live in shallow water. It is an omnivorous grazer that feeds on phytoplankton, periphyton, aquatic plants, small invertebrates, benthic fauna, detritus and bacterial films associated with detritus. Sexual maturity in ponds is reached at an age of 5-6 months. Spawning begins when the water temperature reaches 24°C. The female incubates the eggs in her mouth and broods the fry after hatching until the yolk sac is absorbed. Fecundity is proportional to the body weight of the female. A 100 g female will produce about 100 eggs per spawn, while a female weighing 600-1000 g can produce 1000 to 1500 eggs. Nile tilapia can live longer than 10 years and reach a weight exceeding 5 kg.

Development of farming technologies

In populations of tilapia, males grow faster and are more uniform in size than females. For this reason, the farming of monosex populations of tilapias which is achieved either by manual sexing, direct hormonal sex reversal, hybridization or genetic manipulation, has been reported as solutions to the problem of early sexual maturation and unwanted reproduction. Manual sexing which entails elimination of females based on sexual dimorphism observed in the urogenital papilla, is simple but is time consuming, requires qualified personnel and usually results in 3-10% errors.

Hybridization between different species did not effectively solve the problem of unwanted reproduction mainly due to difficulty in sustaining production of all-male hybrids. Hormonal sex reversal involves the addition of steroids in feeds for a short period during the fry stage. The use of

this technique however has not been fully accepted in some countries due to concerns on impact on human health. Production of 'supermales' through genetic manipulation could solve this issue.

Farming systems

Tilapia farming ranges from a rural subsistence (extensive, low input practices, non-commercial and for household consumption) to a large-scale (capital intensive, commercial purpose and market driven) level, depending on the intensity of management employed.

Water-based systems

Cage farming:

Cage culture of tilapia avoids problems with over breeding because eggs fall through the cage meshes. The other main advantage is that the farmer does not necessarily need to own the water body where the cages are placed. The cages can be made of netting or are sometimes made from bamboo or other locally available materials. The fish derive most of their nutrition from the surrounding water; however they may also be fed supplementary feeds. Typical stocking rates at harvest are 10 kg/m^3 maximum. Intensive cage culture with stocking rates of around 25 kg/m^3 is also getting popular. Average production levels are variable in different systems and countries. Under intensified cage culture production levels of 100-305 kg/m^3 are reported (Alceste and Jory, 2002, Costa *et al*., 2000).

Land-based systems

Ponds:

The main advantage of ponds is that fish can be grown very cheaply through fertilization. Many different types of ponds are used for tilapia culture. The most widespread, but most unproductive are low input ponds with uncontrolled breeding and irregular harvesting; yields are typically 500-2000 kg/ha/yr of uneven sized fish. If monosex fish are stocked and regular manuring and supplementary feeding is practiced yields can be up to 8000 kg/ha/yr of even sized fish. Polyculture of tilapia with other native fishes in freshwater ponds is also widely integrated with agriculture and animal farming.

Intensive tanks:

Intensive tank culture avoids problems with overbreeding because there is no space for males to set up territories. It requires a constant supply of water, either gravity fed or pumped. Usual maximum stocking rates in tanks where the water is changed every 1-2 hours would be around at 25-50 kg/m3.

Husbandry Techniques

The husbandry techniques developed over the last 20 years have revolutionized the expectations of tilapia culture, making it one of the most productive forms of finfish aquaculture in the world. Four hatchery and stocking practices have contributed most to this change:

- Stocking good species such as *Oreochromis niloticus* instead of *Oreochromis mossambicus*
- Hand sexing of juveniles: There are clear differences between the sexes in tilapia species, particularly in the form of the urinogenital opening, fin morphology and adult colouration. Skilled hatchery workers can achieve over 95 % male populations on 5-7 cm fish.
- Hybridization: *O. hornorum* is the only known species which consistently produces all male fry when crossed with *O. niloticus* or *O. mossambicus*. The main problem is the maintenance of the pure lines.

- Hormonal sex reversal: Fry can be collected at the yolk sac or first feeding stages, no later than one week after released from the female, and fed with feed containing the sex reversal hormone.

Indian scenario

In India, tilapia (*Oreochromis mossambicus*) was introduced in 1952, with a view to filling up unoccupied niches, such as ponds and reservoirs. The species spread all across the country within a few years due to its prolific breeding and adaptability to wide range of environmental condition. Overpopulation of the species affected the fisheries of several reservoirs and lakes as in Vaigai, Krishnagiri, Amaravati, Bhavanisagar, Tirumoorthy, Uppar and Pambar reservoirs in Tamil Nadu, Walayar, Malampuzha, Pothundy, Meenkara, Chulliar and Peechi reservoirs of Kerala, Kabini reservoir of Karnataka and Jaisamand Lake of Rajasthan. Introduction of *O. mossambicus* in Jaisamand lake not only resulted in reduction of average weight of major carps, but also posed threat to species like mahseers (*Tor tor* and *T. putitora*), which are on the verge of extinction. The Fisheries Research Committee of India had imposed ban on tilapia propagation in 1959.

The Nile tilapia was introduced to India during late 1970s. In 2005, River Yamuna harboured only negligible quantity of Nile tilapia, but in two years' time, its proportion has increased to about 3.5% of total fish species in the river. Presently in the Ganges River system, proportion of tilapia is about 7% of the total fish species.

However, tilapia holds vast promise to become an important species for aquaculture in India, considering the demand for more fish. M/s Vorion Chemicals, Chennai had successfully cultured and marketed some varieties of tilapia, and reported neither escapes to natural water bodies nor any ecological threats. There are many unpublished data about the availability of tilapia in reservoirs of Tamil Nadu and some other states of India. In the Kolkata Wetlands, some farmers are producing mono sex tilapia on commercial scale in waste water.

Studies carried out at CIFA for a period of three years during 1998 to 2000 with GIFT tilapia had demonstrated production levels of 5-6 mt per crop of 4-6 months duration. Further, the study also showed the possibility of tilapia farming under polyculture with the three Indian major carps and showed higher growth over rohu and mrigal at similar stocking levels. Monosex population (all male) also could be produced with provision of 17α Methyl testosterone treated feed for four weeks.

Only four fish farmer groups, M/s Aresen Bio Tech, A.P, Vijaywada, M/s Ananda Aqua Exports (P) Ltd., Bhimavaram, A.P, M/s Indepesca Pvt. Ltd., Mumbai M/s CP Aqua (India) Pvt. Ltd., Chennai, and M/s Rajiv Gandhi Centre for Aquaculture (RGCA), the R & D arm of the Marine Products Export Development Authority (MPEDA) are already permitted by Government of India for the seed production and farming of tilapia (Mono sex and mono culture of Nile/GIFT/golden tilapia) in accordance with the guidelines for the hatchery operation and farming of tilapia, developed by the Sub-Committee under the National Committee on Introduction of Exotic Aquatic Species into Indian Waters.

Potential for tilapia culture in India

As the demand for fish is increasing, diversification of species in aquaculture by including more species for increasing production levels has become necessary. Introduction of tilapia in our culture systems is advantageous because it represents lower level in food chain, and thus its culture will be economical and eco-friendly. Mono sex culture of tilapia is advantageous because of faster growth and larger and more uniform size of males.

The development of Genetically Improved Tilapia (GIFT) technology is based on traditional selective breeding and is meant to improve commercially important traits of tropical farmed fish which is a major milestone in the history of tilapia aquaculture. Through combined selection technology, the GIFT program achieved 12-17% average genetic gain per generation over five generations and cumulative increase in growth rate of 85% in *O. niloticus* (Eknath and Acosta,

1998). Other varieties like 'red tilapia' also hold promise. There is high potential of export of tilapia to US, Europe and Japan.

Guidelines for tilapia culture in India

I. Steering committee

i. The Ministry of Agriculture (MoA), Govt. of India may constitute a Steering Committee at National level to oversee and monitor the tilapia seed and grow-out production. This Committee may empower respective State Fisheries Departments for monitoring, controlling and surveillance (MCS) of Hatchery/Farming (Nursery as well as Grow-out) facility.

ii. The Steering Committee constituted by the MoA shall recommend standard guidelines with regard to quarantine measures required for tilapia brood seed (stock) importation for Hatchery and Breeding Programmes.

iii. This Steering Committee is empowered to modify/revise the guidelines as and when required. The steering committee based on feedback on implementation of guidelines will give more specific guidelines on vulnerable areas / sanctuaries and permissible therapeutics.

iv. A Committee constituted by the respective State Government is authorized to call for details from any Hatchery/Breeding/Nursery/Farm facility registered for tilapia aquaculture in case of violation of the prescribed guidelines.

v. The Farmers/Entrepreneurs who intend to undertake tilapia Hatchery/Breeding/Nursery/Grow-out Farming shall register with the respective State Fisheries Department using the appropriate format prescribed by the Steering Committee.

II. Culture systems and practices

i. **Registration:** Farmers who intend to take up Tilapia culture shall apply to the State Fisheries Department in the prescribed Proforma (Annexure-I) for permission.

ii. **Location:** Farms may be located in areas which are not prone for floods or in a buffer zone around a declared sanctuary or bio-reserve or other vulnerable areas in order to avoid escape to the open water bodies.

iii. **Type and culture Intensity:** Farming of only monosex male/sterile (through either hormonal manipulation or cross breeding) is permitted.

iv. **Area of Culture systems:** Each Farm should not be less than 1.0 Acre water spread area. Size of each pond should not be more than 10.0 Acres.

v. **Species:** Species recommended is Nile Tilapia or improved strains/hybrids of Tilapia

vi. **Size of the seed to be stocked:** Grow-out ponds should be stocked with sex reversed tilapia (SRT) seed of more than 10 g. 30 Days old sexually reversed tilapia (SRT) to be reared to 10 g size raised in on-farm nurseries or in registered seed farms.

vii. **Stocking density:** Maximum no of 5 nos/m^2

viii. **Bio-security:** The approval for farming of tilapia shall be accorded only to those 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. Therefore, there should be a standard design specifying the minimum requirement of bund height water management systems and other bio-security measures which are necessary for farming. 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 (b) Provision of Bird scaring device/fencing is mandatory, (c) Bund height should be high enough to avoid fish escape and (d) sluice gates must be provided with appropriate mesh size to prevent escape of fish/eggs/fry.

ix. **Cage culture in Reservoirs and Tanks:** Cage culture of tilapia shall be restricted to those reservoirs which are having already established stocks of tilapia. Before initiation of such farming assessment studies should be carried out by respective state fisheries departments in order to ascertain the presence of tilapia population in such reservoirs. Cage area in the

reservoir should not exceed 1% of effective water area (EWA). Stocking size in cages must be more than 50 g weight. Accordingly, cage net should have appropriate mesh size. Use of formulated floating pellet feed with minimum protein content of 25% is encouraged in cage culture.

x. **Intensive tilapia culture:** Farms intending to undertake recirculatory farming practice should register with state fisheries departments with a stocking density of not more than 150 nos/m^3 with provision of floating feeds. Biosecurity measures followed in this case must conform to the standards specified for Grow-out farms

III. Establishment of Hatchery

Entrepreneurs who intend to establish tilapia seed hatcheries have to obtain approval from steering committee and also to be registered with State Fisheries Departments. Hatcheries shall obtain brood stock from the approved foreign/Indian companies. Hatcheries shall sell seed only to the registered nurseries/farms.

IV. Seed production of tilapia

i. The Steering Committee will recommend establishment of tilapia National Breeding Programme (tNBP) for tilapia through ICAR fisheries research institutes and other similar agencies.
ii. The steering committee shall identify and approve the Foreign/Indian companies who are eligible to supply brood seed (stock) to commercial hatcheries.
iii. The steering committee shall inspect and approve the design and lay-out of hatchery including quarantine facility. Quarantine of imported seed for 21 days is necessary to avoid any incidence of disease outbreak. Imported seed stock may also need to be quarantined with companion species in order to assess susceptibility/resistance against exotic pathogens.
iv. Production of mono-sex male tilapia by the hatcheries should conform to the protocols specified under the guidelines.
v. Tilapia breeding programme with an objective of selective breeding for genetic improvement in subsequent generations involving geneticist should be encouraged to avoid future catastrophe due to inbreeding.
vi. Sex reversal using non-hormonal techniques/technology should be encouraged.

V. Seed nurseries

Nurseries which are intending to raise seed (Seed Farms) for tilapia culture have to be registered with State Fisheries Departments following the guidelines available for Grow-out farms. Nurseries should procure sex reversed tilapia (SRT) seed only from the registered hatcheries.

VI. Health monitoring

Health of the farm stock may be checked periodically and in case of disease incidence, permissible therapeutics may only be used judiciously.

VII. Record keeping

Registers should be maintained pond wise on day to day management of the farm indicating the details of stocking, source of seed, inputs, sampling details, water quality details, health, growth etc. The records should be produced at the time of inspection by the concerned fisheries authorities.

VIII Harvesting

Feeding should be suspended one/two days prior to harvest. Harvesting may be done using drag nets or any other quick harvesting methods.

IX. Post-Harvest and Transport

Harvested fish should be immediately iced and transported for domestic markets/processing plants. Adequate infrastructure facilities for processing of tilapia in value added items should be encouraged

X. Training and Awareness Programmes

Training programmes and awareness camps on Better Management Practices of tilapia are proposed to be conducted for achieving sustainability. Exposure visits to the Officials of Govt/Research Organization/Progressive farmers/Entrepreneurs to countries where tilapia culture is popular and successful. The training programming for farmers shall be taken up by the concerned State Fisheries Department/Research Organizations/KVK's.

XII. Evaluation and impact assessment

i. Evaluate the effectiveness of preventive steps taken up to prevent escape of tilapia from ponds and cages and improve them
ii. Impact of escapees on ecosystem and how they would modify the invasive capacity of existing tilapia species to be determined.

XIII. Further technical suggestions

i. **Fertilization:** Fertilization in pond culture using organic manures can be done depending on the nutrient status of the soil as and when required.
ii. **Types of feeds:** Formulated floating pellet feed/farm made pellet feed with minimum protein content of 20%
iii. **Feed storage:** Proper feed storage facility should be provided at the farm site with proper ventilation and management of humidity. The feed should be stacked on raised wooden platforms without touching the walls to avoid mold. The feed should be used within three months from the date of production.
iv. **Harvesting**: Feeding should be suspended one/two days prior to harvest. Harvesting may be done using drag nets or any other quick harvesting methods.
v. **Post-Harvest and Transport**: Harvested fish should be immediately iced and transported for domestic markets/processing plants. Adequate infrastructure facilities for processing of tilapia in value added items should be encouraged.

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Annexure-I

Format for Application

S.No	Particulars	Remarks
1.	Name and address of the Applicants(s)/ registered company/establishment in full (in Block Letters with permanent address)	
2.	Status of the Farm: Individual/Society/Private/proprietary/Partnership	
3.	Address for communication	
	Street:	
	City:	
	District:	
	State:	
4.	Location of the farm	
	State: District: Taluk/ Mandal Revenue Village: Survey No:	
5.	Ownership (Whether free hold or on lease)	
6.	If on lease, Specify the lease period and attach copy of the lease period	
7.	Whether the farm is registered with DoF and approved by CAA/ Other Agency (Enclose a copy of the certificate)	
8.	Attested Copy of the layout of the farm approved by DoF/MPEDA/Chartered Engineer	
9.	List of species that are cultured in the farm	
10	Source of water	
11.	Pond History	
	a) Month & year of construction of the ponds and financial assistance received if any.	
	b) Production details of Fish/ shrimp from the year of construction	
	c) Whether assistance for fish farming received under any scheme of the Central / State Government? If so, please provide the details:	
	d) Present condition of the ponds, if existing	
12.	Details of the proposed ponds construction/renovation/ repair works of the ponds	
13.	Proposed date of operation of the farm and tentative schedule of activities	
14.	List of Machinery and facilities available at the farm (As per to the Performa at Appendix-1.	
15.	Estimates regarding input costs and economics of operations in culture of pangas in ponds and cages	

Place:
Date:

Signature of the applicant:
Name:
Address:

- **This form should be accompanied by the additional information regarding available infrastructure at the farm as per the Appendix-I and the declaration by the applicant as per the Appendix-II.**

Appendix-1

Proforma for furnishing details of infrastructure available at the farm

Name of the Owner/Lessee: Place:

Physical facilities

Farm Extent	:
No. of Ponds	:
Area of each Pond	:
Bund high of each pond	:
Water outlet (Hume pipes/ Sluice gates)	:
Sedimentation tank	:

Buildings

a) Office/ Admn	:
b) Living Quarters	:
c) Stores	:
d) Lab for undertaking basic tests	:

Machinery:

Pumps	:
Aerators	:
GenSet	:
Machine Room	:

Appendix-II

Declaration to be furnished by the owner of the farm along with the application (to be signed on the Rs 100/- Non- judicial stamp paper).

1. I/ We……., aged ……son(s) of ……

…….and owner(s) of the farm at ……

…….declare that I/ We have read and understood the norms for undertaking tilapia culture and agree to abide by the conditions laid down in the guidelines.

2. I/We hereby declare that/We shall follow the guidelines specified issued ……

by Govt of India ……guidelines for farming tilapia.

3. I/We also agree to abide by any instructions that may be issued by concerned agency from time to time regarding the culture of pangasius sutchi/ failing which I/We understand that the registration may be cancelled.

4. I/We also agree to the inspection of the farm by any designated officer(s) of the Agency at any time, with prior intimation.

5. I/We also agree to provide information regarding source of the seed, production record, laboratory analysis sheets to the inspection team and shall submit regular reports.

6. I/We also agree to abide by the specifications and penalty clause laid down in the guidelines in the farming of tilapia failing which shall be liable to the cancellation of the approval issued by ……., destruction of stock and pond(s).

7. We also undertake that a quality certificate shall accompany the consignment of fish shipped from my establishment (Self certification) regarding the chemicals/ antibiotics residue status of the fish.

Place: Signature
Date: Address:

DATA SHEET

Daily recordings of feed and water quality management

Pond No: Area: No stocked: Size: Density:

Stocking Date: Time: Fry Source: Condition: A Wt:

Date	DOC	ABW	% Survival	Fertilizers:		Water Quality Parameters:					
				Organic	In-organic	Ph	Temp	Trans'	DO	S%O	NO_2-NO_3

Feeds			Health observations	Treatment (approved chemicals)	Remarks
Type	Qt	No. of Feedings			