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मत्स्य भारत

Matsya Bharat

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Tilapias – the most amenable fishes Introduced and Farmed Worldwide

[Article and Photo-credit: pages 26-38]

In this Issue

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Days to Remember

Feb 02	World Wetlands Day
March 22	World Water Day
March 23	World Meteorology Day
April 05	National Maritime Day
April 16	World Entrepreneurship Day
April 22	International Mother Earth Day
May 22	International Day for Biological Diversity
May 23	World Turtle Day
May 24	World Fish Migration Day
June 05	World Environment Day
June 08	World Oceans Day
July First Saturday	International Day of Cooperatives
July 10	**National Fish Farmers' Day**
	NFDB Formation Day
July 11	World Population Day
Sept 16	International Day for Preservation of Ozone Layer
Sept 18	World Water Monitoring Day
Sept 26	World Hunting & Fishing Day
Oct First Monday	World Habitat Day
Oct 16	World Food Day
Nov 21	**World Fisheries Day**
Dec 03	World Conservation Day
Dec 05	World Soil Day
Dec 14	World Energy Day

Seasonal Fishing Ban/ Closed Season (60 days)

East Coast of India	15 April to 14 June
West Coast of India	01 June to 31 July

CONTENTS

Featured Article

Aquaponics – an Integrated Fish and Plant Production System for Urban, Suburban and Rural Settings*

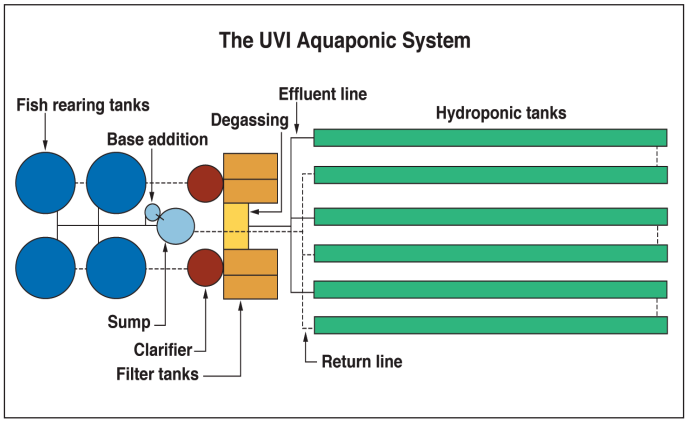
1. What is Aquaponics?

Aquaponics is an integrated fish and plant production technology, essentially comprising of two sub-systems, *viz.,* '*Aquaculture*' and '*Hydroponics*'. The underlying principle is to efficiently utilize water to produce two crops rather than one and to partition and share nutrient resources between fish and plants. Modern Aquaponics is the result of work initiated during 1988 by Drs. Mark R. McMurtry, P.V. Nelson and D.C. Sanders at the New Alchemy Institute, North Carolina State University, USA. Subsequently, starting in 1997, Drs. James E. Rakocy, D.S. Bailey, K.A. Shultz and W.M. Cole at the University of the Virgin Islands (UVI), USA, researched, developed and designed the UVI Commercial Aquaponic System to produce 5 tonnes of Tilapia and 5 tonnes of Basil/ Leaf Lettuce per year. Later, the UVI Aquaponics System has been adopted in Canada and Australia.

2. Categories of Aquaponics

Under the broad head of Aquaponics the following categories could be distinguished: (i) Freshwater Aquaponics, (ii) Saltwater Aquaponics, (iii) Warmwater Aquaponics and (iv) Coldwater Aquaponics, wherein freshwater fish/prawn/crayfish and vegetables, saltwater fish/shrimp and seaweeds/macro-algae, coldwater fish and plants are grown, respectively. Depending on the scale, Aquaponic Systems could be categorized as back-yard, small-scale, commercial-scale and industrial-scale units. However, depending on whether the fish/plant production is meant for domestic or commercial purpose or to cater to a high-end niche market, fish could be the primary crop while vegetables are the ancillary crop or vice versa or emphasis could be on growing both fish and plant species that are in demand. On the whole, fish and the metabolic wastes they generate are essentially the life-line of an Aquaponic System.

*Compiled by: Dr. K. Ravindranath, Senior Consultant (Technical), National Fisheries Development Board, Hyderabad – 500 052. [Email: krnath.nfdb@rediffmail.com]



Layout of Aquaponic System designed by University of the Virgin Islands (UVI) to yield 5 tonnes of Tilapia and about 5 tonnes of leafy vegetables per year [By Dr. James E Rakocy, et al., Courtesy of the Southern Regional Aquaculture Centre, USDA]

3. Why Aquaponics?

Aquaponics is often hailed as the future of food production. Aquaponic systems are said to utilize only 2 to 10% of the water required in traditional vegetable or crop production and have the potential to produce 10 times the output, without the use of harmful chemicals, pesticides, etc. The most significant aspect of Aquaponic Systems is the minimum extent of land/space required, leading to what is being dubbed as Urban Aquaponics/ Urban Agriculture/ Urban Farming/ Urban Gardening/ Terrace Gardening/ Vertical Gardening/ Office Farm (indoor), etc. Aquaponics may also reduce the burden of environmental pollution and to some extent the impact of climate change on food production.

4. Aquaponics and its Sub-systems

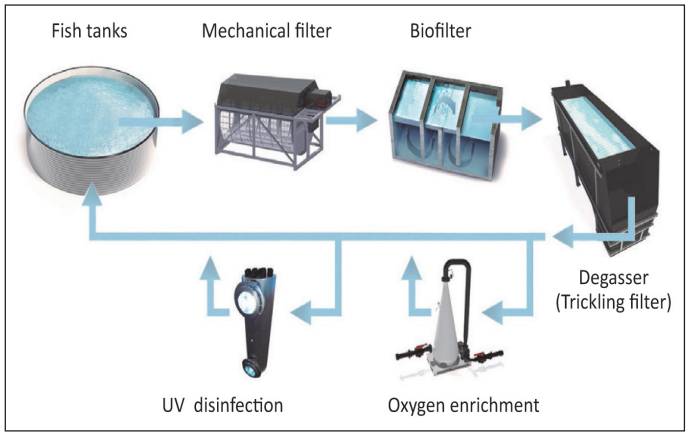
Aquaponics *per se* comprises of two principal components (sub-systems): the Aquaculture Sub-system and the Hydroponics Sub-system.

4.1 The Aquaculture Sub-system:

Aquaculture is the farming and husbandry of aquatic organisms. The Aquaculture sub-system in Aquaponics generally comprises of the Recirculation Aquaculture System (RAS) where fish/ prawn/ shrimp are cultured at high densities.

The Recirculation Aquaculture System (RAS):

Recirculation Aquaculture System is a technology developed for intensive fish culture under controlled conditions wherein water is re-circulated and re-used, drastically reducing the use of new water. However, intensification results in higher quantities of waste products such as unconsumed feed, undigested food/ faeces (suspended solids), metabolites such as carbon dioxide (CO_2) and ammonia (NH_3) all of which are harmful to fish and their environment if not removed or transformed. Therefore, the water in the fish tank is continuously passed through: a Mechanical Filter (to remove suspended solids), a Biological Filter (wherein *Nitrosomonas* bacteria convert harmful ammonia into nitrites and *Nitrobacter* bacteria convert nitrites into nitrates required for primary producers/ plants), a Trickling Filter (for degassing/ stripping water of CO_2, N_2 and H_2S), Oxygenator/ Oxygen-Cone (diffusion equipment to saturate water with dissolved oxygen from an aerator or O_2 generator), UV Filter (for disinfection), etc.



Chief components of a Recirculation Aquaculture System [Source: A Guide to Recirculation Aquaculture – An introduction to the new environmentally friendly and highly productive closed fish farming systems. By Jacob Bregnballe, FAO and EUROFISH, 2015]

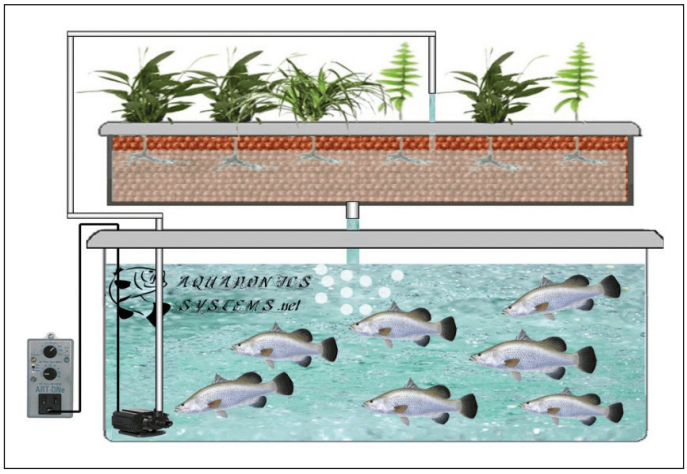
4.2 The Hydroponic Sub-system:

Hydroponics is a method of growing plants without soil, using nutrient-enriched water. The Hydroponic sub-system in Aquaponics varies depending on how the plants are cultivated, *viz:*

(i) Flood & Drain Hydroponics where plants grow in solid media such as gravel or expanded clay pebbles (hydrotons) through which water passes – Most common in hobbyist system.

(ii) Deep-water Raft Hydroponics where plants float on the water surface – Most common in commercial systems.

(iii) Nutrient-Film Hydroponic Technique (NFT) where water passes through horizontal channels or trickles down vertical PVC pipes both of which are provided with holes, net-cups, etc., to hold individual plants – Most common in exclusively hydroponic systems.



Diagrammatic representation of a basic 'Flood-&-drain-Solid-media-type Aquaponic' Setup [Picture Credit: aquaponicssystems.net, Courtesy of Flickr/flickrhivemind]

A 'Deep Water Raft Hydroponics' system where plants grow floating on the effluent-rich water without any solid-medium [Photo Courtesy of Bryghtknyght, CDC South Aquaponics Greenhouse at Brooks, Alberta, Canada, Source: Wikipedia]

Aquaponics using 'Nutrient-film Technique' to grow various leafy vegetables: Horizontal Channels (left) and Vertical Towers (right) [Photo at left Courtesy of Ryan Somma, Leafy Greenhouse, and Source: Wikipedia; Photo at right Courtesy Pinterest.com]

5. The Fish Feed and Plant Nutrients

Aquaponics is an RAS-based fish and plant production system. One of the most important starting inputs in a Recirculation Aquaculture System (RAS) is fish feed which has to be of high-quality. Commercially available pellet feed or floating extruded feeds are commonly used for raising high-value fish. Low-value or omnivorous fish could be fed low-cost mash/artisanal feeds. Alternate feeds include duckweed (grown within the Aquaponic System) for herbivorous fish, and worms from Vermicultue or Black Soldier Fly Larvae (BSFL) (*Hermetia illucens* Linnaeus) grown using kitchen leftovers, for feeding carnivorous fish.

The waste products excreted by the fish get converted into nutrients (nitrates) which the plants utilize. Plants require several macro- and micro-nutrients such as phosphorous, potassium, calcium, magnesium, sulfur, iron, etc., which may not be available in a newly set up Aquaponic System. The question from where other nutrients come from is the factor that basically defines the Aquaponic process. It has been shown that plants can be grown with nothing but fish waste and that in a mature Aquaponics System many plants grow better than in Hydroponics. The key to this success lies in high-quality fish feed, a mature biological filter and optimum pH range. As the pH tends to drift downwards (7.0 to 6.8) there is a need to adjust it upwards (7.0 to 8.0) by adding some calcium/potassium carbonate/hydroxide as required. For plants to establish in a newly setup Aquaponic System, the Hydroponic medium or grow-beds/ media-beds may be periodically supplemented with Potassium, Calcium, Iron, etc. In a simple Flood & Drain Hydroponic sub-system where plants grow in solid media-beds, worms establish themselves, consume the fine solids and release plant nutrients.

6. Energy Requirements

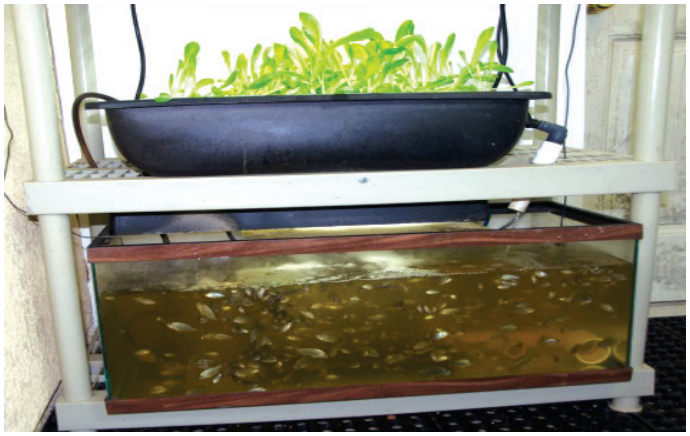
Aquaponic Systems require electrical energy for operating pumps and motors to re-circulate water through the various sub-systems and to run the gadgets such as mechanical drum-filter, aerator, etc. However, the layout design is such that energy is conserved by letting the water flow down by gravity to the extent possible. Power failure may lead to loss of fish stock. Therefore, power back-up is a must for continuous running of pumps/motors, etc.; renewable energy sources such as solar and wind power could be integrated to reduce energy costs.

7. The Fish

A wide variety of commercially important fish species are grown in the RAS of Aquaponic Systems in different parts of the world. They include different Tilapia species and their strains/ hybrids, Common Carp, Silver Carp, Grass Carp, Channel Catfish, Rainbow Trout, Arctic Char, Striped Bass, Largemouth Bass, Yellow Perch, and the Giant Freshwater Prawn (*Macrobrachium rosenbergii*). Enough stocks of fish seed (fry/ fingerlings/ yearlings) are to be kept ready to stock the RAS tanks after harvesting the grownup fish, so as to keep the Biological Filter stable and the Hydroponic sub-system running.

Aquaponics Fish Tanks (RAS) located at the President William McKinley High School, Honolulu, Hawaii, USA [Photo Courtesy of Hawaii Department of Agriculture, Source: Wikipedia]

Ornamental fish are good candidate species to be raised in an Aquaponic setup. Gold Fish (*Carassius auratus*) or Koi Carp (*Cyprinus carpio*) is especially suitable for this purpose. A variety of plants could be raised by incorporating a Hydroponic sub-system into an existing freshwater ornamental fish farm or even by latching it up with a good-sized aquarium indoors.



'A Mini Aquaponic System' that integrates a Lettuce grow-bed unit with an aquarium that works as Tilapia nursery [Photo Courtesy of the AquaponicsUSA's Blog – WordPress.com]

In India, usually Tilapia (*Oreochromis mossambicus)* is grown in Aquaponic systems as it is hardy and accepts a variety of feeds. Major and minor carps are also being attempted. The MPEDA at their Aquaculture Regional Centre in Palakkad, Kerala, have demonstrated nursery rearing of Seabass (*Lates calcarifer*) along with plants in an Aquaponic system.

MPEDA's demonstration project for nursery rearing of Seabass in an Aquaponic System in Nanniyode Panchayat in Palakkad district, Kerala [Photo: Courtesy of The Hindu Business Line, Kochi, November 25, 2014]

8. The Plants

A wide variety of plants are being grown in Aquaponic Systems. Their choice and number primarily depend on the stocking density of fish in the RAS sub-system and the nutrients that thereby become available to the plants. Crop duration and nutrients requirement are most important factors. Most often, vegetable plants are grown, and among them leafy vegetables such as lettuce, spinach, coriander, basil, mint, mustard, broccoli, cabbage, cauliflower, etc. are the primary choice because of their lower nutrient requirement, compared to fruiting plants such as tomatoes, cucumbers, chilies, capsicum, peas, strawberries, melons, or even onions, ginger, beets, sweet potato, roses, etc.

Aquaponics Growbeds located at the Pentair Aquatic Ecosystems Demonstration Farm in Apopka, Florida, USA, an example of the diversity of plants that can thrive in close proximity to each other [Photo: Courtesy of Hawaii Department of Agriculture, Source: Wikipedia,]

A rather large Aquaponics Home System - five barrels, a fish tank (at right) and a partially sunken sump (at left) [Photo Credit: Dallashomestager, Courtesy of Flickr/photos/homecheckdesigner]

The leafy vegetables (herbs) are grown in a Deep-water Raft/ Nutrient-film Technique (NFT) Hydroponic sub-system, while the fruiting/ bulbous/ rhizome/ medicinal/ flower plants are grown in Solid-media/ Grow-bed type Hydroponic sub-system. Generally, fruiting plants are grown separately in mature Aquaponic Systems that provide adequate nutrients.

To ensure staggered planting and harvesting, a constant supply of saplings of the plants to be grown in Aquaponic Systems is necessary. Therefore, it is necessary to maintain seeds and a nursery of the required plants close by.

9. Diseases

Like in any other food production system, fish as well as plants in the Aquaponic System are susceptible to diseases. However, in a well designed system, disease incidence is much less than in field-grown crops. Further, drugs/ antibiotics/ chemical/ pesticides/ insecticides should not be used as they would cause harm to either the fish or bacteria in the biological filter or the plants. Therefore, preventive measures, biological methods and non-conventional approaches are adopted. In addition, the diversity of plant species grown mitigates disease problem.

10. Production & Harvesting

Generally, grow-out period of fish is much longer than that of the plants raised. However, the duration of fish culture could be short (45 to 60 days) if the RAS is used for production of fry or fingerlings of food fish or if ornamental fish are grown. If fish are to be grown to pan size/ table purpose the culture duration could be 6 to 9 months or even more. Fish harvesting could be either staggered, so as to market them at regular interval, or all at a time. For continuous production and marketing of fish, the RAS fish-tank units have to be proportionately increased in number.

Plant production could also be either staggered-type or batch-type. Most leafy vegetables reach market size in 3 or 4 weeks. Therefore, 3 or 4 growth stages of the plants are maintained and 1/3 or 1/4 of the crop is harvested and marketed weekly. In case of fruiting vegetable plants, the crop duration could be 3 months or more, in which case batch harvesting is done.

A key factor in the design of an Aquaponic System is the ratio between the fish-rearing RAS unit and the plant-growing Hydroponic unit. Again, the volume of RAS unit depends on the intensity at which fish are raised; the quantity of feed added determines the amount of metabolic waste products produced and ultimately the plant nutrients generated. The fish to plant sub-systems ratio according to some is 1:2 by surface area or volume while according to some it is 1:7 by volume. But, adequate research into various factors is necessary to arrive at the optimum for a given production plan.

11. Marketing

Fish, vegetables, fruits and flowers grown in a commercial Aquaponic Enterprise have to compete with field-grown crops. Generally Aquaponic Units are supposed to produce organically grown, chemical-/ pesticide-free products, and cater to niche markets (health-food stores, restaurants, homes) at a premium price. The perishable nature of the produce, harvest, post-harvest handling, shelf-life and marketing aspects have to be kept in mind while formulating the business plan.

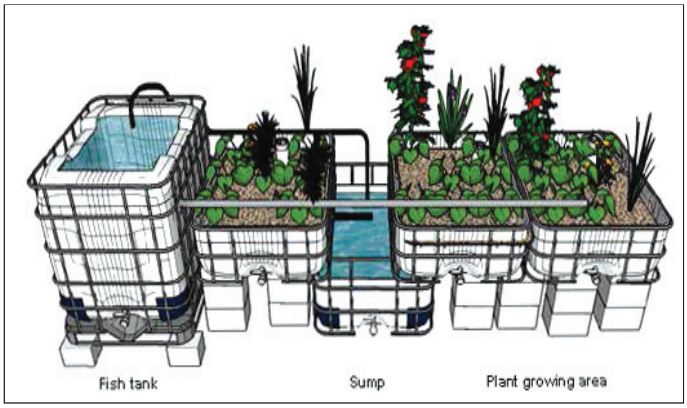
12. Scale & Profitability

Since decades, Recirculation Aquaculture System, Hydroponics, Controlled Environment Agriculture and Green Houses have been operating independently, commercially and successfully in different countries. Aquaponics involves hybridization of these proven technologies, and is evolving. Commercial-scale Aquaponics is technically feasible but its economic viability and profitability depend on several factors. There have been successful as well as failed Aquaponic Enterprises. Failure is largely due to: (i) the intricacies involved in integrating the different sub-systems; (ii) several alternate ways of configuring the system; (iii) inadequate operational awareness/ experience of the entrepreneur; (iv) high capital (infrastructure), operational (electricity - uninterrupted supply required) and input (fish feed, etc.) costs involved; (v) single point failures affecting the whole system; (vi) low or fluctuating market price of produce; (vii) defective business plan with respect to sales, revenue generation; etc.

Commercial Aquaponic Systems aim at intensive production and are inherently capital intensive. They are also more complex than stand-alone Aquaculture or Hydroponic Systems. The driving principle should be growing high-value fish and plants that can be easily marketed and generate the highest net income per unit area and unit time. A thorough economic analysis of the proposed business plan with due diligence covering all

variable factors need to be done before launching a commercial venture. It would be worthwhile referring to some of the studies that throw light on aspects such as weaknesses/disadvantages, effectiveness, production, profitability, etc., in Commercial-scale Aquaponics (*vide infra*: Further Reading).

Small-scale/ Backyard/ Urban-farming/ Roof-top Units, in contrast, are less intensive, cheaper, more successful and serve domestic or local needs, providing fresh and organically grown fish and vegetables on a continuous basis.



Small-scale Aquaponic Unit comprising of a Fish Tank, Sump and Plant-growing Area [Illustration Credit: Moti Cohen, Courtesy: Small-scale aquaponic food production – Integrated fish and plant farming. FAO Fisheries and Aquaculture Technical Paper 589, Food and Agriculture Organization of the United Nations, Rome, 2014]

The potential for growing medicinal plants in Aquaponic Systems has not been explored. Obtaining electricity from Renewable Energy source and meeting Organic Certification criteria would have added economic gains. Further, replacing commercial fish feed (a major cost component) with alternate food source or growing herbivorous fish [such as Grass Carp *Ctenopharyngodon idella* (Cuvier & Valenciennes, 1844) or *Tilapia rendalli* (Boulenger, 1897) often referred to as herbivorous tilapia] may be other viable options for small-scale units. There is now a shift to Community-based Aquaponics in rural areas providing job opportunities to rural youth. In some cities in the USA and Japan, Aquaponics is even shifting indoors into homes and offices using Vertical- / Gallery-type Units, under natural/ artificial light, supplying fresh leafy vegetables year round. Readymade, plug-and-play-type Modular Aquaponic Systems/Kits are also being marketed for the public to produce organic vegetables in the backyard/ at home.

Vegetable production part of the low-cost Backyard Aquaponics System (using empty water bottles) developed by the Department of Aquaculture, Bangladesh Agricultural University [Photo Credit: Dr. M.A. Salam, Courtesy of Wikipedia]

13. Aquaponics in India:

13.1 ***Aquaponics Experimental Unit***, at the ICAR-Central Institute of Fisheries Education (CIFE), Mumbai, was established in 2010, where research is being conducted on various aspects of Aquaponics. Experiments were conducted initially in small-scale units and later in larger-scale units. Trials were conducted using different species of fish such as Common Carp, Koi Carp, Gold Fish and Tilapia. Leafy plants such as Spinach, Mint, Basil and fruiting plants like Tomato, Chilly, Okra, Brinjal and Capsicum were grown using different techniques of Aquaponics such as media filled bed, floating raft, nutrient film and vertical tower. Studies were conducted to determine the optimum fish to plant ratio, water flow rate, water cycling, water quality parameters, etc. The research results were published in scientific journals. [*Source: Dr. A.K. Verma, Senior Scientist, Division of Aquaculture, ICAR-CIFE, Mumbai*]

Aquaponics Unit at ICAR-CIFE, Mumbai: an outdoor unit (left) with Spinach growing in gravel beds integrated with fish tanks containing Koi Carp and a polyhouse unit (above) for growing Spinach in verical towers, nutrient-film horizontal pipes and on floating rafts

13.2 ***Nanniode Aquaponics***, Nanniode, Palakkad, Kerala, is said to be India's Largest Commercial Aquaponics Farm. It was established by Shri Vijayakumar Narayanan in 2012. He organizes seminars, runs classes and offers consultancy for commercial projects on Aquaponics at his Nanniode Aquaponics Research and Development Centre (NARDC), in Palakkad. According to him Aquaponics can be started as a hobby to meet household needs in just 20 sq m of space requiring 500 kg fish in 10,000 litres of water. It would cost about Rs. 40,000 to 50,000. For commercial operations about 160 sq m of space, 5,000 kg fish in 50,000 litres of water and an investment of Rs. 1.50 to 1.75 lakh are needed. Aquaponics Hobbyist could grow 500 kg fish and up to 1000 kg vegetables, while Commercial Aquaponics Enterprise could grow more than 1000 kg fish and more than 1000 kg vegetables per annum.

At NARDC a variety of techniques are being used in Aquaponic production of fresh fish and organic vegetables. Currently 'Sand Media Culture Technology', developed by Dr. Mark R. McMurtry, Oklahoma, USA, is being adopted wherein plants are grown on sheets of gravel laid on the banks of a pond. Two pumps are required, one for blowing air into the pond and the other for pumping water on to the gravel where plants are grown under shade nets. Another design is the Raceway Aquaponic System. Shri Vijayakumar Narayanan assisted entrepreneurs in Kerala, Goa, Telangana and Tamil Nadu States in setting up Aquaponic Farms.

[*http://nanniodeaquaponics.blogspot.com; The New Indian Express, May 29, 2016*]

Different techniques being adopted at Nanniode Aquaponics Research and Development Centre (NARDC), in Palakkad, Kerala [Source: *Blog: http://nanniodeaquaponics.blogspot.com (picture above) and The New Indian Express, 29th May 2016 (picture below)*]

13.3 ***Anjali Aquaponics Farm***, spread over 15 acres in Gundedu village, Balanagar mandal Mahboobnagar district, Telangana State (65 km from Hyderabad), was established in 2014 by a progressive farmer Shri Bh. R. Viswanadha Raju. 'GIFT'/ Red Tilapia' is cultured in 25 – 30 sq m and 1.2 – 1.5 m deep tanks at a density of 100/cu m in an RAS mode, and 'organic vegetable' crops like lettuce, cabbage, other leafy vegetables, tomatoes, bottle gourd, bitter gourd, etc., are grown on gravel beds, rafts, vertical towers and on trellises (framework) in the open. Attempts are also underway to raise high-value fish such as Striped Murrel and Seabass besides Carps in additional RAS tanks. [*Personal communication*]

Images of Anjali Aquaponics Farm, Gundedu village, Mahboobnagar district, Telangana State, showing RAS tanks, fish, vegetable crops cabbage, lettuce, tomato in gravel beds, bottle gourd on trellises in the open, and a compact 'Home Aquaponics Unit' [Photos Courtesy of Shri Bh. R. Viswanadha Raju]

13.4 ***Aquaponics India***, Jaipur, Rajasthan, run by Messrs Himanshu Jakhar, Sneh Shekhawat, Pippa Woodhead, offers an intensive 3-day residential training programme at their own Aquaponics farm and consultancy at customer's site. [*http://aquaponicsinindia.com*]

13.5 ***India Aquaponics***, established in 2013 at Chandigarh by Messrs Parag Thakkar, Parul Thakkar and Pardeep Vedi, has a 600 sq ft facility; they developed an Aquaponics monitoring systems that can provide online information to the user anywhere. They offer urban solution known as CSA – Community Supported Agriculture, where every individual can setup small Aquaponics farm. They offer systems ranging from 500 sq ft to 2,500 sq ft for commercial production. A basic system of 6 sq ft is also available which requires only 25-30 W power that can be obtained from a solar power system.

[*www.indiaaquaponics.com*]

13.6 ***Prakruthi Aquaponics***, is a voluntary group working towards Green Thoughts and Green Living. Prakruthi successfully set up many Hydroponic systems for different farms in Trivandrum and Kollam. They have established an Aquaponics unit at the Coconut Nursery in Kazhakuttom in Thiruvananthapuram, Kerala, at an approximate cost of Rs. 10,000. The systems make gardening more productive and economical.

Aquaponics system setup by Prakruthi at the Coconut Nursery in Kazhakuttom in Thiruvananthapuram, Kerala. [Source: http://www. technoparktoday.com]

13.7 ***Vigyan Ashram***, Pabal, Pune, Maharashtra. They have an experimental setup for Aquaponics under the supervision of Shri Ranjeet Shanbag. They have had initial success and are working on commercializing it. They also have a Fab Lab where they fabricate, among other things, 80 W Portable Solar Panel Kit. [*http://vigyanashram.com*]

Aquaponics model (left) and a demonstration unit (above) at Vigyan Ashram [Photos: Courtesy of Vigyan Ashram, Pabal, Pune, Maharashtra]

13.8 ***Urbagrow Aquaponics***, at Survey Park, Kolkata, West Bengal, comprises of a 1000 sq ft rooftop Aquaponic Garden producing an abundance of vegetables.

[*http://www.urbagrow.com*]

13.9 ***Radongrow India*** is said to be one of the biggest online stores in India, offering all the items required for Hydroponics. They also provide end to end solutions for installing Hydroponic systems.

[*http://www.radongrow.com*]

13.10 ***Indian Aquaponics Society***, started on 19 March 2012, is an online facebook-group sharing information on Aquaponics through posts by members.

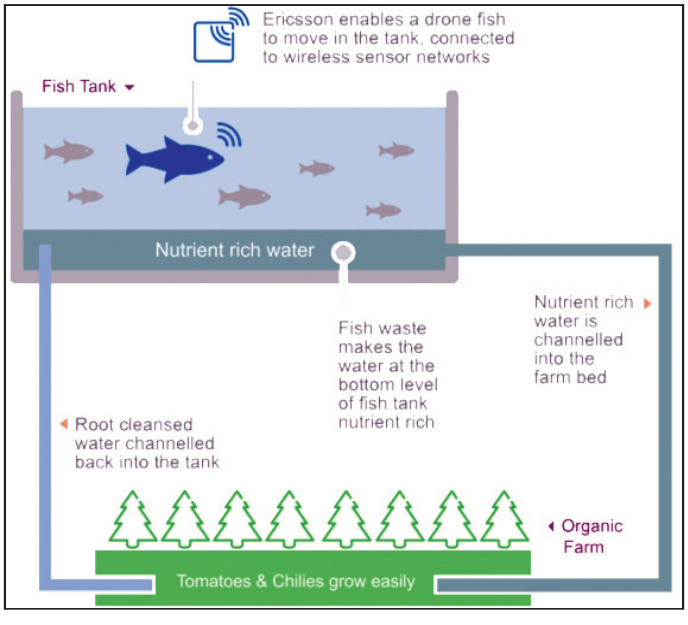
[*https://www.facebook.com/IndianAquaponicsSociety*]

A domestic vertical Aquaponic Garden producing an abundance of leafy vegetables [Photo Courtesy: Indian Aquaponic Society]

13.11 ***Aquaponics in a Smart Village in Andhra Pradesh:***

Mori, a small cashew-exporting village in East Godavari district of Andhra Pradesh is being developed as a 'Smart Village' by the Innovation Society of the A.P. Government in association with the Garwood Centre for Corporate Innovation at the University of California at Berkeley-Haas School of Business, USA. The Swedish communication technology firm Ericsson, one of the partners in the effort, demonstrated on 28 December 2016 at Mori village, the 'Connected Aquaponics' and 'Smart Water Grid Management' using its Internet of Things (IoT) Solutions. The 'Connected Aquaponics' integrates aquaculture and hydroponics for reuse of the ammonia-rich waste water from aquaculture for organic farming and recycles water back to the aqua farm.

Ericsson's 'Connected Aquaponics' system enables a drone fish, which is connected to a wireless network, to move around in the tank. The drone fish, which forms the core of the advanced IoT driven 'sensory framework', monitors temperature, pH, salinity, ammonia, and nitrate levels. The data collected is stored in cloud-based servers and then further transmitted in real-time to farmers via the mobile Aquaponics App. This enables farmers to better manage inputs, optimally use/re-use water and improve crop yield.



Working principle of Ericsson's 'Connected Aquaponics' system [Graphics Courtesy: Ericsson-Connected-Aquaponics-Mori-Smart-village-Infographic.pdf]

Demonstration of IoT driven Aquaponics Mobile App to Aqua Farmer in Mori village, East Godavari district, Andhra Pradesh [Photo Courtesy: Chrisanta Dias, networkedindia.com]

[Source: *The Hindu, June 20, and December 30, 2016; http://tech.firstpost.com, December 29, 2016; Courtesy:* Chrisanta Dias, *January 2, 2017, http://www.networkedindia.com/2017/01/02/ericssons-connected-aquaponics-empowers-andhra-pradeshs-farmers/*]

14. The Conundrum of Pesticides-laden-Vegetables

Recently, researchers from the Department of Entomology at Professor Jayashankar Telangana State Agricultural University, Hyderabad, analyzed Spinach samples collected from three vegetable markets in Hyderabad for the presence of pesticide residues. They found in all 11 pesticides in Spinach samples, while five pesticides (chlorpyrifos, triazophos, cypermethrin, deltamethrin + triazophos and profenophos) were frequently found in all the samples at levels much higher than that permitted in other crops. Further, it is stated that these pesticides are not recommended for use in vegetable crops.

Courtesy: *V. Nilesh, The New Indian Express, 16th January 2017*].

The above observations corroborate the advantages of cultivating leafy vegetables organically in an Aquaponic System.

15. Beyond Aquaponics

Aquaponic Systems may range from fully recirculating to fully non-recirculating. In the latter case, referred to as ***'open loop system'***, water from the fish tank that passes through the plant-growing section does not return to the fish tank; instead, the discharged water is used for integrating with a variety of other components such as urban horticulture, agro-forestry, animal husbandry, beekeeping, as well as for integrating with 'micro-livestock' and other organisms for greater bio-diversity. Such a system has been termed ***'Microponics'*** (by Gary J Donaldson, *vide* Wikipedia). ***'Vermiponics'*** refers to integration with Vermicomposting or Black Soldier Fly Larva (BSFL) composting. ***'Bioponics'*** is a growing-system that uses an anaerobic process to transform plants into fertilizer or uses biomass/bioslurry to provide 100% nutrient needs of new plants. Bioponics is a ***'closed loop system'*** that is said to be more ecologically sustainable than Aquaponic Systems as the latter require external inputs such as commercial fish feed.

In China, Aquaponic Systems of 1.0 to 1.6 ha area, that float on Polyculture Fish Ponds or on Lakes having extensive Aquaculture Industry, were installed to grow rice, wheat, and other plants. Similarly, an 'Integrated Floating Cage-Aquaponics System (IFCAS) has been installed in Barisal, Bangladesh, to grow vegetables.

Growing rice in Aquaponic System on fish pond in China [Photo Credit: Dr Kangmin Lee; Source: Aqua Biofilter project Lake Taihu having extensive aquaculture industry, by Tom Duncan; permaculturenews.org]

An Integrated Floating Cage-Aquaponics System (IFCAS) in Barisal, Bangladesh. [Photo Credit: WorldFishCentre, Malaysia, Courtesy of Pinterest]

[Source: *https://en.wikipedia.org; http://blogs.usda.gov/2013/11/08/hooked-on-aquaponics/; http://www.theaquaponicsdoctors.com; WorldAquacultureMagazine, September 2015; The Aquaponics Lab, Open Source Aquaponics, Todmorden, England, UK (http://aquaponicslab.org); http://www.agricultureinformation.com/postings/india-aquaponics*]

16. Further Reading

(i) Books written by pioneers and experts in Aquaponics :

Recirculating Aquaculture Tank Production Systems: Aquaponics – Integrating Fish and Plant Culture, by James E. Rakocy, Michael P. Masser and Thomas M. Losordo, Southern Regional Aquaculture Centre (SRAC, USA) Publication No. 454, November 2006 Revision, 16 pp, describes the commercial-scale 'University of the Virgin Islands (UVI) Aquaponic System' that is widely used today.

Commercial Aquaponic Systems: The Science and Engineering of Recirculating Fish Culture with Hydroponic Plant Production", by Dr. Wilson A. Lennard, is said to be the most comprehensive work in the field of Aquaponics to date, being published by Aquaponic Solutions, Australia.

"*Small-scale aquaponic food production – Integrated fish and plant farming",* by Christopher Somerville, Moti Cohen, Edoardo Pantanella, Austin Stankus and Alessandro Lovatelli, is published by the Food and Agriculture Organization of the United Nations, Rome. FAO Fisheries and Aquaculture Technical Paper 589, 2014, pp 288.

(ii) Publications that review the problems, effectiveness, production and profitability of Commercial-scale Aquaponics:

Aquaponics Research Project – The Relevance of Aquaponics to The New Zealand Aid Programme, Particularly In The Pacific. Commissioned Report Prepared by Hambrey Consulting for New Zealand Aid Programme, Ministry of Foreign Affairs and Trade, December 2013.

Commercial aquaponics production and profitability: Findings from an international survey. David C. Love and six others, 2014. *Aquaculture* (Published by Elsevier B.V.) 435 (2015) 67–74.

Effectiveness of Aquaponic and Hydroponic Gardening to Traditional Gardening. Ezekiel Okemwa, Technical University of Mombasa, Kenya. December 2015. *International Journal of Scientific Research and Innovative Technology,* ISSN: 2313-3759, Vol. 2, No. 12: 21-52.

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1. North and Northeast

1.1 Fourth Assam International Agri-Horticultural Show – 2017 Organized at Guwahati

The 4th Assam International Agri-Horticultural Show – 2017 was organized by the State Agriculture, Horticulture and Food Processing Departments in association with Assam Agricultural University (AAU), Indian Chambers of Commerce (ICC) at College of Veterinary Science, Khanapara, Guwahati, Assam, from 6-9 January 2017. NFDB co-sponsored the event and sanctioned Rs.2.14 lakh. Shri Sarbananda Sonowal, Hon'ble Chief Minister of Assam, along with Shri Atul Bora, Agriculture Minister, Shri Keshav Mahanta, Science and Technology Minister, and other dignitaries participated in the inaugural function. His Excellency, Shri. Banwari Lal Purohit, Hon'ble Governor of Assam was Chief Guest for the valedictory function.

NFDB participated by putting up a stall, displayed various activities and schemes and publications including a Digital Album. Live indigenous and exotic ornamental fishes were displayed in aquaria to create awareness among the public. ***Channa aurantimaculata*** Musikasinthorn (2000), a highly priced native ornamental fish endemic to the Brahmaputra River basin in the States of Assam and Arunachal Pradesh and locally called ***Nagacheng***, was a point of attraction for the visitors at the NFDB stall.

Channa aurantimaculata *displaying its natular colours in a aquarium at NFDB Stall in the Assam International Agri-Horticultural Show-2017 at Guwahati, Assam*

1.2 NFDB Sanctioned Project on Ornamental Fishes of Brahmaputra Basin Reviewed

NFDB sanctioned a project entitled 'Germplasm Inventorization, Brood Stocking & Captive Breeding of Ornamental Fish Species of Upper Brahmaputra Basin' to Dibrugarh University, Assam, at an outlay of Rs. 47.76 lakh. A two-day Project Monitoring Committee (PMC) meeting was held on 9 and 10 January 2017 Shri Apurba Kumar Das, Sr. Executive (Tech), NFDB Northeast Regional Centre, Guwahati visited the project site, inspected the infrastructure developed and discussed about progress of research work with Dr. S.P. Biswas, PI of the Project.

The project is in the last phase of implementation, and one more trial spread over two months is required for perfecting the breeding protocols of two indigenous ornamental fish species *viz., Channa aurantimaculata* Musikasinthorn (2000), and *Mystus dibrugarensis* (Chaudhuri, 1913). Dr. S.P. Biswas said that Completion Report of the Project would be submitted by 30 June 2017.

A view of the 'Aquarium House' developed under NFDB assisted project at Dibrugarh University, Dibrugarh, Assam

1.3 NFDB organizes seminar on Ornamental Fisheries Development in North East India at Guwahati, Assam

The North East Regional Centre of NFDB at Guwahati, Assam, organized a seminar on 'Strategy for Development of Ornamental Fisheries in North East India through NFDB'

on 21 January 2017 at ICAR-CIFRI Regional Centre, Guwahati. Assam. Dr. B. K. Bhattacharjya, Principal Scientist & Head, ICAR-CIFRI Regional Centre, Guwahati; Dr. Sanjay Kumar Das, Principal Scientist & Head (Fisheries Division), ICAR Research Complex for NEH Region, Barapani, Shillong, Meghalaya; Dr. Binod Kalita, Professor & Head (Aquaculture), College of Fisheries, Assam Agricultural University, Raha, Nagaon, Assam; Dr. (Mrs.) Bibha Chetia Borah, Principal Scientist & Incharge, Fisheries Research Centre, Assam Agricultural University, Jorhat, Assam; Dr. Dandadhar Sharma, Associate Professor (Zoology), Gauhati University, Guwahati, Assam; Mr. Satyajit Sarmah, Joint Director of Fisheries, Govt. of Assam; Mr. Gagan Sarma, Deputy Director of Fisheries, Govt. of Assam; Mr. Raben Das, Fishery Extension Officer & Incharge, Amranga Ornamental Fish Farm Unit, Govt. of Assam; Mr. Sonmoina Bhuyan, SMS (Fisheries), Krishi Vigyan Kendra, Nalbari, Assam Agricultural University, Nalbari, Assam; Mr. Chinmay Kakaty, Entrepreneur (Ornamental Fisheries), Guwahati; Mr. Prabal Sarma, Entrepreneur (Ornamental Fisheries), Guwahati, Mr. Bimal Roy, Entrepreneur (Ornamental Fisheries), Guwahati; and officials of NFDB Regional Centre, Guwahati, participated and coordinated. After the presentations, a brain storming session was held to formulate strategies for development of Ornamental Fisheries in the Northeastern States with funding from NFDB.

Participants at the Seminar on Development of Ornamental Fisheries in North East India held at ICAR-CIFRI, Guwahati, Assam

1.4 NFDB participates in the *'World Wetlands Day'* programme organized at Jorhat, Assam

A day-long programme to observe the '***World Wetlands Day***' was organized on 2nd February 2017 by Fisheries Research Centre (FRC), Assam Agricultural University (AAU), Jorhat, Assam. Dr. (Mrs.) Bibha Chetia Borah, Principal Scientist & Incharge, FRC, AAU, delivered the inaugural address. Dr. Sanjay Sarma of NFDB delivered a presentation on the topic 'How NFDB can help in the Wise Use and Conservation of Wetlands in North Eastern Region'. More than 60 participants, mostly *Beel* Users and *Beel* Development Committee (BDC) members, from different parts of the region attended the programme. A brochure on 'Conservation and Judicious Use of Wetlands' was also released on the occasion.

*Participants of the '**World Wetlands Day**' programme organized at Fisheries Research Centre, Assam Agricultural University, Jorhat, Assam*

1.5 Fish Feed Mill in Golaghat district, Assam inspected for feasibility of expansion

During 2009-10 Shri Rameswar Borah established a Small Fish Feed Mill with NFDB assistance of Rs. 1.5 lakh. The project site is located in Nora Kuwar Bongaon under Central Block of Golaghat District, Assam. It is about 7.0 km from Golaghat town and is well connected by motorable road. The feed mill has a grinder and a mixer and production capacity is about 1 tonne per hour of mash fish feed. Shri Borah has been operating the mill successfully and now intends to establish a larger formulated pellet feed plant with a capacity of 1 tonne per hour of floating pellets and 6 tonnes per hour of sinking pellets. The new fish feed plant is proposed to be established adjacent to the existing mill.

On 3 February 2017 Dr. Sanjay Sarma and Shri Abu Shamim Ahmed of NFDB accompanied by Shri Prosanta Borah, DFDO Golaghat, and the beneficiary Shri Rameswar

Borah, visited the feed mill premises for physical verification of the ongoing operations and the proposed project site, and found that adequate land is available for expansion.

Premises of the existing fish feed mill (left) and the interior of the mill (right) established with NFDB funding by Shri Prosanta Borah at Golaghat, Assam

1.6 All India Radio Guwahati, Assam facilitates popularizing Central Sector Schemes under *Neel Kranti Mission 2016*, in the North East States

With a view to popularise fisheries development schemes under the ***Neel Kranti Mission, 2016*** (Blue Revolution) launched by the Govt. of India, among the end-users/ stakeholders/ beneficiaries, especially in the North East States, NFDB sanctioned Rs. 1.38 lakh to the All India Radio (AIR), Guwahati, Assam. Eight Spots per day (each 20-second) were broadcast from 6:30 AM to 8:30 PM for one month from 23 January to 22 February 2017. Additionally, 8 bonus Spots were also offered each day.

Subsequently, two Live Phone-in-Programmes were arranged by the AIR, Guwahati – the first one was on 6 February 2017 and the second one was on 3 March 2017, in which Officers of NFDB Regional Centre, Guwahati, participated. The response from the listeners during both the live programmes was quite encouraging and a good number of phone calls were received; they were briefed about Blue Revolution Schemes, how to apply, whom to approach, documents required, subsidy amount, etc.

NFDB Officials participating in the Live Phone-in-Programme at All India Radio (AIR), Guwahati, Assam

1.7 NFDB sponsored 'Mizoram Fish Festival 2017' organized at Aizawl

A three-day 'Mizoram Fish Festival 2017' was organized from 8 to 10 February 2017 by the Dept. of Fisheries, Govt. of Mizoram, at the Transport Dept. Building, Temple Square, Aizawl, Mizoram. NFDB sponsored the event and allotted Rs. 25.0 lakh to the Director of Fisheries, Mizoram.

Shri Lal Thanhawla, Hon'ble Chief Minister of Mizoram, inaugurated the first ever Mizoram Fish Festival in the presence of Shri R. Lalzirliana, Honb'le Minister for Agriculture, Dr B.D. Chakma, Honb'le Minister for Fishery

The venue of Mizoram Fish Festival 2017 (above), Shri Lal Thanhawla, Hon'ble Chief Minister of Mizoram at the NFDB Stall (middle), traditional Bamboo Dance (bottom left) and visitors experiencing 'Doctor Fish Spa' in one of the stalls at the venue (bottom right) at Aizawl, Mizoram

and other dignitaries. Dr. Sanjay Sarma, Sr. Executive (Tech) & Officer In-Charge and Shri Abu Shamim Ahmed, Consultant of NFDB Regional Centre, Guwahati, put up a stall and explained the various activities and schemes of NFDB to the Hon'ble Chief Minister, other dignitaries and visitors.

The Dept of Fisheries and ZOFISHFED sold fishes at a discounted price (Rs. 150 per kg) which attracted many customers. 'Dr. Fish Spa Therapy' was another point of attraction, which many youngsters gave a try. On the second day of the festival, a symposium on "Development of Fisheries, Conservation and Propagation of Indigenous Fish Species of Mizoram" was conducted at the DI&PR Hall, Aizawl, in which renowned fishery scientists from northeast region, representatives from the leading Aqua-Tourism spot of Assam at Jashingfa and members of National Angling Federation participated and shared their experiences.

1.8 Training programme on Ornamental Fish Breeding and Culture conducted at Gauhati University, Assam

A two-day training programme on 'Ornamental Fish Breeding and Culture' was conducted on 11-12 February 2017 at the NFDB funded '***Integrated Ornamental Fish Farming Unit***' of the Dept. of Zoology, Gauhati University, Guwahati, Assam, in collaboration with ICAR-CIFA, Bhubaneswar. More than 30 participants from Assam who are engaged in ornamental fisheries sector, besides students and Research Scholars of the Dept. of Zoology participated.

Participants and resource persons of the training programme on 'Ornamental Fish Breeding and Culture' at NFDB funded Unit at Gauhati University, Guwahati, Assam

Dr. Swaroj Swain, Principal Scientist, ICAR-CIFA, Bhubaneswar and Shri Kripan Sarkar, a renowned ornamental fish breeder and exporter from Jalpaiguri, West Bengal were the chief resource persons. Breeding and culture of some commercially important exotic and native ornamental fishes as well as live feed culture were demonstrated. Officers of NFDB Regional Centre, Guwahati, participated in the valedictory function.

1.9 Minister of State for Agriculture visits Fisheries Projects in Tripura

Shri Sudarshan Bhagat, Hon'ble Minster of State for Agriculture and Farmers Welfare, Govt. of India, made a field visit to the Northeast State of Tripura from 18 to 21 February 2017 to participate in various Agriculture related programmes and also to observe fisheries developmental activities in the State. Dr. Sanjay Sarma, Sr. Executive (Tech) & Officer-in-Charge, NFDB Regional Centre, Guwahati, accompanied the Minister.

Hon'ble Agril. Minister at farmers pond during visit to Golaghati Community Tank Management Committee, Tripura

On 19 Februaray 2017, Shri Sudarshan Bhagat, visited College of Fisheries, Central Agriculture University, Lembucherra, and laid foundation stone for the Vocational Training Centre. On 20 February 2017, the Hon'ble Minister

visited the Community Tank (pond) at Golaghati, having 1.1 ha waterspread area and managed by the Community Tank Management Committee comprising of people from surrounding locality (25 families). The community was trained in scientific fish farming with NFDB assistance and aerators were procured with RKVY funds. They are adopting multiple stocking and multiple harvesting technique and producing about 8,000 kg fish per year.

The Hon'ble Miniter later visited ICAR-KVK at Birchandramanu, South Tripura District where he inauguraed Magur Fish Seed Production Unit. On 21 February 2017, the Minister visited the under-construction NFDB funded MG Fish Market at Agartala, the capital of Tripura State.

1.10 NFDB sponsored Skill Development Programme organized at College of Fisheries, Raha, Assam

A week-long Skill Development Programme on 'Development of Managerial Skills of Fishery Extension Workers for Improving Fisheries and Aquaculture Sector of Assam', sponsored by NFDB, was organized from 22 to 28 February 2017 by the College of Fisheries, Assam Agricultural University (AAU), Raha, Nagoan district, Assam.

Participants of the Skill Development Training Programme conducted at College of Fisheries, AAU, Raha, Nagoan district, Assam

Twenty Fishery Demonstrators (FDs) - grass root level Fishery Extension Workers of the Fishery Dept., Assam - participated in the programme wherein they were introduced to different technical and managerial aspects of fish farming and aquaculture activities. Dr. P.C. Bhuyan, Associate Professor, College of Fisheries, AAU was co-ordinator of the programme. Practical demonstrations and hands on training on different aspects of fish farming and aquaculture were imparted. A training manual on "Development of Managerial Skills for Enhancing Fish Production", prepared by Dr. P.C. Bhuyan and M.P. Dutta, was distributed to the participants. Officers of NFDB Regional Centre, Guwahati participated in the inaugural and valedictory functions.

1.11 *Krishi Vigyan Kendras* (KVKs) in North East Region conduct NFDB sponsored Skill Development Programmes

The ***Krishi Vigyan Kendras*** (KVKs), functioning under Agricultural Technology Application Research Institute (ICAR-ATARI), Zone-III, in the North East Region, conducted various Skill Development Programmes that were sponsored by NFDB, Hyderabad. In all, 52 Skill Development Programmes (comprising of class-room lecture, on-farm demonstrations and field/ exposure visits) were conducted through 25 KVKs where Subject Matter Specialist (SMS) in Fisheries were available. Each KVK undertook two programmes of 3 to 5-day duration, with 25-30 participants in each. NFDB released Rs. 24.17 lakh for the 52 programmes through the Director, ICAR-ATARI, Zone-III. Eighteen KVKs have completed the two training programmes and submitted reports; some have done one, while those at the remaining KVKs are under progress.

(1) KVK, AAU, Kahikuchi, Kamrup district, Assam: "Integrated farming systems", 26-30 February 2016; and "Composite fish farming system", 09-11 February 2017. A Training Manual on Fish Farming was distributed to the trainees. Shri Parag Sarma, SMS Fisheries, was course coordinator.

Participants at KVK, Kamrup and demonstration of application of potassium permanganate in fish pond at Amranga Govt. Farm

(2) KVK, Karimganj, Assam: 'Integrated Fish Farming Systems', 25-29 January 2017; and 'Integrated Fish Farming Systems', 21-23 February 2017. Dr. Ranjit Bordoloi, SMS Fisheries, was course coordinator.

Participants at KVK Karimganj and demonstration of liming in integrated horticulture-pig-fish ponds

(3) KVK, Udalguri, Assam: "Community Tank Management for Enhanced Fish Production", 19-21 January 2017; and "Integrated Fish Livestock Farming" 13-17 February 2017. Shri Pabitra Saharia, SMS Fisheries, was course coordinator. Field visit was made to Sonali Fish Seed Farm located at Bhergaon.

Shri A. K. Das, SE (Tech), NFDB Regional Centre, Guwahati delivering a lecture to participants at KVK Udalguri and participants on a visit to a fish farm

(4) KVK, Nagaon, Assam: "Composite Fish Farming", 24-28 January 2017; and "Integrated Fish Livestock Farming", 15-19 February 2017. Shri Dhiren Nath, SMS Fisheries, was course coordinator. Field visit to a local fish farm was arranged.

Dr. A K Chakraborty, Director of Research (Vety), AAU, Khanapar, Guwahati addressing participants at KVK Nagaon and practicals during a local field visit

(5) KVK, Dhubri, Assam: "Integrated Fish Farming Systems", 22-26 February 2017, exposure visits to Satrasal Maa Carp Hatchery and Fish Farm, Satrasal and to the Fish Farm of Shri Dhrubajyoti Baruah (National award winning farmer) at Kachakhana were arranged.

Trainees on a field visit to Satrasal Maa Hatchery and Fish Farm at Satrasal

The second programme was on "Value Added Fish Products", 21-25 March 2017, demonstration and hands on training on preparation of various value added fishery products imparted to farm women participants. Shri A. Paul, SMS Fishery Science, was course coordinator; programmes were held at Kalita Bhawan, Bilasipara, Dhubri.

Shri A Paul, SMS Fisheries, with the participants sun drying the fish papads prepared by them during the training

(6) KVK, Kokrajhar, Assam: "Integrated Fish Farming Systems", 1-6 March, 2017, practical demonstration on different aspects of pond management, animal husbandry as well as paddy-fish, fish-cum-horticulture systems, etc were given during the training.

Participants on a field visit to an Integrated Fish-cum-Horticulture Farm (above) and at Shri Hemanta Narzary's Fish Farm (below) in Kokrajhar district, Assam

The second programme was on "Composite Fish Farming", 20-24 March 2017. A local field visit and practical demonstration on different aspects of pond management was also carried out at the fish farm of Shri Hemanta Narzary, a progressive fish farmer from Garuphela village, Gossaigaon in Kokrajhar district. Shri A. Rajbangshi, SMS Fishery Science, was course coordinator.

(7) KVK, Nalbari, Assam: "Integrated Fishery Based Farming Systems", 26-30 December 2017; and the second programme was on "Air-breathing fish breeding and rearing with special reference to Magur, Kawai and Singhi", 08-10 March 2017. Nalbari is one of the promising district of Assam where some farmers have already started commercial seed production and culture of some air breathing fishes especially Magur (*Clarias batrachus*) and Koi (*Anabas testudineus*). A field visit to a local fish farm and Magur hatchery, in Nalbari district was arranged. Shri Sonmoina Bhuyan, SMS Fishery, was course coordinator.

Participants at the Farm Science Centre of ICAR-KVK, Nalbari, Assam

(8) KVK, East Siang, Arunachal Pradesh: "Integrated Farming Approaches for Livelihood and Nutritional Security", 3-5 January 2017, at College of Horticulture and Forestry, Central Agriculture University (CAU), Pasighat, Arunachal Pradesh. Dr. Ajal Kumar Pandey, Dean, Dr. B.N. Hazarika, Professor and Dr. Pranab Sharma, Assoc. Professor shared their views and experiences on Integrated Farming Systems prevalent in Arunachal Pradesh; participants were taken to an Integrated Farm of a successful farmer situated at Amritpur village, Dhemaji district, Assam. The second programme was on "Recent advances in aquaculture for increasing fish productivity through polyculture system", 13-17 February 2017; participants were taken to a nearby fish farm and carp hatchery in Dhemaji district of Assam. Shri S.M. Hussain, SMS Fisheries, coordinated the programmes.

Participants in a theory class (above) at KVK, College of Horticulture and Forestry, CAU, Pasighat, Arunachal Pradesh and on a local field visit (below) to a fish farm in Dhemaji district of Assam

(9) KVK, East Kameng, Arunachal Pradesh: "Composite Fish Culture", 16-22 February 2017; and "Integrated Fish Farming", 06-10 March 2017, at the KVK, Dept. of Agriculture, Govt. of Arunachal Pradesh, East Kameng district. A field visit was arranged to a local fish farm. Dr. Magen Modi, District Veterinary Officer, was one of the resource persons and Shri Satyendra Kumar, SMS Fishery, was course coordinator.

Participants on field visit to a local fish farm in East Kameng district, Arunachal Pradesh

(10) KVK, Anjaw, Arunachal Pradesh: "Cold Water Fish Culture: An Innovative Approach for Sustainable Development in Hill Area of Anjaw District, Arunachal Pradesh", 6-8 March 2017 at KVK, ICAR-RC for NEH, Anjaw, Arunachal Pradesh; farmers, farm women and rural youth participated. Major Ravindra Kumar of Army Camp, Hayuliang, grace the valedictory function as Chief Guest and distributed the certificate to the participants. Shri Prasanta Mahanta was Course Coordinator.

Participants with resource persons (above) and Major Ravindra Kumar of the Army Camp, Hayuliang, distributes Certificates (below) at the KVK, ICAR-RC for NEH Region, Anjaw, Arunachal Pradesh

(11) KVK, Upper Siang, Arunachal Pradesh: "Composite Fish Farming", 17-21 February 2017; apart from class room sessions, trainees were taken to the fish

Participants on field visit to a local fish farm in Upper Siang district, Arunachal Pradesh

farms of Shri Oson Paron, Sikam, Geku town, Shri Kut Ejing, Sikka Dine village and Shri Kikkin Paron, Sumsing village, all in Upper Siang district, where practical demonstration on different aspects of pond management were conducted

(12) KVK, Jaintia Hills, Meghalaya: "Integrated Fish Farming Systems", 20-23 February 2017; second programme was on "Post harvest technology in fisheries", 27 February to 01 March 2017; both held at Farmer Training Hall, Rymphum, Jowai. The training methods adopted include Lecture cum Discussion, using Audio Visual Aids, Method Demonstration and local Field Visits.

Participants on a field visit (above) and demonstrations on preparation of value added fish product (below) at KVK, Jayantia Hills, Meghalaya

(13) KVK, East Khasi Hills, Meghalaya: "Composite Fish Farming", 14-16 December 2016; trainees were taken to Meghalaya State Fishery Research and Training Institute at Mawpui, Rebhoi district, for practical demonstration of different aspects of pond management. The second programme was on "Integrated Fish Farming Systems", 6-10 March 2017; a field visit to the ICAR-NEH, Umium, Barapani was arranged.

Participants on a field visit to Fishery Research and Training Institute at Mawpui, Rebhoi district (above) and at the Farm Science Centre of the KVK, East Khasi Hills (below), Meghalaya

(14) KVK, West Khasi Hills, Meghalaya: "Method of Freshwater Carp Culture in Hill Region", 16–20 January 2017; field visit to ICAR-RC NEH Region, Barapani, where practical demonstrations were conducted. The second programme was on "Integrated Fish Farming Systems", 23–28 January 2017; field visit to ICAR-RC NEH, Umium, Barapani, was arranged. Shri Rudolf Pakyntein, SMS Fisheries, was course coordinator.

Participants on field visits to ICAR-RC NEH, Umium, Barapani, Meghalaya

(15) KVK, Senapati, Manipur: "Integrated Fish Farming Systems", 20-23 February 2017; the second programme was on "Composite Fish Culture", 22-25 March 2017; Dr. M. Bedajit Singh, Deputy Director (Instruction), Central Agril. University, Imphal, Shri L. Lilakumar, Fishery Officer, MASTEC, Imphal, Shri Th. Kiran Singh, DDM, NABARD, Senapati district and Th. Monica, Project Asst. (ARYA Project) were the resource persons; local field visit was arranged. Dr. N. Jyotsna, was Programme Coordinator.

Participants with resource persons at the KVK (above) and demonstration during field visit to a fish farm (below) in Senapati district, Manipur

(16) KVK, Andro, Imphal East, Manipur "Community Tank Management for Enhancing Fish Production", 11-15 March 2017; second programme was on "Freshwater Carp Culture - an Innovative Approach", 16-20 March 2017; both at Jiribam, Manipur. A local field visit to the fish farm of Shri Hemanta Singh, Dibang was undertaken. Shri A. Salam, SMS (Fisheries) was course coordinator.

Participants in a theory class at KVK, Andro, Imphal East district, Manipur

(17) KVK, West Tripura: "Composite Fish Farming", 6-9 December 2016; second programme was on "Integrated Fish Farming", 14-17 December 2016; rural youth and farmer from Teliamura Block, Padmabil Block, Tulashikar Block, Khowai Block under Khowai district, and from Kamalpur Block under Dhalai district participated. Dr. Pradyot Biswas, Asst. Professor, College of Fisheries, CAU, Lembucherra, Tripura, was the resource person. The practical sessions on pig-cum- fish, duck-cum-fish, poultry-cum-fish and horticulture based fish farming systems was conducted at the KVK demonstration unit. Exposure visit was made to a progressive farmer's ponds. Shri Subrata Choudhury, Programme Assistant Fishery, was course coordinator.

Demonstration of water analysis to the participants in the lab at KVK (above) and demonstration of plankton at the pond site during a field visit (below)

(18) KVK, North Tripura: "Composite Fish Farming", 08-12 March 2017; at West Chandrapur, Dharmanagar, North Tripura. The trainees were taken to the fish Farm of Shri Ardhendu Nath, a private entrepreneur and progressive farmer from Deocherra area of North Tripura, where the trainees practically witnessed different integrated fish culture systems like Pig-cum-fish culture, Poultry-cum-fish culture, Horticulture-cum-fish, etc. Shri B. Bal, SMS, coordinated the programme.

Participants on a one-day exposure visit and interaction with Shri Ardhendu Nath, a progressive fish farmerin North Tripura

2. Farmers' Note Book

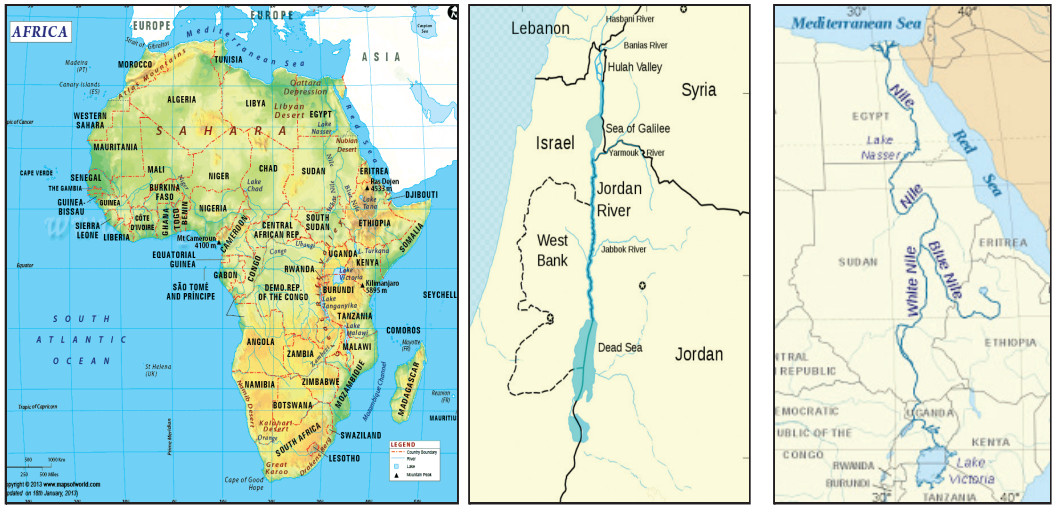
2.1 Tilapias – the most amenable fishes Introduced and Farmed Worldwide*

In this Chapter, in the previous seven Issues, under the theme 'Lesser Known Freshwater Fish with Good Economic Potential', general information on the Striped Murrel *Channa striata* (Bloch, 1793), the Spiny Eel *Mastacembelus armatus* (Lacepède, 1800), Climbing Perch *Anabas testudineus* (Bloch, 1792), Mola Carplet *Amblypharyngodon mola* (Hamilton, 1822), Desi Magur/ Walking Catfish *Clarias batrachus* (Linnaeus, 1758), Asian Seabass *Lates calcarifer* (Bloch, 1790) and the Giant Gourami *Osphronemus goramy* Lacepède, 1801, was provided.

In the present issue general information and less known facts about **Tilapias** are presented. Some 100 species of fishes belonging to the Order Perciformes and Family Cichlidae are collectively referred to as **Tilapias**. Tilapia species that contribute significantly to fisheries and aquaculture production belong to the genera *Oreochromis, Sarotherodon and Tilapia*. The Nile Tilapia *Oreochromis niloticus* (Linnaeus, 1758), the Genetically Improved Farmed Tilapia (GIFT) strain of *Oreochromis niloticus*, their hybrids and strains, that were developed and introduced worldwide including India, the Mozambique Tilapia *Oreochromis mossambicus* (W.K.H. Peters, 1852), besides some general aspects of the species of other two genera, *viz., Sarotherodon and Tilapia* are dealt with in this article.

Native Range of Tilapias

Tilapias are native to Africa and the Levant (Eastern Mediterranean countries). They were fished for thousands of years since Biblical times from the 'Sea of Galilee' a large freshwater lake (= Lake Galilee/ Lake Tiberias/ Lake Kinneret/ Lake Gennesaret, 166.7 km^2 in extent) situated in northeast Israel, the fishery comprising mostly of the fish now known as *Sarotherodon galilaeus* (Linnaeus, 1758). Nile Tilapia *Oreochromis niloticus* (Linnaeus, 1758) is native to the Nile River (6,800 km long) and its associated lakes – Lake Victoria, Lake Albert, Lake Kyoga, Lake Rudolph, etc., which feed the White Nile and Lake Tana that feeds the Blue Nile. The Nile River basin passes through 10 countries in the African Continent and the Nile Delta opens into the Mediterranean Sea off Cairo, Egypt. The Mozambique Tilapia O*reochromis mossambicus* (W.K.H. Peters, 1852) is native to (i) Zambezi River and associated Lake Kariba and Lake Cabora Bassa in Zambia, Zimbabwe and Mozambique, (ii) Lake Tanganyika and Lake Malawi/Nyasa in Tanzania, Malawi and Mozambique and (iii) the Bushman River and Kariega River in South Africa which drain into the Mozambique Channel and the Indian Ocean. Species belonging to the genera *Tilapia* and *Sarotherodon* are native to the Congo, Niger, Volta and Senegal Rivers and Lake Chad and Lake Volta basins in Central and West African countries.



*Africa Continent the home to most Tilapias (left); the native habitat of **Sarotherodon galilaeus**: Sea of Galilee (=Lake Tiberias) along Jordan River in Israel, (middle); and the native habitat of Nile Tilapia **Oreochromis niloticus**: the White and Blue Nile Rivers and associated lakes in Northeast Africa (right) [Maps Courtesy of the Wikipedia.org and Wikimedia.org]*

Compiled by: Dr. K. Ravindranath, Senior Consultant (Technical), National Fisheries Development Board, Hyderabad – 500 052. [Email: krnath.nfdb@rediffmail.com]

*Maps showing the native habitats of **Oreochromis mossambicus**: Zambezi River, Victoria Falls, Lake Kriba and Lake Cabora Bassa along its course, and Lake Malawi/ Nyasa in Southeast African countries (above) and the Bushman River and Kariega River in South Africa (below) [Maps Courtesy of the Wikipedia.org and Wikimedia.org]*

*St. Peter's Fish or the Mango Tilapia, **Sarotherodon galilaeus** (Linnaeus, 1758), native to Central Africa and West Asia (Israel, Syria, Jordan) [Photo by Dr. David Darom, Courtesy of Dr. Daniel Golani, www.fishbase.org]*

*Nile Tilapia, **Oreochromis niloticus** (Linnaeus, 1758) with typical vertical stripes [Photo by David Hodges, ICLARM Report; Courtesy: WorldFish Centre]*

*The Mozambique Tilapia, **Oreochromis mossambicus** (W.K.H. Peters, 1852), native to South-East Africa [Photo by Greg Hume – Own Work, Courtesy: Wikipedia.org]*

Oreochromis niloticus (Linnaeus, 1758)

Common Name

Nile Tilapia, St. Peter's Fish

Vernacular Names (common to all species)

English:	Tilapia
Tamil:	Tilapia, Cumeriyavil, Jilebi, Kari, Kendai, Neyyi
Telugu:	Tilapi, Jilebi,
All other States:	Tilapi

Description

In Nile Tilapia (*Oreochromis niloticus*) body laterally compressed, deep, caudal peduncle length and depth equal; scales cycloid, lateral line with a break towards the end and starting again two to three scales below; mouth protrusible with wide gape, lips swollen and jaws with minute teeth; Dorsal fin long and continuous, spiny portion with 15-18 spines, soft portion with 11-13 rays; Anal fin with 3 spines preceding 9-11 soft rays; Caudal fin truncated. Body colour variable, typically greyish-black, darker above and paler along belly, with characteristic vertical stripes throughout depth of body extending up to the caudal fin. Sexual dimorphism and dichromatism is most pronounced in mature fish during spawning season; males are larger than females and exhibit conspicuous breeding colours: typically, lower part of head and body, Dorsal, Pectoral and Caudal fin margins become reddish; Anal fin in males is more pointed while it is rounded in females.

In areas co-inhabited by other *Oreochromis* species, there is interspecific hybridization leading to considerable overlap in meristic and morphometric characters that makes it difficult to distinguish species morphologically (Trewavas, 1983). The more widespread and ubiquitous Mozambique Tilapia *Oreochromis mossambicus* (W.K.H. Peters, 1852) could be distinguished from Nile Tilapia by the absence of regular vertical stripes, and instead, juveniles, females and non-breeding males of *O. mossambicus* typically display 2-5 mid-lateral black blotches while the breeding males are black in colour with yellow pigmentation in the throat region.

Habit & Habitat

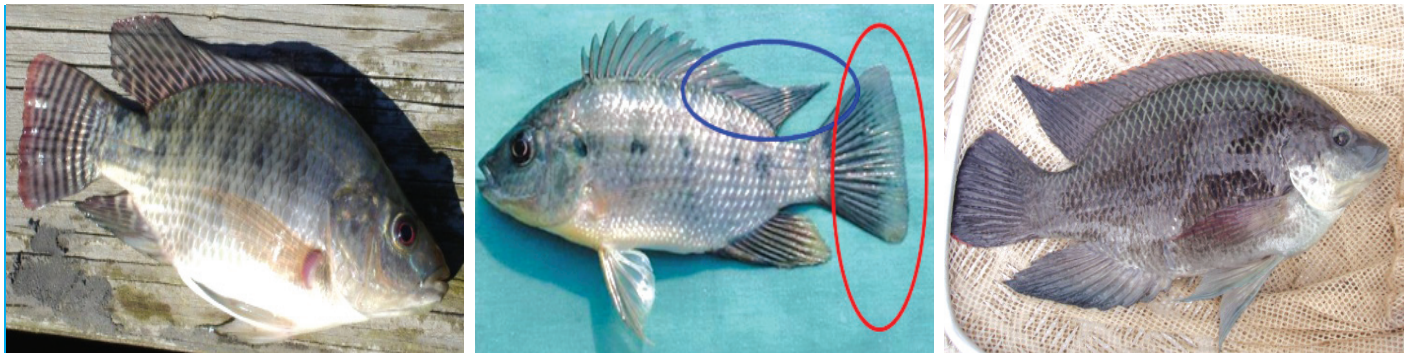
The Nile Tilapia (*Oreochromis niloticus*) thrives in freshwaters: inhabits rivers/streams, lakes/ponds, swamps/stagnant water bodies that may be weed infested, and enters flooded plains; it can tolerate up to 15 ppt brackish water. Being a tropical fish, prefers waters having 31-36^{o} C, but can survive water temperatures 10-42^{o} C; however, below 22^{o} C growth is curtailed and become susceptible to disease. The presence of labyrinthiform organ enables them to survive in waters with low oxygen content, facilitates aerial respiration, breathe moist air and remain alive out of water for long periods. In contrast, the Mozambique Tilapia (*Oreochromis mossambicus*) tolerates full strength seawater.

Food & Feeding

Tilapias in general are omnivores, can survive on a variety of food organisms, including phytoplankton, zooplankton, insects, algae, aquatic plants, etc. They also accept formulated pellet feeds. Nile Tilapia has been found to also feed on mosquito larvae. Farmed Mozambique Tilapias are known to learn to feed themselves by using demand feeders.

Size & Weight

Nile tilapia (*Oreochromis niloticus*) weighing 6.0 kg was recorded from Kariba Reservoir in Zimbabwe, and a 2.8 kg fish measuring 53 cm was recorded from Kaptai Lake in Bangladesh. Fish weighing 2.0 kg are frequently captured from the wild in their native range. Farmed Nile Tilapia often attains 200-250 grams in 4-5 months to 500-700 grams in 8-9 months in fertilized ponds. The improved strains of Nile Tilapia attain 750-800 grams in 6 months when fed in



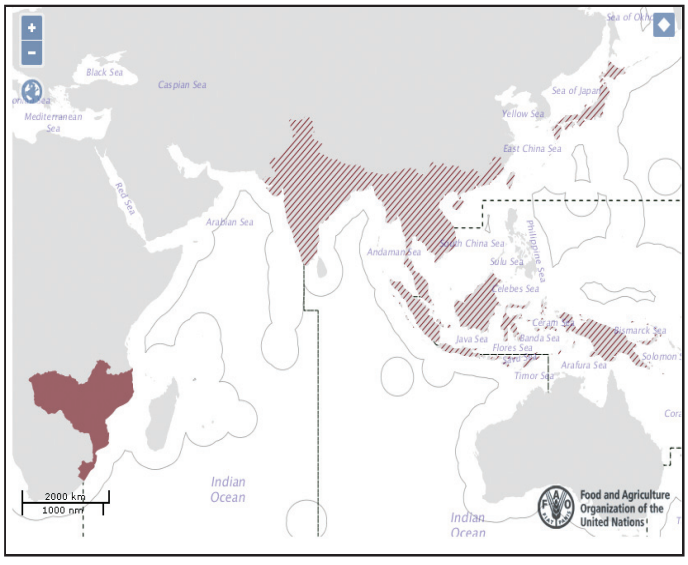
Oreochromis niloticus *(left) showing characteristic vertical stripes on the body and especially on caudal fin [Photo Credit: Pam Fuller, Courtesy: United States Geological Survey] and* ***Oreochromis mossambicus*** *showing the mid-lateral black blotches in juvenile (middle) and none in adult (right) [Photos Credit: Dept. of Agriculture, Fisheries and Forestry, Queensland, Australia]*

ponds/cages. The fish can live up to 10 years and attain 60 cm length.

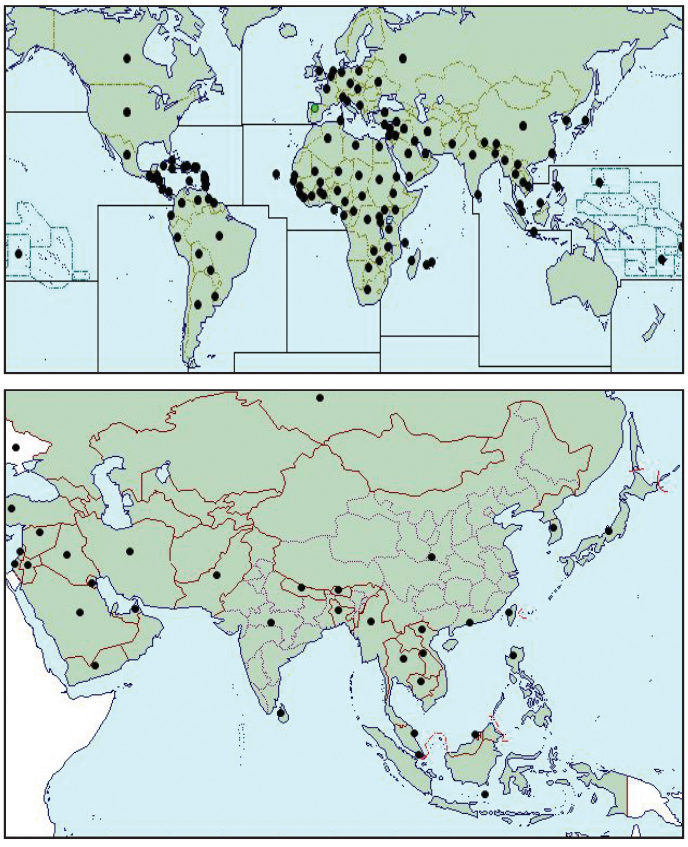
Distribution & Introductions

The Nile Tilapia is essentially a freshwater fish, native to Nile River basin and associated lakes in Northeast Africa, the Niger River and Senegal River basins, Lake Chad and Lake Volta in West Africa, and also the coastal rivers of Israel.

Tilapias are one of the most widely introduced fishes globally, although they (especially the ***Mozambique Tilapia*** introduced during 1940-1950) later acquired the dubious distinction as the most invasive pest fishes on account of their ability to adapt to various environmental conditions, breed prolifically, compete with and even displace endemic species. The IUCN included Tilapia in the list of 100 of the 'World's Worst Alien Invasive Species'. However, for farming purpose ***Nile Tilapia*** the more desirable species was introduced (during 1960-1980) worldwide – Brazil, United States, Canada, Ecuador, Columbia, Bolivia, Peru, Guyana, Jamaica, United Kingdom, Germany, Saudi Arabia, Japan, Thailand, Philippines, Vietnam, China, Taiwan, Indonesia, Bangladesh, India, Pakistan, etc.



Geographical distribution of Mozambique Tilapia ***Oreochromis mossambicus*** *(W.K.H. Peters, 1852), native range in Southeast Africa shown solid and introduced range in Asia shown hatched [Source: FAO Species Fact Sheets]*



Geographical distribution of Nile Tilapia ***Oreochromis niloticus*** *(Linnaeus, 1758) introduced in different countries worldwide (above) and in Asia (below) [Source: Centre for Agriculture and Bioscience International (CABI) – Invasive Species Compendium; Courtesy of Kevin Fitzsimmons, University of Arizona, USA and Tsungai Zengeya, Univeristy of Pretoria, South Africa]*

Commercially Important Tilapias

The Nile Tilapia *Oreochromis niloticus* (Linnaeus, 1758), Mozambique Tilapia *Oreochromis mossambicus* (W.K.H. Peters, 1852), Blue Tilapia *Oreochromis aureus* (Steindachner, 1864) and Redbreast Tilapia *Tilapia rendalli* (Boulenger, 1897) are some of the important commercially farmed species. However, currently (i) a number of faster growing 'Genetically Improved Strains' of Nile Tilapia derived through selective breeding techniques (GIFT), (ii) hormonally sex reversed All-male Tilapias, (iii) Genetically All-male Hybrid Tilapias (GMT) and (iv) Hybrid Red Tilapias produced from Genetic Mutants, are all being farmed extensively as well as intensively to meet the increasing global demand (See **Tables-1, 2, 3, and 4**).

GIFT Tilapia (All-male Nile Tilapia) (left) and nursing hapas held in a pond (right) at the RGCA-MPEDA Tilapia Farm, Manikonda village, Ungunturu Mandal, Krishna district, Andhra Pradesh [Source: http://www.rgca.org.in/tech_proj]

Table - 1. Commercially Important Species of Tilapias

Sl. No.	CommonName	Scientific Name	Author &Year	Native Range
1	Nile Tilapia	*Oreochromis niloticus*	(Linnaeus, 1758)	Egypt, Sudan, Uganda
2	St. Peter's Fish	*Sarotherodon galilaeus*	(Linnaeus, 1758)	Jordan, Israel,
3	Redbelly Tilapia	*Tilapia zillii*	(Gervais, 1848)	South Morocco, Sahara,
4	Mozambique Tilapia	*Oreochromis mossambicus*	(WKH Peters, 1852)	Mozambique, Zambia, South Africa
5	Blackchin Tilapia	*Sarotherodon melanotheron*	Ruppell, 1852	Mauritania to Cameroon
6	Blue Tilapia/ Israeli Tilapia/ Blue Kurper	*Oreochromis aureus*	(Steindachner, 1864)	Chad, Niger, Israel, Jordan
7	Sabaki Tilapia	*Oreochromis spilurus*	(Gunther, 1894)	Kenya
8	Redbreast Tilapia/ Congo Tilapia	*Tilapia rendalli*	(Boulenger, 1897)	Dem. Republic of Congo (Congo River)
9	Wami Tilapia	*Oreochromis urolepis urolepis*	(Norman, 1922)	Tanzania
10	Zanzibar Tilapia	*Oreochromis urolepis hornorum*	(Trewavas, 1966)	Zanzibar, Tanzania

Table - 2. Some of the 'Improved Strains' of Nile Tilapia *Oreochromis niloticus* (Linnaeus, 1758) Farmed Worldwide

Sl. No.	Name of the Strain / Lineage	Remarks/ Chief Traits/ Growth Rate (with reference to original stock)
1	**Nile Tilapia** (50 fish) gifted by The Emperor of Japan to the King of Thailand in 1965 which were held and bred at the '**Chitralada Palace**', Bangkok, Thailand	Founding stock of 120 fish introduced in 1962 in Japan from Nile River, Cairo, Egypt
2	**GIFT Strain**: WorldFish Centre, Philippines & Malaysia (1988-2001) (derived from wild Nile Tilapia from Egypt, Ghana, Kenya and Senegal, and farmed Nile Tilapia from Israel, Singapore, Taiwan and Thailand)	Growth 85% higher than founding populations of Nile Tilapia, through selective breeding methodology (based on original programme developed for Salmon and Trout in Norway in the 1970s)
3	**Chitralada Strain**: Nam Sai Farms, Thailand (acquired the fish in 1994 from the Asian Institute of Technology, Bangkok, Thailand) - CHI_1 and CHI_2 strains developed	Growth very fast up to 250g. In 6 months it attains 400g in fertilized ponds and 750g in fed ponds/cages
4	**GIFT, Thailand Strain**: Nam Sai Farms, Thailand (acquired 5th and 9th generation of GIFT-strain in 1997 and 2000, respectively, and developed into a single strain)	Growth as in Chitralada- strain. Disease resistance higher. Most widely cultured in Thailand.
5	**Big Nin Strain**: Nam Sai Farms, Thailand (acquired a GIFT-strain in 2004 from Philippines and developed it)	Attains 800g in 6 months in fed ponds/cages
6	**Nam Sai-2 Strain**: Nam Sai Farms, Thailand	F1 hybrid of GIFT x Big Nin; not used for breeding
7	**Abbassa Strain**: WorldFish Centre, Egypt (developed from native Nile Tilapia)	Growth 28% higher than the best commercial breed in Egypt
8	**Akosombo Strain**: WorldFish Centre & Water Research Institute (WRI), Ghana (developed from Nile Tilapia)	Improved productivity through a selective breeding program. Matures in five months
9	**King Abdul-Aziz Strain**: Science and Technology Fish Culture Project, Riyadh, Saudi Arabia	Year of introduction and origin of founding stock not known
10	**GIFU Strain**: Shangai Fisheries University, China (derived from 11th generation GIFT-strain)	Grows twice as fast as local commercial strain in China
11	**BFRI Super GIFT Strain**: Fisheries Research Institute, Bangladesh (developed during 2008-2012 through family selection)	Derived from 14th generation GIFT-strain, resulting in 39.25% higher individual growth
12	**FaST (FAC Selected Tilapia) Strain** [International Development Research Centre (IDRC), Canada and Freshwater Aquaculture Centre (FAC), Central Luzon State University, Philippines]	Product of 34 generations of within family selection among domesticated strains of Nile Tilapia from Israel, Singapore, Taiwan and Philippines
13	**GenoMar Supreme Tilapia (GST™) Strain**: GenoMar ASA, Norway/ Genomar Supreme, Philippines (derived from 9th generation GIFT-strain)	Genetically All-male (YY) strain, developed through DNA-typing and a revolving mating scheme
14	**Genetically Male Tilapia (GMT®)**: Fishgen Ltd, University of Wales, Swansea, UK	Androgenetic (YY) All-male strain produced by an unique (heat and pressure shock) Fishgen technology

15	**Stirling (All-male) Red Tilapia Strain**: University of Stirling, Stirling, UK (founder stock derived from Egypt)	Pure breeding All-male Strain produced by Androgenesis (YY)
16	**GOTT Strain / 'Tilapia Augusta'**: University of Gottingen, Germany	An unique selection line/strain yielding high proportion of males through sustainable temperature and other treatments
17	**Israeli ND-56 Red Tilapia Strain**: Nir David Fish Breeding Farms, Aquaculture Production Technology Ltd., Israel	Uniform red colour; hormonally sex reversed all-male strain. Tolerates up to 35 ppt salinity
18	**MPEDA (India)**: (i) **GIFT-strain** (10th generation from WorldFish Centre, Malaysia) and (ii) **Redline GMT®-strain** (from Fishgen, Swansea, UK)	46 families of G3 GIFT-strain developed and a fully pedigreed selective breeding programme in progress. All-male GIFT and GMT Red Tilapia seed produced

Red Tilapia

The name 'Red Tilapia' refers to several variants/strains of Tilapia, derived from selective breeding of mutants and hybrids, *viz.,* Taiwanese Red, Florida Red, Israeli Red, South African Red, Stirling Red, Jamaican Red, etc. (see **Table-3**). They have an attractive pink/orange/red body colouration unlike the greyish/black colour of normal Tilapias. Also, the membrane lining the body cavity inside (peritoneum) is pink/white unlike the black one in other tilapias. These features make Red Tilapia resemble some of the high-value marine fish such as Red Snapper (*Lutjanus sp.*) and fetches higher price especially in the USA. Therefore, Tilapia Farmers in Jamaica and Colombia have shifted from Nile Tilapia to Red Tilapia for export purpose. However, compared to the Nile Tilapia, growth-rate, survival-percentage and yield is relatively less in Red Tilapia. But, the higher market price it fetches offsets these drawbacks.

Fisheries & Aquaculture

Tilapias support subsistence fisheries in countries of their natural distribution as well as in their exotic habitats. Global annual production of Tilapias is about 5.0 million metric tons. The Tilapias, popularly referred to as "***aquatic chickens***", are a good source of protein and owing to moderate size, rapid growth and palatability they are being farmed worldwide. Tilapias are the third most widely farmed fishes, next to Carps and Salmon. The Nile Tilapia is well-suited for aquaculture because of its wide range of trophic and ecological adaptations, as well as its adaptive life-history characteristics that enable it to occupy many different tropical and sub-tropical freshwater niches (Trewavas, 1983). 98% of all farmed tilapia is grown outside its native habitat, in about 85 countries. Tilapias are being farmed in earthen ponds, cages installed in lakes and reservoirs, as well as in intensive Recirculation Aquaculture Systems (RAS) worldwide. To circumvent

*Monosex Nile Tilapia **Oreochromis niloticus** (Chitralada Strain) (left) and Red Tilapia (right) raised in NFDB funded intensive ponds of M/s Svara Biotechnovations, at Therku Pethampatti village, Madurai district, Tamil Nadu [Photo Credit: Above photos and photo of 'Tilapia Culture Pond' on cover page, Courtesy of Mr. S. Vaitheeswaran]*

Table - 3. Hybrid Red Tilapias Produced from Genetic Mutants (*All-Males produced by Hormonal Treatment*)

Sl. No.	Name of Hybrid	Cross Between	Chief Traits
1	Taiwanese Red Tilapia Hybrid (first reported Red Tilapia - 1960)	Mutant Reddish-Orange Female *Oreochromis mossambicus* X Normal Male *Oreochromis niloticus*	Tolerates higher salinities
2	Florida Red Tilapia Hybrid (1970) (Mzambique Tilapia X Zanzibar Tilapia)	Red-Gold Male *Oreochromis mossambicus* X Normal Female *Oreochromis hornorum*	Tolerates higher salinities
3	Israeli Red Tilapia Hybrid (Nile Tilapia X Blue Tilapia)	Red Female Nile Tilapia from Egypt *Oreochromis niloticus* X Wild-type Male Blue Tilapia from Israel *Oreochromis aureus*	Tolerates lower temperatures
4	South African 'Red-5' Strain of Mzambique Tilapia	Red *Oreochromis mossambicus* X Best-performing Normal *Oreochromis mossambicus* and Backcrossed with Red	The most salt-tolerant Red Tilapia
5	Israeli ND-56 Red Tilapia (Tetra-hybrid Strain)	Female *Oreochromis niloticus* ND-5 Family-line X Male *Oreochromis niloticus* ND-6 Family-line	Uniform red colour skin Salt tolerant
6	All-male Stirling Red Tilapia Strain (University of Stirling, UK)	Red Female *Oreochromis niloticus* from Egypt X Red Male *Oreochromis niloticus* from Egypt	Androgenetic (YY) All-Males

prolific breeding and stunted growth of mixed sex population in ponds, and as males grow faster and to a larger size, the 'All-male Tilapia' farming is being practiced worldwide.

Reproduction & Breeding

Tilapias are prolific breeders. They are classified as either '*mouth brooders'* or '*substrate spawners'*. The mouth brooders in turn are classified as maternal mouth brooder, paternal mouth brooders and bi-parental mouth brooders.

(i) Mouth Brooders:

Maternal mouth brooders: Among species belonging to the genus *Oreochromis*, *viz.,* Nile Tilapia (*O. niloticus*), Mozambique Tilapia (*O. mossambicus*) and Blue Tilapia (*O. aureus*) the female parent broods the eggs. Each breeding male sets up and defends a territory and excavates a basin-shaped spawning pit (nest) in the shallow sandy or muddy bottom. The male and female display courtship behavior; female lays eggs in the pit/nest and after fertilization by male, the female sucks the fertilized eggs (even unfertilized eggs and sperms) into the mouth (buccal cavity) and incubates up to 200 eggs for 12-14 days, until hatching.

Paternal mouth brooder: *In the case of Sarotherodon melanotheron* (Blackchin Tilapia), the male parent performs the mouth brooding while the female leaves the nest. ***Bi-parental mouth brooding:*** In the case of *Sarotherodon galilaeus* (St. Peter's Fish), both parents brood the eggs and defend the newly hatched fry.

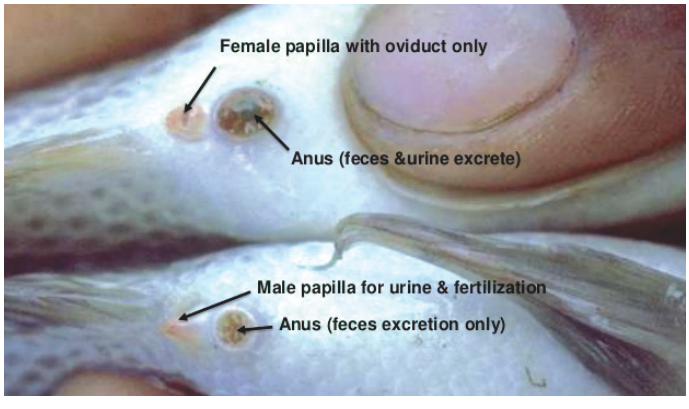
(ii) Substrate Spawners:

Species of the genus *Tilapia, viz.,* Redbreast Tilapia (*T. rendalli*) and Redbelly Tilapia (*T. zillii*) are substrate spawners: a male and female form a bonded mating pair, build a nest and defend it. After fertilization, both parents guard and aerate the eggs till hatching and chase away predators.

Spawning pits/ nests built by male Tilapias at the bottom of an earthen pond [Photo Credit: A.A. El Gamal, Courtesy of Fish Consulting Group]

Seed Production

Availability of quality fry/fingerlings of the desired species/ strain is one of the major constraints in the expansion of Tilapia farming. Differentiating the species/strains of Tilapia, early sexual maturation (4-5 months old), low fecundity, frequent spawning, stunted growth, territoriality and hierarchies among males, nest-building and mouth-brooding habits, etc., are some of the challenges in Tilapia seed production. Some of the advantages with Tilapias are: omnivorous feeding habit, sexual dimorphism, asynchronous breeding, no need for hormonal inducement, spawning throughout the year in the tropics and during the warmer months in the subtropics, and tolerance to handling and manipulation. In males the genital papilla (behind the anus) is pointed and has a common urino-genital opening, whereas in females it is flat and rounded having a horizontal slit-like genital opening (oviduct).



Sexual dimorphism in Tilapias: Note the difference in the shape and size of genital papilla and anus in the female (above) and the male (below) [Photo Credit Fish Base (2006), Courtesy of Tilapia Culture SlideShare,]

In Nile Tilapia sexual maturity begins at 5-6 months age; length at first maturity varies from 6.0-28.0 cm (average 18.6 cm). Fecundity of females varies from 300-1500 eggs/ fish. Nile Tilapia can be bred in earthen ponds, tanks, hapas and cages. In Vietnam, earthen ponds (1000-2000 sq m) are fertilized and after appearance of sufficient natural food, farm raised broodfish weighting 100 g each are introduced at the rate of about 1.0 kg/sq m, in the ratio of 2-8 females per male. Mass spawning occurs and fry are observed in about three weeks. Spent fish are netted out and over the next 10-30 days fingerlings of 6-14 g are harvested, graded and sold. Three to four such breeding cycle are undertaken in a year either with the same broodfish or new breeders. In Thailand, broodfish are mass spawned in large hapas (120 sq m; female-male ratio being 2:1). Fish are examined every 5 days; fertilized eggs and yolk-sac fry are collected from the mouths of females, transferred to hatching jars, trays and nursing tanks. In Egypt, broodfish are stocked in cement tanks (3 x 6 x 1 m) at the rate of 3 females: 1 male/ cu m. Hatchlings are collected and nursed in 150 L tanks. Hatcheries in East Africa source their Nile Tilapia broodfish from the African Great Lakes. It has been observed that 3-year old broodfish held at low stocking density of 4 fish/ sq m produced higher quantity and better quality fry that showed the best growth performance.

'All-male Tilapia' Seed Production

Sex reversal is the most common and widely adopted technique for the production of exclusively male Tilapia seed (to achieve higher growth rate and prevent uncontrolled breeding in ponds). Fry measuring less than 14 mm length are required for sex reversal as the gonads at this stage are undifferentiated. For this purpose, 3-7 day old fry produced at the breeding/hatching facilities are collected and segregated by passing through a 3.2 mm mesh. They are stocked in hapas or tanks at densities of 3000-4000/ sq m; fry are fed quality feed containing 40% protein; the feed during preparation is mixed with the male sex hormone (17 alpha methyl testosterone – MT) at a concentration of 60 mg MT/kg feed. The initial feeding rate is 20-30% body weight per day, which is gradually reduced to 10-20% by the end of the 3-4 week (21-28 day) sex-reversal period by when the fry attain 0.2-0.4 g weight. By this method of oral administration of MT to early fry, the undifferentiated gonads of the genetically-female fry degenerate, and 95-97% of the resulting fry are males.

Growout

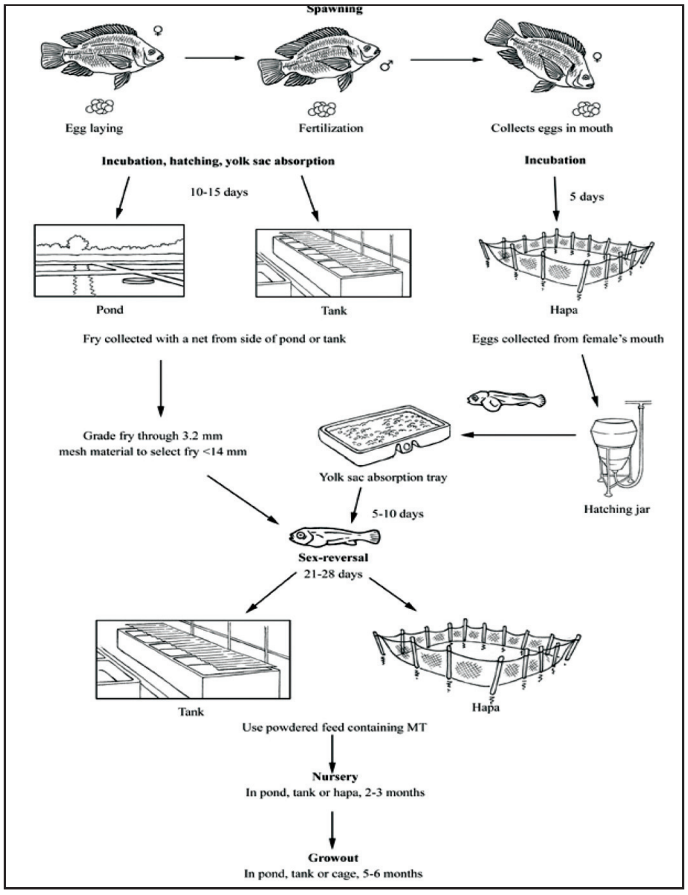
The All-male Tilapia fry are stocked in nursery ponds, tanks or hapas at a density of 20-25/ sq m, reared for 2-3 months to fingerlings weighing 30-40 g, and finally stocked in growout ponds or tanks at a density of 2-3/ sq m and cultured for 5-8 months to market size fish of about 500 g each. With pond fertilization and supplementary feeding, yields of 3-5 tonnes/ ha/ 5 months are obtained. In semi-intensive ponds, using quality feed, yields as high as 10 tonnes/ ha/ 5-8 months could be attained.

Nile Tilapia is cultured also in floating cages installed in lakes and reservoirs; cage mesh size is 1.9 cm or greater. In Brazil, cages of 4 cu m volume stocked at 200-300 fingerlings/ cu m yield 150 kg/ cu m, while cages of 100 cu m volume stocked at 25-50 fingerlings/ cu m yield 50 kg/ cu m. In Colombia, cages of 2.7 to 45 cu m volume are stocked with 30 g all-male fingerlings and raised to 150-300 g in 6-8 months; final density is 160-350 fish/ cu m yielding 76-116 kg/cu m.

Under Recirculation Aquaculture Systems (RAS) at a stocking density of 50 fingerlings/ cu m, Tilapia production levels of more than 10 kg/ cu m of rearing tank volume are attained in about 120 days. At higher stocking densities and intensive management, RAS yields could be as high as 60-120 kg/ cu m.

Organic Tilapia

If agriculture and aquaculture products are grown according USDA's National Organic Standards, such products are given the '***Organic Seal***'. According to EU Directive 96/ 22/EC (entry into force 23 May 1996), administering substances having androgenic or other actions to aquaculture animals and the holding of such animals on a farm or market for human consumption is prohibited. The demand for Organic Foods in the US and EU is increasing. Therefore, to meet the increasing demand in these niche markets, techniques have been developed to produce '***Organic Tilapia***' without the use of hormones for



Production Cycle of All Male Tilapia [Source: Cultured Aquatic Species Information Programme – Oreochromis niloticus (Linnaeus, 1758). FAO Fisheries and Aquaculture Department]

Table - 4. All-Male Tilapias Produced by Hybridization (*Without Hormonal Treatment*)

Sl.No.	Name of Hybrid	Cross Between	Chief Traits
1	All-Male Hybrid Tilapia	Male *Oreochromis hornorum* X Female *Oreochromis niloticus*	Genetically all-males. Grows well above 25°C water temp and spawns above 20°C temp
2	Israeli ND-21 Hybrid All Males	Female *Oreochromis niloticus* ND-2 Family-line X Male *Oreochromis aureus* ND-1 Family-line	Genetically all-males. Grows well even at 22-25°C water temp
3	Israeli ND-41 Hybrid All Males	Female *Oreochromis aureus* ND-4 Family-line X Male *Oreochromis aureus* ND-1 Family-line	Genetically all-males. Spawns even at 18-20°C water temp

production All-Male Tilapias through hybridization of selected species and family-lines. Examples include Genetically Male Tilapia (GMT®) and All-Male ND-21 and ND-41 Tilapia Strains developed by Fishgen Ltd., UK and APT Ltd., Israel, respectively (See **Table-4**).

Tilapia in Aquaponics

Aquaponics is an integrated fish and plant production system. Fish feed required to keep the system running is the major cost component. Tilapias with their omnivorous feeding habits are one of the most suitable fishes for Aquaponics. Among the Tilapias, the Redbreast Tilapia or Congo Tilapia, *Tilapia rendalli* (Boulenger, 1897), often referred to as herbivorous tilapia, has been found to be even more suitable. In Colombia, *Tilapia rendalli* has been reared in cages to commercial size by feeding leaves of a terrestrial macrophyte *Alocasia macrorrhizos* (L.) and other plants [www.fao.org/3/a-l5902e/l5902e06.htm]. In Johannesburg, South Africa, *Tilapia rendalli* is grown in an Aquaponics setup solely on lettuce or merely its off-cuts [Henri Pereira, http://www. myaquaponics.co.za/blog/aquaponics-miracle-fish-tilapia-rendalli/] and at the Aquaponics Africa Farm in Northern Natal, South Africa, *T. rendalli* is fed *Lemna* the duckweed and a wide range of plant products including banana and mulberry leaves, etc. [Ken Konschel, http://aquaponicsafrica.co.za/feed.html].

The Redbreast Tilapia *Tilapia rendalli* thrives in water temperatures above 22° C, ideal range being 28-32° C. It can grow to 400 grams in 6-8 months and to 1.0 kg in 12-18 months. In Aquaponic Systems it is usually harvested when 250-300 grams.

Known Diseases in Tilapia

Tilapias are generally considered hardy and resistant to diseases. However, the FAO document on Aquaculture of Nile Tilapia, *Oreochromis niloticus,* lists the following diseases: Bacterial Diseases - Motile Aeromonas Septicaemia, Vibriosis, Columnaris, Edwardsiellosis, Streptococcosis; Fungal Disease – Saprolegniosis; and Protozoan Diseases - Ciliates, Monogenetic Trematodes; which could be avoided by maintaining a high quality environment and reducing handling stress.

Emerging Disease – Tilapia Lake Virus (TiLV)

In 2009, wild Tilapia species in the Sea of Galilee (= Lake Tiberias or Lake Kinneret) and farmed Tilapia in commercial ponds in Israel suffered from unknown disease and the mortality rate was as high as 70%. Morbidity and mortality of wild fishes in the Lake was strikingly restricted to tilapine fishes (*Sarotherodon galilaeus, Tilapia zillii, Oreochromis aureus*), while other fishes were unaffected. A couple of years later Tilapia in commercial ponds in Ecuador also suffered mass mortality. The dead Tilapia in Israel showed disease signs in the brain and nervous system, whereas those in Ecuador showed disease signs in the liver. Samples from another outbreak in Ecuador in 2012 were investigated by Dr. W. Ian Lipkin, Columbia University, New York City, USA. Simultaneously, mortalities in Israel were investigated by Dr. Eran Bacharach, Tel Aviv

Redbreast Tilapia or Congo Tilapia, ***Tilapia rendalli*** *(Boulenger, 1897), an herbivorous fish suitable for rearing in Aquaponic System [Photo at Left, Credit: Nigel Triggs, Courtesy: Edson Rechi, Congo Tilapia, Aquarismo Paulista, São Paulo, Brazil; Photo at Right, Credit: Henri Pereira, Courtesy: http://www. myaquaponics.co.za]*

*Nile Tilapia that succumbed to **Tilapia Lake Virus (TiLV)**, in Ecuador (left) [Photo Credit: Hugh Ferguson, Courtesy: www.mailman.columbia.edu], in Israel (middle) [Photo Credit: Avi Eldar, Courtesy: https://phys.org/news/2016-04] and in Egypt (right) [Photo Credit: WorldFish, Egypt, Courtesy: http://www.tilapia-farming.com/2017/03/22]*

University and Dr. Avi Eldar, Kimron Veterinary Institute, Bet Dagan, Israel, etc.

Findings of the collaborative study by 18 researchers representing five institutions in four countries were published, by Prof. Eran Bacharach and 17 others, in a research paper entitled "***Characterization of a Novel Orthomyxo-like Virus causing Mass Die-Offs of Tilapia***" [on 5 April 2016 in **mBio**, Journal of The American Society for Microbiology]. They characterized the causative agent as a novel Orthomyxo-like Virus and named it ***Tilapia Lake Virus* (TiLV)**, an RNA virus that is very contagious and transmitted through water. Further, they described the complete genomic and protein sequences that would facilitate TiLV detection, containment and enable vaccine development.

Since 2015 Tilapia farms in Egypt have been experiencing the so-called "**Summer Mortality**" (syndrome). Epidemiological surveys indicated that 37% of fish farms were affected, with an average mortality rate of 9.2% and an estimated economic impact of around US$100 million/year. Prof. Manfred Weidmann, Institute of Aquaculture, University of Stirling, Scotland, UK, and Dr Michael Phillips, Director of Science and Aquaculture, WorldFish, Egypt, in a collaborative study tested tissue samples from seven Tilapia farms and found that three samples tested positive for Tilapia Lake Virus (TiLV). Focus is now on managing the disease and minimizing the impact. [News, 19 March 2017, http://www.stir.ac.uk/news/2017/03/egyptian-mortality-mystery-tilapia-fish/]

Tilapia Lake Virus Vaccine

Prof. Eran Bacharach (Dept. of Cell Research & Immunology, The George S. Wise Faculty of Life Sciences, Tel Aviv University, Tel Aviv, Israel) and Dr. Avi Eldar (Fish Diseases Laboratory, The Kimron Veterinary Institute, Bet Dagan, Israel) have invented a vaccine comprising of an attenuated strain of ***Tilapia Lake Virus* (TiLV)** for protecting Tilapine fishes from TiLV-induced disease. The vaccine has been **Patented** (Priority date: February 13, 2014, Publication date: December 8, 2016, and Publication Number: US20160354458 A1). [https://www.google. com/patents/US20160354458]. A series of tests consisting of vaccination, experimental infection with TiLV, disease reproduction, etc., using SPF Chitralada Tilapia *Oreochromis niloticus* were undertaken to test the efficacy of the **TiLV-vaccine**. Survival among vaccinated fish was 62-64% while in the control group it was 3%.

Nile Tilapia Genome Sequenced

Researchers at the Tropical Aquarium Facility, Institute of Aquaculture, University of Sirling, Scotland, UK, led by Prof. Brendan McAndrew and Dr. David Penman, have developed special lines of the Nile Tilapia (*Oreochromis niloticus*) that allowed production of Red Tilapia and All-Male Tilapia. Using DNA from one such special line of Nile Tilapia, they achieved a breakthrough in sequencing the complete genome. This is the first commercial aquaculture species to have its genome sequenced; the associated data are available to the scientific community worldwide [http://www.aqua.stir.ac.uk/]. The scientists hope that this discovery would facilitate identifying genes that affect traits such as growth, sex determination, disease resistance, etc., and to develop truly domesticated strains of Nile Tilapia.

Further Reading

Anonymous. *https://en.wikipedia.org/wiki/Nile_tilapia; http://www.fishbase.org/summary/2; http://www.iucngisd.org/gisd/species php?sc=1322*

Anonymous. Cultured Aquatic Species Information Programme – *Oreochromis niloticus* (Linnaeus, 1758). Fisheries and Aquaculture Department, FAO of the UN.

Chhorn E. Lim and Carl D. Webster (eds.), *Tilapia: Biology, Culture, and Nutrition*. Published by Food Products Press, An Imprint of the Haworth Press Inc, New York, London, Oxford (2006).

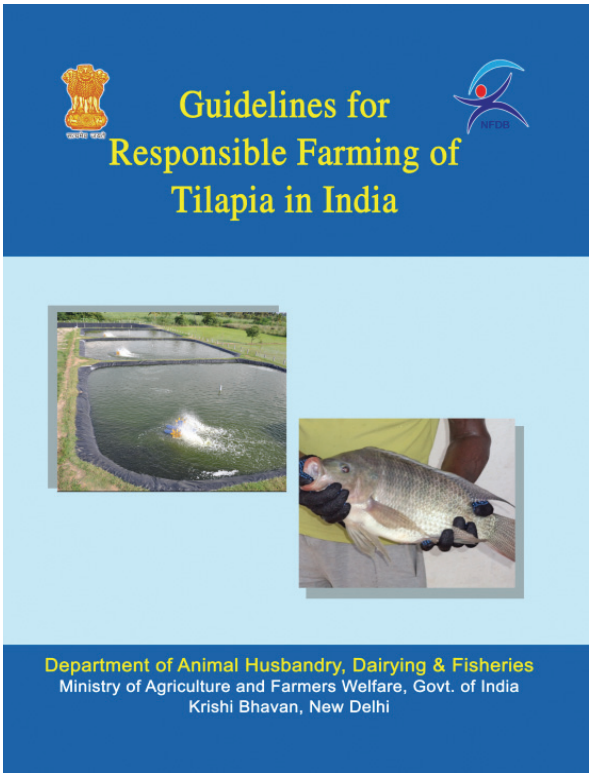
Leonard L. Lovshin, 2000. Criteria for Selecting Nile Tilapia and Red Tilapia for Culture. In K. Fitzsimmons and J. Carvalho Filho (eds.), *Tilapia Aquaculture in the 21st Century*. Fifth International Symposium on Tilapia Aquaculture. American Tilapia Association and Departamento de Pesca e Aqüicultura/Ministério da Agricultura e do Abastecimento, Rio de Janeiro, Brazil, pp. 49–57.

Ponzoni, R.W., James, J.W., Nguyen, N.H., Mekkawy, W., Khaw, H.L. *Strain Comparisons in Aquaculture Species: A Manual*. 2013-12, CGIAR.

R.S.V. Pullin and R.H. Lowe-McConnell (eds.), *The Biology and Culture of Tilapias*. ICLARM Conf. Proc. 7, 1982.

Trewavas, E., 1983. *Tilapiine fishes of the genera Sarotherodon, Oreochromis, and Danakilia*. Publication No. 898. British Museum of Natural History, London, UK.

WorldFish, 2015. Factsheet – Genetically Improved Farmed Tilapia (GIFT). www.worldfishcenter.org



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3. New/ Innovative Technologies in Fisheries

3.1 Anti-obesity Nutraceutical developed from Seaweeds by ICAR-CMFRI, Kochi, Kerala

An anti-obesity nutraceutical has been developed from seaweeds by scientists at Central Marine Fisheries Research Institute (ICAR-CMFRI), Kochi, Kerala. The product, named Cadalmin™ Antihypercholesterolemic extract (***Cadalmin™ ACe***), is a natural remedy for obesity and dyslipidemia. Seaweeds (macro algae) are known to contain bioactive compounds that possess medicinal properties. The above said product was extracted from seaweeds inhabiting the coastal waters of India. According to Dr Kajal Chakraborty, Senior Scientist in Marine Biotechnology Division of ICAR-CMFRI, who developed the product, the bioactive pharmacophore leads from seaweeds were used to prepare the nutraceutical product.

Cadalmin™ ACe can be administered to regulate clinical indicators leading to obesity: triglycerides, good (HDL) and bad (LDL) cholesterol, visceral fat, total adipose tissue and dyslipidemia. The product contains 100% natural marine bioactive ingredients obtained from selected seaweeds by a patented technology, and would be made available in 400 mg capsules. The nutraceutical does not have any side effects as established by detailed pre-clinical trials. According to Dr P Vijayagopal, Head, Marine Biotechnology Division, ICAR-CMFRI, active ingredients in the product will be packed in plant-based capsules to meet the dietary needs of the large vegetarian population in India and abroad.

Large scale extraction of the active principles from the raw material was optimized in a factory unit. The total yield of the active principles from the raw material was found to be greater than 20%, which demonstrated the commercial feasibility of the nutraceutical product. The product is being licensed to a pharmaceutical company for commercial production.

Shri Justice P. Sathasivam, Hon'ble Governor of Kerala, released the product during the inaugural ceremony of the Platinum Jubilee Celebrations of the ICAR-CMFRI at its Headquarters in Kochi on 18th February 2017.

Cadalmin™ Antihypercholesterolemic extract is the fourth in the series of the nutraceutical products developed by the ICAR-CMFRI. Two anti-arthritic and one anti-diabetic

Cadalmin™ Antihypercholesterolemic extract, an anti-obesity nutraceutical product from seaweeds, developed by ICAR-CMFRI, Kochi, Kerala

nutraceutical products are the other products developed by the institute in the past. All these technologies have been commercialized through pharmaceutical companies.

[Source: *http://www.cmfri.org.in/patents.html; ICAR-Central Marine Fisheries Research Institute, Kochi, Kerala*]

3.2 Hybrid Solar-Wind Powered Chilling Chamber and Dehydrator developed and installed at Fishing Harbour in Machilipatnam, Krishna district, Andhra Pradesh

With funding received under the 'Central Sector Scheme on Blue Revolution: Integrated Development and Management of Fisheries', from Dept. of Animal Husbandry, Dairying & Fisheries (DADF), Ministry of

Hybrid Solar-Wind Powered Chilling Chamber and Dehydrator installed at the Fishing Harbour in Machilipatnam, Krishna District, Andhra Pradesh.

Agriculture & Farmers Welfare (MoA&FW), Govt. of India, New Delhi, the Rural Technology Park of the National Institute of Rural Development (RTP-NIRD&PR), Rajendranagar, Hyderabad, in association with its technology partner M/s Teewave Technologies, Hyderabad, and through the Dept. of Fisheries, Govt. of Andhra Pradesh, have installed a 1.2 tonne ***Hybrid Solar-Wind Powered Chilling Chamber*** and a 250 kg ***Hybrid Solar-Wind Powered Dehydrator*** at the Fishing Harbour in Machilipatnam, Krishna District, Andhra Pradesh, at a total cost of Rs. 15.00 lakh.

The Hybrid Solar-Wind Powered Chilling Chamber has a capacity to store 1,200 kg of fresh fish at controlled temperature (+8 to–20° C). The system has a 3 kw solar panel, 650 w windmill, 4 kw solar inverter and an 800 ah battery bank. The 250 kg Hybrid Solar-Wind Powered Dehydrator is used for making dry fish at a faster rate under neat and hygienic conditions unlike in the time-taking traditional method of sun drying where fish are spread on the soil/platforms in the open resulting in contamination.

Subsequently, the Dept. of Fisheries, Govt. of Andhra Pradesh, have identified 9 more centers and submitted a revised project proposal for installation of higher capacity units, each with 3.0 tonne Hybrid Solar-Wind Chilling Chamber powered by 5 kw solar panels, 1.5 kw windmill and using solar-wind inverters with a grid-tied system. RTP-NIRD&PR and M/s Teewave Technologies have taken up the project and the process of installation and commissioning of the 9 units is under progress.

[Inputs from: *Shri PVSL Narasimham, M/s Teewave Technologies, Cherlapally, Hyderabad; http://www.teewave.co.in*]

4. NFDB Initiatives

4.1 Projects Implementation in Northern Zone States – First Review Meeting held at Panchkula, Haryana

The First Zonal Meeting to review implementation of projects in the six States in Northern Zone, *viz.,* Jammu & Kashmir, Himachal Pradesh, Punjab, Haryana, Uttarakhand, and Uttar Pradesh, was held on 10 February 2017 at Kissan Bhavan, Panchkula, Haryana, under the Chairmanship of Shri Aditya Kumar Joshi, Joint Secretary (Fisheries), Dept. of Animal Husbandry, Dairying & Fisheries (DADF), Ministry of Agriculture & Farmers Welfare, Govt. of India, & Chief Executive, NFDB, Hyderabad. Officials from the respective State Fisheries Dept., Ministry and NFDB participated.

With a view to double the production from Inland Fisheries Sector, Govt. of India launched the Central Sector Scheme (CSS) on Blue Revolution. The DADF is working towards National Fish Seed Action Plan and the 'Mission Fingerling' is a step in that direction. Budget to the States under Blue Revolution was allotted after discussion and arriving at consensus and funds have been released to all northern States. For proper utilization of funds, Zonal Meetings would be held periodically. NFDB officials would inspect the ongoing schemes and evaluate the completed schemes. Dr. Bimal Kinkar Chand, Executive Director (Tech–II), NFDB, made detailed presentation on the physical and financial status of the projects funded under Blue

First Northern Zonal Review Meeting held on 10 February 2017 at Panchkula, Haryana to review implementation of fisheries projects in States

First Eastern Zonal Meeting held on 16 March 2017 at CIFE Kolkata Centre, Salt Lake, Kolkata to review implementation of fisheries projects in States

Revolution Schemes and NFDB Schemes. This was followed by presentations from the States.

The State specific issues were discussed and deliberated. It was resolved that the States would: (i) refund all unspent amount by March 2017; (ii) submit part Utilization Certificate (UC), if any; (iii) submit progress report on monthly basis to Ministry/NFDB; (iv) J & K State to complete the unfinished work at the NFDB funded Wholesale Fish Market at Srinagar and make it functional immediately; and (v) get State share of the projects released and complete the projects in all respects by March 2017. The Joint Secretary (Fisheries), DADF, appealed to all States to finalize the SAPs/DPRs as per the format circulated and submit the same to NFDB/Ministry.

4.2 Projects Implementation in Eastern Zone States – First Review Meeting held at Kolkata, West Bengal

The First Zonal Meeting to review implementation of projects in the six States in Eastern Zone, *viz.,* Odisha, Jharkhand, Bihar, West Bengal and Andaman & Nicobar Islands was held on 16 March 2017 at CIFE Kolkata Centre, Salt Lake, Kolkata, under the Chairmanship of Shri Aditya Kumar Joshi, Joint Secretary (Fisheries), Dept. of Animal Husbandry, Dairying & Fisheries (DADF), Ministry of Agriculture & Farmers Welfare, Govt. of India, & Chief Executive, NFDB, Hyderabad. Officials from the respective State Fisheries Dept., Ministry and NFDB participated.

Shri Aditya Kumar Joshi, Joint Secretary, in his opening remarks recalled that doubling farmers' income is the aim of our Hon'ble Prime Minister and there is no better enterprise than fisheries to achieve this. Dr. Bimal Kinkar Chand, Executive Director (Tech–II), NFDB made detailed presentation on the physical and financial status of the projects funded to Eastern Zone States under Blue Revolution Schemes and NFDB Schemes, followed by presentations from the States.

The State specific issues were discussed and deliberated. It was resolved that the States would: (i) refund all unspent amount by March, 2017; (ii) submit pending UCs immediately; (iii) submit progress report on monthly basis to the Ministry/NFDB; (iv) ensure that NFDB funded Fish Markets are put to use immediately; (v) get respective State share released and complete the projects in all respect at the earliest; and (vi) finalize the SAPs/DPRs as per the format circulated by the Ministry/NFDB and submit the same to NFDB/Ministry at the earliest.

In view of the State of Andaman & Nicobar Islands not attending the review meeting the Joint Secretary called upon all States to attend review meeting without fail. He further observed that implementation of the NFDB funded Backyard Hatchery Units in WB was not up to the mark. Some of the beneficiaries were found not contributing their share. The implementing agencies were requested to keep close watch on such cases and ensure investment of 100% share by beneficiaries.

4.3 NFDB sponsored Training for Prospective Aquapreneurs conducted by MANAGE, Hyderabad

A 13-day Training Programme on 'Advances in Fisheries Technology and Extension Management for Fisheries Development', sponsored by NFDB was conducted by the

National Centre for Management of Agricultural Extension (MANAGE), from 16 to 28 January 2017 at Rajendranagar, Hyderabad. This is third in the series of training programmes funded by NFDB and is offered to the Agripreneurs who have undergone the 2-month business management training under ACABC–Scheme of the Govt. of India, to take up business in fisheries sector. Thirty participants from Maharashtra, Tamil Nadu, Telangana, Bihar, Jharkhand, Rajasthan, Uttar Pradesh and Karnataka States registered for the course. Dr. M.A. Kareem was the Course Director.

Participants of NFDB sponsored Training Programme for Aquapreneurs in one of the sessions at MANAGE, Hyderabad (above) and on an Exposure Visit to Bhimavaram, Andhra Pradesh (below)

The broad frame work of the training include Global and National Perspective of Fisheries Development, Private Partnership initiatives in Fisheries Development, Extension Approaches and Methods for Fisheries Extension; Advances in Technology and Business Opportunities in Fresh Water Aquaculture, Brackish Water Aquaculture, Mariculture and Ornamental fish culture; Integrated Fish Farming; Marketing Strategies to increase Fisheries Business; Export Oriented Schemes in Fisheries; Entrepreneurship Development in Fisheries; Business Orientation on Fisheries Services, ICT initiatives for Fisheries Development; Post-Harvest Technologies, Processing and Value Addition; Various development schemes initiated by NFDB; Technical, Financial and

Participants of NFDB sponsored Training Programme for Aquapreneurs interacting with Officers at NFDB, Hyderabad

Market feasibility of a Project and Interface with a Successful Entrepreneur.

Dr. R. Suresh, Sr. Consultant HRD, NFDB; Dr. P. Chandrashekara, Director (Agrl. Extension), MANAGE; Dr. Atul Kumar Jain, Director, OFTRI, Udaipur; Dr. Radheyshyam, Senior Consultant, NFDB; Dr. Ganesh Kumar, Principal Scientist NAARM, Rajendra Nagar; Dr. Rakesh Kumar, MPEDA, Bhimavaram, AP; Mrs. S. Glory Swarupa, Consultant, NFBD; Dr. Udairam Jothi, Managing Director, AA Bio-Tech, Chennai; Dr. Madhusudhan Rao, CIFT, Vishakhapatnam; Dr. Bimal Kinkar Chand, Executive Director, NFDB; experts from ICAR Fisheries Institutes CMFRI, Kochi, CIBA, Chennai and CIFA, Bhubaneswar, were also invited. Dr. M.A. Kareem and Dr. Shahaji Phand, MANAGE, also handled the sessions.

Local field visit to M/s Anjali Aquaponics, established by Shri Br. R. Vishwanadha Raju at Gunded Village, Shadnagar Mandal, Mahbubnagar district, Telangana, was organized. The participants were also taken on an Exposure Visit to Coastal Andhra Pradesh, where they visited M/s UNO Fish Feed Farm, KrishiVignan Kendra (KVK) & Fisheries Research Station, Fish and Prawn ponds, Hatcheries, all in Bhimavaram; Yanam Fish Market; State Institute of Fisheries Technology and Koringa Mangroves Forest. The participants interacted with women SHG groups at Uppada and Ameenabad villages to understand their livelihoods based on fisheries. The participants were encouraged to identify a suitable fisheries related activity and prepare a draft Bankable Project Report individually under the guidance of Dr. Kalyan Sundaram, AGM (Retd.) and made the presentation. On 25 January 2017 the trainees visited NFDB, and interacted with Officers on various aspects of fisheries development in the country, opportunities and schemes available for entrepreneurs in this sector.

4.4 NFDB sponsored Training Programme for Fisheries Extension Officers conducted by MANAGE, Hyderabad

A 6-day Induction Training Program for the newly recruited Fisheries Extension Officers on 'Extension Management Approaches for Fisheries Development', sponsored by NFDB was conducted by the National Centre for Management of Agricultural Extension (MANAGE), from 20 to 25 February 2017 at Rajendranagar, Hyderabad. Thirty one participants from the Dept. of Fisheries of Andhra Pradesh, Bihar, Chhattisgarh, Goa, Madhya Pradesh, Manipur, Odisha, Rajasthan and West Bengal registered for the training.

Dr. R. Suresh, Senior Consultant, NFDB; Dr. Anil Kumar Saxena, Retd. Professor, National Police Academy; Dr. J. Vasantha Kumar, Retd. Dean of Agriculture, Annamalai University, Tamil Nadu; Dr. Ganesh Kumar, Principal Scientist, NAARM; Dr. Kathiresan, Faculty, CDAC, Hyderabad and Dr. Karupanchetty, Director, ISBA, Hyderabad; Dr. Kareem, Deputy Director, Dr. Lakshmi Murthy, Deputy Director (Doc), Dr. B.K. Paty, Director (Marketing), and Dr. P. Chandrashekara, Director (Agri. Extn), from MANAGE, handled the training sessions.

Important topics covered are: An over view & Status of Fisheries Development in the Country – Issues &

Participants of NFDB sponsored Extension Training Programme on a visit to M/s Anjali Aquaponics Farm, Gundedu village, Mahbubnagar district, Telangana

Participants of NFDB sponsored Extension Training Programme on a visit to NFDB, Hyderabad

Challenges, Work Ethics & Soft Skills, Status of Fisheries Extension in the Country, Extension Approaches of NFDB in Promoting Fisheries Development, Alternate Extension Approaches to Promote Fisheries, Extension Reforms – Issues & Challenges, Process documentation of Extension Services, Integrated Extension Services through Farming Systems Approach and Farming Situation Based Extension, Strategies for Linking Farmers to Markets, Marketing

Strategies to increase Fisheries Business, Public Private Partnership – Initiatives in Fisheries, Role of ICT – Initiatives in Fisheries Development and Business Incubation for Fisheries Development.

Local field visit to M/s Anjali Aquaponics, established by Shri Bh. R. Vishwanadha Raju at Gunded Village, Shadnagar Mandal, Mahbubnagar district, Telangana, and an interactive session with Officers at NFDB were arranged.

4.5 National Consultative Workshop on Prospects of Shrimp Hatcheries and Farming held at NFDB, Hyderabad

A National Consultative Workshop on "Prospects of Shrimp Hatcheries and Farming Development in the Country with Special Reference to *L. vannamei* was held on 28th February 2017 at NFDB, Hyderabad. The meeting was chaired by Dr. Paul Pandian, Fisheries Development Commissioner, Govt. of India. Participants include Dr. R. Jayaraman, Director (Technical), Coastal Aquaculture Authority, Chennai; Dr. A. Panigrahi, Principal Scientist, ICAR-CIBA, Chennai; Dr. P. Ram Mohan Rao, Dept. of Fisheries, Govt. of Andhra Pradesh; members of Prawn Farmers Federation of India (PFFI) and All India Shrimp Hatchery Association (AISHA), and Officers of NFDB, Hyderabad. Issues pertaining to the problems and prospects of shrimp aquaculture development in the country with special reference to *Litopenaeus vannamei* (Boone, 1931) were presented by the stakeholders and deliberated.

*Participants at the National Consultative Workshop on Prospects of Shrimp Hatcheries and Farming Development in the Country with special reference to **L. vannamei** held at NFDB, Hyderabad*

4.6 Stakeholders Consultation Workshop on 'Development of Ornamental Fisheries' organized at NFDB, Hyderabad

A Stakeholders Consultation Workshop on 'Development of Ornamental Fisheries' was organized on 9th March 2017 at NFDB, Hyderabad. Shri Aditya Kumar Joshi, Joint Secretary (Fy), DADF & Chief Executive, NFDB, in his opening remark stated that the DADF envisages implementation of a 'Pilot Project on Ornamental Fisheries' through NFDB with a total outlay of Rs. 61.89 Crore. The proposed project focuses on integrated development of ornamental fisheries sector along with substantial improvement in the economic status of stakeholders. Shri L. Shankar, Jt. Commissioner (Fy), DADF also participated and spoke.

Dr. Utpal Kumar Sar, Executive Director (Tech.) while welcoming the participants explained the objective of the workshop: (i) to brief the States on the modalities of the Project, (ii) identify thrust areas and (iii) sensitize the States for successful implementation of the Project. Out of 12 States invited, officials and stakeholders from eight States, *i.e.*, Kerala, Karnataka, Tamil Nadu, Odisha, Maharashtra, Madhya Pradesh, Uttar Pradesh and Rajasthan participated.

Dr. Atul Kumar Jain, Director, Ornamental Fisheries Training and Research Institute (OFTRI), Udaipur, Rajasthan, made a presentation on conceptualization of the 'National Action Plan (NAP) on Development of Ornamental Fisheries'. The purpose of NAP is to suggest plan of action for employment generation, livelihood creation, augmentation of export and to encourage formation of cooperatives and SHG's in Ornamental Fisheries sector.

Shri Aditya Kumar Joshi, Joint Secretary (Fy), DADF & Chief Executive, other dignitaries, officials, stakeholders and participants at the workshop on Development of Ornamental Fisheries, organized at NFDB, Hyderabad

Dr. B K Chand, Executive Director, NFDB made a presentation on the Pilot Project. Fourteen Activities/ Schemes have been identified: *Freshwater Backyard Rearing Unit; Freshwater Medium Scale Rearing Unit; Freshwater Integrated Ornamental Fish Unit; Marine Backyard Rearing Unit; Marine Integrated Ornamental Fish Unit; Marine Demonstration Unit; Aquarium Fabrication cum Retail Unit; Establishment of Aquarium Units in Schools/ Colleges/ Govt. Offices; Capacity Building Programmes; Establishment of Ornamental Wholesale Market; Establishment of Freshwater Ornamental Fish Brood Bank; Promoting National/ International Aquaria Shows; Establishment of Public Aquariums; and Backyard Ornamental Aquatic Plant Unit.*

Tentative allocation of number of units amongst the State was also announced; the allocations are indicative and subject to receipt of appropriate proposals from the States. Dr. Chand emphasized on implementation framework and urged the States to initiate preparation of project proposals immediately, complete the same and to submit to NFDB at the earliest.

Presentations by representatives from each State were discussed and deliberated. Apart from Officials from the State Fisheries Departments, the following stakeholders shared their experience in the Ornamental Fisheries Sector: Shri Santosh Baby, Ornamental Fish Exporter from Kerala, Shri Ayyappa, Stakeholder from Karnataka, Shri Christopher, Stakeholder from Tamil Naidu, Shri Indramani Srivastava, Ornamental Fish Breeder & Trader from Uttar Pradesh, Shri Ravindra Upadhyay, Aquarium Fabricator from Rajasthan.

Dr. B K Chand summed up the deliberations of the workshop and requested all the States to cooperate in the successful implementation of the project. The workshop ended with the concluding remark from the Chair.

5. Important Events

5.1 NFDB Participates in '*Krishi Unnati Mela*' at IARI, Pusa, New Delhi

A 3-day '*Krishi Unnati Mela'* was organized by the Indian Council of Agriculture Research (ICAR) at IARI Campus, Pusa, New Delhi during 15-17 February 2017. Shri Radha Mohan Singh, Hon'ble Union Minister for Agriculture & Farmers Welfare, Govt. of India, inaugurated the fair. The inaugural function was also attended by Shri Sudarshan Bhagat, Hon'ble Union Minister of State for Agriculture & Farmers Welfare, Shri Devendra Chaudhry, Secretary DADF, and Dr. Trilochan Mohapatra, Secretary DARE & DG ICAR.

NFDB participated in '*Krishi Unnati Mela'* and put up a stall displaying information on various fisheries activities and schemes. M/s Teewave Technologies, Hyderabad, showcased NFDB sponsored models such as: Fish Meat & Bone Separator, Portable Eco-Hatchery, Solar Powered Ice-Block Maker, Deep-Freezer, Solar Technologies Display-Vehicle, etc. Dr. John Samuel, Consultant, Dr. Ajay Pandey, Consultant and Shri M. Ramesh, Junior Consultant, NFDB, participated and explained to the visitors about NFDB activities and schemes besides demonstrating the functioning of various models displayed at the stall. Literature on Schemes under *Neeli Kranti Mission*, copies

of *Matsya Bharat*, Cage Culture Guidelines and information on displayed models were distributed to farmers who visited the stall in large numbers. A group of 20 progressive farmers from Punjab accompanied by Officials of the Dept. of Fisheries, Govt. of Punjab visited NFDB stall to know more about the displayed models specially fish bone meat separator. The three aquariums installed at the stall were the 'centre of attraction' and many people visited to know more about Ornamental Fish Culture.

Visitors enquiring about various NFDB activities and schemes and farmers from Punjab inspecting models displayed in NFDB stall at Krishi Unnati Mela at IARI, Pusa, New Delhi

5.2 NFDB Participates in '*Gramodaya Mela*' in Chitrakoot, Madhya Pradesh

The '*Gramodaya Mela'* was organized by 'Deen Dayal Research Institute' in Chitrakoot, Satna district, Madhya Pradesh, during 24-27 February 2017 as part of celebrating the birth centenaries of great social reformers Shri Nanaji Deshmukh and Pandit Deendayal Upadhyaya. Dr. Ajay Pandey, Consultant, participated and put up the NFDB stall showcasing various fisheries activities and schemes under *Neeli Kranti Mission* launched by the Govt. of India.

The '*Gramodaya Mela'* was attended by several distinguished dignitaries including, Shri Kaptan Singh Solanki, Hon'ble Governor of Haryana, Shri Narendra Singh Tomar, Hon'ble Union Minister of Panchayati Raj, Rural Development, Drinking Water and Sanitation, Shri Giriraj Singh, Hon'ble Union Minister of State, Ministry of Micro, Small and Medium Enterprises, Shri Rajiv Pratap Rudy, Hon'ble Union Minister of State for Skill Development and Entrepreneurship, and Smt. Archana Chitnis, Hon'ble Minister of Women and Child Development, Govt. of M.P. A large number of peoples including farmers and entrepreneurs also visited the NFDB stall to know about the fisheries activities and schemes.

The Pavilion and NFDB Stall in the 'Gramodaya Mela' at Chitrakook, Satna district, Madhya Pradesh

5.3 Training on 'Shrimp Disease Diagnosis and Disease Surveillance' conducted by SIFT, Kakinada under NFDB sponsored NSPAAD Project

A three-day training programme on 'Shrimp Disease Diagnosis and Disease Surveillance' was conducted at the State Institute of Fisheries Technology (SIFT), Dept. of Fisheries, Kakinada, Andhra Pradesh, during 8-10 March 2017, under the "National Surveillance Programme on Aquatic Animal Diseases" (NSPAAD), a network project funded by NFDB to the National Bureau of Fish Genetic Resources (NBFGR), Lucknow.

The objective of training programme was to build capacities on collection of samples, disease diagnostic tools, disease surveillance and preparedness to tackle emerging shrimp diseases. Twenty eight participants (Aqua Field Technicians-4, Multipurpose Fisheries Extension Assistants-8 and Aquaculture PG Students-16) took part. On the first day, trainees were given an overview of different diseases in *L. vannamei* shrimp and diagnostic tools available. On the second day, trainees were taught tissue sample collection, preservation and fixation methods and also practical training in water analysis and microbiology

Training programme on 'Shrimp Disease Diagnosis and Disease Surveillance' conducted at SIFT, Kakinada, Andhra Pradesh, under NFDB sponsored NSPAAD project

laboratory techniques. On the third and final day, trainees were demonstrated PCR techniques and briefed about disease surveillance (both active and passive) with respect to emerging diseases such as Early Mortality Syndrome (EMS)/ Acute Hepatopancreatic Necrosis Disease (AHPND) and Infectious Myonecrosis Virus (IMNV).

Shri K. Sita Rama Raju, Principal, SIFT, monitored the training programme; Dr. P. Ram Mohan Rao, Principal Investigator and Dr. T. Vijaya Bharathi, Co-Principal Investigator of the NSPAAD Project from AP Fisheries Department, conducted the programme and two Senior Research Fellows provided the demo cum hands-on training. A training manual and certificate of participation were distributed to the trainees.

6 NFDB Field Notes

6.1 Secretary, Dept. of Animal Husbandry, Dairying and Fisheries, MoA&FW, Govt. of India visits National Freshwater Fish Brood Bank, Kausalyaganga, Bhubaneswar, Odisha

Shri Devendra Chaudhry, Secretary, Dept. of Animal Husbandry, Dairying & Fisheries (DADF), Ministry of Agriculture & Farmers Welfare (MoA&FW), Govt. of India, New Delhi, visited the National Freshwater Fish Brood Bank (NFFBB) facility of NFDB, Kausalyaganga, Bhubaneswar, Odisha, on 28 February 2017 to review the ongoing activities. He was accompanied by Shri L. Shankar, Joint Commissioner (Fy), Shri S.K. Rath, Asst. Commissioner (Fy), Govt. of India, Dr. Salim Sultan, Sr. Consultant (Fy), the Commissioner-cum-Secretary, Fisheries and ARD Dept., other Senior Officials of the Dept. of Fisheries, Govt. of Odisha, Scientists from ICAR-CIFA, Bhubaneswar, etc. Dr. B.K. Chand, Executive Director, NFDB, Hyderabad, welcomed Shri Devendra Chaudhry and other dignitaries.

Shri Subrat Dash, Senior Executive and O-i-C, briefed the Secretary about the layout of the NFFBB farm, captive brood stock available, current and proposed breeding programmes, quality fish seed production, fry and fingerling rearing activities, breeder seed disseminated to different States, etc. Shri Devendra Chaudhry, Secretary, DADF, went round the farm and was shown the brood stock and advanced fingerlings of Catla, Jayanit Rohu, Amur Carp, Minor Carp, Magur, etc. It was informed that with the available brood stock, 200 lakh (20 million) spawn could be produced, which would yield some 60 lakh (6 million) breeder seed for dissemination to States for further rearing into brood fish in their respective Brood Banks. It was also submitted that additional ponds, tanks and a Circular Hatchery were required to achieve optimum production.

Shri Devendra Chaudhry, Secretary, DADF, MoA&FW, Govt. of India, inspecting the farm facility, brood fish and fish seed at National Freshwater Fish Brood Bank of NFDB, at Kausalyaganga, Bhubaneswar, Odisha

6.2 NFDB team inspects works executed at three Fish Markets in Mysore, Karnataka

On 27 February 2017, Dr. Uptal Kumar Sar Executive Director (Tech), Shri G. Vijaya Lazarus, Executive Director (Infra) and Shri B.V. Balaji, Senior Executive (A&F) NFDB visited three fish markets in Mysore, Karnataka, to assess the progress of works for which NFDB provided financial assistance. They were accompanied by Shri Sunil Babu Assistant Executive Engineer, Smt. Jyothi Assistant Engineer, of the Mysore Municipal Corporation, besides the Deputy Director and other officials from Directorate of Fisheries, Karnataka.

(i) Wholesale cum Retail Fish Market, N.R. Mohalla, Mysore, Karnataka:

Surface hardening of premises is yet to be done; retail stalls are 40 and the wholesale stalls are 10, of size 5.0 m x 3.0 m; wholesale stalls lack raised platform; flooring of the passage and stall area are without antiskid tiles; internal drainages not covered with MS grill; effluent treatment plant (ETP) lacks filter media chamber; rain water harvesting structure is not executed; electrical work is going on; NFDB name and logo are to be prominently placed. The Corporation Engineers have agreed to take up the incomplete works.

Wholesale and retail stalls in fish market at N.R. Mohalla, Mysore, Karnataka

(ii) Retail Fish Market, Mandi Mohalla, Mysore, Karnataka:

The retail fish market has 24 stalls; water supply work is completed; internal drainage covered with MS grill; flooring not antiskid-type; rain water harvesting structure (RWHS) and ETP filter media chamber not taken up; Corporation Officials were advised to complete these components before handing over to the beneficiaries.

Front and inside view of the retail fish market at Mandi Mohalla, Mysore, Karnataka

(iii) Devaraja Fish Market, Mysore, Karnataka:

The retail fish market is constructed on the first floor of existing mutton market, has plinth are of 925 sq m, and 48 stalls; the original sanction is for two floors with ground floor of 16 retail stalls and first floor with 16 stalls for dry fish; total plinth area being 525 sq m. Staircase is too steep

and narrow; internal drainage not covered with MS grills; toilet block, RWHS, ETP not take up. The team interacted with fish vendors, 34 of them selling 3.0 to 3.5 tonnes of fish every day. Corporation engineers were advised to resolve the issues raised by the vendors and complete the works.

Staircase leading to retail fish market on the first floor and inside view of the Devaraja Fish Market, Mysore, Karnataka

6.3 NFDB and DADF funded projects launched in the States of Delhi and Haryana, inspected

Dr. Radheyshyam, Sr. Consultant (Fisheries) and Ms. Dorothy M.S, Executive Assistant (Technical), NFDB, Hyderabad visited the States of Delhi and Haryana during 14-21 March 2017 to inspect (A) Projects funded by NFDB during 2010-12 and implemented by the Delhi Agricultural Marketing Board (DAMB) and Dept. of Fisheries (DoF), Haryana, and (B) Projects funded during 2016-17 and those proposed for funding during 2017-18 by Dept. of Animal Husbandry, Dairying and Fisheries (DADF), Govt. of India, and implemented by DoF, Govt. of Haryana.

(A) NFDB Funded Projects in Delhi and Haryana:

(i) 'Modernization of Wholesale Fish Market at Gazipur, Delhi': NFDB released Rs. 202.50 lakh during 2010-11 and 2011-12 out of which an unspent balance of Rs. 17.00 lakh is remaining with the State till date. The matter was discussed with Ms. Shakshi Mital, Vice Chairman, Delhi Agricultural Marketing Board (DAMB), Govt. of NCT Delhi at Janakpuri, New Delhi, who instructed the concerned officials to submit UC in case funds are utilized or to refund if not utilized. The "Delhi Fish Poultry and Egg Marketing Complex, Gazipur", biggest wholesale fish market in Delhi, is spread over 6.0 ha, has 252 shops of which 238 shops were allotted to fish commission agents with valid licence. A portion of the fish market was constructed with NFDB assistance, however NFDB name board with logo is lacking.

The market receives around 43,040 to 58,873 tonnes of fish from different States: Andhra Pradesh (50%), Gujarat and Maharashtra (15% each), Kolkata, W.B. (8%), Rajasthan (5%), Haryana (3%), Uttar Pradesh (2%) and Himachal Pradesh (2%). From here wholesalers dispatch fish to Delhi (35%), U.P.(15%), J&K (15%), Punjab (10%), W.B. (10%), Haryana (5%), Assam (5%) and Bihar (5%). The market provides permanent employment to about 1000 person at a salary of Rs. 9000 -15000 per month and daily wage work to about 2000 person earning Rs. 300-400 per day. Fish arrivals at the market start from midnight and the market is active from the early morning hours. Cleaning of the market is done twice a day by flushing with water.

Delhi Fish Poultry and Egg Marketing Complex at Gazipur, constructed with NFDB financial assistance (above); Indian Major Carps and Exotic Pacu (Piaractus brachypomus) on sale at the market

(ii) 'Establishment of Processing Unit for Value Added Fish Products' by M/s Sultan Fish Farm at Karnal, Haryana: NFDB provided financial assistance of Rs. 25.00 lakh to Shri Neeraj Chaudhary (CEO) through the Dept. of Fisheries, Haryana. Funds were properly utilized and UC was submitted. The Fish Processing Unit is located at Butana village, Nilokheri PO, Karnal district, Haryana State, and housed in a two storied building having: weighing and pre-processing room, processing hall (with various machines for de-heading, de-skinning, de-gutting, de-boning, filleting) flake ice production unit, packaging units, cold storage, quality control laboratory, store room and a guest house. There is a separate unit for extraction of

NFDB funded Fish Processing Unit that manufactures value added fish products established at Butana, Nilokheri, Karnal, Haryana (above); some of the fish processing equipment in the unit (middle); ready to eat value added fish products manufactured in the unit (below)

fish oil for manufacture of Omega-3 fatty acid and for waste treatment. The unit is working at 100% capacity and on commercial scale. The value added fish products under the brand names "Fishbite" and "Crispy" are being marketed in Chandigarh, Himachal Pradesh, Uttarakhand, Dehradun, Delhi and National Capital Regions through distributors. The farmer-cum-entrepreneur is processing fish produced in his own farm, besides sourcing from a reservoir in Rajasthan which he took on lease. The farmer also buys back fishes for processing from other farmers to whom he supplies fish seed from his hatchery. The extracted fish oil rich in Omega-3 fatty acid is sold at Rs. 7000 – 8000 per kg.

(B) DADF Funded Projects in Haryana:

To accelerate fish production in the State, the DoF, Govt. of Haryana proposed various projects under 10 activities and accordingly the DADF, Govt. of India, under CSS Blue Revolution Scheme sanctioned financial assistance to the tune of Rs.1122.05 lakh and the same was released to the State in two installments during the year 2016-17.

The projects/ activities comprising of (i) 'New Pond Construction and One Time Input', (ii) 'Pond Renovation and One Time Input' and (iii) 'Utilization of Saline/Alkaline Land for Aquaculture' in 17 villages in six districts namely Rohtak, Sonipat, Panchkula, Ambala, Kanal and Kurukshetra in the State of Haryana were inspected by Dr. Radheyshyam, Sr. Consultant (Fisheries) and Ms. Dorothy M.S, Executive Assistant (Technical) of the NFDB.

DADF funded new ponds constructed at Kheri Manajat village, Rohna village, Sonipat district, and at Kheri Sampla village, Rohtak district, Haryana State

A total of 35.99 ha pond area pertaining to 21 fish farmers has been excavated under the activity of New Pond Construction/ Renovation and One-time Input Costs. However, CSS subsidy (2016-17) is yet to be received by the fish farmers. Officials of DoF, Haryana, informed that before the end of March 2017 subsidy amount would be transferred to the beneficiaries' bank accounts through DBT channel. Further, based on applications submitted for the year 2017-18 to DoF, Govt. of Haryana, 10 fish farmers of 3 villages of Karnal, Panchkula and Rohtak districts are also constructing and/or renovating ponds under the CSS Blue Revolution Scheme.

DADF funded ongoing pond construction and renovation work in the proposed land area for the year 2017-18 under CSS Blue Revolution Scheme: 12.00 ha saline affected land at Garnawathi village, Rohtak district; 12.42 ha area at Naggal village, Ambala district; new pond construction at Kheri Sampla village, Rohtak district; newly constructed pond at Hangola village, Panchkula district; 2.00 ha pond site proposed for renovation at Garawathi village, Rohtak district; pond renovation with one time input costs proposed at Sambhali village, Karnal district, Haryana State

6.4 NFDB and DADF funded projects implemented by Dept. of Fisheries, Govt. of Goa, inspected

Dr. Bimal Kinkar Chand, Executive Director and Mrs. S. Glory Swarupa, Consultant, HRD visited Goa during 21-24 March, 2017 to inspect NFDB and Dept. of Animal Husbandry, Dairying and Fisheries (DADF), Govt. of India, funded projects implemented by the Dept. of Fisheries (DoF), Govt. of Goa. Discussions were held with Dr. (Mrs.) Shamila Monterio, Director and other Fisheries Officials.

NFDB funded five Mobile Fish Retail Outlets (vans) and these are being operated from different locations *viz.,* Vasco, Zuari Nagar, Polem, Navelim, Mapusa, by the Fishermen Cooperative Society Members. Each member is earning around Rs. 8,000/- per month.

NFDB funded Mobile Fish Retail Outlet at Vasco, Goa

Fish Landing Centre at Issorcim and Ambelim are being constructed, with the funds released during 2016-17 by DADF under CSS on Blue Revolution, to facilitate fishing boat operations and landing of catch. Officials of DoF, Goa, are issuing tokens at the Jetties/ Fish Landing Centres to fishing vessels that go on voyage, and are recording data on fish landings.

Fish Landing Centre constructed at Issorcim, Goa with the fund released under CSS on Blue Revolution during the year 2016-17

Fish Landing Centre constructed at Ambelim, Goa with the fund released under CSS Blue Revolution during the year 2016-17

Cutbona Fishing Jetty is the biggest in Goa, and was funded by DADF, Govt. of India, while the approach road is laid by DoF, Goa. Most of the Mackerel and Butterfly Fish catch that is landed here is consumed in Goa and a small quantity is transported to Kerala and Karnataka.

Basket loads of Mackerel landed at Cutbona Jetty, the largest in Goa

NFDB funded 13 Open Sea Cages for culture of Seabass that were installed by the DoF, Goa, with the technical support from CMFRI, and managed by the Polem Open Sea Cage Culture Group. The fishes are to be harvested during April/May. Mr. Pradeep, President of the Polem Group is hopeful of getting good profits.

NFDB funded Sea Cages for culture of Seabass by Polem Fishermen Group, at Polem, South Goa

NFDB also funded development of Reservoir Fisheries at Chapoli; Cages funded under RKVY were installed at the site for culture of Pungasius.

NFDB assisted Pangasius culture in RKVY funded Cages installed in Chapoli Reservoir, Goa

A 3-day training programme on Oyster Farming, funded by NFDB was organized from 21-23 March 2017, at Fisheries Training Centre (FTC) of the DoF at Ela-Dhauji, Old Goa. There were 20 participants and the programme was coordinated by Dr. Smitha Mazumdar. Mr. Chandrakant Velip, Deputy Director, Fisheries; Mr. Sagar Naik, Fisheries Officer and Ms. Snigdha Patil, Asst. Superintendent of Fisheries were present. The NFDB Officials participated in the valedictory function.

Participants, resource persons of training programme on Oyster Farming with NFBD officials at FTC of the DoF at Ela-Dhauji, Old Goa

Earlier NFDB funded another training programme on Crab Culture which was conducted by Ms. Rashmi, at the Dept. Farm at Ela-Dhauji, Old Goa.

Ongoing pilot project on Mud Crab Culture and Milk Fish Farming at Govt. Fish farm, Ela-Dhauji, Old Goa

7. Fishers & Farmers News

7.1 Fisherwomen from Clam Fishing Villages undergo training on Processing and Value Addition at ICAR-CIFT, Kochi, Kerala

The Department of Science and Technology, Govt. of India, funded a project for developing Cluster Based Clam Fisheries and setting up of clam processing facility at Perumbalam village in Alappuzha district, Kerala. A cluster level training programme for Clam Fishers of the village was organised at ICAR-Central Institute of Fisheries Technology, Kochi, Kerala, on 3rd March 2017. The fisherwomen from the clusters in Panambukad and Perumbalam South regions of the village participated in the first of the training series. The training focused on processing of clam meat and preparation of ready to eat products like clam samosa, cutlet, pickle and bonda. The training programme was led by Dr. Nikita Gopal, Dr. J. Bindu, Principal Scientists and Shri S. Sreejith, Scientist, of the Institute.

Fisherwomen learning about Clam Processing (above) and hands-on experience (below) during the training programme at ICAR-CIFT, Kochi, Kerala

8. Fisheries & Aquaculture Industry News

8.1 Industry stakeholder consultation on Blue Economy jointly conducted by FICCI and ICAR-CIBA, Chennai, Tamil Nadu

As a part of India's Business Engagement with Indian Ocean Rim (IOR) countries, Industry-Stakeholder Consultation on Blue Economy was conducted jointly by FICCI and ICAR-CIBA on 27th February 2017 at Chennai. Representative stakeholders from industry, State and Central Govt. and research organizations, Universities and farming community took part in the meeting. Mr. AR RM Arun, Chairman, FICCI, Tamil Nadu State Council, welcomed the gathering. Mr. Rajiv Bhatia, former Ambassador, chairing the consultation, highlighted on blue economy as a business opportunity incorporating sustainable ways for ocean based trade. The objective of the task force was to explore investment and economic activity, examine issues of doing business with IOR countries, provide recommendations for enhancing business in priority sectors, and connecting with ***Sagarmala*** initiative of the Govt. of India. The key areas include fisheries and aquaculture, biotechnology, mining, minerals, renewable energy, manufacturing, shipping, ports and maritime logistics, tourism and leisure, construction, ICT, education and research.

Dr. S.V. Alavandi HOD, AAHED, CIBA presented the bird's eye view of CIBA's research activities towards the goal of Blue Economy and future programmes envisaged with special reference to brackishwater aquaculture, under the FICCI taskforce. Dr. T. Ravisankar, from Technology Management Unit of CIBA highlighted on rich marine biodiversity, aquaculture potential and related business in the IOR and fish trade flow from IOR countries. Dr. M. Sakthivel, founder Aquaculture Foundation, emphasized that with limited land resources, coastal waters and sea had enormous potential for aquaculture and mariculture for production of fish, sea weeds, biodiesel and

Dignitaries and participants at the Industry-Stakeholder Consultation on Blue Economy held on 27th February 2017 at ICAR-CIBA, Chennai, Tamil Nadu

bio-fertilizers using natural resources, potable deep seawater supply and tidal energy. It was felt that tourism in the form of surfing, snorkelling, gaming and including local fishermen and women with eco-tourism in marine parks will contribute to Blue Economy. Drugs from marine chemicals and hydrocarbon extraction were also discussed. Issues of fishermen crossing boundaries for want of better fish catch were highlighted. Banning purse seine/ mesh-size regulation along with sea ranching and identification of Potential Fishing Zones by ISRO/INCOIS were also suggested as remedies.

Mr. Murari, IAS (retd), Advisor to FICCI and Govt., in his concluding remarks mentioned that there was urgent need for cold chain, upgradation of deep sea fishing vessels especially for tuna fishing, vessel building, improving fishing vessels' energy efficiency and preventing small size and lesser valued fish from being discarded at seas by deep sea fishermen.

[Input from The Director, ICAR-CIBA, Chennai, Tamil Nadu; *director.ciba@icar.gov. in; director@ciba.res.in*]

8.2 NFDB Funded Community-based Initiatives in Cage Culture of Fish in Andhra Pradesh and Telangana States

(i) Andhra Pradesh:

Inland fisheries sector has been identified as a driver of economic growth for fishers and other communities in several States such as Andhra Pradesh, Telangana, Jharkhand, and Chhattisgarh. The Dept. of Fisheries, Govt. of Andhra Pradesh submitted a proposal for setting up Cage Culture Units in 12 reservoirs, at 24 cages per reservoir, to rear Tilapia (GIFT variety) in an effective water spread area (EWSA) of 15,592 ha at a total project cost of Rs. 1080.00 lakh. NFDB sanctioned a subsidy amount of Rs. 423.00 lakh during 2015-16.

Tata Trusts, as part of its Corporate Social Responsibility (CSR) initiative, worked across six locations in Visakhapatnam, Vizianagaram, Srikakulam, and Anantapur districts of Andhra Pradesh in helping pilot Cage Fish Culture initiative of the Govt. of Andhra Pradesh, with the participation of local communities. Mr. Karthik Ramesh (an alumnus of the Indian Institute of Management Calcutta), Manager Projects at Tata Trusts, was responsible for implementing the Cage Culture Project in Andhra Pradesh.

The Dept. took up the Cage Culture of Tilapia in Pedderu Reservoir, V Madugula mandal, in Visakhapatnam district with an outlay of Rs. 80 lakh. Around 1.5 lakh small fry were brought from Rajiv Gandhi Centre for Aquaculture (RGCA), Vijayawada, and reared with special care in Tandava Reservoir for two months. Subsequently, 1.05 lakh fingerlings that survived were shifted to the growout cages, wherein survival of 90 per cent was registered and 45 metric tonnes of fish were harvested in 45 days. Similarly, Tilapia raised in Cages in Vizianagaram and Srikakulam districts recorded good growth and survival; total quantity of about 100 metric tons was harvested from Cages in north coastal districts of Andhra Pradesh.

In Visakhapatnam district, the cooperative society took real ownership of the cages, and every Saturday, about 70 members, men and women, young and old, went together to clean the cages. They also performed the task of moving their cages over a kilometer in water to avoid conflicts with other water users.

Cages stocked with Tilapia being cleaned by cooperative society members of Pedderu Reservoir in Visakhapatnam district, Andhra Pradesh

In Vizianagaram, for the first time, the cooperative society members tried spawn rearing in low-cost cages they manufactured on their own. Having achieved success, the cooperative society became a resource centre where 40 other cooperatives from the district came to learn from them.

A fish cage designed for spawn rearing and launched by the local community in Vizianagaram district, Andhra Pradesh

In Srikakulam, a set of small ponds that lay unused for several years was identified by 53 women, cleaned, prepared for stocking and rearing fish seed for stocking in cages. The capacity of societies in managing the resources, engaging with the market, and book-keeping was built through exposure visits, surveys of local markets and training. The Anantapur cooperative society started the process of savings, with each member contributing Rs 10 per kg of fish sold to a corpus for seed production in the coming season.

[Photos & Information Courtesy: Karthik Ramesh, *http://www.villagesquare.in/2017/01/09/communities-in-andhra-pradesh-find-success-in-inland-fisheries/* and VVLN Rao, *http://www.thehansindia.com/posts/index/Andhra-Pradesh/2016-07-14/Cage-Culture-of-Tilapia-fish-to-net-good-returns/241962*]

(ii) Telangana State:

The Dept. of Fisheries, Govt. of Telangana State launched Cage Culture Demonstration Projects in six major reservoirs to raise Pangasius and Tilapia, with the objective of encouraging fishermen and farmers to take up Cage Culture on their own. The State Govt. officials visited Jharkhand where Cage Culture of Pangasius is undertaken on a large scale and in an integrated manner.

The Dept. of Fisheries identified Koilsagar (Mahabubnagar district), Pocharam (Medak district), Nizamsagar and Sri Ram Sagar (Nizamabad district), Kadem Reservoir (Adilabad district) and Lower Maneru Dam (Karimnagar district) for the demonstration project launched at an estimated cost of Rs 167.56 lakh, of which, the State Govt. contributed Rs 100.56 lakh and NFDB sanctioned a subsidy amount of Rs 67.04 lakh during 2014-15. The Govt. sent 167 farmers to Chandil Reservoir in Jharkhand as part of the 'Exposure Visit', which was also funded by NFDB. M/s RVR & Co of Bengaluru, Karnataka took up the demo project at Lower Maneru, Nizamsagar, SRSP and Kadem Reservoirs, while M/s Dass and Kumar of Varanasi, Uttar Pradesh, executed the project at Pocharam and Koilsagar Reservoirs.

Under the project, the fish are grown in HDPE Modular Cages of 6 x 4 x 4 metres. Six such cages constitute a battery. Two cages in each battery will be nursery cages and four will be grow-out cages. Two batteries of cages (12 cages in all) were placed in each reservoir.

In the first phase, 30,000 fingerlings of Pangasius were stocked in 8 Cages and 30,000 fry of Tilapia in 4 Cages; floating pellet feed was served. Yield at the end of 10-month culture period was 11 tonnes of Pangasius (average weight 500 g) and 150 kg of Tilapia (average weight 250 g). Inadequate space in the 4 nursery cages significantly hampered survival and growth of Tilapia.

[Source: Mr. Jagdish Kumar, The Fish Site, *http://www.thefishsite.com/fishnews/25692/telangana-stae-opts-for-cage-culture/* and Dr. B. Laxmappa, District Fisheries Officer, Mahabubnagar]

Cage Culture of fish in Koilsagar Reservoir, Mahabubnagar district, Telangana State: fish being fed (left); fish being harvested (right above); harvested Pangasius and Tilapia (right bottom) [Photo Credit: Above photos and photo of 'Tilapia Cages Culture' on cover page, Courtesy of Dr B. Laxmappa, DFO, Mahabubnagar district]

9. NFDB News

9.1 Secretary, Dept. of Animal Husbandry, Dairying and Fisheries, MoA&FW, Govt. of India visits NFDB, Hyderabad

Shri Devendra Chaudhry, Secretary, Dept. of Animal Husbandry, Dairying & Fisheries (DADF), Ministry of Agriculture & Farmers Welfare (MoA&FW), Govt. of India, New Delhi, visited NFDB, Hyderabad, on 10th January 2017 and took a Review Meeting on NFDB activities. He was accompanied by Shri Aditya Kumar Joshi, Joint Secretary (Fy), DADF & Chief Executive, NFDB; Dr. Paul Pandian, Fisheries Development Commissioner, Shri P.R. Meshram, Director (Fy. Stat.), Shri L. Shankar, Joint Commissioner (Fy), Govt. of India; and Dr. Salim Sultan, Sr. Consultant (Fy). Shri B. Venkateswara Rao, Commissioner of Fisheries, Telangana State and his Officers also participated. All the Technical Officers, Consultants and Interns, Administrative Officers, Consultants and Staff of NFDB attended the meeting.

Shri Devendra Chaudhry, Secretary, DADF, Shri Aditya Kumar Joshi, Joint Secretary (Fy) (left), Shri B. Venkateswara Rao, Commissioner of Fisheries, Telangana State and Dr. Paul Pandian, FDC, Shri P.R. Meshram and Shri L. Shankar, (right above) and Officers, Consultants and Staff of NFDB (right below) at the Review Meeting held on 10th January 2017 at NFDB, Hyderabad

After a round of self introductions by all those present, Shri Devendra Chaudhry, Secretary, DADF, sought to know the organizational structure, staffing pattern and job roles at the NFDB, Hyderabad and Guwahati, Assam and NFFBB Bhubaneswar, Odisha. Dr. B.K. Chand, Executive Director (Tech) made a presentation on the NFDB Activities and Projects sanctioned to different States and UTs since inception. Dr. Utpal Kumar Sar, Executive Director (Tech), provided additional inputs. The Secretary enquired about the Utilization Certificates (UCs) pending, and instructed to take stern action if UCs are pending for more than 2 years. He instructed that: all the project sanctioned during the last 5 years are to be Geo-tagged and their physical achievements with photographs put on the Portal; long pending projects should be closed and further releases for their completion are to be based on fresh project proposals that could be considered on a case by case basis.

Shri Devendra Chaudhry, Secretary, DADF, further suggested: follow up of schemes/ projects sanctioned to States & UTs by conducting review meetings in the States (two at a time with immediate effect) involving all stakeholders; NFFBB role and activities to be critically reviewed and evaluated; special drive to be made for development of Inland and Marine Ornamental Fisheries in the country with an emphasis on exports by setting up a Special Purpose Vehicle (SPV) by allocating Rs. 50 crore, with a provision for 100% assistance; to initiate a study to increase production of Coldwater Fish (Mahseer and Trout) by 10 times in 3 years; Training & Extension to be only project based; to prepare Draft State Action Plans (encompassing only 3 districts, 3 blocks and 6-10 villages), send to States/ UTs and to conduct workshops for their modification and adoption; each State to focus only on 2 species of fish such that their production increases by 100 times; and regular inspection of project sites by NFDB Technical Staff.

Shri Devendra Chaudhry, Secretary, DADF, reviewed the status of NFDB funded projects pending in Telangana State by enquiring from Shri B. Venkateswara Rao, Commissioner of Fisheries, Telangana State and his Officers, and suggested for a follow up of pending projects.

9.2 Republic Day observed at NFDB, Hyderabad

The 68th Republic Day of India was observed at the NFDB, Hyderabad with solemnity and reverence on 26th January 2017. The National Flag was hoisted by Dr. Utpal Kumar Sar, Executive Director (Technical), at 9:00 AM followed by rendering of the National Anthem by one and all. Dr. Utpal in his address urged the Officers and Staff to strive hard for achieving the targets set under the '*Neel Kranti Mission*' (Blue Revolution). Subsequently, light refreshments were served to all those present.

Dr. Utpal Kumar Sar, Executive Director (Technical) addressing the Officers and Staff of NFDB, Hyderabad on the occasion of Republic Day on 26th January 2017

9.3 Minister for Fisheries, Govt. of Kerala visits NFDB, Hyderabad

Smt. J. Mercykutty Amma, Hon'ble Minister for Fisheries, Govt. of Kerala, accompanied by Dr. Kartikeyan, Director of Fisheries, Shri Roy Tom Lal, Addl. Private Secretary to Minister, Shri M. Anil Kumar, Chief Engineer, Harbour Engineering, Govt. of Kerala, visited NFDB, Hyderabad on 9 February 2017. NFDB Officials Shri G. Vijaya Lazarus, Executive Director (Tech-Infra), Shri B.V. Balaji, Senior Executive (Admin & Fin), Dr. Manne Persis, Sr. Executive

Smt. J. Mercykutty Amma, Hon'ble Minister for Fisheries (top), Director of Fisheries and Officers of Govt. of Kerala (middle) and NFDB Officials at the interactive meeting held on 9 February 2017 at NFDB, Hyderabad

(Tech), Shri Amit Bhardwaj, Executive (Tech), Ms. Sreerenju Hariharan, Executive Assistant (Tech) and Dr. T.V. Suresh, Consultant (Tech) participated in the discussions. Dr. Manne Persis made a presentation on the various activities and schemes of NFDB. Status of projects being implemented in Kerala with NFDB financial assistance was reviewed.

9.4 Students from Kolhapur, Maharashtra on Study Tour, visit NFDB, Hyderabad

A group of 50 final year Postgraduate Students from Dept. of Zoology, Shivaji University, Kolhapur, Maharashtra visited NFDB, Hyderabad on 7 February 2017 as part of their Study Tour. The students were accompanied by Dr. S.R. Yankanchi and Dr. M.V. Santha Kumar, Assistant Professors. NFDB Officials explained the activities and interacted with the students.

Students from Dept. of Zoology, Shivaji University, Kolhapur, Maharashtra at NFDB, Hyderabad

9.5 Karnataka Farmers on an Exposure Visit to Andhra Pradesh visit NFDB, Hyderabad

On 9 February 2017, some 70 farmers from Hassan and Mysore districts of Karnataka State visited NFDB to know the activities, schemes and subsidies of NFDB. A team of officials from Dept. of Fisheries, Hassan and Belur accompanied the farmers. They were on an Exposure Visit to fish farming centres in Andhra Pradesh. An interactive session with Officers of NFDB was arranged for the visiting farmers.

Farmers and Fisheries Officials from Hassan and Mysore districts of Karnataka at NFDB, Hyderabad

10. NFDB in the Media

The Assam Tribune

THE ASSAM TRIBUNE, GUWAHATI 7
TUESDAY, JANUARY 3, 2017

CITY

Bid to develop ornamental fisheries in NE

SATURDAY, JANUARY 7, 2017 — CITY — THE ASSAM TRIBUNE, GUWAHATI 5

Agri-Horticultural Show, 2017 inaugurated

The Mizoram Post

AIZAWL THURSDAY 09 FEBRUARY 2017

CM inaugurates first-ever Mizoram Fish Festival

6 THE ASSAM TRIBUNE, GUWAHATI — SATURDAY, FEBRUARY 11, 2017

Fish seed village: a concept for self-reliance

Dhruba Jyoti Sharma, Sanjay Sarma

NEWSLINK

English Daily

(The leading English daily in Mizoram) Aizawl February 9, Thursday 2017

Chief Minister inaugurates first-ever Mizoram Fish Festival

11. Announcements

11.1 World Aquaculture 2017

"World Aquacultue 2017" will be held from 26–30 June 2017 in Cape Town, South Africa, with involvement from countries throughout the Africa continent and around the world. Aquaculture is rapidly growing in Africa and increasingly being integrated into the continent's food systems. Therefore it is time for the world aquaculture community to focus on Africa. A major international trade show at World Aquaculture 2017 is the place to learn about the latest aquaculture technologies presented by exhibitors from around the world. [Source: *www.was.org*]

11.2 The University of Arizona 2017 Shrimp Pathology Short Course

The "2017 Shrimp Pathology Short Course – Disease Diagnosis and Control in Marine Shrimp Culture" is to be conducted during 17–22 July 2017 by the Aquaculture Pathology Laboratory, University of Arizona, Tucson, USA. Registration is limited to 30; per candidate course cost is US$ 2,000.00 (if deposited before 1st June 2017) and US$ 2,500.00 (on or after 2nd June 2017). The Course comprises of Lectures, Labs and Demonstrations that will be presented by Staff from the Aquaculture Pathology Laboratory. Contact: Dr. Arun K. Dhar, Ph.D., Associate Professor & Director, Aquaculture Pathology Laboratory and Molecular Virologist, or Ms. Deborah Huie The University of Arizona, School of Animal and Comparative Biomedical Sciences, Aquaculture Pathology Laboratory, 1117 E. Lowell Street, Room 102, Tucson, Arizona 85721, USA, Phone: 520-621-4438; Fax: 520-626-5602, Email: adhar@email.arizona.edu; dhuie@email.arizona.edu

[Source: *https://acbs.cals.arizona.edu/aqua*]

11.3 Asian Pacific Aquaculture 2017

The "Asian Pacific Aquaculture 2017 – Transforming for Market Needs" is to be held during 24-27 July 2017 at Kuala Lumpur, Malaysia. It is the place to learn about the latest in aquaculture, see the newest technology in the trade show with exhibits from around the world. 'Special Producer Sessions APA 2017' will have special sessions to address the everyday practical concerns and needs of aquaculture farmers. Specific information will be provided on current problems farmers are facing.

[Source: *www.was.org*]

11.4 Aqua Nor 2017

"Aqua Nor 2017", an important meeting place for the aquaculture industry and the world's largest aquaculture technology exhibition since 1979, is to held during 15-18 August 2017 at Trondheim, Norway. During Aqua Nor, numerous seminars, mini-conferences, lectures, debates and presentations are held.

[Source: *http://www.thefishsite.com/events/*]

11.5 Fourth Annual International Conference on Fisheries and Aquaculture 2017

The '4th Annual International Conference on Fisheries and Aquaculture 2017' under the theme "***Depletion of Aquatic Biodiversity and Aquaculture as a Decisive Remedy***" is to be organized during 24 - 25 August 2017 at Colombo Sri Lanka. The International Institute of Knowledge Management (TIIKM) is organizing the conference for the fisheries sector currently experiencing major issues in the sustainability of aquatic resources due to human interventions. ICFA 2017 will create a stage to voice researches that will enable approaches and steps towards arriving at that decisive remedy foreseeing a sustainable future.

Aquatic biodiversity is a vital component for recreation, food security and economic development of a nation. The fisheries sector has faced numerous issues resulting from human interventions in the form of overfishing, oil spills and pollution arising from waste disposals in the marine habitats. The subject of paramount importance is to be addressed and the need for the message to be disseminated is crucial. The Conference will witness the participation of academicians, researchers, industry expects, policy makers and professionals in the fields of Fisheries and Aquaculture, and pave the way for necessary measures to overcome the problems faced by the sector and for precautions to counter issues that will arise in future.

[Source: *http://aquaconference.com*]

11.6 Tenth Symposium on Diseases in Asian Aquaculture (DAA 10)

The "10th Symposium on Diseases in Asian Aquaculture (DAA10)" is to be held during 28 August – 1 September 2017 at The ANVAYA Beach Resort, Bali, Indonesia, by the Fish Health Section, Asian Fisheries Society, in collaboration with Indonesian Ministry of Marine Affairs and Fisheries.

[Source: *https://www.asianfisheriessociety.org/events.php*]

National Fisheries Development Board

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Ministry of Agriculture and Farmers Welfare, Govt. of India)
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