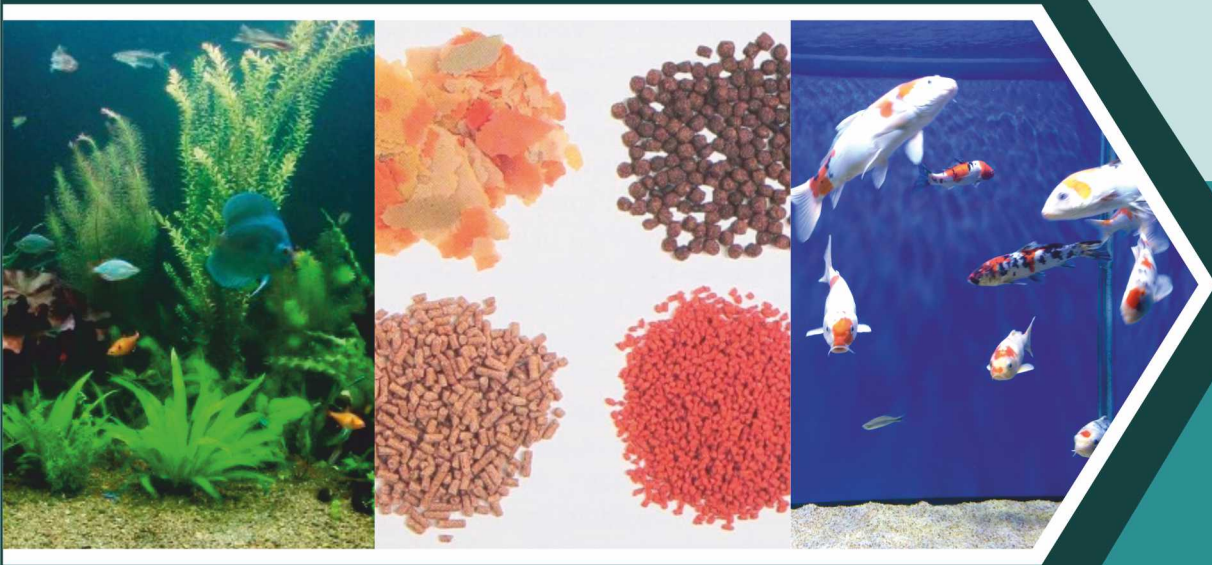


FRESH WATER ORNAMENTAL FISH CULTURE AND MANAGEMENT

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Scheduled Caste Sub Plan, Govt. of India



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Preface

Ornamental fish keeping is a well-liked hobby and the trade in ornamental fish expanded in about 130 countries. The major chunk of the ornamental fish stock is gathered from the tropical developing nations. In the global market, the industry is dominated by freshwater fishes (60%) including gold fish, discus, zebra danio, tetra, and live beares. The two species, neon tetra and guppy share 1/4th of the global trade by volume and about 15% of the total trade value.

The ornamental fish exports expanded continuously from US\$ 177.7 million to 364.9 million in 2011 and then marginally dipped to US\$347.5 million in 2014-15. In Indian ornamental fish export, about 90% are indigenous freshwater species collected from wild. The Western Ghats of India is one of the 34 – biodiversity ‘hotspot’ areas of the world.

The major share holders of export of ornamental fish from India are Singapore, USA, Hong Kong, China, Japan and Malaysia. India is considered as one of the mega-ichthyo-diverse countries globally. However, India stands only at the 31st position in the global market of ornamental fish trade with a share of US\$ 1.06 million in 2016.

The Middle East and Asia are coming up as potential markets for the aquarium industry. India occupies a significant position in world fisheries. Ornamental fish production is especially high owing to the trainings, subsidies and assistance provided by public institutions in India, and also in response to the strong demand and attractive prices in the country for these fish.

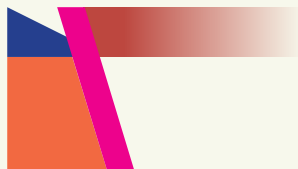
Home aquaria have shifted from traditional glass tanks to imported moulded aquaria, sleek wall-mounted plasma aquaria, nano aquaria etc. There is increasing demand for aquaria in hotels, hospitals, airports, banks etc. There are more and more ornamental fish exhibitions being held, and big and small public aquaria are being opened in many parts of the country. Outlets of product lines like ornamental fishes, aquatic plants, aquaria, equipment, accessories, feeds, medicines etc., are increasing. The bigger and more colourful species have greater demand in India. Initially, ornamental fish production and trade were highly concentrated in four states i.e. West Bengal, Tamilnadu, Maharashtra and Kerala, which supplied other states.

This technical bulletin will be able to share valid information on the scope, challenges and basic requirements of ornamental fish keeping, which will enable the hobbyists to make the fish keeping more scientific and interesting.

Authors

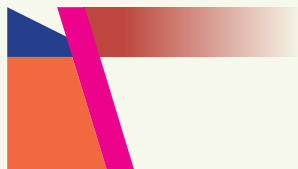
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INTRODUCTION

It will be interesting to note that aquarium fish keeping is only next to the most favored hobby, photography in the world (Das et al. 2005; Singh and Ahmed 2005). The fishes can be reared in aquariums, plastic tanks and garden ponds for the recreation and leisure (Mukherjee et al. 2000). The wild captured freshwater indigenous fish species contribute to about 90% of the ornamental fish export from India (Silas et al. 2011). The Western-Ghats region of India is recognized as one of the hot spots of biodiversity in the global context. In this region, 155 indigenous ornamental fishes are identified among which 117 are endemic. The ornamental fish trade from India contributed US\$ 0.24 million in 1991, and 2.10 million in 2008. The share of the sector for the total Indian fisheries value has enhanced from 0.04% to 0.15% from 1991 to 2008. The ornamental fish industry expanded with growth rates of 6.1%, and 15.5% in terms of quantity and value respectively during 1991-2009. The ornamental fisheries sector of the country registered a growth of 14.4% in value, 12.1% in volume, and 2.1% in unit value during the period (Rani et al. 2013). The south-east Asian countries (Singapore, Hong Kong, Malaysia), USA, China, and Japan were the major importers of our ornamental fish (Rani et al. 2014). In terms of Ichthyo-faunal diversity, India is considered as a mega-diverse region (Mittermeier et al. 1997). Asia is the home of 3500 fishes (Kottelat and Whitten 1996). The Asian region provides about 60% of the marine and freshwater ornamental fishes in global trade (INFOFISH 2016). The massive chunk of the trade, say 90%, is supported mainly by freshwater ornamental fishes and the rest from marine fishes (Tissera 2010). However, India stands only at the 31st position in the global market of ornamental fish trade with a share of US\$ 1.06 million in 2016. Developing technology for breeding, seed production and culture of ornamental fishes in suitable localities is an essential requirement for the sectors (Murty 1995).



AQUARIUM FABRICATION AND MANAGEMENT FOR FRESHWATER FISHES

Aquarium, the receptacle for maintaining aquatic organisms, either freshwater or marine, or a facility in which a collection of aquatic organisms is displayed or studied. The earliest known aquarists were the Sumerians, who kept fishes in artificial ponds at least 4,500 years ago. The first display aquarium was opened to the public in 1853 at Regent's Park in London. It was followed by aquariums in Berlin, Naples, and Paris. P.T. Barnum, the circus entrepreneur, recognized the commercial possibilities of living aquatic animals. In 1856, the first display aquarium was opened at the American Museum in New York City as a private enterprise. A freshwater glass aquarium contained *Vallisneria spiralis* (eelgrass) and goldfish, from *The Book of the Aquarium and Water Cabinet* (Shirley Hibberd 1856).

A total of 45 public/commercial aquariums were established throughout the world by 1928. After World War II, the growth declined and few public aquariums were established. The concept of keeping aquarium and aquarium fishes in India was introduced and popularized by the Britishers and the initial setups were with exotic species. Nowadays, many households, restaurants, offices and public places hold aquaria made of glass, and acrylic materials (Kutz 2002).

Fabrication of aquarium tank:

Essential factors for tank construction are the size and shape of the tank, thickness of the glass, the volume of water, and the density of fish that it holds.

Size of the aquarium:

The minimum considerable size (cm) of an aquarium is 60 x 30 x 30 (LxBxH). The water volume required by an individual fish should be kept in mind when we design the size of an aquarium or small pool for keeping the ornamental fishes. The two common aquarium sizes are 45×25×25 cm, and 60×30×30 cm (Pandey and Shukla 2005; Esther 1998).

Standard rectangular shaped aquarium dimensions:

Length (cm)	Breadth (cm)	Height (cm)	Capacity (L)	Glass thickness (mm)
60	30	30	54	4
90	30	38	103	5
120	30	45	162	6
150	45	60	405	10
180	45	60	486	12

Fish stocking density in aquarium: Should keep the fish at low density, it should not over crowd, for number of fish keeping to aquarium purpose use the formula:

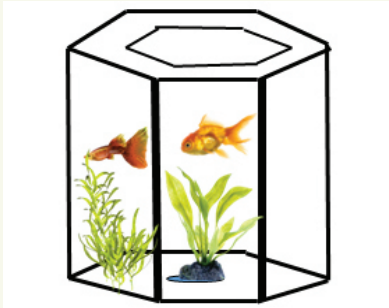
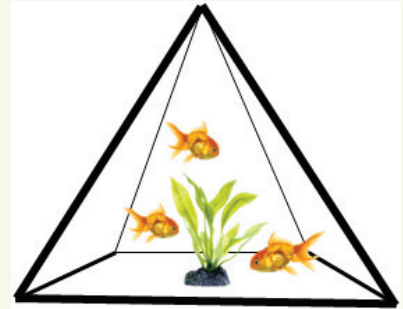
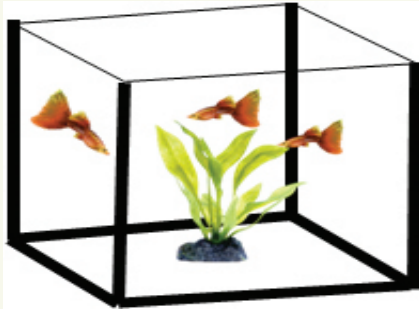
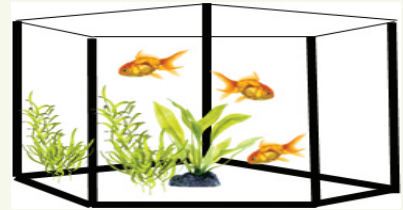
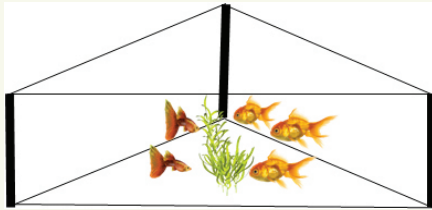
Stocking density (numbers) = (Length of Aquarium (cm) x Breadth of Aquarium (cm))/20



Rectangular Aquarium

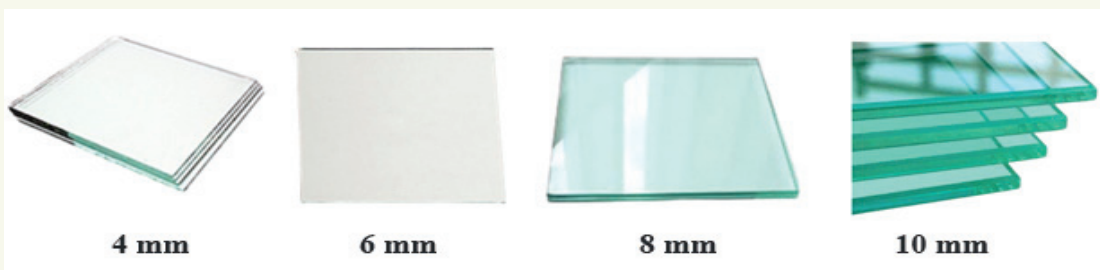
Shape of the aquariums:

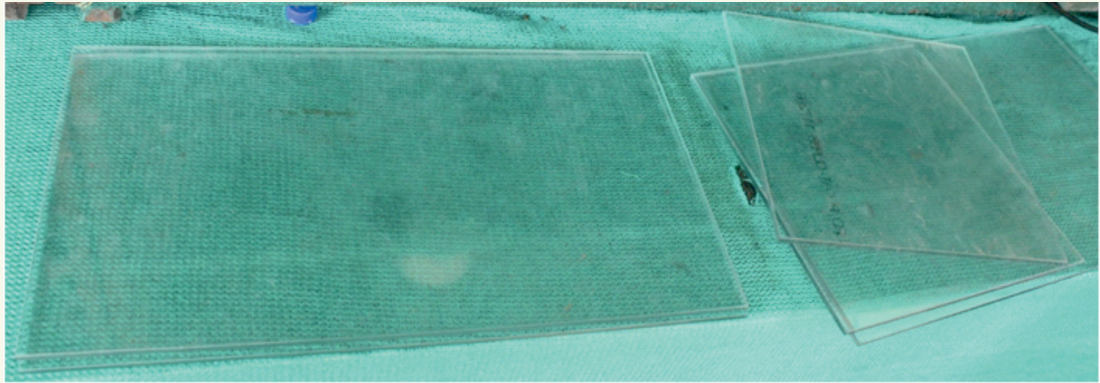
In addition to the traditional rectangular aquarium, aquariums are made in different shapes such as square, triangle, rectangle, hexagonal, trapezoid, global, pyramid shaped, etc. However, every fish species cannot be kept in all types of aquariums.



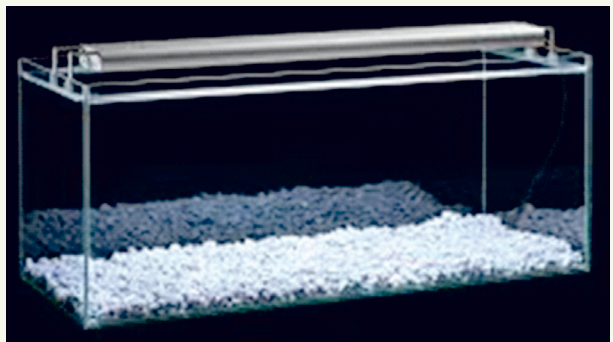
Important Aquarium Accessories:

1. **Glass:** Glass panels of required size are cut and cleaned- 4 side panels and 1 base panel.
2. **Substrate:** The bed substrate of an aquarium is generally gravel including pebbles and small stones of 3-5 cm and white sand. These substrates are kept as a bed at the bottom to grow plants also. Composts must be washed well before use.

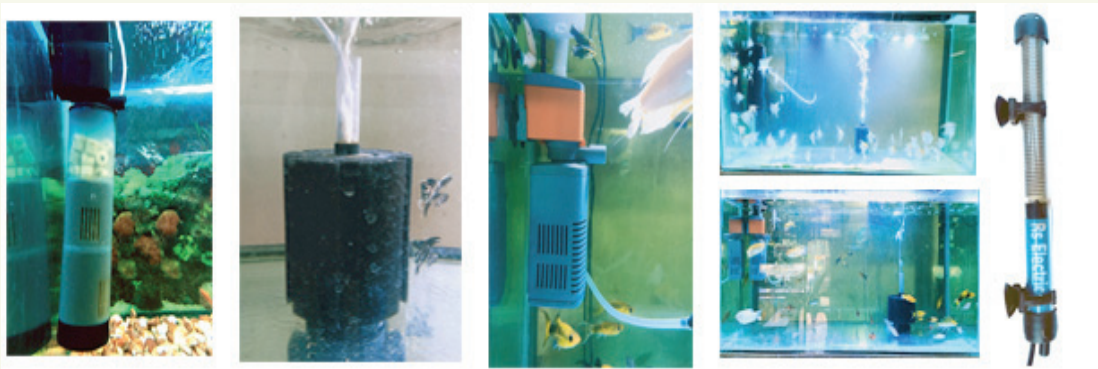




3. **Lighting arrangement:** Aquarium lamps about 25 w (240 v) fluorescent white tube is suitable for 48"x18"x12" aquarium which would be fixed above the water surface leaving a gap 4-6 inches. Light is a stimuli for plant growth (photosynthesis). At least 10-12 hr of light period is needed. The most popular- fluorescent lamp and compact fluorescent lamp- gives a cool and effective illumination. Imported aquarium lamps (Gro-lux) - enhance the colour of fishes. Lamp always fitted in the hood - so no shade falls on the viewing side. Necessary to give a ventilation to minimize the build-up of heat in the aquarium.



4. **Thermometer:** The ornamental fishes require optimal thermal conditions to be comfortable in an aquarium without oxygen deficiency and disease/ailment. Therefore, a thermometer (made of transparent glass/perspex) is placed inside the aquarium as fixed on the glass surface using a magnet.
5. **Heater-stats (Heaters with thermostats):** Tropical Freshwater fishes are warm water fish. These fish cannot survive in cold waters. For that temperature range should be 18 °C - 29 °C depending upon the species. The heater-thermostat system would help in regulating the temperature and to keep optimal conditions in an aquarium. Generally, this system is kept inside the aquarium either partially or completely submerged.



6. **Aerator:** Aerator for an aquarium is usually consists of a regulator, power source, air tubes and small joints. Aerators are used in aquarium to increase the oxygen content and remove excess carbon dioxide. Aerator must be kept above the water level in order to prevent back sucking of water if the power supply fails.
7. **Filters:** For water quality maintenance, mainly using mechanical, chemical, biological filters.

Mechanical: Water passes through a filtration material like filter wool. Generally this is the first stage of filtration process; here filter medium is filter wool, to sieve particulate waste from the aquarium water. In the mechanical filtration system the waste (excess feed, fish excretion, decayed plant material and other debris) from the aquarium water is physically trapped by the fibrous structure of filter wool, then which can be removed. Mechanical filter media must be washed or replaced on a regular basis.

Biological: Water passed through a filter bed and bacteria convert toxic ammonia to less toxic nitrates. The breakdown of the waste from the aquarium water by beneficial bacteria (in nitrogen cycle, in nitrification process, ammonia molecules are oxidized, in this reaction first production is Nitrite (NO_2) and the second one is Nitrate (NO_3); The ammonia is converted to nitrite caused by the genera, *Nitrosomonas*, *Nitrosococcus*, *Nitrospira* and *Nitrosolobus* bacteria, then nitrite is converted to nitrate caused by the genera, *Nitrobacter*, *Nitrococcus*, *Nitrospina* and *Nitrospira* bacteria). These beneficial bacteria multiply in the media such as foam sponge and in the substrate.



Handy aquarium filter

External Hang on Canister Filter

Hang on back filter

Chemical: Water filters through activated carbon (charcoal). This activated carbon is eliminating the dissolved wastes from the aquarium water. Unfortunately this process also neutralizes some medical treatments.

There are also under-gravel and reverse-flow filters recommended by the aquarium traders. This device, filters the water by mechanically, chemical and biologically.

8. **Hood (cover) and Stand:** Aquarium hood prevents the dust, fishes from jumping out, reduce heat loss and evaporation, it may take the form of a plain glass sheet, plywood or metal-hood and also improves the aesthetic beauty

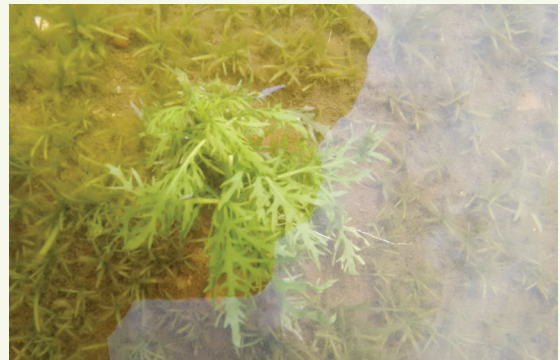


of the unit. The stand should be firm and capable of the weight of full tank-gravel, water and accessories. Stand made of wood or metal (Iron, steel).

9. **Aquarium Plants:** Aquarium plants make a natural appearance and provide oxygen in the aquarium. These aquarium plants are useful as shelter, food to aquarium fishes and also the best environment for fish spawning. The plant can be surface /free floating plants (*Lemna sp.*, *Pistia sp.*, *Salvinia sp.*, *Riccia sp.*, *Azolla pinnata* (mosquito fern), *Eichhornia* or Rootless submerged plants: *Ceratophyllum sp.*, *Myriophyllum sp.*, *Nitella sp.*, *Cabomba sp.*, *Limnophila sp.*, *Hygrophila sp.* or Rooted submerged plants: *Vallisneria sp.*, *Hydrilla sp.*, *Najas sp.*, *Potamogeton sp.*, *Cryptocoryne sp.* and *Sagittaria sp.*



Cryptocoryne spiralis



Hygrophilla difformis



Ludwigia sedioides



Hydrilla verticillata

FRESHWATER ORNAMENTAL FISHES



Pethia setnai (Narayan Barb)



Haludaria pradhani (Melon barb)



Pethia ticto (Ticto barb)



Carinotetraodon travancoricus
(Malabar pufferfish)



Danio rerio (Zebra Danio)



Danio malabaricus (Malabar danio)



Devario aequipinnatus (Giant Danio)



Rasbora dandia (Black line Rasbora)



***Garra mullya* (Sucker fish)**



***Dawkinsia filamentosa* (Blackspot barb)**



***Aplocheilus lineatus* (Striped panchax)**



***Lepidocephalichthys guntea* (Guntea loach)**



***Mystus malabaricus* (Jerdon's Mystus)**



***Puntius vittatus* (Green stripe barb)**



***Lepidocephalichthys thermalis*
(Common soiny loach)**



***Puntius mahecola* (Mahecola barb)**



Osteochilus nashii (Nash's barb)



Channa gachua (Dwarf snakehead)



Channa marulius (Great snakehead)



Xenentodon cancila (Freshwater garfish)



Etroplus maculatus (Orange chromide)



Ompok goae (Butter catfish/Goan catfish)



Glyptothorax lonah (Mountain catfish)

COMMON ORNAMENTAL FISHES



Atractosteus spatula (Alligator gar)



Osteoglossum bicirrhosum (Arowana)



Serrasalmus rhombeus (Pirahna)



Piaractus brachypomus (White pacu)



Astronotus ocellatus (Oscar)



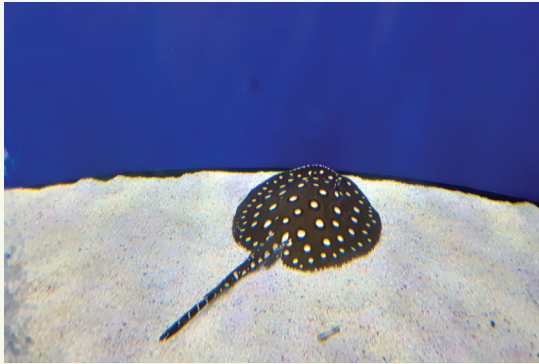
Betta splendens (Fighting fish)



Pterophyllum scalare (Angelfish)



Horabagrus brachysoma (Gunther's catfish)



***Potamotrygon leopoldi* (White-blotched stingray)**



***Cyprinus rubrofasciatus* (Koi carp)**



***Phractocephalus hemiliopterus* (Red-tail catfish)**



***Heros severus* (Golden severum)**



***Monodactylus argenteus* (Silver moony)**



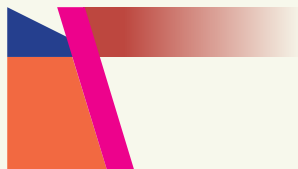
***Carassius auratus* (Gold fish)**



***Poecilia sphenops* (Molly)**



***Poecilia reticulata* (Guppy)**



NUTRITION AND FEEDING

For fish, the essential nutrients are proteins (amino acids), lipids (fats, fatty acids), carbohydrates (sugar, starch), vitamins, minerals, supplements (pro-biotics and pre-biotics), and water. Fish species develop a number of feeding coaptations (morphological, physiological and behavioural) to utilise the food sources and acquire the nutrition. Feeding habit of the fish vary such as carnivorous, herbivorous, omnivorous and also there is enormous diversity in their feeding patterns. Some species are surface feeders, and others are column and bottom feeders. Diets for aquatic animals can only be effective if they are formulated to contain the full array of necessary nutrients at appropriate concentrations relative to each other along with appropriate factors inducing rapid consumption on a consistent base. (Conklin and Piedrahita 2003).

Generally, the first portion of the digestive system in fish is the mouth. The positioning of the mouth is critical. Most carnivorous fishes have a terminal mouth. Suckers and some other bottom feeders (catfishes) have subterminal mouths. Some species of fish have teeth. The teeth of fish are generally adapted for performing specialized functions. Predatory catfish will, for instance, have small sharp pointed teeth (Berg 2005). The digestive process differs in different fish species, but there are elements common to many fishes, and these could serve as a basis for estimating general parameters of digestion. A well-known and widespread relationship is the dependence of oxygen consumption rate on weight and temperature (Tseitlin 1980). Some fishes depend on natural feed (sturgeon fish) (Yousefian et al. 2010) and some thrive on formulated artificial feed. A formulated fish feed should contain macro-nutrients, vitamins and trace elements to keep the fish active and in good health. To make the aquarium similar to their habit: adjusting the temperature, light, salinity, oxygen, pH and hardness and filling with plants, the fish might feed the natural system and take the food. In ornamental fish, a correct formulation of the diet improves the nutrient digestibility, supply the metabolic needs and reducing the maintenance cost and at the same time the water pollution (Yohana and Wilson 2011).

Characteristics of fish feed:

Flavour and taste, sound, smell, colour and buoyancy of food are the primary factors influencing the feeding of ornamental fishes.

Flavour and taste: Smell can be detected by the specific anatomical receptors in fish, but the flavour has to be dissolved in water for the fish to locate it. Some fish have receptors in their mouths, or on the head or lips. Some even have taste receptors on their skin. These receptors carry messages to the brain and tell the fish to swim towards the food (Berg 2005). Fish are governed by olfactory senses and taste buds. The food should be available with a pleasant flavour and good taste for fish (Yousefian et al. 2012).

Sound: Fishes are routine in their feeding activity that they start grouping when they hear sounds that usually precede feeding (Berg 2005).

Smell: In nature, fish needs to be able to identify their food and also their mates through the sense of smell. So, many fish species have nostrils that help them to identify the various things they come across. These sensors thus help the fishes to find their food (Berg 2005).

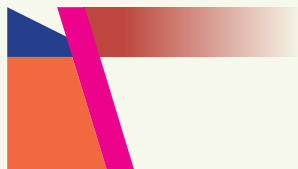
Colour and buoyancy of food: Fishmeal has a yellow-brown, russet, off-white or dusty colour and few are white. Fishmeal has slight differences in appearances and smells according to its type. The moisture should be within 10% to ensure its storage and use it safely. The buoyancy of fish meal depends on the fish in the aquarium. Bottom feeder and most tropical fish prefer to take the food when it sinks to the bottom (Yousefian et al. 2012).



Floating pellet



Sinking feed



NUTRITIONAL REQUIREMENTS OF ORNAMENTAL FISH

Ornamental fish have the same nutritional requirements as food-fish except for the fact that the growth of ornamental fishes is not much focussed. Prepared of complete artificial diets supply all the ingredients of protein, fats, carbohydrates, vitamins, minerals and trace element, necessary for the optimal growth, reproduction and health of the fish. The fish generally prefers composite diets,, those containing all the required protein (15-50%), lipid (10-25%), carbohydrate (10-25%), ash (5-10%) and in addition about 5 percent other material such as trace element, vitamins, minerals, supplementary and complement (probiotic, prebiotic and enzymes). The nutritional value of a dietary ingredient is in part dependant on its ability to supply energy. Physiological fuel values are used to calculate and balance available energy values in prepared diets. They typically average 4, 4, and 9 kcal/g for protein, carbohydrate and lipid, respectively (Craig and Helfrich 2009). The efficiency of nutrient use by ornamental fish can contribute to the formulation of appropriate diets, as well as helping to decrease the elimination of nitrogen and phosphorus in excreta, thereby favouring the maintenance of the water quality and reducing environmental pollution caused by effluence (Zuanon and Salaro 2011). Protein requirements for ornamental fish species vary with feeding behaviour, and they can be supplied through varied sources as described below:

- a. Herbivorous and omnivorous juveniles, grower and brood stock: 30-40% (soybean meal, mustard meal, groundnut meal, wheat gluten)
- b. Carnivorous (e.g. cichlids): Above 45% (Fish meal, squid meal, shrimp meal, clam meat)
- c. Larval stages (most of the species): Above 50% (natural/live feed)

Suitable feed for ornamental fishes regarding their feeding habitat:

- a. Surface feeders: Dry mash/meal
- b. Column feeders: Mixture of dry/moist feed
- c. Bottom feeders: Moist / wet / paste feed

Percentage nutrient requirement of a fish at young and brood stock stages:

Nutrients	Proteins	Lipids	Carbohydrates	Vitamin-mineral
Young	40-45	4-6	40-45	1-2
Brood stock	30-40	6-8	40-45	1-2
Sources	Fish meal, squid meal, shrimp meal, clam meat, soybean meal, mustard meal, groundnut meal, wheat/maize gluten or live feed	Fish oil, vegetable oil (sunflower, linseed, etc.)	Corn flour, rice bran, wheat bran	Synthetic forms

Use of natural carotenoids for pigmentation in fishes:

When a hobbyist/customer observes an ornamental fish, the first and foremost criteria is considered would be the pattern of pigmentation along the surface. The ornamental fish industry also hurdles to keep the natural color of the fish in the captive conditions. The skin colour in ornamental fish is regulated by the presence of carotenoids. The carotenoids are supplied through feed to improve the color and market value of the aquarium fishes. The common carotenoids available in fishes are tunaxanthin (yellow), lutein (greenish-yellow), beta-carotene (orange), alpha, betadoradexanthins (yellow), zeaxanthin (yellow-orange), canthaxanthin (orange-red), astaxanthin (red), echinenone (red) and taraxanthin (yellow). Here, the carotenoids are supplied to fish through feeding on algae, artemia, yeast, zooplankton, chironomid larvae, tubifex, shrimp and crab meal, and flower and vegetable extracts. Astaxanthin, lutein, and β -carotene are some of the synthetic carotenoids available in the market (Gupta et al. 2006).



Maize flour



Fish meal



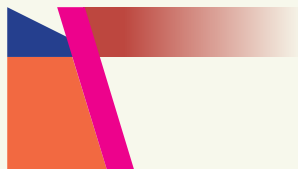
Prawn meal



Groundnut oil cake



Wheat bran



ORNAMENTAL FISH DISEASES AND MANAGEMENT

Disease is one of the critical limiting factors that hinder the development of ornamental fish culture. Due to diseases, 50%–100% of ornamental fishes have been lost in culture systems annually. The control of disease is very complex and often it is very difficult. Diagnosis of the infection and identification of factors affecting the infection are critical. The identification of life stages and life cycle strategies are also very important. Generally, the diseases of aquatic animals are extremely difficult to control and prevention is better than cure. Prevention is often related to control of the environment and management of the culture system involving the following important aspects. Stress is the major disease-causing factor for ornamental fish, which is due to inadequate or incorrect feeding practice, inadequate habitat conditions, and overcrowding. Long-term exposure to stress has a profound effect on the fish's wellbeing. Stress reduces the growth, reproductive ability, immune response, and alter the blood chemistry in fish. The major symptoms showed by the diseased fish are abnormal swimming, wandering movement, drooping dorsal and anal fins, staying isolated, scratching of body in hard substratum, cloudy or exophthalmic eyes, discoloration and cloudy patches on the skin, loss of appetite, and excessive mucus, etc.

The fish diseases are broadly classified into communicable diseases (caused by microbes and parasites), non-communicable diseases (caused by environmental, nutritional and genetic factors and certain conditions of unknown causes) and neoplastic diseases (tumors and cancers). Generally, microbial diseases are symptomatic and if identified properly, it can be controlled using antibiotics. In parasitic diseases, specific symptoms may not be there and are very difficult to control.

Freshwater ornamental fish diseases

Protozoan Diseases					
Disease Name	Commonly Affected fish	Causative agent	Symptoms	Treatment	References
<i>Chilodonella sp.</i> infestation (<i>Chilodonellosis</i> disease)	Freshwater tropical ornamental fishes. Channel catfish (<i>Ictalurus punctatus</i>), goldfish (<i>Carassius auratus</i>).	<i>Chilodonella piscicola</i> , <i>C. hexasticha</i>	Attacks skin and gills of the fish, easy to identify by microscopically its heart-shaped structure and slow circular motion.	Formaldehyde, malachite green or salt treatment.	Lewbart 2001; Padua et al. 2013 http://www.pondstarsuk.com/wp-content/uploads/2016/09/chilodonella-piscicola.jpg ; https://fishpathogens.net/pathogen/chilodonella
<i>Epistylis sp.</i> (Heteropolaria) (Red sore disease)	Oscars, cichlids and gold fishes. Commonly in catfishes. Skin lesion gold fish	Branched stalked ciliated protozoan, <i>Heteropolaria colisarum</i> .	Ulcers or Cotton-like growth on the skin, red coloured lesion on scales and spine.	Formaldehyde treatment, Clean well-filtered tank is the best solution.	Lewbart 2001; Sharma et al. 2012. https://www.google.com/search?q=Epistylis+(heteropolaria)+pdf&aq=chrome..69j57.42513j0j7&client=ms-android-xiaomi&sourceid=chrome-moble&ie=UTF-8#sfbu=1 Moyses et al. 2015 (http://www.scielo.br/pdf/rbpv/v24n3/1984-2961-rbpv-24-3-283.pdf)
<i>Hexamita sp.</i> (Spirotrunculus)	Freshwater tropical ornamental fishes.	Flagellated protozoa.	Severe treatment disease. It is an ectoparasite causing head and lateral line erosion.	Effective treatment with metronidazole.	Lewbart 2001. https://www.jbl.de/en/blog/detail/247 ; https://agrificedn.tamu.edu/fisheries/files/2013/09/Introduction-to-Freshwater-Fish-Parasites.pdf

Costiasis	Most common in major carps and freshwater aquarium fishes.	A flagellated protozoal ectoparasite. Mastigophoran parasites <i>Costia necatrix</i> , <i>Bodomonasrebae</i> , <i>Trypanosomapunctati</i> .	A bluish coating on the skin of the fish and presence of a large amount of mucus.	Formaldehyde, malachite green treatment.	Lewbart 2001. Sharma et al. 2012. https://link.springer.com/reference/workentry/10.1007/978-3-642-27769-6_714-2 ; http://www.fishbase.org/diseases/diseasessummary2.php?discode=29 ; http://www.fishbase.org/Diseases/DispicSummary.php?pic=CostiaDa.jpg&notcom=
Ichthyophthiriasis (Ich)	Most common in fresh water tropical ornamental fishes.	Trophozoites. Protozoan ciliate, <i>Ichthyophthirius multifiliis</i> .	Whitish cysts on the skin, gills and fins.	Prevention is the best method. Although formaldehyde, malachite green treatment is carried out.	Lewbart 2001. Sharma et al. 2012. https://en.wikipedia.org/wiki/Ichthyophthirius_multifiliis#/media/File:Ichthyophthiriasis.jpg ; https://en.wikipedia.org/wiki/Ichthyophthirius_multifiliis#/media/File:Ichthyophthirius_multifiliis.jpg
Trichodiniasis	Freshwater and salt water fishes.	A group of peritrichal ciliated protozoans like	White to bluish haze on the skin and increasing the mucous production. On the skin may develop ulcers and the fins may fray.	The chelated copper compounds, like Argant and Aquavet are effective for the protozoan parasite.	Sharma et al. 2012. fishdiseases">https://www.adfg.alaska.gov>fishdiseases ; http://article.sciencepublishinggroup.com/html/10.11648.j.ajls.2015030601.15.html
Tetrahy-meniasis (Guppy killer disease)	Mostly guppies, fresh water tropical ornamental fishes.	<i>Tetrahyomena corlissi</i> , possibly <i>Chilodonella sp.</i>	Raised scales, epithelial sloughing, Small white spots (1mm) in the skin and musculature of the fish, and a loss of equilibrium.	Prevention is the best method.	Hoffman et al. 1975; Lewbart 2001. http://ufdcimages.uflib.ufl.edu/UF/E0/04/51/16/00001/SRIWANAYOS.Ppdf

Myxosporidiosis	Freshwater Fishes	The common myxosporidia genera are <i>Leptotheca</i> , <i>Chloromyxum</i> , <i>Henneguya</i> , <i>Thelohanellus</i> , <i>Myxidium</i> , <i>Leptospermum</i> , etc.	Fish weakness, emaciation, raising of the scales along their posterior margins, falling of scales, etc.	Disinfect aquarium and equipment on a regular basis. Use formaldehyde for targeting of free swimming spore stages.	Sharma et al. 2012; Read et al. 2007. http://www.bvmj.bu.edu.eg/issues/25-2/32.pdf ; http://nexusacademicpublishers.com/uploads/files/Nexus_447.pdf
Bacterial Diseases					
Furunculosis (Fin Rot)	Siamese fighting fish, Mollies, Goldfish and other cyprinids.	<i>Aeromonas salmonicida</i>	Ulceration of skin, distended abdomen, and inflamed fins and fin bases, fin rot	Use antibiotics and chemicals at different doses. In case of serious infection mainly in brooder fishes, the affected parts of fins are removed surgically, and the wound is disinfected by washing with 1% solution of silver nitrate followed by keeping fish into a solution of $K_2Cr_2O_7$ (1:25000) for recovering of a wound for 7 days. Vaccination (bacterin).	Idowu et al. 2017; https://articles.extension.org/sites/default/files/w/b/77/Furunculosis.pdf ; https://www.researchgate.net/profile/Gokhlesh_Kumar/publication/301536167-Aeromonas_salmonicida_Update_online_links/5762844c08aefc1f664c1a09/Aeromonas_salmonicida-Updates-on-an-old-acquaintance.pdf?origin=publication_detail
Dropsy or Pine cone disease	Gold fish, Rosybarb, Molly, Gourami & Common carp (koi) Dropsy disease in goldfish	<i>Aeromonas sp.</i> , <i>Pseudomonas sp.</i>	Abdominal distension (ascites) and cutaneous oedema of fish is the common symptom. The belly of fish. Distends considerably and its scales protruded outward giving a pine-cone appearance.	The affected fishes could be effectively treated by incorporating terramycin in the feed.	Wildgoose 1998; https://en.wikipedia.org/wiki/Dropsy_(fish_disease)#/media/File:Hydropsie.jpg ; https://en.wikipedia.org/wiki/Pseudomonas

Columnaris	Goldfish, Barbs, Mollies and Sword Tails	<i>Flexibacter columnaris</i>	Anorexia, whitish plaques eroding the affected area (mouth, body surface, fin, gills), orange lesions.	Antibiotic medication and disinfect the aquarium	Idowu et al. 2017
Exophthalmia or pop eye disease	Gold fish, Barbs, Angel fish, Mollies and Sword Tails	<i>Diplostomum spathaceum</i> or 'eye fluke' and parasitic copepod <i>Omatokoita elongate</i>	Bulging of one or both eyes	Oxytetracyclin medication may be work effectively.	http://www.wetwebmedia.com/fwsubwebindex/fwpopyeafaqs.htm ; https://onlinelibrary.wiley.com/doi/pdf/10.1046/j.1365-2761.1998.00122.x
Necrotizing granuloma-like tuberculosis	Tropical ornamental fishes, abdominal distention, haemorrhages on the skin, scale loss, faded pigmentation and in viscera white coloured, different sized granulomas in gold fish.	<i>Mycobacterium sp.</i> Numerous granulomas with eosinophilic necrotic centers (H&E stain) in histological section of the kidney of a gold fish.	Uncoordinated swimming, abdominal swelling, loss of weight, skin ulceration, white nodule formation as granuloma in liver, kidney, spleen in both fresh and marine water fish	May need the destruction of all affected stocks and disinfecting the holding tanks and plumbing. Ethanol, lysol and sodium chlorite have been reported efficiently capable of destroying the pathogen in aquaria, while potassium peroxymonosulfate is ineffective.	Hashish et al. 2018 ; https://www.google.com/search?q=Necrotizing+granuloma+like+tuberculosis+in+freshwater+ornamental+fishes&ei=dFWSXMfdCl_79QOW4Z3IBg&start=10&sa=N&ved=0ahUKEwjH562D_pDhA_hWPFx0KHZZzwB2kQ8tMDCH8&biw=1455&bih=717
Fungal Diseases					
Saprolegniasis (Cotton wool disease)	All ornamental fishes mostly in Gold fishes, Skin lesion on fish due to Saprolegnia fungus	<i>Aphanomyce slaevis</i> , <i>Aspergillus niger</i> and <i>Saprolegnia parasitica</i>	Epidermal tissues and produce clumps of hyphal strands that project outwards from the infection site resembling cotton wool like growth on fish radiating out	Antibiotic medications, External disinfectant treatments, Copper sulphate treatment.	Chauhan et al. 2014; https://www.adfg.alaska.gov/static/species/disease/pdfs/fishdiseases/saprolegniasis.pdf .

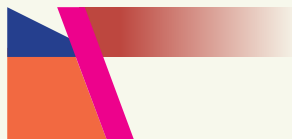
Branchio- mycosis (Gill rot)	All freshwater fishes multifocal necrosis of gill filaments producing a notched appear- ance of the gill margin of fresh- water fish due to branchiomycosis	<i>Branchiomyces sanguinis</i> and <i>Branchiomyces demigrans</i>	Fish may appear lethargic; gills appear striated or marbled with pale areas representing infected and dying tissue.	Maintain good management practices. Formalin and copper sulphate treatment, aquaria must be disinfected and dried.	Klinger and Francis-Floyd 1996; http://www.koiorganisation.com/national.org/sites/default/files/FUNGUS%20branchiomycosis%202014.pdf.
Viral Diseases					
Lymphocys- tis Disease	Bony fishes (freshwater and marine water fishes), including cichlids, killifishes, gouramies, sunfishes, gobies, butterflyfishes, damselfish, snook, drums etc.,	<i>Lymphocystivirus</i> or <i>Lymphocystis</i> disease virus (LCDV), (family <i>Iridoviridae</i>)	Small to moderate- sized, irregular, nodular, wart- like or pearl like growths on the fins, skin, or gills, these may be cream to graycolored but can be other colours if they appear under pigmented areas.	Only course is to destroy the fish and effectively disinfect all equipment.	Yanong 2010 https://agrifilecdn.tamu.edu/fisheries/files/2013/09/Lymphocystis-Disease-in-Fish.pdf .
Spring viremia of carp (SVC)	Common carp, grass carp, bighead carp, silver carp, Crucian carp, gold fish. Koi infected with SVCv. Exophthal- mia and petechia hemorrhages on body wall.	Rhabdovirus carpio, a bullet-shaped RNA virus	Darkening of the skin, exophthalmia (pop-eye), ascites (dropsy), pale gills, haemorrhages in the gills, skin, and eye, and a pro- truding vent with a thick mucoid (white to yellow- ish) faecal cast.	Antiviral drugs are not avail- able to treat SVC or other viral diseases. Maintain the water temperature above 20 °C may prevent a po- tential outbreak. Complete disinfection of aquaria	Petty et al. 2002; http://edis.ifas.ufl.edu/pdffiles/VM/VM10600.pdf .

Koi Herpes virus (KHV)	Koi and common carp fishes Gill lesions and herpetic skin lesions on the body and fin erosion in koi infected with koi herpes virus (KHV)	Cyprinid herpes virus-3 (CyHV-3) Electron micrograph image of cyprinid herpesvirus 3 virion. Scale bar = 100 nm.	Lethargic, swim at the surface and may show behavioural signs of respiratory distress.	Disease affected fish can be culling and discarded.	Ganguly 2016; http://cmsadmin.atp.co.il/Content_siamb/editor/61_3_3_7%20goodwin.pdf ; https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3294573/pdf/10-0593_finalS.pdf ;
Carp Pox (Fish pox)	Mostly Koi carp.	Cyprinid herpes virus-1 (CyHV1)	Individual lesions are formed on the epidermis which gives a milky appearance. These are benign and non-necrotizing and resemble epidermal hyperplasia. The lesions are papillomatous in nature, and many times secondary bacterial infections are also evident.		https://ifm.org.uk/wp-content/uploads/2018/08/Carp-pox.pdf ;
Herpesviral Hematopoietic Necrosis	Goldfish Skin.	Cyprinid herpes virus-2 (CyHV-2)	Anorectic and exhibit pale gills and ascites; At necropsy, the spleen and kidneys (anterior and posterior) are often enlarged.		https://www.researchgate.net/profile/Nicholas_Crossland/publication/324609455-Investigation_of_a_Cyprinid_Herpesvirus_1_Disease_Episode_in_a_Group_of_Pond-Reared_Koi/links/5b418eca6fdccb90a8d73/Investigation-of-a-Cyprinid-Herpesvirus-1-Disease-Episode-in-a-Group-of-Pond-Reared-Koi.pdf?origin=publication_detail ;

Crustacean diseases					
Argulosis	Mostly gold fish and koi fish	<i>Argulus coregoni</i> , <i>Argulus japonicas</i> and <i>Argulus foliaceus</i> .	Erratic movements, rubbing themselves against the wall of the tank, abnormal swimming, frayed fins, loss of appetite, flashing, scratching, mucous increase, blood spots in the surface of fish body and fins.	Chemotheraputants will damage to the environment and human health. Disinfect aquarium and equipment regularly. Prevention is the best method.	Saha and Bandyopadhyay 2015; https://www.researchgate.net/publication/273892005-DIAGNOSTIC_AND_PATHOLOGICAL_STUDY_OF_ARGULUS_JAPONICAS_IN_GOLDFISH_CARASSIUS_AURATUS ; https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4408894/pdf/cm2015000093.pdf .
Lernaeosis	Freshwater ornamental fishes like gold fishes, one spot live bearers, perches etc., and farmed catla fish.	<i>Lernaea cyprinacea</i> is a parasitic copepod.	Lernaea infestation is serious effects on fish, disruption and necrosis of gill epithelium, haemorrhages, muscle necrosis, intense inflammatory response.	Prevention is the best method. Although, Dip treatment with $KMnO_4$ suggested.	Sharma et al. 2012; Hassan et al. 2008; https://www.researchgate.net/publication/316689193-LERNAEA_ANCHOR_WORM_INVESTIGATIONS_IN_FISH ; https://invasions.si.edu/nemesis/calendar/speciesummary.jsp?TSN=89254 .

Helminth diseases

Gyrodactylosis (Skin Flukes)	Freshwater ornamental fishes, mostly guppy fishes, carp.	<i>Gyrodactylus</i> spp. e.g. <i>Gyrodactylus bullatarudis</i> , <i>Gyrodactylus elegans</i> , <i>Gyrodactylus turbull</i> , <i>Gyrodactylus salaris</i> , <i>Gyrodactylus arcuatus</i> .	Fish movement very less, fins will start falling, body colour changes to yellow and appear blood spots on their body.	Acetic acid and sodium chloride solutions treatment effective for major carps. Also dip treatment of formaline and dip treatment of salt may be effective.	Sharma et al. 2012; https://folia.paru.cas.cz/pdfs/fo/2018/01/06.pdf ; dergipark.gov.tr/download/article-file/132871; https://en.wikipedia.org/wiki/Gyrodactylus_salaris ;
Dactylogyrosis (Gill Flukes)	Freshwater ornamental fishes mostly gold fishes. Cyprinid fishes.	<i>Dactylogyrus</i> spp. e.g. <i>Dactylogyrus extensus</i> , <i>Dactylogyrus achmerowi</i> , <i>Dactylogyrus anchoratus</i> .	Gill movements increased appears damaged gill tissues.	One hour bath treatment with Chloramin-T (authorized by council regulation (EEC) no. 2377/90 of the European Council.) 7-15 mg/L.	Abidi et al. 2011; https://eprints.kingston.ac.uk/39278/1/Brewster-B-39278.pdf ; https://pdfs.semanticscholar.org/18e9/4eb2fe10b3d6f8dc3c5a3b651383aa1b0e23.pdf ; http://www.lifesciencesite.com/lisj/life140817/03_326711/sj140817_19_33.pdf



SCHEMES FOR DEVELOPMENT OF ORNAMENTAL FISHERIES

Pradhan Mantri Matsya Sampada Yojana (PMMSY)

The PMMSY scheme will be implemented as an umbrella scheme having both centrally Sector components and centrally sponsored scheme components. It would focus on all round development of fisheries sector through a bunch of diverse interventions along the fisheries value chain right from production to consumption. The Scheme would maintain a fine balance between production and productivity activities including technology infusion, post-harvest infrastructure including strengthening and modernization of value chain and a robust management and regulatory framework. One of the key objectives of the scheme is to enhance fish production and productivity, now thrust would be given for quality, sustainability, standards and traceability in fisheries sector from 'catch to consumer', post-harvest infrastructure and management, modernization and strengthening of value chain, enhancement of fisheries export competitiveness and a robust fisheries management and regulatory framework.

Enhancement of production and productivity

In ornamental aquaculture, input support and facilities such as brood banks, hatcheries, rearing facilities, and quality seed units will be provided for enhancing production and productivity. Infrastructure and systems for seed and feed certification, input quality testing, aquatic animal health management including quarantine, and disease diagnostics laboratories and referral laboratories, capacity building and establishment of extension support services will be supported.

India's share in the global ornamental fish industry is minimal. In view of growing domestic and export market demand, support under PMMSY will be provided for ornamental fish cultivation through requisite interventions like establishment of production units, introduction of commercially important exotic species, breeding technology, extending technological, marketing and logistic support to entrepreneurs.

Under PMMSY, aquaparks are proposed as hubs of multifarious fisheries activities/facilities covering various stages/aspects of fisheries and aquaculture value chain. Inter alia, Aquaparks may be centers of production of quality seed and feed, pre and post-harvest infrastructure, business & commerce, logistics, marketing, export promotion, innovation, technology incubation, knowledge dissemination, recreation etc. Besides, Aqua parks may be developed on a hub and spoke model integrating clusters/areas with end to end solutions based on local needs and specific themes.

Development of ornamental and recreational fisheries

Sl. No	Sub-component and Activities	Unit	Unit cost (Rs. lakhs)	Governmental Assistance (Rs. lakhs)	
				General (40%)	SC/ST/Women (60%)
1	Backyard Ornamental fish Rearing unit (both Marine and Fresh water)	Nos	3.00	1.20	1.80
2	Medium Scale Ornamental fish Rearing Unit (Marine and Freshwater Fish)	Nos	8.00	3.20	4.80
3	Integrated Ornamental fish unit (breeding and rearing for fresh water fish)	Nos	25.00	10.00	15.00
4	Integrated Ornamental fish unit (breeding and rearing for marine fish)	Nos	30.00	12.00	18.00
5	Establishment of Fresh water Ornamental Fish Brood Bank.	Nos	100.00	40.00	60.00
6	Promotion of Recreational Fisheries.	Nos	50.00	20.00	30.00

Markets and marketing infrastructure

Sl. No	Sub-component and Activities	Unit	Unit cost (Rs. lakhs)	Governmental Assistance (Rs. lakhs)	
				General (40%)	SC/ST/Women (60%)
1	Construction of fish retail markets including ornamental fish/aquarium markets.	Nos	100.00	40.00	60.00
2	Construction of fish kiosks including kiosks of aquarium/ornamental fish	Nos	10.00	4.00	6.00

Funding schemes available from MPEDA

Recently the Marine Products Exports Development Authority (MPEDA) launched subsidy scheme for setting of ornamental fish breeding units to facilitate foreign exchange. Under this scheme MPEDA provides subsidy for the ornamental fishery to registered self help group and societies. To support livelihood and to promote foreign trade. Financial assistance is provided at the rate of 25% of the total investment, subject to maximum of Rs 10 lakh. The MPEDA has also launched a Green Certification scheme, the first of its kind for the freshwater ornamental fishery, to curb the harmful impact of wild capture of aquarium fishes and help maintain the environmental and economic sustainability.

Financial Assistance for setting up of Ornamental Fish Unit in Goa following schemes are available for ornamental fisheries development.

- (a) For setting up of a Breeding unit- 50% of the actual cost limited to Rs. 1,50,000/-.
- (b) For setting up of a Rearing unit- 50% of the actual cost limited to Rs. 1,50,000/-.
- (c) For setting up of a Rearing unit & Breeding unit- 50% of the actual cost limited to Rs. 2,50,000/-.

Eligibility/Criteria

Fish farmer/ Individual should be resident of Goa for last fifteen years. Applicant site should have adequate water facilities for setting up of the unit. Applicant having own/ leased land, adequate to set up an ornamental unit can avail the benefit under this scheme. Applicant should undergo training programme on ornamental fish farming organized by the Fisheries department/ MPEDA/ ICAR.

Schemes for ornamental Fisheries by the NFDB

- Ornamental fish production – Backyard hatcheries for women SHGs/ Fisher women cooperatives/ other house holds
- Medium scale unit for ornamental fish production by the entrepreneurs
- Integrated ornamental fishery units with hatcheries for ornamental fishes
- Setting up of Aquarium fabrication units - women SHGs / Fisher women cooperatives/ others
- Training and demonstration to the beneficiaries of the scheme.

Backyard hatcheries for Ornamental fish production

- Members of women SHGs / fisherwomen cooperatives and any household those who have own house with a minimum area of approximately 200-250 sq. ft. vacant land with adequate water facility for setting up of ornamental fish production unit.

- Members of women SHGs/ fisherwomen cooperatives and any household those who have vacant land with a minimum area of approximately 200-250 sq. ft. and adequate water facility on lease for a minimum of 7 years period adjacent to their house for setting up of ornamental fish production unit .
- Willing to take up the activity in accordance with the guidelines of NFDB
- Prospective beneficiaries willing to undergo training at the Government sponsored institutions

Medium scale ornamental breeding and rearing unit

- Entrepreneurs having owned a minimum area of approximately 300 sq. ft. vacant land with adequate water facility for setting up of ornamental fish production unit.
- Entrepreneurs having taken a minimum area of approximately 300 sq. ft. vacant land with adequate water facility on lease for minimum period of 7 years for setting up of ornamental fish production unit .
- Willing to take up the activity in accordance with the guidelines of NFDB
- Prospective beneficiaries willing to undergo training at the Government sponsored institutions.

Integrated ornamental fishery units

- State Fisheries Department / Fisheries corporations / Federations/ICAR institutions having own land and water facilities adequate enough to set up the unit. The land along with water facility may be hired on lease basis with a minimum period of 7 years.
- The private entrepreneurs having owned a minimum land area of 1000 sq. fts. and water facility for setting up of integrated ornamental unit.
- The private entrepreneurs having taken a minimum land area of 1000 sq. fts. and water facility on lease for a period of 7 years to set up of integrated ornamental unit.
- Willing to take up the activity in accordance with the guidelines of NFDB
- Prospective beneficiaries willing to undergo training at the Government sponsored institutions.

Aquarium fabrication units

- Members of Women SHGs /fisherwomen cooperatives and any individual having owned adequate vacant place for setting up fabrication of aquaria unit as prescribed by the NFDB.
- Members of Women SHGs/ fisherwomen cooperative societies, any individual having taken adequate vacant land on lease for a minimum period of 7 years for

setting up fabrication of aquaria unit as prescribed by NFDB.

- Willing to take up the activity in accordance with the guidelines of NFDB
- Prospective beneficiaries willing to undergo training at the Government sponsored institutions

Training of beneficiaries

- Members of Women SHGs /Fisherwomen cooperatives and any individual setting up of ornamental units
- Willing to take up the activity in accordance with the guidelines of NFDB.

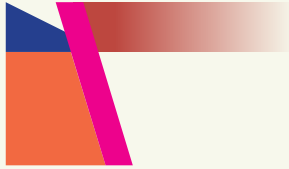
S. No.	Name of the activity	Unit cost	Pattern of assistance
1	Backyard Hatchery	Rs. 1.50 lakh	40% unit cost as subsidy to members of Women SHGs/ Fisherwomen Cooperative Societies/ Entrepreneurs
2	Medium Scale Unit	Rs 4.00 lakh	40% unit cost as subsidy to all categories of beneficiaries
3	Integrated Ornamental Fishery Units	Rs 15.00 lakh	40% Subsidy to the Government Agencies/ Government Institutions/ Entrepreneur
4	Setting up of Aquarium Fabrication Units	Rs. 1.00 lakh	40% unit cost as subsidy to members of Women SHGs/ Fisherwomen Cooperative Societies. 25% unit cost as subsidy to Entrepreneurs/ individual persons.

Financial Assistance for setting up of Ornamental Fish Unit in Goa Quantum of Assistance

- (a) For setting up of a Breeding unit- 50% of the actual cost limited to Rs. 1,50,000/-.
- (b) For setting up of a Rearing unit- 50% of the actual cost limited to Rs. 1,50,000/-.
- (c) For setting up of a Rearing unit & Breeding unit- 50% of the actual cost limited to Rs. 2,50,000/-.

Eligibility/Criteria

1. Fish farmer/ Individual should be resident of Goa for last fifteen years.
2. Applicant site should have adequate water facilities for setting up of the unit. Applicant having own/ leased land, adequate to set up an ornamental unit can avail the benefit under this scheme.
3. Applicant should undergo training programme on Ornamental Fish Farming organized by the Fisheries Department/ MPEDA/ ICAR



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