FISH FARMING IN THE TROPICS

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Summary

Fish farming is the industry of producing fish through husbandry or culture for food, recreation and other purposes, which dates back to ancient Egypt and China. There are over 100 species of fish that are farmed in the world. Fish farming includes the breeding, rearing of young and grow-out to market size of cultured species.

The basic principles of fish farming cover the adaptation of fishes to the aquatic environment, their food habits and breeding characteristics. The factors essential for

growth and survival of the fish are adequate oxygen in the water, food and waste elimination.

In the farming of tilapias in the tropics, as an example, the culture units used are ponds, tanks and net cages. The production methods vary according to the management applied such as those for extensive, semi-intensive and intensive systems. Suitable fishes for culture are those that are easily bred, grow fast, are hardy and have a good market.

Techniques for induced breeding of fishes, monosex culture, control of parasites and diseases, polyculture, and integrated farming systems are applied in fish farming to enhance seed supply and productivity.

As an enterprise, fish farming is subject to the same economic principles as any industry dependent on capital, labor, and resources. Compared to other animal protein-producing industries, fish farming is considered to be more efficient and profitable.

With depletion of the world's wild fish stocks, aquaculture is expected to produce fish to fill the growing demand. The future of fish farming is therefore bright. Expansion of fish farming in estuaries and marine areas rather than in freshwater bodies is foreseen because of the increasing demand for freshwater. Sound government policies for zoning fish farms, regulation of practices for environmental protection and market development are needed for sustainable fish farming.

1. Definition and Brief History of Fish Farming

Fish farming is the business or industry of producing fish through husbandry and is synonymous to fish culture. In broader terms, fish farming is a part of aquaculture, which deals with the culture of plants and animals in water.

The farming of fish includes breeding, rearing of the young and the grow-out of juvenile fish to adult or harvestable fish. Fishes are cultured in freshwater, brackishwater and seawater for food, recreation and other purposes.

Fish husbandry dates back to 2500 B.C. when the Nile tilapia was kept in holding ponds in ancient Egypt. The breeding of common carp in China was recorded as early as 475 B.C. Carp culture was extensively practiced in Europe in the Middle Ages (1400–1600.) The first success in the artificial fertilization of brown trout eggs was reported in 1853 in the United States. Commercial culture of warmwater fish began in the late 1920s.

2. Principles of Fish Farming

'The basic principles of fish farming deal with the cultured fish and its cultural requirements. There are more than 100 fish species that are grown throughout the world. The major fishes that are cultured in the tropics are listed in Table 1.

Family	Species	Common Name
Anabantidae	*Helostoma temmincki*	Kissing gourami
	Osphoronemus gouramy	Giant gourami

	Trichogaster pectoralis	Pla salid
Centropomidae	*Lates calcarifer*	Sea bass
Chanidae	*Chanos chanos*	Milkfish
Cichlidae	*Oreochromis aureus*	Blue tilapia
	Oreochromis mossambicus	Mozambique tilapia
	Oreochromis niloticus	Nile tilapia
Clariidae	*Clarias batrachus*	Asiatic catfish
	Clarias gariepinus	African catfish
	Clarias macrocephalus	Asiatic catfish
	Aristichthys nobilis	Big head
Cyprinidae	*Barbodes gonionotus*	Java carp
	Carassius auratus	Goldfish
	Carassius carassius	Crucian carp
	Catla catla	Catla
	Cirrhinus molitorella	Mud crab
	Cirrhinus mrigala	Mrigal
	Ctenopharyngodon idella	Grass carp
	Cyprinus carpio	Common carp
	Hypopthalmicthys molitrix	Silver carp
	Labeo calbasu	Calbasu
	Labeo rohita	Rohu
	Mylopharyngodon piceus	Black carp
Mugilidae	*Mugil cephalus*	Gray mullet
Ophicephalidae	*Channa striatus*	Snake head
Schilbeidae	*Pangasius pangasius*	Mekong catfish
	Pangasius sutchi	
Serranidae	*Epinephelus salmoides*	Estuary grouper
	Epinephelus coioides	Orange-spotted grouper
	Epinephelus malabaricus	Black-spotted grouper
Siganidae	*Siganus vermiculatus*	Rabbit fish
	Siganus guttatus	

Table 1. List of Important Cultured Fishes in the Tropics.

Fishes are vertebrate animals belonging to the Class Osteichthyes of the Animal Kingdom. They are characterized as being poikilothermous ("cold-blooded") and provided with gills for breathing in water. Fishes reproduce sexually by producing young that hatch in the reproductive tract (live-bearers) or outside (egg-layers).

Suitable fishes for culture are those that can easily be bred, grow fast and have a good market. Species that are hardy and can tolerate crowding are also preferred.

Cultured fishes can be classified according to their food habit as herbivores (plant-eaters), carnivores (animal-eaters), and omnivores (plant and animal-eaters.) In the aquatic ecosystem, fishes can occupy the niches for phytoplankton-feeder, zooplankton-feeder, carnivore, and bottom-feeder (see Figure 1.).

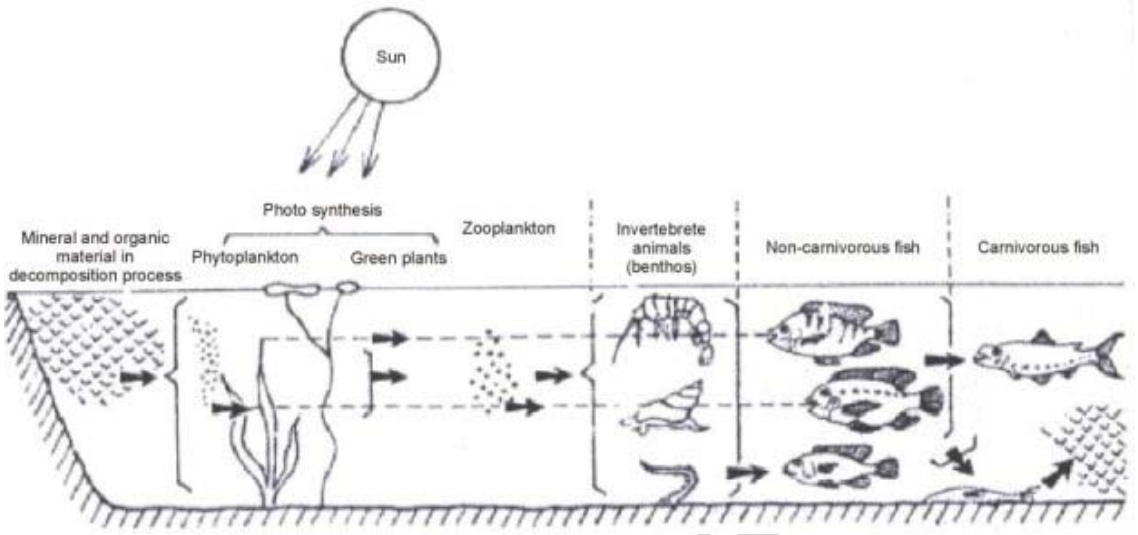

Figure 1. The Food Chain in the Aquatic Ecosystem (after Bard et al., 1976.)

Lacustrine (non-flowing water) fishes such as tilapias easily breed in ponds than riverine (flowing water) species (e.g. Asiatic carps.) For the latter group, induced spawning techniques such as hypophysation and stripping may be necessary for production of seeds or fry in hatcheries.

In the tropics, the water temperature range of 22 to 32 ^{o}C year-round is conducive for fish breeding and growth. Some fishes can breed as often as once or more per month (e.g. tilapias) while others are seasonal spawners (e.g. grass carp.) Catadromous fishes like the eel and milkfish naturally breed in the sea and migrate to lacustrine waters as lakes for growth.

Fish growth generally depends on food availability and dissolved oxygen in the water. For cultured fishes, feeds can be given in addition to natural food in the water produced through photosynthesis to increase the carrying capacity of the culture unit (e.g. ponds and cages.) An adequate oxygen supply in the water is needed by fish for metabolism. Dissolved oxygen is affected by temperature, water chemistry (e.g. pH and salinity), water depth, and biological oxygen demand.

The growth and survival of cultured fishes require good water quality. Fishes excrete urine and produce solid wastes (feces) that can pollute the culture environment. The proper balance of fish biomass with food supply and water quality is essential for successful fish culture.

3. Tilapia Farming: A Case Study

For illustrating the principles and practices of fish farming in the tropics, tilapia farming is a good example.

3.1 Fish Characteristics

Tilapias are warm water fishes originating from Africa. The major tilapia species that are commercially farmed in over 40 countries of the world are the Nile tilapia *(Oreochromis niloticus)*, Mozambique tilapia *(O. Mossambicus)*, and blue tilapia (*O. aureus)*, and their hybrids. A mutant form of tilapia known popularly as the red tilapia is also widely cultured.

Tilapias are desirable fishes for farming because they are easily bred in captivity, grow fast and are economical to culture. As foodfishes, tilapias are well accepted in many regions of the world particularly in Asia, Africa and the Americas. The leading tilapia producing countries are China, Indonesia, Thailand, and the Philippines.

Tilapias feed low in the food chain. They readily take natural food in the water such as microscopic plants and animals (plankton) through their efficient feeding apparatus but can also accept artificial diets. The fishes are particularly adapted to digesting blue-green algal cells with the highly acidic condition in their stomachs. In the breeding of tilapias, the male builds a nest at the substratum to attract the female. The male can breed with more than one female. The female tilapia mouthbroods the fertilized eggs, which hatch into sac, fry inside the buccal cavity. The female releases the fry after 7 to 10 days from hatching.

Tilapias grow to maturity in less than four months in the tropics. Breeding of tilapias can also occur throughout the year. Male tilapias grow faster than the females and are known to grow up to a size of 3 kg or more. Culture of tilapias is done in ponds, tanks and net cages in freshwater, brackishwater or seawater. The Nile tilapia (see Figure 2) is the most important species for freshwater culture while the Mozambique tilapia is the most salt-tolerant.

Figure 2. Nile tilapia (*Oreochromis niloticus*.)

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Biographical Sketch

Rafael D. Guerrero III was born in Manila, Philippines on August 7, 1944. He graduated from the University of the Philippines with the B.S. Zoology and M.S. Applied Zoology in 1964 and 1970, respectively. He took up his Ph.D. Fisheries Management from Auburn University, Alabama, U.S.A. in 1974. He is currently the Executive Director of the Philippine Council for Aquatic and Marine Research and Development based in Los Baños, Laguna, Philippines. He is also the National Focal Point for the ASEAN Committee on Science and Technology Sub-Committee on Marine Science of the Philippine Department of Science and Technology. He has authored several books on fish culture with emphasis on tilapia farming. He pioneered the commercial application of the sex reversal technology for tilapias. He has served as Dean of the College of Fisheries of Central Luzon State University in the Philippines and as consultant for freshwater aquaculture and fisheries policy studies of various local and international organizations. His current professional work is on fisheries technology impact assessment, technology management and aquaculture enterprise development. He is an Academician of the Philippine National Academy of Science and Technology and President of the Philippine Fisheries Association.