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GROW-OUT CULTURE MANAGEMENT FOR FRESHWATER FINFISHES

Several types of grow-out culture systems for freshwater finfishes have been developed in the Southeast Asian region. Most common are the earthen and concrete pond culture and the pen and cage grow-out culture in lakes and reservoirs. Each has its own requirements for species of fish to be cultured, water management, fertilization, feeding schemes, etc. Following are relevant management techniques commonly applied to the more popular cultured species in the region.

Item One: Pond Grow-out Management

Pond preparation. Initially, the pond bottom soil is sundried to eliminate undesirable species. Some undrainable ponds are treated with inorganic pesticides for disinfection purposes. Submerged and floating weeds are removed as these compete for nutrients in the soil and water, occupy space intended for fish, and tend to reduce fish harvesting efficiency.

Pond draining and drying are important for the following reasons:

1. **Nutrient regeneration.** Organic matter mineralization or the conversion of some nutrients by aerobic process is hastened.
2. **Control of unwanted fish population.**
3. **Reduced oxygen demand of sediments**. Aerobic oxidation and decomposition of organic matter are accelerated. Better pond sediment substrate for benthic fauna is created.
4. **Control of vegetation.** Weeds that hamper fish culture operations are eradicated.
5. **Disease control.** Fish louse *Argulus* and the parasitic copepod *Lernea* are controlled.
6. **Pond maintenance.** Removal of excessive sediments and debris in the pond bottom are facilitated.

Fertilization. Fertilizers enhance natural food productivity in the pond. The amount and type of fertilizer required by a certain pond vary according to the water and soil qualities in the pond, bottom mud, and type of fish for culture among others. It is best therefore to conduct soil and water tests on the site so that proper recommendations on the type and amount of fertilizers can be given.

There are two types of fertilizer: organic and inorganic. Organic fertilizers are animal manures and plant wastes containing about 40-50% carbon by dry-weight basis. These materials usually have low NPK (nitrogen, phosphorus, potassium) content, and are thus applied in large quantities. The most commonly used organic fertilizers are poultry, pig, and cattle manure. In China, night soil or human excreta is also used to fertilize carp ponds.

Inorganic fertilizers are simple inorganic compounds which primarily contain at least one or two elements of the NPK. Commercial inorganic fertilizers used for pond culture are the same as those for agricultural crops.

Water quality management. Good water quality is a prerequisite for the propagation of desirable aquatic organisms. In the pond, it enhances higher survival, better growth, and increased reproduction.

Important parameters to be considered in order to maintain good water quality are the following:

1. **Dissolved oxygen (DO).** It is probably the most critical water quality variable in fish culture. The primary sources of DO under a fish culture system is through photosynthesis and from atmospheric oxygen diffusion. Loss of oxygen is caused by plant (micro and macro) and fish respiration and oxygen diffusion back into the air. Concentrations of DO are lowest in the early

morning just before sunrise, increasing to its maximum level in late afternoon, then decreasing during the night. The desirable level of DO in the pond is about 5 ppm or higher. Fish cease to feed or grow well if DO level remains at 3-4 ppm.

Oxygen depletion in the pond is caused by (a) excessive water fertility due to fertilization and/or feeding, resulting in high plant respiration and phytoplankton die-offs and (b) too high stocking density. Consumption of DO by fish and other organisms for respiration accounts for the greatest loss of DO.

Low DO level in the pond can be predicted by the color (brownish) of the water and fish behavior (surfacing especially in the early morning).

Low DO level in the pond can be corrected by (a) emergency aeration technique and (b) mechanical aeration. The former is done by flushing high DO water into low DO pond. It is effective and inexpensive where adequate supply of high DO water is available as in streams, wells, or adjacent ponds. Mechanical aeration makes use of paddlewheel that circulates and splashes water into the air and the air blower which injects air either at one side of the pond or through a perforated pipe.

2. **pH.** It indicates whether the water is acidic or basic (alkaline) in reaction. To determine a typical pattern, water pH is usually measured early in the morning (6 am) and in the afternoon (6 pm). pH values of about 6.5-9.0 at daybreak are considered best for fish production. The acid and alkaline death points for fish are approximately pH 4 and pH 11, respectively. Although fish may survive, slow growth of fish occurs with morning pH values between 4 to 6 and 9 to 10.

3. **Ammonia (NH_3).** In freshwater ponds, ammonia occurs as a product of fish metabolism and decomposition of organic matter by bacteria. There are two types of ammonia in water: the un-ionized ammonia and the ammonium ion. The un-ionized form of ammonia is toxic to fish, while the ammonium ion is not, except at extremely high concentrations.

For pond fishes, the toxic levels of un-ionized ammonia range from 0.6 to 2.0 mg/l. High concentrations of total ammonia-nitrogen usually occur after phytoplankton die-offs at which time CO_2 is also high and pH is low (acidic). However, it is seldom that concentrations of ammonia in ponds are high enough to adversely affect fish growth.

Clay turbidity. Suspended materials brought about by turbidity reduce light penetration required for photosynthesis, thereby reducing oxygen generation and phytoplankton production. When resulting from plankton organisms, such turbidity is desirable in the pond. However, when turbidity is due to suspended clay particles, it becomes undesirable. A persistent clay turbidity of 30 cm or less may prevent development of plankton blooms.

Clay turbidity can be avoided by applying organic materials such as cut hay or grasses or manure in the pond at 0.05 kg/m^3 of pond water for a turbidity of 25 ppm and 0.4 kg/m^3 for turbidity of 200 ppm. Another technique is to apply alum (aluminum sulfate, $Al_2(SO_4)_3 \cdot 14H_20$) which causes suspended clay particles to coagulate and precipitate from the water column within a few hours. The rate of application is from 25 to 30 mg/l of water. Lime can also be used to prevent persistent turbidity; however, continuous application of lime causes an increase in water pH.

Fish management. One of the most important considerations in pond management is the stocking of the appropriate species and quantity of fish. A fishpond can only support so much fish according to the available space and amount of food present. This limitation is referred to as the "carrying capacity" or the "maximum standing crop" of a pond. However, the carrying capacity of the pond can be increased by fertilization and supplemental feeding. Aeration and running water systems usually increase the amount of DO thus increasing the carrying capacity of a pond.

The stocking rate of a pond can be further increased by polyculture system (culture of different species with diverse feeding habits in one pond) and by stock manipulation (stocking of fish of different ages or sizes).

Pond culture involves different management systems and stocking practices. These are:

Monoculture. It is the stocking of a single species in one area which could be monosize, multistage, or multisize stocking. Monosize stocking means to stock one species at one time and to harvest all fish upon reaching marketable size. Too high stocking density will mean slow growth and/or survival rates, whereas too low stocking density will result in inefficient utilization of food in the pond.

To avoid the disadvantages of monosize stocking, a multistage stocking is used where fish of uniform sizes are stocked in progressively larger ponds as more space is needed. The density of fish is adjusted based on body size as they are transferred to larger ponds. The smaller ponds are then prepared for the succeeding batches of younger fish.

Multisize stocking is the stocking of fish of different age groups. Feeding habits of fish vary as they grow, i.e., fry feed mainly on plankton while adults feed on a variety of feed sources. This enables periodic harvesting of marketable-sized fish.

Monosex stocking. This practice is most applicable to tilapia where excessive reproduction needs control. However, this requires considerable expertise in manually separating the sex of tilapia or in the application of hormones for sex inversion.

Double cropping. It is the stocking of two species in the same pond but during different seasons or time of culture (in cases where the two species have different culture seasons depending on the availability of seeds for stocking).

Polyculture. It is the stocking of different species having complementary feeding habits thereby efficiently utilizing the different feeding niches of the pond. A very good example is the Chinese carp culture in ponds using bighead, silver, and grass carps.

Item Two: Pen Grow-out Management in Lakes

The fishpen industry in the Philippines was started in 1970 primarily for the culture of milkfish in Laguna de Bay. The culture of milkfish in pens in the lake proved to be more successful than that in brackishwater ponds. Today, however, it is not only milkfish that is being cultured but also tilapia, bighead and silver carps, and the common carp.

The size of pens varies from <1 ha to >100 ha. The principal materials used in constructing fishpens are bamboos and nylon nets. Palm tree (*anahaw*) trunks are staked along the periphery of the pen to give additional strength against strong winds and waves especially during typhoons. The shape of the pens also varies but most are rectangular or square. However, most operators agree that circular or oval pens are more advantageous because (1) less material and labor costs are needed, (2) dirt, obstacles, and water hyacinths carried by winds and waves do not stay in one place but find a way out of the pen, and (3) fish do not get trapped in the corners during strong winds and rains but swim around in schools.

Source of fingerlings for stocking. Fingerlings of milkfish, carp, and tilapia are stocked directly in the fishpens. Nurseries of these species are established elsewhere. For milkfish, major sources of fingerlings are Malabon (Metro Manila) and Bulacan. Fish fry are collected from the wild. Bighead and silver carp fingerlings are produced by several hatcheries built mostly around the vicinity of the lake. Tilapia hatcheries and nurseries are found all over the lake. The sizes of milkfish and carp fingerlings for stocking range from 6-7 cm. For tilapia, 5-cm fingerlings are used for stocking.

Time of stocking. The best time to stock fishpens is between March and June which coincides with the highest production of natural food in the lake. Temperature ranges from 30 to 33°C which favors fast growth of fish. Also during this time of the year, phytoplankton reaches a production of about 30 g/m^3/day. Primary productivity ranges from 0.5 to 9.0 g C/m^3/day.

Pen preparation prior to stocking. Most fishpens have a nursery compartment within the grow-out pen. Before the fingerlings arrive, the nursery as well as the grow-out pens are netted using a seine net for predator fish and other species like snakeheads, catfish, etc. which could wipe out the stock. The peripheral nets are checked for damages where the fingerlings could pass and escape.

Fish stocking in the grow-out compartment. The fingerlings are released from the nursery compartment by lowering one side of the net until all the fish have gone out. In Laguna de Bay, the stocking density of milkfish or tilapia is regulated by the Laguna Lake Development Authority (LLDA) at 25 000 ind/ha. For a polyculture system utilizing tilapia, silver carp, bighead carp, and common carp, a stocking density of 40 ind/m^3 is suggested, spread out at the ratio of 30 tilapia: 5 silver carp: 4 bighead carp: 1 common carp. Selective harvesting of tilapia may be done at intervals of 4-5 months since tilapia reach marketable size (100 g) earlier than the rest of the stock.

Feeding. Fish are not usually given supplemental feeds as long as primary productivity is high, especially during summer. However, during times when food production is low, fine rice bran may be broadcast on the water surface at 10-15 sacks/ha.

Pen maintenance. The area is inspected daily for possible damage to nets. Security around and inside the fishpen especially during nighttime should be provided to check on poachers. Guardhouses should be strategically located around the fishpen.

Harvest. Fish can be harvested when they attain a minimum size of about 100 g (10 pieces to a kilo) for milkfish and tilapia and 1.5-2.0 kg each for bighead and silver carps. Fish are harvested by purse seine, gill net, or cast net. About 15-20 people are needed to operate a purse seine.

Item Three: Cage Grow-out Management in Lakes

The cage may be a floating or stationary type. The former is suitable for deeper portions of the water body while the latter is best for the shallower portions. The floating type of cage is moored to keep it in place. Size of cage varies from a small 3m x 3m x 1.5m to a large 9m x 16m x 1.5m or 18m x 20m x 1.5m.

Fish stocks. In the Philippines, tilapia are the most commonly used species for cage culture. Tilapia are stocked at 10-30/m^2 of cage depending on the season. In Laguna Lake, 5-cm tilapia fingerlings are stocked at 20/m^2 during the months of April to July when natural food is abundant. In 75-120 days, the fish may attain a size range of 150-180 g each. A lower stocking density is recommended during September to February when natural food density is low. However, stocking density can be increased if supplemental feeding of rice bran is used.

Maintenance of cages. The nets are periodically cleaned of algae and freshwater sponges that attach to the net as well as to the bamboo posts. These materials tend to clog the nets and thus limit water circulation in and out of the cage. During inclement weather, cages which are provided with cover may be submerged at least a foot beneath the water surface to prevent damage from strong waves.

Harvest. Total harvest of fish may be done when majority of the stock have reached the desired size for market. Partial harvest is done only for fish of harvestable size while the smaller ones are allowed to grow further.

Source: Armando C. Fermin, "Grow-out Culture Management for Freshwater Finfishes" (lecture notes in *Aquaculture Management* training course, April 1990), SEAFDEC/AQD, Tigbauan, Iloilo.

COMPARING NUTRIENTS IN WILD AND FARMED FISH

Do farmed fish measure up to their wild cousins in nutrient? They certainly do in protein. It is important that farmed fish should not be compromised in this respect because protein is one