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Fact Sheet FA-4

Raceway Production of Warm-Water Fish[1]

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Many who are interested in commercial fish farming strike upon the idea of raising catfish or other warm-water species in raceways. This idea seems appealing because yields per unit of growing area may be theoretically increased and the need for large ponds eliminated or reduced. While the thought process that leads one to this conclusion is sound, there are other factors which make the raceway culture of warm-water fish a rather risky, and as yet an economically unproven venture. Nevertheless, interest in the use of raceways or other similar intensive systems remains high and those who are trying to evaluate the pros and cons often find a scarcity of information on which to base their decisions. There are sometimes unique situations where raceway systems may be practical and profitable. The general operating characteristics of raceways and related intensive systems are described below.

Facilities

Raceways are generally constructed in a ratio of 5 to 1 (or greater) length to width, and with a depth of 3 to 5 feet. Water should flow evenly through the system to eliminate areas of poor water circulation where waste materials or sediment may accumulate. Raceways may be constructed above ground or in the ground from cement or fiberglass, and even wood has been used. Fish culture in raceways requires a large quantity of good quality water, preferably supplied by gravity flow from artesian wells or higher elevations. If pumping is required, operating cost may be high and risks increased due to possible failure of pumps or power supply.

Water Requirements

One should consider raceways only if an abundance of good quality water is available. On the average, 1 to 3 gallons per minute of flow should be available for each cubic foot of raceway volume at densities of 3 pounds of fish per cubic foot. If supplemental aeration is used, the water requirement may be somewhat reduced. Water flow should be sufficient to keep solid waste material from accumulating in the raceway and to dilute liquid waste (primarily ammonia) excreted by fish.

Water Quality

To achieve good production and minimize problems of stress and disease, water quality should be sustained within desirable ranges at all times. Oxygen should be maintained above 60% of saturation. Ammonia levels should remain below 0.1 mg/l in the discharge. Alkalinity, hardness, pH and temperature should remain within the optimum range for the cultured species. Water quality should be monitored frequently, especially oxygen and ammonia, to ensure that conditions remain suitable. This enables the producer to learn more about the production system and its operating characteristics. Water quality test kits, which are available from aquaculture supply catalogs, are suitable for most routine analyses.

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Water Management and Recirculation

Traditionally, raceways are considered to be single pass, flow-through systems. Some fish farmers have developed raceways which are joined with ponds, and use the ponds to clean the water prior to reuse. If such a system is designed, the pond(s) should have a volume of at least 7 times the total daily discharge volume of the raceway. This allows sufficient time for water quality improvement. Since pond culture is a successful and traditional way of growing catfish and most warm-water species, it is not practical to build ponds so one can use a raceway system. If existing ponds are available, but not suitable for traditional fish culture due to excessive depth, uneven bottom or debris, a raceway system of this type may be considered.

Recirculating systems are often proposed as a type of closed or semi-closed raceway. The water is reconditioned by clarification, biological filtration, and reaeration so that most of the water is re-used and only a fraction of the total daily flow is made up of new water. The productive capacity of this system is dependent on the ability of the filtration system to remove wastes and on the volume of replacement water used to improve water quality. Fish production in systems of this sort may reach levels similar to that achieved in raceways. Water quality should be monitored frequently in such a system since without high rates of water exchange, toxic metabolites may accumulate rapidly if the biological filtration system is not sufficient to handle the wastes.

Stocking Rates

The quantity of fish which can be grown intensively in a raceway is more dependent on the quantity and quality of the water than on the size of the facility. Small fish consume proportionally more oxygen per unit of body weight than larger fish, and therefore are normally stocked at lower densities. Densities of fish stocked in raceways may range from 1 to 10 pounds per cubic foot of water, depending on the capacity of the system to support the population. In practice, stocking densities can be calculated based on expected harvest weight of fish to be produced, or based on the carrying capacity of the system. With the latter method, the number of fish is reduced as their size increases.

Feeds and Feeding

Fish produced in ponds derive part of their nutrition from natural foods. In raceway culture, fish are dependent on a prepared diet for all of their nutritional needs. Therefore, feeds for intensive fish culture need to be of a better quality and the fish farmer must pay a higher price. Higher protein content and more complete vitamin and mineral supplements are usually the two major improvements in the feeds for intensive fish culture systems. Since raceways are flowing water systems, feeds not directly used by the fish are lost from the system. Growers should strive to ensure that fish are not overfed, and adjust feeding rates accurately to ensure efficient production. Poor feed conversion rates typically indicate improper feeding practices, inadequate diet composition, or adverse environmental conditions. Feeding rings, backwash areas, or temporarily stopping water exchange may be considered if flow rates are such that feed is too quickly flushed from the system.

Constraints and Risks

This discussion has considered general aspects of the design, operation and management of raceways and similar intensive systems. The information presented is not a guide to developing such a system since the engineering and management involved are complicated. Anyone considering such a venture is strongly urged to thoroughly evaluate the economic costs and management requirements of the operation prior to proceeding (Table 1). There are a number of raceway systems that have been tried in the past for warm-water fish without a great deal of success. Some of the reasons why these systems are still considered high risk or economically unfeasible should be emphasized.

It is premature to discard raceways systems as unworkable. The knowledge and skill of aquaculturists is continually increasing as they strive to achieve better and more intensive ways of raising fish. To date, however, the pond system of production has worked better for warm-water species. Little sponsored research is being conducted on raceway culture and at present it remains for the entrepreneur to develop and test their potential. There is no question that fish can be raised intensively in raceways and recirculating systems, but the bottom line remains that in the majority of circumstances, it has not been proven to be competitive with existing production methods.

Table 1. Constraints and Risks of Raceways.

Constraints
Large water requirement
High costs of construction
High operating costs
Require more expensive feeds
Discharge permit required
Require more management skill
More stress on fish
Vulnerable to catastrophe
Price competition from pond raised fish
Risks
Insufficient water supply
Poor water quality
Mechanical failure
Power failure
Massive fish kill