Planning for Commercial Aquaculture

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Introduction

Aquaculture, the practice of growing finfish and shellfish under controlled conditions, is not a new concept. The Japanese, Chinese, Romans, Egyptians, and Mayan Indians of South America farmed fish for food and recreation prior to 2000 BC. They constructed ponds and raised fish much as fish are raised today. Both freshwater and saltwater fish are currently raised commercially throughout the world. Other fisheries-related products, such as shrimp, crayfish, oysters, clams, and frogs, are also raised commercially. Although many fish are reared commercially, the vast majority of fishery food products eaten in the United States are produced from wild stocks captured in natural waters, not farmed.

Fishery food products are a potential answer to the growing problem of world dietary animal-protein shortages. Fish are able to convert their feed into flesh about two times more efficiently than chickens and five to ten times more efficiently than beef cattle. Feed conversion rates of fish are higher than other common commercial animal protein sources because: (a) fish can utilize foods that are not used by most land animals; and (b) they require less energy from their foods to live. Moreover, fish can use the entire three-dimensional environment of ponds, from top to bottom and sideways, for living space, while terrestrial animals are confined to the two-dimensional surface of the ground. Consequently, the proper combination of fish species, adequate fertilizations, and careful feeding can result in yields approaching 6,250 pounds per acre compared to approximately 1,000 pounds per acre yield from beef cattle production. The potential for commercial production and the lure of high profits have accelerated the interest in fish farming and other types of aquaculture.

Establishing a commercial aquacultural enterprise involves a four-step process that should be strictly followed by the prospective aquaculturist.

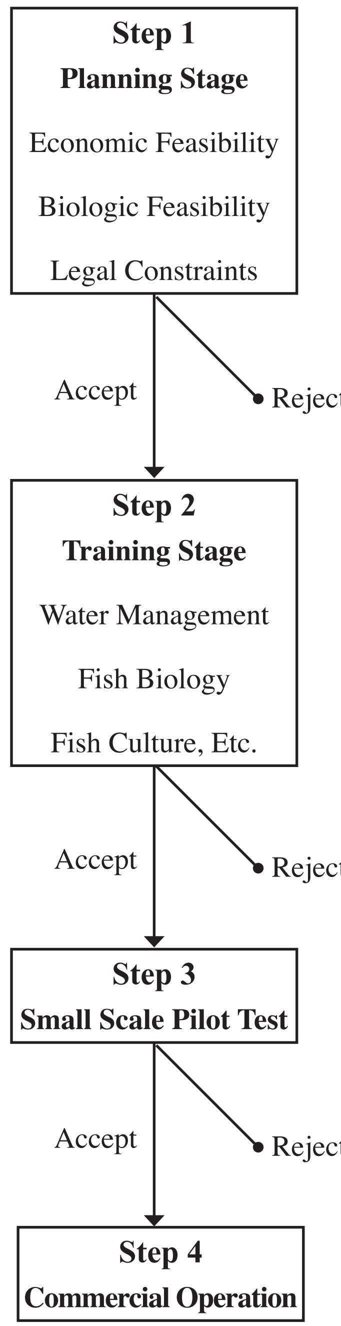

Figure 1. Flow Diagram: Four-Step Process to Establish a Commerical Aquacultural Enterprise

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Step 1 -- Planning

An exhaustive planning stage is necessary before any large capital investment in aquaculture is made. This step is particularly important when deciding on the feasibility of any costly venture. The planning stage involves a detailed evaluation of the biologic, economic, and legal feasibility of raising a particular fish or group of fishes. Both economic and biologic considerations are of equal importance in the United States. Legal constraints can also severely limit the potential for aquaculture in certain areas.

Economic Feasibility

An aquaculture venture will be economically feasible if a fish or fisheries product can be produced at a cost competitive with other animal-protein sources and can be sold at a reasonable profit. Economic considerations can be divided into demand, finance, production, and marketing.

Product demand involves the relationships between the amount of product that consumers will purchase, the selling price, the price of competing products, the size of the consuming population, and the income of the consuming population. Many fish and fisheries products command high prices as luxury food items, but these items are characteristically in short supply. Since demand for luxury foods is normally limited, increased production would result in reduced product revenues. Other fish and fisheries products which command lower prices must compete with meat products. Until these aquacultural products can compete favorably in terms of price with chicken and hamburger, the size of the fish-consuming public will remain relatively low.

Financing is also a very important economic consideration. Private sector financing can be characterized as conservative. Rarely can the private sector be persuaded to finance projects where risks are high, profits uncertain, and past experience to guide decisions unavailable. Capital for aquaculture is often difficult to obtain from private sources. Public financial assistance does not currently include aquaculture; however, some programs available to agriculture have been extended to include aquaculture.

Production economics involve various direct costs which can be divided into systems costs, production costs, and processing costs. These factors can be outlined as follows:

I. Systems costs
  1. Initial facilities investment
    a. land (ponds, raceways, wells)
    b. buildings and equipment (tanks, filters, pumps)
    c. alternative power sources (solar, electrical, fossil fuel)
  2. Maintenance
  3. Depreciation
  4. Taxes
  5. Interest on working capital

II. Production costs
  1. Fish stock (eggs, fingerlings, spawners)
  2. Chemicals (disease control, additional fertilizer)
  3. Feed
  4. Labor
  5. Water pumping, heating, oxygenation
  6. Fuel (operation and transport)
  7. Miscellaneous supplies
  8. Harvesting
    a. equipment (nets, lifts, tractors)
    b. labor
    c. holding and/or transport facilities

III. Processing costs (if applicable to product)
  1. Direct cost to producer
  2. Shipment to processing facilities

Most aquaculture ventures are extremely labor-intensive. The cost of labor usually represents the most limiting factor in terms of production costs. Less labor-intensive aquaculture ventures are normally limited by high feed costs. Poor understanding of the nutritional requirements of fish and fisheries products results in rigid diet formulations. The costs of diets can skyrocket if a particular necessary ingredient becomes scarce. Processing can be considered a production cost if existing processing facilities are not available to the producer. Processing costs, as well as the multitude of state and federal regulations governing processing, can pose a significant constraint to prospective aquaculturists.

Marketing involves the movement of goods from the producers to the consumers. New aquaculture industries can have significant marketing problems. Ideally, the marketing network for food items involves processors, distributors, and outlets. Although a producer can bypass processors and distributors, bypassing these middlemen will greatly increase costs and risks. Because of the additional risks involved, it is desirable to work through an established marketing network that can adapt to a new aquacultural product.

Establishing a market network for a new aquacultural product requires a continuous, year-round supply of the fish or fisheries products sent to the processor. Until a year-round production system can be assured, a processor will be hesitant to invest in expansion or conversion of existing equipment to handle the new product. Processors prefer to contract for products from producers on a strict schedule basis to avoid slack periods of production. Market development will be restricted if supplies are seasonal. Unfortunately, the temperatures in temperate climates restrict growth rates and promote seasonal yields. Year-round supplies can only be obtained by holding market-size aquatic animals to meet processor demand or by raising the aquatic animals in controlled temperature systems.

Distributors transfer live fish from processors to outlets or from producers to outlets. Problems associated with such distribution include low quantity and poor quality. Inadequate distribution (product handling and storage) of live fish can result in a consumer preference for well-processed, frozen, imported aquaculture products. Improper handling of live fish results in fish deaths, impaired taste, and ultimately reduced future sales.

Outlets for aquacultural products range from recreational fish ponds (live fish) to groceries and restaurants (processed food items). Outlets for processed aquacultural food items will purchase their products based on quality and costs. Consequently, imported products can often outcompete domestic sources because of established processing and distribution facilities and reduced labor costs.

Catfish production serves as an example of the economic constraints that face the potential fish farmer. A recent economic analysis of catfish production in ideal areas (level land, adequate ground water, and a growing season of approximately 210 days) indicates that a well-trained catfish producer-operator who performs all labor functions can expect net cash returns on an annual basis of $6,264.21 from a single crop of fish on 80 acres of land. By necessity, the successful catfish farmer is usually characterized by multiple agricultural activities that include production of soybeans, cotton, rice, cattle, etc., or by extensive acreage devoted to catfish production on a year-round basis. It has been reported that less than 10 percent of the U.S. catfish farmers make a sustained yearly profit (average investment yields returns of 8.3 percent) even though certain individual operators have realized returns as high as 55 percent on their initial investment. The availability of low-cost foreign fish products has had a severe impact on the commercial catfish farmer. Processed, packaged, and frozen channel catfish shipped from South America often cost less in New Orleans than the break-even price for pond-raised Louisiana channel catfish sold live at the pond bank. Growth in channel catfish farming has been restricted largely to the Southeast because of regional demand. Consequently, the acreage devoted to catfish farming has stabilized at approximately 50,000 acres.

The complexities of determining the economic feasibility of an aquacultural venture dictate that a professional economist design and perform the initial analysis. Before an economist is hired to survey the economic feasibility of a particular aquaculture venture, it may be advisable to determine the preliminary biologic feasibility of raising the desired fish or fisheries products in a particular area. Not all fish or fisheries products are suitable for culture in certain areas. Environmental constraints such as water quality, water temperatures, and the length of the growing season dictate where an aquatic organism can be raised commercially.

Biologic Feasibility

Water supply is a critical environmental constraint and restricts site selection for an aquacultural facility. Desirable water supply characteristics include relatively constant flow, constant or acceptable water temperatures, high levels of dissolved oxygen, low levels of harmful gases, low siltation levels, limited possibilities of introducing diseases or wild fishes, and no chemical or organic pollution sources. Based on these characteristics, water supply sources can be ranked from most to least desirable as springs, wells, streams, lakes, and reservoirs, respectively. Surface runoff is usually an unacceptable water source for commercial ponds because of seasonal limitations and pollution potential. Any potential water source should be adequately tested, both in terms of quantity and quality, before any facility expenditures are made.

Commercial production of aquatic organisms is often limited by water temperature and/or the length of the growing season. The body temperature of an aquatic organism is approximately the same as the water temperature that affects its activity and growth. Therefore, the water temperature must be at levels which promote growth during a significant portion of the year to enable commercially economic production of the animal. The level of temperatures that promote growth differs among types of aquatic animals. For example, trout require lower water temperatures than channel catfish for optimal growth. Temperatures below the optimal levels prolong the time required to raise an aquatic organism to market size and, consequently, raise production costs. Temperatures above the optimal level for growth will stress the aquatic organism and result in disease and often death.

Although fish and fisheries products in general have higher feed conversion rates than most terrestrial animals, not all fishes are suitable for intensive culture. Additional biologic constraints limit which aquatic organisms can be raised at commercial densities. Lack of knowledge of the reproductive biology, nutrition, and diseases of specific aquatic organisms represents the major biologic constraint to their culture.

The reproductive biology of a potentially cultural aquatic organisms must be well understood. Control over its reproductive biology is essential for commercial culture. Culture of wild captured stocks is entirely dependent on the unpredictable availability of wild fry or seed. Control over the reproductive biology of a desired aquatic organism allows the aquaculturist to produce offspring at desired times and in desired numbers.

Nutritional requirements represent a major factor in determining the suitability of an aquatic species for aquaculture. As mentioned earlier, the price of feeds based on rigid formulations can fluctuate severely with ingredient availability. This problem cannot be avoided unless the nutritional requirements of an aquatic organism considered for aquaculture are understood so ingredient substitution can be made. The nutritional requirements of fish and fisheries products are not well understood even for fish like trout and channel catfish, currently under intensive commercial culture. Some fish and fisheries products require natural feeds consisting of algae, insects, minnows, etc. If these animals are raised commercially, their natural feeds must be raised as well.

A third biological constraint to aquaculture is disease resistance and control. When aquatic animals are raised intensively they are crowded into a limited area, which tends to promote the spread of disease. If diseases cannot be identified and treated quickly, the entire stock can be lost in a few days. The potential of disease-caused disasters to aquaculture makes knowledge of diseases and their control mandatory.

Advances in reproductive control and disease control will improve the commercial potential of established as well as new aquatic species. Selective breeding and advanced systems technology will also have positive effects on eliminating many of the current biologic constraints on the development of aquaculture.

Legal Constraints

Various local, state, and federal laws can also restrict the development of aquacultural enterprises. These fall into a variety of categories including land-use laws, access laws, water-use laws, environmental laws, health and safety laws, and permit procedures and requirements. The U.S. Department of Agriculture is the lead agency in aquaculture.

If the economic, biologic, and legal aspects of the planning stage indicate that the proposed aquaculture venture is feasible, the prospective aquaculturist can proceed to Step 2.

Step 2 -- Training Stage

Production of fish or fisheries products requires a different set of technical and managerial skills than other agricultural activities. Before a would-be aquaculturist can successfully grow aquatic organisms, he needs specialized training in water quality management, aquatic weed control, parasite and disease control, nutrition and feeds, cultural techniques, marketing, and processing skills. Although an informed aquaculturist can minimize the potential risks associated with raising aquatic organisms, the untrained fish farmer continually faces the possibility of unpredictable disaster.

The necessary technical and managerial skills required for aquaculture can be gained in either of two ways. The prospective aquaculturist can obtain the necessary training by enrolling in selected college-level courses or by attending special workshops during the summer. Either alternative for obtaining the necessary skills is costly and time-consuming. An alternative way to obtain needed technical and managerial skills is to hire a fisheries biologist trained in aquacultural techniques. Many of the large, established aquacultural ventures have succeeded because professional aquaculturists were hired to perform the technical and managerial functions. However, hiring a trained aquaculturist is often undesirable for the potential producer because of cost and/or the desire of the potential aquaculturist to perform his own labor functions.

Regardless of the method utilized in obtaining technical and managerial skills, they are necessary in the developmental process for establishing a commercial aquaculture venture. Once the skills are acquired, the prospective aquaculturist can proceed to Step 3.

Step 3 -- Pilot Test

A small-scale pilot test is desirable to permit a commercial trial to determine the validity of estimates made during the planning stage. If the initial planning studies overestimated the biologic feasibility, economic feasibility, or the product's acceptability, or the economic outlook has changed, losses can be minimized by testing the estimates through a pilot test. A pilot project also permits the new aquaculturist to develop his managerial skills learned in Step 2. The magnitude of errors resulting from lack of experience can be greatly minimized by obtaining that experience during a pilot test.

A full-scale commercial operation should be undertaken (Step 4) only after the pilot project verifies the feasibility of the proposed commercial aquacultural venture and the skills of the aquaculturist.

Step 4 -- Commercial Operation

The size and nature of a commercial aquacultural venture will depend on the results obtained from each of the three preceding steps. Based on the complexity and involvement required to complete Steps 1-3, few people interested in establishing a commercial aquacultural operation ever pass Steps 1 or 2. A few people interested in aquaculture progress to Step 3 and decide to restrict the size of their operation. A small-scale operation can often provide a rewarding supplemental income by rearing fish for stocking recreational ponds or fee fishing lakes.

Very few potential aquaculturists proceed to Step 4, a commercial operation. Large-scale commercial aquacultural industries are often regionally located in areas where markets for fish products are established, processing and distribution networks are available, and the cultured species can compete favorably with captured wild fishes. The lack of an established national network of processors, distributors, and markets will continue to limit the growth of large-scale commercial aquaculture outside the established regional areas in the near future.

The Future of Aquaculture in the U.S.

The potential for aquaculture is theoretically very high. A number of factors threaten the future expansion of aquaculture, such as water pollution and potential increases in efficiency of terrestrial agriculture. However, the interest in aquaculture, the anticipated funding and developmental support through the U.S. Department of Agriculture, and advances in technology and scientific knowledge will have a positive effect on the potential for aquaculture in the U.S.

Some Critical Factors to Consider in Aquaculture:

1. Economic

   Is there a high demand and sufficient market for your product?

   Are sufficient capital or "high-risk" loans available for your operation?

   What's the cost of land purchase and pond or raceway construction?

   What are the finance interest and tax rates?

   What's the cost of maintaining facilities, purchasing equipment, and providing energy?

   What's the cost of purchasing fish stocks, fish feed, and chemicals?

   What are the processing and shipping costs?

2. Biologic

   Is there a continuous supply of high-quality water available?

   Is the water temperature optimal and the length of the growing season sufficient?

   Is the species selected for rearing adaptable to culture conditions?

   Do you have an adequate knowledge of the reproductive biology, nutritional requirements, and common diseases of the species?

   Is there an adequate supply of eggs, fingerlings, or brood stock available to you?

3. Legal

   What are the federal, state, and local laws that affect aquaculture?

   What are the permit procedures and license requirements necessary for aquacultural operations?

Additional Readings

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