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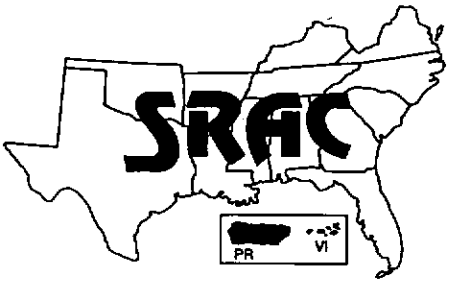

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Aquaculture: Realities and Potentials When Getting Started

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The outlook for aquaculture in this country is a bright one. Health-conscious consumers are increasing their consumption of fish and shellfish. Fish catches from the oceans are declining and subject to contamination scares. The result is an increased demand for farm-raised fish. Southern states are fortunate to have a long growing season and other resources that have allowed establishment of several large aquaculture industries, most notably **catfish, baitfish** and **crawfish.**

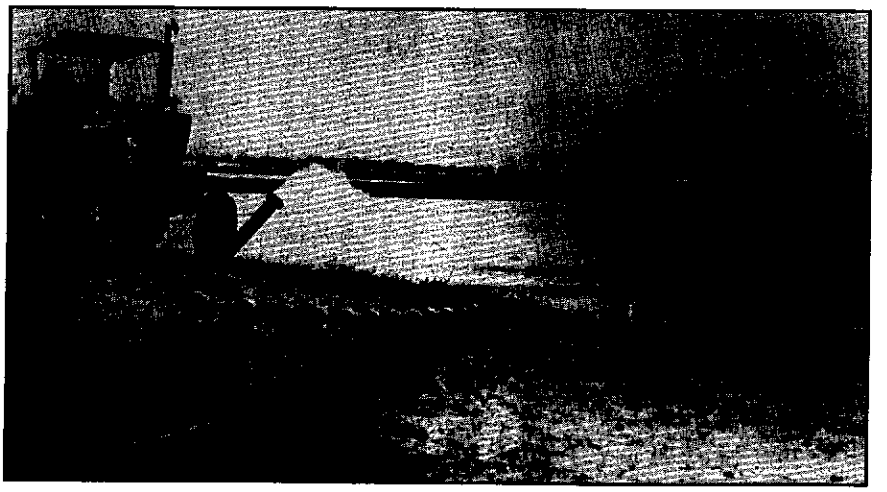
While prospects for fish farming in general are very good, the potential for individuals thinking about starting a fish farm varies widely. This publication is designed to allow the individual with an interest in aquaculture to get a clear picture of the challenges involved in establishing a successful fish farm. Although most of what is presented here applies to traditional freshwater aquaculture, readers interested in marine culture systems and speciality type aquaculture will also be able to glean useful information. A glossary is included at the end to help with new terms.

Is fish farming for you?

Running most fish farms is a lot like running a feedlot. Closely packed and heavily fed fish must be watched closely to catch problems early before they turn into disasters. This is difficult since fish cannot be readily seen. New fish farmers may feel like they are working blindfolded until they get comfortable using water quality test equipment, changes in water color and feeding response as their "eyes" for early warnings of problems. Nighttime work is done throughout the warm months and includes checking dissolved oxygen levels and running aeration equipment as needed.

In addition to the problems that good management can control, fish farmers can still face disasters. Unusually hot, cold or cloudy weather can stress fish and bring on disease. Fish can be affected by off-flavor problems that make them unmarketable for weeks to months. Flooding and the resultant loss of fish plague many fish farms. High feed prices and low fish prices can lead to economic losses even in years when production is good.

Because fish farming overlaps with public issues like wildlife conservation, food safety and water quality, the fish farmer in many states must be ready to endure a



Harvest operations in a large levee type catfish pond.

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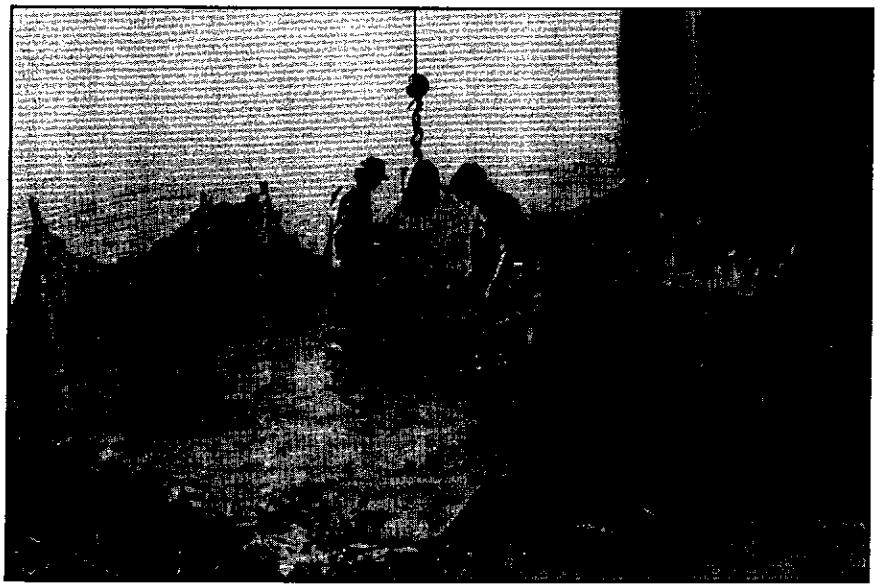
gauntlet of regulations and permitting procedures. Fish-eating birds are protected by federal law and can be killed in limited number only after obtaining a permit. Approved drugs and treatments for fish diseases are in short supply. Many states have or are drafting laws controlling water discharges from fish farms. Regulations requiring water conservation and reuse for crop irrigation are likely to become increasingly common for aquaculture in the future.

In spite of these problems, established fish producers will tell you that fish farming is a great way of life. Being tied closely to the land and living out the seasons make countryside living a rewarding experience. Fish farmers enjoy a deep sense of pride and satisfaction as they watch their fish feeding, growing and finally being harvested.



Hard physical work under tough conditions is a part of most fish farming.
Photo credit: USFWS Fish Farming Experiment Station

Facilities that work

Although fish farms may seem like a brand new idea, they really are not. Decades of work by farmers and researchers have led to the development of proven facilities for growing fish. **Keep it simple** by sticking closely to these tried and proven designs. Control your inventing urge until you have several years experience in fish farming and fully understand all the reasons why things are done certain ways.

The great majority of aquaculture products in the South are produced in levee and watershed ponds. Other production facilities, including cages, raceways, flow through tanks and recirculating systems, have not been as widely successful for a variety of reasons.

Levee ponds are standing water impoundments built by excavating the pond area to a shallow depth and using the soil obtained to build a perimeter of levees or dykes. The advantages of levee ponds include ability to harvest by seine without draining and availability of oxygen all the way to the bottom of the pond. Disadvantages include relatively high construction costs and the need for a site with a slope of less than 5 percent, soil clay content of at least 20 percent and wells or other reliable water sources.

While they may not appear glamorous, levee ponds are state of the art when it comes to reliable, economical production for catfish and most other warmwater finfish. Crawfish are produced in much shallower levee pond type structures. (See Southern Regional Aquaculture Center [SRAC] publications, numbers 100, 101 and 240.)

Watershed ponds are standing water impoundments built by damming ravines or small valleys. From 5 to 30 acres of watershed is needed to supply the water for one surface acre of pond. Advantages of watershed ponds include lower construction costs than levee ponds and ability to make use of steeper sites. Disadvantages include the inability to refill ponds at will and lack of oxygen at greater depths, which can lead to fish kills if a turnover occurs. (See SRAC publication No. 102.)

> ***"After I got into it, I realized the producers I visited early on weren't as dumb as I had thought and I wasn't as smart."***

Cages are floating enclosures in which fish are grown using a complete feed. Main advantage of cages is that they allow the use of existing water bodies for fish culture that would otherwise be impractical to harvest. Main disadvantages are greater vulnerability to theft, disturbance, moderately low oxygen levels and quick spread of disease organisms. (See SRAC publications, numbers 160 - 166.)

Raceways and flow through tanks are long channels or tanks through which fresh water flows continuously and is then discarded. Main advantages of raceways and flow through tanks are ease of handling and harvesting fish and control of waste buildup by flushing. The main disadvantage is the shortage of sites with abundant water of the right temperature, that is artesian or available without excessive pumping costs. Groundwater in the South is generally suitable for cold water fish such as trout, but too cold for warm water species such as catfish. Heating water for raceways is prohibitively expensive.

Recirculating systems are tank systems in which water is filtered and reused. Filtration is generally done by large beds of bacteria known as biofilters. Main advantages of recirculating systems are that ideal growing temperatures can be maintained year-round and they can be located anywhere. Main disadvantages are lack of reliability, high production costs and need for constant attention. Biofilters can be killed by chemicals used for disease treatments or even die on their own unexpectedly. While many think that recirculating systems have a future in fish farming, the short term outlook for them remains experimental. (See SRAC publication no. 451).

Location is everything

Much time, effort and money have been wasted trying to force fish farms to fit in impractical locations. First and foremost, a fish farm needs **abundant, good quality water.** To get a sense of the large amounts of water needed, consider that raising just 1,000 pounds of catfish will take about 244,000 gallons (0.75 acre-feet) of water. This is in a typical levee pond that is drained once every 5 years. Raising the same amount of catfish in a raceway requires an enormous amount of water – roughly 65 times as much as in a levee pond!

Underground water from wells and springs is preferred for fish farming because it is free from wild fish and parasites. Some fish farms do use water from lakes and creeks but problems with fish parasites and invasion by trash fish are a constant battle. Surface waters also carry the threat of random contamination by pesticides or other harmful chemicals. Some ground and surface waters are totally unsuitable for fish farming. Have your water source tested before you purchase property or break ground. Your county Extension center or aquaculture Extension specialist can assist you in determining how best to test the suitability of water for fish farming.

Suitable soils and slopes are vital for the proper, economical construction of ponds of the type used to produce most aquaculture products in the South. To hold water, soils generally need to have 20 percent or more clay content and be free of rock outcroppings, sand lenses and other causes of excessive seepage. Ponds built on sites where soils hold water poorly often must be abandoned since corrective measures are costly. Levee ponds are generally built only in areas with less than 5 percent slope with about 1/2 percent being ideal. See SRAC publications, numbers 100 and 101, for more information on levee ponds.

Areas with more than 5 percent slope are generally better suited for watershed type ponds. See SRAC publication No. 102 for more information on watershed ponds. Your county Soil Conservation Service office can assist you in evaluating the suitability of a site for pond construction. Raceways and other production facilities are less dependent on soils and slopes.

Laws and regulations can prohibit fish farms on certain sites. A site classified as a wetland usually cannot be developed. Feeding of any livestock in the watershed of a municipal water supply lake may be prohibited. Sites close to public waters may not be feasible for fish farms due to concerns about escape of fish or discharge of water. Contact your county Extension agent or aquaculture Extension specialist for a list of agencies involved in permitting fish farms. Obviously, it is best to investigate possible restrictions and have your permits in hand before making a major investment in a site.

What to grow?

Like any other business, fish farms must produce what their markets want to buy. Outside of major aquaculture areas, fish farmers must work doubly hard to be sure that their resources are suitable for what they wish to produce and to build their own markets from the ground up. Ideas for developing markets are contained in SRAC Publication No. 350, *Small Scale Marketing of Aquaculture Products.* In major aquaculture areas, there are processors and other established markets for certain products. In this case, your problem is probably not deciding what to grow but if you can get production costs down low enough to succeed.

Catfish are the major aquaculture product in the South. Production is centered on Mississippi, Arkansas, Alabama and Louisiana, although smaller industries exist in most other southern states. Catfish production is divided into fingerling production and food fish production. Many producers specialize in one or the other. Key requirements for **levee** pond catfish farms include 25 gallons per minute of water for each surface acre of pond and land suitable for levee ponds as described in the previous section. The investment needed ranges from $3,000 to $5,000 per surface acre, excluding land costs. Key land and water requirements for **watershed** pond catfish farms include those listed for watershed ponds in the previous section. The investment needed ranges from $2,000 to $4,000 per surface acre, excluding land costs. See SRAC publications nos. 180 and 181 as well as other catfish farming fact sheets available in your state.

Crawfish production is centered on Louisiana and eastern Texas, although there are small farms scattered throughout the South. The red swamp and white river species of crawfish are the most commonly cultured. Key requirements for these and other burrowing species include heavy clay soils and from 70 to 100 gallons per minute of water per surface acre of pond. Flat sites are needed to allow economical pond construction. The hand labor needed to empty and reset traps daily during the harvest season may be hard to obtain outside of major crawfish pro-

duction areas. An investment of approximately $80,000 is required for a 40 acre crawfish farm, excluding land costs. (See SRAC publications, nos. 240 - 242.)

Baitfish production consists mainly of golden shiners with smaller amounts of fathead minnows and goldfish. Arkansas dominates baitfish production. Key requirements include a site suitable for levee ponds and 20 or more gallons of water per minute per surface acre. The investment required for a 100 acre baitfish farm is in the neighborhood of $200,000. (See SRAC publications, nos. 120 - 122.)

Largemouth bass, bluegill and other sport fish fingerlings are widely produced for stocking recreational fishing ponds. Key requirements include land and water resources suitable for levee or watershed ponds. Special skills are required to handle, protect and provide food for very young fish. Experience in producing large fish is usually obtained before the production of fingerlings is attempted. (See SRAC publications, nos. 140 - 142, 200, 201.)

Rainbow trout farming in the South centers on the Smoky Mountains of North Carolina, Tennessee and northern Georgia where water from mountain streams is diverted to flow through concrete raceways and tanks. A small farm is considered to be one with a water flow of 500 gallons per minute. The establishment cost required for such a small farm is approximately $26,000. (See SRAC publications, nos. 220 - 223.)

Striped bass, hybrid striped bass and red drum for food are newly developing species for fish culture. Farms are concentrated somewhat along coastal areas. Levee pond culture predominates with some interest in flow through systems and recirculating systems. Water should have an alkalinity of 100 mg/L or more. (See SRAC publications, nos. 300 - 303, 320 - 324.)

Tropical aquarium fish for the pet market are raised mainly in Florida due to the favorable climate there. Both small earthen ponds and tanks are used. The conditions required to spawn and rear tropical aquarium fish can be difficult to provide. Requirements vary from species to species and information may be difficult to obtain.

Many additional species may be feasible for your situation. Others may not be. Many types of fish and shellfish are uneconomical or impossible to produce because of lack of proven feeds or fingerlings or other technical problems. Sticking to tried and proven forms of fish farming is the best advice when starting out. There is no easy money to be made in aquaculture. If someone offers you something that sounds too good to be true, it probably is.

The heart of good management

Nothing is as important from a farm-raised fish's point of view as **water quality**. Dissolved oxygen levels in water can drop quickly, suffocating them. Wastes produced by fish can build up, harming their delicate gills and leading to other problems. Fish farmers can deal with these dangers, but only after they have learned how to use water quality test equipment. The Cooperative Extension Service in most of the southern states offers water quality workshops for fish farmers. These let you get hands-on experience using test equipment, learn what the water quality numbers mean and what management actions to take.

Reasons to start small

Big mistakes are expensive. There is no good use for facilities built the wrong way or on the wrong site. The most common examples are ponds that will not hold water or cannot be drained.

More time is available to develop markets and learn what your customers need. You may find a more profitable market for what you produce than you had originally planned and need to change your way of growing and harvesting to fit this new market.

Design of ponds and facilities can be improved. Different size ponds or other changes can easily be made when expanding at little or no added cost.

Fish farming may not be to your liking. The labor or management required may not be what you had expected.

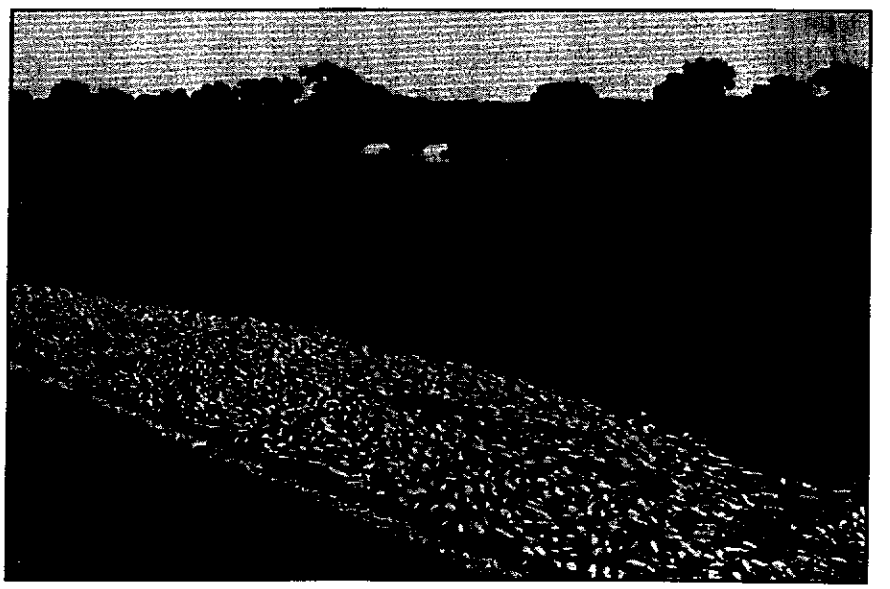


Figure 1. The price of poor water quality management is dead or sick fish.

(See SRAC publications, nos. 370 and 371.)

New fish farmers who put off buying and learning to use test equipment often sail along happily believing the warnings do not apply to them. Then suddenly they discover an entire pond of dead or sick fish (Figure 1). Producers who take the time to check oxygen, ammonia, nitrite and other water quality factors on a regular basis find that the effort pays off in many fewer fish kills and disease problems.

Dollars and sense

Taking the plunge into aquaculture should be done only after careful planning. This may not be as complicated as you think. A good way to start is to list the income and expenses you expect. First, consider the **income** your fish farming operation will produce. Generally this means estimating the amount of fish you will produce and the price you will receive for them.

Next, make a list of the expendable items you will need to buy each year to produce your fish. This will include feed, fingerlings, labor, fuel, electricity, equipment repair, interest on borrowed money, etc. These are your **variable costs**.

Finally, make a list of costs for everything associated with machinery. These are your **fixed costs**. Examples include pond construction, wells, pumps, trucks, feed bins, tractors, aerators and buildings. Do not overlook the cost of buildings, tractors or other equipment that is already purchased. They should be charged off some each year of their expected life since they will eventually need to be replaced. Equipment used for other jobs on the farm also needs to be partially charged so each enterprise can stand on its own. For example, a tractor that is used 20 percent of the time for fish farming would show up on your list as 0.20 tractors. You may wish to look over published fish farming budgets available through your county Extension center to help insure that your listed expenses are complete.

One major reason to estimate income and expenses is to be able to project your return or profit. Another use of the same numbers is to project a breakeven cost for what you produce. To get these critical numbers you will need to organize your information into a form known as an enterprise budget. Your numbers are already divided into three lists: income, variable costs and fixed costs. Now put these numbers into four columns: item, quantity, $/unit and total as shown below (Figure 2.)

Income			
Item	**quantity**	**$/unit**	**total**
Fish	50,000 lbs	$0.75/lb	$37,500
Total income			$37,500 (A)

Variable Costs			
Item	**quantity**	**$/unit**	**total**
Feed	43 tons	$250/ton	$10,750
Fingerlings	40,000	$0.12 each	4,800
Hired labor	300 hrs	$4.00/hr	1,200
Electricity			800
Equipment repair			750
Sub total			$18,300
Interest 12%			$ 2,196
Total variable cost			$20,496 (B)

Fixed Costs					
Item	**quantity**	**$/unit**	**total**	**useful life**	**ann. depr.**
Pond construction	15 acres	$ 3,000	$45,000	20 yrs	$2,250
Well	1	10,000	10,000	20	500
Truck	0.20	18,000	3,600	10	360
Oxygen meter	1	800	800	5	160
Tractor	0.20	12,000	2,400	10	240
Aerator	1	1,500	1,500	10	150
Storage building	0.40	8,000	3,200	20	160
Harvest equipment	1	2,000	2,000	5	400
Sub total			$58,500		$4,220
Interest 12%			$ 7,020		
Total yearly fixed cost					$11,240 (C)

Estimated return (A-B-C)	$5,764
Breakeven cost (B+C) /total lbs produced	$0.63/lb

Figure 2. A sample enterprise budget.

Do not get discouraged if the estimated return is tiny or even negative. The first budget is just a starting point. Consider ways to reduce your costs. In this example, doing your own pond construction work with used equipment could reduce pond construction costs by half. This would raise total return by $3,825 per year.

Another way to reduce costs would be to use your own funds instead of borrowing. If you were able to take money out of a Certificate of Deposit yielding 7 percent, your savings on interest over a 12 percent bank loan would be 5 percent or a total of $3,840.

A third way to reduce costs would be to get bigger. This is often the only way to earn a profit when selling to high volume, low price buyers such as processing plants. You may also wish to try budgets for different size fish farming operations to determine how big you must be to reach different income levels.

Income can be increased by seeking out different buyers willing to pay higher prices. SRAC publication No. 360, *Small Scale Marketing of Aquaculture Products,* discusses many of these alternatives. Be creative – time spent finding and developing specialty markets can yield good returns.

"If it won't work on paper, chances are it won't work at all."

Think like a banker

Regardless of how you will finance your operation, you will find it to your advantage to think like a banker. Find out if your plans make good technical and economic sense by getting out and talking with a wide range of people. This includes potential customers, Extension specialists, Soil Conservation Service employees, businessmen and others. Visit as many fish farms as you can. Keep an open mind but remember that some fish farmers have pet theories and ideas that may or may not apply to your situation.

Here are some of the major areas anyone making a major investment in a fish farm should carefully consider:

Production technology

- Is the species you plan to produce being profitably produced on commercial farms or is it still in the experimental stage of development?
- Has the proposed production facility design been proven through wide-spread profitable use or is it an experimental system?
  - Experimental species or production systems may seem glamorous but few individuals can afford to risk the money needed for such research.

Physical resources

- Does the proposed site have the right soil, slope, water and road access conditions for the type of production facility to be built?
- Is there a better type of production facility for this site?
- Is the proposed site only marginally suitable?
  - If so, consider other sites before committing yourself.

Marketing

- Who are your planned customers?
- How much will they buy from you, how frequently and at what price?
- What are their preferences/demands as far as product size, form, uniformity and other factors?
- Is the market already saturated?
- Who is the competition and how will you compete against them?
  - Get a realistic picture of your strengths and weaknesses by looking at the situation from the customer's point of view.

Seedstock, feed and specialized supplies

- How will you obtain a reliable supply of fingerlings or other seedstock, at a reasonable price?
- Can you afford the extra investment in time and money needed to develop your own seedstock production capacity?
- Is there a proven, economical diet available for the species you plan to produce?
- Do you have a reliable, affordable source for other specialized supplies and equipment?

Financial factors

- What is your strategy for obtaining funding?
  - A formal business plan should be prepared anytime a major investment is planned. Your county Extension center should be able to provide fact sheets or other assistance in preparing business plans.
- Are there other ways that the money could be invested for greater return at less risk and equal personal satisfaction?
- Can your financial situation stand a new fish farm that will only break even or suffer a loss the first several years of operation?

Personal factors

- Can your personal situation stand the extra stress of starting a new enterprise?
- Do you and/or your employees have the skills needed to make the proposed operation work?
  - Consider management skills as well as mechanical and farming skills needed.
- Would you hire yourself to do the planning, management and day to day labor required?
  - Be honest with yourself about your strengths and weaknesses.

For non-farmers

Most farmers were born and raised on a farm. Very few learned how to farm as an adult. As a non-farmer, this puts you at a considerable disadvantage. You will need to go through a period of on-the-job training. Are you the kind of person who does most of the maintenance and repair work? Can you put up with outdoor work during bad weather and odd hours? If so, great – these are skills and tolerances you will need on a fish farm. If not, you may wish to reconsider before getting into fish farming.

Agriculture has never been an easy way to make a living. Far from leading a peaceful worry-free life, farmers often face weather problems, low market prices, diseases and long working hours. Farming today requires much more than just being able to produce a crop. Successful farmers must have a sound understanding of the economics of their operation, keep good records and work to find the best markets for their product.

Planning for the unexpected

- How will you minimize or cope with construction delays due to bad weather, slow government permits, lack of specialized equipment or other bottle necks?
- Hope for the best but be prepared for the worst.

The bottom line

Commercial aquaculture involves all the struggles that go with any form of farming. In addition to these, fish farmers must plan carefully to make sure that their production facility is based on a tried and proven design, the site conditions are right, and reliable markets exist or can be developed.

In return for their efforts fish farmers enjoy an independent, countryside style of life and can expect to receive a reasonable return on investment, similar to many other forms of agriculture.

Glossary

Aquaculture - The production and sale of farm-raised aquatic plants and animals.

Bacteria - Microscopic animal life, some kinds of which are responsible for the decay of dead materials and wastes.

Biofilter - Component of recirculating systems consisting of a large surface area upon which bacteria grow. These live on fish waste products, breaking them down into forms much less harmful to fish.

Dissolved Oxygen - Oxygen dissolves poorly in water and is often in short supply for aquatic animals. Warm water holds even less oxygen than cold water.

Fingerlings - Young fish from 1 inch in length up to 1 year of age. This stage comes after the fry stage.

Fry - Young fish from the time of hatching up to 1 inch in length.

Levee Ponds - Standing water impoundments built by excavating the pond area to a shallow depth and using the soil obtained to build a perimeter of levees or dykes.

Off-flavor - Aquatic animals can absorb and take on bad flavors from the water in which they live. These musty, muddy or otherwise undesirable flavors usually come from substances put out by certain species of microscopic plants (phytoplankton).

Raceways - Long channels through which large amounts of new water flow continuously and are then discarded. Usually built of concrete, these can also be earthen channels or long tanks of other materials.

Recirculating Systems - Tank systems which rely on biofilters to break down harmful fish waste products so water can be reused.

Seine - A long net used to capture fish.

Turnover - Mixing of top and bottom water that can lead to fish kills, especially in watershed ponds. During summer a cold bottom layer of water lacking in oxygen develops. In fall, the bottom and top layers can suddenly mix or "turnover."

Watershed Ponds - Impoundments built by damming ravines or small valleys. Runoff from the surrounding watershed fills the ponds.

Water Quality - The degree of suitability of water for growing fish and other aquatic organisms. Water high in dissolved oxygen and low in animal wastes such as ammonia is generally considered to be of high quality. Other factors also come into play such as alkalinity, chlorides and harmful substances such as iron and hydrogen sulfide. Water quality can change quickly in fish farming situations and so must be regularly checked on site.

Further information and assistance

County Extension offices are likely to offer the SRAC publications listed here as well as other fact sheets tailored to fish farming conditions in your state. County agriculture Extension agents, especially those in major aquaculture regions, are increasingly likely to be knowledgeable about opportunities for aquaculture in your area. If not, most southern states have aquaculture Extension specialists who are accessible through your Extension office.

County Soil Conservation Service offices offer free pond planning and layout services based on expert knowledge of local soil conditions. The pond specifications they provide can be a major help in insuring fish farming ponds get built the right way.

Third Report to the Fish Farmers is an excellent reference on most aspects of warm water fish farming in freshwater. Although it is out of print, copies of selected chapters can be obtained by contacting the Publications Clerk, U.S. Fish and Wildlife Service Fish Farming Experiment Station, P.O. Box 860, Stuttgart, AR 57722.

The **Fourth Report to the Fish Farmers** was in final preparation at the time this publication was prepared and may now be available by contacting the same source.

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