Module IV
Farming in Water

To The Teacher—Module IV is intended to develop fundamental student competencies in producing aquacrops. This includes making decisions about which crop to produce and how to produce it using various water facilities, harvesting and processing the crop. The level of instruction is introductory. Instruction in the details of aquacrop production will involve species-specific modules. This module is comprised of eight problem areas:

IV-A Growing Aquacrops  IV-E Growing in Cages
IV-B Producing Seed      IV-F Growing in Tanks and Raceways
IV-C Rearing Seed        IV-G Harvesting the Crop
IV-D Growing in Ponds    IV-H Processing the Crop

Each problem area can be used independently and sequenced in the teaching calendar as best fits the local instructional program. The suggested sequence is to teach IV-A, Growing Aquacrops, first. If seed are to be produced and reared, IV-B, Producing Seed, and IV-C, Rearing Seed, would follow IV-A. If seed are not to be taught, skip to the problem area that provides the appropriate production system, i.e., ponds, cages or tanks and raceways. Of course, most all instructional programs will include IV-G, Harvesting the Crop. IV-H, Processing the Crop, should be included if the students need fundamental competencies in processing. Of course, most instructional programs will teach all of the problem areas.

Each problem area provides a suggested systematic instructional strategy with considerable emphasis on student activity. The content and techniques focus on achieving the objectives for the problem area. Traditional lecture-presentation and discussion teaching strategies can be enriched with the review and application activities. Application is essential if students are to become proficient in areas of aquacrop production. (Species-specific modules should be used for the details of producing aquacrops in various water facilities.)
Module IV — Sources of Reference Materials

The sources of the reference materials cited in the problem areas are as follows: (Note: Materials are listed in alphabetical order by the last name of the senior author.)

Processing Channel Catfish by Gale R. Ammerman (1989) is available from: Mississippi Agricultural and Forestry Experiment Station, Mississippi State University, Mississippi State, MS 39762.


Water Quality in Ponds for Aquaculture by C. E. Boyd (1990) is available from: Auburn Agricultural Experiment Station, Auburn University, AL 36849.


Fish Farming in Recirculating Aquaculture Systems by Louis A. Helfrich and George Libey (n.d.) is available from: Department of Fisheries and Wildlife Sciences, Virginia Tech, Blacksburg, VA 24061.

Trout Production: Handling Eggs and Fry by Jeffrey M. Hinshaw (1990) is available from: Agricultural Experiment Station, North Carolina State University, Raleigh, NC 27695.


Carolina’s Freshwater Aquarium Handbook by Daniel E. James (1989) is available from: Carolina Biological Supply Company, 2700 York Road, Burlington, NC 27215, or Carolina Biological Supply Company, Box 187, Gladstone, OR 97027.

Watershed Fish Production Ponds: Site Selection and Construction by John W. Jensen (1989) is available from: Alabama Cooperative Extension Service, Auburn University, Auburn, AL 36849.

Introduction to Aquaculture by Matthew Landau (1992) is available from: John Wiley and Sons, Inc., 605 Third Avenue, New York, NY 10158.

Commercial Catfish Farming by Jasper S. Lee (1991) is available from: Interstate Publishers, P.O. Box 50, Danville, IL 61834-0050.


Engineering Considerations in Closed Recirculation Systems by Thomas M. Losordo (n.d.) is available from: Department of Zoology and Biological and Agricultural Engineering, North Carolina State University, Raleigh, NC 27695.


Cage Culture (series of five titles) by Michael P. Masser (1988) is available from: Kentucky State University, State Specialist for Aquaculture, Frankfort, KY 40601.

Product Forms, Packaging, Yields and Product Mix by Joe H. McGilberry, Virgil Culver, Gladden Brooks, Ken Hood, Stuart Dean and Dixie LaBruyere (1989) is available from: Mississippi Cooperative Extension Service, Mississippi State University, P.O. Box 5446, Mississippi State, MS 39762.

Seafood Processing: A Factory Visit by Zan Skelton (1983) is available from: Gulf Coast Research Laboratory, P.O. Box 7000, Ocean Springs, MS 39564.


Aquaculture and the Aquarium by Craig Watson (n.d.) is available from: IFAS Extension Agent in Aquaculture, University of Florida, 5339 State Road 579, Seffner, FL 33584-3399.

Catfish Farmers Handbook by Thomas L. Wellborn (1989) is available from: Mississippi Cooperative Extension Service, P.O. Box 5446, Mississippi State, MS 39762.


Site Selection of Levee-Type Fish Production Ponds by Thomas L. Wellborn (1988) is available from: University of Florida, Institute for Food and Agricultural Science, Gainesville, FL 32601.


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Transparency Masters
T IV-A-1 Farming in Water: Growing Aquacrops
T IV-A-2 Deciding Factors in Fish Farming
T IV-A-3 Growout Water Facilities
T IV-A-4 Diagram - Round Tank Showing Center
T IV-A-5 General Structure of Earthen Raceway
T IV-A-6 Water Flow in Earthen Raceway
T IV-A-7 Classification of Water Crops by Temperature
T IV-A-8 Sources of Seed
Module IV-A — Farming in Water

Problem Area: Growing Aquacrops

Estimated Time: 3-6 hours

Purpose/Goal: This problem area develops student competencies in basic fish production principles. Basic methods are stressed; future problem areas will address growing in specific water structures. (The species-specific modules should be used to teach more advanced methods for the various species.)

Learning Objectives: Upon completing this problem area, students will be able to:
• Identify factors to consider in determining whether to grow fish;
• Describe the facilities used in growout operations;
• Explain important environment factors;
• Describe where seed can be obtained.

Instructional Resources:

The following instructional resources are needed to complete this problem area:

Essential:
• Transparencies made from the masters attached to this teaching plan.

Additional: The following books:

Aquaculture: The Farming and Husbandry of Freshwater and Marine Organisms, by Bardach, Ryther and McLarney.

Third Report to the Fish Farmers, by Dupree and Huner.

Textbook of Fish Culture: Breeding and Cultivation of Fish, by Huet.

Introduction to Aquaculture, by Landau.

Commercial Catfish Farming, by Lee.

CONTENT AND PROCEDURES

Preparation
(Interest Approach):

The interest approach prepares students for studying the general aspects of growing fish.

The procedure to use follows:

1. Ask students the following question:
   “What do we need to know to successfully grow fish?”

2. List their responses on the chalkboard.
   (Avoid any assessment of what is said at this stage.)

3. Ask: “If you were considering being a fish farmer, what are the important decisions you would have to make about going into aquaculture?” (These should relate to the first question, above.)

4. List the areas of decision on the chalkboard. Indicate this problem area provides information to help with making these decisions.

5. This should lead into presentation of the problem area objectives.
# AQUACULTURE

## Presentation

### Key Questions/Summary of Content

This teaching plan helps students develop fundamental competencies in growing food fish.

### Teaching Techniques

Present the objectives by using T IV-A-1 or by writing on the chalkboard. Allow students time to write the objectives in their notebooks.

## I. What factors should be considered in determining whether to grow fish?

A. Fish farmers must know what they are doing when they start an aquaculture business.
   1. Observations of other aquafarmers are helpful.
   2. Prospective aquafarmers must be willing to take the risk involved.

B. Five factors are important in deciding to farm fish:
   1. Knowledge — individual’s competence in the culture of fish.
      * Individuals need to realize there is a lot of difference in farming livestock or row crops and the production of aquacrops. (For example, the water environment must be managed.)
      * Some individuals begin by involving themselves in an intensive educational program to learn about aquaculture.
   2. Technical support — the availability of people who are highly knowledgeable of aquaculture; aquaculture consultants are available in some areas.
   * Diagnostic laboratories are a part of the technical support fish farmers may need.

A. Explain the importance of people understanding what they are getting into when they become involved in fish farming. Cite examples of people who have gone into fish farming and later decided it wasn’t for them.

B. Use T IV-A-2 or the chalkboard to present the factors.

- Provide examples of educational programs that might be available locally, such as through a land-grant university.

- Explain that diagnostic labs assist aquafarmers by performing examinations of aquacrop specimens to determine the causes of problems, etc.
Some government agencies have well-qualified individuals to assist the aspiring aquafarmer. Example: the local agent of the Cooperative Extension Service.

3. Facilities — having the facilities needed for particular species to be grown.

- Sizeable acreage may be needed to establish a farm with ponds of sufficient scope to provide adequate income. Intensive production systems involving tanks may require considerable investment of money.

- Experienced fish farmers often suggest that a new fish farmer should begin small and grow into the business.

- Legal regulations must allow the establishment of an aquafarm on the site available; sometimes zoning regulations prohibit aquafarms.

4. Resources — primarily refers to financial resources, as money is needed to establish and operate the aquafarm.

- Includes the availability of suppliers of equipment, seed, feed and other inputs.

- Market outlets must be available for the product once it has been produced; a quality product is of little value if it doesn’t have a ready market.

- Certainly, the resources must include a supply of labor to help operate the aquafarm.

5. Personal preferences — what the individual likes to do.

- People who like the environment of aquaculture are more likely to be successful. Examples: Do you like to work in water? Do you like the smell of fish? Are you willing to work long hours?

- Experience can provide an opportunity to discover likes and dislikes; the prospective aquafarmer is advised to spend some time working on an aquafarm before going into the business.

- Explain the problems people have with zoning when they try to start a small aquaculture business in the backyard of their city home.

4. Use the chalkboard to develop a short list of the equipment needed to start an aquafarm. Assign a dollar value to the items. Total the amount for all of the items.

- Explain that marketing will be covered in considerable detail in Module V.

5. As an activity in personal assessment, students could be asked to make a list of things they like to do and things they don’t like to do (emphasis should involve working in aquaculture). After the lists are made, have students review their lists and make judgements about how their preferences are suited to aquafarming.
II. What facilities are needed for growout operations?

A. Careful planning is needed to ensure that the investment made in facilities is well used.
   1. Good facility plans are essential.
   2. Careful study should be made of the available water supply and how used water will be handled.
   3. Selection of the species to be grown as related to the climate and other natural resources available is important in planning.

B. Several water facilities are used in aquaculture; each has unique growout possibilities.
   1. Ponds — earthen ponds are reservoirs of water constructed by excavating dams or levees.
      - With careful management, ponds can be productive and profitable water structures for aquaculture.
      - Site selection depends on the structure of the soil (will it hold water?), availability of a water supply and previous use of the land (land to which pesticides have been applied might have dangerous residues).
      - Climate and species requirements are definite factors in using ponds; warm water fish usually can't be grown in ponds in cold climates and vice versa.
      - Ponds are very popular with some species. Examples: catfish and crawfish.
   2. Cages — structures used in bodies of water to contain fish.
      - Cages typically float in the water, with the top exposed. Example: catfish cages. A few cages are submersible, as in the ocean farming of salmon.
      - Cages are constructed of a wood, metal or plastic frame covered with a netting strong enough and with a mesh that will restrain the fish crop.
      - Cages used with catfish are typically 4 ft. wide, 4 ft. high and 6 to 10 ft. long. Larger

A. Ask students to explain planning.
   (Planning refers to developing an approach to fish farming in advance of starting the farm and deciding on new directions after a farm is underway.)

B. Use T IV-A-3 or the chalkboard to list and summarize growout facilities.

   - Study soil profiles in the local area and test samples for pond suitability.
   - Invite a local Soil Conservation Service technician to serve as a resource person on the selection of pond sites.

2. Explain that cages are covered in more detail in a later problem area (IV-E).
cages may be used with salmon and other crops in the ocean.

3. Pens — structures similar to cages but are anchored to the bottom of the pond or stream.
   - Pens don’t have bottoms and are used in water 2 to 4 ft. deep.
   - Pens are more often used in broodfish production than with food fish.

4. Tanks — containers of various sizes and shapes used to grow fish.
   - Tanks may be round or rectangular.
   - Tanks are constructed of metal, fiberglass, glass or other material.
   - Tanks are usually above ground.
   - Tanks should be constructed to allow oxygenated water to enter at the top and the “dirty” water to be removed from the bottom, thereby carrying feces and wasted feed out of the tank.
   - Water should enter a round tank so that it flows in a circular direction at the outer perimeter of the tank; the water near the middle of the tank will be less active and allow matter in it to settle out and be removed with the outflow.

5. Raceways — water structures that use flowing water.
   - With careful management, very intensive production is possible.
   - Raceways may be constructed of earth, metal, fiberglass or other material.
   - Some tanks are treated as raceways.
   - A large volume of water is needed; some involve elaborate filtration systems.
   - A series of structures may be aligned so that water flows from one to the other by gravity and over a baffle to help keep it aerated.

6. Long lines — these are strong ropes that are suspended into the water for the culture of oysters and mussels.

3. Be sure students understand the difference between pens and cages. Pens are used primarily on broodfish farms; cages are used to growout fish.

4. Explain that tanks and raceways are covered in more detail in Module IV-F.

5. Use T IV-A-4 or a sketch on the chalkboard to show construction features of a round tank.

5. Use T IV-A-5 or a sketch on the chalkboard to show the general structure of a raceway.

6. Use T IV-A-6 to show how water flows in a series of raceways. Explain the functions of the parts involved.

6. Determine if any students have observed the use of long lines. Have them explain what they saw.
• The rope must be securely anchored at the surface.
• A strong material, such as plastic, that will resist destruction should be used.
• Bags, racks or nets may be used on the rope for the aquacrops to attach themselves or hold the growing crop.

III. What environmental factors are important in growout operations?

A. Two important environmental factors must be considered in deciding to produce an aquacrop.
   1. Water quality and supply — a constant supply of water of the quality needed for aquaculture must be available.
   • Sources to be assessed include: wells, springs, streams, lakes, rivers, estuaries, oceans, municipal systems and industrial effluent.
   • Groundwater obtained with wells or springs is often used because of its cleanliness; however, it is low in oxygen and must be oxygenated before use.
   • Natural bodies of water may present problems with diseases, trash fish and poor quality.
   2. Temperature — species vary in temperature requirements.
   • Any cooling or heating of the water can add big costs to the production of an aquacrop.
   • Water is classified into three temperature ranges: warm (75°-90° F; suitable for catfish, tilapia, shrimp and oysters), cool (60°-80° F; suitable for striped bass and walleye) and cold (48°-65° F; suitable for salmon and trout).

B. Some growers try to manipulate the environment by heating the water or growing fish in a building.
1. It is possible to grow fish in geographic areas where they are not adapted to the climate.
2. Costs of making the environment suitable may be prohibitive to making a profit on the aquacrop.

IV. Where are seed obtained?

A. Quality seed that will grow rapidly are needed.
1. Sources of seed must be reliable; check on the reputation of the source before buying.
2. Seed should be graded into uniform sizes and species; defective or injured seed should be culled.

B. Several sources of seed are available:

1. Catch in the wild — This involves going to streams and lakes and capturing seed. Quality is always a problem. With some species, wild seed may be the only seed available to the farmer. Wild seed can introduce new genetics into a fish farm, and there is usually no charge for the seed.
2. Produce your own — The growout farmer must also operate a hatchery. Quality can be controlled by the grower, but resources are needed to establish and operate the hatchery.
3. Buy from a commercial hatchery — In areas where aquaculture is practiced, several commercial sources may be available. Be sure to check the seed quality before buying. This saves the growout farmer the investment and work of operating a hatchery.
4. Buy from a government operated hatchery — State and federal agencies may operate hatcheries and sell some of their seed to the public. These agencies are usually more concerned with maintaining wild stocks in the streams and lakes. Quality should be good and prices fair.

A. Ask students to explain the meaning of "seed." (They can refer back to Module I.)

B. Use T IV-A-8 or the chalkboard to outline the four sources of seed.
1. Ask students to describe how wild stock could be captured.
   • In a laboratory activity, take the class to capture wild seed. Be sure to follow all safety and legal procedures.
2. Ask students to name advantages and disadvantages of each method of obtaining seed. Develop a list of advantages on the chalkboard.

4. Take a field trip to a government hatchery or invite a resource person to speak to the class on hatchery operations.
Review

Review by having students demonstrate their mastery of the problem area objectives. (Use T IV-A-1 to show the objectives.) Call on class members to explain the content related to each objective. Review can also involve application and evaluation activities.

Application

Application can be achieved in several ways. A few examples are presented here:

- Students can apply the information in their supervised experience programs.
- Students can apply the competencies in the school aquaculture laboratory.
- Have students visit a local growout farm and prepare a report on their observations.
- Have students prepare displays or bulletin boards that depict fish production.
- Have students prepare entries about aquaculture for the local school science fair.
- Have students make an aquaculture video or slide show. It could be used as a public relations tool for your program and your FFA chapter.

Evaluation

Evaluation should focus on the extent to which the students have achieved the problem area objectives.

- Question students about the content of the objectives.

- Observe how students approach the work in their supervised experience program or in the school’s aquaculture laboratory.
- Give a written test. (See attached sample.)
Farming in Water

Problem Area: Growing Aquacrops

Instructions: Answer the following questions. Be sure to spell correctly and provide the most complete information you can. Name ________________________________

1. Five factors are important in deciding to begin farming fish. Name these factors and briefly describe each.

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<th>Factor</th>
<th>Description</th>
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<tbody>
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<td>b.</td>
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<td>c.</td>
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<td>d.</td>
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<td>e.</td>
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2. Which of the factors in question 1 would be most important to you if you were considering a career in fish farming? Why?

Which? __________________________________________

Why? __________________________________________

3. Six water structures used in aquaculture are listed below. Briefly describe each.

- ponds ________________________________________
- cages ________________________________________
- pens ________________________________________
- tanks ________________________________________
- raceways ____________________________________
- long lines ________________________________
4. Water is classified into three temperature ranges. Identify the items below as being associated with cold water (by using a “C”), cool water (by using an “L”), or warm water (by using a “W”).

_____ trout  
_____ salmon  
_____ walleye

_____ temperature 60°-80° F  
_____ temperature 75°-90° F  
_____ temperature 48°-65° F

_____ catfish  
_____ shrimp

5. Quality seed are important to the aquafarmer. Four sources are available. List the sources and offer one advantage of each.

<table>
<thead>
<tr>
<th>Source</th>
<th>Advantage</th>
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</table>
1. a. Knowledge — The competence an individual has in the culture of fish.
   b. Technical support — The availability of people who are highly knowledgeable in aquaculture.
   c. Facilities — Having the facilities needed for particular species that are to be grown.
   d. Resources — Primarily financial resources, as money is needed to establish and operate an aquafarm.
   e. Personal preferences — What an individual likes to do.

2. Knowledge

Knowing how to care for and market your aquacrop will determine the success or failure of your aquafarm.

3. ponds — Earthen ponds are reservoirs of water constructed by excavating dams or levees.
   cages — These structures are used in bodies of water to contain fish.
   pens — These structures are similar to cages but are anchored to the bottom of the pond or stream.
   tanks — These are water structures that use flowing water.
   raceways — These are containers of various sizes and shapes used to grow fish.
   long lines — These are strong ropes suspended into the water for the culture of oysters and mussels.

4. C trout  C salmon  L walleye
   L temperature 60°-80° F  W temperature 75°-90° F  C temperature 48°-65° F
   W catfish  W shrimp

5. a. Catch in the wild — can introduce new genetics, usually no charge
   b. Produce your own — quality can be controlled by the grower
   c. Commercial hatchery — saves growout farmer investment, operation of hatchery
   d. Government hatchery — quality should be good; price should be fair
Farming in Water:
Growing Aquacrops

OBJECTIVES

• Identify considerations in deciding to farm fish
• Describe facilities used in growout
• Explain growout environment factors
• Describe where to obtain seed
Deciding Factors in Fish Farming

- Knowledge — competence in fish culture
- Technical support — availability of competent advice
- Facilities — kind and size
- Resources — financial as well as availability of inputs and markets
- Personal preferences — your wishes
Growout Water Facilities

- Ponds — earthen water reservoirs
- Cages — floating containers made of mesh, used in large lakes or oceans
- Pens — meshed structures attached to bottom of ponds
- Tanks — round or rectangular structures
- Raceways — structures using flowing water
- Long lines — lines suspended in water
Round Tank Showing Center Removal of Water with Double-Sleeve Pipe

(wastes are removed from the bottom of the tank)

Water in-flow pipe creates circular flow toward center

Water level

Sleeve over drain pipe

Cut away side of tank

Drain pipe

→ = direction of water flow
General Structure of Earthen Raceway
Water Flow in Earthen Raceway
Segments Placed in a Series
Classification of Water Crops by Temperature

WARM WATER
75°-90° F
Species include oyster, shrimp, catfish and tilapia

COOL WATER
60°-80° F
Species include striped bass and walleye

COLD WATER
48°-65° F
Species include trout and salmon
Sources of Seed

CATCH IN THE WILD
• From streams and lakes
• Low cost
• Poor quality

PRODUCE YOUR OWN
• Likely to be high quality
• Costs to operate hatchery

BUY FROM COMMERCIAL HATCHERY
• Saves cost of hatchery
• Quality can be good
• Check reputation before buying

BUY FROM GOVERNMENT HATCHERY
• Should be of good quality
• Price should be fair