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Module IV-C — Farming in Water

**Problem Area:** Rearing Seed

**Estimated Time:** 7-14 hours

**Purpose/Goal:** This problem area develops student competencies in rearing seed in a hatchery or nursery. The instruction will include hatching eggs, feeding the young, grading the seed and transporting seed. (More detail on rearing seed is in the species-specific modules.)

**Learning Objectives:** Upon completing this problem area, students will be able to:
- Explain how to hatch seed in different incubators;
- Describe how to feed young seed;
- Describe the kind of feed to use;
- Identify feeding methods in the hatchery;
- Explain how to grade seed;
- Describe how to transport seed.

**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:

- *Textbook of Fish Culture: Breeding and Cultivation of Fish,* by Huet.
- *Introduction to Aquaculture,* by Landau.

**Equipment:**
- Samples of commercial fish food of various sizes for fry and fingerlings, samples of live food of various species, aquaria and automatic fish feeders.
CONTENT AND PROCEDURES

Preparation
(Interest Approach):

This interest approach prepares students for developing seed-rearing competencies.

The procedure to use follows:

1. **Display various samples** of commercial and live food used in hatcheries. Have these available at the start of class. Allow time for students to carefully observe the various forms. The feed can be studied by watching, smelling and touching.

2. **Call on various individuals** to describe what they are seeing.

3. **Have several feed container labels** available and call on students to read the ingredients. Have them state the percent protein and other nutrients in the feed.

4. **This activity should lead** into listing the problem area objectives.
AQUACULTURE

Presentation

<table>
<thead>
<tr>
<th>Key Questions/Summary of Content</th>
<th>Teaching Techniques</th>
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<tbody>
<tr>
<td><em>This teaching plan helps students develop fundamental competencies in rearing seed used in aquaculture.</em></td>
<td><em>Present the objectives by using T IV-C-1 or by writing on the chalkboard. Allow time for students to write the objectives in their notebooks.</em></td>
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I. How are seed hatched using different methods of incubation?

A. Hatcheries may use several methods to incubate eggs.

1. Hatching troughs are structures used to incubate eggs, hatch eggs and rear fry.
   - Troughs are usually 6 to 9 ft. long, 2 to 3 ft. wide and 8 to 14 inches deep.
   - Troughs are often constructed of concrete, aluminum or wood.
   - Water typically flows or circulates through the trough.
   - A screened standpipe is usually located at the end of the trough opposite where the water enters. The screen prevents fry from escaping with the out-flow water.
   - Baskets made of mesh wire are used to suspend the eggs in the water.
   - A rotating shaft with paddles may be used to simulate the fin and body movement of adult fish in hatching. The eggs are gently lifted and water flows around them.
   - Careful monitoring of the eggs and water is essential to observe progress in incubation.
   - Water temperature must be kept at the appropriate level for the eggs to hatch (this varies with the species of fish).

A. Use T IV-C-2 or the chalkboard to present incubation methods in hatcheries.

1. Have students construct a hatching trough in the mechanics laboratory. Use the best material available locally. This will involve:
   - obtaining or making plans;
   - developing a bill of materials;
   - measuring, cutting and fitting the pieces;
   - assembling the final product;
   - testing it in the school aquaculture laboratory.
• Troughs are very popular with commercial aquafarmers because trough incubation makes for relative ease in providing control over the hatching environment.

2. Upwelling incubator is a kind of container used to hatch eggs for aquaculture.
   • Water enters the bottom through a hose and special discharge nozzle.
   • The water discharge lifts the eggs and keeps them suspended.
   • Water leaves the container at the top.
   • Water temperature can be regulated with this type of incubator.

3. Round or rectangular tanks can be used to incubate eggs.
   • The procedure is similar to that followed with the trough.
   • Water temperature can be regulated.
   • Proper flow and aeration are essential.
   • Water movement must keep the eggs suspended and prevent the eggs from adhering to surfaces.

4. Ponds are natural incubators and function on the fish reproducing cycle.
   • It is very difficult to control water temperature.
   • Insects and other predators may destroy the eggs.
   • Egg diseases are difficult to treat in ponds due to the volume of water.
   • Aeration and water movement may be needed.
   • Pond incubation may rely on the broodfish to provide the needed water movement.

B. Eggs are often placed in special containers.

2. Arrange for students to inspect an upwelling incubator. Have them study the design and operation.

3. Have students discuss the similarities of tanks and hatching troughs.
   • Use an aquarium in the lab or classroom as an example by hatching fish. Several aspects of water management in hatcheries can be taught with the aquarium.

4. Ask students to explain why it is difficult to manipulate the water when fish are hatched in a pond.
   • Ask students to define “predator.”
1. Eggs are fragile and must be handled properly.
2. Some eggs adhere together in masses; others float independently of each other.

3. Two types of containers are commonly used.
   • Incubation tray — a wire mesh basket in which the eggs are placed while in the incubator. It is used with troughs and other structures. Trays are usually constructed of screen wire with holes .5 to .75 mm in diameter. The trays are 10 in. wide, 20 in. long and 4 in. deep. The bottom should be covered with 1.5 to 2.0 inches of water (enough to cover the eggs).
   • Vertical trays — trays stacked one on top of the other 5 to 7 trays high. This method saves floor space and allows more eggs to be incubated at a time. Construction materials are similar to the incubation tray. This method is sometimes used with trout.

C. The length of time required for hatching eggs varies.
1. Species have different incubation periods. Many species will hatch in 4 to 8 days.
2. Length of incubation depends on water temperature.
3. Eggs tend to change color during the incubation process. Some are known as “eyed eggs” because the developing embryo can be seen. Eggs tend to change to a reddish color as they mature. Unfertilized eggs don’t exhibit this color change.
4. A newly hatched egg is known as a “fry.” If it has a yolk sac attached, it is known as a “sac fry.” The yolk sac provides energy until the fry can take food and usually gone in no more than 3 or 4 days.
5. With some species, the seed become “fingerlings” when the fish reach one-inch in length.

C. Use T IV-C-3 or the chalkboard to help describe the time required for hatching.

1. Explain that chicken eggs are packaged in protective cartons even though the eggs have shells that offer some protection. Examine fish eggs close up to determine the nature of the shell.
2. Have students construct a sample incubation tray in the mechanics laboratory. The tray should be constructed to be used in the hatching trough that was constructed earlier. (Contact the state aquaculture specialist or the Regional Aquaculture Center to obtain plans.)

3. Have egg specimens at different stages of incubation for comparison.

4. Have specimen of sac fry and fry available for student inspection. (These can be obtained from the school lab, local farm or stream or lake.)

5. Use T IV-C-4 or the chalkboard to explain terms associated with young seed.
II. How are young seed fed?

A. The earliest stages of life are most vulnerable.
   1. A poor diet at this time will result in poor quality seed and a possible crop failure.
   2. Some hatchery operators use a rule similar to that of rearing human infants on "changing and feeding."

B. Two general types of feed are used:
   1. Live food — several species of organisms can be used for food.
      • Phytoplankton (aquatic algae) and zooplankton (aquatic rotifers, copepods and brine shrimp) can be used with some species of seed.
      • The kind of live food used depends on the size of the cultured species. The smaller the animal the smaller its mouth parts. Therefore, the food particles will need to be smaller. Algae are generally the smallest and brine shrimp the largest.
      • Insect larvae and nematodes may also be used as live food.
      • Young are often started on live food because they are not able to digest artificial feed or they will not eat artificial feed; a "weaning" takes place when the young are changed from live food to artificial feed.

2. Processed commercial feed — feed manufactured especially for growing seed, much as they are manufactured for feeding livestock.
   • Fry of the larger species can usually be fed commercial feed from the beginning. Examples: catfish, trout and salmon.
   • Commercial feed must contain the essential nutrients. Protein content should be 35 to 55 percent, depending on the species. Nutrient levels vary as the seed grows. Feed usually have a high percent of fish meal.

1. Have students explain the term "stunted." Ask them to describe how it relates to fry that aren't properly fed.

B. Use T IV-C-5 or the chalkboard to outline the types of feed used.
   1. Have live food specimens available for student inspection.

   • Ask students to explain why the size of the live food varies with the size of the species.

2. Have commercial feed specimens available for student inspection. Include the container labels listing the nutrients and contents of the feed.

   • Ask students why young seed need food with a higher protein content than older fish in growing ponds. (Figure protein)
• Feed particle size is an important factor. It must be a size that the fish can consume.
• Automatic feeders or a hatchery attendant may be present to sift or sprinkle feed onto the surface of the water in the hatching facility.

III. What kind of feed should be used?

A. Feed selection depends on four factors:
   1. Cost — aquafarmers must have an economical feed that will produce efficient growth in the seed.
   2. Need for management — some feeding methods may require more management. If live food are to be fed, they must be grown or purchased. Feeding manufactured feed requires regular feeding every hour.
   3. Size and types of fish — size of fish is a definite consideration in selecting the particle size of the feed. Fish species vary in feeding habits and needs, requiring knowledge by hatchery personnel in how to meet the needs of the seed crop.
   4. Availability — food that are economical, of high quality and readily available may be better than trying to use something different.

B. Live food require special considerations.
   1. Advantages of live food are:
      • best for species with small fry;
      • less chance of water becoming fouled;
      • usually thought to be superior to commercial feed for young seed.
   2. Disadvantages of live food are:
      • can be expensive because they must be raised;
      • individuals who understand how to grow the live food must be involved in the hatchery.

C. Commercial feed has advantages and disadvantages.

A. Use T IV-C-6 or the chalkboard to list four factors in selecting feed.

B. Use T IV-C-7 or the chalkboard to summarize the advantages and disadvantages of live food.

C. Use T IV-C-8 or the chalkboard to summarize the use of commercial feed.
1. Advantages of commercial feed:
   - easy to obtain;
   - custom rations (formulas) can be prepared;
   - convenient to use;
   - amenable to automatic feeders;
   - often more economical than live food.
2. Disadvantages of commercial feed:
   - may not be as nutritious as live food;
   - can spoil if not properly stored;
   - can cause water problems if too much is used.

1. Have students write feed companies and request feed samples.

   - Ask students to identify practices that help prevent feed spoilage and waste. Examples: protect from rain, control rats and buy only the amount that will be fed soon.

IV. What are the methods of feeding seed?
A. Four ways are commonly used to feed seed:
   1. No feeding — used when the seed are growing in water where natural productivity of phytoplankton and zooplankton is sufficient for the crop. Some fertilization of the water facility may be needed to encourage plankton growth. This is used primarily with ponds but sometimes with tanks.
   2. Hand feeding — involves sifting or throwing the feed onto the surface of the water. It allows for close monitoring of the seed and can reduce waste by feeding only the amount that will be eaten. Labor is required to be on duty much of the time for 24-hours a day.
   2. Ask students to name the advantages and disadvantages of hand feeding based on size of farm.

   3. Automatic feeders — mechanical devices that distribute feed. They may be activated by water movement, air or a timer and are useful in small water facilities. They allow continuous feeding, but require investment of money to purchase and are subject to breakdowns that can cost the loss of the seed crop if not carefully monitored.
   3. Bring examples of automatic feeders to the classroom for students to examine or take a field trip to a farm or trade show where the feeders can be observed.

   4. Demand feeders — mechanical devices involving a hopper suspended over the water with a gate operated by a pendulum in the water. Fish open the gate to receive feed by moving the pendulum. Demand feeders are best for larger seed and fingerlings. Demand feeders can conserve feed.
B. Miscellaneous methods are used by some farmers but not very widely. Large-scale growers using ponds might use truck or tractor-powered blow feeders that blow the feed out onto the water. Very large operations have been known to use airplanes for feeding.

V. How are seed graded?

A. Grading insures seed are of uniform size, species and quality.

B. Grading is used for the following purposes:
   1. Separate seed into lots of uniform size (this can reduce competition and cannibalism in some species);
   2. Ensure that all seed in a lot should receive the same feed because of uniform size;
   3. Remove trash fish;
   4. Remove deformed or damaged seed;
   5. Provide a uniform lot to a buyer at the time they are sold.

C. Grading should be done with fry and fingerlings. Most species need to be graded 1 to 2 times in each stage of growth.

D. Unnecessary grading should be avoided.
   1. Grading can create stress and make seed vulnerable to disease.
   2. Seed can be damaged by the grading process resulting in loss.
   3. The grading process requires expensive time and labor.

E. Three methods of grading are used:
   1. Eye/hand method — involves handling and measuring each fish.
      • This is a slow and time consuming procedure.
      • Large volumes of fish require huge amounts of time.
      • Many young seed are too small for this procedure to be efficient.

A. Use T IV-C-10 or the chalkboard to outline grading and the purposes of grading.

1. Explain that growers who buy seed want uniform species and sizes. They don’t want to get trash fish with their seed.

5. Explain that selling seed lots of uniform size protects the buyer and the seller.

D. Use T IV-C-11 or the chalkboard to list why unnecessary grading should be avoided.

E. Use T IV-C-12 or the chalkboard to outline three methods of grading.

1. Have students practice measuring a small fish. Let different students measure the same fish to check accuracy and reliability.
2. Hand-held graders — involves using sets of parallel bars that allow fish of a certain size to pass through.
   • This method works well in rectangular tanks and vats.
   • A series of parallel bars with different spacing can be used to sort the fish into several groups by size.
   • Baskets with very small screens can be used with tiny seed.

3. Mechanical graders — work on the same principal as the hand-held graders only the mechanical grader is larger and can handle greater volumes of fish.
   • Samples need to be checked by hand to verify accuracy of mechanical sorting.
   • This method can be used with large quantities of different size fish.

VI. How are seed transported?

A. Seed usually have to be moved to a growing facility unless they are produced in a growout pond and are allowed to remain there.

B. Various containers are used to transport seed.
   1. Plastic bags in styrofoam containers can be used for small seed. These work well for air shipment.
   2. Small tanks in cars, trucks, trailers or vans can be used for larger quantities of seed.
   3. Large tanks on trucks and trailers may be needed for large quantities of seed that have been grown to stocking size.

C. Hauling must involve keeping the seed healthy and suitable for use in stocking growing facilities.
   1. General precautions in hauling are:
      • Prevent stressing the seed — stress occurs when the seed are exposed to conditions to which they are not well adapted.
- Keep the water at the appropriate temperature — varies with the species being transported; sometimes pieces of ice are added to the water used for hauling fish or the container is placed on pieces of ice.

- Keep the water well oxygenated — when plastic bags are used, pure oxygen may be injected before top is sealed; large tanks require aeration and/or the continual injection of oxygen depending on the stocking density of the fish.

- Use a prophylactic treatment — use an approved chemical to treat the fish while they are being transported to prevent disease.

- Use quality water in the haul tank — avoid using water which is harmful to the fish.

- Properly dispose of used water — used water should not be run into fish ponds, natural streams or lakes or other places where it will contaminate the water supply.

- Follow applicable regulations — obtain needed permits from agencies that regulate the hauling of fish.

- Operate the equipment safely — hauling equipment should be kept in good operating condition and operated in a safe, legal manner.

- Have students review literature on species grown locally to determine the best temperature for water used in haul tanks.

- Have students attend an aquaculture equipment exhibit to observe different kinds of haul tanks, aerators and other hauling equipment.

- Have students research literature on the species grown locally to determine the approved chemicals and rates of prophylactic treatments for use in haul tanks.

- Ask students to explain why water from a haul tank should not be disposed of in a growout pond.

- Contact the appropriate local or state agency to obtain a copy of regulations that apply to hauling fish.

- Review an operator's book for motor vehicles that haul fish in your state. Have the drivers education teacher at the school speak to the class on how to safely operate a truck with a haul tank.
Review

Review by having students demonstrate their mastery of the problem area objectives. Call on various members of the class to explain the content for each objective. In some cases, have the students assess the content to identify the procedures that would work best in the local community or in their supervised experience programs.

Review can also be a part of application and evaluation.

Application

Application can involve several approaches. Here are a few examples.

- Students can apply the content of the problem area in their supervised experience programs.
- School laboratory activities can be used to apply the content.
- You can have students visit local hatcheries and observe the practices followed in rearing seed.

Evaluation

Evaluation should focus on the extent to which the students have achieved the problem area objectives. Here are a few examples.

- Question students about the objectives. (This can also be used for review.)
- Observe how students approach rearing seed in their supervised experience programs and in the school laboratory.

- Review students' notebooks to determine how well they have kept notes on the problem area content.
- Give a written test. (See attached sample.)
Farming in Water

Problem Area: Rearing Seed

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

Name

1. Four methods of incubating eggs were presented. Name the methods and briefly describe each.
   a. 
   b. 
   c. 
   d. 

2. What are the two major factors affecting the length of time required for incubation?
   a. 
   b. 

3. Young seed are usually fed either live food or commercial feed. Indicate which of the following are advantages of each by placing an “L” in the space by an advantage for live food and a “C” in the space by an advantage for commercial feed.

   _____ best for species with very small fry
   _____ easy to obtain
   _____ convenient to use
   _____ custom rations are available
   _____ less chance of fouling water
   _____ automatic feeders can be used

4. Briefly describe each of the following four ways of feeding seed.

   no feeding
   hand feeding
   automatic feeders
   demand feeders
5. **What is grading? Why is it done?**

   What?

   Why?

6. **Hauling seed can create problems. What are several precautions in hauling?**
   
   a.
   
   b.
   
   c.
   
   d.
   
   e.
   
   f.

7. **Define the following terms:**

   sac fry

   fry

   fingerling
Farming in Water

1. a. Hatching troughs — Structures used to incubate and hatch eggs and rear fry. Troughs are often constructed of concrete, aluminum or wood.

   b. Upwelling incubator — A container used to hatch eggs in which water temperature can be regulated.

   c. Tanks as incubators — Round or rectangular tanks used to incubate eggs in which water temperature, flow and aeration are essential.

   d. Ponds — Natural incubators that function on the natural cycle of fish reproduction.

2. a. Species type

   b. Water temperature

3. _____ best for species with very small fry  
   _____ easy to obtain
   _____ convenient to use  
   _____ custom rations are available
   _____ less chance of fouling water  
   _____ automatic feeders can be used

4. no feeding — When natural productivity of phytoplankton and zooplankton is sufficient for the crop. Fertilization may be needed to encourage plankton growth.  
   hand feeding — Sifting or throwing feed onto water surface, allowing for close monitoring of the seed.
   automatic feeders — Mechanical devices that distribute feed. Automatic feeders are activated by water movement, air or a timer allowing continuous feeding.
   demand feeders — Mechanical devices involving a hopper with a gate operated by a pendulum in the water. Demand feeders are activated by the fish and conserve feed.

5. What? A process to insure seed are of uniform size, species and quality.  
   Why? Removal of trash fish, deformed/damaged fish, size separation, to provide uniform lots to buyers.

6. a. prevent stressing the seed

   b. keep water at correct temperature

   c. keep water well oxygenated

   d. prophylactic treatment for disease

   e. use quality water in haul tank

   f. operate the equipment safely

7. sac fry — newly hatched young with yolk sac attached

   fry — young seed after sac is gone

   fingerling — used with some species when seed reach 1-inch length, maximum length is 10 inches
Farming in Water:
Rearing Seed

OBJECTIVES
• Explain how to hatch seed in different incubators
• Describe feeding young seed
• Describe the kind of feed to use
• Identify methods of feeding
• Explain how to grade seed
• Describe how to transport seed
Incubation Methods

- Hatching troughs
- Upwelling incubators
- Tanks of incubators
- Ponds
Hatching
Time Requirements

- Vary with species (often 4 to 8 days)
- Depends on water temperature
- Egg color shows stage of development
Fry

- Sac Fry — newly hatched young with yolk sac attached
- Fry — young seed after sac is gone
- Fingerling — name used with some species when seed reach an inch in length; applies up to a maximum length of 10 inches
Types of Feed Used in the Hatchery

- Live food
- Plankton
- Brine shrimp
- Copepods
- Insect larvae
- Nematodes
- Commercial feed
- Particle size varies
- Ingredients vary
- High protein needed
Factors in Feed Selection

• Cost
• Need for management
• Size and species of fish
• Availability
Live Food

ADVANTAGES:
- Best with very small fry
- Less chance of fouling water
- Usually superior to commercial feed

DISADVANTAGES:
- Expensive to produce
- Must be cultured (requires knowledge)
Commercial Feed

ADVANTAGES:
- Easy to obtain
- Custom rations can be prepared
- Convenient to use
- Amenable to automatic feeders
- Often more economical than live food

DISADVANTAGES:
- May not be as nutritious as live food
- Can spoil if improperly stored
- Can cause water problems if too much is used
Grading

DEFINITION:
Process to insure seed are of uniform size, species and quality

REASONS TO GRADE:
• Separate by size
• Remove trash species
• Remove deformed or damaged seed
• Aids sale
Problems Caused by Grading

- Creates stress in fish
- Fish can be injured in the process
- Expensive (requires labor and equipment)
Methods of Grading

- Eye/hand method
- Hand-held graders
- Mechanical graders
Containers for Hauling Seed

- Plastic bags in styrofoam containers
- Small tanks
- Large tanks
Precautions in Hauling

- Prevent seed stress
- Keep temperature at proper level
- Oxygenate water
- Use prophylactic treatments
- Use quality water
- Properly dispose of used water
- Follow regulations
- Operate equipment safely
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T IV-D-3  Considerations in Pond Site Selection
T IV-D-4  General Considerations in Pond Design
T IV-D-5  Considerations in Designing Watershed Ponds
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T IV-D-7  Species for Pond Culture
T IV-D-8  Feeding Frequency in Ponds
T IV-D-9  Amount to Feed in Ponds
T IV-D-10 Forms of Feed for Growout
T IV-D-11 Methods of Feeding in Growout Ponds
T IV-D-12 Growout Pond Oxygen Supply