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Handouts

- H IV-E-1 Cage Design

Transparency Masters

- T IV-E 1 Farming in Water: Growing in Cages
- T IV-E 2 Cage Culture
- T IV-E 3 Advantages of Cages
- T IV-E 4 Disadvantages of Cages
- T IV-E 5 Cage Requirements
- T IV-E 6 Species Cultured in Cages
- T IV-E 7 Factors in Cage Site Selection
- T IV-E 8 Feed Methods in Cages
Module IV-E — Farming in Water

Problem Area: Growing in Cages

Estimated Time: 3-6 hours

Purpose/Goal: This problem area develops student competencies in growing aquacrops in cages. This will involve a study of cage site location, cage design, placing cages, selecting species for cage culture and feeding in cages. (Information on producing adapted species in cages is presented in the species-specific modules.)

Learning Objectives: Upon completing this problem area, students will be able to:
- Define cage culture;
- List advantages and disadvantages of cage culture;
- Describe cage design requirements;
- Select species for cage culture;
- Specify site selection criteria;
- Describe how to feed in cages.

Instructional Resources:

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

Essential:

- Transparencies made from the masters attached to this teaching plan.
- Copies of the handout, H IV-E-1, Cage Design.
- The following bulletins:
  
  What is Cage Culture? by Masser.
  Cage Culture: Site Selection and Water Quality, by Masser.
  Cage Culture: Species Suitable for Cage Culture, by Masser.
  Cage Culture: Cage Construction and Placement, by Masser.
  Cage Culture: Handling and Feeding Caged Fish, by Masser.
  Cage Culture: Cage Culture Problems, by Masser.
  Cage Culture: Harvesting and Economics, by Masser.

Additional: Any general aquaculture books, such as:

Principles of Fishery Science, by Everhard and Youngs.

Introduction to Aquaculture, by Landau.

CONTENT AND PROCEDURES

Preparation
(Interest Approach):

The interest approach prepares students for their study of growing aquacrops in cages. The strategy will be to get students thinking about the kinds of animals grown in cages.

The procedure to use follows:

1. Ask students to name the kinds of animals that live in cages. Develop a list on the chalkboard. Examples: pet birds, lions, monkeys, snakes and tigers.

2. Ask students where these cages are found. Examples: bird cages are found in homes; lion, monkey, snake, and tiger cages are typically found in a zoo.

3. Have students explain why these animals are kept in cages.

4. Ask students about growing aquacrops in cages in water: Is it possible? Why would you want to use a cage? What kinds of aquacrops can be grown in cages?

5. Lead from interest approach into listing the problem area objectives.
Presentation

Key Questions/Summary of Content

This teaching plan develops basic student competencies in the use of cages in aquaculture.

Teaching Techniques

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

I. What is cage culture?

A. Cage culture of fish is done by enclosing fish in a cage or basket that floats in the water.
   1. Water flows freely through the cage and between the fish.
   2. Primarily used in large bodies of water such as lakes, oceans and rivers where it is impossible to confine animals otherwise.

   • Without confinement, the animals would escape.
   • Confinement procedures used allow the aquacrop access to the water in the structure.

   3. Can be used with polyculture where one species is caged and the other is not.
   4. Water quality affects caged aquacrops the same as it does those not in cages.

II. What are the advantages and disadvantages of cages?

A. As with any culture technique, cages have advantages and disadvantages.
   1. Growers should carefully study the pros and cons of cage culture before investing.
   2. It is a good idea to begin with a few cages and grow into cage aquafarming.

   • Explain that fish in cages are somewhat like animals in the zoo: they will escape and become unmanageable if allowed to do so.

   3. Explain how polyculture could involve using cages to keep the species separate yet in the same water facility.
B. Cages have several advantages in aquafarming.

1. Harvesting is simplified — Since the fish are already contained, they may be easily removed from cages by dipping or by lifting and dumping the cage.

2. Aquacrops are easy to observe — Fish can’t escape from the cage and, therefore, are easier to observe for disease, water management, feeding and other aspects.

3. Acceptable where ponds are not available or suitable — Cages can be used in water areas where the construction of ponds would not be allowed or possible (Example: “wetlands” do not allow the construction of ponds, but allows the use of cages in existing water).

4. Water reservoir used for other purposes — Sport fishing could be available in a pond with the aquacrop isolated in another area of the water.

5. Allows experimentation — A farmer considering fish culture or growing another species could test the new venture in cages; this would minimize risk. Cages also have research applications in similar situations.

6. Wastes moved from culture area — Natural water flow moves excrement and wasted feed away from the culture area, thus reducing fouling from these products.

7. Easy to treat diseased fish — Fish in cages strong enough to be lifted can be treated by dipping the entire cage in a large vat of chemically-treated water for a short time and returned to the growing water.

C. Cages have several disadvantages in aquafarming.

1. Theft is easy — Since the fish are contained, it is easier for the fish to be stolen.

2. Vandalism releases fish — Areas where cages are used need to be protected to prevent vandals from maliciously releasing fish from the cages.

B. Use T IV-E-3 or the chalkboard to list cage advantages.

2. Emphasize the importance of observing a fish crop in using the best management practices.

5. Explain that a farmer producing a crop in ponds could test a new species in the same ponds without disrupting the crop being produced.

C. Use T IV-E-4 or the chalkboard to present the disadvantages of cage culture.
3. Nutrition problems — Caged aquacrops must be fed nutritionally complete food; there is rarely any natural food in a cage.

4. Fish injury — Confinement increases the possibilities of injury and disease; cage contact can cause scrapes and cuts. Due to closeness, disease outbreaks can spread rapidly.

5. Construction failure — If cages break open or develop holes in the mesh, fish escape into the water and are lost.

6. Public objections — The public may object to cage use in public water areas.

5. Relate how a mature aquacrop could be ready for harvest and breakout the day before. They are lost in the big water reservoir and aren’t likely to be captured.

III. What are the important considerations in cage design?

A. Basic cage requirements are that the material be strong, durable and non-toxic.

1. Cages must be capable of retaining the aquacrop and also allow maximum water circulation through the cage.

2. Cages are constructed using a frame, mesh or netting, feed ring, lid and flotation device.

3. Cages can be constructed by the farmer or purchased from an aquaculture supply company.

B. Shapes and sizes of cages vary.

1. Cages may be round (cylindrical), square or rectangular.

2. Size depends on strength of construction, whether or not cages will be lifted and management considerations in treating for diseases and harvesting.

- Cylindrical cages are typically 4 ft. in diameter and 4 ft. high.
- Square cages are typically 4 ft. in all dimensions.
- Rectangular cages may be 4 ft. deep and high and 8 ft. long.
- Different sizes are used for various applications.

A. Use T IV-E-5 or the chalkboard to summarize design considerations.

1. Have students collect brochures from cage manufacturers and display them in the classroom.

Note: The content here focuses on small cage applications, not the large applications in salmon culture.

2. Use H IV-E-1, Cage Design, to illustrate shapes and sizes.

- Have students design and construct a cage in the lab. Students should develop a precise bill of materials and prepare careful working drawings of the cage. Students may compete to see who has the best drawing. Place the cage in a pond and use it to produce.
3. Strong materials are needed if the cages will be lifted.
   • Size of cage determines the number and weight of fish it can hold.
   • Several hundred fish in a cage can result in a weight that requires considerable cage strength.
4. Several factors must be considered to determine stocking rates.
   • Stocking rate varies with the species and water capacity.
   • A given volume of water can produce no more fish in cages than it can produce if the fish had free access to the water.
   • Competition from wild species often reduces the number of fish that can be grown on an acre of water in cages.
   • Stocking rates are often stated as number of fish per cubic yard of cage (example: one cubic yard can be stocked with 175-250 catfish fingerlings).
   • Cubic yards in a square or rectangular cage are found by multiplying (length x height x width) and dividing by 27 (there are 27 cubic ft. in one cubic yard).

C. Materials used in construction are fairly easy to obtain.
1. Cage frames are made of wood, steel, aluminum, PVC pipe or fiberglass.
Wood and steel frames should be coated with a water-resistant paint.
Bolts and other fasteners should be rust resistant.
2. Cage mesh is usually galvanized wire, plastic-coated wire, solid plastic mesh and nylon netting.
   • Mesh size should be no smaller than one-half inch to allow for good water movement.
   • Mesh size should not be large enough to allow the escape of the aquacrop or the entry of trash fish or other animals.

   • Have students refer to a length-weight chart and calculate the weight of 200 fish that are 11 inches long in a cage. (This involves multiplying the weight per fish by the number of fish.)

   • Explain the carrying capacity of water is no greater when the fish are in cages.

   • Using the chalkboard, demonstrate how to calculate the number of cubic yards in a rectangular or square cage. Provide examples of cage dimensions and let students determine the cubic yards. (The volume in a cylindrical cage is calculated the same as the volume of water in a round tank, as presented in Module III.)

2. Have students review brochures or catalogs containing cages and determine the kinds of materials used as netting.

   • Ask students if the mesh can keep out all trash fish or predators. (No! Some are so small that they can enter.)
3. Feeding rings are designed into the tops of the cages.
   - Feeding ring keeps feed in the cage. Without the feeding ring, the feed will move out of the cage into areas where the aquacrop cannot use it.
   - Each cage usually has one ring.
   - Feeding rings are made of 1/8 or 3/16 in. mesh material.
   - Feeding rings are usually 12-15 inches in width.
   - Feeding rings are attached to sides of the cage at the water line.
4. Tops or lids are needed on all cages to keep the fish from escaping and to keep poachers out.
5. Flotation devices keep the cage from sinking.
   - Inner tubes, styrofoam, water-proofed foam rubber, capped PVC pipe and plastic bottles may be used as flotation devices.
   - Cages can be suspended from docks or other structures.
6. Cages need to be anchored so they don’t float away. They may be tied to a secure structure, a heavy object attached to the cage may be dropped to the bottom or other anchoring means.

   • Call on a student to explain why a feed ring uses a mesh that is much smaller than the mesh of the cage.

5. Take a field trip to a farm that uses cages and observe the kinds of flotation devices used.

IV. What species may be grown in cages?
   A. Several species may be suited to cage production.
      1. Water quality is just as important with cages as it is with open pond culture.
      2. Some species have proven adaptable to cage culture.
B. Only a few species are currently being grown in cages.
   1. Salmon is the only species with a significant volume of cage production.
   2. Catfish, tilapia, trout, striped bass, red drum, bluegill and carp have been produced on a limited basis in cages and may be adaptable to cage production.

V. What factors are considered in selecting a site for cages?

A. Most cage production is in existing water reservoirs that are large and difficult to manage.

B. Several factors should be considered in site selection:
   1. Depth of water — Cages should usually be in water that is 10 ft. or more in depth. Deep water allows wastes to be moved from the cage area.
   2. Water quality — Water should be of the quality suitable for the species being cultured; laboratory analysis of water samples is needed. Dissolved oxygen, pH, temperature, ammonia and turbidity should all be studied before starting cage culture.
   3. Prevailing winds — Areas used for cage culture should not be protected from prevailing winds. Winds can damage cages and move them away but are needed to keep the water well oxygenated.
   4. Protection from storms — Areas that are rough and stormy should be avoided.
   5. Natural currents nearby — Wastes are moved away from the cages by natural currents.
   6. Runoff — Sites should not be selected that have direct runoff from municipal wastewater plants or farms.

B. Use T IV-E-6 or the chalkboard to list examples of species that can be grown in cages. Have students name those on the list that can be grown in the local area.

B. Use T IV-E-7 or the chalkboard to list cage site selection factors.
   1. Select a body of water in the local area and have students assess it from the standpoint of cage culture.
   2. Use T IV-E-7 or the chalkboard to list cage site selection factors.
   3. Call on a student to explain how the wave action causes increased DO in the water.
   4. Ask a student to explain how rough and stormy water can cause problems with cages.
VI. How are aquacrops fed in cages?

A. Since aquacrops are confined, they must receive complete rations.
   1. Commercial feed used with crops in open ponds or other facilities are usually appropriate.
   2. The same general feeding procedures in open ponds apply in cages.

B. Feeding methods involve putting the feed into the feed ring by hand.
   1. Caged fish are often fed each day. Sometimes growers feed 6 days a week.
   2. Amount and frequency of feeding depends on water temperature, stocking rate and size of fish.
      • Feeding rate is the same as it would be in an intensive pond based on the weight of the fish.
      • Water temperature is important in establishing feeding rate. Fish eat more at the temperature to which they are most adapted.
   3. Floating pellets should be used.
      • Floating feed is trapped inside the feeding ring until it is eaten.
      • Sinking feed falls through the cage and, if not eaten, falls out the bottom and is wasted.
      • Pellet sizes are usually 1/8 in., 3/16 in. or 1/4 in. (When small fish are first placed in cages, they are fed the smaller pellets. As fish grow, pellet size increases.)

B. Use T IV-E-8 or the chalkboard to outline cage feeding methods.
   • Call on a student to review the feeding rate used in ponds.
     (Two general rules: 3% of live weight and no more than will be eaten in 10 minutes.)
   3. Demonstrate floating pellets by placing several in a container of water. Also, put several sinking pellets in the water. Ask students to describe their observations.
      • Show samples of the pellet sizes listed here. Have students match pellet size with the appropriate fish size.
**Review**

Review should focus on the teaching plan objectives. Call on students to explain the content related to each objective. Laboratory activities can help students review the content. Also, students can be asked to give oral reports on their activities and observations during field trips, from brochures and other activities.

Instruction during supervised experience visits can review problem area content as related to the activities underway.

**Application**

Application can involve some of the review activities. Here are additional ways of achieving applications.

- Students can apply competencies in cage culture as a part of their supervised experience programs.
- Students can grow aquacrops in cages in the school laboratory.
- Students can construct cages in the mechanics laboratory.
- Students can experiment with fish crops grown in cages compared to open ponds.
- Students can develop science fair projects, bulletin boards, displays and other projects to demonstrate areas of cage culture.

**Evaluation**

Evaluation should focus on the extent to which the teaching plan objectives have been achieved. Here are a few suggestions to use in evaluating.

- Question students about the problem area content.
- Observe how students perform in their supervised experience program.

- Observe how students who complete the aquaculture program and begin a career in aquaculture approach their work.
- Observe how students perform the activities associated with the problem area, such as science fair exhibits and construction projects in the school laboratory.
- Give a written test. (See attached sample.)
Farming in Water

Problem Area: Growing in Cages

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

Name

1. What is cage aquaculture?

2. Cages have advantages and disadvantages. Several of each were studied in class. Select the two most significant advantages and disadvantages and tell why.

   Advantages                  Why
   a. __________________________
   b. __________________________

   Disadvantages                Why
   a. __________________________
   b. __________________________

3. Describe cage construction with the terms listed below. (Indicate the kind and description of the items.)

   materials_________________________
   cage mesh_________________________
   cage frame_________________________
   flotation devices__________________
   size______________________________
   feed ring________________________

4. Cage sites involve several considerations if production is to be successful. Indicate which of the following items are important in selecting a site for cages by placing an "X" in the blank.

   _____ near a beach        _____ near an electric power plant    _____ water quality
   _____ water depth         _____ natural currents in water          _____ away from sewage runoff
   _____ not in prevailing wind   _____ close to an island      _____ protected from storms
   _____ isolated from poachers
5. Describe the practices listed below in feeding fish in cages.

- amount ____________________________
- frequency ____________________________
- method ____________________________
- form of feed ____________________________
Farming in Water

1. The culture of fish done by enclosing fish in a cage or basket that floats in the water.

2. a. Harvesting simplified — Since the fish are already contained, they may be easily removed from cages.

   b. Easier observation — Fish cannot escape from the cage and therefore are easier to observe for disease, feeding, etc.

   a. Theft is easy — Since the fish are confined, it is easier for the fish to be stolen.

   b. Nutrition problems — Caged aquacrops need nutritionally complete food; there is rarely any natural food in cage.

3. materials — strong, durable and non-toxic

   cage mesh — galvanized wire, plastic-coated wire, solid plastic mesh and nylon netting

   cage frame — made of wood, steel, aluminum, PVC pipe, rust resistant bolts and fasteners

   flotation devices — inner tubes, styrofoam, water-proofed foam rubber, etc.

   size — depends on construction strength; various sizes for various applications

   feed ring — made of mesh material, attached to the sides of cage at water line

4. ___ near a beach ___ near an electric power plant ___ water quality

   ___ water depth ___ natural currents in water ___ away from sewage runoff

   ___ not in prevailing wind ___ close to an island ___ protected from storms

   ___ isolated from poachers

5. amount — based on weight of the fish, water temperature, stocking size and size of fish

   frequency — daily, 6 days/week, depends on water temperature, stocking size and size of fish

   method — putting feed into the feed ring by hand

   form of feed — floating pellets should be used; and feed is trapped inside until eaten
AQUACULTURE

CAGE DESIGN

SQUARE
3' x 4' x 3'

RECTANGULAR
8' x 4' x 4'

ROUND
2 FEET

WATER LINE

FLOATS
Farming in Water:
Growing in Cages

OBJECTIVES
• Define cage culture
• List advantages and disadvantages of cage culture
• Describe cage design requirements
• Select species for growing in cages
• Specify criteria to consider in site selection
• Describe how to feed in cages
Cage Culture

DEFINITION:
Enclosing fish in cage or basket that floats in water

CHARACTERISTICS:
• Water flows freely through cage
• Used in large bodies of water
• Polyculture but separate species
• Importance of water quality same as in ponds
Advantages of Cages

- Harvesting simplified
- Easy to observe crop
- Acceptable where ponds are not
- Can use reservoir for other purposes
- Experiment
- Wastes removed from culture area
- Easy to treat for disease
Disadvantages of Cages

- Theft of crop
- Vandalism
- Nutrition
- Fish injury
- Construction failure
- Public objections
Cage Requirements

SHAPE:
- Round (cylindrical)
- Square
- Rectangular

SIZE:
- Round — 4 feet high and diameter
- Square — 4 feet dimensions
- Rectangular — 4 x 4 x 8 or 4 x 8 x 8
Species Cultured in Cages

- Salmon (predominant)
- Catfish
- Tilapia
- Trout
- Striped Bass
- Red Drum
- Bluegill
- Carp
Factors in Cage Site Selection

• Depth of water (10-plus feet)
• Water quality
• Prevailing winds
• Protection from storms
• Natural water currents
• Runoff
Feed Methods in Cages

- Hand feeding
- Feed each day
- Same rate as in open pond
- Consider water temperature
- Use floating pellets