# Table of Contents

Module IV-B: Farming in Water: Producing Seed ..................................................1
Content and Procedures.........................................................................................2
Presentation (Key Questions/Summary of Content, Teaching Techniques) ..........3
Review/Application/Evaluation .............................................................................13
Test .......................................................................................................................14
Test Answer Key .................................................................................................16

Transparency Masters

- T IV-B-1 Farming in Water: Producing Seed
- T IV-B-2 Hatchery Functions
- T IV-B-3 How Seed are Produced
- T IV-B-4 Environmental Factors in Seed Production
- T IV-B-5 Sexual Reproduction of Aquaculture Organisms
- T IV-B-6 Mating
- T IV-B-7 Spawning
- T IV-B-8 Cultural Procedures in Reproducing Aquacrops
- T IV-B-9 Artificial Reproduction with Fish
- T IV-B-10 Facilities in Spawning
- T IV-B-11 Factors in Selecting Method for Obtaining Seed
Module IV-B — Farming in Water

Problem Area: Producing Seed

Estimated Time: 8-16 hours

Purpose/Goal: This problem area develops student competencies in producing seed. The problem area will include reproduction processes, such as mating, hatchery requirements and selecting a method of producing seed. Emphasis is on fish crops.

Learning Objectives: Upon completing this problem area, students will be able to:

- Describe the purpose and functions of a hatchery;
- Describe ways seed are produced;
- Explain environmental factors in a hatchery;
- Describe the sexual reproduction processes of aquaculture organisms;
- Describe procedures in reproducing aquaculture organisms;
- Describe the spawning facilities used in aquaculture;
- Select a method of producing seed for an aquafarm.

Instructional Resources:

The following instructional resources are recommended in teaching this problem area:

Essential:

- Transparencies made from the masters attached to this teaching plan.
- Copies of the following bulletins:
  - Trout Production, by Hinshaw.
  - Channel Catfish: Life History and Biology, by Wellborn.

Additional: The following books:

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

Preparation
(Interest Approach):

The interest approach prepares students for developing basic competencies in the reproduction of aquacrops, particularly fish.

The procedure to use follows:

1. **Give students this example:** A fish farmer is preparing to stock 100 acres of growing ponds. The rate of stocking is 6,000 fingerlings (seed ready for stocking) per acre. How many fingerlings are needed to stock the 100 acres? (Answer: 600,000 fingerlings)

2. **If the farmer wishes** to use 5-inch long fingerlings and the cost is one cent per inch, what will it cost to stock the growing ponds? (Answer: $30,000)

3. **Ask students to provide** suggestions on how the farmer can obtain this number of fingerlings. Examples of responses are: buy from a fingerling grower, operate a hatchery, or catch in the wild. Ask students what happens if the fingerlings die. (The farmer has lost the amount invested plus the potential profit of the crop that now has to be restarted.)

4. **Explain that aquafarming requires** a lot of seed and that obtaining seed requires considerable investment. Efficiency is needed to ensure success with the seed. Quality seed must be available. Losses must be prevented. This problem area is about the opportunities that exist in seed production.

5. **Lead from the interest approach** into the problem area objectives.
# Key Questions/Summary of Content

This teaching plan helps students develop competencies in producing seed for aquaculture.

# Teaching Techniques

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

## I. What is a hatchery? What are the functions of a hatchery?

**A.** A hatchery produces the seed for aquaculture. (Note: The terms seed and seedstock are used synonymously.)

1. Large volumes of quality seed are required.
2. Seed must be available at the right time of year for stocking growout facilities.

**B.** Hatcheries involve three major functions.

1. Selecting, maintaining and reproducing the broodstock.
   - As the technology of producing an aquacrop advances, broodstock selection is increasingly based on genetics and other factors of improvement.
   - The reproductive processes of the species broodstock being used, such as temperature, tide change and seasons when the species naturally reproduce, must be understood.

2. Collecting and hatching eggs.

   - Depending on the species being cultured, various methods are used to collect and hatch eggs.
   - Proper care is essential to prevent egg loss (known as roe or spawn).

## B. Use T IV-B-2 or the chalkboard to help present the functions of a hatchery.

1. Using the school laboratory, involve students in all three functions of a hatchery.

2. Take a field trip to a nearby aquafarm to observe hatchery functions. Have students give reports on their observations.

3. Ask students to explain different natural occurrences that tend to regulate reproduction in aquacrops.

4. Observe eggs at various stages of incubation. Have students describe what they see.
• Hatching methods vary and may involve natural hatching or artificial hatching.

3. Rearing the young to seed size.

• Newly hatched young require expert care to survive.

• Seed must be available at the right time to meet the needs of food aquacrop producers.

II. How does seed production vary by species?

A. Procedures vary between species and within species.

B. Species may be placed into three groups based on how seed are produced.

1. Wild-caught seed with little hatchery use.
   • These seed are captured in the wild and may not enter a hatchery.
   • Species include: mussels, carp and shrimp.
   • As with any technique, there are exceptions. Considerable research is underway to develop hatchery procedures for shrimp.

2. Seed are produced in the same facility where growout occurs.
   • There is little distinction between the hatchery phase and growout.
   • Sometimes there is an overpopulation problem and the crop doesn’t growout as it should.
   • Species include: crawfish and tilapia.

3. Seed are produced using facilities separate from the broodstock.
   • Sophisticated procedures of artificially hatching eggs may be used.
   • Species include: salmon, trout, catfish, hybrid striped bass, red drum and oysters (shrimp and carp are sometimes included here).

3. Display examples of newly hatched young. Stress the importance of proper management because of the young’s small size and fragile qualities.

B. Use T IV-B-3 or the chalkboard to present a summary of variations among species in terms of how seed are obtained.

2. Emphasize the problems that may result from overpopulation of a growout facility with this method of obtaining seed. For example, tilapia reproduce profusely and can stunt the growth of the entire crop. All-male populations are sometimes used to prevent reproduction.

3. Explain that most major aquafarm species are produced in distinct hatchery operations.
III. What are the important environmental factors in a hatchery?

A. Reproducing and rearing seed are sensitive to conditions; large losses can occur if the proper procedures aren't followed.

B. Nine environmental factors are important to success in producing seed.

1. Temperature — each species has an optimal temperature for incubation and hatching.
   - Deviating from the temperature can stop the maturation process or reduce spawning and hatching rate.

2. Matter in water — sediments and other solids in the water can cause damage to the seed after hatching.
   - Solids such as rust, waste and sediment must be mechanically filtered or settled out of the water.

3. Flow rate — refers to the speed at which water travels through the hatching trough or other facility.
   - Flow rate is usually measured as gallons per minute (gpm).
   - Incubated eggs require different flow rates depending on the incubation device and species.

4. Oxygen concentration — dissolved oxygen (DO) is critical.
   - Oxygen is taken from the water through the gills; it is essential for respiration.
   - Minimum oxygen level for most species is 4 to 5 ppm; a few species can survive on less. Examples: carp and tilapia.
   - Oxygen enters the water in three ways: from the surface through contact with the air, from photosynthesis by small plants in the water and from mechanical aeration.

5. Water purity — water in a hatchery should be free of dissolved pollutants, toxic materials and disease organisms.

A. Review previous instructions by asking students to explain the importance of environment.

B. Use T IV-B-4 or the chalkboard to present hatchery environmental factors in seed production.

1. Ask students how the temperature of the water in a hatching trough can be kept constant. Have them relate their observations to the function of a heater in an aquarium.

2. Remind students of their study of water and the samples observed in class.

- Students can determine flow rates of hatching facilities in the school laboratory.

4. Ask a student to review the importance of DO, as studied in a previous module.
   - Ask a student to review methods of aerating water, as studied in Module III.

5. Conduct tests on water from a hatchery to determine its quality for use with a species grown locally.
- Water in a hatchery must be cleaned to remove wastes such as ammonia and nitrite.

- Ammonia is a product of fish excrement. It is toxic in low levels, but can be removed by water exchange or biological filtration (biological filtration is the conversion of ammonia to nitrite and then to nitrate by bacteria).
- Ammonia levels above .02 ppm are considered unsafe.

- The appropriate pH depends on the species.
- A pH of 7.0 to 9.0 is usually desired.

7. Hardness — amount of calcium and magnesium in the water.
- Optimal levels are 120 to 400 ppm.

8. Alkalinity — the measure of carbonates and bicarbonates in the water.
- Alkalinity prevents pH fluctuations.
- Expressed in terms of equivalent calcium carbonate (CaCO₃).

9. Light quality — the hours and intensity of light present in a hatchery in a 24-hour period.
- Light intensity is a part of light quality (light intensity is the relative brightness of the light rays).
- Direct sunlight should not be permitted (indirect sunlight is usually okay).

- Ask students to describe the impurities that may be in local groundwater. Do these have an effect on aquacrops?
- Ask a student to review the source of ammonia in fish water, as studied in a previous module.
- Ask students to name methods of filtering water.
- Take a field trip to observe a biological filter system in operation or study the model used in the aquaculture laboratory.

7. Ask students to explain hardness (refer to Module III).

9. Take a field trip to observe how a hatching facility is protected from direct sun. What type of construction material is used?

IV. What are the sexual reproduction processes of aquaculture organisms?

A. Sexual reproduction involves fertilization.
   1. It is the union of an egg and a sperm.
      - Eggs are produced by females in ovaries.
      - Sperm are produced by males in testes.
   2. Eggs contain yolk as food for the developing embryo; sperm contain no yolk.
   3. The fertilized egg is known as a zygote.

A. Use T IV-B-5 or the chalkboard to define terms used in sexual reproduction of aquacrops.

2. Break open a chicken egg to explain the yolk. Allow students to closely observe parts of the egg.
B. Mating is the behavioral interaction between the male and female which will result in fertilization of the eggs; specific ritualized mating or courtship behavior occurs.

1. With fish, there is a courtship which results in the female spawning eggs (discharging from the body) and the male releasing semen (the fluid containing sperm) as the female spawns.

2. With crustaceans (shrimp and crawfish), ritualized mating results in the transfer of sperm to the female prior to spawning.

3. With molluscs (oysters and mussels), males expel sperm into the water and the females expel eggs into the water but no ritualized mating occurs.

C. Spawning is the release of eggs from the female; mating may occur prior to spawning or as spawning occurs.

V. What procedures are used in reproducing aquaculture organisms?

A. Aqua farmers must frequently intervene in the reproduction of aquacrops to be certain a sufficient supply of seed will be available.

B. Aqua farmers may use one of three general procedures in reproducing aquacrops.

1. Natural reproduction — no artificial inducement is used to get aquacrops to reproduce; usually relies on seasonal reproduction of the species.
   - Growout ponds — some species reproduce in growout ponds.(Examples: crawfish reproduction takes place in late winter or early spring in the growout ponds without any manipulation by the farmer; mussels reproduce naturally in the wild and seed are collected by placing a substrate in the ocean where and when the larvae are present, with the larvae settling on the substrate; marine shrimp reproduce naturally in the ocean, with seed collected with nets as they grow in the wild.)

B. Use T IV-B-6 or the chalkboard to describe mating.

2. Ask a student to define "crustacean."

C. Use T IV-B-7 or the chalkboard to explain spawning.

B. Use T IV-B-8 or the chalkboard to outline procedures in reproducing aquacrops.

1. Ask students to name an aquafarm that uses natural reproduction. Have them include the species and how the aquacrops are reproduced.
• Breeding ponds — some species reproduce in small ponds specifically for breeding; it is usually seasonal and tied to the species natural cycle. The process may involve: (1) placing selected females into tanks, pens or ponds; (2) placing selected males in with the females; and (3) providing a nest or spawning container, such as a plastic bucket or a milk can large enough for two fish to enter. Examples: catfish and carp.

2. Modified natural reproduction — some special treatment is provided to induce natural reproduction out of season.

• Higher quality diets such as fresh food and supplements, are sometimes used.

• The physical environment such as light (also known as photoperiod) and temperature cycles may be manipulated.

• Hormonal manipulation may be involved; approaches vary with different species.

• Example 1: with marine shrimp, eyestalk (or eye) ablation (surgically removing the eyestalk) causes the reproductive cycle of females to begin, because the organs that control the cycle are located in the eyestalk — removing one eyestalk is as effective as removing both and the shrimp’s survival rate is greater.

• Example 2: with fish, the female may be injected with hormones to induce maturation — the hormones may be derived from fish pituitary gland extract, luteinizing hormone (LH), human chorionic gonadotropin (HCG) or luteinizing hormone-releasing hormone (LHRH).

• Example 3: adding solutions to the water, such as adding hydrogen peroxide or serotonin to the spawning water of oysters.

• After spawning, the fertilized eggs are collected and transferred to a hatching area.

• Take a field trip to observe a breeding pond. Talk to the manager about the pond’s use. Use the school laboratory pond for a close examination.

2. Ask students to tell about any experiences they have had with modified natural reproduction in aquaculture.

• Take a field trip to a farm that uses hormonal manipulation and observe the practices followed.
• Some species lay eggs in masses that are easy to collect. Example: catfish.
• With some species, one of the parents tends the eggs until hatching.
• Some species of tilapia hold the fertilized eggs in their mouths until the eggs hatch.
• Crawfish and freshwater prawns carry eggs externally (attached to their bodies) until they hatch.

3. Artificial reproduction — used to eliminate the need for mating.
• Since mating behavior is the most sensitive part of reproduction, artificial means are sometimes difficult to use.
• With artificial methods the farmer may not always be able to tell when the organism is ready to spawn; a problem occurs if the eggs do not contain sufficient yolk to support embryo life — poor quality seed are produced.
• Artificial methods with fish usually involve the following steps:
  1. Female fish are held in hand while the eggs are “stripped” (forced out by pressure to the belly) into a pan or tray;
  2. Male fish are held over the eggs that have been stripped and their semen is stripped out onto the eggs much as the eggs are stripped from the female;
  3. Eggs and semen are stirred to obtain maximum fertilization;
  4. Fertilized eggs are placed into an incubation device;
  5. Incubation must be appropriate for the species. Examples: trout and catfish.
• Artificial methods with shrimp involve gluing a spermatophore (sperm packet from a male shrimp) to the ventral surface of a mature female; when the female spawns, the eggs are fertilized.
• Explain that egg masses may contain thousands of eggs. For example, a female catfish lays 2,000 or more eggs per pound of body weight. Have students calculate how many eggs a 5-pound broodfish might lay.

3. Demonstrate the process of artificial reproduction. Grow the aquacrop in the school lab.
• Explain that if eggs are stripped before the fish is ready to spawn, the eggs may not be fully developed. There may not be enough yolk to support the embryo.

• Use T IV-B-9 or the chalkboard to summarize artificial reproduction in fish.
• Refer to the species-specific modules for more details on stripping and other means of reproducing aquacrops.
• Take a field trip to a laboratory that uses sperm packets in shrimp reproduction.
MODULE IV-B

- Artificial methods with oysters involve removing eggs and sperm from the oysters and mixing them together in a small container.

VI. What spawning facilities are used in aquaculture?

A. Specialized facilities are needed to produce seed.
   1. These vary depending on the species and the methods used in spawning.
   2. Since these facilities may require considerable investment, some farmers specialize in seed production for growout farmers.

B. Four kinds of facilities are used in spawning.
   1. Ponds — widely used with certain species, such as catfish in commercial aquaculture. They are known as spawning ponds.
      • Pond size is generally about one half acre in size, with water depth of 2 to 7 feet.
      • The parent stock (broodstock) may have free rein or be restricted in access to the water.
   2. Pens — structures in ponds that are anchored at the bottom and often open at the top. They are usually only a few feet wide and long — similar to a pen for a pet dog.
      • One mature, ready-to-spawn female is placed in each pen along with one male of the same species.
      • A spawning container (bucket, milk can, ammunition box, mats for baitfish, etc.) is usually placed in the pen for easy inspection for the presence of an egg mass. (Spawning containers should be large enough to allow a pair of fish to swim into the container for mating.)
      • Spawning containers should be checked regularly for spawns and the egg mass carefully removed for hatching in an incubator.
   3. Tanks — various sizes and shapes of tanks are used in spawning aquacrops;

A. Ask students to describe some of the facilities needed in a hatchery. Have them estimate the cost of establishing and operating the facility. The cost may be too great for some aquafarms. If too much money is tied up in a hatchery, there may not be enough to operate the growout facility.

B. Use T IV-B-10 or the chalkboard to present the four kinds of facilities used in spawning.

2. Be sure students understand that a pond or other water structure must be available with a pen or a cage.
   • Ask students if they know of a farm that uses pens. Have them describe the practices followed.

   • Have students construct spawning containers in the school laboratory.

3. Use the school laboratory facilities to demonstrate reproduction using tanks.
• Round tanks 12 to 18 feet in diameter to allow for mating behavior may be used with marine shrimp.
• Rectangular tanks may be 6 feet wide, approximately 20 feet long and have water about 3 feet deep.
• Small aquaria (a few gallons in capacity) may be used to spawn ornamental fish.
• A nice feature of tanks is the water temperature is much easier to control. Heating water is expensive, but can possibly be profitable if aquacrops can be reproduced at times of the year unnatural for them.
• Since tanks confine the broodstock, they must be regularly monitored in case water problems begin to develop.
• Tanks must have filtration or flow-through systems to maintain water quality.

4. Cages — floating structures with tops, sides and bottoms.
• Cages may be used in large lakes or the ocean to confine brood fish.
• Regular inspection is needed to detect spawning and move the spawn for hatching.

• Take a field trip to a farm that uses tanks in reproducing aquacrops and observe how the tanks are used.

VII. What factors should be considered in selecting a method of obtaining seed?

A. Seed production is a highly specialized area of aquaculture.
1. Knowledge and skill are needed to reproduce aquacrops.
• Hatchery operators must know the specific cultural requirements of the species being produced.
• Specialized facilities are needed and may require considerable investment. The amount of investment depends on the size of the hatchery.
2. The aquafamer must decide whether or not to produce seed.
• This is a part of developing an aquafarm plan.

A. Call on students to describe areas of knowledge needed to reproduce aquacrops. This includes the time of the year that reproduction naturally occurs, mating behavior, incubation processes, etc.
• The aquafarmers preference is an important factor.

3. Aquafarms may: 1. specialize in seed production only and not be involved in growing out, 2. specialize in growing out and buy the seed from a seed producer, or 3. have a combination of seed production and growout farm.

B. Four factors should be considered in selecting a method of obtaining seed:

1. Adaptability of species — some species are easy to spawn, others are more difficult;
• The farm managers and employees level of knowledge and skill is a definite consideration.

2. Quantity of seed needed — the volume of seed required is an important consideration.
• Small aquafarms cannot afford the expense of building spawning facilities and should buy seed from specialized seed producers.
• Large producers will likely find a hatchery is needed to ensure a good supply of quality seed is available.

3. Resources available — establishing a seed production facility requires considerable investment. Some aquafarmers may not have sufficient resources.
• Using resources for seed production may restrict the growout operation.

4. Availability of seed — in some cases, plenty of seed producers may be available. In others, seed may not be available at all. If seed aren’t readily available, the growout farm may be forced into seed production.

3. Explain the three ways aquafarms may be involved in seed production. Have students evaluate the methods as alternatives they might use in their supervised experience programs.

B. Use T IV-B-11 or the chalkboard to list the four main factors in selecting a method of obtaining seed.

2. Be sure students understand that small farms often can’t afford a hatchery or they specialize in seed production.

4. Ask students what kind of seed is available in the local area. Indicate that if the aquafarmer chose to produce a species not available, the seed would have to be transported a long distance or the farm would need to produce its own seed.
Review

Review by having students demonstrate their mastery of the objectives. Using T IV-B-1, show the objectives and call on students to explain the content related to each. The activities in the teaching plan, application and evaluation activities also serve as review.

Application

Application can involve several approaches:

• Students can use what they have learned in their supervised experience programs.

• Students can apply the content to conduct activities in the school aquaculture laboratory.

• Arrange a field trip to observe a hatchery operation. Have students report on their observations.

• Have the students prepare a bulletin board that describes different methods of obtaining aquaculture seed.

• Have the students prepare an exhibit of various seed specimens used in aquaculture.

Evaluation

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

• Observe how students perform in their supervised experience programs.

• Review the students’ notebooks for the information they are recording.

• Question students about the content, which can provide a good indication of their level of comprehension.

• Give a written test. (See attached sample.)
Farming in Water

Problem Area: Producing Seed

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

Name___________________________

1. Hatcheries are involved in three major functions related to the production of seed for aquaculture. Name and briefly describe these functions.
   a. __________________________________________
   b. __________________________________________
   c. __________________________________________

2. Nine environmental factors are important in hatcheries. These are listed below. Briefly describe each.
   temperature_________________________________
   matter in the water ___________________________
   flow rate ____________________________________
   DO _________________________________________
   water purity_________________________________
   water pH____________________________________
   hardness_____________________________________ 
   alkalinity____________________________________
   light quality________________________________

3. Sexual reproduction of aquaculture organisms involves several processes. Explain the following terms.
   fertilization__________________________________
   mating_______________________________________
   spawning____________________________________
4. Distinguish between natural, modified natural and artificial reproduction. Assess which of these methods would be best with the predominate species in your local community.

5. Four kinds of facilities are used in spawning, as listed in the left column below. Match the statement in the right column with the appropriate term in the left column, showing your selection by writing the letter in the blank. (There may be more than one correct match.)

- ponds
- cages
- pens
- tanks

- a. float in the water
- b. are anchored to the bottom of ponds
- c. can control the water temperature
- d. usually approximately one-half acre in size
- e. can be used to isolate broodfish in large lakes
- f. requires careful monitoring of water

6. The decision to produce seed is important to the aquafarmer. What are four important factors to consider in making the decision?

a.

b.

c.

d.
Farming in Water

1. a. Selecting, maintaining and reproducing the broodstock; selection is based on genetics and other factors; understanding the species’ reproductive processes.

   b. Collecting and hatching eggs; methods depend on the species, proper care to prevent loss of eggs, various hatching methods-natural and artificial.

   c. Rearing young to seed size; newly hatched young require expert care for survival; seed must be available at the right time to meet the producers’ needs.

2. temperature — Each species has optimal temperature for incubation and hatching.

   matter in the water — Sediments and other solids can damage seed after hatching.

   flow rate — The speed water travels through the hatching trough/other facilities.

   DO — Dissolved oxygen taken from water through gills; essential for respiration.

   water purity — Water should be free of pollutants and toxins, cleaned of wastes.

   water pH — The concentration of hydrogen ions in the water.

   hardness — The amount of calcium and magnesium in the water.

   alkalinity — The measure of carbonates and bicarbonates in the water.

   light quality — The hours and intensity that is present in a 24-hour period.

3. fertilization — The union of an egg and a sperm.

   mating — The behavioral interaction between the male and female which will result in fertilization of the eggs; specific ritualized mating/courtship may occur.

   spawning — The release of eggs from the female; mating may occur prior to spawning or as spawning occurs.

4. Natural — No artificial inducement is used.

   Modified natural — Some special treatment used to induce natural reproduction.

   Artificial — Used to eliminate the need for mating.

5. ponds — d. usually approximately one-half acre in size

   cages — a. float in the water, e. can be used to isolate broodfish in large lakes

   pens — b. are anchored to the bottom of ponds

   tanks — c. can control the water temperature, f. requires careful monitoring of water

6. a. Adaptability of species — Some species are easy to spawn, others difficult.

   b. Quantity of seed needed — The volume of seed required is important.

   c. Resources available — A seed-producing facility requires considerable investment.

   d. Availability of seed — In some cases, seed may or may not be available.
Farming in Water:
Producing Seed

OBJECTIVES
- Describe hatchery purposes and functions
- Describe three ways seed are produced
- Explain hatchery environmental factors
- Describe aquaculture reproduction processes
- Describe procedures in reproducing aquaculture organisms
- Describe the spawning facilities
- Select a method of producing seed
Hatchery Functions

1. Selecting, maintaining and reproducing broodstock
2. Collecting and hatching eggs
3. Rearing young to seed size
How Seed are Produced

- Wild seed without hatchery
- Seed produced in growout facilities
- Seed produced separately from growout (in hatchery)
Environmental Factors in Seed Production

- Temperature
- Matter in water
- Flow rate
- Oxygen (DO)
- Water purity
- Water pH
- Water hardness
- Water alkalinity
- Light quality
Sexual Reproduction of Aquaculture Organisms

- Fertilization — union of egg and sperm
- Egg — produced by female, contains yolk (food supply for embryo)
- Sperm — produced by male
- Zygote — fertilized egg
Mating

DEFINITION:
Interaction between male and female organisms

SPECIES VARIATIONS:
• Fish
  – ritual behavior
  – female releases eggs (spawns)
  – male releases semen (fluid containing sperm)
  – fertilization occurs in water
• Crustaceans
  – ritual behavior
  – sperm transferred to female prior to spawning
• Molluscs
  – no ritual behavior
  – sperm and eggs expelled into water
Spawning

DEFINITION:
Release of eggs by female

VARIATIONS:
Mating may occur before or after spawning

Note: Egg mass may be known as a spawn.
Cultural Procedures in Reproducing Aquacrops

- Natural reproduction — uses natural cycle of organism
  - Growout ponds
  - Breeding ponds
- Modified natural reproduction — modifies natural cycle of organism
  - Diets
  - Physical environment
  - Hormones
- Artificial reproduction
Artificial Reproduction with Fish

STEPS:
1. Eggs stripped from female into pan
2. Semen stripped from male onto eggs
3. Eggs and semen stirred
4. Fertilized eggs moved to incubator
Facilities in Spawning

- Ponds
  - small
  - water 2 to 7 feet deep
- Pens
  - anchored to bottom of pond
  - may have open top
- Tanks
  - round
  - rectangular
  - aquaria
- Cages
  - float in water
Factors in Selecting Method for Obtaining Seed

- Adaptability of species
- Quantity of seed needed
- Resources available
- Availability of seed