M.Sc. IN FISHERY SCIENCE
LAB MANUAL
4th Semester

Prepared By
Biological Science Dept.
Fishery Science

MIDNAPORE CITY COLLEGE

FSC-494
GENERAL PRACTICAL
(Core course - 4 credits: 50 Marks)
[University Examination - 50]
[Based on FSC -401 (Unit – 1 & 2) and FSC -402 (Unit – 1 & 2)]

1. Fish handling, icing, freezing of fin fish and shellfish. Calculation of ice requirement for freezing.
2. Preparation of fish fillets.
3. Study of proximate composition of fish.
4. Preparation of value added product
5. Preparation of fish by-products.
6. Isolation and identification of fish spoilage causing microbes and their culture
7. Collection of data and presentation of data. Testing of Goodness of fit; Chi squire (X2) test and Student's t-test.
8. Operation of MS-Excel, tabulation of biological data, simple computation of different groups of data, making chart with MS-Excel, Bar-diagram, Line-diagram, Pie diagram. Preparation of Power Point presentation on any topics on fisheries.
9. Database development through the survey, collection & analysis of data from fish market/ Fisheries Co-operative society / Fish farms / NGOs etc.

LAB-1: Preparation of Fish Fillets

Introduction: The purpose of this lab manual is to provide a step-by-step guide for the preparation of fish fillets. Fish fillets are commonly used in culinary applications and require proper handling and preparation techniques to ensure food safety and quality. This lab will cover the basic process of filleting a fish and preparing fillets for cooking or further processing.

Materials:

1. Fresh whole fish (species of your choice)
2. Cutting board
3. Filleting knife
4. Kitchen shears
5. Tweezers or pliers
6. Clean towels or paper towels
7. Disposable gloves (optional)
8. Plastic bags or containers for storing fillets
9. Ice or a cool environment for temporary storage of fillets
10. Safety goggles or glasses (recommended)

Procedure:

1. Setup:
    a) Ensure a clean and organized workspace.
    b) Put on disposable gloves and safety goggles/glasses if desired.
2. Fish Preparation:
    a) Rinse the whole fish under cold running water to remove any surface impurities.
    b) Pat the fish dry with a clean towel or paper towel.
    c) Place the fish on the cutting board, with the head facing away from you.
3. Removing Scales:
    a) Hold the tail firmly and scrape the fish's scales from tail to head, using the back of the knife or a scaler.
    b) Repeat this process on both sides of the fish until all scales are removed.
    c) Rinse the fish again under cold running water to remove loose scales.
4. Gutting the Fish:
    a) Make a shallow cut along the belly of the fish from the vent (anus) to the base of the head.
    b) Insert the tip of the knife into the belly cavity and carefully cut open the fish.

c) Reach inside the cavity and remove the internal organs, including the guts, liver, and gills.
d) Rinse the cavity thoroughly with cold water to remove any remaining blood or debris.
e) Pat the fish dry with a clean towel or paper towel.

5. Filleting:

a) Lay the fish on its side and make an incision behind the gills, following the natural curve of the fish's body.
b) Starting from the head, insert the knife at a slight angle and cut along the backbone, moving towards the tail.
c) Apply gentle pressure with the knife, following the backbone and separating the fillet from the fish.
d) Repeat the same process on the other side of the fish to obtain the second fillet.
e) Remove any remaining rib bones or pin bones from the fillets using tweezers or pliers.

6. Cleaning and Storing Fillets:

a) Rinse the fillets under cold running water to remove any residual blood or scales.
b) Pat the fillets dry with a clean towel or paper towel.
c) Place the fillets in plastic bags or containers and store them in a cool environment or on ice until further use.

Safety Precautions:

1. Always handle the filleting knife with caution and keep your fingers away from the blade.

2. Use safety goggles or glasses to protect your eyes from any flying scales or bone fragments.

3. Ensure the workspace is clean to prevent cross-contamination and maintain food safety.

4. Dispose of the fish waste properly, following local regulations and guidelines.

Conclusion: This lab manual has provided a detailed procedure for the preparation of fish fillets. Following the steps outlined in this manual will help ensure the proper handling, cleaning, and filleting of fish for culinary purposes. Proper fish fillet preparation is essential for maintaining food safety and quality, and it is crucial to

LAB-2: Lab Manual for Preparation of Fish Oil

Introduction: Fish oil is a valuable product derived from the extraction of oil-rich tissues in fish, such as the liver or fatty parts. It is rich in omega-3 fatty acids, which are beneficial for human health. This lab manual provides a step-by-step guide for preparing fish oil from fish samples.

Materials:

1. Fresh fish samples (preferably oily fish species)
2. Cutting board
3. Sharp knife
4. Blender or food processor
5. Cheesecloth or fine mesh strainer
6. Glass jars or bottles for storage
7. Funnel
8. Paper towels or absorbent pads
9. Disposable gloves

Procedure:

1. Setup:
    a) Ensure a clean and organized workspace.
    b) Put on disposable gloves for handling the fish samples.
2. Preparation of Fish:
    a) Rinse the fish samples under cold running water to remove any surface impurities.
    b) Pat the fish samples dry with paper towels or absorbent pads.
    c) Place the fish on a cutting board.
3. Tissue Selection:
    a) Identify and separate the oil-rich tissues from the rest of the fish, such as the liver or fatty parts.
    b) Remove any scales, bones, or unwanted parts from the selected tissues.
4. Tissue Processing:
    a) Cut the selected tissues into small pieces to facilitate the extraction process.
    b) Place the tissue pieces in a blender or food processor.
5. Blending/Processing:
    a) Blend or process the tissue pieces until a smooth paste or emulsion-like consistency is achieved.
    b) Ensure that all tissue particles are well broken down.

6. Straining:

    a) Line a funnel with cheesecloth or a fine mesh strainer.
    b) Place the lined funnel over a glass jar or bottle.
    c) Pour the blended fish mixture into the funnel, allowing the oil to separate and pass through the strainer.
    d) Gently press the mixture with a spoon or spatula to extract as much oil as possible.

7. Oil Collection:

    a) Allow the oil to pass through the strainer completely, collecting it in the glass jar or bottle.
    b) Discard the leftover fish solids trapped in the strainer.

8. Storage:

    a) Seal the glass jar or bottle tightly to prevent oxidation and contamination.
    b) Store the fish oil in a cool, dark place, such as a refrigerator, to maintain its quality and freshness.

9. Clean-up:

    a) Dispose of fish waste and other biological materials following proper laboratory protocols.
    b) Clean the blender or food processor, strainer, funnel, and workspace with soap and water.

LAB-3: Lab Manual for Preparation of Fish Fingers

Introduction: Fish fingers are a popular and delicious snack made from boneless fish fillets coated in a crispy breadcrumb coating. This lab manual provides a step-by-step guide for preparing fish fingers, which can be enjoyed as a standalone snack or served as a part of a meal.

Materials:

1. Fresh fish fillets (preferably white fish like cod, haddock, or pollock)
2. Breadcrumbs (plain or seasoned)
3. All-purpose flour
4. Eggs
5. Salt and pepper (optional)
6. Cooking oil (vegetable or canola)
7. Baking sheet or baking dish
8. Plastic wrap or parchment paper
9. Mixing bowls
10. Whisk or fork
11. Paper towels or absorbent pads
12. Disposable gloves

Procedure:

1. Setup:
    a) Ensure a clean and organized workspace.
    b) Preheat the oven to the appropriate temperature (as per fish cooking instructions).
2. Preparation of Fish Fillets:
    a) Rinse the fish fillets under cold running water to remove any surface impurities.
    b) Pat the fish fillets dry with paper towels or absorbent pads.
    c) Cut the fish fillets into rectangular strips of approximately equal size, resembling finger shapes.
3. Coating Station:
    a) Set up a coating station with three separate bowls: one for flour, one for beaten eggs, and one for breadcrumbs.
    b) Season the flour and breadcrumbs with salt and pepper (if desired).
4. Coating Process:
    a) Take one fish finger and coat it in flour, shaking off any excess.

b) Dip the floured fish finger into the beaten eggs, ensuring it is fully coated.
c) Transfer the fish finger to the bowl of breadcrumbs and press gently to coat all sides evenly.
d) Place the coated fish finger on a clean plate or baking sheet.
e) Repeat the process for all remaining fish fingers.

5. Frying Method:

a) Heat cooking oil in a deep frying pan or skillet over medium heat.
b) Carefully place the coated fish fingers into the hot oil, ensuring they are not overcrowded.
c) Fry the fish fingers for about 2-3 minutes on each side until golden brown and crispy.
d) Remove the fried fish fingers from the oil and place them on paper towels to absorb excess oil.

6. Baking Method:

a) Preheat the oven to the appropriate temperature (as per fish cooking instructions).
b) Place the coated fish fingers on a greased baking sheet or baking dish.
c) Bake the fish fingers in the preheated oven for approximately 15-20 minutes, or until they are golden brown and cooked through.

7. Serving:

a) Allow the fish fingers to cool slightly before serving.
b) Serve the fish fingers with your choice of dipping sauce, such as tartar sauce, ketchup, or mayonnaise.
c) Garnish with fresh lemon wedges and parsley (optional).

8. Clean-up:

a) Dispose of any waste and clean the cooking utensils and workspace following proper kitchen hygiene practices.

LAB-4: Lab Manual for Preparation of Fish Cutlet

Introduction: Fish cutlets are flavourful and savoury patties made from minced fish and various spices. They are a versatile snack or appetizer that can be enjoyed on their own or used in sandwiches or burgers. This lab manual provides a step-by-step guide for preparing fish cutlets.

Materials:

1. Fresh fish fillets (preferably boneless and skinless)
2. Potatoes (boiled and mashed)
3. Onion (finely chopped)
4. Garlic cloves (minced)
5. Ginger (grated)
6. Green chillies (finely chopped)
7. Fresh coriander leaves (chopped)
8. Bread crumbs
9. All-purpose flour
10. Eggs
11. Salt and pepper
12. Cooking oil (vegetable or canola)
13. Mixing bowls
14. Frying pan or skillet
15. Spatula or slotted spoon
16. Paper towels or absorbent pads
17. Disposable gloves

Procedure:

1. Setup:
    a) Ensure a clean and organized workspace.
    b) Preheat the oven to the appropriate temperature (if baking the cutlets).
2. Preparation of Fish:
    a) Rinse the fish fillets under cold running water to remove any surface impurities.
    b) Pat the fish fillets dry with paper towels or absorbent pads.
    c) Cut the fish fillets into small pieces.
3. Fish and Potato Mixture:

a) In a mixing bowl, combine the minced fish, mashed potatoes, chopped onion, minced garlic, grated ginger, chopped green chillies, and chopped coriander leaves.
b) Season the mixture with salt and pepper to taste.
c) Mix all the ingredients thoroughly until well combined.

4. Shaping the Cutlets:

a) Take a portion of the fish and potato mixture and shape it into a patty or cutlet of desired size and thickness.
b) Repeat the process to shape all the cutlets.
c) Place the shaped cutlets on a plate or tray.

5. Coating the Cutlets:

a) In a shallow bowl, whisk the eggs until well beaten.
b) Place the bread crumbs in another shallow bowl.
c) Dip each cutlet into the beaten eggs, ensuring it is fully coated.
d) Roll the egg-coated cutlet in the bread crumbs, pressing gently to coat all sides evenly.
e) Place the coated cutlets on a separate plate or tray.

6. Frying the Cutlets:

a) Heat cooking oil in a frying pan or skillet over medium heat.
b) Carefully place the coated cutlets into the hot oil, ensuring they are not overcrowded.
c) Fry the cutlets for about 2-3 minutes on each side until golden brown and crispy.
d) Remove the fried cutlets from the oil using a spatula or slotted spoon.
e) Place them on paper towels to absorb excess oil.

7. Baking the Cutlets (optional):

a) Preheat the oven to the appropriate temperature.
b) Place the coated cutlets on a greased baking sheet.
c) Bake the cutlets in the preheated oven for approximately 15-20 minutes, or until they are golden brown and cooked through.

8. Serving:

a) Allow the cutlets to cool slightly before serving.
b) Serve the fish cutlets with your choice of sauce or chutney.
c) Garnish with fresh coriander leaves (optional).

9. Clean-up:

a) Dispose of any waste and clean the cooking utensils and workspace following proper kitchen hygiene practices.

LAB-5: Lab Manual for Process of Fish Drying

Objective: To understand and practice the process of fish drying as a method of fish preservation.

Materials:

1. Fresh fish (species of choice)
2. Knife and cutting board
3. Salt or curing mixture
4. Drying racks or screens
5. Weighing scale
6. Timer or clock
7. Data recording sheets

Procedure:

1. Introduction to Fish Drying:

    a) Begin the session with an overview of fish drying as a method of fish preservation.
    b) Discuss the advantages and challenges of fish drying, including increased shelf life, reduced weight and volume, and the need for proper hygiene and environmental conditions.

2. Preparation of Fish for Drying:

    a) Start by selecting fresh fish of appropriate species and size for drying.
    b) Demonstrate the proper technique for cleaning and gutting the fish.
    c) Cut the fish into desired sizes or fillets for drying, considering the thickness and uniformity of the pieces.

3. Curing and salting:

    a) Explain the importance of salting or curing fish before drying to enhance preservation.
    b) Prepare a salt or curing mixture according to a suitable recipe or recommendation.
    c) Apply the salt or curing mixture evenly to all surfaces of the fish pieces.
    d) Allow the fish to rest and absorb the salt or curing mixture for a specified time (e.g., 1-2 hours).

4. Drying Process:

    a) Set up drying racks or screens in a well-ventilated area away from direct sunlight, dust, and pests.
    b) Place the salted fish pieces on the drying racks, ensuring proper spacing between them for air circulation.
    c) Monitor and maintain suitable drying conditions, including temperature (around 20-30°C) and humidity (below 60%).

d) Observe and record the drying time at regular intervals, noting any changes in appearance or texture.

5. Monitoring Drying Progress:

   a) Check the drying progress by inspecting the fish pieces. They should gradually lose moisture and become firm, leathery, and less sticky.
   b) Measure the weight of a few fish pieces at different time intervals using a weighing scale, recording the data on the data recording sheets.
   c) Note any observations regarding changes in colour, texture, or aroma during the drying process.

6. Determining Dryness:

   a) Determine the dryness of the fish by examining the moisture content and texture.
   b) The fish is considered dry when it reaches a moisture content of around 20-30% or when it becomes hard, brittle, and breaks easily.

7. Evaluation and Storage:

   a) Evaluate the dried fish for quality, including taste, aroma, and overall appearance.
   b) Discuss the importance of proper storage to maintain the quality and prevent rehydration or spoilage.
   c) Package the dried fish in suitable containers or packaging materials, ensuring they are airtight and stored in a cool, dry place.

Safety Precautions:

1. Follow standard food safety practices, including hand washing, wearing gloves, and maintaining clean work surfaces.
2. Handle knives and cutting tools with care, ensuring they are sharp and in good condition.
3. Keep the drying area clean, free from pests, and protected from potential contaminants.

Disposal:

1. Properly dispose of any fish waste according to local regulations and waste management guidelines.
2. Clean and sanitize all equipment used during the session to maintain hygiene standards.

LAB-6: Lab Manual for Process of Fish Salting Technique

Objective: To understand and practice the process of fish salting as a method of fish preservation.

Materials:

1. Fresh fish (species of choice)
2. Salt (non-iodized or sea salt)
3. Curing container or basin
4. Weighing scale
5. Timer or clock
6. Data recording sheets

Procedure:

1. Introduction to Fish Salting:
    a) Begin the session with an overview of fish salting as a traditional method of fish preservation.
    b) Discuss the benefits of fish salting, including extended shelf life, enhanced flavour, and reduced microbial growth.
2. Selection of Fresh Fish:
    a) Start by selecting fresh fish of suitable species and size for salting.
    b) Choose fish that are of good quality, without signs of spoilage or damage.
3. Cleaning and Preparation:
    a) Demonstrate the proper technique for cleaning and scaling the fish.
    b) Gut the fish carefully to remove the internal organs.
    c) Rinse the fish thoroughly under cold water to remove any residual blood or debris.
    d) Pat the fish dry with a clean towel or paper towels.
4. Salting Process:
    a) Prepare a suitable container or basin for the salting process.
    b) Spread a layer of salt evenly at the bottom of the container.
    c) Place the fish on top of the salt layer, ensuring there is space between each fish.
    d) Sprinkle a generous amount of salt over each fish, covering them completely.
    e) Continue layering fish and salt until all the fish are salted.
    f) Cover the container with a clean cloth or lid.
5. Salting Time and Monitoring:
    a) Set a timer or clock to monitor the salting time.
    b) The duration of salting depends on the size and thickness of the fish. Generally, smaller fish require less salting time than larger ones.

c) Monitor the salt penetration by observing changes in colour and texture of the fish. The fish will become firm and less glossy as the salt draws out moisture.

6. Evaluation and Rinsing:

a) After the designated salting time, carefully remove a fish from the container for evaluation.
b) Check the fish for desired firmness and salt penetration by pressing it gently with your finger.
c) If the fish meets the desired texture, rinse off the excess salt under cold running water. If not, return it to the container for additional salting time. d. Repeat the evaluation and rinsing process for each fish.

7. Drying and Storage:

a) After rinsing, pat the fish dry with a clean towel or paper towels.
b) Place the salted and rinsed fish on a drying rack or clean surface to allow them to air dry.
c) Ensure proper ventilation and protection from pests during the drying process.
d) Monitor the drying time and record any observations regarding changes in texture and appearance.
e) Once the fish are fully dried, package them in suitable storage containers or bags for long-term storage.

Safety Precautions:

1. Follow standard food safety practices, including handwashing, wearing gloves, and maintaining clean work surfaces.

2. Handle knives and cutting tools with care, ensuring they are sharp and in good condition.

Disposal:

1. Properly dispose of any fish waste according to local regulations and waste management guidelines.

2. Clean and sanitize all equipment used during the session to maintain hygiene standards.

LAB-7: Calculation of Ice Requirement for Short-Term Freezing

Objective: To understand and practice the calculation of ice requirement for short-term freezing of fish or other perishable food items.

Materials:

1. Fish or perishable food items (optional for demonstration purposes)
2. Weighing scale
3. Thermometer
4. Calculator
5. Data recording sheets

Procedure:

1. Introduction to Ice Requirement Calculation:
    a) Begin the session with an overview of the importance of proper ice requirement calculation for short-term freezing.
    b) Explain the significance of maintaining the desired temperature to ensure food safety and quality.
2. Determining the Weight of the Fish or Food Item:
    a) Weigh the fish or food item that needs to be frozen using a weighing scale.
    b) Record the weight on the data recording sheet.
3. Estimating the Heat Load:
    a) Calculate the estimated heat load by multiplying the weight of the fish or food item by its specific heat capacity.
    b) The specific heat capacity of fish is approximately 0.92 Kcal/kg °C. c. Record the calculated heat load on the data recording sheet.
4. Determining the Required Ice Quantity:
    a) Determine the desired storage temperature for the fish or food item. For short-term freezing, it is typically -18°C (0°F).
    b) Calculate the heat of fusion (latent heat) of ice, which is approximately 79.7 Kcal/kg or 144 Btu/lb.
    c) Divide the calculated heat load by the heat of fusion to determine the required ice quantity in kilograms or pounds. Ice Quantity (kg) = Heat Load (Kcal) / Heat of Fusion (Kcal/kg)
    d) Record the calculated ice quantity on the data recording sheet.
5. Monitoring the Freezing Process:

a) Prepare a suitable container or freezer to hold the fish or food item.
b) Place a thermometer inside the container to monitor the temperature.
c) Add the calculated quantity of ice to the container.
d) Place the fish or food item on top of the ice.
e) Monitor the temperature regularly using the thermometer and ensure it remains at or below the desired storage temperature (-18°C or 0°F).

6. Evaluation and Documentation:

a) Observe and record the temperature readings at regular intervals during the freezing process.
b) Monitor the duration required for the fish or food item to reach the desired storage temperature.
c) Note any observations regarding the quality, texture, or appearance of the frozen product.

Safety Precautions:

1. Follow standard food safety practices, including handwashing and maintaining clean work surfaces.
2. Handle fish or perishable food items with care to prevent cross-contamination.
3. Use caution when using a weighing scale and handling sharp objects such as knives.

Disposal:

1. Properly dispose of any fish waste or food items according to local regulations and waste management guidelines.
2. Clean and sanitize all equipment used during the session to maintain hygiene standards.

Note: The above procedure is a general guide for calculating ice requirement for short-term freezing. The specific requirements may vary depending on the type of food item and storage conditions.

LAB-8: Lab Manual for Moisture Content Analysis of Fish Muscle (Infrared moisture analyser)

Introduction: Moisture content analysis is a crucial parameter in assessing the quality and freshness of fish muscle. Determining the moisture content helps in evaluating the water-holding capacity and potential spoilage of fish samples. This lab manual provides a step-by-step guide for conducting moisture content analysis of fish muscle.

Objective: To determine the moisture content in fish muscle using an infrared moisture analyser.

Materials:

1. Fresh fish sample (muscle portion)
2. Infrared moisture analyser
3. Analytical balance
4. Sample containers
5. Desiccator
6. Spatula or scoop
7. Laboratory oven
8. Heat-resistant gloves

Procedure:

1. Sample Preparation:
    a) Obtain a representative sample of fish muscle.
    b) Remove any visible skin, bones, or scales from the sample.
    c) Cut the sample into smaller pieces to ensure uniformity and faster drying.
    d) Weigh the sample accurately using an analytical balance and record the weight.
2. Calibration of the Infrared Moisture Analyser:
    a) Switch on the infrared moisture
    b) Perform the calibration process as per the instrument's user manual.
    c) Ensure that the instrument is calibrated and ready for use before proceeding with the analysis.
3. Analysis with Infrared Moisture Analyser:
    a) Preheat the moisture analyser to the recommended temperature specified by the manufacturer.
    b) Open the sample container of the moisture analyser and place it on the sample pan.
    c) Tare the sample pan to zero.
    d) Using a spatula or scoop, transfer an appropriate amount of the prepared fish muscle sample into the sample container.
    e) Close the sample container and place it back on the moisture analyser.

f) Start the moisture analysis program on the instrument, following the manufacturer's instructions.
g) Wait for the analysis to complete, and record the moisture content value displayed by the moisture analyser.
h) Remove the sample container from the analyser and clean it thoroughly before the next analysis.
i) Repeat the analysis for each sample if multiple samples need to be tested.

4. Calculation of Moisture Content:

a) Calculate the moisture content using the following formula:
Moisture Content (%) = [(Wet Weight - Dry Weight) / Wet Weight] × 100
Wet Weight: Initial weight of the fish muscle sample.
Dry Weight: Weight of the fish muscle sample after drying.

5. Drying the Sample in an Oven (Optional):

a) After completing the moisture analysis with the infrared moisture analyser, transfer the sample from the sample container to a pre-weighed drying dish.
b) Spread the sample evenly in the drying dish.
c) Place the drying dish in a laboratory oven preheated to the recommended temperature (usually around 105°C) for a specified duration (e.g., 2-4 hours).
d) After the specified drying time, remove the drying dish from the oven using heat-resistant gloves and place it in a desiccator to cool.
e) Once the dish reaches room temperature, weigh it using an analytical balance to obtain the dry weight of the sample.
f) Calculate the moisture content using the formula mentioned in Step 4.

Note: The optional step of oven drying provides a secondary method for moisture content determination and can be used for verification purposes or if the infrared moisture analyzer is not available.

Safety Precautions:

1. Follow standard laboratory safety protocols, including the use of appropriate personal protective equipment (PPE) such as gloves and lab coats.

2. Handle the fish samples carefully to avoid any contamination or injury.

3. Be cautious while operating the infrared moisture analyser to prevent burns or injuries from hot surfaces.

4. Use heat-resistant gloves when handling the drying dish from the oven.

LAB-9: Calculation of ice requirement for freezing of 1000 kg of fish

Introduction: Determining the ice requirement for freezing a specific quantity of fish is crucial for maintaining its quality and preventing spoilage during storage and transportation. This lab manual provides a step-by-step guide to calculate the ice requirement for freezing 1000 kg of fish, considering the specific heat capacity and latent heat of fusion of ice.

Materials:

1. Calculator
2. Pen and paper
3. Knowledge of specific heat capacity and latent heat of fusion of ice (specific values provided in the procedure section)
4. Safety goggles
5. Gloves

Procedure:

1. Determine the specific heat capacity of fish:
    a. Research or consult relevant literature to obtain the specific heat capacity of the type of fish being considered. The specific heat capacity varies depending on the fish species and water content.
    b. Assume a specific heat capacity value for fish. For example, the specific heat capacity of fish can range from approximately 3.0 to 4.5 Joules per gram per degree Celsius (J/g°C).
2. Calculate the heat transfer required to freeze the fish:
    a. Determine the desired temperature decrease for freezing the fish. For example, assume a temperature decrease of 20°C.
    b. Calculate the heat transfer using the formula:
    Heat transfer (Q) =
    Mass of fish (m) × Specific heat capacity of fish (C) × Temperature decrease (ΔT)
3. Convert the heat transfer to the ice requirement:
    a. Determine the latent heat of fusion of ice. The latent heat of fusion of ice is approximately 334 Joules per gram (J/g).
    b. Convert the heat transfer to the ice requirement using the formula:
    Ice requirement (in grams) =
    Heat transfer (Q) / Latent heat of fusion of ice (334 J/g)
4. Calculate the ice requirement for 1000 kg of fish:
    a. Convert the mass of fish to grams (if needed) for consistent units.
    b. Mass of fish (in grams) = Mass of fish (in kg) × 1000

Multiply the ice requirement obtained in step 3 by the mass of fish: Ice requirement for 1000 kg of fish (in grams) = Ice requirement (in grams) × Mass of fish (in grams)

5. Convert the ice requirement to the number of ice cubes or volume of ice (optional):

    a. If desired, determine the number of ice cubes or volume of ice needed by considering the mass of each ice cube or the density of ice. Use the formulas mentioned in the previous response, adjusting the units accordingly.

6. Document the results: Record the calculated ice requirement for freezing 1000 kg of fish, including any additional calculations for the number of ice cubes or volume of ice.

Conclusion: Calculating the ice requirement for freezing a specific quantity of fish is essential for maintaining its quality during storage and transportation. By following this lab manual, you can accurately determine the ice requirement for freezing 1000 kg of fish based on the specific heat capacity and latent heat of fusion of ice. This knowledge will help ensure proper freezing and preservation of fish, minimizing spoilage and maintaining its freshness.

LAB-10: Computer Data Analysis

1) Make a bar diagram on inland fish production (2021-22) of different states of India using MS Excel and comment on it.

Table 1.6 : Year-wise Fish Seed Production in India		
S.N.	Year	Production (Lakh Fry)
1	1985-86	63,220
2	1986-87	76,010
3	1987-88	86,080
4	1988-89	93,250
5	1989-90	96,910
6	1990-91	1,03,320
7	1991-92	1,22,030
8	1992-93	1,25,000
9	1993-94	1,42,390
10	1994-95	1,45,440
11	1995-96	1,50,070
12	1996-97	1,58,520
13	1997-98	1,59,040
14	1998-99	1,51,560
15	1999-00	1,65,890
16	2000-01	1,56,080
17	2001-02	1,57,580
18	2002-03	1,63,330
19	2003-04	1,92,310
20	2004-05	2,07,910
21	2005-06	2,19,880
22	2006-07	2,36,480
23	2007-08	2,41,440
24	2008-09	3,21,770
25	2009-10	2,93,130
26	2010-11	3,41,095
27	2011-12	3,65,651
28	2012-13	3,49,202
29	2013-14	4,14,484
30	2014-15	3,93,487
31	2015-16	3,54,350
32	2016-17	3,57,439
33	2017-18	4,44,207
34	2018-19	4,81,974
35	2019-20	5,21,865
36	2020-21	5,40,690

2) Make a simple line diagram using year-wise fish production in India by MS Excel and comment on it.

Table 3.1: State wise Fish Consumption Data (Per Capita/Kg): 2020-21		
S. N.	States/UT	Yearly Fish Consumption (Per Capita/Kg.) 2020-21
1	Andhra Pradesh	8.91
2	Arunachal Pradesh	3.65
3	Assam	11.89
4	Bihar	9.6
5	Chhattisgarh	19.7
6	Goa	78
7	Gujarat	7.44
8	Haryana	0.3
9	Himachal Pradesh	2.22
10	Jharkhand	10.61
11	Karnataka	10.55
12	Kerala	17.93
13	Madhya Pradesh	4.87
14	Maharashtra	4.72
15	Manipur	18.25
16	Meghalaya	9.00
17	Mizoram	3.38
18	Nagaland	6.06
19	Odisha	16.34
20	Punjab	0.4
21	Rajasthan	0.01
22	Sikkim	1.16
23	Tamil Nadu	9.3
24	Telangana	8.7
25	Tripura	25.53
26	Uttarakhand	0.81
27	Uttar Pradesh	11.09
28	West Bengal	NR
29	A and N Islands	77.84
30	Chandigarh	NR
31	Daman and Diu, D & Nagar Haveli	1.2
32	Delhi	0.25
33	Jammu & Kashmir	6.00
34	Ladakh	0.05
35	Lakshadweep	125
36	Puducherry	18.88
ALL INDIA		6.31
NR: Not Received		
Source: Department of Fisheries, State Govt. / UT Administration		

3) Make a pie diagram on state wise fish consumption data by MS Excel and comment on it.

Table.5.1: Trend of Export of Fish and Fish Products (2010-11 to 2021-22)							
Year	Quantity (Tonnes)	Value (in ₹ Crore)	US Dollar (Million)	Unit value (Rs. /Tonnes)	Unit value Index*	Annual growth rate (%)	
						Quantity	Value
2010-11	813091	12901.47	2856.92	158671.89	12	19.85	28.39
2011-12	862021	16597.23	3508.45	192538.46	11	6.02	28.65
2012-13	928215	18856.26	3511.67	203145.42	10	7.68	13.61
2013-14	983756	30213.26	5007.70	307121.60	9	5.98	60.23
2014-15	1051243	33441.61	5511.12	318114.75	8	6.86	10.69
2015-16	945892	30420.83	4687.94	321609.99	7	-10.02	-9.03
2016-17	1134948	37870.90	5777.61	333679.62	6	19.99	24.49
2017-18	1377244	45106.89	7081.55	327515.69	5	21.35	19.11
2018-19	1392559	46589.37	6728.50	334559.46	4	1.11	3.29
2019-20	1289651	46662.85	6678.69	361825.42	3	-7.39	0.16
2020-21	1149510	43720.98	5956.93	380344.49	2	-10.87	-6.30
2021-22	1369264	57586.48	7759.58	420570.00	1	19.12	31.71

Source: Marine Products Export Development Authority(MPEDA), Kochi
* Descending order of unit value

4) Make a line diagram trend of
   a) export on fish and fish product in quantity
   b) export on fish and fish product in amount (Rupees)

FSC-495

SPECIAL PAPER PRACTICAL (Aquaculture)

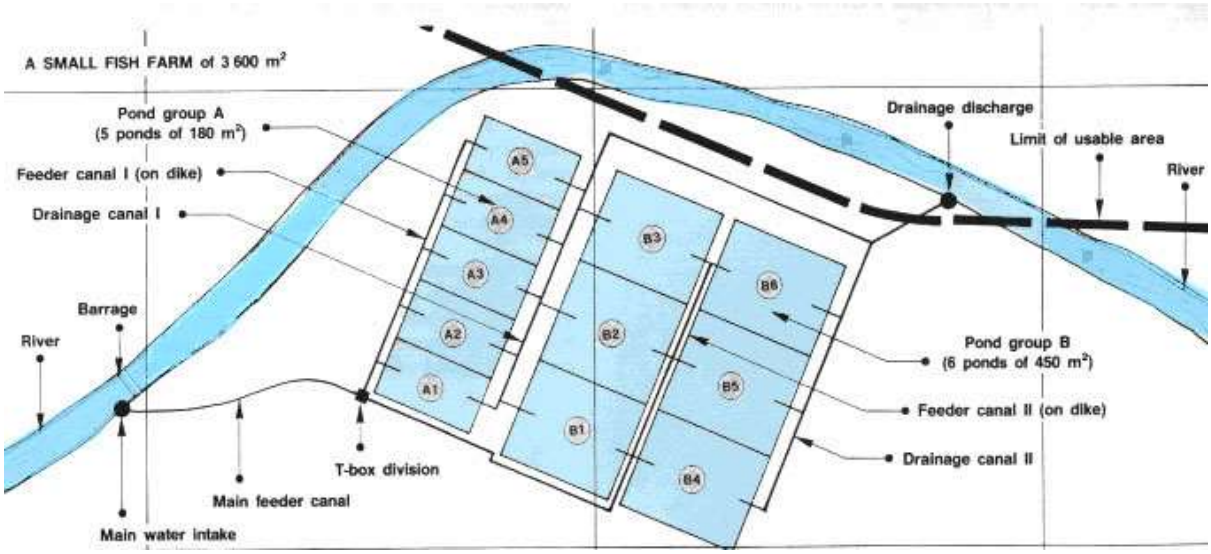
(Core course - 4 credits: 50 Marks)

[University Examination - 50]

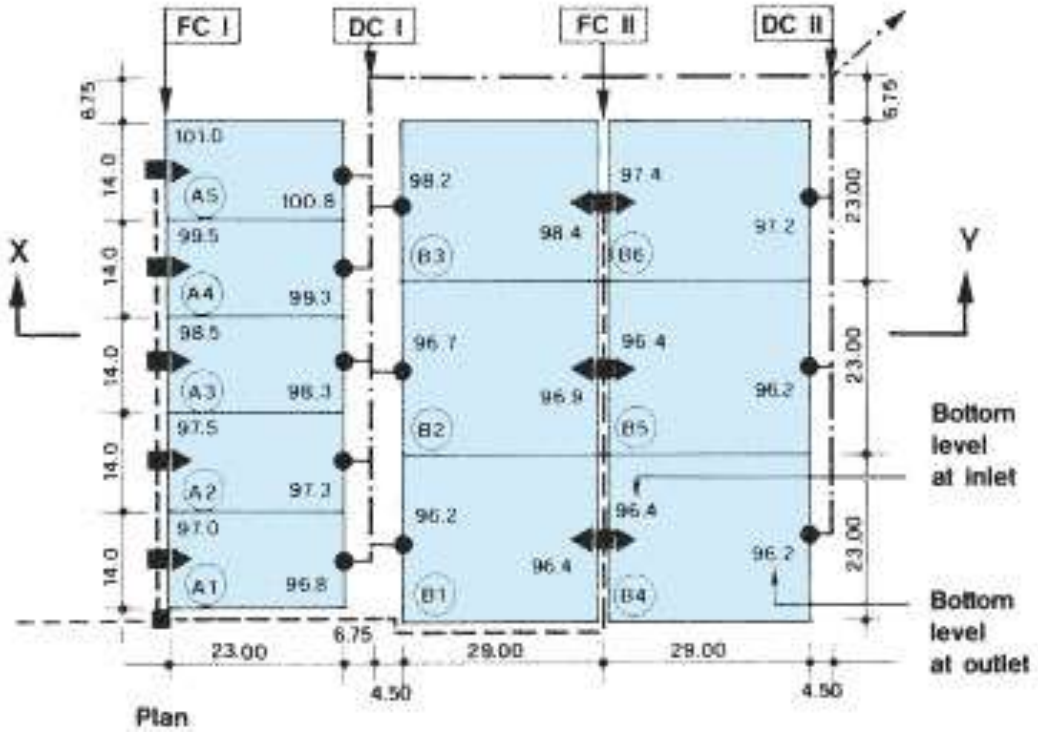
[Based on FSC -403 (Unit – 1 & 2)]

1. Design and layout of different aquaculture system through computer.
2. Analysis of the aquaculture project: site, water supply, soil type, topography, drainage system, computations for water requirement, seepage and evaporation. Types of ponds and their designs.
3. Identification and working of various equipments used in aquafarm and hatchery.
4. Preparation of project proposal through chart/ model for different fish production systems.
5. Lime and fertilizer requirement calculations in aquafarm.
6. Economic analysis of carp farming & shrimp farming.
7. Study of the fish chromosome.
8. Study of hormonal manipulation in fish.
9. Study of different transgenic and hybrid fish.

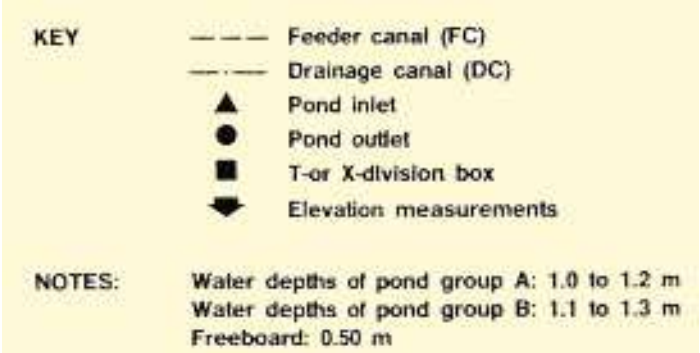
LAB – 1: Layout of an Aqua Farm

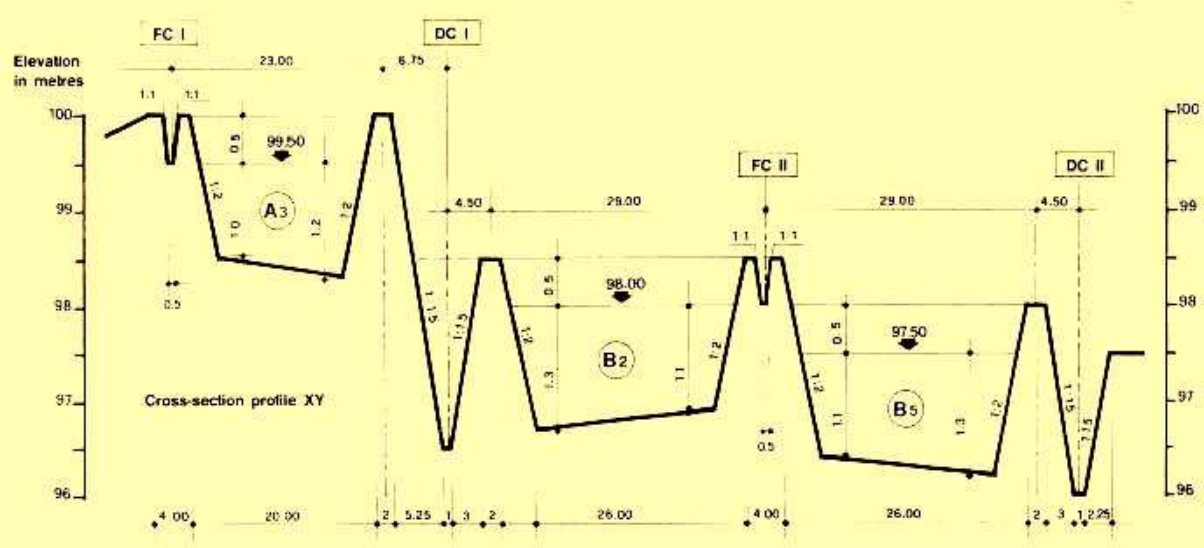


General Layout of the Farm

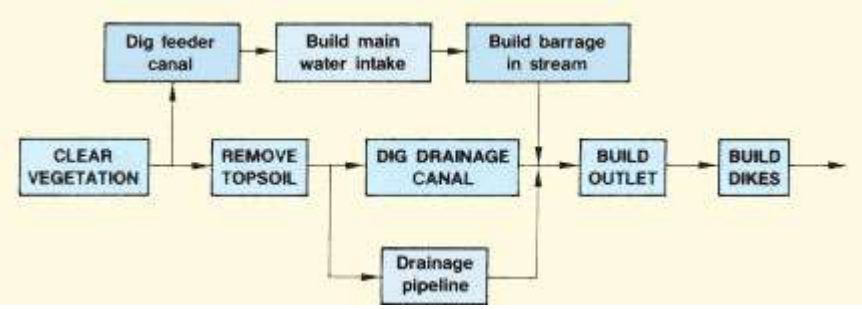


Detailed Layout of the Farm





Cross section Layout of the Farm



Schedule Activity

The farm having

1) Five small rearing pond of 180 m^3.
2) Six large pond of 450 m^3.
3) Feeder Canal – 200 m.
4) Dikes – 150 m^3

Working hours for the construction of the farm

1) Working hours for manual construction of rural ponds – 130 hrs.
2) Feeder canal – 50 hrs.
3) Excavation/dikes construction – 600 hrs.
4) Inlet/outlet pipes – 10 hrs.
5) Total working time – 785 hrs.

LAB – 2: Layout of an Eco-Hatchery System

The prototype carp hatchery, which can be developed for breeding of rohu consists of components such as

1. Overhead tanks,
2. Spawning pool,
3. Male broodfish cistern,
4. Acrylic jars for incubation of fertilized eggs,
5. Hatchling collection cisterns and
6. Circular hatching pool for mass scale incubation of fertilized egg

Overhead tanks - Two overhead tanks of 10,000 litre capacity each were constructed 5 feet above the ground level. Both the overhead tanks were joined together at the bottom by galvanized iron (GI) pipe. Water is supplied to the hatchery from a pond. The pond water is pumped to the overhead tank after filtering through bolting silk cloth to avoid plankton in the hatchery water. From the overhead tanks, water is supplied to different units through GI pipes.

Spawning pool - The Circular Chinese type of spawning pool was constructed for breeding/ spawning purpose. During selective breeding work, only female broodfishes were released in the spawning pool for full sib family production. However, for mass scale spawn production, both male and female broodfishes were released. The diameter of the spawning pool is 3.0 m. Water depth is maintained at 0.6-0.7 m. Showering system was also provided in the wall of the pool with plastic sieve tubes. Single water inlet with 60° tangent was fitted at the bottom of the sidewall. The water depth is controlled by outlet on the sidewall of the pool. Water current is produced in the spawning pool before two hours of calculated spawning time through the inlet pipe. The speed of the water is maintained at 3-4 m/ second. The volume of the spawning pool is 5 m^3. Broodfish @ 6 kg/m^3 is used on an average in the spawning pool for breeding purpose. For fullsib family production, 25-30 kg of female broodfishes are utilized; whereas for mass scale spawn production, average 16 kg female and 14 kg males (1:1 by number) are used for breeding in a single operation.

Male broodfish cistern - For the production of fullsib families in selective breeding study, male and female broodfishes are to be stripped separately to obtain gametes. So after hormone injection they have to be kept separately. One rectangular (3.5 m x 1.8 m x 1.0 m) male broodfish cistern was constructed for holding male broodfish. The water outlet was fitted at a height of 0.9 m in order to maintain the water depth at 0.9 m. The cistern was fitted with two showers from both the sides to supply oxygenated water. After hormone injection, male broodfishes are released to the breeding hapa fixed in the cistern.

Acrylic jar hatching unit - The transparent acrylic jars in which fertilized eggs are incubated get water supply from bottom through a flexible connecting pipe. There are seven acrylic jars in each unit. The hatchery complex consists of three such units; so, 21 acrylic jars are there in

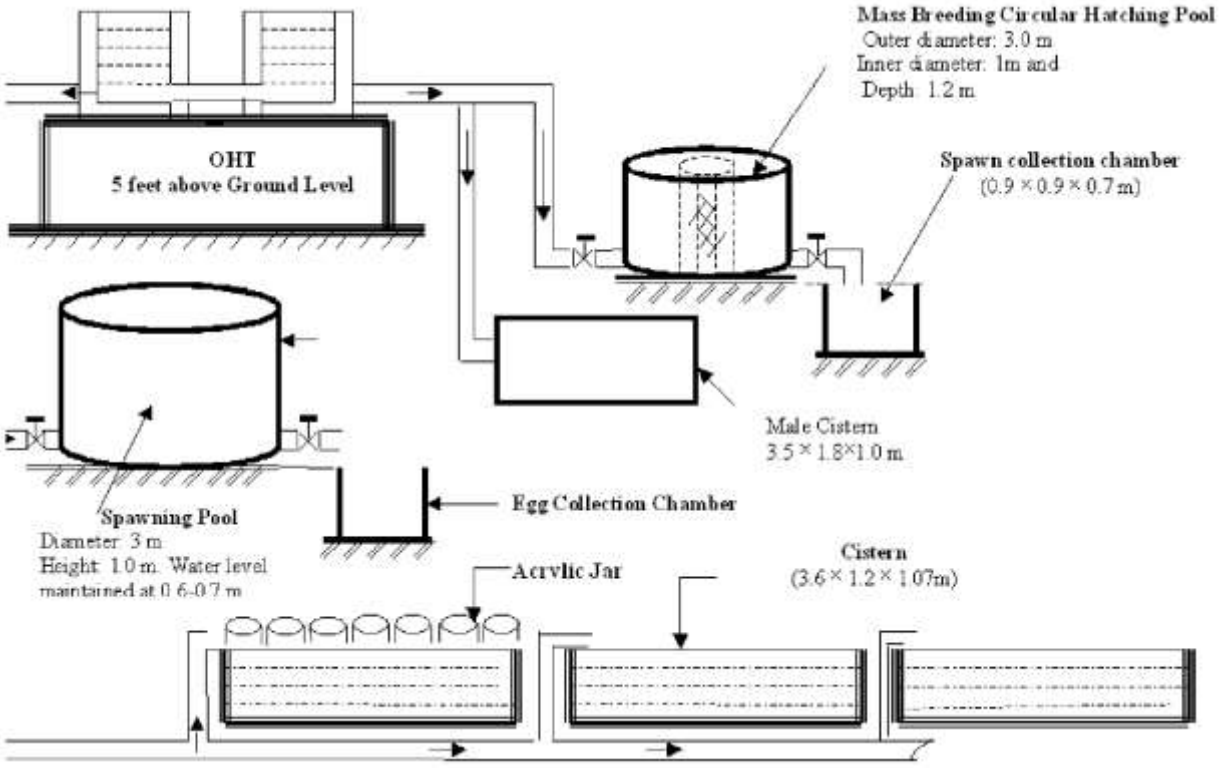
the hatchery that can incubate 21-fullsib families in a single operation. Each acrylic jar has the specifications as shown in Fig. 1b. The capacity of each jar is 15 l. At the bottom of the jar a sieved guard of 18 mm diameter and 5 mm thickness was fixed. A total 17 holes of 2 mm diameter were fitted in each jar to block the flow of eggs into the pipe. Only swollen eggs are loaded in the jars. In each jar 60,000-75000 numbers of fertilized eggs can be loaded @ 4000-5000 numbers/l. The outlet of the jar is connected to fibreglass channel, which opens to hatching hapa separately. After 14-16 hours of incubation, the eggs hatch and hatchlings start migrating with the water flow to the hatchling collection hapa. The migration normally gets completed by 20-24 hours.

Hatchling rearing unit - Each acrylic jar independently opens to hatchling collection hapa. The hatchling collection hapas are made up of bolting silk cloth having 1.2 m length, 0.5 m width and 1.0 m height. The hapas have tapes to join the four corners with the cistern. At the bottom side of the hapa small weights are tied to prevent floating. Each cistern receives spawn from seven acrylic jars separately into seven hatchling collection hapas. There are three cisterns in the hatchery and each cistern has the dimension of 3.6 × 1.2 × 1.07 m. Showers are provided from the top to each hatchling collection hapa. The water depth of the cistern is maintained at 0.85 m. Hatchlings are kept in those hapas for 60-72 hours (till complete absorption of yolk sac).

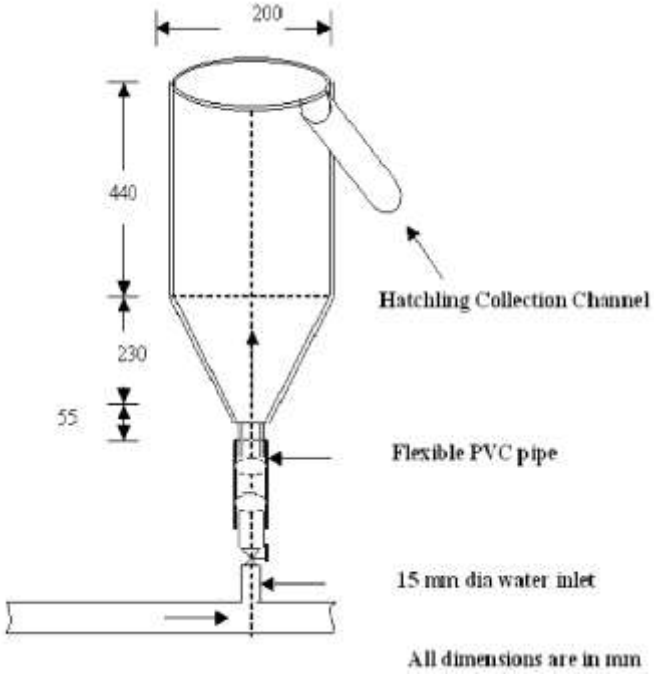
Circular hatching pool - One circular hatching pool was also constructed for mass scale incubation of fertilized eggs to spawn. The diameter of the pool is 3.0 m. It is a double circular smooth cistern made of brick and RCC material. The hatching pool has two chambers and water enters into the cistern by ten numbers of duck mouth inlets and expel out through a screen encircling the inner chamber. A delivery pipe was erected on the central outlet hole to maintain the water depth of the incubation chamber. The pool was also provided with spawn delivery outlet fixed at the bottom of the outer wall. The duck mouths were arranged in holes equidistant from each other and from both inner and outer walls of the chamber. The equidistant principle with unidirectional water flow allows the eggs to circulate without low oxygen and without touching the screen of the cistern. The depth of the pool is maintained at 1.0 m. The mesh size of the inner screen is 0.32 mm in order to prevent the escape of hatchlings. The eggs are loaded @ 7 lakhs/ m3. The regulated water flow in the hatching pool is maintained at 0.4-0.5 m/second for first 12 hours and then reduced to 0.1-0.2 m/second to avoid premature hatching. For rest of the period, it is maintained at 0.3-0.4 m/second.

Water requirement assessment - Water requirement study was conducted for fullsib family spawn production involving water used in spawning pool, male cistern, hatching acrylic jars and incubation in the cistern in one cycle i.e., from spawning to spawn. Whereas in mass scale improved rohu spawn production, water utilization in spawning pool and circular hatching pool were taken into account. Water requirement in each case was studied till complete absorption of yolk sac in the hatchlings. Water output was measured on hourly basis. Each hour was again divided into three observations of one-minute duration at every 20-minute interval. Finally, total water requirement for each full sib family and per million spawn production was estimated.

A Prototype Hatchery Model for Breeding of Indian Major Carps



Layout Diagram of Specialized Selective Breeding Hatchery



View of Single Unit Acrylic Jar

LAB-3: Lab Manual: Lime and Fertiliser Requirement and Calculation

Objective: The objective of this lab is to calculate the lime and fertilizer requirements for an aqua farm based on specific parameters and water quality analysis.

Materials:

1. Water samples from the aqua farm
2. pH meter
3. Water testing kit (including reagents for alkalinity, ammonia, nitrate, and phosphate)
4. Calculator
5. Lime (calcium carbonate)
6. Fertilizer (appropriate for aquafarm use)
7. Safety goggles
8. Lab coat

Procedure:

1. Water Quality Analysis:

   i. Collect water samples from the aqua farm in clean containers.
   ii. Measure the pH of each water sample using a pH meter and record the values.
   iii. Perform water tests using the appropriate reagents and following the instructions provided with the water testing kit.

      - Test for alkalinity: Determine the alkalinity of the water sample and record the result.
      - Test for ammonia: Determine the ammonia level in the water sample and record the result.
      - Test for nitrate: Determine the nitrate level in the water sample and record the result.
      - Test for phosphate: Determine the phosphate level in the water sample and record the result.

2. Lime Requirement Calculation:

   a) Calculate the lime requirement using the following formula:
   b) Lime requirement (kg) = [(2 × alkalinity (mg/L)) - (0.7 × pH) - 1] × volume of water (m^3)

3. Fertilizer Requirement Calculation:

   a) Calculate the nitrogen (N) requirement using the following formula:
   N requirement (kg) = [(desired nitrate level - measured nitrate level) × volume of water (m^3)] / 10
   b) Calculate the phosphorous (P) requirement using the following formula:
   P requirement (kg) = [(desired phosphate level - measured phosphate level) ×

volume of water (m^3)] / 10

c) Calculate the potassium (K) requirement using the following formula:
K requirement (kg) = [(desired potassium level - measured potassium level) × volume of water (m^3)] / 10.

4. Lime and Fertilizer Application:

a) Based on the lime requirement calculated, determine the appropriate amount of lime (calcium carbonate) to apply to the aqua farm. Follow the manufacturer's instructions for application rates.
b) Based on the fertilizer requirements calculated, determine the appropriate amount of fertilizer to apply to the aqua farm. Follow the manufacturer's instructions for application rates.
c) Apply the lime and fertilizer to the aqua farm according to the recommended application rates.

Safety Precautions:

1. Wear safety goggles and a lab coat to protect yourself from any potential hazards.
2. Follow the manufacturer's instructions for handling and applying lime and fertilizer.
3. Dispose of any unused or leftover chemicals and materials as per local regulations.

Note: The desired nutrient levels may vary depending on the specific requirements of the aqua farm and the targeted species. Consult with aquaculture experts or professionals for specific recommendations.

LAB-4: If a pond having 6 ft. of depth with 150×80 sq. ft. area, how much of potassium permanganate is required to disinfect that pond @ 5 ppm concentration?

Answer:

The volume of the pond - 150×80×6 cu. ft. = 72000 cu. ft.

The conversion of 1 cu. ft. - 28.3168 litres

Total water volume in the pond = 72000×28.3168 = 2038809.6 litres.

Hence, potassium permanganate is required to disinfect that pond @ 5 ppm concentration is

Total amount of $KMnO_4$ = 2038809.6×5 = 10194048 mg. = 10.194048 kg.

LAB-5: Model Bank Project for Eco-Hatchery

Introduction:

The commonly cultivated six species - Catla ([p) Rohu (*Labeo rohita*), Marigal (*Cirrhinus mrigala*) Silver carp (*Hypothalmichthys molitrix*), Grass carp (*Ctenopharyngodon idella*) and Common carp (*Cyprinus carpio*) are considered to be the best culturable species of fishes in the inland water system. These fishes originally belong to riverine environment and when cultured in standing water bodies such as ponds and tanks, they attain maturity but normally do not breed under confined conditions. Special attempts are therefore made to breed them by artificially creating riverine conditions and stimulating their endocrine system. The technique of breeding fish by other than its natural course is known as INDUCED BREEDING. Induced breeding techniques has been developed for production of quality fish seed of culturable varieties. It is one of the most dependable method of producing pure seed of desired species of fish. Further this technique has helped to produce fish seed in those areas where natural collection of fish seed was not possible.

Method of induced Breeding: Hypophysation - The technique of breeding the fish by administering pituitary gland extract injection is known as induced breeding or hypophysation. The pituitary gland secretes several hormones of which Gonadotropin is the most important for breeding.

The increasing demand of fish pituitaries have now been solved to some extent by the introduction of HCG, now readily available in the market. The HCG is now increasingly becoming popular due to its low cost. A mixture of HCG and pituitary hormone extract in definite proportion are employed successfully for breeding fish.

Collection of pituitary gland:

Glands are collected from ripe fish by removing the upper part of the skull(scalp) by a sharp knife or a bone cutter. After removing the scalp, the brain is exposed which is then cut from the posterior end and lifted up anteriorly. As soon as the brain is lifted the gland can be seen located in the cavity covered by a thin membrane. It is carefully picked up with the help of tweezers and kept immersed in a cavity block or a petri dish in absolute alcohol under cover.

Preservation and storage of pituitary glands:

While exposing and removing the glands great care is taken to avoid any contact with water. It is most important because the hormone of the pituitary gland is soluble in water. There are three methods for preservation of pituitary glands: -

1) preservation in absolute alcohol
2) preservation in acetone
3) preservation by quick freezing

Identification and selection of breeders for spawning:

The success of induced breeding depends on the proper selection of breeders. The identification the sex is made on the basis of the external characters. The mature males are distinguished from the females by the presence of denticulation on the dorsal surface of the pectoral fin which is rough to touch. Further, in males the abdomen is comparatively flat and the vent is not swollen but they ooze milt at slight pressure on their abdomen. The ripe females have soft and bulging abdomen with swollen pinkish genital opening. The presence or absence of pre-anal ridge is also taken into

consideration as a sign of maturity for selection of female breeders. For the production of quality seed and better growth, breeders of standard quality may be selected viz., Catla-3kg and above, rohu, grass and silver carp-2kg and above, mrigal and calbasu-1kg and above.

Maintenance of breeders:

Farm raised breeders give better results. The breeders can also be collected from ponds and rivers. The best time for collection is from November till March. The optimal rate of stocking may be 2000-2500 kg per hectare. Organic manure along with low dose of single super-phosphate (17 to 20 kg. per hectare) may be applied at fortnightly intervals in the pond where catla and silver carp is stocked as major species. Pond/tank stocked with grass carp as the major species need not be manured regularly. It may be fed with submerged aquatic vegetation during winter months and with grass on the advent of the spring (at the rate of 1-2% of the body weight) for acceleration of gonadal development. For other species feed prepared by mixing de-oiled rice bran and oil cake at the rate of 1-2% of the body weight of fish stock is desired in the initial stages. Fish meal containing 30% protein could be a better substitute for oil cake at the later stage (advent of the spring).

The mature male and female breeders are segregated and stocked sex-wise in separate ponds about 1-2 months before their breeding season and their genetic conditions and stage of maturity are checked periodically.

Breeding technique:

After selection of brood fishes from the segregated brooder ponds they are kept in the hapa at fish farms or in fish seed hatcheries for about 6-7 hours for conditioning. After proper conditioning the individual brood fish is weighed in a hand net using a spring balance. The breeders are then ready to receive injection.

Determination of dosage for injection:

Doses of pituitary gland extract is calculated on the basis of milligrams of pituitary gland per kilogram body weight of the recipient fish. Determination of proper dosages of pituitary gland alone or in combination with H.C.G. depends largely on the stage of sexual maturity of the breeders and also to some extent on the environmental (climatic) conditions. Spawning of carp may be obtained by administration of a single dose of 5-10 mg. of pituitary gland per kg. body weight to the female breeders. In males a low dose of 2 mg per kg. body weight is usually given. Better results are however obtained by injecting a preliminary dose of 2-3 mg per kg. body weight to the female fish alone and a second dose of 5-8 mg per kg. body weight after an interval of 6 hours. The males receive only a single dose of 2-3 mg. per kg. body weight at the time of 2nd injection to the female. Both the sexes are then put together in a definite ratio in circular spawning pool inside indoor hatchery.

Preparation of gland extract:

Once proper dosages are determined, the quantity of glands required for injecting the breeders is calculated. The required quantity of glands is then taken out from vials, dried on a filter paper and macerated in a tissue homogenizer with a little distilled water or 0.3% common salt solution. The homogenized glands are then centrifuged and the supernatant liquid is decanted and diluted with the same solvent to a known volume. the following dilutions are recommended.

Weight of brooder Prepatory dose Final dose

1.0 to 2.0 kg 0.50cc/fish 0.75 cc/fish

Above 2 kg 0.75 cc/fish 1.50 cc/fish

Method of injection:

Intra-muscular injection of fish pituitary extract is administered usually in the region of the caudal peduncle a little above or below the lateral line region or near the shoulder region. For injecting the fish, the needle is inserted under a scale, parallel to the body of the fish and then pierced into the muscles at an angle. A 2ml graduated hypodermic syringe is most convenient for injecting most of the fishes. The size of the needle depends upon the size of the breeder to be injected.

Breeding environment:

Success of spawning by hypophysation depends on the hydrological and climatic conditions. Temperature is one of the most important factors. It has been observed that 250-280C is most conducive for breeding. However, spawning could be induced at or below this temperature range. The percentage of fertilisation and hatching under uncontrolled conditions is not very satisfactory. Circulation of fresh water containing 5-9 mg/litre of oxygen promotes better success in spawning, higher fertilisation of eggs and higher recovery of hatchlings from fertilised eggs.

Spawning and hatching:

Eco-hatchery-circular spawning pool:

It is circular cement pool (8 metre in diameter) with 50 cubic metres of water holding capacity. The bottom of the pool slopes to the centre where there is an outlet pipe (10 cm dia) leading to the incubation pond (egg collection chamber). The wall of the spawning pool is provided with diagonally fitted inlet pipes at an angle of 450for circulation of water creating artificial riverine conditions. After circular pool is filled with water, about 80 kg. of females and 80 kg of males are released into the pool. When the breeders start coming up to the surface the valves are opened so that a circular current is created. The speed of water current is maintained at about 30 meters per minute.

The yield of 10 million eggs per breeding operation is usually achieved.

Eco-hatchery-Incubation pool:

As spawning goes on in the spawning pool, the fertilised eggs are led into the incubation pool (3 metre diameter - double walled circular pool, with inner wall of regulated mesh permitting outflow of water) where water at a regulated speed enters through the duck mouth valves fitted on the floor of the outer chamber. The speed of the water is regulated @2.5 litre/sec. in the initial stage and then reduced to 2.0 litre/sec. when movement of embryo inside the eggs starts. After hatching, the speed is again increased to 3.0-3.5 litres/sec. and the hatchlings are allowed to remain there for about 3 days till the yolk sac is absorbed.

Rearing of seed-hatchling to fry/fingerling stage:

Presently two techniques are practiced.

1. Rearing in earthen ponds at the fish farm.
2. Two phased seed rearing - Phase one inside the hatchery building and phase two rearing in earthen pond at fish farm.

Rearing in earthen ponds at fish farm up to fry stage:

From the hatchling receiving ponds (nursery ponds), the weeds are removed. Unwanted fishes are removed using mahua oil cake containing 4-6% saponin at the rate of 2000-2500kg/ha metre. Lime is applied @ 250-300 kg per ha. for neutralizing acidity and helping mineralisation of organic matter. Manuring of ponds with cow dung @5000kg/ha is done about 15 days before the anticipated date of stocking by broadcasting all over the pond (dose of cow dung is doubled weigh Mauna oil cake is not used). Aquatic insects are controlled suitability of water is tested thereafter ponds are stocked with about 3-4 days old spawn usually in the morning hours. The moderate rate of stocking may be 25-30 lakhs/ha.

Supplementary Feed:

A mixture of finely powdered groundnut/mustard oil cake and rice bran/polish, in equal proportion by weight is supplied to the fry. Cobalt chloride or manganese sulphate (trace elements) @0.01 mg/day/spawn may be added to the feed. Addition of yeast increases survival of fry. Feed may be broadcast all over the pond commencing from the day of stocking. Feeding may be stopped one day earlier to the harvesting. The generally recommended feeding schedule is as under.

Period	**Rate of feeding per day**	**Approximate quantity per one lakh of spawn/day**
1st to 5th day	4 times the initial total weight of spawn stocked	0.56 kg
6th to 12th day	8 times the initial weight of spawn stocked	1.12 kg
13th & 14th day	No feeding	

Feeding not to be suspended in adverse ecological conditions.

Harvesting of fry:

The fry in about 2 weeks' time generally grows to 25-30 mm size. They are harvested with fine meshed (1.5 mm) drag net in the cool morning hours avoiding the cloudy days.

Chinese Fish hatchery - A few tips

- The location of a Chinese Hatchery should ideally be on a sloping high land for economical construction. If sloping land is available the floor level of the spawn collection tank should be adjusted to the ground level for draining out water by gravity.
- The level of eggs transfer outlet located at the centre of spawning tank should be about 10 cm. above the level of central overflow pipe at the top of the hatching tank. This will enable complete transfer of eggs from the spawning tank to use outside the tanks.
- Overflowing water from the hatching tank should not be passed on to the spawn collection tanks but should be put to use outside the tanks.
- Separate fresh-water supply lines should be installed from the overheads water tank to each tank i.e. spawning tank, hatching tanks and spawn collection tanks in order to ensure independent working of each.
- Water spraying arrangements should be provided for aeration and oxygenation in the three tanks.
- Eggs transfer pipe should discharge the water along with eggs into the hatching tank in

between the two walls of the hatching tank to avoid damage of eggs.

- The walls of the spawning tanks should be provided with water inlet pipes installed in a diagonal position to create a circular water flow during the spawning period.
- Where water flow is insufficient for circulation, multiple-chambered hatching pools with paddle wheels for circulation may be constructed.

A. Capital cost

ECO-HATCHERY

Item	**Cost (Rs.)**
1. Renovation of tank of 2 ha water spread area involving excavation up to 1-foot depth	30,000
2. Circular breeding pool & hatching pools	
i. Breeding pool of 8 m diameter	30,000
ii. 3 Hatching pools of 3m diameter @ Rs. 15,000/- per pool	45,000
3. Overhead tank of 5000 gallons capacity	50,000
4. Shallow tube well 8"x6"x200'	25,000
5. Pump set (5HP)	20,000
6 Generator set with 10 KVA alternator	50,000
7. Guard shed and office room	25,000
8. Brood stock-5 tonnes	150,000
9. Contingent expenses for nets, equipments hapas etc.	30,000
	455,000

B. Recurring cost

I. Cultural cost for 3 preparatory months

i.	Feeding of brood stock @ 3% body weight for 5 tons of fish with 13,500 per kg artificial feed (150 kgsx30 daysx3 months) @ Rs.3/- per kg.	40,500
ii.	Salary of 2 guards-cum-labour @ Rs.450/pm	37,000
iii.	Cost of netting 2 times a month for 3 months	600
		43,800

II. Cultural cost for five operating months

	Feeding of brood fish @ 1.5% body weight for 5 tons of fish with 11,250 kgs artificial feed (75 kgs.x30 daysx5 months) @ Rs.3/kg	33,750
ii.	Wages of 2 guards-cum-labour @Rs.450/month for 5 months	4,500
iii.	Operation cost of electric pump/generator on equal ratio @ Rs.5.00 per hour for 5 hrs. daily (Rs.5x5hrsx30 daysx5months)	3,750
iv.	Additional labour for 5 months	36,000
v.	Misc. cost for pituitary glands, equipment, electricity etc.	19,250
		97,250

III. Cultural cost for 4 post-operatory months

i.	Manuring, liming and fertilising @Rs.450/- ha/month	3,600
ii.	Wages for 2 guards-cum-labour @Rs.450/- ha/month	3,600
iii.	Cost of periodical netting @ Rs.50/- per.month	400
iv	Other expenses	300
		7,900

Total Recurring cost (I+II+III) = Rs.1,48.900/-

C. Unit cost

i.	Capital cost	Rs.4,55,000
ii.	Recurring cost	Rs.1,48,900
		Rs.6,03,900

PRODUCTION

A. Installed Capacity

	Unit	size	No.	Capacity
i.	Spawning pool	8 m dia	1	150-200 kgs. brood fish
ii.	Hatching pools	3m dia	3	150 litres fertilized egg per pool or 450 litres of fertlised eggs from 3 pools requiring 8-0 kgs. of female brood fish or 160 kgs. of total brood fish.

B. Expected utilisation of installed capacity

i.	Per batch requirement of female brood fish	80 kgs.
ii	Per batch requirement of brood fish for single run (male or female)	160 kgs
iii.	Total number of hatchery runs @5 run/month for 5 months	25 runs
iv.	Total requirement of brood fish in 5 months (160 kgs.x25 runs)	4000 kgs
v	Requirement of breeder for 5 months operation (considering 90% of the brood fish will attain maturity and 90% of the matured breeders would respond to hypophysation)	4940 kgs
vi.	Number of spawn produced per kg body weight of female brood fish (considering @ 1.2 lakh/kg female, 90% fertilisation 80% hatching rate) * say 80,000	80000 nos.
vii.	Spawn produced from female brood fish in a single run	64 lakhs

C. Expected Income

I Gross income/run

I.	Gross income/run	
i)	From sale of 51.2 lakhs of major carp spawn (80% of the produce) @ Rs.200/lakh	Rs. 10,240
ii)	From sale of 12.8 lakhs of exotic carp spawn (20% of the produce) @Rs.500/lakh	Rs.6,4000
		Rs. 16,640
II	Gross income/month (Rs. 16,640/-x5 runs)	Rs. 83,200
III	Gross income in 5 operative months	Rs.4,16,000

iv	Net income	Rs. 2,67,050

* The fecundity may be as high as 2.0 lakh/kg of body weight of female brood fish. However, an average rate of 1.2 lakh/kg body weight is considered for purpose of economics.

Financial Analysis of Eco Hatchery

Particulars	**Years**				
	1	**2**	**3**	**4**	**5**
Capital Cost	4.55	-	-	-	-
Recurring Cost	1.49	1.49	1.49	1.49	1.49
Total	7.04	1.49	1.49	1.49	1.49
Income	2.08	4.16	4.16	4.16	4.16
Net Income	-4.96	2.67	2.67	2.67	2.67
NPV of cost@15%	2.32				
NPV of Benefits@15%	9.82				
NPV@15%	Rs2.32 lakhs				
BCR	1.24:1				
IRR	40%				

LAB-6: Model Bank Project for Shrimp Farm

1. INTRODUCTION

India is endowed with a long coastline and hence offers scope for large exploitation of marine wealth. Till a few years back, fishermen in India were involving themselves in traditional marine fishing. In the seventies fishermen started concentrating on catching prawns more commonly known as `shrimps' due to high profitable return on the same on account of their export value. Brackish water prawn farming started in a big way during 91-94 especially in the coastal districts of Andhra Pradesh and Tamil Nadu. Subsequently due to disease problems, litigation in supreme court and other social and environmental problems the sector suffered a huge set back and most of the corporate farms were closed. However, the small units continued to do farming and adopting extensive prawn farming systems. The shrimp farming has now been regulated with the establishment of Aquaculture Authority of India as per directions of Supreme Court for issuing licenses and overall supervision. It is commonly said that after Green and White Revolution in India, it is time for Blue Revolution to exploit the huge potential in fisheries sector. Shrimps are called the "Pinkish Gold" of the sea because of its universal appeal, unique taste, high unit value and increasing demand in the world market.

2. Scope for brackish water shrimp farming

The over exploitation of shrimp from natural sources and the ever-increasing demand for shrimp and shrimp products in the world market has resulted in the wide gap between the demand and supply shrimp in the International market. This has necessitated the need for exploring new avenues for increasing prawn production. The estimated brackish water area suitable for undertaking shrimp cultivation in India is around 11.91 lakhs ha. spread over 10 states and union territories viz... West Bengal, Orissa, Andhra Pradesh, Tamil Nadu, Pondicherry, Kerala, Karnataka, Goa, Maharashtra and Gujarat. Of this only around 1.2 lakhs ha. are under shrimp farming now and hence lot of scope exists for entrepreneurs to venture into this field of activity. The following table gives the state-wise potential and present level of development as on March 1996.

Sr.	State	Estimated brackish water area (ha.)	Area under cultivation (ha.)
1	West Bengal	405,000	34,660
2	Orissa	31,600	11,000
3	Andhra Pradesh	150,000	50,000
4	Tamil Nadu	56,000	2,879
5	Pondicherry	800	37
6	Kerala	65,000	14,657
7	Karnataka	8,000	3,500
8	Goa	18,500	650
9	Maharashtra	80,000	716
10	Gujarat	376,000	884
		1,190,000	118,983

3. Location of the project

The first and foremost requirement for entering into this venture is the acquisition of suitable land. The details of land identified/surveyed in coastal districts are available with the department of fisheries of the concerned State Governments and with the Regional offices of the MPEDA functioning in the coastal states of India. A suitable site is one that can support optimum conditions for the growth of shrimps at targeted production level. Most of the lands available along the coastline are owned by the State Governments. In some cases, the entrepreneur has to get it on long term lease from the revenue authorities of the State Government. If it is a private land, one has to preferably purchase on outright basis. While selecting the site for the project, the entrepreneur should ensure the following :

i) Area should be accessible preferably by a road even during the monsoon season.

ii) Mangrove area with large tree stumps should not be selected.

iii) Site should have good pollution free water supply of both freshwater and brackish water. Water quality parameters required for maximum feed efficiency and maximum growth of Penaeus monodon are given below:

	Water Parameters	**Optimum level**
1	Dissolved Oxygen	3.5-4 ppm
2	Salinity	10-25 ppt
3	Water Temperature	26-32 (C 0)
4	pH	6.8-8.7
5	Total nitrite nitrogen	1.0 ppm
6	Total ammonia (less than)	1.0 ppm
7	Biological Oxygen Demand (BOD)	10 ppm
8	Chemical Oxygen Demand (COD)	70 ppm
9	Transparency	35 cm
10	Carbon dioxide (less than)	10 ppm
11	Sulphide (less than)	0.003 ppm

iv) The areas should be flood free

v) Location with a natural slope, for proper drainage should be selected.

vi) Social problems due to competing use of water resources and drainage of waste water should be properly taken care of.

vii) Availability of necessary infrastructure namely electricity, ice factory, cold storage, communication facilities etc., are necessary for successful management.

4. **Borrowers' profile**

Complete details of the entrepreneurs, partnership firm, registered company should be given. Qualification and experience of the promoters, net worth of the borrowers, other activities undertaken

by them, financial ability etc., have to be furnished.

5. **Technical feasibility of the project**

As the project envisaged new technologies, the borrowers may take the help of a competent outside agency to prepare the technical feasibility report on the project. However, to serve as a guidelines to the entrepreneurs in this regard the technical parameters are given in Annexure-I. However, the first and foremost requirement of the project is to get a license from Aquaculture Authority as per the existing norms and as per guidelines issued by Supreme Court.

6. **Physical and financial outlay**

Details of the physical and financial outlays involved for setting up of 5 ha. Brackish water prawn farm is furnished in Annexure No. II. It can be seen therefrom that the total cost including working capital expenses for raising the first crop for a 5 ha. Prawn farm works out to Rs.37.60 lakhs. While submitting the project to the banks for sanction of loan entrepreneurs are expected to submit detailed plan and estimates for all the civil works to be undertaken as also invoices of various items to be purchased from the suppliers.

7. **Margin money and bank loan**

The entrepreneur has to bring in 25% of the project cost out of his own resources and the balance of 75% will be provided by banks as bank loan. However, NABARD could consider providing margin money loan assistance in suitable and eligible cases as per the guidelines contained in circular no. DPD 67/92-93 dated 24.2.1993.

8. **Rate of refinance**

NABARD refinance is available for projects for setting up of shrimp farms provided the same is technically feasible and financially viable. NABARD is agreeable to provide refinance as per existing norms.

9. **Financial viability**

For undertaking shrimp culture within CRZ and outside CRZ the following assumptions have been made

		Improved Traditional (within CRZ)	Extensive (outside CRZ)
i.	Farm Size	5 ha	5 ha
ii.	Culture period	4-4 ½ months	4-4 1/2 months
iii.	Stocking density (PL-20)	50,000/- ha	1,00,000/- ha
iv	Survival	70%	65%
v	Expected production	1.2 tonnes/ha/crop	2.5tonnes/ha/crop
vii	Price of shrimp has been taken as Rs.250/kg		

The financial analysis for extensive system of shrimp farming has been shown in Annexure No. III. Results of the analysis are as under:
i. NPW at 15% DF - Rs.61.314 lakhs.
ii. BCR at 15% DF - 1.515

iii. IRR is more than 50 percent

10. **Marketing**

Because of huge gap between supply and demand of shrimps in local as well as international market, there may not be any problem in marketing the same. Shrimps can either be sold directly by the farmers in the market or sold to exporters for processing before export. Shrimps can be exported in frozen form with head on, head less, battered and breaded, or IQF products or any other form with value addition. The prawn has to be packed as per requirements of importing countries and therefore this should be decided after a detailed market survey. It is always advisable to get in touch with local distributing agents of the customer country. Hygienic packaging, display and appearance of the packet are key factors to attract consumers of importing countries.

11. Rate of interest

As per existing RBI guidelines interest rate to be charged to the ultimate borrower for loan exceeding Rs.2 lakhs will be as decided by the lending Bank. NABARD's interest rate for refinance would be as per existing norms prevailing at the particular time.

12. Repayment period

As can be seen from Annexure No. IV. the borrower will be able to repay the bank loan in 5 years with a moratorium of one year on repayment of principal.

13. Security

Security from the ultimate beneficiaries has to be obtained as per the rules of financing banks which have to be in conformity with the guidelines of RBI.

14. Conclusion

As shrimps have got good export potential, establishment of shrimp farms as per the model scheme indicated above is recommended for consideration by banks for financing.

ANNEXURE I

Technical Parameters for establishing a extensive shrimp farm

A -1. Design and Construction of shrimp farm :

An extensive shrimp farm should be of the size 0.4 - 0.5 ha. and preferably drainable from the management point of view. The ponds generally should have concrete dikes, elevated concrete supply canal with separate drain gates and adequate life supporting devices like generators and aerators.

The design, elevation and orientation of the water canals must be related to the elevation of the area with particular reference to the mean range of tidal fluctuation. The layout of the canals and dikes may be fitted as closely as technically possible to existing land slopes and undulation for minimizing the cost of construction.

2. General Earth Work

It is normally carried out in the following order:

1. Site clearing

2. Top soil stripping
3. Staking of centre lines and templates
4. Preparation of dike foundation
5. Excavation of drainage canals
6. Construction of dikes (peripheral and secondary)
7. Forming and compaction of dikes.
8. Excavation of pits for gates.
9. Levelling of pond bottom.
10. Construction of gates and refilling of pits
11. Construction of dike protection.

The top soil may be set aside and should again be spread later to preserve pond bottom fertility.

3. The essential components of a shrimp farm are: -

1. Ponds
2. Water intake structure
3. Store room for feed and equipment
4. An area for cleaning of the harvest
5. A workshop and pump house
6. Watch and ward room, office and a mini laboratory.

B. **Ponds**

From the management point of view, it is better to go in for ponds of 0.4 ha-0.5 ha size. These ponds should be preferably completely drainable. The ponds are partitioned by secondary dykes. In order to render over all protection to the cultured stock and all related structures a perimeter dyke also can be constructed.

The height of the perimeter dyke will depend upon the following factors, such as :

1. Height of water level in the area.
2. Elevation above mean sea level.
3. Height of free board.
4. The percentage allowance for soil shrinkage.

The partition dykes determine the size and limit of each grow out pond and its height is determined by the following factors namely:

1. The height of water column in the pond
2. Free board
3. Wave action
4. Shrinkage factor

The shrinkage factor is decided by the type of soil like heavy, medium and light soils.

C. **Gates**

They regulate the inflow and outflow of water into the pond and also are responsible for maintaining the desired water column in the pond. The main gates are constructed on the perimeter dyke and are usually located on the partition dykes and they regulate the water column in the individual ponds. It can be made out of concrete or PVC or Asbestos piping.

D. **Drain canals**

They are generally trapezoidal in cross section and its discharge capability is decided by area of cross section and velocity of water flow.

E. **Pond preparation**

Proper pond preparation will ensure higher production. The main objectives of pond preparation are :

1. To eradicate weed fishes and organisms
2. To remove obnoxious gases
3. To improve the natural productivity of the pond eco system
4. To maintain high water quality for proper growth and higher survival percentage.

Eradication of unwanted organisms is usually carried out by draining out the entire water and drying the pond bottom till it cracks. This also helps in removal of obnoxious gases and oxygenation of the pond bottom. It also improves the fertility of the soil.

Liming is done for correcting the pH and to kill pathogenic bacteria and virus. In undrainable ponds mahua oil should be applied @ 200 ppm to eradicate the weed fishes. After around two weeks' time organic and inorganic fertilisers are applied to enrich the soil and water. Once the thick lab-lab is formed the water level is raised and the pond is made ready for stocking.

F. **Selective stocking:**

The most suitable species for culture in India are the Indian white prawn *Penaeus indicus* and tiger prawn P. Monodon. The stocking density varies with the type of system adopted and the species selected for the culture. As per the directives of Supreme Court only traditional and improved traditional shrimp farming can be undertaken within the CRZ with a production range of 1 to 1.5 tonnes/ha/crop with stocking density of 40,000 to 60,000/ha/crop. Outside CRZ extensive shrimp farming with a production range of 2.5 to 3 tonnes/ha/crop with stocking density of 1,00,000/ha/crop may be allowed.

In order to have uniform growth of the cultured animal it is always advisable to go in for hatchery reared seeds.

G. **Food and feeding**

Shrimp diets may be supplementary or complete. In an extensive system the shrimps need a complete diet. Although natural food items have good conversion values but they are difficult to procure in large quantities and maintain a continuous supply.

At present most of the aquaculture farms depend on imported feed with a FCR of 1:1.5 - 1.8. The feeding could be done by using automatic feed dispensers, or by broadcasting all over the pond. If feeding trays are employed in selected pockets in the pond wastage in feed can be reduced.

H. **Harvesting:**

Complete harvesting can be carried out by draining the pond water through a bag net and hand picking. The average culture period required is around 120-150 days during which time the prawns will grow to 20-30 gm size (depending on the species). It is possible to get two crops in a year. Harvested shrimps can be kept between layers of crushed ice before transporting the consignment to

market.

ANNEXURE II

Estimated physical and financial outlay involved for setting up of a shrimp farm

A.	CAPITAL COST	Rs. lakhs
a)	Earth work for construction of ponds, drainages and feeder canals etc. (20000 m 3) Rs.25/m3	'5.0
b)	Lining of feeder canal	0.7
c)	Water inlet structure for ponds (2 Nos.)	0.5
d)	Water outlet structure for ponds (10 Nos.)	1
c)	Main outlet sluices (2 Nos.)	0.3
d)	Pump House, generator shed cum workshop etc	1
g)	Office, laboratory and stores	2
h)	Watchman shed	0.2
i)	Drinking water storage and supply network	0.75
j)	Pumps (3 Nos. Mixed flow pump of 25 HP each)	2.55
k)	Aerators (10 Nos. 1 HP)	2
l)	Electrical installations	2
m)	Generators (7 nos. X 30 KVA)	4
n)	Lab and farm equipment`	1
o)	Miscellaneous expenditure	1
	TOTAL	24
b.	OPERATIONAL COST FOR THE FIRST CROP	
a)	Seed @ Rs.300/1000 Nos. For 2 lakhs	3
b)	Feed @ Rs.40/kg for 15,000 kg	6
c)	Chemicals and manures for pond preparation (@ Rs. 15,000/ha)	0.75
d)	Fuel and electricity	1.5
e)	Repairs and maintenance	0.5
f)	Harvesting	0.25
g)	Labour for pond preparation	0.2
h)	Staff salary	0.92
	1 Farm manager 10,000 x 4	
	1 Mechanic 5,000 x 4	
	Farm hands (2) 4,000 x 4	
	Watchman (2) 4,000 x 4	
i)	Office expenses and Misc. expenses	0.5
		13.62
	Total outlay for 5 Ha	Rs.37.62 lakh Say 37.60
	Total outlay per Ha.	Rs.7.52 lakh appx.

Note: 1) Detailed plan and estimates are to be furnished along with the project.

2) Invoices for purchase of various items to be enclosed.

ANNEXURE III

Statement showing Financial Analysis for Shrimp Culture in 5 ha. Farm (Rs. lakhs)

		I year	II to VIII years	
A	COST			
1	Fixed Cost	24	--	
2	Recurring Cost	13.6	27.2	
	TOTAL COST	37.6	27.2	
B.	BENEFIT	25	50	
	NET INCOME	-12.6	22.6	
	Discount Factor at 15%	0.87	3.17	
	Net Present worth of cost	-32.71	86.22	= 118.936
	Net Present worth of benefits	21.75	158.5	= 180.25
	NPW at 15% discount factor	61.314 BCR = 1.515		
	Discount factor at 50%	0.67	1.25	
	NPW at 50%	-8.44	28.25	= 19.808
		Internal Rate of Return is more than 50%		

ANNEXURE IV

STATEMENT SHOWING REPAYMENT OF PRINCIPAL AND PAYMENT OF INTEREST (ILLUSTRATIVE)

Total Outlay = Rs.37.6 lakhs
Margin (25%) = Rs.9.4 lakhs
Bank Loan = Rs.28.2 lakhs
(Rs. lakhs)

Year	Bank Loan Outstanding at the beginning of the year	Net Income		Repayment		Bank Loan Outstanding at year end	Net Surplus
			Interest	Principal	Total		
1	2	3	4	5	6	7	8
1	28.20	25.00	4.23	--	4.23	28.20	20.77
2	28.20	22.60	4.23	7.07	11.30	21.13	11.30
3	21.13	22.60	3.17	8.13	11.30	13.00	11.30
4	13.00	22.60	1.95	9.35	11.30	3.65	11.30
5	3.65	22.60	0.55	3.65	4.20	--	18.40

LAB-7: Model Bank Project for Composite Farm

Model Bankable Project for Composite Fish Culture

Introduction:

Fish is the cheapest and most easily digestible animal protein and was obtained from natural sources from time immemorial for consumption by human beings. However, due to over exploitation and pollution, the availability of fish in natural waters have declined considerably forcing scientists to adopt various methods to increase its production. Fish farming in controlled or under artificial conditions has become the easier way of increasing the fish production and its availability for consumption. Farmers can easily take up fish culture in village ponds, tanks or any new water body and can improve their financial position substantially. It also creates gainful employment for skilled and unskilled youths. The technology developed for fish culture in which more than one type of compatible fishes are cultured simultaneous is the most advanced and popular in the country. This technology is known as Composite Fish Culture. This technology enables to get maximum fish production from a pond or a tank through utilization of available fish food organisms in all the natural niches, supplemented by artificial feeding. Any perennial fresh water pond/tank retaining water depth of 2 metres can be used for fish culture purpose. However, the minimum level should not fall below one metre. Even seasonal ponds can also be utilised for short duration fish culture.

1.1. Fish species involved in composite fish culture

Depending on the compatibility and type of feeding habits of the fishes, the following types of fishes of Indian as well as Exotic varieties have been identified and recommended for culture in the composite fish culture technology:

Species Feeding Habit Feeding zone

Indian Major Carp

Catla	Zoo plankton feeder	Surface feeder
Rohu	Omnivorous	Column feeder
Mrigal	Detritivores	Bottom feeder

Exotic carps

Silver carp	Phytoplankton feeder	Surface feeder
Grass carp	Herbivorous	Surface, column and marginal areas
Common carp	Detritivores/Omnivorous	Bottom feeder

2. Potential: The area under tanks and ponds available for warm fresh water aquaculture is estimated to be 2.85 million ha. In addition, 0.78 million ha of swamps, beels, etc. and low lying water logged area not good for agriculture as also any agriculture land can be converted for fish farming. Out of the total inland fish production around 60% is contributed by the culture sector. The average productivity from ponds at present is to the tune of 2160 kg/ha/year. This shows the tremendous scope for fish culture in the country. The area of 4.56 lakh ha. brought under scientific fish culture by 1997-98 is only 16% of the potential area of tanks and ponds available for development showing immense possibilities for horizontal expansion of composite fish culture.

3. Technical Parameters: Technical parameters of composite fish culture has been enclosed as annexure - I which includes site selection, items of development, pre-and post stocking operations, stocking density, fertilisation, feeding etc.

4. Margin:

The margin money may be considered @ 5, 10 & 15% for small, medium and large farmer respectively and 25% for companies and partnership firms.

5. Subsidy

Subsidy is available for various items like Pond Development, construction of New Ponds, first year inputs etc. under a centrally sponsored subsidy scheme implemented by majority of the State Governments through FFDA's for different categories of farmers, details of which may be obtained from concerned Fisheries Departments.

6. Eligible Borrowers

The following categories of borrowers are eligible to avail credit.

a) An Individual.

b) A company.

c) A Partnership firms.

d) A co-operative society.

e) A group of fish farmers.

Training in fish farming is being provided by the FFDA's to the eligible borrowers and it is essential that the borrower has prior knowledge of fish farming before ailment of bank loan.

7. Financial Outlay:

The details of Capital Cost and Recurring Cost have been indicated in annexure - II. As per annexure the capital cost for excavation of 1 Ha pond works out to be Rs. 1,75,000/- and the recurring cost as Rs 26,000/-. However, the cost is indicative and actual assessment of the cost parameters have to be done while submitting the project to the bank.

8. Repayment

Repayment of bank loan is possible in 6-8 years in equated annual instalments with moratorium on repayment of principal for the first year.

9. Financial Analysis:

As per financial analysis shown in annexure the scheme is financially viable. The financial parameters are as follows

i). NPW @ 15% Rs: 101106
ii). BCR @ 15% 1.51: 1
iii). IRR 25%

10. Rate of Refinance

NABARD provides refinance assistance for fish culture to commercial banks, cooperative banks and Regional Rural Banks. The rate of refinance is fixed by NABARD from time to time.

11. Rate of interest

Interest rate to be charged to the ultimate borrowers would be as indicated by bank/RBI/NABARD

from time to time depending on quantum of loan amount and the agency providing the loan.

12. Security

Security from the ultimate beneficiaries may be obtained as per the guidelines of RBI issued from time to time.

Annexure - I

Technical Parameters

Technical parameters that needs to be considered for Composite Fish Culture project are as follows:

1. Selection of Pond:

The main criteria to be kept in mind while selecting the pond is that the soil should be water retentive, adequate supply of water is assured and that the pond is not in a flood prone area. Derelict, semi derelict or swampy ponds can be renovated for fish culture by dewatering, desilting**,** repair of the embankments and provision of inlet and outlet. The pond may be owned by the individual or taken on lease in which case the lease period should be more or coterminous with the repayment period. The eligible items of pond development are as follows:

i)	Desilting of existing ponds
ii)	Deepening of shallow ponds.
iii)	Excavation of new ponds.
iv)	Impoundment of marginal areas of water bodies.
v)	Construction / repairs of Embankments.
vi)	Construction of Inlets / Outlets.
vii)	Any other item like civil structures, watchmen huts, water supply arrangements / electricity supply arrangements etc. depending on requirements of the project based on its size etc.

2. Pond Management:

Pond Management plays a very important role in fish farming before and after the stocking of fish seed. Various measures that are required to be undertaken in pre and post stocking practices are tabulated below:

A) Pre-stocking:

In case of new ponds, pre-stocking operations starts with liming and filling of the pond with water. However, the first step for existing pond requiring development deals with clearing the pond of unwanted weeds and fishes either by manual, mechanical or chemical means. Different methods are employed for this.

i) Removal of weeds by Manual/Mechanical or through Chemical means.

ii) Removal of unwanted and predatory fishes and other animals by repeated netting or using mahua oil cake @ 2500 kg/ha metre or by sun drying the pond bed.

iii) **Liming -** The tanks which are acidic in nature are less productive than alkaline ponds. Lime is used to bring the pH to the desired level. In addition, lime also has the following effects -

a) Increases the pH.
b) Acts as buffer and avoids fluctuations of pH.

c) It increases the resistance of soil to parasites.
d) Its toxic effect kills the parasites; and
e) It hastens organic decomposition.

The normal doses of the lime desired ranges from 200 to 250 Kg/ha. However, the actual dose has to be calculated based on pH of the soil and water as follows:

Soil pH	Lime (kg/ha)
4.5-5.0	2,000
5.1-6.5	1,000
6.6-7.5	500
7.6-8.5	200
8.6-9.5	Nil

The pond is required to be filled with rain water or water from other sources after liming in case it is a new pond.

iv) Fertilisation:

Fertilisation of the pond is an important means of intensifying fish culture by increasing the natural productivity of the pond. The fertilisation schedule has to be prepared after studying the quality of the pond soil. A combination of both Organic and Inorganic fertilisers may be used for best results. The fertiliser programme has to be suitably modified depending on the growth of the fish, available food reserve in the pond, physicochemical conditions of the pond and climatic conditions.

a) Organic	:	Organic manure to be applied after a gap of 3 days from the date of liming.
b) Inorganic	:	Cow dung @ 5000 kg/ha or any other organic manure in equivalent manurial value
	:	Inorganic fertilisation to be undertaken after 15 days of organic manuring. Requirement of nitrogenous and phosphate fertilisers would vary as per the nature of the soil fertility indicated below. However, any one of the nitrogen and phosphate fertilisers could be used as per given rate.

Inorganic Fertiliser Application (kg/ha/month)

Soil fertility status	Ammonium sulphate	Urea
1. Nitrogen (mg/100 g soil) i) High (51-75) ii) Medium (26-50) iii) Low (upto 25)	70 90 140	30 40 60
2. Phosphorus (mg/100 gm soil)	**Single super phosphate**	**Triple super Phosphate**
i) High (7-12) ii) Medium (4-6) iii) Low (upto 3)	40 50 70	15 20 30

B) STOCKING:

The pond will be ready for stocking after 15 days of application of fertilisers. Fish fingerlings of 10 cm size (approx.) should be used for stocking @ 5000 nos. per hectare. However, if fingerlings of smaller size are used, suitable allowance may be made accounting for mortality. Depending on availability of seed and market condition, stocking can be of 3, 4 or 6 species combinations in the following ratio.

Species combination (ratio)

Species	3-species	4-species	6-species
Catla	4.0	3.0	1.5
Rohu	3.0	3.0	2.0
Mrigal	3.0	2.0	1.5
Silver Carp	-	-	1.5
Grass Carp	-	-	1.5
Common Carp	-	2.0	2.0

C)POST STOCKING:

a) Supplementary feeding:

Fishes need much more food than what is available naturally in the pond. Fishes can be fed with a mixture of bran and oilcake in equal quantities daily. The feed should be placed on a bamboo tray and lowered to the pond bottom or it can be sprayed at the corners. After some time the fishes will get used to this type of feeding and aggregate at the same place at particular time. The recommended feeding rate is as under:

Culture period	Quantity per day in kgs.
I quarter	1.5 to 3
II quarter	3 to 6
III quarter	6 to 9
IV quarter	9 to 12
Total (for the year)	1,655 to 2,700

b) Manuring:

i) Organic manuring may be done in monthly instalments @ 1000 kg/ha.
ii) Inorganic fertilisation may be done at monthly intervals alternating with organic manuring. However, the monthly rate of fertilisation will depend on pond productivity and the growth of the fishes. It should be ensured that excess fertilisation does not take place which may result in eutrophication.

D) Harvesting:

Harvesting is generally done at the end of 1st year, when the fishes attain average weight of 750 gms. to 1.25 kg. A production of 4 to 5 tons/ha can be obtained in a year. However, for the purpose of working out economics' a production level of 3 tons/ha/year may be considered. Harvesting is done by partial dewatering and repeated netting. In some cases, complete dewatering of ponds is resorted to.

3) Vertical expansion of fish culture:

A number of measures are now being employed by the entrepreneurs to increase the per hectare production of fish. Important measures adopted are stocking of Yearlings by stunning the growth of fish seed during first year, heavy stocking and multiple harvesting after the fishes attain a size of 500 gms., multiple stocking and multiple harvesting, use of aerators, integrated fish farming with animal husbandry activities like dairy, poultry, piggery or duckery to get daily organic manuring to the pond thus increasing its fertility. It is possible to increase the per hectare production of fish to 7 to 10 tonnes per ha per year by employing different methods as indicated above.

Annexure - II

Indicative Unit Cost and Income for 1 Ha pond requiring 1-meter excavation

Item	**New ponds Excavation up to 1 metre depth**
A. Capital cost: 1.Excavation 10,000 m3@Rs.15/m3 2.Construction of inlet/outlet (L.S.) 3.Equipments & Gears (L.S.) 4.Total	150000 20000 5000 175000
B. Recurring cost: 1.Lime 500 kg @ Rs. 5/kg 2.Fingerlings 5000 Nos.@ Rs. 400/1000 Nos. 3.Organic manure(cow dung) 15 tonnes @Rs.300/ton 4.Urea 330 kg@Rs.5/kg 5.Triple Super Phosphate165 kg@Rs.5 per kg 6.Mustard oil cake1350 kg@Rs.6/kg 7.Rice Bran: 1350 kg@ Rs.3/kg 8. Insurance cost@4% of Seed and Fertilizers 9. Miscellaneous including Harvesting, Marketing expenses and Watch and Ward etc.	2500 2000 4500 1650 825 8100 4050 960 2415 27000
C. Income: 1. Production (From second year onwards) 2. Sale Price (per Kg) 3. Total Income	3000 Kg Rs 30/- Rs 90,000/-

ANNEXURE- III

Statement showing Financial Analysis for Composite Fish culture in New Ponds(Indicative)

(Amt in Rs.)

A. Cost	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
1. Fixed Costs	175,000	-						
2. Recurring Costs	27,000	27,000	27,000	27,000	27,000	27,000	27,000	27,000
Total	202,000	27,000	27,000	27,000	27,000	27,000	27,000	27,000
B. Benefits								
1. Income from sale of fish	-	90,000	90,000	90,000	90,000	90,000	90,000	90,000
2. Net Income	-202,000	63,000	63,000	63,000	63,000	63,000	63,000	63,000

3. NPV Costs	273,332							
4. NPV Benefits	374,438							
5. NPV	101,106							
6. BCR	1.51:1							
D. IRR	25 %							

LAB-8: Lab Manual for Transgenic Fish

Creating transgenic fish involves complex laboratory techniques and requires expertise in genetic engineering. While I can provide a general outline of the process, it is essential to note that working with transgenic organisms requires specialized training and access to a well-equipped laboratory facility. Additionally, local regulations and ethical considerations may apply when conducting genetic modification experiments. Here is a basic overview of the steps involved in creating transgenic fish:

1. Experimental Design:
    - Define the purpose of the experiment and select the target gene or genes to be introduced into the fish.
    - Determine the appropriate fish species for the experiment and ensure access to a suitable breeding colony.
2. Gene Isolation and Modification:
    - Identify and isolate the desired gene from a donor organism or create a synthetic gene construct.
    - Modify the gene, if necessary, to optimize its expression or incorporate specific regulatory elements.
3. Vector Construction:
    - Prepare a suitable vector to carry the gene of interest. Commonly used vectors include plasmids or viral vectors.
    - Insert the modified gene into the vector, ensuring proper orientation and integrity of the DNA sequence.
4. Introduction of the Transgene:
    - Choose a suitable method for introducing the transgene into fish embryos or early-stage fish larvae. Common techniques include microinjection or electroporation.
    - Prepare the transgene delivery system, which may involve diluting the vector DNA and combining it with delivery reagents or buffers.
5. Transgenic Fish Screening and Selection:
    - Establish methods for identifying and selecting transgenic fish from non-transgenic individuals. This may involve visual markers or molecular assays, such as PCR or DNA sequencing.
    - Rearrange the selected transgenic fish in a controlled environment, ensuring appropriate conditions for growth and development.
6. Breeding and Line Maintenance:

- Develop a breeding strategy to establish stable transgenic lines, which involves crossing transgenic fish with non-transgenic fish of the same species.
- Conduct genotyping to confirm the presence of the transgene in subsequent generations and establish breeding protocols for maintaining the transgenic line.

7. Phenotypic Analysis and Characterization:
   - Observe and document any phenotypic changes or traits resulting from the transgene expression.
   - Perform molecular analyses to confirm gene expression levels and assess any functional changes associated with the transgene.
8. Ethical and Regulatory Considerations:
   - Ensure compliance with local regulations and ethical guidelines governing genetic engineering experiments.
   - Prioritize animal welfare and minimize any potential adverse impacts on the environment.

Advantages of Transgenesis in Fish:

1. Enhanced Growth and Productivity: Transgenic fish can be engineered to exhibit improved growth rates and feed conversion efficiency, leading to higher productivity in aquaculture operations. This can contribute to increased food production and potentially address global food security concerns.
2. Disease Resistance: Transgenic fish can be engineered to possess enhanced resistance to specific diseases or pathogens. By introducing genes with disease-resistant traits, such as antibacterial peptides or antiviral proteins, fish farmers can reduce the impact of infectious diseases and minimize economic losses.
3. Environmental Adaptation: Transgenesis can enable the introduction of genes that enhance fish tolerance to adverse environmental conditions, such as temperature extremes or low oxygen levels. This trait can help mitigate the effects of climate change and expand aquaculture operations to new regions.
4. Research and Biomedical Applications: Transgenic fish serve as valuable research models for studying gene function, developmental processes, and human diseases. They can also be used to produce specific proteins for biomedical purposes, including the production of pharmaceuticals or bioactive compounds.

Disadvantages of Transgenesis in Fish:

1. Ethical and Welfare Concerns: Genetic modification raises ethical considerations related to animal welfare and the potential impact on natural ecosystems. The welfare of transgenic fish must be carefully monitored to ensure they do not suffer from unintended physiological or behavioral consequences.

2. Environmental Risks: Transgenic fish that escape from aquaculture facilities may pose ecological risks if they reproduce in the wild. Interbreeding between transgenic and wild fish populations could lead to genetic contamination or alter the natural genetic diversity, potentially impacting ecosystem balance.

3. Regulatory Challenges: Developing and commercializing transgenic fish may face regulatory obstacles, including safety assessments, labeling requirements, and public perception. Compliance with regulations and public acceptance are critical factors in the successful adoption of transgenic fish in aquaculture.

4. Unintended Effects and Uncertainty: Despite extensive testing, unintended genetic effects or unpredictable interactions between transgenic fish and their environment may occur. It can be challenging to fully understand the long-term consequences of introducing foreign genes into the genome, emphasizing the need for thorough risk assessment and monitoring.

5. Potential for Genetic Escape: Maintaining containment and preventing the escape of transgenic fish can be challenging. If transgenic fish enter natural ecosystems, it may be difficult or impossible to reverse their introduction, potentially leading to irreversible ecological consequences.

LAB-9: Lab Manual for Hybrid Fish

Creating hybrid fish involves crossing individuals from two different species to produce offspring with mixed genetic traits. Here is a general outline of the steps involved in making hybrid fish:

1. Identify Parental Species:
    - Choose two fish species that are capable of crossbreeding and have desired traits for the hybrid offspring.
    - Consider factors such as compatibility, breeding behavior, and genetic compatibility to ensure successful hybridization.
2. Breeding Environment:
    - Set up separate tanks or ponds to house the parental fish species.
    - Ensure appropriate water quality, temperature, and other environmental conditions suitable for breeding.
3. Conditioning and Selection:
    - Condition the parental fish for breeding by providing a well-balanced diet and maintaining optimal conditions.
    - Select healthy and sexually mature individuals from each species for breeding, ensuring they are free from diseases or genetic abnormalities.
4. Induce Spawning:
    - Determine the optimal spawning conditions for each parental species, including temperature, lighting, and water chemistry.
    - Use appropriate techniques to induce spawning, such as adjusting water temperature or introducing hormonal treatments.
5. Crossbreeding:
    - Place the selected individuals from each parental species in the same tank or pond to allow for natural mating.
    - Monitor their behaviour and spawning activity to ensure successful fertilization.
6. Egg Collection:
    - After spawning, monitor for the presence of fertilized eggs.
    - Collect the eggs carefully to avoid damage, using techniques like gently siphoning or carefully removing them from spawning substrates.
7. Incubation:

- Transfer the collected eggs to separate incubation tanks or trays.
- Maintain suitable water conditions, such as temperature and oxygen levels, to promote proper egg development and hatching.

8. Larval Rearing:
    - Provide appropriate nutrition for the hatched larvae, considering their specific dietary requirements.
    - Monitor water quality parameters and perform regular water changes to maintain optimal conditions.
9. Hybrid Identification:
    - As the larvae grow, observe and document their physical characteristics to identify hybrid individuals.
    - Confirm hybrid status through genetic testing, if necessary, to ensure accurate identification.
10. Growth and Development:

- Continue rearing the hybrid fish, providing appropriate nutrition and monitoring their growth and development.
- Consider factors such as tank size, water quality, and feeding regime to promote healthy growth.

11. Further Breeding and Evaluation:

- Select mature hybrid individuals with desirable traits for potential further breeding or evaluation.
- Assess the hybrid offspring's characteristics, such as growth rate, disease resistance, or other desired traits.