NURTURING GREEN AQUACULTURE IN MYANMAR

ESSENTIAL GUIDELINES FOR FISH FARMING

PREPARED BY INTERNATIONAL COLLABORATING CENTRE FOR AQUACULTURE AND FISHERIES SUSTAINABILITY

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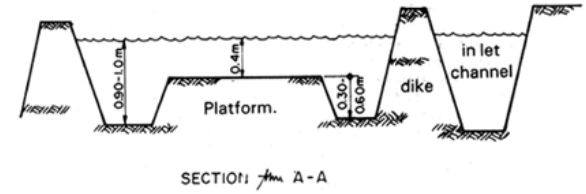
1. FISH CULTURE IN PONDS

Although aquaculture has been developed for more than a century in Southeast Asia, the main farming practices are still traditional. Such operating practices are characterized by low productivity and relatively low technical and financial inputs. Due to the high market demand for the product and the low cost of land acquisition, these traditional farms are still commercially profitable.

Shrimp/fish productivity in ponds can be increased by applying modern farming techniques such as enhancing farming activities through adjusting pond size, increasing stocking density, using aerators, applying formula food, etc. This will mean significant increases in financial and high-tech inputs that most small farmers in developing countries may not be able to afford.

Traditional or extended culture methods

The ponds used in this type of farming system are often irregular in shape and size (3–20 ha). Usually each pond has a peripheral ditch 10–20 m wide and 30–60 cm deep. In Thailand, the middle of the pond is about 40 cm above the bottom (Figure 1), while in the Philippines, the pond bottom is completely flat.



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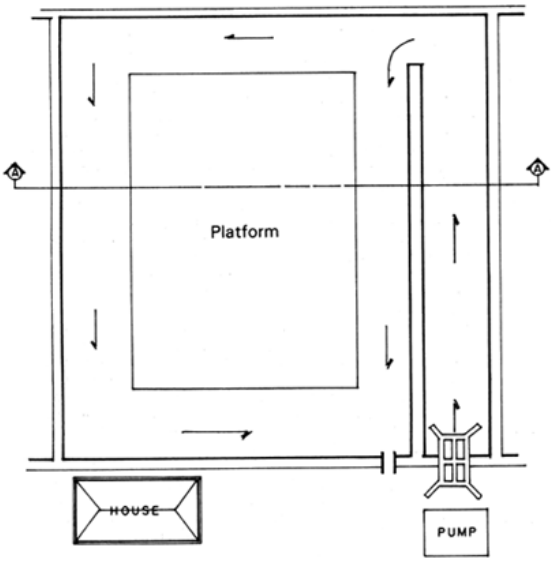


P L A N

2. BIOGRAPHIC CHARACTERISTICS OF CULTURED FISH SPECIES

2.1. Silver pomfret (Pampus argenteus (Euphrasen, 1788))

2.1.1. Short desciption

- Body firm, very deep, oval, and compressed
- Dorsal and anal fins preceded by a series of 5 to 10 blade-like spines with anterior and posterior points. Pelvic fins absent. Caudal fin deeply forked, the lower lobe longer than the upper. Color is gray above grading to silvery white towards the belly, with small black dots all over the body. Fins are faintly yellow; vertical fins with dark edges.
- Length at first maturity:

Maturity: Lm 25.3cm

Max length : 60cm SL male; common length: 30cm SL male

2.1.2. Distribution Countries

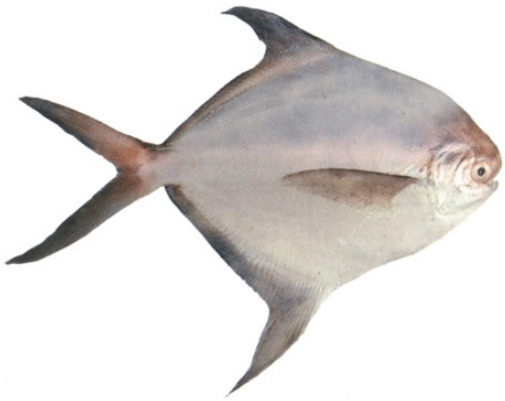
- Indo-West Pacific: Persian Gulf to Indonesia, north to Hokkaido, Japan. Extralimital captures have been made from the Adriatic and off Hawaii. Not recorded from Australasia
- Fish live in the middle and upper layers, live in groups.
- The white pomfret is a tropical species that is well adapted to high temperature conditions rather than low temperature. The suitable temperature is from 21 - 420C, the optimal temperature is from 28-300C.
- White pomfret can live in an environment with a salinity of 100/00 or less.
- The appropriate oxygen content is greater than or equal to 3mg/l.
- The suitable pH for fish to grow is from 6 to 7.5. pH greater than 8 adversely affects the growth and development of fish.

2.1.3. Nutrition and growth

- The white pompano is an omnivorous fish with low food selection, which is favorable conditions for the development of this species. Food for white pompano is grains, agricultural products, plants, worms, small crustaceans, snails...
- The fish has a fairly fast growth rate, the fingerlings of 5-7 cm size, if raised well after 3-4 months, can reach 0.8 - 1kg/fish.

2.1.4. Reproduction

- White pomfret is a type of fish that spawns many times a year.
- In the natural environment, fish mature in conditions of flowing water, suitable water temperature, and guaranteed water level.



2.2. The bighead carp

2.2.1. Identification:

The bighead carp is a large, narrow fish with eyes that project downward. Coloration of the body is dark gray, fading to white toward the underside, and with dark blotches on the sides. Its head has no scales, a large mouth with no teeth, and a protruding lower jaw. The bighead carp can be identified by a smooth keel between the anal and pelvic fins that does not extend anterior of the base of the pelvic fins.

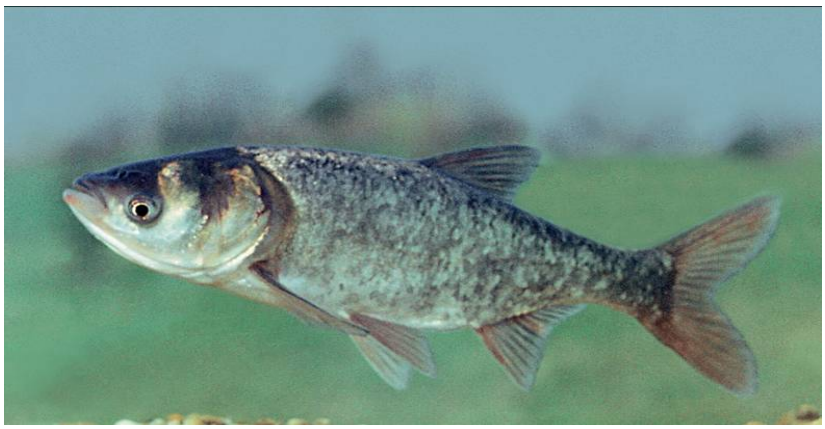
2.2.2. Distribution Countries :

- Southern and central China (Li and Fang 1990; Robins et al. 1991).
- Fish live in the upper and middle floors. Adaptation to temperature is 270C and pH 5.5-6. The dissolved oxygen content is more than 2mg/l.

2.2. 3. Nutrition and growth

- Bighead carp is a powerful filter-feeder with a wide food spectrum that grows fast and reproduces quickly
- In the wild, the catfish mainly eats zooplankton, in addition to phytoplankton and a little substance.

In addition to the above food, we can use artificial foods to supplement fish such as rice bran, bean residue, flour, dried peanuts.



Female bighead carp reach sexual maturity at three years of age, while males can reach sexual maturity in two years; however, this varies significantly with changing environmental conditions

2.2.4. Reproduction

- Bigheaded carps are only known to spawn in large, turbulent rivers and it is believed that a rising hydrograph (flood event) is a primary spawning cue (Kolar et al. 2007). Fecundity increases with age and body weight and is directly related to growth rat.

2.3. Graa carp *Ctenopharyngodon idella* (Valenciennes, 1844)

2.3.1. Identification

- Body olive to brassy green above, silvery white to yellow below; body cylindrical; pharyngeal teeth laterally compressed, serrated, with a groove along grinding surface, usually in two rows.

2.3.2. Distribution

- Asia: Eastern China and Russia (Ref. 48) in eastern Siberia, Amur River system. Widely transported around the world
- The fish is widely adapted to environmental conditions, living in still water and flowing water.

Freshwater; brackish; benthopelagic; potamodromous; depth range 0 - 30 m

- Grass Carp appears to be tolerant of low levels of salinity

Tolerant of a wide range of temperatures from 0° to 38°C, and a preferred temperature of 25.3°C.

2.3.3. Nutrition and growth

- Feed on higher aquatic plants and submerged grasses; takes also detritus, insects and other invertebrates. One of the world's most important aquaculture species and also used for weed control in rivers, fish ponds and reservoirs.
- In addition to eating plants, grass carp can also use many other foods such as cereal flour, agricultural by-products.
- Grass carp is a species with a fairly fast growth rate. 1 year old grass carp weighs about 1 kg, 2 years old weighs 2 - 4 kg.

2.3.4. Reproduction

- Male grass carp 3 years old, female 4 years old begin to reach sexual maturity and participate in reproduction.
- The spawning season of fish is from March to September, the spawning season is in April, May, and June.

2.4. Tilapia

2.4.1. Identification

- Tilapia has short body, tall body, large thick and hard scales, fish color changes according to environment and species

2.4.2. Distribution

Tilapia originating from Africa was introduced to Vietnam. Fish has the advantages of fast growth, fast reproduction, omnivorous ability to adapt to environmental conditions, so it has become a popular cultured fish in many countries around the world.

Fish can live in different layers of water.

The intolerance of tilapia to low temperatures is a serious constraint for commercial culture in temperate regions. The lower lethal temperature for most species is 10-120C for a few days

- Optimal water temperature for tilapia growth is about 20 to 32oC. Growth at this optimal temperature is typically three times greater than at 250C.
- Tilapia can survive in pH ranging from 5 to 10 but do best in a pH range of 6 to 9.
- All tilapia are tolerant to brackish water and they can live with salt concentrations up to 400/00
- Tilapia survive routine dawn dissolved oxygen (DO) concentrations of less than 0.3 mg/L, considerably below the tolerance limits for most other cultured fish.

2.4.3. Nutrition and growth

- Tilapia are omnivores, can eat a variety of foods such as organic detritus, plankton, aquatic insects, soft plants and agricultural by-products.

- Growth rate of tilapia depends on culture conditions and feed. After 3 to 4 months of rearing, monoecious tilapia reached a weight of 300g/fish.4.4. Sinh sản

2.4.4. Reproduction

- Tilapia are species that breed year-round except on very hot or cold days. Usually fish spawn at temperatures above 200C. The number of eggs in a year is from 6 to 11 times.
- Fish can spawn for the first time when 3-4 months old. Tilapia fish have the habit of sucking and incubating eggs in the mouth.
- Tilapia currently raised are monogamous fish that have been treated with the hormone 17α testosterone.

testosteron.

2.5. CARP

2.5.1 Description & biology

The colour of carp varies. In the wild they are usually olive green to bronze or silvery in colour with a paler underside

Scale variations, including large shiny scales either scattered or in a line along the flanks.

Carp can grow to a very large size

2.5.2. Distribution

- Carp are a large freshwater fish native to central Asia. They are extensively farmed in Europe, Asia and the Middle East, and are a popular angling fish in Europe.
- They live in the bottom. Carp are usually found in still or slowly flowing waters at low altitudes, especially in areas where there is abundant aquatic vegetation

2.5.3 Nutrition and growth

- Carp are omnivores, fish mainly eat benthic organisms such as mollusks, worms, larvae, insects, in addition, they also eat organic humus, plant tubers, plant sprouts.

- Carp is a species that can tolerate temperatures from 0 – 40^0C, suitable temperature from 20 - 270C. pH from 4 - 9, suitable from 6.5 - 8.
- Carp have low oxygen. Carp can live in salt concentrations from 0 - 80/00, double when life at the brackish water concentration up to 140/$_{00.}$
- Carp is a slow-growing species after 1 year of culture, the weight is 0.5kg/pcs. Carp V1 after 8 months of culture can achieve a weight of 0.7kg/pcs.

2.5.4. Reproduction

- Under the right conditions, carp are highly fertile. They mature early - as early as 1 year for males and 2 years for females - and females produce large numbers of sticky eggs (up to 1.5 million for a 6kg fish).
.- The spawning season of carp is in spring and autumn. Focus on February - March of the solar calendar and August, September, and October. The egg laying temperature is from 18 to 28^0C, the suitable temperature is from 20 to 24^0C.

3. FISHING TECHNIQUES

3.1. Site Selection and Design of Pond Facilities

- Ponds are active in water source, not polluted by industrial and agricultural wastewater.
- Choose locations near rivers and streams, easy to get water and easy to drain. There are no trees around.
- The soil for digging fish ponds must be clay mixed with soil, meat soil or clay mixed with meat. Farmers should dig ponds in a place with sloping terrain so that the pond banks are sustainable and easy to change water for fish.
- The ponds are usually rectangular in shape with the size of about 1-2 ha, width = 1/3 of the length; length and width perpendicular to the wind direction. Depth from 1m or more, the bigger the pond, the deeper the water, the better the fish farming. The pond bank can hold water, 0.3 - 0.5m higher than the highest water level in the pond.
- Vegetation; preferably without big tree stumps and thick vegetation which entail large expense for clearing; areas near river banks and those at coastal shores exposed to wave action require a buffer zone with substantial growths of mangrove.
- Water supply and quality: with steady supply of both fresh and brackish water in adequate quantities throughout the year; water supply should be pollution-free and with a pH of 7.8-8.5.

Each pond has separate entrance and exit to facilitate water change, pond preparation and harvesting. A diagonal ditch, 5–10 meters wide and 30–50 cm deep extending from inlet to outlet was also constructed to facilitate drainage

and collection of fish during harvest. The ditch is also a shelter for fish during sunny days.

- Accessibility: preferably readily accessible by land/water transport; close to sources of inputs such as fry, feeds, fertilizers, and markets, fish ports, processing plants, and ice plants; and linked by communication facilities to major centres.

3.2. Pond renovation

*** For new ponds:** Supply and drain water into the pond 2-3 times to wash the pond, apply lime to help stabilize the soil pH, the amount of fertilizer depends on the pH of the pond bottom, the amount of fertilizer is from 7 to 10kg/100m2. water in and out 1-2 more times, then take water into the pond, measure the pH, if it is stable at above 6.5, proceed to color the water with manure, the amount of fertilizer with the newly dug pond needs to be applied from 25 – 30kg/100m2, in addition, inorganic fertilizers can be used to cause color**.**

*** For old ponds: Includes the following steps:**

– Step 1: Pond treatment: Drain the pond water, drain the water to catch all trash fish in the pond.

+ Repairing water supply and drainage sluice banks, dredging bottom mud leaving only 20cm of bottom mud, releasing toxic gas, removing pathogens from the pond. Flattening the bottom helps benthic organisms develop well and facilitate harvesting.

– Step 2: Apply lime: Use burnt lime- calcium oxide (Cao) or limestone - calcium carbonate (CaCO3) to evenly sprinkle the bottom and around the pond edges to make the bottom environment porous, kill disease-causing parasites, and help benthic animals develop to create a base. fish food, helping to keep the pH and water environment stable. The amount of lime applied depends on the soil pH with non-acidic soil ponds pH ≥ 6.5 apply 7-10kg / 100 m2, clay and sour ponds, 10-15kg / 100m2 if the pond is polluted, it can be applied up to 20kg/100m2. Then drain the water and wash it 1-2 times. Apply lime all over the pond surface, pond banks, especially the feeding points.

The purpose of liming is

+ Eliminate sour, eliminate bacteria and parasites that cause fish diseases

+ Make the bottom mud layer porous, breathable, accelerate the conversion of organic soil into nutrient salts.

+ Provide 1 amount of calcium to facilitate the growth of organisms (can be considered as a fertilizer).

– **Step 3:** Drying the pond: The time to dry the pond depends on the weather to ensure that the pond is dry. Minimum drying time is 7 days. Pond standards after drying: dry pond bottom, cracked crow's feet **(Note: if pond bottom is contaminated with alum, only the bottom of the pond should be dried, not cracked).**

Ponds have soil that dries and drains repeatedly, i.e. filled and drained to remove acids that form oxidation.

– **Step 4: Water supply and fertilizing causes water color**: Water supplied to the pond must be filtered through a filter bag attached to the sluice gate or the outlet of the pump, to avoid trash fish and bad fish from entering the pond. When taking in water, it is necessary to check the water environmental factors. When water reaches from 1 - 1.5m, apply 30-50 kg of manure per 100m2 (note: manure has been well composted with 2-5% lime powder), or green manure 30-50kg/100m2. Soak in water after 3-5 days when the pond water is green in color of young bananas or bean pods (meaning natural food sources have developed abundantly), then stocking is carried out.

3.3. Stocking

3.3.1. Culture Species

Commonly raised species in freshwater ponds are the carps, tilapia, catfish, and carp. In Asia, which produces most of the world's fisheries, fishponds are mostly freshwater or brackish. In China and Southeast Asian countries, pond culture is traditionally dominated by freshwater species, mainly carp, usually polyculture or monoculture.

- The fingerlings must be small, reaching the standard size for each type of fish: white pompano, tilapia, carp, catfish: 5-6cm/com, grass carp, flower sesame, white sesame: 10-12cm/fish , floating fish: 6-8cm/fish.
- The fish has healthy expression, active swimming, no deformity.
- Scales covered, no scratches, no disease, bright colors.

3.3.2. Stocking

Stocking density of each fish species is at the rate of 2-3 fish/m2. In there:

Species	Main species: Tilapia	Main species: Grass carp
Carp V1	5	5
Tilapia	45	25
Grass carp	20	40
White pomfret	10	10
White carp	10	10
Bighead carp	5	5
Hybrid catfish	5	5

- Before stocking, it is necessary to bathe the fish with sterile water to prevent disease, usually according to the following ratio: salt water mixed with 300g salt / 10 liters of water, bathe the fish for 15-30 minutes.
- When releasing fish, it is necessary to gently manipulate, soak the fish bag in the pond water for 10-15 minutes to balance the temperature inside and outside the pond. So that the fish when released do not suffer from thermal shock.
- Open the mouth of the bag to let the fish swim out slowly.

3.4. Feeding and

3.4.1. Feed

- Natural food
- Green food
- Processed food (germs)
- Industrial food
- Agricultural by-products (pig, chicken, quail)

Notes: + Concentrated feed equal to 2-3% of fish body weight/day.

+ Green food equals 25-35% of fish body weight/day.

In addition, there are many farmers have started to make their own fish food by using a blender to compress the feed using natural ingredients, mixed with probiotics and vitamins to enhance the nutrition of the fish. farmed fish. The simplest fish food is prepared at the pond using locally available raw materials such as rice or corn bran, coconut bran, rice bran as a carbohydrate source. They are often mixed with animal protein such as trash fish/fish meal, shrimp head and snail meat. Complementary feed for tilapia is made with 80% rice bran and 20% fishmeal. Use blenders and extruders to create feed mixtures, compressing them into fibers to feed the fish. However, the disadvantage of this type of food is that it will sink into the water, not float like industrial food. The advantage is to reduce production costs, lower costs than buying industrial feed.

- For industrial feed: there are often many different formulas to match the protein needs of the farmed organism, which, as a rule, will decrease with age. Therefore, fish food comes in many different forms such as feed for young fish,

food for fish during growth and development, and supplementary food for preparation for harvest. In which starter feed has the highest crude protein (CP) content of about 40% and finishing pellets has the lowest CP content of about 20%. The starter feed is used in the first month of rearing, the finishing feed in the last month and the growth food in the middle months.

3.4.2. Feeding

During the process of feeding fish, farmers need to pay attention to the following factors:

* Visual inspection
- Weather
- Water color
- Health condition

* Fixedness
- Amount
- Quality
- Time
- Location

Time	Amount of concentrate (calculated by % of the weight of fish in the pond)
1st month	8-9
2nd-3rd month	4-6
4th-5th month	2-3
Next months	2

- Daily feeding rates usually start at 5% and 10-15% of the estimated biomass of farmed fish, respectively, and decrease to as low as 2% and 5% respectively until harvest.

- The daily food ration is divided into equal portions throughout the day. Freshwater fish like tilapia are usually fed twice a day - early morning and late afternoon.

3.4.3. Feeding method

Food is spread into the water evenly throughout the pond to ensure that the fish can be eaten at all locations.

3.5. Management

* Periodically apply manure 10-15kg/100m2 + green manure 20-30kg/100m2, if no green manure, apply NPK: 0.2-0.4kg/100m2/week.

* Regularly check the pond bank, post culverts, monitor the fish activity in the early morning or evening, observe the water color of the pond: if it is light green or brown, it is good. If there is an abnormal change in water color, it is necessary to re-check the culture environment factors with test tools (test kits), monitor the fish's activities in the early morning or evening, and pay attention to the water quality. Closer to light blue or brown water color is good, kill pests that harm fish or lose fish.

**** In the timing of changing seasons, noteworthy***:

- Track pond water color
- Regularly observe fish condition, in which:

+ Weak swimming fish, ashore are weak fish.

+ Fish with floating head phenomenon for a long time, lethargic swimming is oxygen-deficient water.

3.5.1. Water management

- To prevent the deterioration of the pond environment, pond water is continuously freshened by the entry of new water from the river or water source (through the supply canal) while old water is drained through the outlet/drainage gate and through the drainage canal into the sea or river.
- Pond water is also regularly sampled and measurements taken of basic/essential parameters, particularly dissolved oxygen, pH, and salinity. This is important for the purpose of determining the need for corrective/remedial action to bring water quality to optimum levels and obtain good yields.
- Dissolved oxygen levels are kept, as much as possible, above 5 ppm by pumping and aeration. Problems of acidity are corrected by liming. Salinity is an important parameter for penaeid culture and has to be maintained within a range of 15-25 ppt for best results. During summer months, high-salinity water can be diluted by mixing with fresh water from springs or deep wells.
- A flow-through system of water management that allows the simultaneous entry and exit of water into and out of the pond is essential in any high-density culture system. This is effected by the provision of separate inlets and outlets for all the ponds, each inlet regulating the flow of water from the supply canal to the pond and each outlet controlling the discharge of water out of the pond into the drainage canal. Both the supply and drain gates are so designed as to bring water into and drain water out of the lower levels of the pond, where water quality tends to get poorer faster as a result of the accumulation of wastes and their subsequent decomposition.

3.5.2. Pond maintenance

Aside from feeds and water management, the following pond maintenance procedures are carried out: regular application of fertilizers, lime, and pesticides; prevention of entry of predators; monitoring of the stock for growth rate

determination as a basis of feeds and water management; and regular pond upkeep and maintenance.

Extensive ponds are fertilized regularly using either organic fertilizers like chicken, cow, or pig manure, or inorganic fertilizers like urea, ammonium phosphate, or both, to maintain the plankton population in the pond. The fertilizers are either broadcast over the pond water surface or kept in sacks suspended from poles staked at certain portions along the pond periphery. Semi-intensive and intensive culture systems do not require fertilization since they do not need natural food-based.

3.5.3. Check for leftovers in the pond

Pay attention to monitor and check the daily feed of farmed fish to ensure that the feeding and growth of fish is stable, as well as to make a forecast of the fish harvest schedule.

3.5.4. Regular Upkeep and Maintenance of Facilities

The pond dike and gates are checked regularly for cracks that could lead to seepages and losses of stock. The dikes are best planted with grass or vegetative cover to prevent erosion. The gates and other support infrastructure are properly maintained for efficient operation.

3.6. Harvesting

Fish with enough time and reaching the desired size will be harvested at the end of the culture period by draining the pond and using harvesting nets to catch the fish or shrimps. The latter are harvested with a bag-net attached to the sluice gate as water is drained out of the pond at low tide. Tilapia are harvested using seine nets after the pond water is drained to half-level the night before.Harvest of milkfish takes advantage of their behaviour of swimming against the current. The method, known in the Philippines as "pasulang" or "pasubang" involves draining 85-90% of the pond water during low tide and allowing in the water at the incoming high tide so that the fish swim against the current through the tertiary gate and into the catching pond, whose gate is closed once a large number of fish is impounded. The fish in the catching pond are then harvested by seining and the rest hand-picked.

- About 6 months, it is advisable to prune and release fish once; Or proceed to harvest in the last days of the year.

- The purpose of compensating pruning is to harvest those that are old enough.

4. FISH DISEASE

4.1. Impact of disease on farmed fish

- Reduced fish growth and production;
- Increased feeding cost caused by lack of appetite and waste of uneaten feed;
- Increased vulnerability to predation;
- Increased susceptibility to low water quality;
- Death of fish.

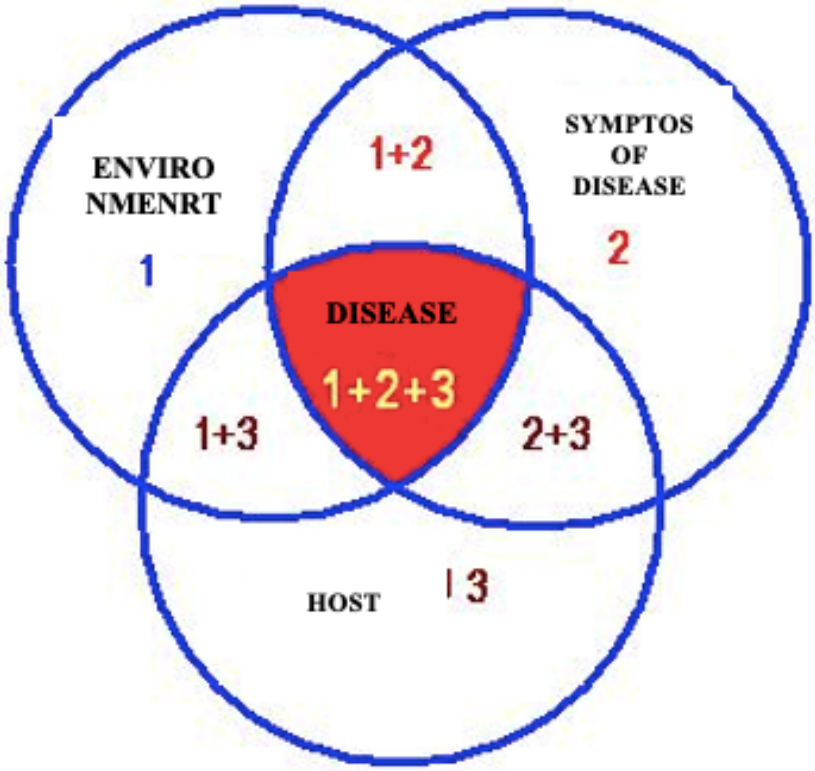
4.2 Causes of diseases in fish

Main causes of disease in farm fish

There are several causes of disease that may affect the fish directly or may continue to cause disease problems. Basically, any factor which causes stress or difficulty to the fish decreases its resistance to disease and increases the chance of disease problems occurring.

- The three main causes of disease are..

- Pathogens;
- Host: the resistance of the main organism, the host carrying the disease;
- Habitat: Conditions that are unfavorable to the host and create conditions for pathogens to develop.



When fish are stressed from exposure to harsh or toxic conditions, it is important to pay attention to issues such as: feed (excess in the pond causing eutrophication), lack of dissolved oxygen, pH changed, the presence of harmful gases such as ammonia, hydrogen sulfide, toxic substances in plants appear around the pond or in the pond such as saponins, mycotoxins; pesticide residue...

Beside, other factors on the fish farm may also be responsible for the survival and propagation of disease organisms, making disease control much more difficult such as:

- the presence of diseased wild fish;
- the presence of intermediate hosts such as snails and fish-eating birds, necessary for completing the life cycle of the disease organism;
- the introduction of disease organisms through contaminated inputs such as food, trash fish or processing wastes, for example imported eggs, juveniles, or broodstock, and water from an upstream pond or farm.

4.3. Prevention and Therapy of Fish Diseases

While it is very difficult to completely avoid fish diseases, it is always better to try to prevent their occurrence than to let them develop and then try to cure them when they start to cause problems. Treating fish is much more difficult and often requires the services of a specialist. By the time appropriate treatment can be

organized, the disease may have become more severe. In some cases, the surviving fish are so weakened that effective treatment is difficult.

- Clean the pond carefully before stocking fish, pay attention to remove impurities and carefully check the water source before putting it into the pond.
- Choose to buy high quality, disease-free fingerlings.
- Feed the fish full, full of nutrients, pay attention to check whether the food in the pond is excess or lacking. Add vitamin C to fish feed to improve resistance.
- Maintain suitable pond environment factors for fish growth.
- Periodically apply lime and hang lime bags at the top of the water supply.
- Use some medicinal plants (herbal drugs) to feed fish to prevent diseases.

Some medicianl plans to prevent and treat fish diseases

In fish, the parasitic outbreak acts as an important limiting factor for aquaculture. The medicinal plants (herbal drugs) can be used not only against diseases but even more so, as growth promoters, stress resistance boosters and preventatives of infections. The herbs can also act as immunostimulants, conferring the non-specific defense mechanisms of fish and elevating the specific immune response

- ***Chinaberry***
  + Prevention of diseases caused by parasites.
  + How to use: beam into the pond, dosage 30-40kg/100 m2
- ***Nettle pot***
  + Prevention of hemorrhagic disease, enteritis
  + How to use: take 4-5kg of leaves pounded to get water, mixed with food for 100kg of fish/day for 7 consecutive days
- ***Garlic***
  + Prevention of inflammatory bowel disease, gill rot
  + How to use: use 2kg for 100kg, mix in feed for 3 days continuously.
- ***Garden purslane (other name: Portulaca)- Portulaca oleracea L***
  + Treatment of inflammatory bowel disease caused by bacteria
  + How to use: wash vegetables and then sterilize with 3% salt water, spread vegetables in the floating frame of the pond, feed once a day, continuously for 6 days with a dosage of 1.5-3kg of purslane per 100kg of fish. .

4.4. Some diseases in fish

There are three major groups of living organisms that may be responsible for fish diseases:

- Viruses;
- Bacteria;
- Parasites.

4.4.1. Hemorrhagic Disease of Grass Carp

Hemorrhagic disease of grass carp is the most serious infectious disease of grass carp and causes significant losses of fingerlings. The main clinical signs are external and internal hemorrhage. The disease is caused by aquareovirus and has several serotypes. The optimal epidemic temperature of this disease is 25-28°C. The disease appears in late spring, early summer and autumn in fish has size from 15 tom 25cm (0.3-0.4kg),

- Signs of disease: Dark skin, lethargic floating fish on the face. Dead fish with protruding and hemorrhagic eyes, pale gills, gill cap, hemorrhagic fins. Peel off the fish skin to see muscle spots or whole body hemorrhage. Visceral haemorrhage but intestinal wall is not necrotic.
- Disease prevention: When the disease occurs, regularly disinfect the water in the pond with clear lime or hang a bag of lime at the top of the water supply.

4.4.2. *Bacterial hemorrhagic disease (red spot)*

Hemorrhagic disease (also known as red spot disease) is one of the common diseases in freshwater fish with the highest frequency in intensively cultured pangasius and has caused great losses to farmers.

A causative agent is a group of bacteria called Aeromonas spp. including Aeromonas hydrophila, A. sobria and A. caviae. In which, Aeromomas hydrophila is considered as the most important species causing disease for freshwater fish

Clinical signs:

+ When infected in the early stages: fish eat less or stop eating, floating lethargically on the surface. The fish skin often changes color to dark without silver, the fish loses its viscosity.
+ In the next stage, hemorrhagic spots appear on the body, at the base of the fins, around the mouth, eyes, and anus. In addition, there are sores that go deep into the muscle

+ Swelling around the eye sockets, loss of mucus; hemorrhagic anal inflammation; abdominal distension, fibrous fins are torn. In terms of lesions, the intestines may be filled with flatulence, the liver and kidneys are often necrotic.

- **Treatment and prevetion**:

+ Clean the pond, remove the dead fish out of pond.
+ In case of good water quality and no dead fish detected, 30% of the water should be exchanged.
+ The detritus at the bottom should be carefully checked and siphoned (if necessary)
+ Regularly hang bags of lime in water disinfection cages, dosage of calcined lime Hanging bags of lime (CaO) 2kg/100m3 weekly.
+ Fish meat uses the method of mixing with food to feed. Use Oxytetracycline or Erythromycin or Sulfamethoxazole: 3 -5 g/kg feed.

4.4.3. Mycosis fungal disease

Clinical signs: on the skin appears a gray-white area, on which there are small, soft fibers, after a few days the mycelium develops into white cotton-like tufts. The disease usually appears in the fall.

Cure:

+ Mix salt water with the ratio: 300g salt / 10 liters of water to bathe the fish for 15-30 minutes.

+ Use formol to bathe fish with a concentration of 15-20ml/m3 for 20 minutes.

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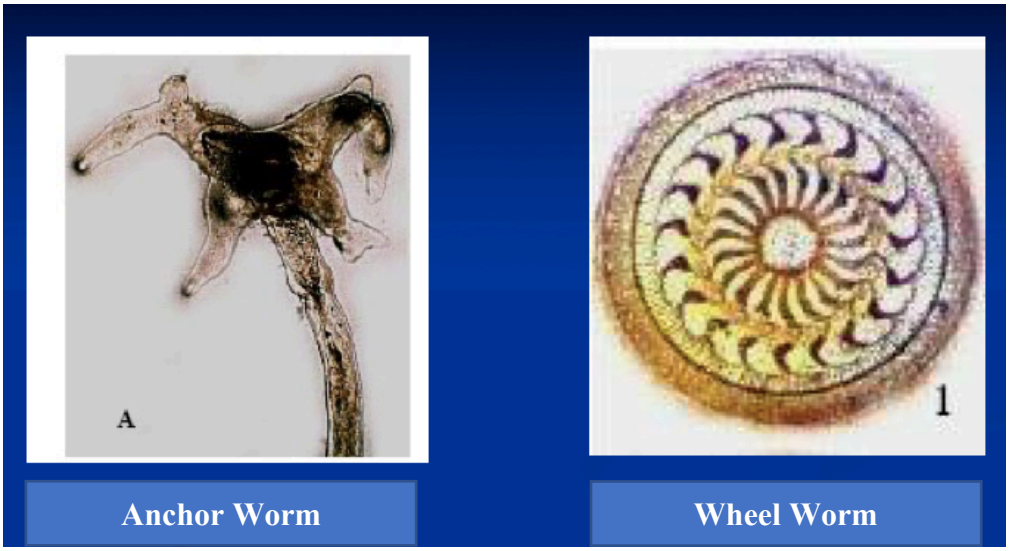
4.4.4. Wheel infection

Signs of disease: on the body of the fish there is a lot of white turbidity, the skin changes color, the fish floats in groups on the surface, the fish swims without orientation, lethargy, flips the belly and sinks into the pond and dies.

Prevention and treatment: Use copper sulfate (CuSO4) to bathe with a concentration of 3-5g/m3 for 5 minutes or spray into the pond 0.5-0.7g/m3.

- Use the leaves to treat diseases with a dosage of 30-50kg/m3



4.4.5. Anchor worms disease

- Signs of disease: parasites on fish, sucking nutrients, causing skin ulcers, gills. The fish has poor appetite, is thin and weak, has a big head, a small body, swims sluggishly, the fish loses its balance and swims off-body. The disease occurs in spring, autumn and winter. Especially the fish save through the winter.
- Cure:

+ Use neem leaves with dosage: 30-50kg/m3
+ Use formol to spray the pond with a concentration of 15-20ml/m3.

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