FST 322
Fish Farming Techniques
(2 Units)




O.A BABARINSA *Ph.D*

Course requirements

- Number of units: 2 units
- Lecture period: 2 hour /week(30 hours/semester)
- 75% attendance is required to qualify to sit final examination
- Grading

take home assignment	10%
A short quiz in class	20%
Final Examination	70%

Course Learning Objectives

Upon successful completion of the course students should:

- explain types of aquaculture practices and fish culture methods, their merits and demerits.
- describe types of integrated fish culture, their merits and demerits.
- describe water recirculating system, other enclosures for fish culture, their merits and demerits and explain other management practices in fish farming;
- differentiate between organic and inorganic fertilizers, their merits and demerits;
- explain the term exotic species and implications of exotic species when introduced into aquatic environment;

Course Outline

- Definition and types of aquaculture practices, Importance of aquaculture. Fish culture methods, their merits and demerits.
- Integrated fish culture. History and status of aquaculture in Nigeria. Site selection and selection of fish for aquaculture.
- Water recirculation system and other enclosures for fish culture.
- Principles and methods of stocking, feeding, liming and fertilization.
- Introduction of exotic species and their implications.
- Water quality requirements
- Types and application of organic and inorganic fertili
- Harvesting practices

REVISION

Introduction

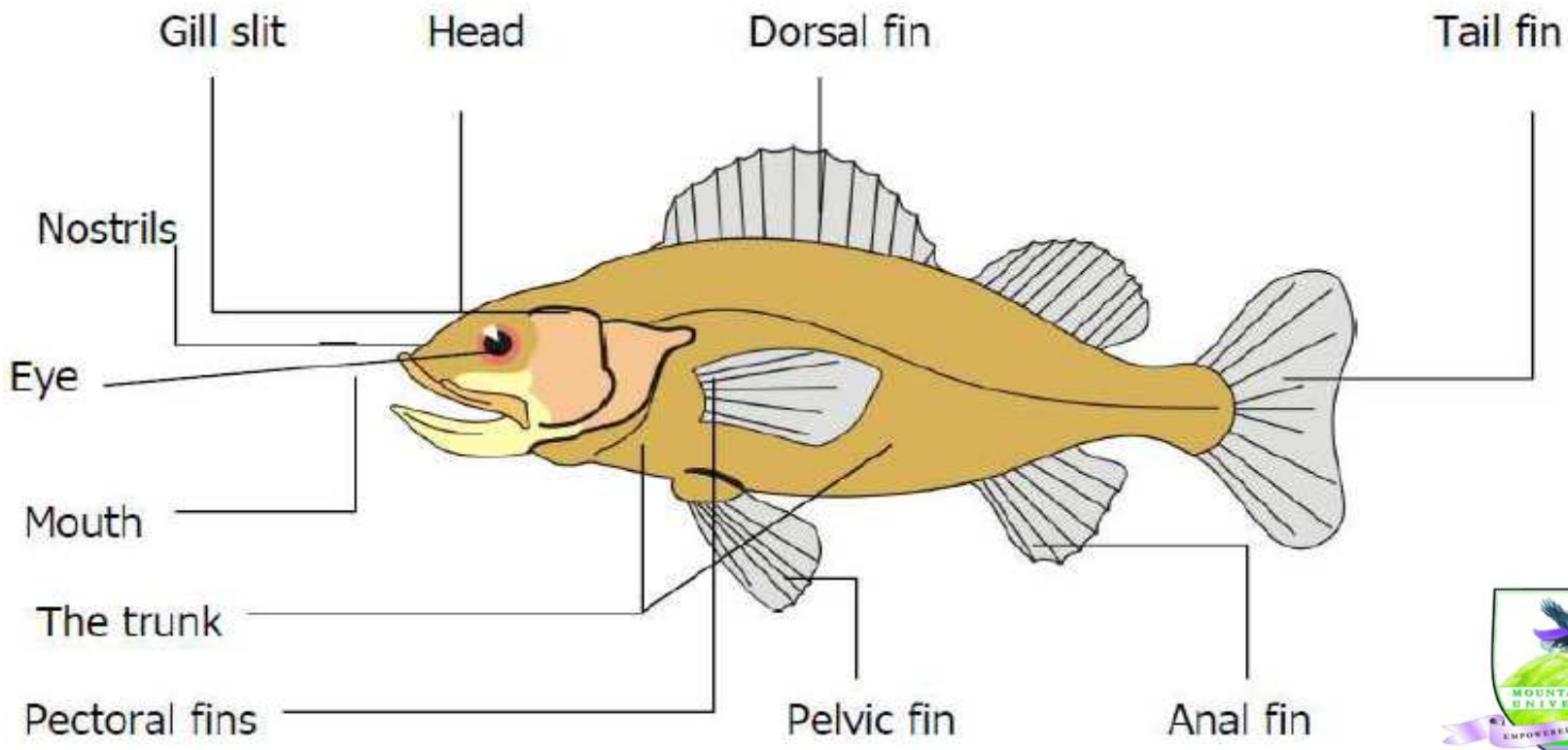
- The term **fish** most precisely describes a vertebrate that have gills throughout life and whose limbs, if any, are in the shape of fins.

- Fish display a great variety of forms and are adapted to the environment in which they live in many ways.

- There are two groups of fish in the class that differs in the composition of their bones.
  - **Bony fish** (fish with well developed hard bones) like tilapia, catfish
  - **Cartilaginous** (fish with soft flexible fibrous bones called cartilage) fish like the shark.

Fish Morphology

- A typical fish is ectothermic, has a streamlined body for rapid swimming, extracts oxygen from water using gills or uses an accessory breathing organ to breathe atmospheric oxygen.



Fishing Industry

- Like most industries in the world, the fishing industry can be divided into 3 major sectors:
  - Artisanal
  - Aquaculture (fish farming)
  - Industrial fisheries

Artisanal Fishing

- This is the small scale sector, usually organised by family unit.
- It is labour intensive and made up of 4 sub-sectors:
  - Riverine and Lake Canoe fisheries
  - Flood pond fisheries based on the exploitation of flood plains. This is seasonal.
  - Coastal Canoe fisheries (along the coast and its made up of fishermen scattered along the coast line)
  - Brackish water Canoe fisheries (along the creeks, lagoons, estuaries)

Aquaculture (Fish Farming)

- This is the cultivation of fish in controlled environment for food purposes.

- It involves selection of sites for fish pond construction, proper construction, stocking and feeding of cultured species, management of pond water, pond bottom and harvesting of fish after culture period.

- This sector of the industry is very versatile and active involving many stakeholders and professionals such as pond engineers, fish health experts, nutritionists and geneticists.

Industrial Fisheries

- This is the use of high technology in form of equipment's in the harvest, delivery and distribution of fish and fish products.
- It is capital intensive and requires the use of highly sophisticated technology.
- It involves a highly organised processing and marketing facilities.
- The Industrial has 2 main sectors
  - Inshore and
  - Offshore
- The inshore is within the territorial shore of Nigeria while the Offshore is in the distant water fishing zone of the country.

AQUACULTURE

Introduction

- Fish is an important source of food, income, employment, and recreation for people around the world.
- It is a very important source of animal protein for both man and livestock in developed and developing countries.
- In Nigeria, the current demand for fish is about four times the level of local production.
- Humans consume approximately 80 percent of the catch as food. The remaining 20 percent goes into the manufacturing of products such as fish oil, fertilizers, and animal food.
- Fisheries and aquaculture are integral parts of agriculture which were found to have the capacity to increase the country's GDP (Gross Domestic Product) and can solve the unemployment problem for our teeming youths if adequately managed.

Aquaculture

- Aquaculture is the science which deals with the cultivation/growing of aquatic organisms (fish , mollusks, crustaceans, other vertebrates, unicellular organism, microalgae and higher plants) using extensive or intensive method in order to increase the production or yield per unit area or volume to a level more than can be obtained naturally in a particular aquatic environment.

Aquaculture

- Aquaculture, a type of agriculture, is also the practice of cultivating aquatic animals and plants in managed aquatic environments.

- Aquaculture in salt-water or marine environments is called maricultures.

- Fish culture, or pisciculture, refers to the husbandry of finfish. The most popular aquaculture species are finfish grown in fresh waters, accounting for over 40 percent of total aquaculture production.

Importance of Aquaculture

- Aquaculture is practiced for a number of reasons, chief among them being food production and income generation. Most fresh-water aquaculture production (over 70 percent) comes from low income, food-deficit countries.

- Even in the poorest countries, fish farming is seldom solely a subsistence activity. So while farmers may consume some of their product, typically fish are sold, thereby enabling farmers to earn income to purchase other goods and services.

Importance of Aquaculture

Additional purposes of aquaculture include:

- Utilizing land unsuitable for agriculture;
- Utilizing inland water bodies such as shallow lakes;
- Reclaiming saline soils;
- Increasing the supply of highly valued species;
- Improving the reliability of fish supplied in the marketplace;
- Offsetting losses in the capture fisheries or in native fish populations;
- Servicing the sport fishing industry;
- Controlling parasites like mosquito and snail larvae that cause diseases such as dengue fever and malaria;
- Storing water; and
- Earning foreign exchange. (Europe and the United States import aquaculture products from Asia, Africa, and Central and South America.)

Fish culture

- Fish culture is the growing of fish in ponds.
- Growing fish in ponds, from which they cannot escape-, allows feeding, breeding, growing and harvesting the fish in a well-planned way.
- Fish culture is one form of aquaculture.
- Fish culture techniques can be described majorly by the type of rearing facilities, technology of production and number of species cultured.

Techniques in Fish culture

- Fish culture techniques may be classified based on the level of manipulation of the environment into three, which are:
  - Extensive Fish Culture
  - Semi- Intensive Fish Culture
  - Intensives Fish Culture

- Based on the number and types of species cultured, fish culture systems can be classified into three:
  - Monoculture
  - Monosex culture
  - Polyculture or composite fish culture

- Other fish farming techniques include:
  - Caging Systems
  - Ponds
  - Raceways
  - Recirculating System
  - Aquaponics

Extensive Fish Culture

- This is any fish culture techniques that do not require any supplementary feeding or energy input to support growth of the species under culture. Its attributes include:
  - There is relatively little or no manipulation of the environment, that is, there is low degree of control in terms of nutrition, predator, competition, disease or pathogen
  - There is low initial cost.
  - Low socking density: about 1-3 tonnes of fish per hectare
  - High dependence on local climate and water quality.

- The system is practiced in ponds, reservoirs and pens/fences.

Semi- Intensive Fish Culture

- This is any system that does not depend exclusively on a natural food chain; supplementary feeding is applied to augment the natural food in water in form of fertilization or linning of the water to increase primary productivity or through wastes e.g. domestic wastes.

- Therefore in a semi-intensive culture system, part of the food needed is supplied through supplementary feeding; stocking density is moderate and much higher than extensive culture systems (3-10 tonnes).

Intensive Fish Culture

- This is any culture systems that do not depend on natural food chain. It is a highly culture system in which the nutrients requirement is supplied during the culture systems. Thus, it involves the use of adequate food both in term of quantity and quality. Its attributes include:

- there is a high degree of control i.e. land manipulation of the environment. There must be recirculation of water in the culture systems, wastes are removed and enough water is supplied.

- initial cost is high

- high technology and high production efficiency for instance electricity must be provided

- allows for high stocking density (20-100 fingerlings per hectares)

- there is tendency towards increased independence of local climate and water quality.

Monoculture

- This is the culture of only one species of fish. It is commonly practiced in intensive fish culture systems.

- Fishes culture, here, have the same feeding habit. It is very useful in Tilapia culture due to their prolific breeding.

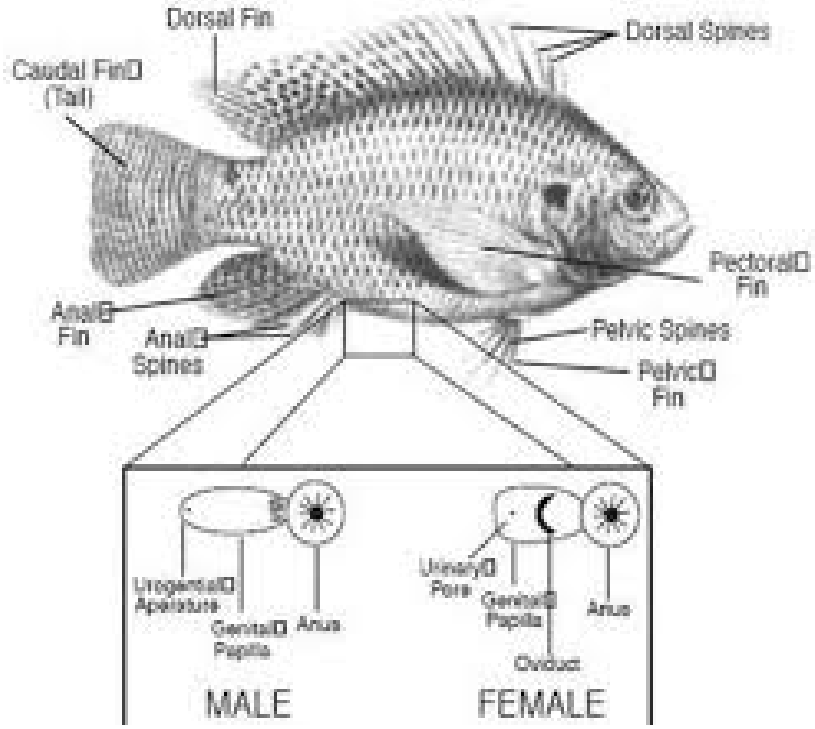
- The advantage of this method of culture is that it enables the farmer to make feed that will meet the requirement of his fish especially in intensive culture system. Fish of different ages can be stocked thereby enhancing selective harvesting.

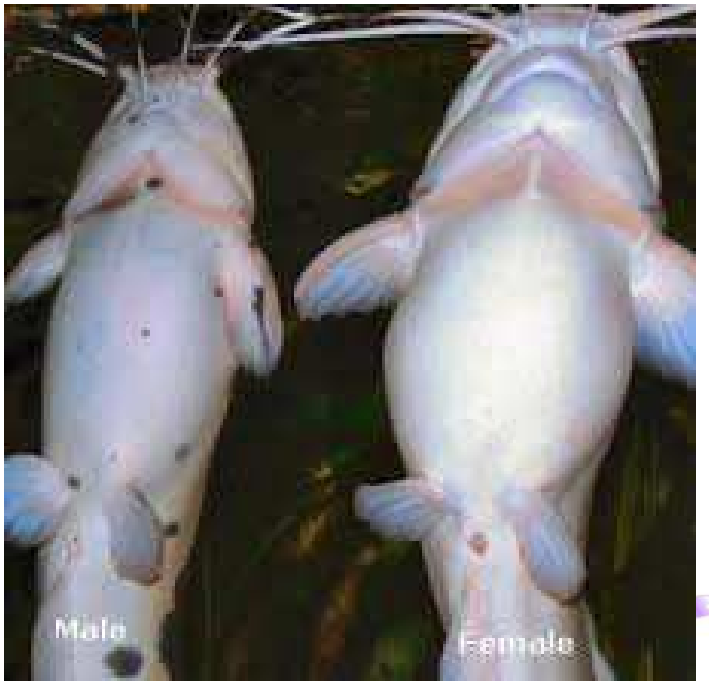
Monosex culture

- It is a type of fish culture in which wild spawning is controlled and desired sex is increased e.g. Female Tilapias in a pond cause uncontrolled breeding. To avoid this, monosex culture is practiced.

- The focus of this culture is to produce male seed stock. This is done by fish culturists by hand sexing (or its also called manual sexing) wherein the males are sorted out from the unsorted stocks of fry.

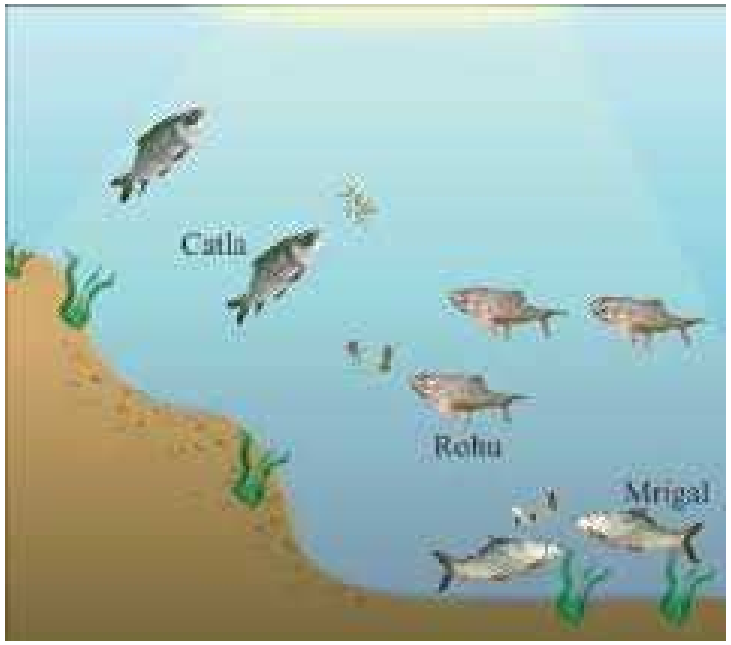
- The sexes can be differentiated by visual examinations of the uro-genital papillae.



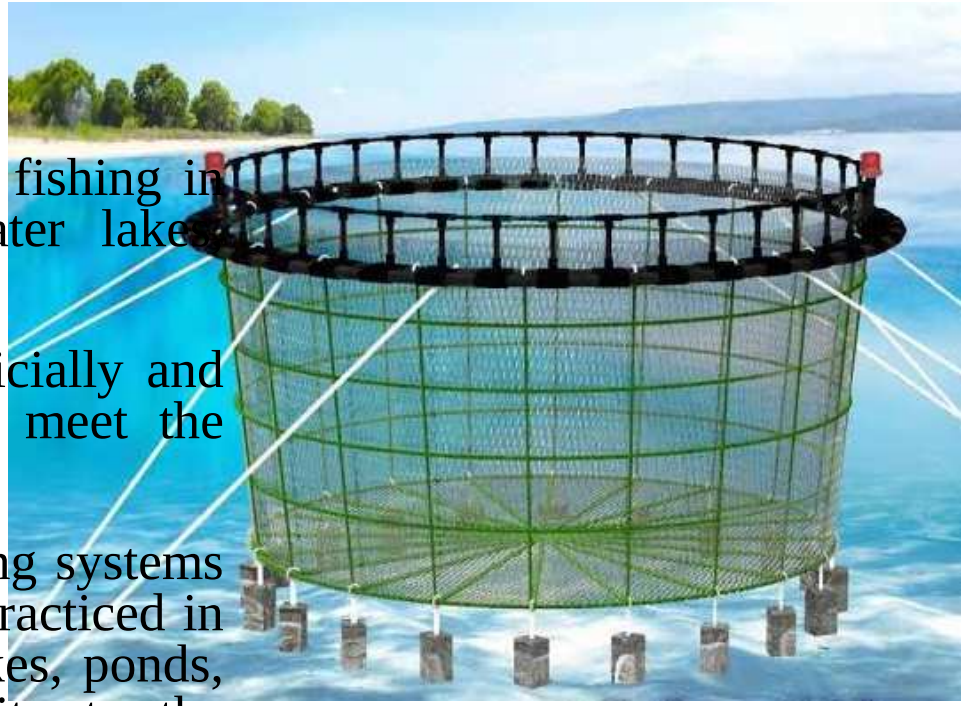


Polyculture or composite fish culture

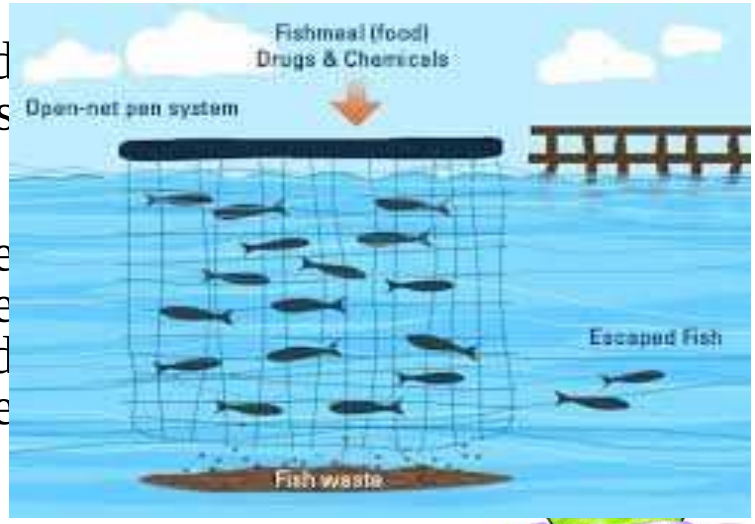
- This is the culture of two or more species of fish in a pond or tank. It is also a system that grows more than one species of fish from the same trophic level.
- Different types of fishes of different feeding habits are cultured to exploit the different kinds of food that is present in the different parts of the pond.
- Polyculture poses no serious competition between the different species as each species renders a beneficial influence on growth and production of the other.
- It is commonly practiced in extensive or semi-intensive fish culture systems and has the advantage of utilizing more ecological systems hence; there is increased utilization of available food.



Caging Systems



- Nets or cages are popular methods of fishing in off shore coastal areas and freshwater lakes, ponds and oceans.
- Fish are raised in the cages, fed artificially and harvested when the numbers of fish meet the required demands of market.
- Some of the advantages of cage farming systems is, that this farming technique can be practiced in various types of water sources like lakes, ponds, seas and oceans, that offers flexibility to the farmers.
- Also, many types of fish can be raise together and the water can be used for various other purposes like water sports.
- In this farming method, superior quality cages are constructed and put in the water sources to raise the fish. Spread of diseases, poaching and concerns of poor quality water are some of the disadvantages of this farming system.



Ponds

- One of the small scale fish farming techniques is raising fish in the pond, especially designed for the purpose of raising fish.
- Small ponds can be made in the farms and houses, which can provide its owner the ability to have control over the farming system.
- Ponds are useful for water harvesting in the dry areas and can also be utilized for raising fish. Waste water can be contained and treated properly to raise fish.
- Release of untreated waste water into the environment is possible, if the ponds are not maintained properly and can cause pollution.

Raceways

- If you visit any fish farming area, you may come across narrow streams flowing between two wall type structures.
- These streams are nothing but raceways and their purpose is to help the farmers divert water from water systems like streams or well, so that it flows through the water channels containing fish.
- There are various restrictions imposed on this type of farming by the government and the farmers are strictly advised to treat the water before they divert it back to the natural waterways.
- Also, the farmed fish can escape raceways and interfere with the wild fish habitat of the waterways.

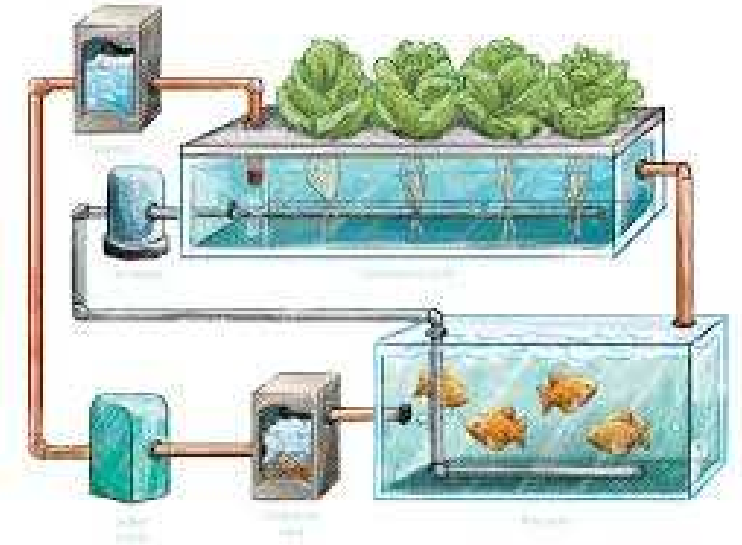
Recirculating System

- The recirculating system uses recycled water for raising fish. The waste water is treated and recycled many times. Many fish species are grown in the recirculating systems.

- However, the operative cost of the electricity is a disadvantage of this method.

Aquaponics

- It is a combination of aquaculture and hydroponics, two systems that are not new, but share a common problem and concern, TOXIC WATER BUILDUP!!.
- In aquaculture, it is the fish emulsion, with hydroponics, it is the fertilizer water. This toxic water is not good for the fish or the plants.
- Aquaculture and hydroponics are systems that compliment each other as a single unit, not as separate units.
- The fish water is pumped to a greenhouse, which is evenly distributed. The fish water feeds the plants, then filters through a porous material (volcanic cinders in Hawaii) and returns to the fish tank by gravity.



History, Present Organisation and Current status of Aquaculture in Nigeria.

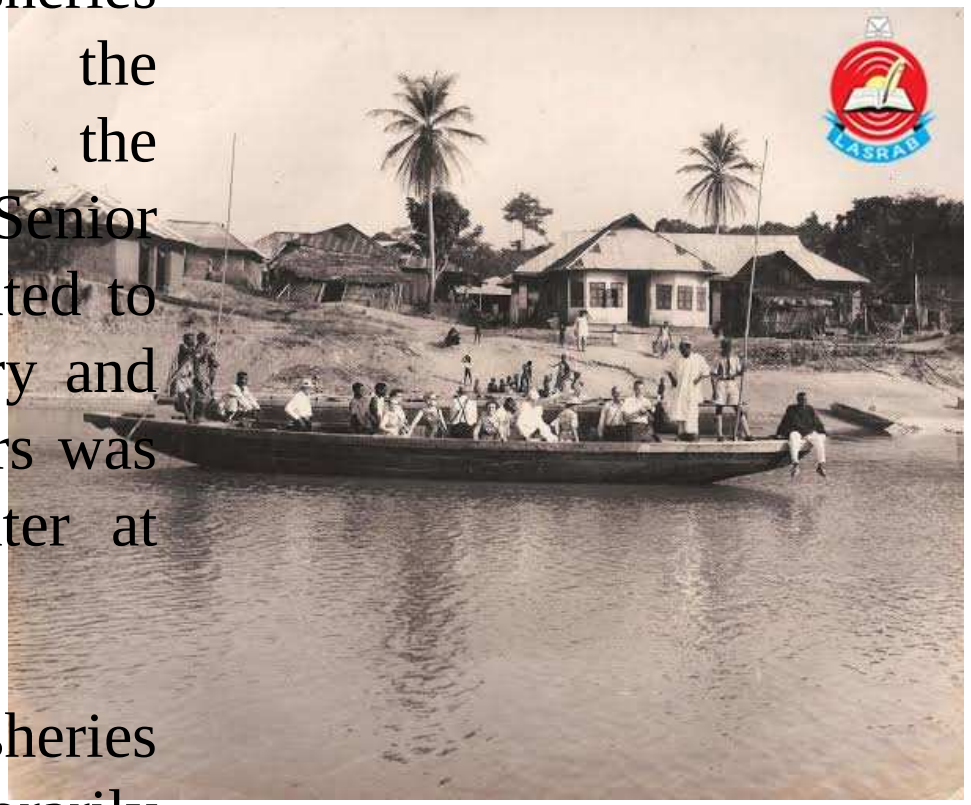
Aquaculture History

- The agricultural history of Nigeria is intertwined with its political history. This is discussed broadly in the context of the varying constitutional frame works, viz: Colonial, the Internal Self Government and the Post-1960 periods, according to sectors.

- A. The history of fisheries development in Nigeria is a comparatively recent one, although reports have shown that a fishing company operated from the coastal waters of Lagos long before 1915. Deliberate efforts at developing the country's fisheries can be said to date back to the Second World War when, because of the naval blockade of the high seas, the then Colonial Administration decided to develop the country's local resources, including fisheries.

Aquaculture History

B. A fisheries organisation was established in 1941 as a Fisheries Development Branch of the Agricultural Department of the Colonial Office and a Senior Agricultural Officer was appointed to conduct a survey of the industry and its possibilities. The headquarters was sited at Apese village and later at Onikan in Lagos,



C. Early in 1945, the Fisheries Development branch was temporarily transferred from the Agricultural Department to the Development Branch of the Secretariat.

Aquaculture History

D. From this date to 1947, the Branch became a section of the Department of Commerce and Industries with a Principal Fisheries Officer in charge. Small motor fishing crafts were acquired for exploratory fishing in the estuaries, lagoons and creeks. It was considered "that these fisheries should receive priority treatment at this stage in Nigeria over sea fisheries".

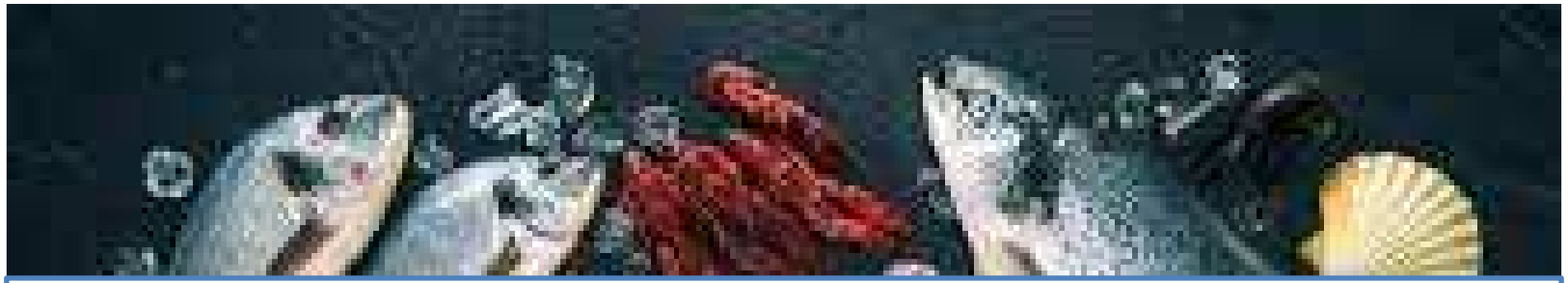
E. Between 1948 and 1950, major efforts were made at extending the artisanal fisheries pro gramme to other coastal areas of Nigeria. An active extension service was established to demonstrate the benefits of improved fishing techniques and gear to the coastal canoe fishermen. A Fish Farmer was appointed to extend this aspect of production and this culminated in the establishment in 1951, of a 160ha industrial-scale fish farm at Panyam on the Jos Plateau. By the end of this period, the branch had grown to become the Federal Fisheries Services under the Federal Ministry of Economic Development.

Aquaculture History

F. Under the 1954 Constitution of Nigeria, the fisheries organisation was split between the Federal and Regional Governments. The Federal Fisheries Service of the Federal Ministry of Economic Department was headed by a Director with laboratories and headquarters in Lagos.

H. The period 1956-66 witnessed great expansion in Nigeria's fishing activities. In the coastal trawler fleet, from a single registered trawler in 1956, the fleet was built up, by 1960, to 13 while the total fish catch increased ten-fold during the period. The general result was that the contribution of fisheries to the country's QDP quadrupled between 1960 and 1970.

I. Awareness Years (1991-2001): In this decade aquaculture witnessed some level of robust development in term of awareness both among private investors, institutions and government as sure means of producing cheaper protein and source of employment.



Site and Fish Selection

Fish Pond (or Enclosure) Sites

- Fish ponds are fish enclosures. They fall into two categories depending on the terrain of the site under construction. These include.

  - **Geophore (or Land-Borne) Sites):** These are fish pond sites borne by land irrespective of the water source, design and other factors. Earthen ponds, weirs, raceways, fish tanks, throughs and tubs belong to the category of geophore sites' enclosure.

  - **Aquaphore (or Water-Borne) Sites**: These are fish pond sites borne by water (wholly are particularly) irrespective of design and material of construction. Cages, pens, creels, and pots are in this category. They are normally immersed in marine, estuarine, lacustrine and riverine waters.

Site Selection

- Selection of suitable sites for fish farm construction is very important. The following three essential conditions guide the proper site selection:
  - Topography
  - Source of water and its quality
  - Soil type

Topography

- It is economical and convenient to construct ponds in waterlogged areas, irrigation command areas or in marginal lands. In such areas construction cost is relatively low mainly due to limited earth cutting.
- Full consideration should also be given to the possible effects of flood. A saucer-shaped area may be an ideal site for a large dug-out pond, because it may hold appreciable quantity of water with a small amount of earthwork
- The site should be easily approachable so that there may not be any difficulty in the transportation of input materials and in the marketing of the produce.

Site Selection

Source of water and its quality

- A dependable source of water supply must be available within or near the site, even for undrainable ponds. However, unlike drainable ponds, undrainable ponds require just sufficient water to fill the ponds and to compensate the water loss through seepage and surface evaporation thereafter.

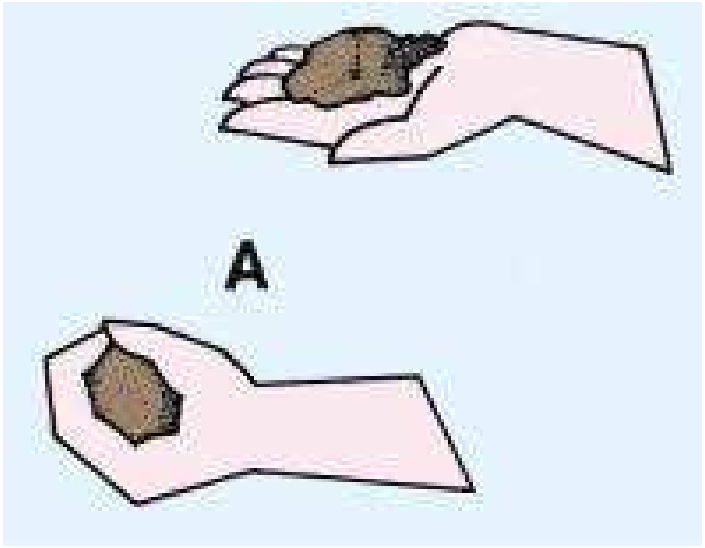
- Equally important is the need for avoiding excess water and hence there must be arrangement for the excess water to escape through a bypass channel or a spillway

- Water should be clear as far as possible. Turbid waters which carry suspended solids cut the light penetration, thus reducing primary productivity of the pond. Excess of suspended solids also adhere closely to the gill filaments and cause breathing problems

- Water temperature also significantly influences the feeding and growth of fish. Prevailing water temperature, ranging between 15°C and 35°C in tropical areas, is most suitable for carps.

Site Selection

Soil type



- Pond soil must retain water. Soils with a low infiltration rate are most suitable for fish pond. Table 1 shows the filtration rate of different types of soils. The best soils for our purpose are thus the impermeable clay which can be easily compacted and made leak proof.

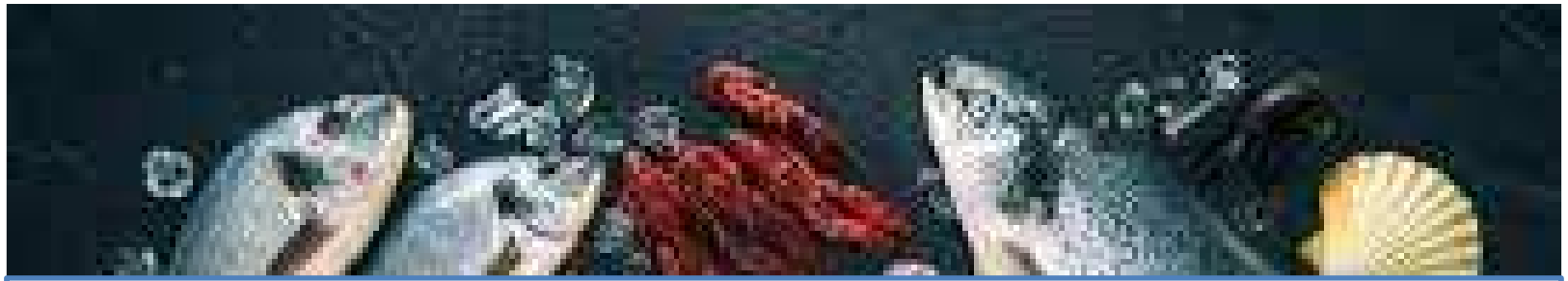
- Peat soils have special problems, since they are usually very acidic in nature and need sufficient liming, while the organic matter decomposition may lead to dissolved oxygen deficiency. Soils rich in limestone also create special problems, since the excessive lime content tends to precipitate phosphate and iron.

- A general and convenient field test for the soil quality is to take a handful of moist soil from the test holes made at the proposed site and to compress it into a firm ball

Fish Selection

- Advances in controlled reproduction of desired species, feed formulation, and water quality management have helped generate the rapid growth of aquaculture. The biological selection of culture species depends on many factors.

- A few criteria that must be considered in choosing a species to cultivate include the following characteristics of a species:
  - **Growth rate;**
  - **Place in the food chain;**
  - **Climate and environmental adaptations;**
  - **Disease resistance;**
  - **Breeding characteristics;**
  - **Compatibility with other fish species in cultivation; and**
  - **Conversion efficiency (feed-to-flesh).**



POND MANAGEMENT

Pond Preparation

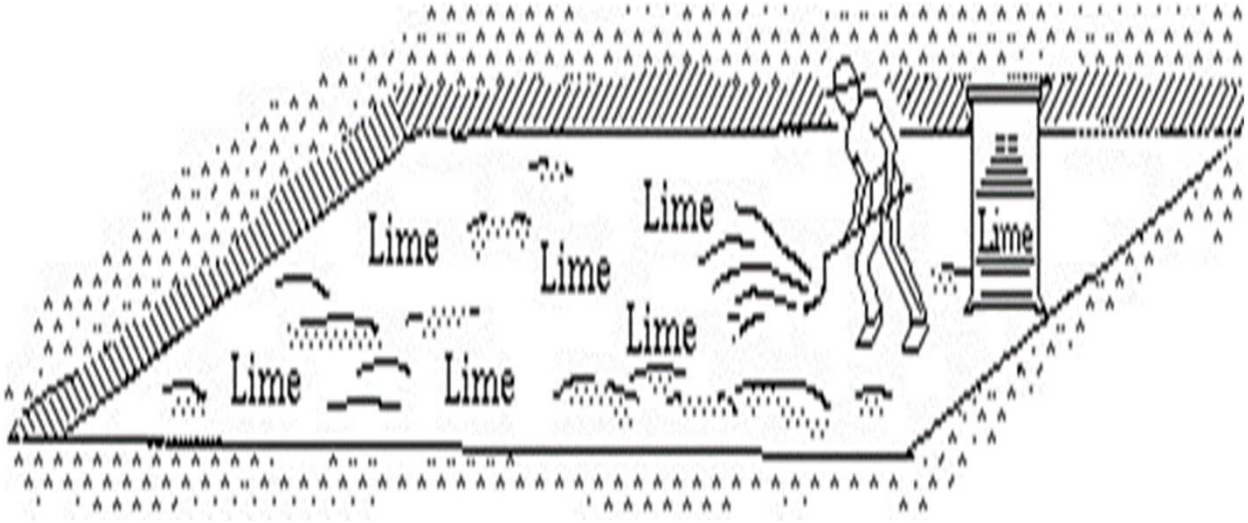
- **Drying the pond bottom:** The pond must be completely drain of water and the bottom allows drying until it cracks. De-silting of the pond is carried out if the pond is very muddy.

- **Repair of pond structures:** The embankments, monks, fish screens and water supply structures are checked and repair carried out before the pond is filled with water.

- **Removal of unwanted organisms and aquatic weed:** While the pond is being dried undesirable organisms e.g. frogs, mollusks, fish predators are eliminated.

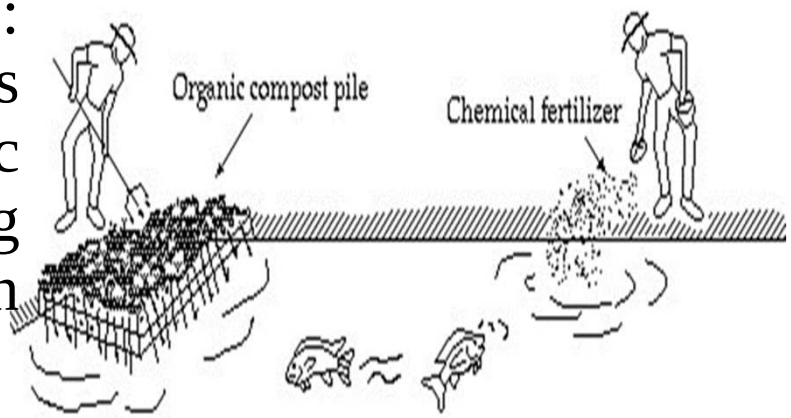
Liming

- Lime is used to improve the pond bottom, and to kill parasite or undesireable organisms in the pond.
- It also prevents water from becoming too acidic.
- Liming increases the alkalinity of the water, thereby increasing the availability of carbon dioxide.
- Materials use for liming and their rates of applications are:
  - Quicklime (caustic lime) = 200 – 500 kg/ha
  - Slake lime (Hydrated lime)=300 – 500 kg/ha
  - Agricultural lime (limestone)=500–2000 kg/ha.



Fertilization

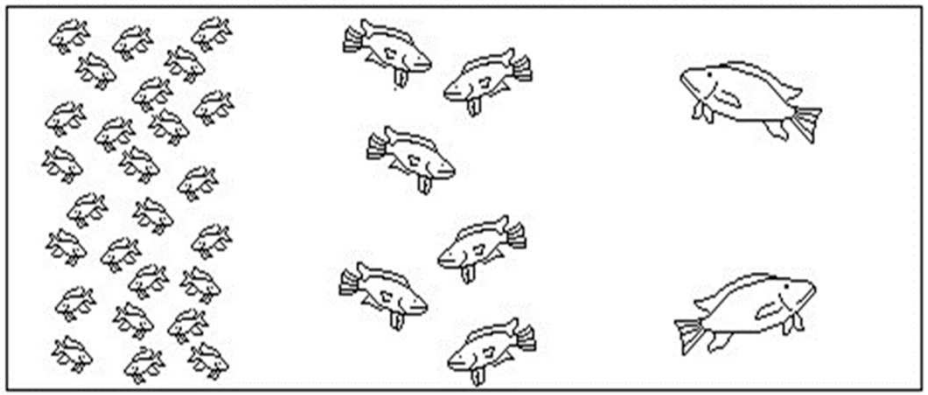
- Fertilizer are substances added to water to increase the production of natural fish food organisms, to make water more productive, fertilizers are added.
- They contain important nutrients which help in production of natural fish food organisms (plankton).
- There are two basic types of fertilizers: organic (animal or plant matter used as fertilizer in ponds.) and inorganic (manufactured fertilizers containing nitrogen, phosphorous and potassium in varying proportions).



- Chemical and organic fertilizers may be applied separately or in combination to ponds.

Stocking

- Stocking a pond means releasing into the pond an adequate number of selected fish species which are of the right size.
- The fish pond is stocked a week after fertilization.
- The stocking density of the pond depends on the fish culture system adopted and the species cultured.
- Generally for pond culture and for species which do not reproduce early, the stocking rate vary from 1- 3 fish/sq.m (i.e.10,000 – 30,000 fish/hectare).
- However, stocking rates can be higher with high technology.

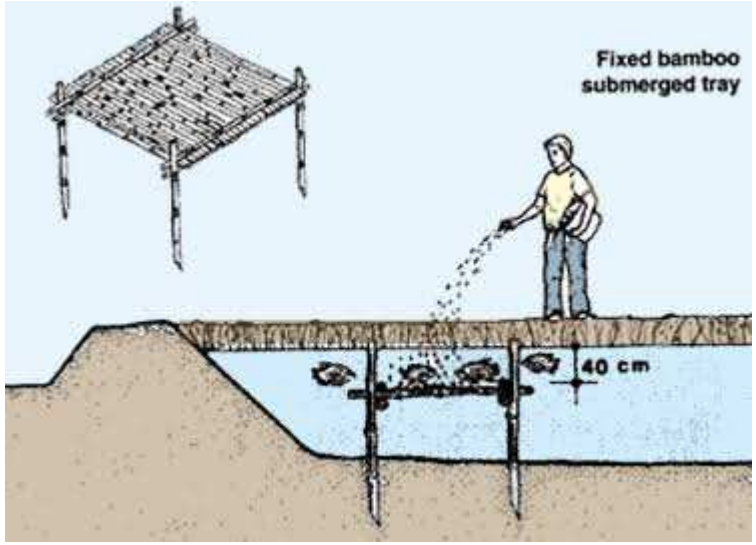


Overstocking results in:	Proper stocking results in:	Understocking results in:
- scarce food	- adequate food	- underutilized natural food
- small size	- large size, high yield	- large size, low yield
- slow growth	- fast growth	- fast growth

Feeding

- In the water natural food is available to the fish. Some fish e.g. Heterotis, Tilapia feed on microscopic plants or soft plant parts and are called herbivore. Some feed on other aquatic animals as well as fish and are called carnivore e.g. Tarpon, Niger perch, while others feed on both plants and animals and are called omnivore e.g. Mudcatfish.

- In culture systems, fish is given supplementary or artificial diet to make them grow faster. There are a variety of fish feeds formulated from different feed ingredients. Pelleted feeds are preferred to powdery feed. However, the size of the pellets must not be too big for the fish to swallow



Feeding

Fish Sampling

- Periodic check on fish growth is vital for pond management.
- Monthly or bi-monthly fish sampling is carried out to check growth rate and to calculate the feed ration.
- During sampling, a small quantity of the fish stock is scooped out, counted, weighed, and returned to the pond.
- Any fish showing signs of disease condition is removed for thorough examination.

Harvesting (Cropping)

- Harvesting a fish pond is undertaken when the fish stock or part of it has attained marketable size. Market size of fish is determined by consumer acceptability and preference.
- Most culturable fish species; with proper feeding and good management attain market size within 6 – 9 months of stocking.
- Cropping of pond can be partial, that is, removal of bigger fish and allowing the smaller one to grow to the desired size or complete (total) i.e. removal of all fish in the pond.
- Feeding is stopped 2- 3 days before cropping. The pond is completely drained and fish scoped out. They are sorted into different sizes and/or different species, counted and weighed. Small fish are returned to the nursery ponds for stocking.
- Tools used for stocking include seine or drag nets, scoop nets, traps, hook and line e.t.c.

Marketing and fish preservation

- Harvested fish can be marketed live, smoked of frozen. Fish can be sold direct to the consumers or through a distributor.

- It may be necessary to advertise fish sales to minimize high post harvest lose. Unsold fish (live) can be preserved by storing in deep freezers or cold rooms. Smokings, sun-drying, salting and canning are other methods of fish preservation.

Record Keeping

- It is important for the fish manager to keep accurate records of all fish farm activities.

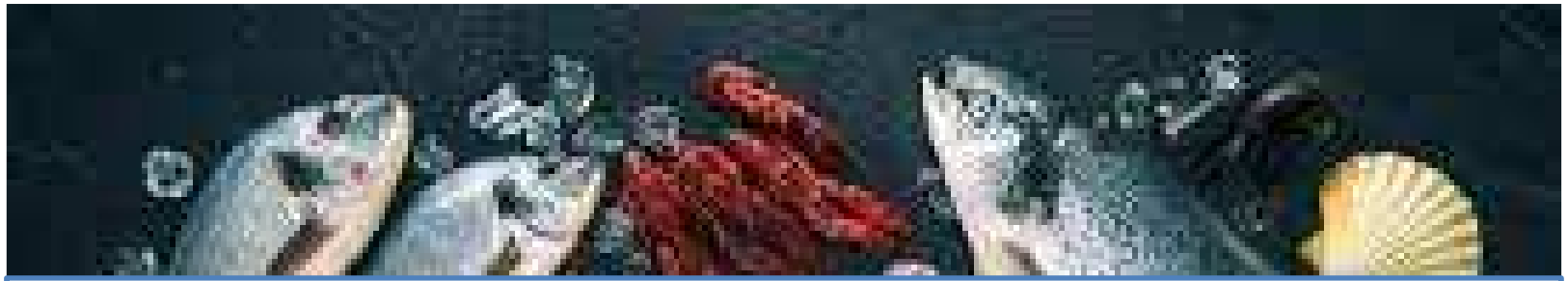
- Such records may include labour cost, cost of lime/fertilizer and rate of application; cost of fingerlings and fish feed; harvest and sales.

- Fish farm records aim in good farm management and in evaluating the economic viability of the project.

Table 10: Sorting (Grading)

Fish Pond Owner ________________ Pond No. _____ Site Location ________________

Date	A – Previous		B – Previous		A – New		B – New		Remarks
	Fish No.	Average Fish Weight (kg)	Fish No.	Average Fish Weight (kg)	Fish No.	Fish Weight (kg)	Fish No.	Fish Weight (kg)	



Water Quality Management in Aquaculture

Introduction

- Management of water quality to include colour, pH, dissolved oxygen content, turbidity, total alkalinity and hardness as well as pollutants is important because they affect survival, growth and reproduction of fish.

- Quality of water must be checked weekly, monthly or bimonthly depending on prevailing conditions. However, colour of water should be checked daily.

Water quality management

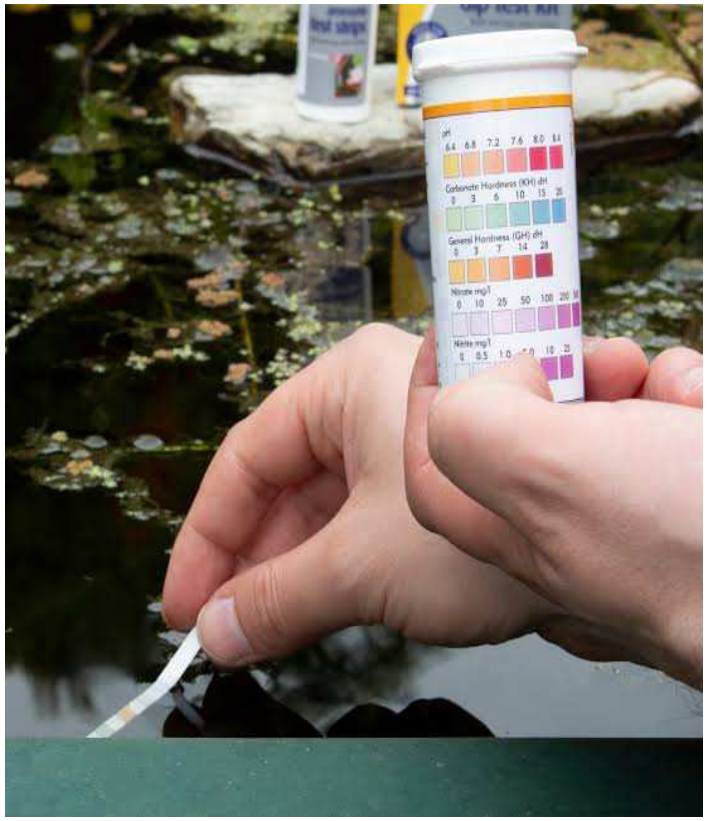
Good water is characterized by the following:

1. It should be greenish or bluish in colour due to phytoplankton. Yellow or brown colour may indicate acid water.
2. It should be about neutral or slightly alkaline. Best pH range for fish production is 6.5- 9.0. Acidic and alkaline death point for pond fish is pH 4 and 11 respectively.
3. It must contain enough dissolve oxygen above 4mg/l. At values of 3mg/l or less growth will slow down, fish may become susceptible to diseases.
4. It must not be muddy or turbid. Secchi disc visibility less than 25cm is not desirable (adequate range = 40-90cm). When Secchi disc is unavailable, the palm should be visible when hand is dipped in water except turbidity is caused by plankton bloom.
5. It must not have offensive odour
6. It must be free of pollutants e.g. oil films, detergents, heavy metals e.t.c.

Water quality Parameters

Control of pH levels in Ponds

- When pH level is consistently low agriculture lime should be applied to raise the pH at the rate of 250-500kg/ha.
- Acidic waters are common in ponds constructed in acid sulphate soils (found in coastal mangrove swamps). Such pond dykes should be limed at the rate of 1-2kg/m (length) and the pond water limed periodically (30kg/ha/month) in addition to the normal one dosage application before stocking.
- High Ph levels can be controlled by application of filler alum (aluminiumsulphate at dosages of 10-20mg/h).



Water quality Parameters

Dissolved oxygen (DO):

This is probably the most critical factor in fish culture.

(a) Causes of low DO: In ponds

- Heavy plankton blooms caused by excess manuring of fish ponds.
- Accumulation of uneaten feeds in ponds caused by over –feeding (high feeding rates) or bad feeding methods.
- Overcrowding caused by high stocking densities.
- Reduction in rates of photosynthesis caused by extended periods of cloudy weather or high turbidity of water.

(b) Indicator of low DO in ponds

- = swimming of fish to water surface to gasp for air. It is serous when this involves bottom fishes and it occurs all over the pond especially around midnight.
- - Lack of response to noise i.e. escapes into deeper waters when scared by noise e.g. clapping of hands.

(c) Control of low DO

- Fertilization should be suspended.
- Feeding rate should be reduced or feeding stopped
- Water should be changed and fresh oxygenated water added to the pond.
- Water should be aerated either by use of aerators or agitators especially if pond water cannot be changed due to shortage.

Water quality Parameters

Turbidity

Cause

- **Suspended silt or clay particles.** Clay turbidity restricts light penetration and may limit growth of plankton. It may also clog and block gill systems of fish and affect rate of reproduction by damaging fish eggs and destroying breeding grounds. Habitats of benthic organisms are also damaged.

- **High plankton density.** Turbidity arising from planktonic organisms is desirable so long as it is not in excess. Excess plankton bloom may limit light penetration due to algal scum on surface and may deplete dissolved oxygen due to respiration.

Control of Turbidity

- - Simply by soaking dry vegetation in pond.
- - By use of chemicals such as lime, filter alum to precipitate suspended solids
- - Fertilization should be suspended if turbidity is caused by plankton blooms.

Water quality Parameters

Alkalinity and Water Hardness

- Desirable level of total alkalinity and total hardness in ponds ranges between 20-250mg/l. If these variables are low (less than 20mg/l) formation and growth of plankton may slow due to low supply of carbondioxide. Low levels of total alkalinity and hardness are increased by liming.

Pollutants

- Their presence in ponds can result in extreme mortality of fish. Control of pollution includes:
  - Location of fish ponds away from heavy industrial centres, oil fields and chemically treated agricultural farms
  - Diverting or re-channelling run-off water from agriculture farms away from ponds
  - Ensuring that source of water for fish culture is of high quality
  - Each pond should have its own inlet and outlet
- Pollution caused by waste products of fish can be controlled by changing the water in the pond