WATER QUALITY OF FISH POND

(A CASE STUDY OF FCT MODEL FISH FARM)

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APPROVAL PAGE

This project has been read and approved as meeting the requirement of the Department of Agricultural Engineering, School of Engineering and Engineering Technology (SEET), Federal University of Technology, Minna, in partial fulfilment for the award of the Post Graduate Diploma (PGD) in Agricultural Engineering (Soil and Water Engineering option).

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Declaration

I declare that this work is a compilation of the experimental findings of the Fish Pond, samples analysed/research carried out on the MFCT Model Fish Farm, and not a copyright of any past work of others.

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Abstract

Water Quality is a major factor for fish production which make up a major part of the diet, protein supplements and rank among the most nourishing of all foods in Nigeria. This is a report of the earlier conducted tests on five water sample taken from the existing fish ponds and a field survey carried out on MFCT Model Fish Farm Garki; as to be able to find the effect of seasonal flooding on the quality of fish water ponds tests which include PH, temperature, turbidity, taste, carbonate and total hardness, Nitrate (No_4), Nitrite (No_3), Carbon dioxide (Co_2), Ammonium and field work survey were conducted and the result obtained from the physical and chemical test conform with the tolerable limits for Inland Surface waters subject to pollution for use as fish culture and other acceptable standard of US and Federal Republic of West Germany Interior Fish & Wildlife Service. (1993 & 1981). However there are some minor observation of high PH, Nitrite and sudden temperature changes. Land mis-use and management are other field problems discovered while the result obtained also shows areas of anomalies and recommendations were made on the immediate and concrete steps to be taken to rectify them.

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1.0 INTRODUCTION

Ministry of Federal Capital Territory Model Fish Farm was established in 1988 by the Department of Agriculture for Research, Extension and Development of the Fishery Sector in the Territory.

The Fish Farm is made up of 1 hectare of Integrated Reservoir cum Poultry and 12Nos. Small Ponds of different sizes ranging from $150m^2$ - $250m^2$. The types of Fish raised includes Cat Fish and Tilapia; Fingerlings are also produced for distribution to fish farmers and for lakes and rivers stocking programmes in the Territory.

The farm is situated in Area 11, Garki 1 District of the FCT (See 3.2).

1.1 PROBLEM OF FLOODING

The fish farm yearly witnessed seasonal flooding of the ponds but with no serious damage to the farm until the establishment of the 1(One) hectare Integrated Reservoir in 1997.

With the establishment of the Integrated reservoir there has been two major flood, the first in 1998 washed away the fish pond dyke in the Northern axis and allow the water in the Integrated Water Reservoir to escape with the fish. This was a great loss economically to the department who has just started consolidating its economic gains from initial investment.

The second flooding after the repair of the reservoir was in 1999, but this time around there was no serious damage done on the earth embark- ment except that the whole area was flooded with water and the likelihood that fingerlings and some other fish must have escaped.

With this major flooding it has become imperative that the effect of the flooding should be looked into in order to proffer appropriate lasting measure and the need to ascertain the level of the water quality of the fish pond which must have been greatly affected by the influx of water that must have brought along with it, sediments, and other polluted particles.

1.2 WATER AND FISH CULTURE

Water is the environment in which fish live, therefore water is a major factor for fish production. Fish farming requires water of high quality and the understanding of its physical and chemical qualities is critical to successful fish culture.

A flow of at least 13 gallons per minute is required for each sizeable surface area for fish production for commercial purposes, while in areas with high evaporation rates or considerate water seapage the minimum water requirement is greater. For maintenance requirement, 20 to 50 gallons per minute is ideal. This should be available during the hot and dry periods of the year.

Water, as a solvent contain both dissolved and suspended matter. This dissolved substances are normally measured in terms of milligram per litre. Suspended materials includes organisms such as minute phytoplankton (plant) and zooplankton (animal), dead organic matter (detritus), living murobes (bacteria) and inorganic matter (clay and silt particles). Water quality requirement therefore varies with culture system and the particular environmental characteristics associated with fish being cultured in.each pond.

1.30 AIMS, OBJECTIVE OF THE PROJECT

CHAPTER II

2.0 LITERATURE REVIEW.

2.1 FISH AND BENEFITS TO MAN.

Fish are vertibrates (back boned animals) that live in water. There are more kinds of fish than all other kinds of water and kind vertibrates put together. Fish live almost anywhere where there is water.

Scientists believed fish are the first animal to have a backbone and that the first fish appeared on the earth about 500 million years ago (the world Book Encyclopedia Volume C 1993). From the smallest fish called Trimmaton nanus (Indian ocean 1 cm long) fish varies in sizes to the largest fish (whale shark of 12 m long, weighing twice as an elephant). There is also in existence the dangerous fish and the stone fish (with poisoneous spines that can kill a human being in a matter of minutes) to mention a few.

Fish benefit people in many ways. Fish make up a major part of the diet of the people in Japan and Norway. In other countries, people eat fish to add variety to their meats. Fish are also important in the balance of nature. Fish rank among the most nourishing of all foods. Fish flesh contains about as much protein as meat does.

2.2 Pond and Pond Life:

Pond is a small, quiet body of water that is usually shallow enough for sunlight to reach the bottom. Ponds have a great variety of animal and plant life. Pond animal may include, fish, frogs, insects, birds. Kinds of natural ponds include, alphine ponds, bog ponds, ice - formed ponds, meadow stream ponds, riverine ponds, sink hole ponds etc. Many farmers build a farm pond for flood control, recreation or to secure a supply of water.

2.2.1 Pond Life

Life in a pond are determined largely by the pond's soil, quality of water and location. Ponds consistantly undergo annual and long term changes. Water level normally rise and fall, because of rainfall. Many natural processes help to maintain ponds, for example, floods and the movement of ice may deepen ponds. Animal activities on the other hand can seriously harm ponds. The quality of a pond rapidly deteriorate when people fill it with rubbish or other wastes. (Encyclopedia Botanica 1970 Vol. 9)

2.2.2 Fish Pond & Kinds

The rearing of fish in a confined body of water is popularly called fish ponds, sizes varies between 0.4 to 0.8 hectares. Adequate of water supply is obtained from natural springs, streams, rivers, lakes, lagoons, tides etc which act as the source.

1 metre deep pond of about 1 hectare needs about 10 million litres of water, while 810,000 galons of water will be required for a 9.6m depth of 1 acre size of pond. (Swaingam, 1974, [illegible]).

Fish pond may be formed by natural conditions as highlighted above or man made. Two types of earthen ponds are used in warm water fish culture, dike ponds and hill ponds. Dike pond usually rectangular raised levels, have relatively level bottoms, while Hill ponds usually have one main level that dam a gully or valley.

2.3 Purpose and Value of a Pond

Farm ponds are built to store runoff water for many purposes. The water may be used for livestock, for irrigation, for orchard spraying, for fire protection, for raising fish and for boating and swimming.

Ponds are of limited value for flood protection, since they are kept nearly full and for ground water gain, because the pond bottoms must be essentially impervious to keep the water from draining away.

2.4 Requirements for a good Farm Pond

A farm pond should be located in a natural drain or on a hill side where enough good water can be expected to flow into it. The pond when filled should be at least 1.8m deep in 20% of the area. Ponds that are to serve as water supply for irrigation have to be fairly large. (Christoph W. 1985)

Ponds with shallow water encourages weed growth. The size of the water shed above the pond should be large enough to keep the pond fitted with water most of the time, yet not so large that there is frequent run off through the emergency spill way. The pond should be large enough to keep the pond filled through extended dry periods and small enough to avoid excessive siltation.

To have clear water flowing into the pond it is desirable to have much of the reservoir in erosion resistant land use such as forest, pasture or meadow. It is particularly important to have the lower reaches of the water shed just above the pond sod, so that erosional debris is filtered out instead of being carried into the pond. ("A guide to Construction of Fish Ponds" 1975, FMWR&R)

2.5 Selection of Site for Pond Construction

Selection of suitable site for the construction of pond depend on the following factors:-

i. Adequate constant level of water in the pond continually;

ii. Topography of the land. Site should be at lower level than the water source.

iii. Type of Soil. Impervious soil is advesable to be soil and clay combination.

iv. Type of vegetation of the site - to minimise cost of clearing. Since evaporation can be the cause of serious water losses, coniferous trees should surround the pond at a distance in order to reduce the wind movement over the pond. Deciduous trees are not desirable, because their leaves falling into the water would impair its quality. In no case should any trees be grown on the dam or near the spillway, because their roots would create seepage danger. (Helmut et al 1978).

2.6 Individual parts of a farm Pond

A farm pond consists of a reservoir that is to store water, a dam, a mechanical spill way, an emergency spill way, a stock watering trough below the pond and a fence to protect the pond.

A mechanical spillway is placed into the pond so that its intake to about 6.4m lower thant the emergency spillway. It consist of a concrete box that is connected to a pipe which leads under the dam and discharges the water in a spillway outlet made of concrete. From here the water is carried off in a sod waterway sometimes with a filter to provide water to a stock tank.

In order to avoid water over topping the dam, all emergency spill way of large cross-section must be provided for every farm pond.

2.7 Maintenance of Farm Ponds

Maintenance of farm ponds is necessary for a satisfactory performance of the same probably the most important item is to protect the emergency spillway from erosion. A farm pond for raising of fish if properly maintained can yield more meat per acre than a pasture. Such management includes the planting of the species of fish, the maintenance of enough water throughout the year, the protection of the water from mud and excessive growth of weeds and algae, the establishment of a desirable level of plant nutrient element in the water and last but not the least, the fishing out of excess numbers of fish, so that there will be enough food for the remaining fish to grow large.

The protection of the pond, the dam and their immediate surroundings from erosion of the watershed draining into the pond, spill way, seeping past the water pipe and removal of tree roots or animal burrows in the dam which are all causes of potential failure should be a routine affairs. (FAO Training Series 4, 1981).

2.8 Fish Pond, Sedimentation and Flood

One of the result of flooding is the filling up of reservoirs with excess water and dropping of part of soil particles and organic matters that the flood has carried due to the nearly still nature of the reservoir inside the pond.

The rate at which reservoirs are filled up with sediment depends on the type of flood, the contributing water shed, type of soil eroded, topography and the ratio between the size of the water shed and the volume of the reservoir. In some cases this may cause reservoir to be filled up completely with silt.

Sometimes the result of sedimentation is seen in the decrease of the bed/stream cross-sectional area and there is not enough space for the water in case of increased run off. The water flows over the banks flooding the low lands more frequently than when the channel is not restricted by sediments. ("Effective Water Mgt." Oct 1983)

2.8.1 Benefits and Damages from Accelerated Sedimentation

The filling up of reservoir and the resulting loss of capacity and usefulness of stream are serious effect of sedimentation. Ponds are always placed in the most suitable and most economical location and once they are filled up, an irreplaceable asset will be lost, since feasible methods to remove the sediment from a filled up reservoir is costly and tedious.

2.9 Present Status of Fish Culture

Fish culture involving the practice of rearing selected varieties of fish in a confined body of water popularly called fish ponds maybe on a small scale with few ponds covering a small area and often referred to as home-stead ponds.

This ponds are generally family owned and bring in a second income to the owner . On the other hand fish culture maybe on a large commercial scale covering a large area and made up of many ponds when the set up is often referred to as fish farms. Most of the existing fish ponds and farms are at present either government owned or private but constructed with government assistance.

The management of ponds is divided into three groups

(1) Extensive (2) Semi-Intensive (3) Intensive

In Extensive pond fish are kept entirely without supplementary feed, relying completely on the pond fauna and flora. The productivity of these ponds can be improved by the application of fertilizer or manure. Extensive carp farming in Europe serves as an example.

Semi-Intensive pond management is the most widespread, and here fish receive supplementary feeding. This type of management is illustrated by the practice of carp farming in South East Asia.

In Intensive fish farming all feed is supplied artificially and the management of oxygen levels in the water is the predominant factor. This is the first step towards industrial production method offering several advantages. Hygience can be improved because cleaning is easier, while water, oxygen and the feed can be controlled by using mechanical or automated equipment.

2.10 Water and Fish (Pond Culture)

According to Hay (1984) of U.S Fish & Wildlife Service Washington DC, water of good quality in adequate amounts, and clay soils that retain water, are the basic requirements for pond culture.

Water serves as medium for waster discharge and reproductive of fish, pronds food and oxygen for fish. Ponds for fish may also be constructed to provide water for crop irrigation. Livestock recreation as well in the modern day setting yield substantial qualities of fish for home use.

2.11 Specific water quality of Pond Culture

For fish pond culture, water must be sufficient in amount and quantity. Quantity of water good for fish culture are unpolluted, rich in oxygen, slightly alkaline and free from Agricultural pesticides. (Craig, 1993)

Suspended Solids and Turbidity have adverse effect on fish (reduce the abundance of natural food available to fish), while an average temperature of between 25°C - 30°C is required with PH range of 6.5 - 9.0 highly recommended.

Ferrous Iron dissolved in water of amount exceeding 0.5ppm can reduce fish growth and are often lethal to small fish. Ferrous Iron can also be detrimental to fish when it precipitates by blocking the gills of fish, thus suffocating them.

Nitrate concentration as low as 3ppm can adversely affect fish growth. This is done when completed with the hemoglobin in fish to form methemoglobin. This reaction reduces the oxygen carrying capacity of the blood.

Hydrogen sulphide is a problem on production ponds in which fish are heavily fed. It develops when uneaten feed, feaces etc decompose in the oxygen free environment (rotten egg odour).

2.11.1 Dissolved Gases

Oxygen content should be regularly monitored in fish culture because it is required for the existence of fish and other via culture life, . . Adeniji (1986) said its presence in good quantity in the culture will improve the water quality in the culture by oxidizing poisonous gases e.g. H_2S, NH_3 etc into their non poisonous forms. 5mg/Litr dissolved oxygen is the minimum required to sustain fish life in a culture.

2.11.2 Dissolved Solids

Total Dissolved Solids constitutes the total amount of material by weight, dissolved in a given amount of pond. Much of the materials consist of electrically charged molecules of ions with paired positive and negative ions. Several common forms called salts, includes table salts and chemical fertilizer to mention a few. The total weight of the dissolved ions in a unit volume of water is termed salinity expressed as parts per thousand. Many fresh water fishes grow poorly or die at salinities greater than 5.0ppt.

2.11.3 Temperature

The most important gas dissolved in water is oxygen. It's solubility like that of other gases, varies immensely with temperature and altitude e.g water can hold 9.2ppm of dissolved oxygen at 68°f but only 7.6ppm at 86°f. Fish growth and activity are directly related to water temperature.

If water contains more of a dissolved gas than normally present at a particular temperature, the water is said to be super saturated with gases. The most common form of super-saturation dissolves Nitrogen. Such super-saturation develops where there is a great deal of turbulence in water. Well water are sometimes super saturated with Nitrogen and when fish absorbs this into their blood stream it often followed by death.

2.12 Fish Production & Pond Preparation

Increase production requires more feed only about 50% of the feed is converted into fish flesh. The non draining technique will probably increase desease problems associated with water quality. Correct pond preparation is essential therefore to fish survival at stocking and to late water quality management.

2.13 Causes of Fish Pond Pollution

Pollution in a body of water is caused by the introduction to it of objectional material. Pollution may be natural or artificial, i.e result of man made activities. Natural is related with adverse weather conditions, flooding, e.g so that it deplete the excessive organic load, and the dissolved oxygen content to the point that the stream or pond becomes incapable of excercing the self-purification process. The deoxygenation maybe sufficient to destroy practically all the fish and other aquatic life.

Impurities in water may be classified as follows; physical e.g taste, colour, odour and turbidity (suspended clay and silt not only muddy in the water, but at high level damage fish gills. They also interfere with penetration of sunlight necessary to permit photosynthesis by phytoplankton (ie. algae and diatems) which is indispensable in pond system because it produces most of the oxygen used by the fish.

Chemical impurities includes inorganic or organic and bacteria i.e pathogenic or disease - producing type of bacteria. Some surface water may contain wild or fresh fish or their eggs. These fresh species are predatory and many carry disease organisms. Many surface water contain pesticidess and other contaminants that can kill fish or render them unacceptable for consumption. (Duggul, 1993)

2.14 Flood and fish pond & pollution

Flood is the rise of the waters of a natural stream above a level associated with the beginning of damage. Damage stage occurs when the stream or pond is bankfull, when channel is completely occupied. Beyond this overflow occurs.

Flood plains occurs from narrow marginal width to an extensive pond channel. Excessive rain caused floods of great damage to fish and fish pond embarkment. The encroachment of community development on the natural channels, concentration of run offs from a moderate storm or rain concentration within short storm period.

2.15 Flooding and Nigeria Setting

Flooding occurs throughout Nigeria in three main forms. Coastal flooding, river flooding and Urban flooding - (Sustainable water shed mgt, FMWR&RD 1998).

Coastal flooding occurs in the low-lying beet of mangrove and fresh water swamps along the coast.

River flooding occurs in the flood plains of the larger rivers, while sudden, short lived flash floods are associated with rivers in the inland areas where sudden heavy rains can change them into destructive torrents within a short period.

Urban flooding in towns located on flat or low lying terrain especially where little or no provision has been made for surface drainage, or where existing drainage has been blocked with municipal waste refuse and eroded soil sediments. Extensive urban flooding is usually the result of the annual rainy season in Lagos, Port-Harcourt, Ibadan, Aba, Warri and Maiduguri.

2.16 Economic and Social consequences of fish pond pollution

Apart from health hazard and sanitary nuisance, water ponds pollution leads to severe economic and social consequences such as the destruction of fish life, by poisoneous substances or excess organic loads that reduce the dissolved oxygen, destruction of structures leading to loss of resources, effect of flood through erosion affecting the water bodies the critical levels or impaired the chemical content of the water, sometimes render the water unsafe for recreational activities, swimming etc. Individuals affected by the results include fishermen who may lose their source of earnings etc.

About 6,600 hectares of fishery and aquaculture have been affected by industrial waste in China, covering fish ponds in Tauguan Irrigation District and coastal fishery along the extreme of WU, Peikeng, Pecheg, Chishu etc. The consequences of this is even greater in terms of health hazard to human being. Ear Quano et-el (1978)

2.17 Principles of Water Pollution

Water pollution control is based on the principles that

(1) Water is polluted when its quality has been altered by the

activities of man to such a degree that reasonable present and prospective uses as designated by public authorities are impaired.

(2) The objective of pollution control is to protect designated uses. (Diamant . 1978).

2.18 Water in its pure state.

Pure water is made up of two atoms of Hydrogen (H_2) "attached" to one atom of oxygen (0) known as one molecule of H_20 to chemist. For water is a chemical - tasteless clear, odourless and colourless.

It is perhaps fortunate for us that water is not pure for the normal drinking water contain several minerals and salts, such as iron (fe), manganese (Mn) calcium (Ca), magnesium (mg), sulphate (So_4) and flouride (f) as well as gases such as carbon-dioxide (Co_2) oxygen (O_2) and Nitrogen (N). Many of these minerals are lacking in our everyday life, but they are essential for health and proper growth of our bodies. (Dennis 1994)

Though water provides these minerals, their proportions have to be carefully watched as indeed does the possible content of large quantity of this minerals and harmful bacteria is a threat to human life.

2.19 Pollution and fresh water fish

Pollution has occured when we are prevented from deriving maximum benefits from our fresh water because they contain un-acceptable levels of chemical or heat derived from man's or climatic activities. This benefits as defined in the UK involve a series of uses including:-

(1) Direct abstraction to portable supply of water

(2) Food for human consumption derived from fresh waters.

(3) Protection of fresh water fish, protection of aquatic life etc.

2.20 History of determination of water quality

Public concern about the determination of the water quality of our rivers began to be voiced in the mid-19th century and in the UK a series of royal commission was appointed to assess the situation and to make recommendations which could be translated into legislation.

It may seem strange that a century of such earnest endeavour to protect the quality of our surface waters produced so little in the way of apparent beneficial results.

According to Turing (1952) as re-visited by Richard (1992) a river was considered by the general public even in 1950 to be polluted only if it was a public nuisance, that is, if the water was unfit to drink or offensive to senses of sight or smell. The presence or absence of fish was not generally seen to be important, even though there was specific legislation to protect these species.

2.21 Fish growth and physical variability.

2.21.1 Fish growth and temperature variability

Temperature influence both ingestion and metabolism and in turn affect fish growth rates. This growth of fish can be related to food supply and temperature changes.

Under conditions of unlimited food supply an increase in temperature will lead to an increase in food intake, but at high temperature there will be an abrupt decline in rates of ingestion. Metabolism rate usually increase with increasing temperature.

Research has shown that frowth of fish increases with increasing temperature peaks, and then declines at high temperature. The temperature at which growth is maximised is called the optimum temperature for growth and should be noted that this optimum temperature is a few degrees lower than the temperature at which food intake is greatest. The term optimum temperature for growth should only be used when describing the results obtained in studies in which fish have been fed maximally, because restricted feeding will have a marked influence upon the growth rate observed at any given temperature (Malcolm 1994).

2.21.2 Oxygen availability and fish growth

The metabolic rates of well fed fish are higher than those of starving fish; Rates of oxygen consumption increases as the feeding conditions of the fish improved. When the level of dissolved oxygen in the water is low, food intake may be suppressed and this is thought to be due to the fact that reduced oxygen availability would be unable to support the high energy demands of well fed fish.

A reduction of food intake at low levels of dissolved oxygen would obviously have consequences for growth. A number of authors have stated that an oxygen concentration of 5mgl is the critical level for food intake and growth of a range of fish species, but other literature seems to differ, believed it depends on the rearing conditions whilst the oxygen concentration determines the volume of water that must be pumped over the gills in order for the fish to obtain a given amount of oxygen. The rate at which oxygen will diffuse from the water to the blood will be dependent upon the oxygen tension. This oxygen tension is also an important factor determining the performance of the fish.

The degree of oxygen saturation of the water can be taking is giving an indication of the oxygen tension. It may be equally if not more appropriate to use oxygen saturation (% saturation) rather than concentration (mg-L) as a criterion when examining critical oxygen requirements for growth. It is to be noted that under different experimental condition, e.g fully saturated fresh water has a dissolved oxygen concentration of 12.72mgL^{-1} at 5^{o}C. So a 5mgL^{-1} critical level of dissolved oxygen would represent 39% saturation i.e (5/1272)x100) at this temperature, but the same critical concentration would however be equal to 61% saturation ((5/8.24) x 100) at 25°C. So extreme condition should be exercised in both preservation and interpretation of result.

2.21.3 Co_2 and fish growth

Co_2 itself is seldom toxic to fish, but high Co_2 concentrations decrease the efficiency of oxygen loading by hemoglobin and the combination of high Co_2 and low O_2 can stress fish severely. This stress can result in death by suffocation, and increase susceptibility to disease or decreased growth.

2.21.4 Nitrogen and fish growth

Nitrogen is an essential element for all living organism because it is contained in protein. But certain Nitrogeneous compounds are detrimental to some aquatic system. The three principal forms are Nitrogen, ammonia of No_3 and No_2.

Introduction of Inorganic fertilizer and excretory products of aquatic organism, protein in the feed atmospheric oxygen are all source of Nitrogen in the pond.

2.22 Collection of Water Sample Procedures

In ponds lakes and flowing water. It is best to collect sample from several location and from various depths.

This samples are only acceptable when they are collected from parts of in and out flow for best result. Where it is suspected that waste water is being discharged, it is important to collect a minimum of three samples:

(i) from the suspect discharge area

(ii) polluted water down stream

(iii) unaffected water upstream

2.23 Precaution in taking readings and sample

(1) If more than one site is sampled, the averages for each site should be summed and averaged and the overall averaged. is taken.

(2) Reading should not be taken beneath a heavy blanket of blue green algae or near healthy, rapidly growing rooted aquatics, because reading there are unrepresentative.

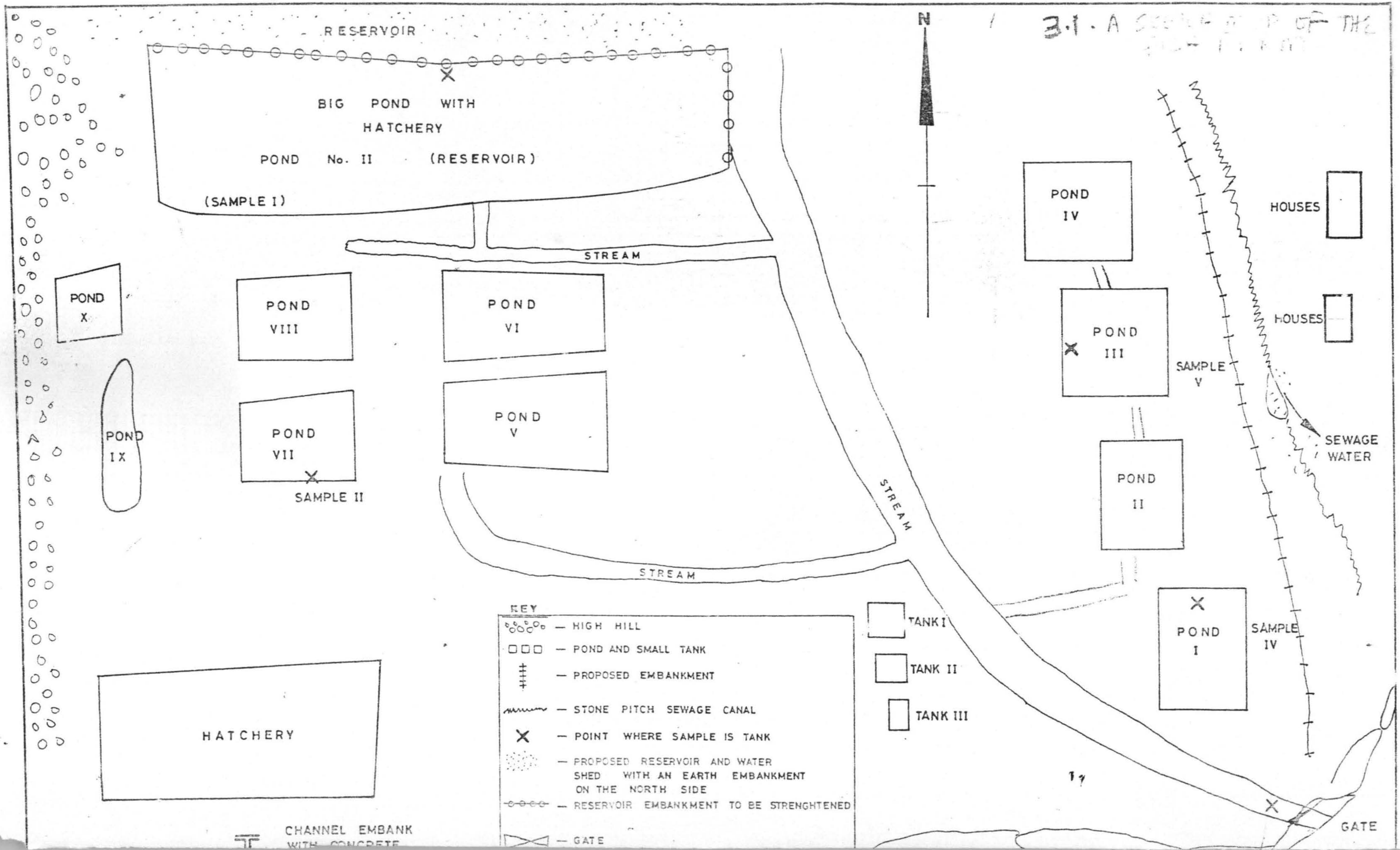
2.24 Development of Water Quality Standards to protect Fish

As far as some of the common polluting chemicals are concerned, identifying the concentration of a given chemical which if exceeded, will cause harm to fish, is not a simple matter. There are many factors that can affect the toxiaty of chemicals and these have to be taken into account, not only in the design of the experiment and the reporting of results, but also in the formulation of water quality standards to protect fish.

In 1960, the Food and Agriculture Organisation of the United Nations set up the European Inland Fisheries Advisory Commission (EIFAC) as a regional body, and, in response to the recognized need for the effective control of pollution to protect fisheries, a working party on water quality formed in 1962 agreed that

> Water quality criteria for fresh water fish should ideally permit all stages in the life cycle to be successfully completed and, in addition, should not produce conditions in a river water which would either taint the flesh of the fish or cause them to avoid a stretch of river where they would otherwise be present, or give rise to accummulation of deleterious substances in fish to such a degree that they are potentially harmful when consumed.
> (RICHARD . 1992)

FIG 3·1 – A SKETCH MAP OF THE FCT FISH MODEL FARM



CHAPTER THREE

ANALYTICAL METHODOLOGY

3.1 - A Sketch map of the fish farm.

3.2 - Description of the Area

The farm is located in the green belt area of the FCT, between Area 8 junction and Area 11 boundary of the Garki 1 District. Because of the strategic location of the farm within the city with his entrance route through Nguru Close makes it a possible tourist attraction if fully developed and managed. The farm is about 130 meters from the popular Obafemi Awolowo Road with a square meter of 4.565 in size.

3.2.1 SURROUNDING FEATURES

Farming activities are going on at the North and West side of the site. Diversion of the sewage water is by the East, close to the natural stream supplying the ponds with water.

There is evidence of erosion and flooding on the East side of the relatively flat land, probably due to mis-use to improper management of land use and encroachment of structures.

3.2.2 TYPES OF EMBARKMENT

The fish ponds are earthen with an earth reservoir embarkment. While the stream channel (main channel) across the farm is lined with concrete structures at about 15m before the intake into the pond only.

3.3.0 Methodology

This involve taking of water samples at five fish pond of choice after a careful selection to have a representative sample for laboratory water quality test of the chosen fish pond.

Five water samples are taking separetely three times viz October, 1999, January & April, 2000 respectively.

(i) First in October at the end of the flood, or later part of the raining season, to assess the effect of flood and too much water (dillution) on the fish pond water quality.

(ii) Secondly in January at the peak of the dry season to assess the changes that may have occurred in the pond water quality as a result of draught.

(iii) In April, at the beginning of raining season to assess the rate and impact of early rain drops on the ecosystem of the fish farm, and the resulting flooding due to the energy force of water erosion.

The above procedures are carefully selected based on the hydrology of FCT, flooding period of the pond, and other considerations based on the cost of test, time factors, equipment, available date on the field etc necessary to obtain the best possible result.

3.3.1 Sampling test technique

Sampling is a process of extracting from a large quality of samples (in this case the fish pond) a portion which is a true representative of the whole composition of the sample since the purpose of the analysis is to determine the quality of water pond, the following procedure was followed.

(1) Five bottles for collecting the water sample of 1 litre capacity thoroughly washed with detergent and rinsed well with water was prepared.

Each of the containers were rinsed again on the site with the sample intended for the work two times before it was filled. This was done in order to prevent external pollution/ interference.

(2) Representative samples of five pond intended for sampling were obtained by dipping it into the pond 20cm below through the aid of the rope tied on the bottle container drawing it with care not to allow particles to get inside and exclude air bubbles and the bottle is closed while still submerged.

(3) Collection of samples was carried out on the same day at five different point viz, 3 fish ponds, the big reservoir and stream water source on the same farm. This point were carefully selected after careful research and recognissance survey of the area to serve as the true representative of the fish farm (see Diagram 3.1) Samples of water in the ponds are collected from points of in and outflow.

(4) Two sets of analysis were carried out on the site at the spot of collection. The analysis were those of the temperature, odour, turbidity and general observation. Every sample collected was

3.7 TEMPERATURE DETERMINATION

PRINCIPLE: Response of a mercury to the change of temperature of the environment.

APPARATUS: MERCURY thermometer and thermometer casing.

PROCEDURE: The Thermometer sensing edge was plunged into the pond to be analysed off a depth of 20cm below and the corresponding reading was taken. (see table 4.1 for result).

3.8 Measurement of Turbidity

PRINCIPLE: Measured by the absorption of light passing through water. Is closely related to total suspended solids. Light penetrated only a short distance in highly turbid waters.

Procedure - If the thermometer sensory point attached with measuring rate dip into the water pond cannot be seen at depth of measurement (i.e depth at dissappearance from view). (See table 4.1) for result.

3.9 TYPES OF TEST CARRIED OUT IN THE LABORATORY

AQUAMERCK - COMPACT LABORATORY FOR WATER ANALYSIS WAS USED (RAPID ANALYTICAL TEST SYSTEM) THE TEST CARRIED OUT WAS EITHER TITRIMETRIC & CALOMETRIC TESTS. AQUAMERCK WATER ANALYSIS WATER KIT & MANNUAL WAS USED.

Test on PH, Ammonium, Nitrate, Nitrate are base on calorimetry. This method is used by the researcher because it allows turbid or discoloured water to be tested.

3.10 GENERAL APPARATUS USED

(1) PIPETTE

(2) PLASTIC TUBE

(3) SCREW CAP

(4) SEAL

(5) BOTTLE

(6) DROPPING TUBE

(7) BUCKET

(8) BRUSH

3.11 GENERAL PRECAUTION TAKEN IN THE LABORATORY

(i) Dropping bottles are kept vertical and drops are released slowly (at a rate of approximately one drop per second) to have a standard size drop and right amount of reagent.

(ii) Reagent and water samples are properly labelled.

(iii) The shelf kit use shelf life has not expired.

3.12 DETERMINATION OF PH

The PH of a water sample is a measure of its hydrogen ion concentration.

METHOD USED: calorimetric determination with mixed indicator.

Principle of the determination

An indicator added to the water sample changes colour according to the PH of the sample. The PH can be rapidly and accurately measured by matching the colour against a comparison scale.

Procedure: Aquamarck water analysis manual was used.

Dropping tube was rinsed with the sample water and filled with 5ml of sample, to which two drops of reagent (PH Indicator Solution) was added, closed and shake briefly.

Both tube were inserted in the comparator and place in the colour scale until the sample plus reagent matches a colour under and the value shown at the top of the comparator is then recorded.

3.13 Determination of Ammonium

Ammonium/ammonia, nitrite and nitrate are typical pollution indicators.

Principles of the determination

In an alkaline medium ammonium reacts with a chlorinating agent to form Mono Chloramine, which reacts with Thymol to form $2,2^1$-180 propyl $-5,5^1$-methlindophenol.

Method - Colorimetric determination by the Indophenol blue method.

Procedure:

- Both tubes were rinsed with the sample water and fill both with 5ml of sample.
- 12 drops of reagent 1 was added to the tuner tube and shaken briefly.
- A level microscopful of reagent 2 provided was added to the Inner tube, closed and shake to dissolve.
- Four drops of Reagent 3 provided was added to the Inner tube closed and shaken briefly
- Both tubes were inserted in the comparator and place onto the colour scale
- After seven minutes the sample plus reagent is compared with the comparator and the value is recorded.

3.14 Determination of Nitrite

Principle - Nitrite detection and determination is based on calorimetric determination with sulfanilic and/W-(1-Naphthyl) ethylene diammonium chloride.

Procedure:

- Both bottles were rinsed and fill with 5ml of sample
- Five drops of reagent 1 was added and shaken briefly.
- Microscoopful level of reagent 2 was added to the Inner tube and shaking briefly until dissolved.
- Both tubes were placed in the comparation and place in the colour scale after 1 minute, matches are made and the values are recorded.

3.15 Determination of Nitrate

Method: Reduction of Nitrate to Nitrite and formation of an azodye with sulfanilic/gentisic acid using calonmetric determination.

Procedure

- Both tubes was rinsed with the sample water and fill with 5 ml of sample.
- a level microscopful of reagent was added closed and shake until dissolved.
- 2 level microscopful of reagent 2 was added and shake for one minute.
- comparator was used to match the colour after five minutes, reading was taken (See table 4)

3.16 Total Hardness Determination

Method: Complexometric titration with Titriplex III against mixed indicator.

Principle of the Determination: Titrant solution is added dropwise to a water sample containing an indicator which changes colour.

Procedure

Measuring vessel was rinsed with water sample and fill to the 5ml mark.

- Three drops of indicator solution was added and shaken the sample turns real in the presence of hardening constituents.
- The titrating pipette is attached loosely to the Titrant solution bottle and fill the dropping tube by slowly retracting the plunger until the lower edge of the black plunger seal is level with the 0°C mark on the scale.
- The titrating pipette is briefly removed stroking the tip of the dropping tube. Titrant were added dropwise to the prepared water sample until its colour changes from red via grey violet to green.
- Record of the total harness of the water was done.

3.17 Determination of Carbonate hardness (CH)

Carbonate hardness (or acid binding capacity, ABC) means the number of one of 0.1 mol/LHCL which is required to titrate 100 ml of water to PH 4.3.

Principle of Determination

Titration of the water sample with hydrochloric acid against a mixed indicator (end point PH 4.3)

Procedure

Measuring vessel is rinsed with the sample and fill to the 5 ml mark with the sample.

Three drops of indicator solution was added and swirl until dissolved. The sample turn blue in the presence of hardening constituents.

The titrating pipette is filled with the titrant solution, briefly stroking the tip of the dropping tube, titrant is added dropwise to the prepared water sample until its colour changes from blue via grey-violet (just before the end point) to red. Swirling the measuring vessel while doing this.

The carbonate hardness is recorded in and the ABC value in mmol/L from the scale on the titrating pipette.

3.18 Oxygen Determination

Principle of determination

The winkler method is used.

Manganese II ions react with dissolved oxygen in an alkaline medium, and are oxidized to higher - valence manganese hydroxides.

Manganese (III) ions are formed in a strongly acidic medium.

Manganese (III) ions oxidise iodide ions to elemental.

Iodione: This liberates an amount of iodide equivalent to the oxygen in solution. The iodine is then titrated with sodium thiosulfate.

Procedure -

Glass bottle is filled to overflowing with water sample, avoiding excessive turbulence and taking care not to trap any air bubbles.

Five drops of reagent 1 and five drops of reagent 2 are added, the bottle is stoppered, shaking and set aside for one minute well closed.

Ten drops of reagent 3 added and re-stopper & shaken well. The measuring vessel is rinsed with the solution and fill to 5ml mark. One drop of reagent 4 is added and shaken well. The solution becomes violet to blue depending on the oxygen content.

The titrant solution is filled with the reagent 5r briefly stroke on the tip of the dropping bottle, and titrant is added dropwise to the prepared water sample until its colour changes from blue to colourless, swirling the measuring vessel while doing this. The oxygen content of the water in mg/l on the scale of the titrating pipette is recorded (See table 4.1 & 4.2)

3.19 Possible Source of Error

Colour Comparator

- Colour comparator of the researcher is an accurate only to the researchers point of judgement (and eye sight).

- Perfection test is to the perfection of the researcher.

Resource Limitation - This relates to the availability of other sampling materials, laboratory equipment, analytical facilities & funds.

Time of Analysis - The time of carrying out the analysis, month, and season may definitely affect the type of result gotten.

NOTE - Knowing before hand the possible sources of error as highlighted above, care has been taken at various point during the research to minimise and reduce the possible source of error to the acceptable limit in such a way that it wil not affect the final total output/outcome of the research.

CHAPTER FOUR

4.0 Experimental Results and Discussion

The report and result of the test carried out on the fish pond water sample taken in MFCT Model Fish Farm Mark 1 are presented in tables 4.1 to 4.3 below:

Table 4.1 Result of test on Water Pond Sample collected on October 27, 1999 and analysed the same day.

Sample No.	1	2	3	4	5
Time Taken	10.11 am	10.50 am	10.35 am	11.05 am	11.25 am
Location or Site Description	Big pond with Integrated Poultry - 1 ha in size	Pond No. VII (See diagram 3.1 Size $150m^2$)	Source of water to the Fish Pond (Near the gate) See Diagram 3.1 1 m in breadth	Pond No. I See 3.1 0.08 ha in size	Pond No. III See 3.1 0.1 ha in size
PH	7	7.2	6.5	8	7
Temperature°C	28.3°C	28°C	25.5°C	28.5°C	28°C
Turbidity (CM) (Clearity)	Water clear up to 30cm below	Clear up to 28cm below	Clear up to 40cm below	Slightly clear up to 15cm	15cm below
Odour	Odourless	None	Normal	tasteless & Odourless	none
General Observation & Point of water sample taken for observation	Water slightly yellowish leakages seen at the extreme north of the pond. Pond fill to capacity	Water sample taken at the outlet of the Pond	Inside the stream, just at the edge of the gate	Outlet	Side way

Sample No.	1	2	3	4	5
Nitrate No_3 mg/L	0.2	0	0	1	0
Nitrite No_2 in mg/L	0	0	0	0	0
Ammonium	0	0.09	0	0	0.1
Free Ammonia (% of total Ammonia at PH values	1%	1.2%	.5%	4%	1%
Oxygen concentration 0_2 in mg/L	14.4	26	16.8	2.5	26
CH - Carbonate hardness (ABC) MMOI/L	1	0.9	.8	1.2	1.6
Total hardness MMOI/L	0.4	1.45	.21	.35	.4
Co_2 Carbon, dioxide in mg/L	12	6.75	29.6	7.44	19.2 *

* See Appendix E. Table five, (Factor table for calculating Dissolved Co_2 from a number of PH Values.)

Table
4.2

Result of test on water pond sample collected on January 26, 2000 and analysed the same day.

ample No.	1	2	3	4	5
ime taken	10.28 am	10.55 am	10.43 am	11.11 am	11.03 am
Location or Site Description	do as in 4.1	do	do	do	do
PH	7	7.5	6.5	7.5	7
emperature °C	26	25.5	23.5	26.5	25
urbidity	mediumly turbid	fairly clear	settled particles	moddy	fully filled with particles
dour	Odourless	-	Odourless		unobjection able
eneral Obser-ation/point of ater sample ken for obser-ation	Clear water	WaterSample taking at the outlet	Reduced flow & water depth	Water Brackish in colour Reddish Brown down side	Water Sample taken by the side
itrate O_3 Mg/L)	0	0	0	0	0
itrite O_2 Mg/L)	-	-	-	-	-
mmonium Mg/L)	0	0.2	0	0	0
ree Ammonia of total mmonia at PH alues	1%	2%	.5%	2%	1%

ample No.	1	2	3	4	5
xygen oncentration $_2$ in mg/L	18	16.8	24.8	27	18 *
H - Carbonate ardness ABC) MMOI/L)	0.9	0.6	0.7	1.0	1.7
otal Hardness MMOI/L	0.8	1.5	0.5	1.3	1.2
CO_2 Carbon dioxide in mg/L	10.8	2.22	25.9	3.7	20.4 *

See Appendix E Table Five

Table 4.3 Result of test on water pond sample collected on 27th April, 2000 and analysed the same day.

mple No.	1	2	3	4	5
me taken	10.43 am	10.25 am	10.10 am	10.18 am	10.35 am
ocation or ite Description	do as in 4.1 & Diagram 3.1	do	do	do	do
H	7.5	7	7.2	8.5	6.5
emperature °C	29	29	27.5	30	26
urbidity	Not turbid	moody water	full of particles	high	low
dour	normal	normal	normal	normal	smelish
eneral Obser- ation & point f water intake or analysis	Pond ripples is beautiful to watch. Clean and fill		The stream is bushy and road path was cleared before water samples can be taken	Pond fill to capacity	1 had to clear up to 5m to gain entrance into the pond. Fingerlins(Tilapia were seen in large numbers
trate ^{3} mg/L	20	10	0	2	4
trite O_2	0.05	0.025	0	0.09	0
monium mg/L	0.3	0	0	0.1	0.2

Sample No.	1	2	3	4	5
Free Ammonia % of total Ammonia at PH Value	2%	1%	1.5%	11%	15%
Oxygen concentration O_2 in mg/L	27	26.8	10	27.5	17.3
CH-Carbonate hard hardness (ABC) MMOI/L	0.7	0.6	1	0.8	0.85
Total hardness MMOI/L	1.8	3.5	4.2	1.5	1.2
Co_2 Carbon dioxide in mg/L	2.59	7.2	7.5	.8	31.45 *

* - See Appendix E table five.

4.4.0 Discussions of Results

4.4.01 Comparism of PH: Between result obtained, the acceptable standard and differences/changes in Oct 1999, January and April 2000.

Range	Result obtained	Ideal PH for fish survival	Fluctuation
October	6.5 - 8	6.5 - 8.0	-
January	6.5 - 7.5		-
April	6.5 - 8.5		+.5

Table 4.4.01 shows the result from PH determinations.

From the comparism in table 4.4.01 above, it was observed that the PH Values of result obtained falls within the acceptable standard except for sample four in April with the PH of 8.5.

In Sample Four, the water pond with PH 8.5 is basic in nature (probably due to dissolving time/salt). The consistency of PH result obtained in Oct 1999, January and April 2000 can also be seen from the table.

4.4.02 The physical Appearance.

The physical appearance of all sample tested as presented in Table 4.1, 4.2 and 4.3 are fairly good for fish survival based on acceptable standard, though there seems to be a progressive change of appearance of water ponds samples collected in the month of January and April 2000 which revealed the presence of suspended particles to moody water.

The particles red in colour affect the colour of the water and its turbidity. (See Appendix table VII). The early rain of April must have carried along with it the suspended particles to pollute the water.

4.4.03 Temperature Measurement

Oxygen saturation is a function of temperature. (See Appendix H table VIII).

Fish can live at temperatures of between 0°C and approximately 40°C. Though the upper limit varies from species to species. The temperature recorded ranges between 25°C in sample 5 of January 26, 2000 to the highest .30°C in sample 4 of 27th Apri, 2000.

Sudden changes of temperature may have a damaging effect on all species of fish, though the species of fish in the pond in consideration (Tilapia, Carp etc) can survive within the range.

Generally the temperature of water samples collected in October 27 1999 is high in comparism to that of January 26, 2000. Water Samples collected and suddendly rise again as we approach April as seen in table 4.3 temperature datas of same water pond samples colelcted for analysis. The temperature changes is understandable because of the seasonal temperature changes variation.

4.4.04 Oxygen Content analysis

Result of oxygen concentration in mg/L of the water sample tested in Oct, Jan and April show super saturation of waterwith oxygen. The range of 10 - 27.5 mg/L recorded falls above 10 mg/L acceptable saturation level. (See Appendix Table VI). The reason could be due to constant flow of water into the ponds from the stream and release of excesses through the exit provided in the ponds must have accounted for aeration through self purification processes.

Determination of acid binding capacity is particularly important in water providing a habitat for fish, because the viability of water is directly related to its ABC.

Table 4.4.14
(Acid Binding Capacity)

ABC	Viability of Water assessment	Classification of Samples Analysis Oct 99	Jan 2000	April 2000
≮ 0.5	Poor	-	-	-
0.5 - 1.5	Moderately viable	1,2,3&4	1,2,3,&4	1,2,3,4,5
> 1.5	Viable	5	5	-

See Appendix G Table VII

4.4.15 - Total hardness

Total hardness reveals the sum of calcium, magnesium, strontium and barium hardness.

Sample Two shows consistency of hardness of over 1 MMOL/L of the water samples collected and taking for analysis in Oct, Jan & April 2000 respectively.

All Samples taken for analysis in January 2000 shows an increase in total hardness over October 1999 water samples and minimum of 100% in increase in April 2000 for Samples 1,2,3, with only Sample five remaining stable. But it is still within the acceptable limit.

4.4.20 - Field work Result & General Remarks on the state of the Fish Farm

4.4.21 <u>POND EMBARKMENT</u>

It was observed that ponds lack proper embarkment and some pond dykes are below the required height and during high rainfall, ponds get filled up causing stocked fish to escape, predators and unwanted species to enter and cause havoc.

Rats and crabs cause great harm to pond dykes by making holes, which allows serious leakages which endanger the stability of the dykes.

4.4.22 Occurrence of Flash Floods

Heavy rainfall is experienced between August and September and stormy rainfall in April/May brings about a seasonal torrent which converge with excesses of rainfall over-loading the gentle topography with water producing floods. The flood is pronounced and could be due to misuse of land in the vicinity.

4.4.23 Filling up of Reservoir due to sedimentation

The filling up of reservoir and the resulting loss of pond capacity, usefulness of stream are observed. The increase in flash flood and erosion increase sedimentation and the soil is deposited in or near the stream, ponds, under undisturbed natural conditions.

Since the stream channel is covered by vegetation the river bed builds up quickly with coarse material that cannot be washed away.

CHAPTER FIVE

5.0 Conclusion and Recommendation

5.10 - Conclusion

The laboratory and field work result obtained from the analysis carried out on the water samples and observation made on the field are used to draw up some possible conclusion.

Fish pond No. 1 (See diagram 3.1) tend to record high PH. Since there seems to be an infiltration of effluent from ready-mixed concrete plants as construction is going on very close to the pond, coupled with the fact that it's the only pond that is not directly being sourced from the stream.

The progressive change of appearance of water pond recorded in October, January and April shows that flooding of the pond is not mainly the course but a natural discolouration and turbidity that sometimes occurs and does not in itself imply that the water is polluted.

Low temperature recorded in the month of January only shows that the cold environment in January affected the fish pond water temperature.

Oxygen content which is required in all fish pond to sustain fish life is acceptable, this is favourable for fish growth and survival.

Nitrite level in April especially in fish pond No. 1(water sample four) is high and could be harmful if allowed to continue to fish survival.

5.20 Recommendation.

Only few fish pond farms exist in Nigeria as at today and so the need to maintain, preserve and sustain FCT fish model Hatchery/ Farm situated in Garki for the benefit of research, production of fingerlins, extension and development of the fishery sector.

With the result of test carried out presented in table 4.1, 4.2, 4.3 and the various arrived conclusions in 5.1, and the state of the fish farm, the following immediate steps is recommended to rectify various anomalies detected and discovered in the course of research.

(1) The immediate surrounding of fish pond one (No.1) should be cleared and prevent infiltration/run off from the construction site nearby. The high PH recorded could damage skin and gills of fish. So for immediate remedy, complete draining of pond and replacement of pond with fresh water is advisable. The addition of soda-ash (Na_2Co_3) could also be added to correct the PH level.

(2) The fish pond (No. 1) should not be allowed to be static. It should be connected to the streams nearby and allow for natural breathing (inflow and outflow processes).

(3) The existing pond dykes should be repaired immediately, periodically, spots should be properly repaired with binding clay. The heights should be raised and be kept at 1 m minimum above the maximum water level while the top width kept at minimum of 1.5m with 2.1 stope (horizontal: vertical).

(4) Flow water from the surrounding environment should be diverted round the eastern side of the pond through dredging, channel improvement and diversion weirs.

(5) Flood plain zoning should be done at the north side of the farm which should include storage reservoirs to control flooding of the pond.

(6) Since topography is not suitable at the Western side for the construction of a diversion channel, the areas should be covered with earth, levelled thoroughly rammed and grass turfed to increase infiltration of water into the soil.

(7) The emergency spill way provided for the ponds should be made of masonry or concrete. It's overflow elevation should be between 3 and 6m above the intake of the spillway.

(8) Leaves should be placed next to streams in order to confine the flood flow to a restricted position of the bottom land and to protect the rest of it from innudation and from sediments.

(9) The stream channels should be stone-pitch completely from 6m entrance into the farm to about 6m outlet from the farm.

(10) Soil conservation techniques practices is advisable in the surrounding areas to protect the green belt areas that has already been encroached with structures, misuse due to improper planning and management.

(11) $KMNO_4$ should be used as an oxidizing agent from time to time to improve water quality (Pottasium Permanganate).

Table 1.0

APPENDIXES

Water seepage in pond through vertical, bottom
(Infiltration through dyke horizontally and drainage system)

A. Natural Soil Type	Seepage losses mm/day
Sand	25 - 250
Sandy loam	13.00 - 76
Loam	8 - 20
Clayey Loam	2.5 - 15
Loamy Clay	0.25 - 5
Clay	1.25 - 10

Source - FAO Training Series 4.1981

Table 2

B. Tolerance Limits for Inland Surface Waters subject to pollution for use as Fish Culture.

(mg/L)

S/No.	Characteristics	mg/l
1.	PH Units	6 - 9
2.	Oils & Greases	-
3.	Electric Conductivity at 25°C mhos	1000×10^6
4.	Dissolved oxygen percent saturation min	40
5.	Free Co_2	6
6.	Amonical Nitrogen	1.2.

Source - Inland Standard Institution
Inland Surface Water subject to Pollution 1993.

Table 3

C. - Range of expected gains and losses of Dissolved oxygen caused by different processes in Catfish ponds with average depth of 3.0 to 4.5 feet at temperature exceeding 70°F.

Gain	Range (ppm)
Photosynthesis by phytoplankto	5 -20
Diffusion	1 - 5
Losses	
Plankton respiration	5 - 15
Fish respiration	2 - 6
Respiration by organism in mud	1 - 3
Diffusion	1 - 5

Source - US Department of the Interior Fish & Wildlife Service

Table IV

D. Determination of Toxic, Free ammonia

The fish toxity of a given ammonium/ammonia concentration is PH - dependent. The table below shows free ammonia as a percentage of total ammonia at various PH values.

PH	Free Ammonia
6	0%
7	1%
7.5	2%
8	4%
8.5	11%
9	25%
10	78%

Source - Aquamerck Compact Laboratory Data FRG.

Table V

E. **Gessner and Schaperclaus, factor table for calculation dissolved Co_2 from a number of PH values.**

PH	Factor	PH	Factor	PH	Factor
6.0	118	6.7	24.0	7.4	4.7
6.1	94	6.8	19.0	7.5	3.7
6.2	75	6.9	15.0	7.6	3.0
6.3	59	7.0	12.0	7.7	2.4
6.4	47	7.1	9.4	7.8	1.9
6.5	37	7.2	7.5	7.9	1.5
6.6	30	7.3	5.9	8.0	1.2

e.g. - ABC value & factor = Co_2 m mg/l
ABC value = 2.2
PH = 7.1 Co_2= 2.2 x 9.4 = 21 mg/l Co_2

Source - A C & L
Data FRG

Table VI

F. **Oxygen demand in Water and Pollution**

0_2 Content mg/l	0_2 Deficit %	% 0_2 Consumption in 2 days
0.4 unsuitable for fish	0-20 suitable for fish	Barely polluted, favourable
4-6 Typifies over dressing, silting pollution, over stocking	20-40 polluted, Limited suitability	Unfavourable slightly polluted
6-8 Just acceptable	40-60- Highly polluted, barely suitable for fish	Unfavourable
8-10 Good	60-100 very highly polluted, unsuitable for fish.	highly polluted

AC & C Data FRG

Table VII QUALITY OF A GOOD WATER FOR FISH CULTURE

G. Recommended Limit

Ammonium	0.05 to 0.5 mg/l
0_2	7 - 10 mg/l for front 3 mg/l least for Carp
Temp	0 - 40°C, Carp - 23 - 27°C 0 - 40°C - Range Ideal
CH Carbonate Hardness	ABC LO.5 - Poor 0.5-1.5 - Viable moderately 1.5 - Viable
PH -	6.5 - 8.0
Colour -	Not too muddy or cloudy
Odour -	No offensive odour & free of pollutant

Aquamarch Compact laboratory
Data FRG

Table VIII

H. Table for determining oxygen levels (Extract)

(Table according to Truesdale, Downing and Lowden, J, Appl. Chem, 5, S3 (1955)

The table sets out the oxygen saturation level as a function of temperature at a total pressure of 760 for an atmosphere saturated with water vapour.

0	14.16	10	10.92	20	8.84	30	7.53
1	13.77	11	10.67	21	8.68	31	7.42
2	13.46	12	10.43	22	8.53	32	7.32
3	13.05	13	10.20	23	8.38	33	7.22
4	12.70	14	9.98	24	8.25	34	7.13
5	12.37	15	9.76	25	8.11	35	7.04
6	12.06	16	9.56	26	7.99	36	6.94
7	11.76	17	9.37	27	7.86	37	6.86
8	11.47	18	9.18	28	7.75	38	6.76
9	11.19	19	9.01	29	7.64	39	6.68
10	10.92	20	8.84	30	7.53	40	6.59

Example: Recorded water temperature in sample No. 1 in Oct 1999 = 28.3°C

Oxygen saturation level from table = 7.75 mg/L

Recorded oxygen concentration = 14.4 mg/L

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