OFFICE OF THE CHIEF JOB CREATION OFFICER
GOVERNOR'S OFFICE
ASABA

YOUTH AGRICULTURAL ENTREPRENEURS PROGRAMME (YAGEP)

TRAINING MANUAL

FOR

FISH PRODUCTION
(2016 CYCLE)

@

SONGHAI DELTA, AMUKPE

26TH SEPTEMBER - 7TH OCTOBER, 2016

COURSE OUTLINE

1. Introduction to Fish and Aquaculture: A National Outlook

   By Dr. Theo Okpidi

2. Terminologies and Simple Equipment in Fish Farming

   By Dr. Theo Okpidi

3. Fish Breeding Techniques and Hatchery Management

   By Dr. A. F. Yakubu

4. Introduction to Fish Diseases - **By Mr. Ari-Smart**

5. Management of Fish Diseases: Simple treatment Techniques.

   By Mr. Ari-Smart

6. Brood Stock Management - **By Olufemi Ajiboye**

7. Types of Fish Farms: Technology and Management Implications

   By Dr. Theo Okpidi

8. Calculation of Water Volume and Stocking Densities

   By Mr. Ari-Smart

9. Sustainable Management of Aquaculture in Nigeria

   By Mr. Ari-Smart

10. Fish Pond Management – **By Mr. Ben Agamah**

11. Fish Feeds Formulation and Feeding Techniques in Catfish Farming

    By Mrs. Aghwadoma F.

12. Fish Pond Maintenance, Fish Processing, Preservation and Packaging

    By Mr. Nwanneka Upright

13. Preparation and Management of Flow-Through Ponds

    By Mr. Ari-Smart

14. Biogenics Record Keeping – **By Mr. By Ari-Smart**

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YOUTH AGRICULTURAL ENTREPRENEURS

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TRAINING MANUAL

ON

INTRODUCTION TO FISH AND AQUACULTURE: A NATIONAL OVERVIEW

BY

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1.0 INTRODUCTION

Fish farming activity in Nigeria started about 50 years ago, with the establishment of a small experimental station at Onikan Lagos and an industrial farm about 20ha at Panyam in Plateau State by Federal Government. This generated a lot of interest in fish farming with the involvement of other levels of government and some private establishment (Longhurst, 1961). Fisheries occupy a unique position in the agricultural sector of the Nigerian economy. In terms of Gross Domestic Product (GDP), the fishery sub-sector has recorded the fastest growth rate in agriculture to the GDP. The contribution of the fishery sub-sector to GDP at 2001 current factor cost rose from N 76.76 billion to N 162.61 billion in 2005 (CBN Report,2005). Fish is an important source of protein to large teaming population of Nigeria. Fish provides 40% of the dietary intake of animal protein of the average Nigerian (FDF, 1997). According to Adekoya (2004), fish and fish products constitute more than 60% of the total protein intake in adults especially in rural areas. Amiengheme (2005) enumerated the importance of fish in Human Nutrition as follows:

1. Food fish has a nutrient profile superior to all terrestrial meats (beef, pork and chicken, etc.) being an excellent source of high quality animal protein and highly digestible energy.
2. Fish is a good source of sulphur and essential amino acids such as lysine, leucine, valine and arginine. It is therefore suitable for supplementing diets of high carbohydrates contents.
3. Fish is also a good source of thiamine as well as an extremely rich source of Omega-3 polysaturated fatty acids, fat soluble vitamins (A, D and E) and water soluble vitamins (B complex) and minerals (Calcium, Phosphorus, Iron, Iodine and Selenium).
4. It has a high content of Polyunsaturated (Omega III) fatty acids, which are important in lowering blood cholesterol level and high blood pressure. It is able to mitigate to alleviate platelet of (cholesterol) aggregation and various arteriosclerosis conditions in adult populations;
5. It reduces the risk of sudden death from heart attacks and reduces rheumatoid arthritis.
6. Omega-3 fatty acids also lower the risk of age related muscular degeneration and vision impairment.

7. It decreases the risk of bowel cancer; and reduces insulin resistance in skeletal muscles.

2.0 NIGERIA FISHERIES PROFILE

- Total Fish Production: 579,537 MT (2005).
- Total Seafood Export Value: $56,800,000 (2005).
- Percentage of GDP: 0.66%.
- Total Number of Jobs: 800,000+; 700,000+ (direct) Percentage of Jobs: Not available

  Source: FAO, Fishstat.

2.1 Top 10 Species Exported (Value):

- Shrimp and prawns, frozen ($52,100,000)
- Crab, frozen ($1,100,000)
- Fish filet, frozen ($900,000)
- Cuttlefish ($600,000)
- Marine fish filet, frozen ($200,000)
- Dried fish ($100,000)
- Molluscs ($100,000)
- Crab meat ($60,000)
- Shrimp and prawns, not frozen ($40,000)
- Crustaceans, frozen ($30,000) *Source: Fishstat/2005*

2.2 Wild Capture Production (FAO)

- Top Exports to the U.S. (Value) 2005: Fish smoked ($8,475).
- Lobster rock live/fresh/dried/salted/brine ($5,560)
- Grand total: $14,035 2006: live/fresh/dried/salted/brine ($9,947) Fish meal for human consumption not > 6.8 kg ($6,307)
- Grand total: ($1,080,012)

Source: Aquaculture Production (FAO)

3.0 INDUSTRY PROFILE

Nigeria's artisanal sector is the largest in the region, with thousands of vessels along the coast, in estuarine areas, and inland that use nets, hooks, traps, and seines.

Several hundred small to medium-sized trawlers, operated principally by smaller firms, fish in coastal waters, mainly in the east. The shallow continental shelf and lack of upwelling reduce the productivity of demersal fishing.

In general, the Nigerian fishery is overcapitalized (200 to 300 additional vessels are licensed annually), and existing vessels are slow to adapt to new fishing practices and gear innovations, thereby reducing fleet efficiency. *Source: FAO*

3.1 State of Processing and Value-Added Industry

Most fish catch is frozen for distribution to urban centres throughout the country. Some fish (mainly artisanal pelagic) is smoked for distribution to villages with limited cold-storage infrastructure. Smoking occurs in small and home-based enterprises along the coast and around Lake Chad, and is done principally by women.

Nigeria has a high rate of domestic seafood consumption - almost all fish production is consumed in country. Shrimp is the only large export; about half of total production is exported.

Source: FAO

3.2 Challenges and Prospects.

Most efforts to increase production are focused on meeting domestic demand.

There is currently little use of processing by-products, such as fish for meals and oils, which are generally discarded.

There is potential for growth in the aquaculture industry, which the government has supported since the 1960s. Currently, most operations are small and private, but some larger companies are attempting to develop economies of scale. *Source: FAO*

Sustainability: The artisanal fishery sector is vital to the local economies of the coastal and estuarine regions. Pollution is a major concern in coastal states

especially in oil bearing inland farms and in estuarine and brackish areas. It now has a serious impact on biological productivity. Erosion, siltation, and illegal fishing also harm productivity in these areas.

4.0 NATIONAL DEMAND AND SUPPLY

Nigerians are large consumers of fish with demand estimate at 1.4 million metric tonnes. However, a demand supply gap of at least 0.7 million metric tonnes exists nationally with import making up the short fall at a cost of almost 0.5 billion US dollars per year. Domestic fish production of about 500,000 metric tonnes is supplied by artisan fisher-folk (85%), despite overfishing in many water bodies across the country (Adekoya, 2004).

4.1 POTENTIAL FOR GROWTH

Nigeria has a land area of 923,768Km2 with a continental shelf area of 47,934Km2 and a length of coast line of 853Km. It also has a vast network of inland waters like rivers, flood plains, natural and man-made lakes and reservoirs (Shimang, 2005). The inland water mass was estimated to be about 12.5 million hectares of inland waters capable of producing 512,000 metric tons of fish annually (Ita,1984; and Shimang, 2005). Delta State has a fair share of the vast fishery resources. These include a large number of rivers, deltaic watersheds and ponds where many fishing activities take place. Despite these considerably high potentials, local fish production has failed to meet the country's domestic demand (FAO, 1995). The fish industry remains the most virgin investment in Nigeria compared with the importation of frozen fish in the domestic market (Ndu, 2006). A sure means of substantially solving the demand -supply gap is by embarking on widespread homestead/small scale fish production.

Fish allows for protein improved nutrition in that it has a high biological value in terms of high protein retention in the body (Anthonio and Akinwumi, 1991), higher protein assimilation as compared to other animal protein sources, low cholesterol content and one of the safest sources of animal protein (Slang, 1973).

4.2 EMPLOYMENT

Fish farming generates employment directly and indirectly in terms of people employed in the production of fishing output and other allied business, it also generates income for all categories of people involved in fish farming and thus contributes to the national income. When compared with livestock, it requires less space, time, money and has a higher feed conserving rate.

In recent times considerable progress has been made in the processing and preservation of catfish this has helped to stabilize the market and opened a new income line for investors.

5.0 A NATIONAL CALL TO FISH FARMING

Out of 35grams of animal protein per day per person recommended by F.A.O, less than 7 grams is consumed on the average (F.A.O., 1991). As a result of this, many Nigerians suffer from protein deficiency due to low protein intake. Nigeria has become one of the largest importers of fish in the developing world, importing some 600,000 metric tons annually. To solve the country's high demand for fish, Nigerians must turn to their under-utilized inland water for improved fish production and aquaculture.

Aquaculture expansion, moreover, has been a slow process, as private sector fish farmers have faced major constraints, including lack of seed and quality feed. As in much of Africa, the most commonly cultured species include catfish (*Clarias gariepinus*, the imported *C. lazera* and *Heterobrachus sp*), Tilapia and Carp. Many fish farms focus on catfish, as they can have a market value of two to three times that of tilapia (F.A.O Agriculture Newsletter). The major constraints to fish farming were identified to be those of environmental impacts of aquaculture operations that is water pollution (Spaulding and Blasco,1997), inadequate supply of fingerlings, inadequate information and feeds supply (Assiah, 1997). In spite of the ever-increasing growth being witnessed by other major sources of animal protein such as livestock and poultry industries, this problem of protein deficiency has continued unabated. The need therefore arose, to explore aquaculture as a means of curbing this menace.

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TERMINOLOGIES AND SIMPLE EQUIPMENT IN FISH FARMING

BY

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1.0. TERMINOLOGIES

Aquaculture-	This is the controlled growth of aquatic species.
Pisciculture-	This is the Aquaculture practice involving finned fish.
Extensive aquaculture-	Managed aquaculture dependent on the local natural s setting, such as a pond on coastal sea area.
Intensive aquaculture-	Managed aquaculture controlled through human e engineered means such as managing, water quality and sources of food.
Fish husbandry-	The breeding and rearing of fish for a variety of seasons.
	Water quality- The characteristics of water such as temperature, acidity, alkalinity, hardness, constituent mineral limits which defines its ability to sustain aquatic life.
Culture tanks-	Agriculture holding tanks used to rear fish farm stocks.
Amphidromous fish-	Migratory fish that lives in both salt and fresh water.
Fry-	Developmental stage of fish immediately after larvae stage, at about an ageless than a week.
Fingerling-	Development stage of fish following fry stage -2-3 inches (5-7 cm)
Brood stock-	Fish raised specially for breeding purpose.
Fish kill-	used when a large amount of fish dies suddenly.
Contaminants-	Both natural and artificial materials not typically formed or found in unusually high concentrations which can be detrimental to fish health.
Toxins-	Any product or by-product in an aquatic environment that is poisonous to aquatic life.
Algal Bloom-	A rapid and excessive growth of algae (tiny green plants in water) generally due to high nutrient levels when the

	algae dies. Algae blooms can deplete oxygen to the point where fish cannot survive.
	Algae bloom can also cause fish kill in early morning periods especially in overstocked pounds due to absence of supportive oxygen from photosynthesis.
Biomass-	The total weight of fish and other life forms in a particular water body.
Biodiversity-	The variation of life form or the number and variety of organisms found in mangrove swamps or chicoko ponds.
Sustainable fishing-	Fishing activity that does not cause or lead to undesirable changes in biological or economic productivity, biological diversity or ecosystem structure and functioning from one human generation to the next.
Gravid.	A female fish laden with ripe eggs.
Dorsal muscle.	Muscle close to the backbone. (Most fish receive injections in this area)
Seining net.	A long net with floats attached at the top and sinkers (weights) at the bottom used in shallow water for catching fish.
Dip net.	A deep circular or square net with a long handle, for taking out dead or sick fish.
Juveniles	Fish (for catfish) about 15 cm (6 inches) long.
Jumpers.	Extremely fast growing fish (noticeable even as early as one week of age)
Dissolved Oxygen	Also called DO. This is the amount of oxygen in water that can support aquatic life. (It is measured in ppm)
Ppm.	Parts per million. (One thousand milligrams make one gram, while One thousand grams make one kilogram.
Ppt.	Parts per thousand.

TDS	Total dissolved solid. This is the amount of recoverable solids dissolved water after drying the water to a constant weight. It has a direct effect on the turbidity (transparency of the water)
Turbidity.	This is the degree of opacity or transparency of the water in a pond. This determines the depth of sunlight penetration which in turn determines the degree of photosynthesis and hence the amount oxygen and carrying capacity of a pond.
P^H	This is the degree of acidity of a body of water in a pond. It has serious implications in the feeding habit and survival of fish at any age. An Ideal P^H range is 6.5 to 8.0.
Liming.	This is the addition of lime (Calcium hydroxide) to raise the P^H.
Fertilization.	This is the addition of animal or poultry waste to a pond in order to generate phytoplankton.
Phytoplankton.	These are tiny green plant life. It is a natural source of food for fish.
Sorting Table.	A table for sorting fingerlings.

2.0 SIMPLE EQUIPMENT FOR FARM USE

1. DO (DISSOLVED OXYGEN) METER OR TEST KIT
2. PH METER
3. THERMOMETER
4. WATER TEST KITS
6. MAGNIFYING GLASS
7. HATCHING TROUGHS OR TANKS

8. DEMONSTRATION PONDS
9. SCOOP NETS
10. PLASTIC SIEVES
11. COMPOUNDED FEEDS
12. DISSECTION KITS
13. WATER PUMP
14. SECCHI DISC
15. MODEL SIENE NET
16. GUTTING KNIVES
17. HAND GLOVES
18. WEIGHING BALANCE
19. OVENS
20. FISH DRYING RACKS
21. BASKETS
22. WHEELBARROW
23. SHOVEL
24 CUTLASSES
25 LIME/FERTILIZER

3.0 SOME SITE EQUIPMENT

A WATER PUMP

BASINS AND JERRY CAN

INFLEXIBLE HOSE

BREEDING BASKET

HATCHIING TROUPHS

A SEINING NET (FOR HARVESTING FISH)

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FISH BREEDING TECHNIQUES AND HATCHERY MANAGEMENT

BY

DR. A.F. YAKUBU

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FISH BREEDING TECHNIQUES AND HATCHERY MANAGEMENT

1.0 INTRODUCTION

Aquaculture sector is the only division of fisheries where its output can easily be determined depending on the type of production system used. In Nigeria today, aquaculture has provided economic, social and environmental benefits by strengthening relationship between the youth and the Government, decreasing dependence on Government for white collar job and also provides security to our economy and culture. However, the increase in world production and change in diet demand a large, more reliable and expensive supply of animal protein and fish products. According to FAO report in 2002, Nigeria requires two million metric tones of fish annually for consumption but all fishery activity in Nigeria including industrial fishery, artisanal fishing and aquaculture can only produce 2 percent (2%) of this requirement.

The aquaculture industry in spite of recorded successes has various hindering problems which include inadequate fish fingerlings for farmers. This has necessitated the Nigerian Institute for Oceanography and Marine Research, Sapele to organize a workshop; on the Technology of Fish Fingerlings (Fish Seed) production; for farmers, so that there would be enough catfish fingerlings for table size fish production. Meanwhile, this handout is specially designed for catfish fingerlings production and its management.

Subsequent workshop will look into other aspects of aquaculture.

2.0 FISH SEED PROPAGATION

What is fish seed?

Fish seeds are young fish (Larvae, fry and fingerlings) that grow to become table or parent fishes.

What is Seed Propagation?

This is the science of assisting parent fish to multiply and have descendants.

Method of fish Seed Propagation

Fish seed propagation could be by:

- Natural spawning
- Induced spawning without hormone treatment
- Hormone induced natural spawning
- Artificial spawning) making parent fish to produce off spring willingly in a controlled environment).

Why Artificial Spawning?

- Fish seed collection from the wild is seasonal and unpredictable.
- By manipulation of hormonal and environmental factors, fish seeds can be produced un-interrupted all year round.
- The disease and genetic history of wild fish are unknown and as such wild seed are less tolerant to changing physical and chemical conditions in ponds than the hatchery-bred.
- Health history and genetic history of hatchery-bred fish could be traced and improved.

Basic Tools used in Fish Seed Propagation

- Concrete tanks/Incubation trough
- Hormone, Needle and syringe
- Funnel incubators
- Plastic Jugar Jars
- Towel
- Razor blade

3.0 ARTIFICIAL SPAWNING

Artificial spawning implies physical manipulation of brood-fish to reproduce and have descendants.

The manipulation could be with or without hormone. Eggs and sperm are extracted from sexually matured brood fish. Completion of oocyte, maturation, ovulation and spermation could be enhanced with administration of hormone. Stripped eggs are fertilized with sperm extracted manually from male brood-fish.

Process of artificial spawning

- Select only healthy mature brood-stock
- Select brood fish with well developed secondary sexual characteristics.
- Check for suitable body confirmation and freedom from injury.
- Select male and female.

4.0 SEX DETERMINATION

The main morphological difference between the male and female is that the female external urinogenital papilla is rounded, while the male papilla is pointed.

- During the spawning season a sexually mature female will have a well rounded abdomen that extends pass the pelvic fin region into the genital area.

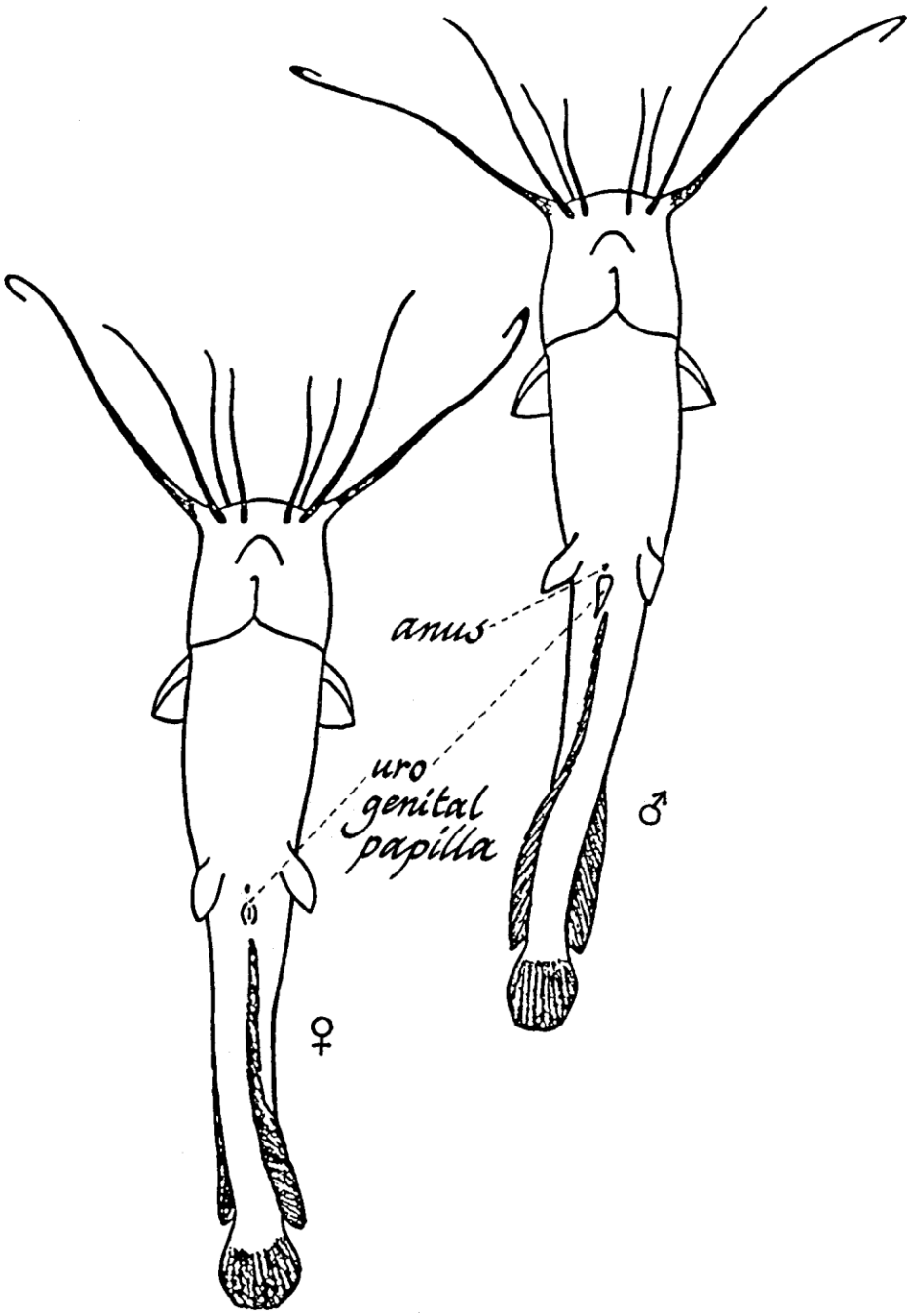

Figure 1. Sexual characteristics of *C. gariepinus*

Selection of female brooder is often on criteria like colour of the egg extruded from the genital papilla – mature eggs are greenish or golden in colour (depending on the specie).

For male, elongated slightly swollen urinogenital papilla with tip reddish in colour should be selected.

5.0 INDUCEMENT

Two commonly practiced method of hormone inducement into fish are:

- Intraperitoneal – Injection within the body cavity which is given through the ventral point of the fish behind either the pelvic or pectoral fin.
- Intramuscular - Injection with the muscle are commonly given on the upper part of the fish above, the lateral line and below the anterior part of the dorsal fin. In either case, it is important to place the needle so that it slides about 45^{o}. For scaly fish do not inject through the scale.

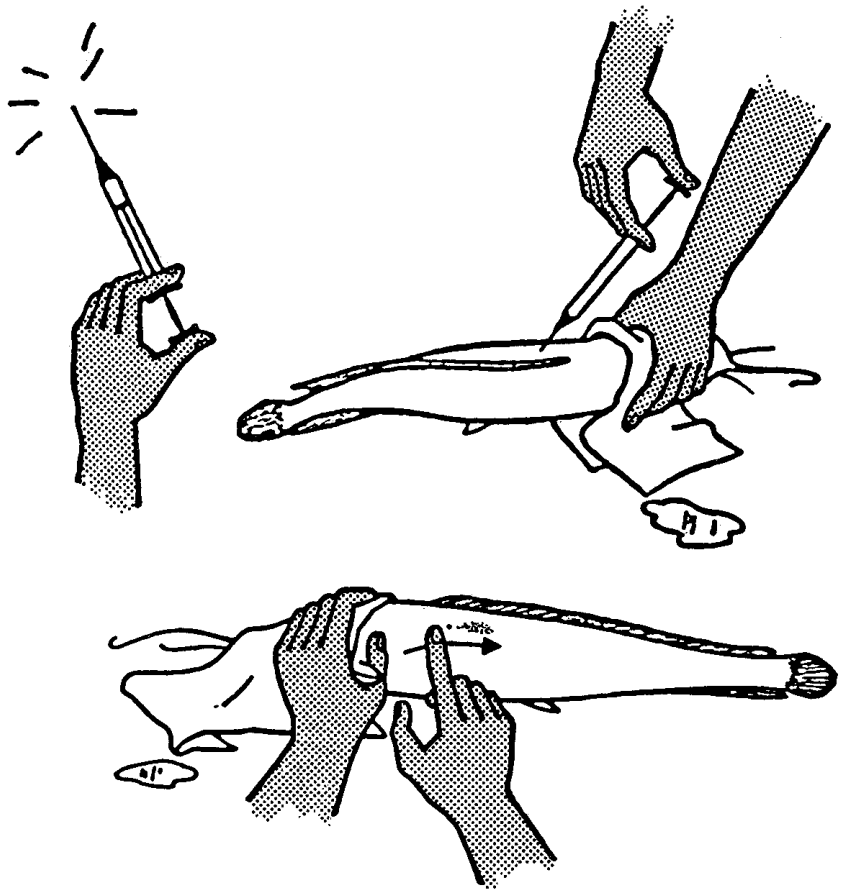

Figure 2. Injection of the female breeders.

5.1 STRIPPING

Injected female should be stripped immediately the latency period expires. The ovulated female is carefully caught with a hand net, and held tightly using wet towel. The abdomen is gently pressed with the thumb from the anterior end of the pectoral

fin on to the genital papilla. The eggs are collected into a dry plastic or enamel bowl. At completion of stripping only few eggs will flow out and often together with some blood. The spawner is now called spent.

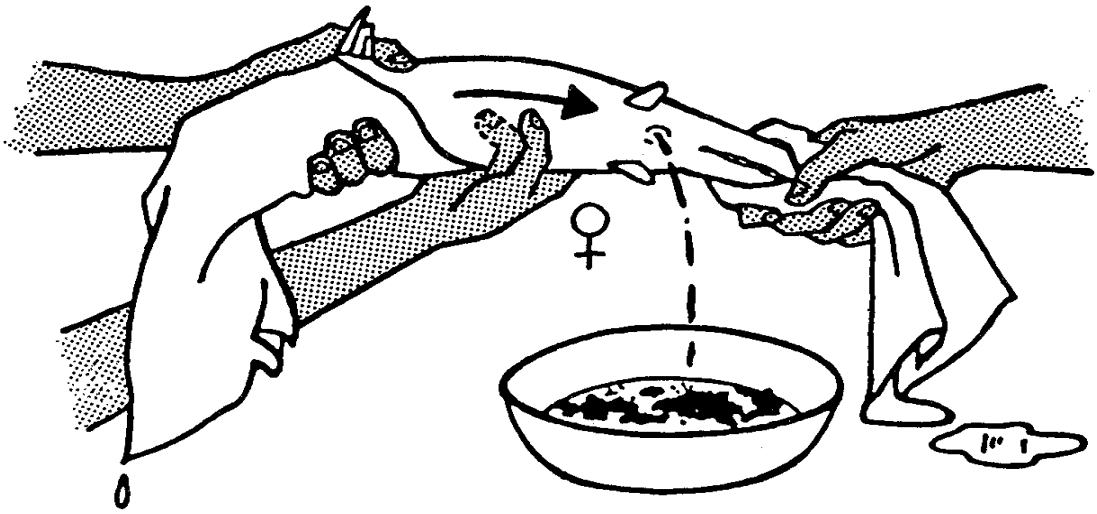

Figure 3. Stripping a female African catfish.

5.2 COLLECTION OF SPERM OR MILT

Catfish sperm is most conveniently collected by killing and dissecting the sperm sac of the matured male fish. The sperm is released into normal saline (7 – 9g/L). Sperm released into fresh water will die after a short period of less than 60 seconds. Freshly procured sperm must be used to fertilize the eggs. Care should be taken to avoid contact of sperm with water before fertilization of the eggs.

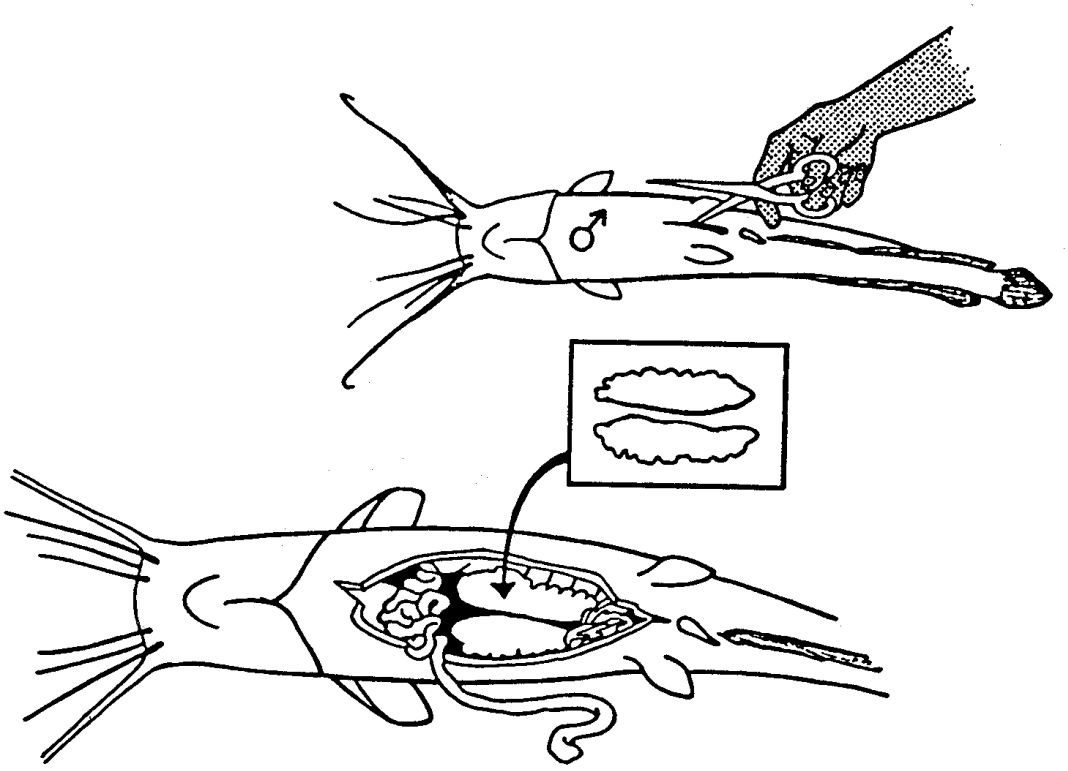

Figure 4. Collection of milt from male African catfish.

6.0 FERTILIZATION AND INCUBATION

Catfish eggs are fertilized artificially by pouring the milt (sperm) into the container with eggs, shaking the two gently and then pouring water into the container to activate the sperm. Incubation of eggs should be in single layer to avoid suffocation and death of the eggs when they ate clustered together. Incubation should be done carefully to ensure that the eggs are properly deposited on artificial egg collector or kakaban. Mosquito net or polyethylene strands can be used as kakaban.

7.0 HATCHING

Fertilized eggs of African Cat fish hatch to larvae. The larvae usually cluster on the bottom of the tank mostly at the corner. Hatching depends on temperature; hatching takes place 24 – 48 hours. After fertilization the larvae do not eat but receive nourishment from their yolk sac. The yolk sac will be gradually absorbed and after about three days, the fry begins swimming up to the water surface searching for food.

It is good practice to remove dead eggs and larvae from the incubation tank immediately they are observed. This is to prevent pollution of the water and hence low hatching rate.

Feeding of the fry commences three to four days after hatching using live feed and gradually switching over to artificial feed.

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INTRODUCTION TO FISH DISEASES

BY

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OUTLINE

1.0 INTRODUCTION TO FISH DISEASE

1.1 PREDISPOSING FACTORS

2.0 TYPES OF FISH DISEASES

2.1 INFECTIOUS DISEASES

2.2 NON-INFECTIOUS DISEASES

2.2.1 ENVIRONMENTAL DISEASES

2.2.2 POOR NUTRITION INDUCED DISEASES

3.0 SYSTEMIC BEHAVIOURAL DIESASES

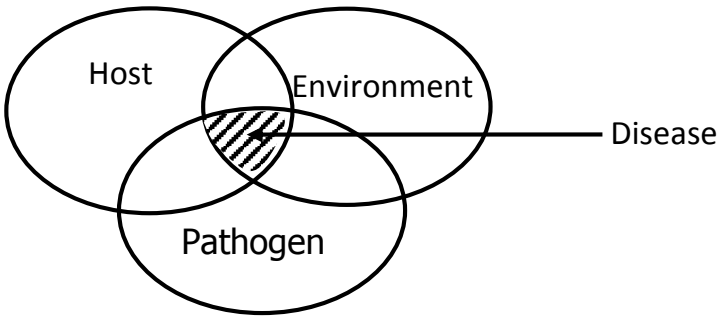
1.0 Introduction to Fish Diseases:

Cat fish reared in ponds are the most popular food fish grown worldwide. However, because of overcrowding and associated stresses they are more susceptible to disease than those in the wild.

Fish disease is a source of colossal loss of revenue to the farmer, a knowledge of its recognition prevention and management is therefore of utmost importance.

1.1 Predisposing Factors:

Three factors are very important before disease sets in. These are the host, environment and the pathogen. (Disease causing organism). Any of these three that are not at optimal levels predisposes the fish to stress, disease and sickness.



A daily observation of fish behavior and feeding habit allows early detection of illness before it can cause any damage.

2.0 Types of Fish Diseases:

There are two broad categories of fish diseases, infectious and non – infectious diseases.

2.1 Infectious Diseases:

Infectious diseases are caused by pathogenic organisms present in the environment or carried by other fish Examples are bacterial, viral, fungi and protozoans (parasites) diseases.

Symptoms of bacterial diseases include hemorrhagic (blood spots) ulcers (sores) along the body, unusual colours on the body or around the eyes and mouth. Enlarged fluid (liquid) filled abdomen and protruding eyes.

It can also be external, resulting in erosion of skin, fins and barbells.

Viral diseases are more difficult to identify by observation since they mimic bacterial infections. Management of viral disease is best left to experts.

Fungal infection rarely attack fish except they have been injured through mishandling. They frequently colonize damaged tissue and appear as cotton-like or brownish growths on the body or gills.

Parasitic diseases are frequently caused by small microscopic organisms called protozoa. They live in the environment and cause irritation to the skin or gills of the fish, weight loss and eventually death.

2.2. Non-infectious Diseases:

Non-infectious diseases may be caused by environmental, genetic or nutritional factors.

2.2.1 Environmental Diseases:

Causative environmental factors include, low dissolved oxygen (often due to overstocking or high water temperature), high ammonia or high nitrite values in the environment. Proper management of these factors will prevent most environmental diseases.

2.2.2 Poor Nutrition Induced Diseases:

Poor-nutrition induced diseases include, broken back disease (due to lack of vitamin C) and anemia (no blood) disease due to low folic acid.

3.0 Systemic Behavioral Disorders:

Very often there are behavioral disorders that help tell you that all is not well with your fish. These include

i. Fish hanging vertically at the surface – this is most likely due to high ammonia or nitrite in water. But when in this position and they are breathing rapidly at the surface (hyper ventilation) it is most likely due to low dissolved oxygen. This is further indicated by a lot of fish coming to the surface to gulp air before returning into the water.

ii. When you notice fish rubbing its body against the container, it's most likely due to external parasites.

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MANAGEMENT OF FISH DISEASES: SIMPLE TREATMENT TECHNIQUES

BY

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1.0 CLASSES OF FISH DISEASE

2.0 COMMON NAMES OF DISEASE, PATHOGENS SIGNS AND POTENTIAL TREATMENT.

2.1 Protozoan parasitic infections

2.2 Bacterial infections

2. 3 Fungi diseases

MANAGEMENT OF FISH DISEASES (SIMPLE TREATMENT TECHNIQUES)

1.0 CLASSES OF FISH DISEASES

PARASITIC INFECTIONS	BACTERIAL
Ich, velvet, hole in the head, neontetra	Fin rot, pop-eye, daily eye, external infections, fish TB, dropsy, septicemia, swim bladder disease, enteric red mouth.
FUNGUS INFECTIONS	**EXTERNAL ARTHROPOD PARASITES**
Body fungus cotton fin fungus	Anchor worms, fish conde, angulus spp.
VIRAL INFECTION/TUMORS	**MISCELLANEOUS AILMENTS**
Lymphocystis, solid tumors	Unidentified lesions, growth of cysts
TRUE WORMS, PARASITES NEMATODES	
Flukes (in skin, gill, eyes) round worms.	

2.0 COMMON NAMES OF DISEASES, PATHOGEN, SIGNS AND POTENTIAL TREATMENT

2.1 Protozoan Parasitic Infections

Common Name	**White Ich Disease**
Pathogen/cause	Ich thyoph, Iturus
Physical signs	Distinct slightly raised white spots that look like white sand on the skin.
Behavioral signs	Scratching against objects, may **hang** and **gasp** near surface if infection reaches the gills. Treat with Malachite green, super ich cure or meditations that contain formalin orcopper sulphate.
Common Name	**Hole in the Head (Hexamita)**
Pathogen	Spironucles are probable suspects
Physical signs	Hole in the head and lateral line erosion and more likely related to water quality factors.

Behavioral signs	Often asymptomatic until serious, lethargy, and may have trouble swimming due to loss of balance.
Potential treatment	Meditation that contain metronidazole

2.2 BACTERIAL INFECTIONS

Common Name	**Bacterial FIN ROT**
Pathogen/ Cause	Non/specific, often associated with poor water quality.
Physical signs	Tattered and frayed/worn out fins, sometimes infected down to the pedicles.
Behavioral signs	Increasing difficulty in swimming
Potential treatment	Test for Ammonia, nitrite and nitrates. Check for pH and correct if needed. Start with Oxytetracyclin. If not resolved then use broad spectrum antibiotics such as gentamycin or erythromycin. Frequent water change.
Common Name	**Pop Eye Disease**
Pathogen/cause	Several organisms (non-specific, severe stress)
Physical signs	Protrusion of eye ball from the socket, caused by accumulation of pus and fluid in the infected orbit (socket)
Behavioral signs	Loss of vision and lethargy
Potential treatment (also for clouding eye disease)	Broad-spectrum antibiotic, pop-eye is a sign of a number of infections, often associated with poor water quality. Test for Ammonia, nitrite and do water change
Common name	**Columnaris, (cotton wool disease) often misnamed "mouth fungus", Fish Tuberculosis (TB)**
Pathogen/cause	Various gram negative and gram – positive organisms (flexibacta columnaris, aeromonas).
Physical signs	White, clear, red/pink areas of necrosis, inflamed patches and sometime deeper ulcers developing, columnaris usually presents near the head and sides of the body and is often mistaken for a fungus. It is characteristically greyish-white or yellow patches on gills, tissue on head may be eaten away.
Behavior signs	**Various:** lethargy, hiding behavior, "hanging", loss of appetite.
Potential treatment	Broad spectrum antibiotics e.g. Kenamycin. Disinfect tank.
Common Name	**Dropsy**
Pathogen/cause	Various organisms (poor water quality)

Common Name	**Bacterial FIN ROT**
Physical signs	Bloated appearance, it's a general appearance of fluid accumulation. In the internal body cavity. It's more a sign of internal infections and multiple organ failure just like kidney failure in human beings if swelling is gradual or parasites or cancer if swelling is gradual.
Behavioral signs	Lethargy, lack of appetite
Potential treatment	Unfortunately, it is usually incurable and fatal. However kenamycin may help. Also try 1/8 teaspoon of salt for every 20L of water. Monitor for 2 weeks. Also improve water quantity.
Common Name	**Hemorrhagic Septicemia**
Cause/pathogen	Various pathogen due to ammonia spike.
Physical signs	Distinct bright red streaks on the puns (caused by vascular inflammation due to systemic (blood borne bacteria infection) sometimes patchy red discolouration on the sides of the body.
Behavioral signs	Depends on severity. If it is due to ammonia, it may show in conjunction with hyper ventilation (fast breathing) and gasping at the surface. Erratic swimming etc.
Potential treatment	Broad-spectrum antibiotic, check your water quality
Common name	**Swim bladder disease**
Pathogen causes	Various: indigestion due to overfeeding, shock, poor acclimatization, stress.
Physical signs	May show limited bloat
Behavioral signs	Fish has difficulty swimming upright despite active attempts, and may occasionally swim "belly up"
Potential treatment	Stop feeding for 3-4 days. Add fresh spinach or skinned green peas to diet.
Common name	Enteric Septicemia of Catfish (ESC)
Pathogen causes	ESC is a highly fatal systemic infection caused by the bacterium Edwardsiella ictaluri.
Physical signs	Small (2-3 mm circular, red spots) over the entire body. Rash-like areas on body. Bloody areas on base of fins. White circular spots (2-3 mm diameter). Raised reddish area on top of head. Ulcerated areas on top of the head (hole-in-the-head). Protruding eyes. Bloated fluid filled belly (yellowish or bloody). Internal organs and tissue hemorrhages. White pustules in the liver.
Behavioral signs	Reduction of feeding intensity. Erratic swimming, swirling, and jumping. Hanging head up, tail down in the pond.

Common Name	Bacterial FIN ROT
Potential treatment	ESC infections can sometimes be controlled or managed by offering feed containing the following antibiotics: Terramycin (oxytetracycline), Romet (sulfadimethoxine-ormetoprim) florfenicol as antibiotic feeds.

2.3 FUNGAL DISEASES

Fungal are a group of organisms called heterotrophs that require living or dead matter for growth and reproduction. Unlike plants, they are incapable of manufacturing their own nutrients by photosynthesis. Fungi are present everywhere--in saltwater or fresh water, in cool or warm temperatures. In most cases, fungi serve a valuable ecological function by processing dead organic debris. However, fungi can become a problem if fish are stressed by disease, by poor environmental conditions, receive poor nutrition, or are injured. If these factors weaken the fish or damage its tissue, fungus can infest the fish. All fungi produce spores--and it is these spores which readily spread disease. The fungal spore is like a seed which is resistant to heat, drying, disinfectants and the natural defence systems of fish The three most common fungal diseases are discussed here. They are known as Saprolegniasis, Branchiomycosis, and Ichthyophonus disease.

Saprolegniasis

Saprolegniasis is a fungal disease of fish and fish eggs most commonly caused by the *Saprolegnia* species called "water molds." They are common in fresh or brackish water. *Saprolegnia* can grow at temperatures ranging from 32° to 95°F but seem to prefer temperatures of 59° to 86°F. The disease will attack an existing injury on the fish and can spread to healthy tissue. Poor water quality (for example, water with low circulation, low dissolved oxygen, or high ammonia) and high organic loads, including the presence of dead eggs, are often associated with *Saprolegnia* infections.

Disease Signs

Saprolegniasis is often first noticed by observing fluffy tufts of cotton-like material--coloured white to shades of grey and brown--on skin, fins, gills, or eyes of fish or on fish eggs. These areas are scraped and mounted on a microscope slide for proper diagnosis. Under a microscope, Saprolegnia appears like branching trees called hyphae. With progression of infection fish usually becomes lethargic and less responsive to external stimuli. So fish under such conditions is a target to predators.

Management and Control

Saprolegniasis is best prevented by good management practices--such as good water quality and circulation, avoidance of crowding to minimize injury (especially during spawning), and good nutrition. Once *Saprolegnia* is identified in an aquatic system, sanitation should be evaluated and corrected. Common treatments include potassium permanganate, formalin, and povidone iodine solutions. Over treatment can further damage fish tissue, resulting in recurring infections. Environmental management is essential for satisfactory resolution of chronic problems. Bath treatment in NaOH (10-25g/lit for 10-20min), KmNO4 (1g in 100lit of water for 30-90 min), CuSO 4 (5-10g in 100 lit water for 10- 30min).

Branchiomycosis

Branchiomyces demigrans or "Gill Rot" is caused by the fungi *Branchiomyces sanguinis* (Carps, Tilapia) and *Branchiomyces demigrans* (Pike and Tench).

Branchiomycosis is a pervasive problem in Europe and Africa, but has been only occasionally reported by U.S. fish farms. Both species of fungi are found in fish suffering from an environmental stress, such as low pH (5.8 to 6.5), low dissolved oxygen, or a high algal bloom. *Branchiomyces* sp. grow at temperatures between 57° and 95°F but grow best between 77° and 90°F. The main sources of infection are the fungal spores carried in the water and detritus on pond bottoms.

Fish with branchiomycosis (gill mycosis): Photo (Adopted from Fish pathology by Reichenbach-Klinke's)

Disease Signs

Branchiomyces sanguinis and *B. demigrans* infect the gill tissue of fish. Fish may appear lethargic and may be seen gulping air at the water surface (or piping). Gills appear striated or marbled with the pale areas representing infected and dying tissue. As the tissue dies and falls off, the spores are released into the water and transmitted to other fish. High mortalities are often associated with this infection.

Management and Control

Avoidance is the best control for Branchiomycosis. Good management practices will create environmental conditions unacceptable for fungi growth. If the disease is present, do not transport the infected fish. Great care must be taken to prevent movement of the disease to non-infected areas. Formalin and copper sulphate have been used to help stop mortalities; however, all tanks, raceways, and aquaria must be disinfected and dried. Ponds should be dried and treated with quicklime (calcium oxide). Ponds should be dried and treated with quicklime (calcium oxide) and copper sulphate (2-3kg / ha). Dead fish should be buried.

SUMMARY

Fungal diseases are often indicative of a more serious problem. Saprolegniasis is a common fungal disease which affects the external surfaces of fish. It can be eliminated easily after the primary cause of illness has been identified and corrected. On the other hand, Branchiomycosis, a relatively new problem and has caused high mortalities in cultured fish, and is difficult to control. Ichthyophonus disease is a systemic fungal disease and once it enters the fish, there is no cure. The best control for all fungal infections is good management: good water quality, good nutrition and proper handling.

COMMON NAME	
Pathogen	Saprolegnia
Physical Signs	Hair like or powdery growth on dead tissue.
Behavioral Signs	Difficulty in swimming malaise
Potential Treatment	Same as columnaris but include malachite green.

SAPROLEGNIA (Fungus) compared with columnaris desease

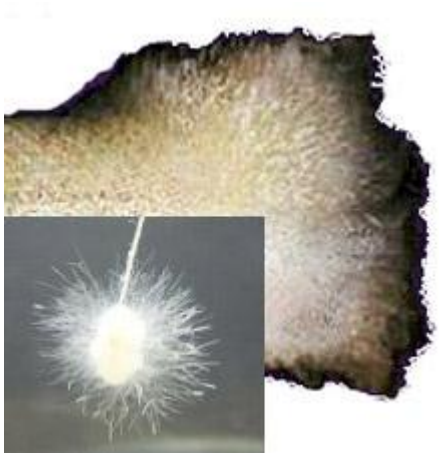
Saprolegnia (often classified as a mold; from the Genus "Saprolegnia") is often confused with Columnaris and for good reasons, they can often be similar in appearance. This similar appearance is why I combined these two unrelated pathogens into this write up.

Close inspection though, will reveal that a fish with Saprolegnia will have hair like growth structures similar to what you might find outside growing on a decaying piece of wood in the forest. This is what differentiates Saprolegnia (referred to as fungus) from Columnaris as you will not see the thin hair like structures upon fish with Columnaris.

Another consideration in differentiating Fungus (Saprolegnia) from Columnaris is that Saprolegnia & fungi often grow on dead tissue, UNLIKE Columnaris which *MUST* have living tissue to live on.

This is an important distinction, since it is often found on dying or dead tissue of a live fish, as well as the remains of a decomposing fish, shrimp, etc. Another noteworthy distinction is that Saprolegnia is generally a more slowly progressing disease than Columnaris (& in fact I have yet to witness a quick or especially sudden die off from Saprolegnia in my 1000s of contracted aquariums). One more consideration for the identification of Saprolegnia/fungi is that out breaks often occur in a pond with large amounts of decaying organic matter, with low pH, and poor circulation in the area of decay. What is also noteworthy is that an outbreak of Saprolegnia can also allow opportunistic bacteria a chance to infect fish, so then you have a double problem.

Saprolegnia is not a true fungus (fungus are from the Kingdom “Fungi” such as Oomycetes), while Saprolegnia are from the Kingdom “Protoctista” which is a catch all Kingdom for the multicellular organisms which don't fit into the Animal, Plant, or Fungus Kingdom. This includes molds, green algae, red algae and more. These organisms, considered to be saprophytic "water molds," are a normal, ubiquitous component of aquatic ecosystems (Saprolegnia are present in ALL aquariums and ponds). Saprophytes live off of decaying organic material.



If you have ever seen a piece of fish food left in the pond and was covered in what looks like cotton, those are all fungus filaments doing their job of breaking down organics, and although they are a natural part of the aquatic environment, an overabundance of Saprolegnia (Fungus) caused by decaying matter (especially in new ponds) can result with the Saprolegnia to start trying to break down your living fish and can also appear as cottony growths on the fish as well.

The picture to the left is a double close-up of a fish tail with Saprolegnia/Fungus, with inner picture a multiple magnification of how the Saprolegnia "mold" looks. Saprolegnia will often get started if there is a large amount of decomposition of nitrogenous organic material such as dead fish left in the aquarium or large amounts of high protein fish food such as krill/shrimp. Injured fish with open sores will amplify this potential problem.

Treatment:

Treatment is somewhat similar to Columnaris, although Saprolegnia responds well to these chemical remedies that are not generally effective for Columnaris (as well as a few antibiotic/organic remedies):

- Acriflavin (found in Fungus Cure) for mild to moderate Saprolegnia infections.

  Acriflavin can be combined with Malachite Green (Victoria Green), or Triple Sulfa for moderate to severe infections. "Fungus Cure" contains both Acriflavin.

KEY POINTS ABOUT SAPROLEGNIA/FUNGUS FOR PREVENTION AND TREATMENT

- Make sure to vacuum out ALL decaying organic matter, especially high protein organics such as uneaten shrimp or similar. I recommend treating all wounds in fish immediately when discovered, *slowly* increasing pH (for fish that can tolerate a higher pH, which even Discus can thrive/breed in a pH above 7.0) and finally maintain proper electrolytes (such as calcium cations) in your pond as well as the possible addition of salt when wounds are discovered for healthy osmoregulation.

- With Saprolegnia, the temperature tolerance by the Saprolegniasis is quite wide; 3C to 33C (37F to 91F). However, sudden changes in temperature can make fish vulnerable to a Saprolegnia infection. So unlike with Columnaris where an ideal temperature of 75F is best for cure, maintaining a not too hot, not too cold aquarium/pond that has STABLE temperatures is what is important!

- It is noteworthy that Saprolegnia thrive in lower pH water, especially under 6.0, although any water under 7.2 provides a habitat that can support strong Saprolegnia growth. With this in mind, keeping slightly more alkaline water is both good treatment and prevention for Saprolegnia.

- Saprolgenia is an opportunistic infection, often the result of water conditions as already noted. However, Saprolegnia/Fungus is also common as the result of injury, whether it be fighting or simply from the fish striking and object in the pond (this is especially common with larger fish, fish in "too small a pond.

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YOUTH AGRICULTURAL ENTREPRENEURS PROGRAMME

(YAGEP)

TRAINING MANUAL

ON

BROODSTOCK MANAGEMENT

BY

OLUFEMI AJIBOYE

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BROODSTOCK MANAGEMENT

1.0 INTRODUCTION

The achievement of maximum sustainable seed production of catfish depends, to a large extent, on broodstock management. Information on broodstock selection, nutrition, fecundity, stocking density, sex ratio and environmental conditions is crucial for maximizing hatchery production efficiency. It is of paramount importance to highlight these parameters:

1.1 Broodstock Selection

Maintaining pure, high-quality broodstock is probably the core of successful seed production. The selection of suitable broodstock will certainly have subsequent effects on the quantity and quality of the offspring produced. The following measures/characteristics should be considered in broodstock selection:

i. Broodstock should be genetically pure, and fish with unknown or questionable origins must be avoided.

ii. Mating of close relatives (in-breeding) of broodstock should be avoided

iii. Broodstock should not be too small, because small fish are less fecund.

iv. Broodstock should not be too old and must not have spawned several times, because fecundity decreases with maternal age and successive spawning.

v. Broodstock should be in good shape and free of deformities and injuries

vi. Inferior and unwanted catfish must be prevented from entering broodstock ponds. Therefore, incoming water should be filtered continuously.

vii. Select broodstock from a reputable fish farm.

1.2 Stocking Density and Sex-Ratio

Maintaining the correct stocking density and sex ratio of farmed catfish will certainly improve hatchery efficiency and mass production of catfish. Suboptimal broodstock density will result in low seed production. Also, high broodstock density often reduces seed production, presumably due to aggression and fighting between males leading to reduction in courtship, egg fertilization and incubation.

1.3 Broodstock Exchange

Exchange of catfish male and female broodstock, after a period of conditioning, could be an effective tool for improving seed production, spawning synchrony and spawning frequency. Conditioning is the separation of males and female in different conditioning units, at high densities, for a period of rest between spawning. During this period, the fish must be provided with good quality feed and appropriate feeding regimes.

2.0 NURSERY POND MANAGEMENT

The success of any enterprise including fingerlings production depends mainly on good management in order to maximize profit. To achieve maximum fingerlings production, nursery ponds must be properly managed before stocking of the fry.

2.1 IMPORTANCE OF POND PREPARATION

1. It increases fish food in the nursery ponds (natural fish food);
2. It reduces predators in the pond (aquatic weeds, aquatic insects, etc);
3. It controls excessive phytoplankton growth.

2.2 HOW TO PREPARE NURSERY PONDS

i. Draining the pond bottom - The pond is completely drained of water. Desilting of the pond is carried out if the pond is muddy.

ii. Predators Control – Predators are unwanted organisms which prey on fry. The predators are adults and tadpoles of frogs and toads, reptiles (snakes), diving beetles, unharvested fingerlings of the previous cropping. While the pond is being dried during draining, these predators are eliminated. They are prevented from entering the pond by using screen net fenced round the pond. The surrounding grasses are cut at all times, and controlled. Dense aquatic weeds occurring inside or along the pond margin are removed manually or mechanically using rakes.

iii. Liming – Lime is considered as a fertilizer since it supplies calcium which is one of the essential nutrients.

Importance of Liming

1. It improves the pH of pond bottom mud and water;
2. It prevents water from becoming acidic. It acts as buffer against pond pH fluctuation.
3. It increases alkalinity of the water thereby increasing the availability of Co_2 in water.
4. It destroys bacteria, parasites, predators in their various life history stages.

Materials used for liming and their rates of application are:

Quick lime (caustic lime)	-	200 – 500kg/ha
Slake (hydrated lime)	-	300 – 500kg/ha
Agricultural lime (lime estoric)	-	500 – 2000kg/ha

Caustic and hydrated lime are commonly used in pond management. The liming material which should be finely grounded, is spread over the entire dry pond bottom.

A period of 2 -3 days should elapse before the ponds are refilled with water to ensure proper mixing of lime with the soil.

- Filling of Water – The pond after liming is partially filled with water to a depth of 0.6m and left for 2 – 4 days to observe any leakage or seepage. It is later completely filled up and fertilized.

- Fertilizing – To make the water more productive, ponds should be fertilized after liming. Fertilizers contain important nutrients which help in the production of natural fish food organism (plankton). There are two basic types of fertilizers, organic and inorganic fertilizers.

- Organic Fertilizers - These are wastes of animals or plant origin e.g. cattle, cow, pig dung, poultry/duck manure, composite (agricultural by products e.g. rice bran, etc.). These materials in addition to acting as fertilizers serve as direct feed for the fish. They are distributed equally over the surface of the water or tied in bags and put in the ponds. About 50kg of poultry manure is ideal for a pond of 0.02ha.

- Inorganic Fertilizers - These are chemicals which contain essential nitrogen, phosphorous, potassium, calcium in various proportions.

Examples of fertilizers used are:

a. Phosphate fertilizers e.g. single super phosphate, triple super phosphate, ammonium phosphate.
b. Nitrogenous fertilizers e.g. urea, ammonium sulphate.
c. Potassium fertilizers e.g. potassium nitrate, potassium sulphate.
d. Mixed fertilizers e.g. NPK

Application Rate

- NPK 15-15-15 = 1000 – 3000kg/ha/yr
- Single and double super phosphate = 500 - 2000kg/ha/yr
- Triple super phosphate = 300 – 1000/ha/yr

The above rates are NOT fixed but act as a guide. To obtain good results, the fertilizers are first dissolved in water and sprinkled over the entire pond surface. This prevents the phosphorous fertilizer from settling on the pond bottom where the phosphorous will be absorbed by the mud.

3.0 STOCKING OF FRY

After proper Nursery Pond Management, the fry after 3 – 5 days in the hatchery tanks are stocked into the nursery ponds. The fry should be transported from the hatchery in clear water which has the same temperature as the pond water.

The fry should not be submitted to a temperature shock. Stock about 65 fry/m^2. After stocking the farmers should check every 2 – 3 days the fertility of the pond water to ensure sufficient production of plankton (natural food|).

The fry are nursed (fed) to fingerlings within 3 – 4 weeks. The stocked fry are fed with rich protein diet of about 45%C.P.; before harvesting when they are at fingerlings stage.

4.0 HARVESTING OF FINGERLINGS

Fingerlings in earthen ponds are due for harvesting after about 4 – 5 weeks. In harvesting the fingerlings, the following instructions are of value:

i. Start emptying the pond (using pumping machine) a few hours before dawn while it is still cool. The water level should fall slowly and a small mesh screen should be put in front of the outlet pipe to prevent fingerlings from escaping.

ii. When the water level is low, drag with drag net. The mean size and weight of the harvested fingerlings will vary between 3 – 6 p.m. and 1 – 3g respectively. During the nursing period, some of the fry will develop faster than the other which may result in cannibalism by the larger specimens.

iii. Put the harvested fingerlings in bowls containing water and place them under shade. (Do not expose the fish to direct sunlight).

iv. If you want to count, put the fish on a smooth table with frames along the sides and holes in the corner. Containers with water are placed under the holes of the table. When counting, remove the shooter from the rest of the fingerlings.

v. Do not over stock the fingerlings in containers. The fingerlings should have enough space to be able to breathe air at the water surface.

Factors responsible for low harvest of fingerlings:

1. Poor zooplankton bloom during the first week after stocking.
2. Impact of tadpoles and frogs (predators).
3. Cannibalism

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TRAINING MANUAL

ON

TYPES OF FISH FARMS:
TECHNOLOGY AND MANAGEMENT IMPLICATIONS

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1.0 INTRODUCTION

There are basically seven (7) types of containment fish farming methods, which are: -

1. Use of Elevated Fish Tanks: These may be: -

   (a) wholly concrete (As in ADP, Ibusa);

   (b) cement blocks and concrete hybrids (As in Koko and Umusam clusters)

   (c) Fixed/Flexible plastic containers

2. Earthen Ponds: These may be static or flow through systems.

3. Floating Cage Systems: Materials used may be Aluminum, or plastic meshes or of suspended wood.

4. Chikoko or Brackish Water Fish Farms.
5. Homesteads or All-go Fish Farms.

(d) Traditional Fish Farms.

(e) Capture Fisheries: Which includes artisanal and industrial capture Systems.

Items 1 – 6 are often referred to as containment fisheries.

2.0 TECHNOLOGIES

There are four (4) different technologies which m be adopted in the construction and management of containment fish farms. These are:

4. Green Water technology.

5. Intensive, Hyper-Intensive and Ultra Intensive Technologies.

6. Tidal or Brackish Water Technology.

7. Fresh Water or Flowing Water Technology.

2.1 Green Water Technology: Is often adopted for static ponds. Irrespective of the mode of containment there is very little or no water change over the entire farming period except it becomes imperative due to adverse physio-chemical

properties of the water. Stocking densities of green water fish tanks / ponds are typically low (3 – 20 fish/m^3).

Construction costs depends on whether one adopts elevated concrete (high cost), hybrid concrete/block (moderate costs, fixed/flexible plastic tanks or whether one chooses recessed earthen ponds).

Depth of green water containers varies from 1m – 1.5m (3-5 Feet) for elevated containers while that for recessed containers varies from 1.5m to 6m. (5-20 Feet).

Cost of earthen ponds are determined by the:

a. Depth (which in turn depends on the level of the sustainable clay bed).
b. Environment and topography – A shallow clay bed in a grassland as opposed to a deep clay layer in a thickly and heavily wooded environment. The latter is often the case in Delta South and Central

2.2 Intensive, hyper-intensive and ultra-intensive technologies

Intensive, hyper-intensive and ultra-intensive technologies often have stocking densities of 50 – 100, 100 – 250 and 250 – 500 fish/m^3 respectively. Although this system has very quick returns, construction and feeding costs are often prohibitive. This system is highly technology dependent and can only be built and run by experts.

2.3 Tidal/brackish water technologies:

This system exploits the variation in water levels due to the inflow and outflow of tidal water to clean toxins from ponds. The ponds are often located in mangrove swamp areas (As in

Ufuoma, Epkan, Egborodo Itsekiri, Ugborode Okpe, Isaba and Ogbe-Ijaw Farm Settlements).

Construction costs depends heavily on the age of the mangrove, the land tenure system and "deve" encumbrance by youths in the area.

These soils are highly acidic and have attendant management and cost implication. The stocking densities are slightly lower than those of flow through ponds but are quite higher than those of static fresh or green water technologies.

Special machines are used to carve out the f blocks which are appropriately laid to prevent leakage. Further costs are incurred in constructing the extensive channels and walk ways needed by this system. Scientifically designed chikoko ponds have separate inlet and outlet channels. Depths are dual levels. ($7^1 – 8^1$ for high tide and $4^1 – 5^1$ for low tides. Predation by wild life must be considered during design, construction and maintenance phases.

2.4 Fresh water technology

Fresh water technology is often adopted for flow through and elevated tank systems.

Elevated fresh water systems use either continuous slow running water changes or do partial daily or twice weekly water changes from taps (as in Songhai Delta Amukpe). Flow through systems on the other hand depend on channeling water from streams, rivers or surface aquifers (springs) through recessed containers. Containment

may be by earth or concrete. The recessed earth maybe clayey by the river side (as in the proposed flow through ponds in Enhwe in Isoko South) or in sandy beaches (as in camp 74, Asaba.)

Recessed flow-through ponds in sandy beaches are cheaper and quicker to build. They require constant maintenance of channels, pond walls and inter-pond link pipes as blockage at any point will spell doom especially for over stocked ponds.

Stocking densities in flow-through systems are higher than those in static green water and elevated fresh water systems for this reason, they are neither to deep (1 – 1.5m = 3-5 feet) nor large in size (e.g. Camp 74).

Stocking densities vary from 20 – 50 fish /m^3 depending on the strength of water flow through and expertise of the farmer. Cost of feeding is also higher in fresh water and flow through systems since the fish depends entirely on the farmer for food.

The cost and choice of appropriate technology depends largely on the nature of the environment, the soil profile, intended level of stocking density and the socio-cultural bent or inclination of the people in a particular location.

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TRAINING MANUAL

ON

CALCULATING AREA AND VOLUME OF PONDS AND TANKS

BY

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1.0 INTRODUCTION

Good fish farm managers must know the area and volume of all ponds and tanks. Exact measurement of area and volume is essential in order to calculate stocking rates and chemical applications. Stocking fish into a pond of uncertain area can result in poor production, more disease and possibly death. Chemical treatments can be ineffective if volume/area is underestimated and potentially lethal if it is overestimated.

Measurements and calculations described in this training manual can be made in either English or metric units. Examples are given in English and metric units. Conversion tables are provided (at the end of this factsheet) for those who wish to use metric units.

2.0 CALCULATING AREAS

Surface area calculation is an essential first step. Pond stocking rates, liming rates and other important management decisions are based on surface area. An error in calculating surface area will inevitably lead to other problems. Measure distances accurately, calculate area and double check all calculations.

You may not need to measure pond area yourself. The contractor who built the pond should have accurate records on pond area.

Less accurate but acceptable methods of measuring pond area are chaining and pacing. Inaccuracies in these methods come from mismeasurements and measurement over uneven/sloping terrain. Measurements made on flat or level areas are the most accurate.

Chaining uses a measuring tape or other instrument of known length. Stakes are placed at each end of the tape. The stakes are used to set or locate the starting point for each progressive measurement and to maintain an exact count on the number of times the tape was moved. Sight down the stakes to keep the measurement in a straight line. The number of times the tape was moved multiplied by the length of the tape equals total distance.

Pacing uses the average distance of a person's pace or stride. To determine your pace length, measure a 30m distance and pace it, counting the number of strides. Pace in a comfortable and natural manner. Repeat the procedure several times and get an average distance for your stride. The formula for calculating distances from pacing is:

Distance = Total Number of Paces x (feet) Length of Average Pace

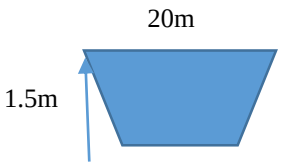
It is a good idea to always pace a distance more than once and average the number of paces.

2.1 SQUARE OR RECTANGULAR PONDS

Ponds built in square or rectangular shapes are the most easily measured. Square and rectangular areas are determined by multiplying length by width. Figure 1 illustrates some typical shapes and sizes of ponds.

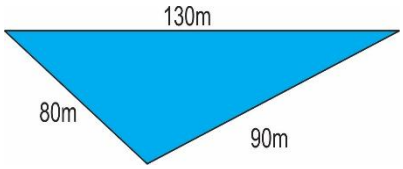
A Rectangle

Fig 1
Rectangle or Square - opposite sides are same length



A Trapezium

Fig. 2
Vertical Trapezium cross section.



A Rectangle

Fig 3
Triangle with no sides 90 degrees

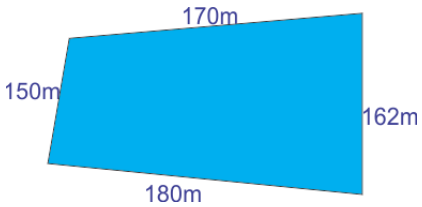


Fig. 5 Irregular shape almost Rectangular

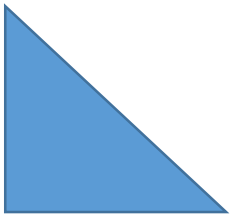


Fig 6 A right angled triangle

Rectangular pond areas are estimated by the formula:

Area = length x width

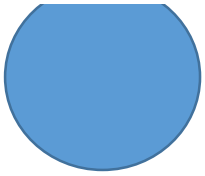


Fig.4 A circular shape

Area of the rectangular pond in Figure 1 is:

Area = 20x 10= 200 square meter

To convert from square meters to square feet (ft2) multiply by 10.56.
To convert from square feet to acres, divide by 43,560 (from Table 1).
Area = 200x10.56 / 43,560= 0.05 or 0.05 acres

In this example the area of the rectangular pond is 200 square meters or approximately 0.05 acres.
Areas of ponds which are almost square or rectangular can be estimated by calculating average length and width measurements.
If we designate the lengths as A and B, and the width as Y and Z then the formula for the area is:

$$\text{Area} = \frac{A + B}{2} \times \frac{Y + Z}{2}$$

For example, figure 5 is an almost rectangular pond that is 150 m on one side and 162 m on the other long side, and 170m on one end and 180 m on the other end, has an area of 27,300 square meters i.e.
((150 + 162) / 2) x ((170 + 180) / 2) or 156m x175m = 27,300 square meters, which is 27,300x10.56 = 288,288 square feet or 6.62 acres.

2.2 OTHER POND SHAPES

Other formulas are used to calculate ponds that are circular and triangular. Even if your pond is not an exact shape, it may be possible to get a reasonable estimate of its area by using one or a combination of these formulas.
Circular pond areas are estimated by the formula:
Area = 3.14 x radius^2
(Radius is one-half the diameter.)
For example, a circular pond with a radius of 6m has an area of 28.3 square meters (3.14 x3x3) the radius can be measured directly or the diameter can be divided by 2. A measurement of the diameter in several directions will help to determine if the pond is truly circular.

2.3 TRIANGULAR SHAPES

Triangular pond areas are estimated by one of two formulas depending on whether the triangle has a square or 90° angle for one of its corners. If a 90° angle is present, the formula is:
Area = 1/2 x length x width
For example, fig 6 is a triangular pond with a length of 250 feet and a width of 220 feet has an area of 27,500 square feet (250 x 220 + 2) or 0.63 acres. It is important to re-member that the longest side (the hypotenuse) is not needed for

the calculation, instead the two sides that touch the 90° angle are used.
If no 90° angle is present (fig 3) and the sides are unequal, the formula is:
Area =V S(S-A) x (S-B) x (S-C)
Where S =1/2 (A+B+C)
And A, B and C are the lengths of the sides,
For example, a triangular pond with' three sides of 80, 90 and 130 feet has an area of 3,549.6 square feet (where S = 150; and \√150(150-80)
x (150-90) x (150-130) or 0.08 acres).

2.4 IRREGULARLY SHAPED PONDS

Many watershed ponds that have been built by damming valleys. These ponds are usually irregular in shape, a reasonable estimate can be made by chaining or pacing off the pond margins and using the following procedures to calculate area.

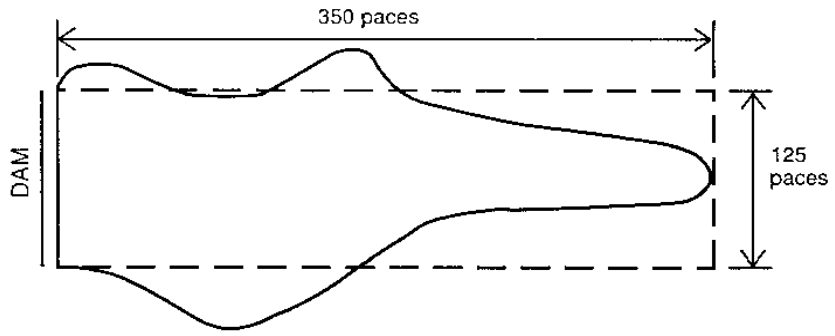


Fig.7. See instructions on how to calculate an irregularly shaped pond.

1. Draw the general shape of the pond on paper (graph paper works best).
2. Draw a rectangle on the pond shape that would approximate the area of the pond if some water was eliminated and placed onto an equal amount of land. This will give you a rectangle on which to base the calculation of area (See Figure 2 below).
3. Mark the corners of the rectangle (from the drawing) on the ground around the pond and chain or pace its length and width. For example, a length of 350 paces and a width of 125 paces would be equal to 896 feet (350 paces x 2.56 feet/pace [pace length, from above]) by 320 feet.

Multiply the length times width (see example above) to get the
approximate pond area. For example, 896 feet x 320 feet = 286,720 square feet or 6.58 acres (286,720 /43,560).
It is a good idea to repeat this procedure two or three times and compare your results. You may want to average these results if they differ.
If a single rectangle does not fit the pond drawing then try to fit some combination of rectangles, circles, and/or triangles. If some combination seems to fit, then calculate the areas of the different shapes, and add the corresponding areas

together to get the total pond area.

3.0 CALCULATING VOLUMES

Volume measurements are needed to calculate the proper concentration of most chemicals which are applied to water and to calculate holding or transport densities.

3.1.0 Tanks

Most tanks used for holding and transporting fish are rectangular. Rectangular volume is calculated by the formula:

Volume = length x width x depth

When measuring a tank, take inside measurements of length and width and the depth at the appropriate water level. If a standpipe or other type of overflow drain is present, then the height to the overflow should be the depth measurement. If the bottom of the tank is sloped toward the drain an average depth measurement should be used. To get average depth of the tank take three measurements: at the shallow end, in the middle, and at the overflow. Add these depths together and divide the total by 3.

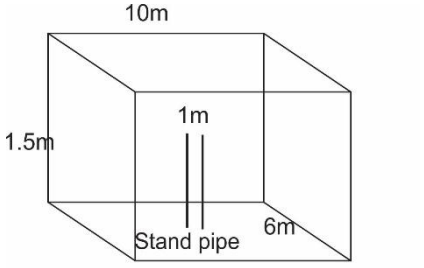


Fig. 8 Rectangular tank

For example, a rectangular tank, without a sloping bottom (see Figure 8 above), has a measured inside width of 6m a length of 10m and a depth at the standpipe overflow of 1m. The calculated volume is 60 cubic meters (10m x 6m x 1m).

In many cases it will be necessary to convert cubic meters (m3) to either cubic feet (ft3) or American gallons. Table 4 gives simple ways to make these conversions. Cubic meters are converted to cubic feet by multiplying by 34.33 (or by dividing by 3.78 to convert to American gallons).

3.1.1 CIRCULAR TANKS

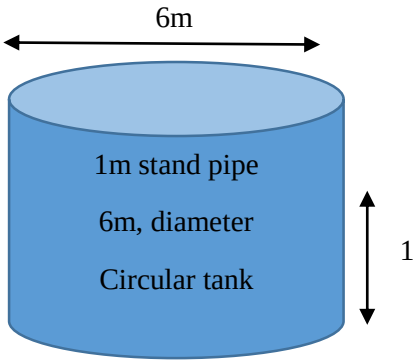
Circular tank volume (Figure 9) is determined by the formula:

Volume = 3.14 x radius^2 x depth

The radius is measured as 1/2 the inside diameter of the tank. The radius is squared or multiplied by itself. For example, a circular tank with an inside diameter of 6m and a standpipe depth of 1m has a volume of 28.30 cubic meters. (3.14 x 3m x 3m x 1m).

Using Table 4 the volume can be converted into American gallons by dividing

3.78 (28.30 /3.78 = 7.5 gallons.



4.0 PONDS

Pond volumes can be calculated using the formula:

Volume = surface area x average depth

Calculating surface area was pre-scented in the first section of this fact sheet. Calculate the average depth by measuring the depth at intervals around the pond. A boat and weighted cord (marked in feet) are used to take depth measurements. Measurement can be done in a grid pattern or in a crisscross pattern.

The number of depth measurements taken affects the accuracy of the estimate. Increasing the number of measurements increases, the accuracy, so take as many measurements as possible.

Record all depth measurements, add them together and divide the total by the number of measurements taken. For example, in Figure 10, the sum of the depth measurements totals 93. feet. Divide 93 by 16 (the number of measurements) to get an average depth of 5.8 feet. The pond volume in this example (taking the surface area as 6.58 acres from previous example) would be 38.16 acre-feet (6.58 acres x 5.8 feet.

Keep good records of your pond area(s) and volume(s). Do not rely on your memory. The water level and volume in watershed ponds may vary from season to season with rainfall, evaporation, siltation and other factors. Pond managers should calculate the volume of ponds at different water levels, so chemical treatments can be applied properly under any condition. Do not guess the area or volume of your pond because the consequences could be costly.

5.0 CONVERSION TABLES

TABLE 1. Useful Conversion Factors (volume refers to water)

1 acre	= 43,560 square feet = 4,840 square yards
1 acre-foot (1 acre–1 foot deep)	= 43,560 cubic feet
1 cubic foot	= 7.48 gallons = 1,728 cubic inches
1 gallon	= 8.34 pounds

TABLE 2. Conversion in Length

From	To				
	inches (in)	Feet (ft)	yard (yd)	centimeter (cm)	meter (m)
in	1	0.0833	0.0278	2.54	0.0254
ft	12	1	0.3333	30.48	0.3048
yd	36	3	1	91.44	0.9144
cm	0.3937	0.0328	0.0109	1	100
m	39.37	3.281	1.0936	100	1

TABLE 3. Conversion for Various Volumes to Attain One Part Per Million.

Amount active ingredient	Unit of volume	Parts per million
2.71 pounds	acre-foot	1 ppm
1.235 grams	acre-foot	1 ppm
1.24 kilograms	acre-foot	1 ppm
0.0283 grams	cubic foot	1 ppm
1 milligram	liter	1 ppm
8.34 pounds	million gallons	1 ppm
1 gram	cubic meter	1 ppm
0.0038 grams	gallon	1 ppm
3.8 grams	thousand gallons	1 ppm

TABLE 4. Conversion in Volume.

From	To						
	in^3	ft^3	fl oz	gal	cm^3	l	m^3
in^3	1	0,000579	0.5541	0.00433	16.39	0.0164	0.00001
f t3	1,728	1	957,5	7.481	0.000283	28.32	0.0283
fl oz	1.805	0.00104	1	0.0078	29.57	0,0296	0.00002
gal	231	0.1337	128	1	3,785	3.785	0.0038
c m3	0.061	0.0000353	0.0338	0.000264	1	0.001	0.000001
l	60.98	0.0353	33.81	0.2642	1	1	0.001
m 3	610,000	5.31	33,800	264.2	1,000,000	1,000	1

in^3 = cubic inches; ft^3 = cubic feet; fl oz = fluid ounce; gal = gallon; cm^3 = cubic centimeter; milliliter = ml; 1 = liter; m^3 = cubic meter.

TABLE 5. Conversion for parts per Million in proportion and percent

Parts per million	Proportion	**Percent**
0.1	1:10,000,000	0.00001
0.5	1:2,000,000	0.00005
1	1:1,000,000	0.0001
2	1:500,000	0.0002
3	1:333,333	0.0003
5	1:200,000	0.0005
7	1:142,857	0.0007
10	1:100,000	0.001
15	1:66,667	0.0015
25	1:40,000	0.0025
50	1:20,000	0.005

100	1:10,000	0.01
200	1:5,000	0.02
250	1:4,000	0.025
500	1:2,000	0.05
1,550.00	0.489583333	0.155
5,000.00	0.180555556	0.5
10,000.00	1:100	1.0

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YOUTH AGRICULTURAL ENTREPRENEURS PROGRAMME

(YAGEP)

TRAINING MANUAL

ON

SUSTAINABLE MANAGEMENT OF AQUACULUTURE IN NIGERIA

BY

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SUMMARY

Aquaculture has an important role in the development of many national economies and plays a key role in rural development in Sub-Saharan Africa including Nigeria.

As the aquaculture industry expands, there is a growing concern over the impacts of aquaculture on the environmental sustainability and also over the requirements on quality and food safety by consumers and regulators. For this reason, there is a need to improve aquaculture technology and management systems in Nigeria to address the need for eco-friendly production process and food safety concerns in the sustainability of national aquaculture.

Nigeria Fisheries Management should be done for job opportunity, for fisher, aquaculturist, related community welfare, and also for fisheries resources and environmental sustainability. In addition, it is mentioned also that the product from both capture and aquaculture fisheries should meet quality standard and product safety. The most critical factors to achieve sustainable aquaculture in Nigeria are availability of good quality seed, good practice in growing out system, aquaculture environments, fish health management, quality of product and marketing.

This write-up deals with the review of Nigeria Aquaculture related with sustainable practices and management schemes to preserve the aquaculture environment, food safety requirements for aquaculture products, and product quality and safety.

KEYWORDS: Sustainable aquaculture, product quality and safety.

1.1 INTRODUCTION

Aquaculture has an important role in the development of many national economies and plays a key role in rural development. Farmers in the Africa, Region contribute over 5 percent of the world's aquaculture production, with China producing 50 percent of global production (Haylor and Bland, 2001). At the global level, aquaculture is one of the fastest growing food production sector (9.6 per cent/yr in the last decade), a fact that will ultimately change the way that fish is perceived as food (Josupeit, et al., 2001).

In Nigeria, the production of Aquaculture increased from 304,962 tons (2000) to 400,000 tons (2004) or increased at the rate of 10.36% per year. As the expansion of aquaculture product, there is a growing concern over the impacts of aquaculture on the environmental sustainability and also over the 2 requirements on quality and food safety by consumers and regulators. In Nigeria, there is also increasing demand among consumers for high-quality, eco-friendly, and safe aquaculture products. The rapid expansion of Fish farms in has led to concerns regarding its long-term sustainability.

The major bottlenecks in the development of sustainable inland finfish are availability of fingerlings, grow-out feeds, environmental issues, disease and marketing (Rimmer and Sugama,2005). The Conference on Aquaculture in the Third Millennium in Bangkok February 2000), noted that there was a need to develop and adopt policies and practices that ensure environmental sustainability, and also as consumer awareness, aquaculture producers, suppliers and processors will need to improve the quality of products and enhance product safety and nutritional value (NACA/FAO, 2000).

The Nigerian policy on sustainable aquaculture requires among others that Fisheries Management should be done for job opportunity, and for fisher, farmer and related community welfare, and also for fisheries resources and environmental sustainability. In addition, the product from both capture and aquaculture fisheries should meet quality standard and product safety.

The most critical factors to achieve sustainable aquaculture in Nigeria are availability of good quality seed, good practice in growing out system, aquaculture environments, fish health management, quality of product and marketing. For this reason, there is a need to improve aquaculture technology and management system in Nigeria to address the need for eco-friendly production process and food safety concerns in the sustainability of national aquaculture. These are parts of a holistic approach which has to be taken to achieve sustainability of Nigerian aquaculture.

The holistic approach includes the culturing technologies, socio-economics, natural resources and the environment. This paper dealt with the review of Nigeria Aquaculture related with sustainable practices and management schemes to preserve the aquaculture environment, food safety requirements for aquaculture products, and product quality and safety.

2.0 SUSTAINABLE PRACTICES AND MANAGEMENT SCHEMES TO PRESERVE THE AQUACULTURE ENVIRONMENT

The guidance of sustainable aquaculture especially on fish pond culture has been issued by the Federal Ministry of Agriculture, Directorate of Fisheries in 2004 and socialized throughout the country. The objectives of

these guidelines are to provide good operation of fish culture in sustainable and eco-friendly manner and to produce good quality and safety harvest. Management practices in this guideline include water management, pond preparation, how to provide good quality seed, feed and feeding management, restriction on the utilization of chemicals and drugs, solid waste and effluent management, and handling or harvest management (FMA, 2004).

3.0 Fish Health Management

Based on the experiences of fish farmers emphasis is on disease prevention. Disease control in fish farms focuses first on preventive measures related to good management practices that maintain good water quality, with better or certified seed, less stress, and high-quality feeds.

All farmers should apply the preventive approach. They should apply probiotics routinely in the pond water preparation, and hold the water in the pond or should not do total water change in the first two months of culture period, and always use (specific pathogen free) SPF seed even though the price of SPF seed is twice more expensive than that of non SPF seed. Apply probiotic to maintain good water quality and to avoid deadly fish diseases.

4.0 Biosecurity.

Biosecurity is applied by making fences to avoid crab or other disease carrier animals from entering the ponds, using filter device in the inlet pipe, and eradicating all disease carriers like wild fish at the water preparation phase. If there is a suspicious disease in the water, sterilization of water using chlorine is made before flushing the water to the environment.

Effluent standard quality has been made and included in the guidance of sustainable aquaculture however, its Implementation in small-scale ponds still needs to be more Socialized.

The depth and length of time of aerating the water is managed based on the fish density in the pond. The awareness of many farmers on the ecological function of mangrove ecosystem has already been well developed.

In several area of fish farms, local community based management have been initiated and reforestation of mangrove is one of their objectives. This activity will help to create better environmental condition of farms. In general, the major activities for the success of fish culture especially catfish culture are the availability of good quality seed, good feeds with appropriate use of protein level, and good management practice.

Farmer's attitude towards change in approaches and new technologies, access to information and technology and the applied strategy of appropriate stocking based on pond carrying capacity are very important. There is a good harvest from fish ponds where there is a good local organization and best management practices.

However, the rapid expansion of fish culture has led to concerns regarding its long term sustainability. Farmers in Nigeria are hampered by the disease outbreaks in their ponds. Even though seeds have been imported from good hatcheries in Indonesia, Holland and Denmark, the socialization of Best Management Practice of Aquaculture is needed and strengthened through good farmer groups. Rapid and early diagnostic on brood stock and on seeds until growing fish in ponds to detect harmful diseases is also required.

Freshwater aquaculture is hampered by contagious diseases which occur in on-growing fish of all ages and in all culture systems. Some alternative strategies have been developed by Fish Health Research institutes, and disseminated to fish farmers in Nigeria with the aim to minimize losses, i.e.

(i) Integrated fish health management,
(ii) using Specific pathogen free (SPF) brood stock fish and strictly quarantine system,
(iii) Applying immune-prophylactics (e.g. feed additive) to increase halt immune status of fish,
(iv) Induce specific immunity “vaccination” by cohabitation technique,
(v) Stress factors avoidance through proper handling, good water quality and appropriate stocking densities.
(vi) Disinfectant use,
(vii) Treatment against secondary infections,
(viii) Biosecurity application,
(ix) Poly-culture system,
(x) Avoidance of macroclimate affect (good and bad season or dry and rainy season), and
(xi) Alternating commodities (non-susceptible species)

Commercial diets for finfish are available in mitigation of environmental impacts of fish farming and may be achieved by keeping stocking density (and hence, pollution loading) well below the carrying capacity of the water body. Improvement of feed formulation and operating integrated culture (using macro algae, filter-feeders and deposit feeders) are also ways to reduce significantly pollution loading and environmental effects from fish farming (Wu, 2001).

There is a problem in the aquaculture development planning especially that in the remote area. The development of aquaculture zone in the remote area is usually hampered by lack of good infrastructure like good irrigation channels, access road, electricity, ice-making plant in the area nearby. Without these good infrastructures, it will be difficult to achieve more efficient aquaculture operation. Hence, marketing of aquaculture product in global perspective will always be less competitive with other exporter countries. For this reason, the result of land capability and carrying capacity assessment which is used for aquaculture planning should be followed by the investment and construction of such infrastructures.

5.0 FOOD SAFETY REQUIREMENTS FOR AQUACULTURE PRODUCTS

Fish processing and fish product should meet “pre-requisites” and quality assurance and food safety. Quality assurance system and food safety has three subsystems i.e.:

(i) quality control and surveillance,

(ii) the development and application of pre-requisites or standard on raw materials, sanitation, handling and processing techniques, product quality, facilities and infrastructure, testing methods, and Certification.

(iii) Hazard Critical Control Point (HACCP) Standard.

The use of Hazard and Critical Control Point (HACCP) system for aquaculture is yet to be commonly implemented in aquaculture production in Nigeria. The system was adopted internationally in 1992. HACCP has strong complement with Sanitation Standard Operating Procedures

SSOP). The HACCP system is used as a base for the implementation of Integrated Quality Management Program.

Monitoring of pathogenic bacteria, chemical contaminations and drug residues. YAGEPreneurs should routinely report disease out-breaks to ensure proper monitoring and quick management.

6.0 PRODUCT QUALITY AND SAFETY IN AQUACULTURE

Breeding using genetically improved brood stock are available and its management are key factors in the process of production of good quality seed.

Integrated quality management control on seed production system should be applied to create more feasible aquaculture, and hence the production sustainability.

6.1 Feeding and nutrition

The pellet feed with its components composed of imported fish meal increased cost of culture farm and minimized the profit especially for freshwater aquaculture. Several steps are taken as a solution to minimize the use of fish meal or minimize the culture cost, i.e.:

(i) increase the utilization of local fish meal.

(ii) substitution of fish meal with agriculture products and wastes, and in turn to minimize the capture or stress on wild fish stock.

(iii) Synchronize the level inputs with the intensity level of culture technology.

Marginal analysis on farm Management usually indicated that maximum profit can be achieved not at a level of maximum input and output, but well below these levels and improvement of feed composition to a feed in

which its nutritional value has been reduced due to fish meal use reduction.

Utilization of fish meal for catfish feed has successfully decreased until the level of 5-10% using soybean meal as a substitute component. Several trials have indicated good results on the application of fish silage, mollusc meats, plant-based protein, and maggot harvested from palm-oil wastes. Integrated aquaculture and poly-culture is a good culture technique in ponds. Intensive fertilization is applied to stimulate natural feed and hence minimize cost of feeds.

7.0 CONCLUSIONS

Best Management Practice of fish culture and Good Aquaculture seed production system growing out pond and Fish health management should move from disease treatment with all the negative environmental impacts and other consequences, to a future of disease prevention with the application of best management practice, the use of Good quality seed:

- provides better quality assurance,
- ensures food safety in aquaculture products and
- meets consumer and regulator demands (to improve product quality and safety in aquaculture).

The implementation of sustainable practices and management schemes which preserves the aquaculture environment would not only increase productivity and incomes of farmers in more efficient, responsible and competitive environment, but also sustainable true aquaculture practice.

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TRAINING MANUAL

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1. INTRODUCTION

Fish Pond Management (Fpm)

Fish pond management involves the duties that are necessary for the successful operation of fish farms in a cost effective manner. This necessarily involves manipulating a complex of interacting biological, physical, chemical and environmental factors that promote high stocking rate, growth rate, survival rate, and good pond structure and water quality.

Fish Pond: Any receptacle that holds water for the culture of fish. It comes in different types.

1. Earthen pond
    a) Freshwater Earthen pond
    b) Brackish water Earthen pond
2. Concrete pond
3. Plastic Tanks
   (Collapsible, Rigid, Wooden troughs with plastic Lining)
    a. Tarpaulin tanks
    b. GeePee/Futura tanks

2. FISH POND INFRASTRUCTURE MAINTENANCE

Fish pond infrastructure must be maintained to reduce high level of depreciation that can lead to water or fish losses.

Shape of pond: This can be of any shape, but they are mainly found in square, rectangular or circular.

Earthen (dugout) fish pond

- ❖ General vegetation cleaning.
- ❖ Filling of cracks, fissures and subsidence in dams.
- ❖ Repair of eroded dam slopes and crests.
- ❖ Regrassing of eroded dams/dykes.

- ❖ Checking and repairs of monks, pipes and outfalls.
- ❖ Plugging of monkboards with clay or cloth stuffings.
- ❖ Manual raking of aquatic weeds and scum regularly.

3. PREVENTION AND CONTROL OF PREDATORS

A) **Dugout ponds**

- ❖ Ponds should be neutralized with agricultural lime at the rate of 200 - 500kg/ha (20 -50g/m^2) or 500 - 2000kg/ha (50 - 200g/ m^2) when necessary.
- ❖ The inlet and outlet water bearer structures should be properly screened.
- ❖ The fish pond should be fenced/screened with nets or wire netting.

B) **Fish tanks**

- ❖ Repair damaged outlet pipes or control valves.
- ❖ Repair of top covering spread nets.
- ❖ Repair of screens/partitions.
- ❖ Removal of scum on the surface of the tanks/pond water.
- ❖ Repair of leakage around pipes/back wall joints.
- ❖ Repair of inlet pipe works/shower spray systems.
- ❖ Cover with netting for block wall fish tanks.

4. APPLICATION OF FERTILIZER, LIME AND POND PREPARATION

Preparation of old and new ponds is done to create a suitable culture environment for the wellbeing and growth of the fish to be stocked.

The principles are basically the same for old and new ponds, though there are minor contingent differences it generally involves LIME and FERTILIZER treatment of pond bottom (to reduce loss by seepage, improve pond fertility and stimulate plankton production), flooding of the pond and maintenance of optimum water depth, sanitation and disinfection of ponds as well as desiltation.

Lime Application (Liming rate)

Quicklime/slacked lime – 20-50g/m^2

Agricultural lime - 50-200g/m^2

Fertilization

Inorganic fertilizer

- NPK, SSP : 5G/m^2
- Urea : 2g/m^2
- Organic/ manure
- Cow dung 100g/m^2
- Chicken dropping 50g/m^2

The ground and powdered lime should be broadcast or spread over the entire dried pond bottom and left to dry on the soil for 14 days (2weeks). The pond is then flooded up to 60cm (0.6m) (above the knees), fertilized and left for 7days for plankton to develop before flooding completely with water to 1.0-1.5m level in readiness for stocking with fish.

Filling of pond

Fill ponds slowly and gradually to avoid mud stirring of pond bottom, turbidity (from silt, sand, clay particles), and possibly dyke collapse from uneven wetting.

If the pond is filled with over - head pipes, sizeable stone, gravel, bricks or wooden board should be placed at the bottom to break the fall of water first. Maintain a reasonable freeboard (minimum15-20cm) and avoid filling pond water to same level as top of pond walls. (The freeboard is the distance between the maximum water level and the top of pond level).

5. PREPARATION OF DRAINED POND FOR NEXT PRODUCTION CYCLE

- ❖ Remove silt, mud, detritus and clay (from dyke erosions, turbid water, organic fertilizer, rain run-off etc.) from pond bottom to maintain pond depth.
- ❖ Completely plough and expose pond bottom to sun and air for some days or until the pond bottom soil cracks.
- ❖ Clear the bottom of twigs, branches, leaves, dead fish etc. and destroy all predators that feed on fish (snakes, frogs)
- ❖ Smoothen the ploughed and cleared area.
- ❖ Check any fences for damage. Repair holes which let in piscivorous (fish eating) animals and clear weeds and unnecessary vegetation in and around the pond to keep pests and predators away.
- ❖ Check inlets and outlets for damage, and all screens for removal of clogs. Replace if necessary, check for all cracks, leaks or weak points on the wall and repair them.
- ❖ Attend to any replanting of grass cover (regrassing) on pond walls or mowing.

6. FISH STOCK MANAGEMENT (FSM)

Stocking normally takes place after pond preparation, liming and fertilization. And is the means of introducing an adequate number of selected fish species of proper size into the ponds for culture. It involves live fish transportation from the wild or hatcheries, and avoidance of stress before and during introduction. Being kept in a relatively small container at high density creates twin problems of high oxygen requirement and rapid deterioration of water quality due to accumulation of metabolic waste which could cause stress and high mortality.

In any fish enclosure, healthy fingerlings of 5-7cm (2’’-3”) should be stocked. Stocking densities should range between 5-10fish/$m^{2.}$. Fish fingerlings should not be fed for 24-72 hours (1-3days) before transportation. They survive better on empty

stomach when in transit. Stocking of fish should be done in early mornings or late evenings in moderately cool weather.

- Fish fingerlings or juveniles should be transported and packed in water filled oxygenated polythene bags or plastic containers.
- Release fish seeds to their new home surroundings slowly to avoid shock due to temperature changes.
- Stocked fingerlings should be sorted after 15days (2weeks) of initial stocking to remove shooters (jumpers) in order to reduce cannibalism and ensure even growth of fish. Sorting could be done and advisable, preferably in the mornings (8.00-10.00am).
- Sorted fish should not be feed for 2hours minimum or 3hours maximum. This will help to relieve the fish of handling stress and regaining lost energy.

7. BRACKISH WATER 'CHICOCO' MANGROVE WETLAND (SWAMP) POND

The mangrove swamp (area) is named after mangrove tree (Rhizophora Spp) which is the dominant vegetation in coastal areas alternately flooded and drained by high and low tides.

The main environmental factors affecting the construction and operation management of (Chicoco Ponds) farm are;

- Water quality
- Vegetation
- Soil condition
- Tidal range
- Land elevation
- Topography
- Climatic conditions

This discussion will dwell only on Tides and Tidal range, and soil conditions, since they appear to be basic "Knowledge Challenge" in the operation and effective management of the Chicoco Ponds.

TIDES AND LAND ELEVATION

Tides are important in fish farming, in the management of mangrove swamp pond, because they are used to fill, drain and maintain adequate DEPTH of water in ponds, tides are caused by the gravitational force of the moon and to a large extent of the sun on the oceans. The moon pulls the ocean water in its direction as it rotates around the earth. The LUNARDAY or the time required for the moon to rotate around the earth is **24hrs and 50mins** long. During this time in Nigeria's coastal water, there is a CYCLE OF TWO HIGH TIDES AND TWO LOW TIDES.

The interval between a consecutive Low Tide and a High Tide average 6 hours and $12\frac{1}{2}$ minutes. Every day the tide will advance 50 minutes because the earth's day is only 24hrs long. Therefore, if a high tide occurs at 9:00am on Wednesday, the high tide on Thursday morning will occur at 9:50am.

Knowledge of the daily change in the time of the tides is important in water management on a Chicoco Pond.

The lunar month is 28 days which is different from the calendar months. Within each lunar month, the high and low tides vary. The highest high tides and the lowest low tides occur during the period of the new moon and full moon when the gravitational forces of the moon and the sun are pulling the oceans in the same direction.

The lowest high tides and the lowest low tides occur during the period of the FIRST and THIRD Quarter moon when the gravitational forces of the sun and the moon are pulling at right angles to each other, the result is that the high and low tides from day to day are not the same, but are constantly increasing or decreasing. Within the lunar month, the high tide rhythmically oscillates up and down so does the low tide. The time between new moon, 1^{st} quarters full moon, 3^{rd} quarter and new moon again is 7days between each of the four phases for a total of 28 days.

Tide guage - a board of 3m x 10 x 250 (9’ x 4’ x 1’) painted white, marked and Numbered at 5cm (2’) intervals from 0.0 – 3.0m.

Measure tides for 1-3 months.

THE EFFECTS OF BOTTOM SOIL PROPERTIES ON FISH PRODUCTION

VARIABLE	RANGE	FISH PRODUCTION
PH	Less than 5.5	Low
	5.5 - 6.5	Average
	6.5 – 7.5	Optimum
	7.5 – 8.5	Average
Available phosphorus	Less than 3ppm	Low
	3- 6ppm	Average
	More than 6ppm	Optimum
Organic waste	Less than 25ppm (25mg/L)	Low
	25 – 50ppm	Average
	More than 75ppm	Optimum
Organic carbon	Less than 0.5%	Low
	0.5 – 1.5%	Average
	1.5 – 2.5%	Optimum
	More than 2.5%	Declining

The effects of liming on water are as follows:

- To increase PH of soil
- Increase the alkalinity and hardness of water
- Flocculate suspended soil particles
- Increase the buffering capacity of the water
- Increase the availability of carbon for photosynthesis
- Enhance bacterial activity in the soil
- Increase availability of phosphorus

LIMING RATE

Dyke - 500g / linear meter - 0.5kg/Linear meter

Pond water - 10g / m^2 (100kg/ha)

Pond bottom - 50g / m^2 (500kg/ha)

USING FISH BEHAVIOUR AS INDICATOR OF LOW PH

- ❖ Fish remain immobile and resting on the pond bottom
- ❖ Fish swim erratically
- ❖ Fish may actually be dying or dead
- ❖ Fish, mudskippers, craps and shrimps may come out to the pond dyke

Another indicator of low PH is a bright YELLOW colour on the pond dykes and/ or yellow- orange colour in the pond bottom. This yellow colour is Ferro-potassium sulphate or jarosite – lime neutralizes and changes the colour to orange.

THE EFFECTS OF PH ON POND FISH

PH	EFFECT
4	Acid death point
4 – 5	No reproduction
5 - 6	Slow growth
6 - 9	Best growth
9 – 11	Slow growth
11	Alkaline death point

COLOUR METER READING

COLOUR	PH
Red	4 or less
Yellow	5 – 6
Green	7 – 8
Blue	8.5 or more

Influence of dissolved Oxygen (Do) Concentration on Pond Fish

Dissolved Oxygen Concentration	Effect
Less than 1 or 2 mg/ L (ppm)	Lethal if exposure last more than a few hours
2 – 5	Growth will be slow if exposure to low Dissolve Oxygen is continuous
5mg/L – Saturation	Best for growth
Above Saturation	Can be harmful if supersaturated conditions exist throughout pond volume. Normally there is no problem

Water colour and water turbidity are also good indicators of acidic conditions.

Normal pond H_2O – fairly green to brown on colour. If after a rain, the pond water suddenly clears and visibility increases and the colour changes to a transparent yellowish – green, then acidic conditions exist. The reason is that oxidation reactions of the acid sulphate soil produce alum AL_2SO_4 which precipitates or removes suspended materials from the pond water.

8. WATER QUALITY MANAGEMENT

Water quality, according to Boyd and lichotkopler (1979), include all physical, chemical and biological factors that influence the beneficial use of water. It affects the survival, growth and reproduction of fish. Fish yields better with in a pond with good water quality than those with poor water quality.

Water quality variable could be grouped into:

a) Physical quality variable.
b) Chemical water quality variable.
c) Biological water quality variable.

Physical water quality variables include temperature and turbidity. Water temperature affects the activities, behaviour, growth, feeding and reproduction of all fishes. A sudden temperature change in temperature will stress or kill the fish. Fish or other Aquatic animals require twice as much O_2 at 30^o C than 20^o C.

Turbidity: Water is turbid when it is not clear. It is therefore a measure of water transparency. Turbidity can be caused by plankton or clay.

9. FISH FARM/ POND EQUIPMENT MANAGEMENT

Fish pond equipment include: hand scoop nets, dragnets, wheelbarrow, weighing scale, knives, basins and jerry-cans of different sizes.

- ❖ Hand scoop nets and dragnets are useful for test cropping and cropping of fish for sales.
- ❖ Fish farm utensils like knives and de-scatters are used for cutting fish into small pieces or for removing scales from the body of fish.

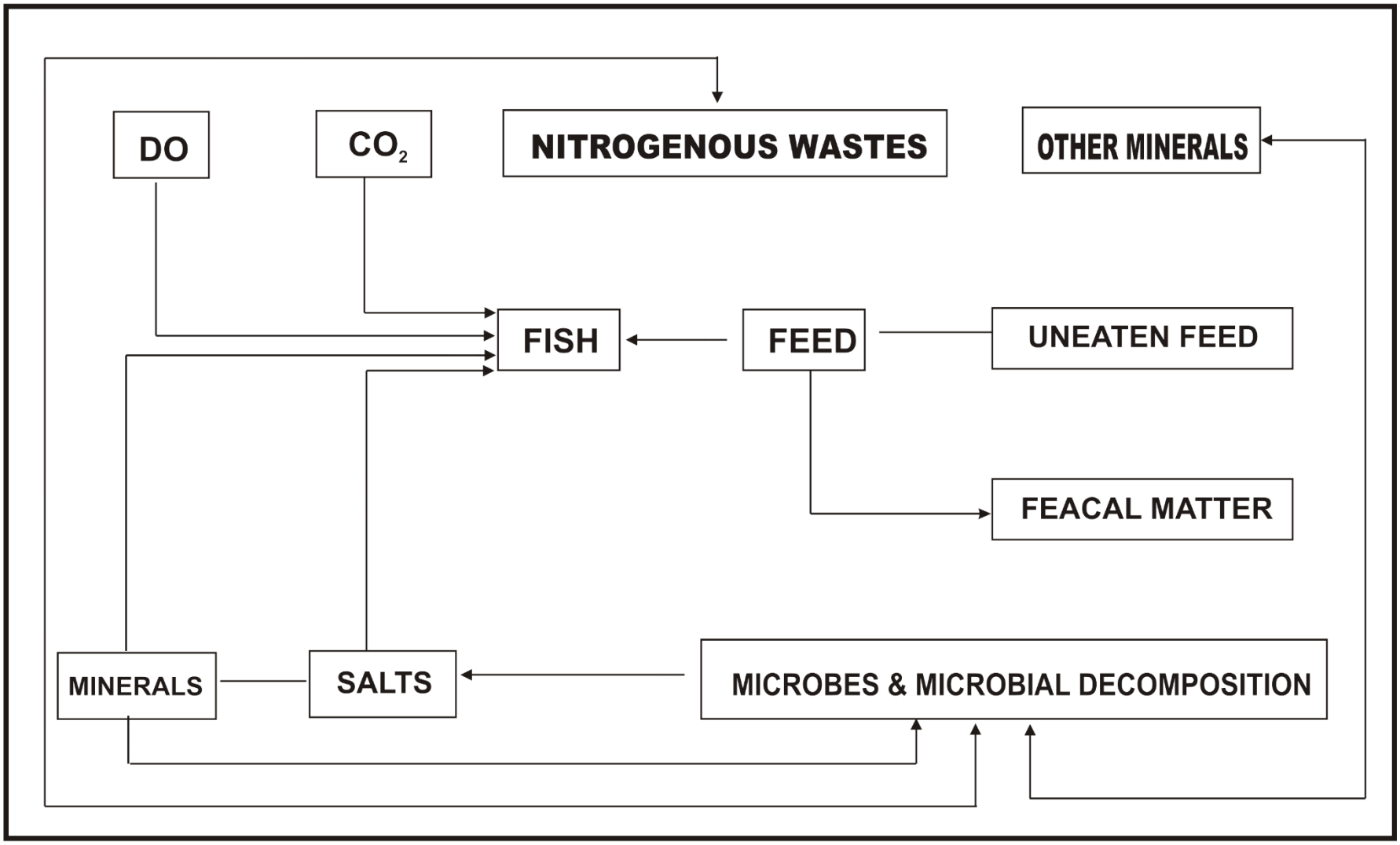
Once a month, it is advisable to disinfect all farm implements by lime-stocking at the rate of 100kg/ha (quicklime) for over an hour, with rinsing and washing to allow for sun drying before reuse. Dragnets and scoop nets should be hung-dried under shade after use before storage.

10. GOOD POND MANAGEMENT PRACTICES (IMPACT POINTS)

- ❖ Stock healthy and disease free fish seeds, preferably obtained from reputable fish hatcheries.
- ❖ Avoid overcrowding and stock correct number of fish seeds per unit area. Monoculture 5-10 fish/m^2. Polyculture (catfish & Tilapia) 5-10 fish/m^2. Combination ratio: 3 catfish: 2 Tilapia
- ❖ Maintain good water level (1.0 -1.5) and quality always.
- ❖ Watch out for fish enemies (including human poachers) and eliminate or control undesirable and unwanted organisms inside and around the pond area.
- ❖ Feed fish regularly twice or thrice daily from the same feeding sport by gradual broadcast.
- ❖ Avoid excessive feeding in order to prevent pond fouling and pollution.

- ❖ Maintain normal pond water, Green colour. Replenish water if colour is too deep green or when the fish begins to gather at the surface to gulp for air.
- ❖ Watch fish behaviour for abnormalities and immediately remove diseased, dead or dying fish (or any other dead animal found in the pond/area).
- ❖ Maintain pond structures. Routinely check for blockages and damages and repair pond walls, pond bottom screens, inlet and water supply structures.
- ❖ Keep accurate records of fish farming activities

10. **FISH AND THE POND ENVIRONMENT**



KEY: DO - DISSOLVED OXYGEN; CO_2 - CARBON (IV) OXIDE

Table 1: Water Quality Parameters: Management

PARAMETERS	RECOMMENDED VALUES	POSSIBLE PROBLEMS	POSSIBLE SYMPTOMS	CONTROL
Dissolved Oxygen	4mg/litre (minimum)	• Heavy plankton bloom due to excess manuring • Overfeeding or after feeding due to increase in oxygen demand to digest food. • Overcrowding due to high stocking densities • Water flow drops in intensive systems. • 'Crash' of algal populations. • Reduction of photosynthetic rate due to cloudy weather or reduced nutrients.	• Crowding near water inflow source • Gasping for air at the pond surface • Refusal to accept feed pellets • Increased vulnerability to disease • Lack of response to noise	• Water should be flushed out • Replace with fresh water • Feeding should be suspended for sometime • Fertilization should also be suspended • Aerate the medium with aerators/blowers to increase oxygen level
Ammonia (NH_3)	0.05MG/litre	• Accumulation of wastes at pond bottom • Over fertilization	• Gasping for air • Few mortalities occurring daily	• Avoid excessive stocking densities and fertilization

PARAMETERS	RECOMMENDED VALUES	POSSIBLE PROBLEMS	POSSIBLE SYMPTOMS	CONTROL
		• Pollution from sewage wastes	• Poor acceptance of feed	• Flush out water and replace with new/fresh oxygenated water • Reduce/deny feeding to reduce metabolism of proteins
				• Reduce feed intake and apply only at optimum level • Use phosphorous only at 45kg/ha (for large ponds)
Nitrite (No_2)	0.30mg/litre	• Mortalities of stocked fish due to lack of oxygen	• Brown patches on the gills known as brown blood disease	• Correct stocking density. Addition of chloride ions (such as Sodium chloride) • Flushing of the system

PARAMETERS	RECOMMENDED VALUES	POSSIBLE PROBLEMS	POSSIBLE SYMPTOMS	CONTROL
				• Correct biofilteration in recirculatory system
Turbidity or suspended clay particles	5mg/l for fry in hatcheries <20mg/l for growing fishes: ideal range is 40cm on secchi disk in ponds or fish tanks	• Excessive mucus production on fish body • Gill damage • Bacterial disease(s) • Reduced abundance of food available to fish • Limit growth of algae • Solids may coat eggs and reduce oxygen transfer and hence reduce hatchability of eggs to frys	• Poor growth • Mortalities	• Correct stocking density • Filteration of water • Use of settling tanks • If turbidity level is low, fertilization could be effective otherwise, the water should be drained off • Screen inlets to reduce inflow of silts • Use of wood ash advisable • 2500-5000kg/ha for old ponds

Table 2: Associated water quality problems

PROBLEMS	POSSIBLE CAUSES	POSSIBLE SYMPTOMS	SOLUTIONS
Reddening/ Pinkishness	Red surface films for use of cotton seed cake in the case of fish tank. Ferric intrusion in earthen/dug-out fish pond due to the oxidation of ferrous items in water. Purplish or pinkish colour from prolonged use of palm kernel cake	• Reddish colouration seen on the medium surface • Pinkish colour observed on the surface	• Stop the use of cotton seed cake or palm kernel cake • Flush ferric intrusion more frequently
Deep Black Dark green colour	Use of blood meal in feed for fish in tanks	• Deep black/ green colour	• Flush or drain water away regularly
Foul smelling Rancidity/ Scumming of pondwater	• Use of uncooked intestinal offals • Dumping of dead foetus of animals • Overfeeding Overfertilization	• Foul odour • Mortalities	Stop feeding with uncooked offals. Pick/rake off uneaten food. Flush/drain out water and replace/ aerate the water. Use cooked or parboiled offals. Offer wel-dried fish pellets. Fertilizer accordingly
Frothing/ foaming/	• Overfeeding • Overfertilization	• Clusters of feed particles on surface	• Stop feeding, feed the desired quality and quantity only.

PROBLEMS	POSSIBLE CAUSES	POSSIBLE SYMPTOMS	SOLUTIONS
slurry	• Mortalities • Slurry debris on surface and bottom	• Deep green colour • Patches of slurry on medium surface or bottom	• Flush out water and replace. • Fertilize according to standard procedures. • Use ash to coagulate the slurry on the water surface
Low oxygen	• High stocking densities • Poor aeration • Overfeeding • Over fertilization • High cloud over	• Fish swim up to the surface frequently and in erratic manner • Refusal of fish to accept feed	• Stop feeding • Flush out water • Aerate the medium
Floating aquatic weeds	Entry through unscreened inlets	• Fish struggling for air. • Still pond surface looks static	Rake off floating weeds at the surface

DELTA STATE GOVERNMENT

OFFICE OF THE CHIEF JOB CREATION OFFICER,

GOVERNOR'S OFFICE.

YOUTH AGRICULTURAL ENTREPRENEURS PROGRAMME

(YAGEP)

TRAINING MANUAL

ON

FISH FEEDS FORMULATION AND FEEDING TECHNIQUES

IN CATFISH FARMING

BY

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INTRODUCTION

The success of the fish farming enterprise is largely determined by the quality and quantity of the feed the farmer is ready to give to the stocked fish. This is as a result of the fact that the yield or the growth of the fish is determined by what they eat. It has been proved that for a farmer to produce 1kg of flesh, the fish must have converted 1kg of the feed it has eaten to flesh. This, therefore, underscores the importance of feeds in the fish farming enterprise. Also for feed to serve its usefulness it must be nutritionally balanced with all the requisite nutrients at the required levels and should be able to meet the energy need of the fish as well as being easily digested.

This paper, therefore, examines the following: -

- Components of feed and feed formulation;
- Feeding of fries, fingerlings to adult fish;
- Feeding techniques and administration of feed supplement.

2.0.0. COMPONENTS OF FEEDS

There are different brands of feeds available in the market for the fish farmer to choose from. Among the foreign brands are Coppens, Multi-feed, Aller-Aqua, Zigler etc. while the indigenously produced brands are Top feeds, Vital feeds, CHI feeds and others. These feeds are packed in 15kg or 20kg bags. They are produced in various sizes of 0.1mm to 1.5mm, 2mm, 3mm, 4mm, 6mm and 9mm, to meet the need of different sizes of fish. Feeds are produced as either floating or sinking pellets. Whatever the brand of feed it must contain certain nutrients that will help the farmer optimize the growth of the fish as well as increase the profit in the catfish farming business. Below are the five essential nutrients in any feed formulation.

2.1.0. PROTEIN

Protein is required for building of the body tissue i.e. for growth and replacement of damaged tissues. This means fish need a continual supply of this nutrient throughout their life for proper growth and maintenance. Proteins are made up of substance called amino acid. Amino acids are classified as either indispensible (essential) or dispensable (nonessential). An indispensible amino acid e.g. lysine and methionine is one that the animal cannot produced or cannot be produced in enough quantities for the need of the body, thus they must be supplied in the diet. A dispensable amino acid is one that can be produced by the animal in quantities enough for

maximal growth. Although the dispensable amino acid can be produced by catfish but they are still added to the diet due to some other advantages derived from them. For example if these amino acids are in the diet, energy is saved in their synthesis and some dispensable amino acids can partially replace some indispensable amino acid. Catfish feed contain a good amount of dispensable amino acid found in the proteins of the various feedstuffs and supplemental lysine and methionine.

2.1.1. The dietary protein requirement of catfish is affected by the following factors: -

- **Fish Size**-Smaller fish need more protein (about 45% to 55%) than bigger fish (about 36% to 42%).
- **Water Temperature**- Feed intake is less at lower temperatures than at higher temperatures.
- **Feed Allowance**- Feeding fish to satiation gives more volume of feed than when fish are not fed to satiation.
- **Natural food available**- Natural culture medium often contain natural food like insects, worms, zooplankton which are additional sources of protein, while the artificially culture medium (e.g. tarpaulin, concrete tanks) lacks these, therefore, feed supplied must be rich in protein.
- **Quality of protein**- Animal protein is of higher quality than plant protein and feed loaded with only plant protein is of lower quality. Fish feed must, therefore, have a combination of plant and animal protein.
- **Management practice**- As a result of the factors mentioned above, it is difficult to set a level of protein that is optimum for all situations. However a range of 28% to 42% crude protein for juvenile fish and above, 45%crude protein for fingerlings and 50% to 55% crude protein for fries has generally been accepted by practicing farmers to give good yield and maximize profit.

2.2.0. CARBOHYDRATE

This nutrient serves as a source of energy and form part of the tissue (e.g. blood glucose, liver glycogen). Since animals can produce carbohydrates from lipid and protein, they do not require carbohydrates in the diet for normal growth and function. Although this is the case with animals,

catfish feed always contain adequate amounts of grain or grain by-products that are rich in starch. Starch not only provides the least expensive source of energy but also aids in feed formulation by helping to bind feed ingredients together and to increase expansion of extruded feeds so that the feed pellets are water stable and can float in water.

2.3.0. LIPIDS (FATS AND OILS)

Lipids are a highly digestible source of energy and contain more energy than carbohydrates. Lipids play a very important role in the body of an animal such as supplying essential fatty acids. The use of lipids in catfish feed help to increase feed palatability but too much of it may result in excessive fat deposition in the body cavity and tissues that may negatively affect processing yield, product quality and storage of processed products. Commercially produced feeds rarely exceed 5-6% with about 3-4% found in the feed ingredients and the remaining 1-2% being sprayed onto the finished pellets, spraying feed pellets with lipid increases dietary energy and aids in reduction of feed dust

2.4.0. VITAMINS

These are organic compounds that are needed in small amounts in the diet for normal growth, health and reproduction. The addition of sufficient levels of vitamins to catfish feed helps to eliminate deficiency diseases. This is the reason catfish feeds are generally supplemented with a vitamin premix that contains all essential vitamins in sufficient quantities to meet the dietary requirement and compensate for losses due to feed processing and storage.

2.5.0 MINERALS

Minerals like calcium, phosphorus are needed for normal functioning of catfish as in other animals. Minerals are classified as macro minerals or micro minerals. The macro minerals like calcium and phosphorus are needed in large amounts while micro minerals are needed in small amount in the body. Feed ingredients of plant origin are poor sources of these minerals, therefore, catfish feeds are usually supplemented with dicalcium, deflurinated phosphorus and trace mineral premix in amounts to meet the dietary requirements.

2.6.0. NON-NUTRITIVE COMPONENTS

The following are the other components of catfish feed that does not give any nutritive value to the feed but their inclusion is of value to the feed.

2.6.1 FIBER

Fiber gives bulk to the food while in the gut. Some of the feed ingredients contain fiber; therefore, addition of other fiber stuff like wheat offal should be avoided to reduce fiber level to the accepted level of 3 to 6% in the diet. Catfish feeds that contain fiber level above the acceptable range will increase the amount of waste material deposited in the ponds. Accumulation of waste materials at the bottom of ponds may deteriorate water quality since their degradation depletes dissolved oxygen.

2.6.2 FEED ADDITIVES

Additives to catfish feeds are used to improve the quality and performance of the feeds. Additives include pellet binders, antioxidants and sometimes antibiotics for sick fish. Pellet binders help to improve stability of the feed in water and also reduce dust while antioxidants help to protect nutrients in the feed from destruction during storage.

3.0.0. FEED INGREDIENTS

No single feed ingredient can supply all the nutrients and energy requirement for optimum growth of catfish. Catfish feed are made from a mixture of feedstuff, vitamin and minerals premixes that provide adequate amount of essential nutrients as well as energy necessary for their use. The amount of each feed ingredient used depends on factors like nutrient requirement, ingredient cost and its availability.

4.0.0. PROTEIN SUPPLEMENTS

Any feedstuff containing 20% or more of protein is considered protein supplements. Protein supplements are classified as animal or plant protein, Animal proteins are of higher quality than plant protein because they have good supply of indispensable amino acid. Sources of animal proteins in catfish feeds are:-

- **FISH MEAL**- Fish meal is got from dried ground tissues of whole fish and contains 60-80% protein. It is used at levels of up to 50% in catfish fry-feeds and up to 12% or below in the fish grow out-feeds.
- **BLOOD MEAL**- Produced from clean fresh animal blood and contains 80- 86% crude protein. It is deficient in methionine and can be used up to 5% in feeds formulation.
- **MEAT AND BONE MEAL:** Got from tissues of animals like cow and contain 50% crude protein. Fish meal is preferable to meat meal because it contains less lysine.
- **CATFISH OFFAL MEAL:** Catfish offal meal is prepared from catfish processing waste and contains about 58% protein.
- **POULTRY BY-PRODUCT**-This is made up of parts of the carcass of slaughtered poultry. It contains heads, feet, underdeveloped eggs and visceral organs. It contains about 65% protein.
- **FEATHER MEAL**-This is made up of hydrolyzed poultry feathers that are specially prepared. It is 85% crude protein though the protein quality is not as high as other animal protein sources.

4.1.0. SOURCES OF PLANT PROTEIN:

- **Soybean Meal**- Contains 48% protein and is prepared by removing the oil before grinding the flakes.
- **Full Fat Soybean Meal**- This is prepared by grinding heated soybeans that has not undergone oil extraction process. It contains 39% protein and 18% fat.
- **Groundnut Cake or Meal**- This refers to the grinded cake of groundnut after the oil has been removed and contains 48% protein.
- **Distillers Dried Grains**- These are the brewers waste produced after removal of alcohol from the cereal grains and contains 27% protein.

5.0.0. ENERGY SUPPLEMENTS

Any feedstuff that contains less than 20% crude protein is considered energy supplements. These include:-

- **Corn Grain**- This is mostly used because of its availability and the cost;

- **Wheat Grain**- This is a good source of energy but more expensive than corn and so is sparingly used;
- **Rice Bran;**
- **Cassava**- Some feed producers use cassava flour;
- **Animal and Plant Fats and Oils**- These are highly concentrated sources of energy. Different fats and oils used by feed producers include fish oil, soybean oil, poultry fat etc.

5.1.0. PREMIXES

Vitamin and mineral premixes are added to catfish feeds.

6.0.0. FEED FORMULATION

With sufficient nutritional information available to the fish farmer, many farmers have resulted to formulation of least cost feed, to reduce cost of production. Several formulas are in use by different farmers. The following are sample formulas for feed formulation:-

6.1.0. *Formula for fish of 200-600 grams:*

At this stage, the fish are still small so their food must be rich in protein (42-45%).

Fish meal (72%)	=	25%
Soybean meal	=	30%
Groundnut cake (GNC)	=	20%
Maize	=	20%
Vitamin C	=	0.01%
Fish premix	=	0.05%
Oil	=	0.05%
Methionine	=	0.01%
Lysine	=	0.01%
Salt	=	0.03%
Dicalcium	=	0.1%
Molasses	=	5%

6.2.0. *Formula for 600 grams and above*

Fish meal (Hanstholm 72%)	=	10%
Soybean meal	=	40%
GNC	=	20%
Carbohydrate (maize)	=	25%
Molasses	=	5%

Based on this formula, one ton of fish feed will have 100kg of fish meal, 400kg of soybean meal, 200kg of groundnut cake (GNC), 250kg carbohydrates, 50kg molasses.

The above are the main ingredients, others such as DCP (Dicalcium phosphate) 10kg, methionine 1kg, lysine 1kg, salt 3kg, vitamin c 1kg, fish premixes 5kg, antibiotics if the fish is sick.

7.0.0. FEEDING TECHNIQUES

Feeding techniques is a highly subjective process that differs among catfish farmers as there does not appear to be one accepted best method for feeding catfish. Considering that many factors (most of which cannot be controlled) affect feeding, there are, therefore, variations in feeding practices in different farms.

7.1.0. In some farms the practice is that of feeding a percentage of the fish body weight to the fish while others it is feeding of fish till satiation (i.e. feeding the fish till they are satisfied). It is generally advised that, to maximize production and profits, catfish should be fed a feed that meets their nutritional requirements using feeding strategy that is adapted to the specific pond conditions at any given time. That is, under normal conditions, catfish should be fed daily as much feed as they will consume without polluting the water. However depending on water quality parameters and the health of the fish it may be wise to reduce the daily feed allowance or to feed less frequently. How much to feed and the frequency of feeding are decisions that must be made daily by farmers based on the conditions of each pond. No two ponds are exactly alike, hence feeding behavior in individual ponds may differ from day to day.

The following recommendation should be considered as guidelines:

7.2.0 FEEDING OF FRIES

Newly hatched catfish fries use their yolk sac as energy and nutrient source. Once the yolk sac is absorbed (approximately 3-5 days after hatching), fries begin to look for food and should be fed frequently, In the hatchery fries should be fed with finely ground flour type feed containing 50-55% protein (Artemia,0.2m or 0.3m Coppenss feed, Skretting German wean I). The number of times of feeding can be up to 8 times a day but care must be taken to manage the water quality. In some cases, natural food like small insect larva can be used where they are available. When feeding, drop feed at the corners of tank as well as the middle.

7.2.1 FEEDING OF FINGERLINGS

Fingerlings should be fed 2-3 times daily with feed containing 45% protein. Size of feed should be 1m or or 1.5m or 2m depending on the size of the fingerling. Broadcast or spread your feed on the water surface.

7.2.2 FEEDING OF JUVENILE FISH TO ADULT

The feed that is recommended should be 36-42% protein, the juvenile fish should be fed the 3m size of feed with minimum of 42% protein after one-month change to 4.5m and after another month change to 6m and thereafter 9m till harvest. Feed your fish twice a day at 5% of their body.

7.3.0 HOW TO CALCULATE PERCENTAGE BODY WEIGHT

- Collect sample of fish from the pond using a hand net.
- Weigh the sample fish and count the number.
- Weight of sample fish is divided by the number of fish in the sample to get the average weight.
- The average weight is multiplied by the total number of fish in the pond to get the total weight in the pond.
- Multiply the total weight by 5% to get the feed allowance for the day.

7.3.1.1. For example if the daily feed intake of a population of 1000 fish is to be calculated;

- You will take sample of fish say 100 fish from the pond.
- Weight of 100 fish = 5,000g
- Divide 5,000 by 100 = 50g (average weight)
- Multiply 50g by 1000= 50,000(total weight of fish in the pond)
- Multiply 50,000g by 0.05 (i.e. 5%) = 2,500g or 2.5kg.

7.3.2. This means that the population of 1000 fish with average weight of 50g will eat 2.5kg of feed daily for the next two weeks. To get their new weight, repeat the exercise, after every two weeks. This exercise will enable you to know if your fish are doing well or not. It will also enable you to know the amount of money you spent on a particular population.

N/B The calculated daily feed intake should be divided into the number of times you want to feed your fish per day.

8.0.0. PREPARATION OF FISH FOR THE MARKET (HARVEST)

If you are going to harvest your fish for the market, You do not feed your fish on the harvest day, stop feeding 24 hours before they are harvested This practice will allow the fish clean their intestines and make them better able to survive the stress

DELTA STATE GOVERNMENT

OFFICE OF THE CHIEF JOB CREATION OFFICER,

GOVERNOR'S OFFICE.

YOUTH AGRICULTURAL ENTREPRENEURS

PROGRAMME

(YAGEP)

TRAINING MANUAL

ON

FISH POND MAINTENANCE

FISH PROCESSING, PRESERVATION AND PACKAGING

BY

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FISH POND MAINTENANCE

Meaning: This means taking proper pond management. There are some necessary practices which are: care and observing necessary practices relating to fish

i. **Clearing of weeds:**

This is done at least once a month to remove weeds and grasses around the farm.

ii. **Cleaning of inlets and outlets:**

This is a daily practice observed to remove debris in the PVC inlets and outlets pipes using long wood to push an empty bag or sack through the pipe.

iii. **Desilting after harvest:**

This is like sweeping your room. Removal of silt that accumulated in the pond helps to maintain water freshness.

iv. **Netting:**

It could be done directly on the pond surface and the side around the pond to prevent predators.

v. **Water management**:

Water is necessary in fish farming, so it is important to maintain water flow in and out of the pond to regulate water quality and temperature which are two important factors that determine feed consumption by fish which would translate to good yield when properly maintained.

It is therefore important to ensure that the water level be up to three meter to encourage locomotion. This level of water helps to maintain high level of oxygen in the water to enhance their feeding habit.

In the case of bad water or water pollution, it would be proactive to change the water completely to allow fresh water into the pond as this would help to restore the oxygen level and water quality needed to sustain the fish.

a. FISH CROP AND FISH CROP QUANTITY

i. Fish crop:

This means the size of fish, while

ii. Fish crop quantity:

Means the number of fish in the pond. It is necessary to observe the basic rule of stocking density which is determined by the square metre of the pond.

Having derived the number of square metre in the pond using a formula

Length x Width x Depth divided by three. Times the number of square meter by three fish per square metre to arrive at the pond's stocking density.

When stocking density is maintained, it would contribute to better yield.

iii. Feeding Practice

It is important to note that the best thing to use in feeding your fish is feed. The low cost strategy of applying other materials into the pond is not ideal as this sometimes introduce harmful bacteria and disease into the pond. It can also lead to water pollution which would not enable the fish to thrive. So the use of properly formulated fish feed which contains all the nutrients necessary for fish growth is the best option. Do not over feed as each grain costs money and could lead to bad water.

iv. Sorting and Grading:

Sorting and grading is a very tedious but important. It means selecting the fish and grouping them according to sizes. This activity is necessary as it helps to reduce cannibalism and ensures efficient management of feed.

v. Fortification of collapsed end:

With the passage of time the walls of the pond would begin to wear away due to repeated rainfall, therefore it is important to fortify the threatened ends using sand bags to avoid total collapse.

1. FISH PROCESSING, PRESERVATION AND PACKAGING

2.1 INTRODUCTION

In today's economy, Africa is making appreciable progress in domestic fish production essentially through fish farming and culture-based inland fish production to increase the protein intake of the populace. The aquaculture industry in Nigeria today is estimated to have a value of some N22 billion and the industry is growing (FDF, 2007). Consequently, there is an increased production of fish and fishery products.

Although there is increase in production but studies have shown that Africa is the only region where animal protein intake through fish consumption has declined over the decade. Post-harvest losses through widespread poor preservation and processing techniques have been identified as one of the prominent causes. This exacerbates the deficit in fish supply; cost-effective post-harvest fish loss reduction would make up for this protein deficiency; improve income, eradicate poverty and improved food security. Fresh fish rapidly deteriorates (spoils) unless some way can be found to preserve it. Good practices, handling,

preservation and processing are the main ways to slow down or stop spoilage of fish after harvesting. The following post- harvest processes; cleaning/washing with portable water, bleeding, gutting, icing, freezing, salting, canning, drying and smoking are necessary to keep fish from spoilage, to increase the storage life (shelf life) and usability of fish.

Globalization not only has brought with it a number of changes in the way in which trade is undertaken, it has also brought an increase in market opportunities. Smoked fish as source of foreign exchange is gradually losing ground. This is adduced to the fact that exportation of processed fish to developed countries is becoming increasingly stringent because of the emerging set of Food Safety and Agricultural Health Standard, along with buyers changing their requirements. Nigeria artisanal fisheries could benefit considerably from increased trade to the ethnic markets in Europe and United States through export of smoked fish if good smoking processes are followed.

2.2 FISH PROCESSING

Fish is a major source of protein and its harvesting, handling, processing and distribution provide livelihood for millions of people as well as providing foreign exchange earning to many countries (Al- Jufaili and Opara, 2006). Appropriate processing of fish enables maximal use of raw material and production of value-added products which is obviously the basis of processing profitability.

The purpose of processing and preserving fish is to get fish to an ultimate consumer in good, usable condition. The steps necessary to accomplish this begin before the fishing expedition starts, and do not end until the fish is eaten or

processed into oil, meal, or a feed. Fish begins to spoil as soon as it is caught, perhaps even before it is taken out of the water. Therefore, the key to delivering a high quality product is close attention to small details throughout the entire process of preparation, catching, landing, handling, storage, and transport. Fish that becomes spoiled or putrid is obviously unusable. Fish that is poorly cared for may not be so obviously bad, but it loses value because of off-flavors, mushy texture, or bad color that discourages a potential purchaser from buying. The aim of fish processing and preservation is to slow down or prevent this enzymatic, bacterial, and chemical deterioration, and to maintain the fish flesh in a condition as near as possible to that of fresh fish. There are several ways fish can be processed such as canning, salting, frying, grilling, barbecuing, drying and smoking.

2.3 SMOKING (COOKING TECHNIQUE)

Smoking is the process of flavoring, cooking, or preserving food by exposing it to the smoke from burning or smoldering plant materials, most often wood. Meats and fish are the most common smoked foods, other fuels besides wood such as rice husks; coconut back can also be employed, sometimes with the addition of flavoring ingredients.

2.3.0 FISH SMOKING

Smoking is a method of preserving fish which combines the following three effects.

- Cooking: If the fish are smoked at high temperature, as in hot-smoking, the flesh will be cooked; this will destroy the enzymes and kill bacteria.

- Drying: The fire which produces the smoke also generates heat and this will not only cook but dry the fish as well.
- Preservative value of the smoke: The smoke produced from burning wood contains a large number of compounds, some of which e.g. phenols, will kill bacteria.

Smoking of fish is one of the most ancient processing technologies. It has been for centuries used for preservation, and is still widely used for this purpose among several communities in the third world where up to 70% of the processed fish is smoked for preservation (Ward, 2003). The long storage life of some smoked fish products is due more to drying and cooking than to preservative value of the chemical compounds deposited on the fish from the smoke (Clucas & Ward, 1996). Commonly use wood that produced good quality smoked fish in Nigeria are Rhizophoraracemosa, Naucleadiderrichii, Lophiraalata, Nauclealatifolia, and Entadrophragmacylindricum.

2.3.1 TYPES OF SMOKING

A. Cold smoking

Cold smoking can be used as a flavor enhancer for items such as fish, chicken breasts, beef, scallops and steak. The item can be cold smoked for just long enough to give some flavor. Some cold smoked foods are cooked, baked, grilled, roasted, or sautéed before eating. Smokehouse temperatures for cold smoking are below 100 °F (38 °C). In this temperature range, foods take on a smoked flavor, but remain relatively moist. Cold smoking does not cook foods.

B. Hot smoking

Hot smoking exposes the foods to smoke and heat in a controlled environment. Although foods that have been hot smoked are often reheated or cooked, they are typically safe to eat without further cooking. Fish is fully cooked once they are properly smoked. Hot smoking occurs within the range of 165 °F (74 °C) to 185 °F (85 °C). Within this temperature range, foods are fully cooked, moist, and flavourful. If the smoker is allowed to get hotter than 185 °F (85 °C), the foods will shrink excessively, buckle, or even split. Smoking at high temperatures also reduces yield, as both moisture and fat are "cooked" away.

C. Smoke roasting (smoke baking)

Smoke roasting or smoke baking refers to any process that has the attributes of smoking combined with either roasting or baking. This smoking method is sometimes referred to as "barbecuing", "pit baking", or "pit roasting". It may be done in a smoke roaster, closed wood-fired masonry oven or barbecue pit, any smoker that can reach above 250 °F (121 °C), or in a conventional oven by placing a pan filled with hardwood chips on the floor of the oven so the chips smolder and produce a smoke bath. However, this should only be done in a well-ventilated area to prevent carbon monoxide poisoning.

2.4 FISH DRYING

Fish drying is a method of fish preservation that works by removing water from the fish. Open air drying using sun and wind have been practiced since ancient times to preserve fish. Drying of fish inhibits the growth of microorganisms and preserves the fish. Fish can be dried on the floor, raised platform, in a solar tent dryer, fish can also be dried by hanging. Well-dried fish keep long if stored under

ideal condition. It can be packed in sealed polythene bags exported or sold in supermarkets, offices and retail markets**.**

2.5 SMOKING TECHNOLOGIES

2.5.1. TYPES OF FISH SMOKER

There are a few basic types of smoker designs, each with their own advantages and disadvantages.

a. Traditional smoking kilns

b. Improved traditional kilns

c. Mechanised smoking kilns

a. Traditional smoking kilns

The apparatus used for smoking fish in traditional tropical fisheries is often rudimentary. Examples are:

- Pit oven
- Mud type smoking kiln
- Drum type smoking kiln
- Earthen ware / pot type smoking kiln

Some ovens and kilns are better than others, but the following disadvantages are common to most:

i) There is an inefficient use of fuel

ii) It is difficult to control the fire and obtain a uniformly smoked product

iii) They are affected by adverse weather conditions

iv) They have a low capacity

v) The material used in construction are often inflammable

vi) constant attention is required to keep the fire burning, or to control the smoking process

However, as most of the construction materials are cheap or freely available, capital costs are minimal.

Galvanized Plank supported oven (Banda Oven)

44-gallon Drum Oven

b. Improved traditional smoking kilns

Several improved designs for kilns have been put forward to try to overcome the disadvantages of traditional smokers. These include:

- the Altona ovens
- the Chorkor oven
- the Ivory coast kiln
- NIOMR/ ARCT Magbon-Alade smoking kiln etc.

NIOMR Smoking kiln

Chorkor Oven

1. **The benefits of improved traditional kilns over traditional smoking kilns**

   These are as follows:

   (a) A working life (shelf life) of four to fifteen years of improved smoking kilns depending on the construction materials

   (b) The relatively low construction cost

   (c) An improved fuel efficiency

   (d) A more easily controlled fire

   (e) An improved quality of product

   (f) Less heat and smoke effect for the operator

   (g) A lower labour requirement

   (h) A versatility of design which allows different amounts of fish to be processed efficiently.

(i) High batch capacity and time efficiency.

At least 755.7tons of smoked fish valued at N1.511billion is produced annually using NIOMR Improved smoking kilns. (Akande, 2012) (There is an increasing demand for NIOMR kiln by entrepreneurs whose business involves local and international trading in smoked fish. It gives quality smoked fish of international standards.

2. Advantages of NIOMR Improved fish smoking kiln

- Good and efficient in the use of Charcoal/firewood. Yes, charcoal + firewood, charcoal only, cooking gas (LPG) Low fuel consumption of fuel wood/charcoal and higher retention of heat because of the insulation leading to a better quality product and quick drying time of 4 to 5 hours.
- Uniform fish drying. Very minimal rearrangement of trays because of the heat exchanger, which provides even distribution of heat.
- The door with a locking system protects the fish against pilferage and attack by rodents.
- The final product comes out with attractive golden yellow or black luster colour depending on the fish being smoked.
- Temperature distribution is very good.

c. Mechanised smoking kilns

These are very advanced smoking kiln which has been developed through the years of research. The most popular is Torry smoke house.

The traditional and improved smokers have no moving parts and rely on natural convection for air circulation. By contrast, mechanical kilns have fans or blowers to move the air across the fish. The kilns are usually expensive both to buy and run but they do give more control over smoking than other kilns. In most design it is possible to regulate the temperature of smoking accurately and to a lesser degree, the humidity of the air and the smoke density.

The use of mechanical kilns for the production of smoked, dried, traditional products in less developed countries is very limited.

Torry Smoke-house

2.6 FISH SMOKING PROCESSES

2.6.0. Pre-smoking processes

Pre-smoking processes is generally required prior to the actual smoking of fish. The process employed is dependent on the type of fish used and the type of product required. The steps involved in smoked fish processing is as follows:

1. Fish sourcing:

Source for good quality fresh/frozen fish as raw material. Look for high grade quality fish; a low quality fish or spoilt fish will give a low quality smoked fish and processing cannot make a bad fish good.

***2. Fish stunning*:**

stunning of live fish must be done in a humane manner. The use of ice is encouraged or cutting the aorta and bleeding to death when technological reason requires the removal of blood from the tissue for further processing. The stunning methods go a long way to determine the quality of the end product.

***3. Grading/Sorting of fish*:**

Sort the fish based on size and species. It is important to use uniform size of fish to enable uniform smoking and drying;

4. Remove scale or slime (depending on the fish type):

Slime accumulating on the skin of dying fish is a protection mechanism against harmful conditions. In some fish species slimes constitutes 2-3% of body weight. Slime creates a perfect environment for microorganism growth and should be removed by thorough washing. Soaking fish in a 2% solution of baking soda and then washing thoroughly can remove slime from fish like African mud catfish *Clarias gariepinus.*

***5. Splitting, gutting and filleting*:**

There several reasons why we cut and gut fish

a) To add value to the product
b) To make the product acceptable to the consumer
c) To maintain quality by reducing spoilage
d) To make further processing easier

e) To reduce processing costs

f) To improve storage life and

g) To reduce transport costs/charges.

***6. Washing*:**

Wash clean the dirt, blood stains and other foreign matters adhering to the fish to leave the fish in clean condition. Clean water should be used for cleaning.

***7. Salting/Brining*:**

Put the cleaned fish in salt solution (brine). Brining imparts taste, and also reduces drying time; there are different salting methods depending on the products e.g. pickle salting, kench salting etc.

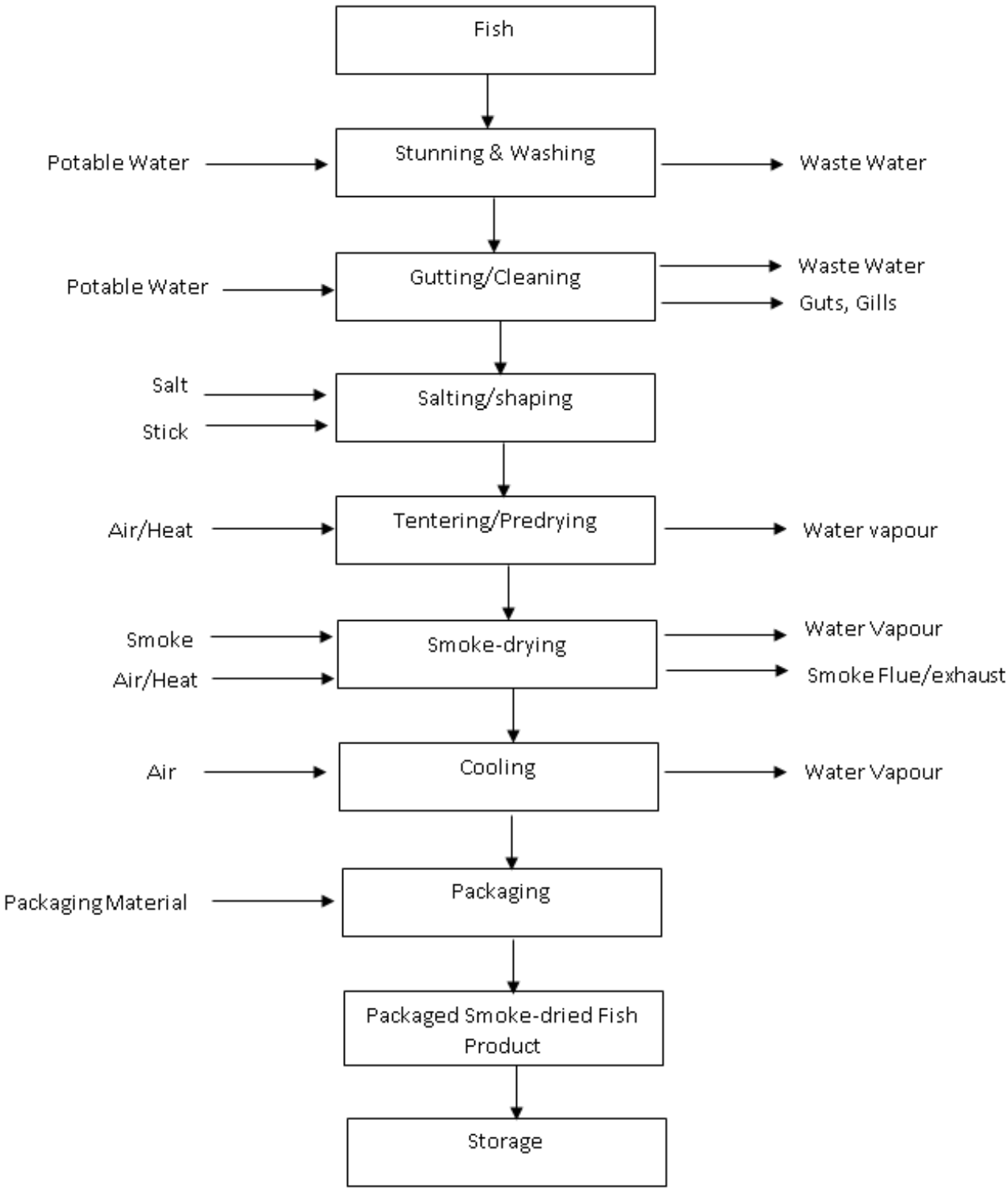
***8. Tendering/ Pre-drying*:**

Allow cleaning water to drip off the fish (Pre-drying) to prepare the fish skin for smoke absorption and rapid moisture loss.

2.6.1 Fish Smoking Processes

1. ***Smoke-drying:*** Exposing the fish to smoke and heat from the burning wood or charcoal to impart smoke and to dry the fish;
2. ***Cooling*:** Allow the smoked and dried fish to cool before packing. Do not pack the fish hot. If packed hot, the fish will become wet and encourage the growth of mould;

3. ***Packaging:*** Using suitable packaging material such as polythene bag, pack the smoked dried fish in the bag and seal it tightly, not exposing the smoked fish to the ambient environment;
4. ***Storage*****:** Store the packed fish in a cool dry place if not eaten immediately. This will increase its storage life**.**



Flow chart for fish smoke-drying process

3.0 QUALITY ASSURANCE/ COMPLIANCE

Quality is what makes a product suitable for its intended users. Food safety and food quality are two vital parameters in food control. Good quality, safe and wholesome food is required for consumption by the populace and for promoting adequate and proper nutrition.

a. Specifications for smoked fish product

- The surface should be bright and glossy, a dull matt indicates that poor quality raw material has been used, or that the products have not been properly treated.
- There should be no traces of dried blood or pieces of gut adhering to the product, their presence indicates lack of care during preparation of the raw fish.
- The surface of the fish should not be heavily contaminated with smuts or dirts. These defects show a lack of care during the brining and smoking processes.
- There should not be extensive gaping or separation of the flakes and the flesh should be free from discolouration; reddening along the backbone, or dark discolouration of the belly walls indicate fish that were stale before they were smoked.
- White crystals of salt on the surface of the fish suggest that they have been too heavily brined, and fish are therefore likely to be too salty to the palette.
- The colour of smoked fish is an unreliable guide to quality, since it depends so much on the degree of smoking or whether or not a dye has been used and what quantity. Permitted dyes are used on many smoked fish products to meet the preferences of particular markets, and there can be

considerable variation in the colour of both dyed and undyed smoked fish. Whatever the colour, it should be uniform and free from blemishes.

- The flesh of smoked fish should feel firm and springy to the touch, and the surface should not be sticky. Smoked fish with soft flabby flesh and sticky surface are stale.
- The odour should be fragrantly smoky; stale products will have objectionable smell and should be rejected.
- The surest way to determine the quality of smoked fish is to eat some. The product should be free from objectionable rancid and bitter flavours. Should there be any doubt on the quality of smoked fish, and they should not be sold.
- The finished product should be packaged in cardboard boxes lined with greaseproof paper, ordinary paper, polyethylene bags or vacuum packed.

b. Test Necessary to Determine Compliance with Specifications and Applicable Statutory Regulations.

i. Microbiological examination

Microbiological Examination is of value in assessing the safety or quality of foods. Traditionally, smoked fish are less prone to microbial spoilage then raw fish; however, moulds are more important spoilage organisms due to drying that takes place during smoking.

A number of microbiological tests of fish and fish products are used by industry for contractual and internal purposes and by authorities to check that the microbiological status is satisfactory.

The purpose of these examinations is to detect for pathogenic bacteria (*Salmonella, Staphylococcusaureus*) or for organisms which are possible indications of faecal contamination, e.g. *Eschericia coli* (*E. coli*) or other types of general contamination or poor manufacturing practices.

Recommended Microbiological (Nigerian Institute for Oceanography and Marine Research (NIOMR), Nigerian Fisheries Laboratory (NFL) Limits for ready –to- eat smoked fish

CRITERION	**SATISFACTORY**	**BORDERLINE - LIMIT OF ACCEPTABILITY**	**Unsatisfactory**	**Unacceptable/ Potential hazards**
	(CFU/g unless stated)	(CFU/g unless stated)	(CFU/g unless stated)	(CFU/g unless stated)
Aerobic plate count (30^0C;48hrs ±2hrs)	$< 10^6$	10^6 - $<10^7$	$\geq 10^7$	N/A*
Indicator organisms *E. Coli(total)*	*< 20*	*20 -<100*	*100* -$<10^4$	$\geq 10^4$
Listeria spp. (not *L. monocytogenes)*	Not detected in 25g	*Present in 25g, <200/g*	*200* -$<10^4$	$\geq 10^4$
PATHOGENS				
Salmonella spp.	Not detected in 25g			*Present in 25g*
V. parahaemolyticus	Not detected in 25g	*Present in 25g, <200/g*	*200* -$<10^3$	$\geq 10^3$
L. monocytogenes	Not detected in 25g	*Present in 25g, <200/g*	*200* -$<10^3$	$\geq 10^3$
Staphylococcusaureus	*<20*	20-<100	*100* -$<10^4$	$\geq 10^4$
C.perfringens	*<10*	10-<100	*100* -$<10^4$	$\geq 10^4$
Bacillus cereus	$<10^3$	10^3- $<10^4$	10^4- $<10^5$	$\geq 10^5$

* **N/A means Not Applicable**

ii. Chemical analysis

Oil in fish undergoes chemical changes due to high degree of unsaturation during storage which results in the production of an unpleasant taste and odour commonly referred to as rancidity. The following analyses must be carried out regularly.

a. Peroxide Value (PV):

The often highly labile fat in fish is susceptible to oxidation. In the early phases, peroxides are formed and these compounds being odourless and flavourless can

often be detected chemically before any rancidity becomes apparent. Peroxide value is a measure of the peroxides contained in the fish oil.

b. Thiobarbituric Acid Number or Value (TBA):

The TBA test is essential because it measures deterioration of both extractable and non-extractable lipid in smoked fish oil.

c*. Total volatile basic nitrogen (TVB-N):*

TVB-N is synthesised by reaction from proteins.

***d. Water activity*:**

Water activity is the measure of the amount of water in a food that is available for the growth of micro-organisms, including pathogens. It determines the storage life of fish. Dried fish products should have water activity around 0.6. According to rules from Food and Drug Administration (FDA) from 2001. Water activity should be lower than 0.85 in foods that are not stored in a refrigerator.

e. Moisture content:

Moisture content is a determinant of the quality of dried food products. Clucas, (1982) reported that dried fish with 25% or more moisture is not sufficient to inhibit microbial growth whereas dried fish with 15% or less moisture is well enough to inhibit microbial growth.

f. Free fatty acids:

FFA is a measure of hydrolytic rancidity, the extent of lipid hydrolysis by lipase action and that fish oil containing high levels of polyunsaturated fatty acids, is very susceptible to oxidative deterioration at varying velocities, strongly depending on the storage conditions and fatty acid profile.

iii.) CHEMICAL HAZARDS IN SMOKED FISH

1. Polycyclic aromatic hydrocarbons (PAHs) in Smoked fish:

During fish smoking, some undesirable compounds polycyclic aromatic hydrocarbons (PAHs) among other compounds are produced which are dangerous to human health. PAHs are classified as carcinogenic compounds and consequently are monitored worldwide in a wide range of environmental matrices, including smoked fish. The concentration of PAHs in smoked fish can be minimized by the use of appropriate smoking kilns and smoking processes. For food safety and food security, maximum levels are necessary for these compounds in foods.

i. Regulations:

The scope of monitored and regulated PAHs in smoked fish is under constant change, influenced by international advisory bodies such as the *World Health Organization (WHO) and the European Food Safety Authority (EFSA)*.

Wild smoking under uncontrolled technological conditions and non-existing legislative measures, what is typical especially for households and developing countries, leads to enormous PAH contents in smoked fish. It has been estimated that nearly 70% of PAHs are consumed with food, including the consumption of smoked fish. B[*a*]P for a long time has been a marker of total PAHs content in food and environmental analysis. However, in many cases, B[*a*]P constitutes only 1–20% of the total PAHs content in the examined matrix. In 2011, changes in the European law on food contaminants (European Food Safety Authority – EFSA) led to the publication of the legislative act on the control of impurity content in food products. One of such documents is the Commission Regulation (EU) No 835/2011 from August19, 2011 amending regulation (EC) No 1881/2006

regarding maximum levels of polycyclic aromatic hydrocarbons (PAHs) in foods, including smoked fish products [Commission Regulation (EU) No 835/2011]. *EFSA* concluded that B[*a*]P is not a suitable indicator for the occurrence of PAH in food and assessed that the sum content of the four PAH compounds B[*a*]P, CHR, B[*a*]A and B[*b*]F (Σ4PAHs) is the most suitable indicator of PAHs in food (EFSA 2008,2012). On the basis of the EFSA opinion (2008), modifications on numerical values regarding acceptable levels of PAHs for particular food groups, were also carried out. In 2011, changes in the European law on food contaminants made by the European Food Safety Authority (*EFSA*) has resulted in the publication of legal acts regarding the control of impurities in food products – Commission Regulation (EU) No 835/2011 (SANCO 2011). In the EU, including also the Polish legislation, amendments included in the Commission Regulation (EU) No 835/2011 of 19 August 2011, regarding modification of maximum levels accepted for polycyclic aromatic hydrocarbons (PAHs) in food products have been adopted. In this document, a change related to the existing marker, indicating the presence of PAHs in food, namely B[*a*]P has been established with the highest acceptable level (5.00 μg kg^{-1}). From 1 September 2014, the maximum level for B[*a*]P was established at 2.00 μg kg^{-1} and for the sum of four PAHs, at 12.00 μg kg^{-1} (Commission Regulation (EC) No 1881/2006; Commission Regulation (EU) No 835/2011). What is more, Commission Regulation (EU) No 1327/2014 from December 12, 2014 provides for exceptions (quote): However, recent evidence shows that in a number of member countries – in some cases including traditionally smoked meat and smoked meat products, as well as traditionally smoked fish and fishery products – it is not possible to achieve lower levels of PAHs in spite of the widest possible use of good practices of smoking, because in those cases there is no possibility to change the practice of smoking without also

causing a significant change in the organoleptic properties of food. The consequence of such action would be the disappearance of this kind of traditionally smoked products from the market, which would result in the closure of many small and medium-sized enterprises.

ii. Regulations /guidelines on smoked fish products

There are relevant regulations in Nigeria governing fishery products. The Sea Fisheries (Fish Inspection and Quality Assurance) Regulations 1995.Inland Fisheries (Fish Quality Assurance) Regulations 1995.These two regulations are contained in the Federal republic of Nigeria Official Gazette No. 31D, vol. 82).

To ensure the quality and safety of aquaculture products and create a good image for local and export markets, the following guiding principles are noted:

1. Prior to harvest, fish should be purged of any residual hormones, drugs, feeds or algal material likely to cause harm or off-flavour. Harvest should be quick and efficient to reduce damage and contamination and adequate storage provided for the product. To maintain public confidence, humane practices should be maintained in handling, harvest, transport and slaughtering of the fish.
2. The quality of products for domestic markets shall conform with the national quality control and health standards. Farmed fish for export shall comply with the regulations of the importing country. Federal Department of Fisheries (FDF) must certify all products destined for export.
3. The Smoking shall be carried out in a separate premises or a special place equipped, if necessary, with a ventilation system to prevent the smoke and heat from the combustion from affecting other premises or places where fishery products are prepared, processed or stored.

4. Materials used to produce smoke for the smoking of fish shall be stored away from the place of smoking and shall be used in such a way that they do not contaminate the products. Wood that has been painted, varnished, glued or has undergone any chemical preservation treatment is prohibited. After smoking, products shall be cooled rapidly to the temperature required for their preservation before being packed.

The safety of foods, including hygiene of fish products, is regulated through Federal Department of Fisheries (FDF), National Agency for Food Drug Administration and Control (NAFDAC) and the Standard Organization of Nigeria (SON).

iv. HAZARD ANALYSIS CRITICAL CONTROL POINTS (HACCP) AND QUALITY ASSURANCE IN SMOKED FISH

Hazard Analyses Critical Control Point is internationally accepted food safety system that is scientific based. Designed to prevent, decrease or eliminate biological, chemical or physical hazards in food. Internationally accepted as the main method to secure food safety in the whole food chain –from farm (sea) to fork.

It is a tool for offering safe food to the consumers

- The consumer requires safe food
- Required in food trade
- HACCP has become the international reference system for food safety assurance World Trade Organization/ Technical Barriers to Trade (WTO / TBT through Codex)
- HACCP provides access to valuable marketing areas.

This is a logical approach to control food hazards and avoid many weaknesses inherent in inspection. Once established, the main effort of quality assurance will be directed towards the Critical Control Points (CCPs) and away from final product testing. This will assure a much higher degree of safety at a reduced cost. HACCP is not a zero-risk system. It is designed to minimize the risk of food safety hazards. Preventive, not reactive. A management tool used to protect the food supply

HACCP system is the responsibility of processing companies, Government bodies evaluate the HACCP system and approve. A third party auditor can also accredit the system in accordance with international standards.

HACCP Pioneered in the 1960's

• First used when foods were developed for the space program
• Adopted by many food processors and the U.S. government

The main elements of HACCP are:

- Identification and assessment of hazards
- Determination of Critical Control Points (CCPs)
- Description of CCPs
- Monitoring of CCPS
- Corrective actions when operation is out of control,
- Verifications and
- Documentation.

Hazards and prevention measures in the production of smoked fish.

PRODUCT	HAZARD	PREVENTIVE	Degree of Control
Raw material	Excess contamination and/or Growth of bacteria	Hygienic handling	CP

PRODUCT	HAZARD	PREVENTIVE	Degree of Control
before landing	Moulds and algae growth on harvesting net and holding through contamination in drag nets; also as a result of cross-contamination	Time/Temperature Control Canoes for exploiting Fish should be dedicated for this purpose	CCP-1 CCP-2
Raw materials on landing	Poor handling vis-à-vis bruising, Excess contamination	Good handling practices (GHP) Time/Temp Control	CP CCP-1
Arrival of raw material at processing site	Substandard quality entering processing	Ensure reliable source Sensory evaluation	CCP-2 **CCP-2**
Washing	Contaminated water	Water quality	CCP-1
Salting -dry -Brining	Salt content too high too low (i.e. unacceptable taste or risk of growth and toxin production by *Clostridium botulinum* respectively)	Use food grade salt. Use correct fish/salt ratio	CCP-2
Smoking	Product inconsistency (Colour texture and moisture). Growth of bacteria.	Standardize grading/methodology Time/Temperature Control	CP CCP-1
Cooling	Bacteria/flies contamination	Time/Temperature Control	

PRODUCT	HAZARD	PREVENTIVE	Degree of Control
Packaging	Packaging material not of food grade/unclean/used/contamination	Visual inspection of packaging material	CCP-1
Storage	Mouldy or unsafe fish	Ensure proper smoking and integrity of packaging	CCP-1

Hazard Analysis Worksheet

Firm name:			**Product description:**		
Firm Address			**Method of storage & distribution**		
			Intended use & Consumer:		
(1) Processing Step	(2) List all potential biological, chemical and physical food safety hazards that could be associated with this product and process	(3) Is the potential food safety hazard significant (introduced, enhanced or eliminated at this step? (Yes/no)	(4) Justify the decision that you made in column 3	(5) What control measure(s) can be applied to prevent, eliminate or reduce this significant hazard?	(6) Is this step a Critical Control Point? (yes/no)

v. Traceability

Traceability is the ability to track any food through all stages of production, processing and distribution (including importation and at retail). Traceability should mean that movements can be traced one step backwards and one step forward at any point in the supply chain.

The EU regulation 178/2002, outlines the general principles of food law and requires that all food businesses must have in place a traceability system. The regulation is minimal in its description of what is required and it would in no way reflect what is considered to be best practice.

For food processing businesses, traceability should extend to being able to identify the source of all food inputs such as:

- raw materials
- additives
- other ingredients
- Packaging.

Traceability is very important, it enables corrective actions (such as a product recall) to be implemented quickly and effectively when something goes wrong. When a potential food safety problem is identified, whether by a food business or a government agency, an effective traceability system can help isolate and prevent contaminated products from reaching consumers.

Traceability allows food businesses to target the product(s) affected by a food safety problem, minimizing disruption to trade and any potential public health risks. It is important for all food businesses (including retailers and importers) to be able to trace products.

v.1 Characteristics of a traceability system

An effective traceability system relies on being able to track product one step forward and one step back at any point in the supply chain. The system a food business has in place includes any procedures for identifying producers, suppliers, customers and products and the records kept including:

- name and address (and other contact details) of suppliers and a description of products or inputs supplied
- name and addresses (and other contact details) of customers and a description of the product supplied to them
- date of transaction or delivery
- batch or lot identification (or other markings)
- volume or quantity of product supplied or received
- any other relevant production records.

Food recall

A food business engaged in the wholesale supply, manufacture or importation of food must have a system, set out in a written document, to ensure it can recall unsafe food. The system should include records covering:

- production records
- what products are manufactured or supplied
- volume or quantity of products manufactured or supplied
- batch or lot identification (or other markings)
- where products are distributed
- any other relevant production records.

This information should be readily accessible in order to know what, how much and from where product needs to be recalled.

4.0 PACKAGING, LABELLING AND MARKETING OF FISHERY PRODUCTS

Packaging is a means of ensuring the safe keep/delivery of a product to the ultimate consumer in sound condition at minimum overall cost. Packaging materials can be primary, secondary and tertiary. There are three basic functions of packaging materials. First, the package must contain the product safely at all times. Second, it must protect and preserve that product during its lifetime. And finally, it must inform and present the product at least as to the destination and its nature.

i. ***Containment function:*** Containers are used to perform the following functions:

1. Easy handling of small and large quality of fish
2. Simplify loading and off-loading and transportation of raw materials
3. Protection against physical damage, contamination and deterioration
4. Offer suitable packing unit for fish
5. Allow fish to reach buyer in good condition
6. Provide economic results from handling to consumption.

ii. ***Presentation/ promotional function:*** The purpose of the sales function of a package is to enable or promote the sales process and to make it more efficient. Promotional material placed on the packaging is intended to

attract the attention of the potential purchaser and to have a positive impact upon his purchasing decision. Promotional material on packaging plays a particularly important role on sales packaging as it is directly addressed to the consumer. Packaging can be used to influence point of sales decision.

iii. ***Protective function:*** The protective function of packaging essentially involves protecting the contents from the environment and vice versa. The inward protective function is intended to ensure full retention of the utility value of the packaged goods. The packaging is thus intended to protect the goods from loss, damage and theft. Packaging protects fishery products during storage, transit and display point of the product. It protects against climatic influence (light, humidity, water, temperature and gas reactions), mechanical forces (impact, abrasion, vibration, compression and stacking), contamination (microorganisms, insects and dirt), quality loss (degradation of colour, odour, flavour, texture, nutritive value and soundness) and theft.

The additional function in particular relates to the extent to which the packaging materials or packaging containers may be reused once the package contents have been used. The most significant example is the recycling of paper, paperboard and cardboard packaging as waste paper.

The packaging materials and packaging containers required for producing packages must be stored in many different locations both before packaging of the goods and once the package contents have been used.

Packaged fish and fishery products protected from contamination and spoilage, and at the same time provide the following outputs:

- reduce fat oxidation especially in the more fatty fish
- reduce dehydration especially in frozen products which leads to textural deterioration and freezer burn
- reduce bacteria and chemical spoilage
- prevent odour permeation
- extend shelf life of a product
- facilitate distribution and display
- give the product greater consumer appeal
- facilitate the display of information on the product

With consumers deluged by a multitude of similar food products, packaging is one of the best ways to create product differentiation. Seafood exporters can use high-quality packaging to out-perform the competition and influence point-of-purchase decisions.

Losses due to insect infestation have always been a common occurrence in cured fish products. A package must be well sealed and of material, which is not readily penetrated, if it is to act as a physical barrier to insects. Boxes made of fibre board or polypropylene, with proper sealing of all openings with adhesive tapes will reasonably resist insect infestation. Likewise, a closely woven heavy cotton sack with good seams may show good results especially where a water-vapour barrier cannot be used.

Other materials can also be used either as box liners or as components of a multi-wall sack, include woven plastic fibres (coated and uncoated), cross laminated plastic films, microporous polypropylene film and spun-bounded polyolefin. In addition, packaging in the Nigerian context can be improved by lining the inner wall of cardboard boxes with plastic bags.

The use of clean good quality sacks lined with polythene or thick brown paper to slow down immigration of *Demestes* spp. and prevent cross-contamination during storage will improve on the packaging with a view to protecting and presenting the products.

To protect smoked-dried fish properly, the following measures must be adopted:

- Packaging in a sturdy container (wooden or cardboard) with a lid to enclose the product
- Packaging should be sufficiently moisture-proof and rigid to withstand rough handling
- Packaging in polythene bags to reduce insect attack and the effect of high humidity

Vacuum packaging reduces the quality of gas surrounding the product, but not the atmosphere of the gas mix. Vacuum packs generally have extended shelf-life, of the order of 50% of the normal shelf-life.

The technique of removing the atmosphere around the food and replacing it with another atmosphere has been developed by the introduction of form–fill-seat machines. The technology is now known as Modified Atmosphere Packaging (MAP) and has become accepted all over the world.

As for the traditional smoke-dried products, the target products for export are smoked whole catfish, chunked smoked *Heterotis*, chunked smoked mixed species of fresh water species such as *Gymnarchus* spp., Nile perch and catfish. Others are smoked bonga, sardinella, sole and a few small white shrimp either in smoked or dried forms. Smoked catfish accounts for 70% of all exports to the ethnic markets in Europe and America. The traditional fish and fishery products are destined for the so-called ethnic markets in Europe, USA, and other countries of the world.

The trade in traditional fish products such as smoked fish, from West Africa to Europe is coming under increasing scrutiny from authorities both in the exporting and importing countries. International trade legislation designed for relatively sophisticated industrial level processing is being applied to what is essentially a traditional process. As a result, processors and exporters fail to meet the required standards set by authorities in the country of export. Likewise, importing country authorities apply inspection procedures, which 1 in 4 consignments fail. Formal trade is therefore being constrained in what is, at retail level in importing countries, a high value product. And parallel to formal trade there is an informal export and import trade, which relies on air passengers who carry small amounts of product in their luggage

As a result of enforcement of relatively recent EU legislation governing fish and fish products and import/export, consignment of smoked fish are regularly detained and often destroyed by Port Health Authorities at various EU Airports.

The main reasons why smoked fish consignments are detained are:

- Smoked fish is smuggled in among other goods such as vegetables and is therefore undeclared and so has no health certificate. Likewise, undeclared

dried meat is concealed in consignments of smoked fish.

- Packaging is inadequate - re-used (computer or TV boxes), in poor condition; newspaper or baskets are used for packing the fish.
- Insect infestation.
- Establishment numbers stapled on the box rather than written on (labelling).
- Health certificates not filled in correctly. For example, the establishment number is used as the reference number. The word "various" is used as the scientific name of species rather than the scientific name.

4.1 Types of packaging material

There are many types of plastics/polymers e.g. Polyethylene (PE), Polypropylene (PP), Polyethylene Terephthalate (PET), Polyamide (PA), Polyvinyl chloride (PVC), Polystyrene (PS). Polyethylene is the most produced plastic in the world, Polyethylene has numerous possibilities, it can be transformed to soft or rigid and strong products. PE has a simple chemical composition, is resistant to aggressive, liquids and damages, does not harm the environment, it is light in weight and can be easily formed.

Types of Polyethylene

LDPE – Low density polyethylene: The oldest type, soft, tough and flexible. For example: films, carrier bags, packaging material, agricultural sheeting.

HDPE – High density polyethylene: Hardest and most rigid type, stiff and hard character. For example, thin carrier bags, bags for fruit, vegetables or fish products. Research shows that is better for smoked fish products.

MDPE –Medium density polyethylene

LLDPE – Linear low polyethylene

5.0 SOME MARKET AND LEGAL REQUIREMENTS OF PACKING MATERIALS

All packaging for food stuff must be produced according to regulations in the end market.

E.g. Regulation (EC) No 1935/2004 and Commission Directive 2002/72/EC, 2004/1/EC and 2004/19/EC relating to plastic materials and articles intended to come into contact with foodstuffs.

Food contact materials should be safe and should not transfer their components into the foodstuff in unacceptable quantities (migration).

An Overall Migration Limit (OML) of 60mg (of substances)/kg (of foodstuff or food simulants) that applies to all substances that can migrate from food contact materials to foodstuffs.

A Specific Migration Limit (SML) which applies to individual authorised substances and is fixed on the basis of the toxicological evaluation of the substance. The SML is generally established according to the Acceptable Daily Intake (ADI) or the

Tolerable Daily Intake (TDI) set by the Scientific Committee on Food (SCF).

Labelling, advertising and presentation of food contact materials shall not mislead the consumer.

Three primary drivers shaping today's food industry

- ***The Economy:*** Consumers more thoughtful about spending and saving more

- ***The Consumer:*** Convenience continues to drive demands and counting on food processors to reduce waste
- ***The Retailer***: Creating choice for consumers with premium store brands, initiating packaging material reduction, and Retail Ready Packaging (RPP) trend.

These drivers are, in turn, directly impacting on today's packaging trends; Sustainability labelling and food safety**.**

Import/Export of fishery products to EU (Conditions)

The products should fulfill the same high standards as products produced in EU with respect to**:**

• Hygiene

• Consumer safety

• Animal health status

• Countries and businesses should understand the principles and philosophy in EU Food Law

• EU food legislation is compliant with the requirements of the Sanitary and Phytosanitary SPS agreement of World Trade Organization (WTO).

• In aquaculture and for live bivalve, molluscs animal health standards must be fulfilled

• The relevant hygiene and public health requirements must be met.

A control plan on heavy metals contaminants, residues of pesticides and veterinary drugs in aquaculture products must be in place.

Control plan must be in place for initial approval and control of establishments

• Import to EU only from approved establishments which are listed on EU website

• Inspections performed by FVO to confirm compliance with the above requirements to establish confidence between the EU commission and the CA in the exporting country**.**

Guidelines on EU's website

EU import conditions for seafood and other fishery products can be found:

http://ec.europa.eu/food/international/trade/im_cond_fish_en.pdf

GUIDANCE DOCUMENT Key questions related to import requirements and the new rules on food hygiene and official food controls can be found:

http://ec.europa.eu/food/international/trade/interpretation_imports.pdf

USA rules and requirements

Bioterrorism

• Registration of all producers importing food and feed to USA 08:48 38

• Each producer should designate US agent

• Prior notice of imported shipments not more than 5 days before arrival

COOL:

•**Country Of Origin Labelling.** Importer and processor must comply with the regulation**.**

Regulations found in Title 21, Part 110 of the Code of Federal Regulations

• Proper practices for the safe and sanitary handling of all foods

Seafood HACCP regulation compliments the cGMP by requiring seafood processors to monitor and document the results of monitoring for eight key areas of sanitation derived from the cGMP. HACCP controls are required for imported fish and fishery products as well as for domestic products.

Importer Verification Procedures

Affirmative steps may include any of the following:

- Obtain foreign processor's HACCP and sanitation monitoring records for the lot being entered
- Obtain continuing or lot-by-lot certificate from competent third party
- Regularly inspect foreign processor
- Obtain foreign processor's HACCP plan and written guarantee that regulation is being met
- Test the product and obtain written guarantee that regulation is being met
- Perform other verification procedures that provide equivalent level of assurance.

6.0 HANDLING OF RESULTANT WASTE FROM FISH AND WATER (THE USE OF BY-PRODUCTS FROM FISH PROCESSING)

6.1 INTRODUCTION

For any industry to establish on economically sound position, complete and profitable utilization of all the available by products is highly essential. A complete package of technology of any product developed especially in food sector, involve maximum utilization of the waste substances that come out of the process. In the fish processing industry, a very important by product is the offal, which consists essentially of all the waste parts like intestines, liver, tails, fins, scales, skin etc. also find good use in preparation of different by-products. Very small fishes caught as by catch from shrimp trawlers, which landed not only in fresh condition but are difficult to handle for processing can be used for production of fish meal which is an important nutritious supplement in cattle, pigs and poultry feeds. Now, growth of aquaculture in our country also has found use of these protein wastes in supplementing the fish and prawn feeds.

These are residual raw materials; they can be used for the production of the following:

a. Novel food ingredients
b. Use of fish proteins as functional ingredients**:** it can be used for forming, solubility, gelation, water holding properties.
c. Bioactive compounds: Peptides, polyphenol, sugars etc.
d. Use of Fish Viscera
    - Loose roe collection
    - Liver in cans
    - Liver oil

- In pharmaceutical industry
- For pet food
- For enzyme extraction
- For soup stock or flavour products
- As hydrolysates for:
  - Aquaculture feed
  - Weaned pig feed
  - Organic fertilizer
- Ensilage
- Fishmeal

The by-products from fish and their multi-disciplinary uses are very interesting and those who have money and entrepreneurship can think of starting these industries.

6.2 IMPORTANT FISHERY BY-PRODUCTS

i. Fish meal

Fish meal is a highly concentrated nutritious feed supplement containing protein, minerals, vitamins and some unknown growth factors. Fish meal has been considered as an important product both for internal use and export. In India, commercial fish meal plants are mostly established on west-coast only. The production involves mainly cooking the waste / fish mass, pressing and separation of oil, drying the pressed cooked mass and pulverizing the dried substance. ISI standards have been drawn up for fishmeal quality for use in livestock feed (ISI: 4307-1973).

1. Product must pass through 2 – 80 mm sieve.
2. Must be free from off odour.

3. Free from adulterants, insects, mites, fungus infestation
4. Free from salmonella
5. Maximum moisture content shall be 10%
6. Crude protein content be minimum 60% for A grade and 50% for B grade
7. Fat content shall not be more than 10% and
8. Maximum content of acid insoluble ash shall be 3 % for A grade and 5% for B grade.

Fish meal is a highly concentrated nutritious feed supplement containing protein, minerals, vitamins and some unknown growth factors. Fish meal has been considered as an important product both for internal use and export.

ii. Fish oils

Fish oils are mainly of two types, body oils and liver oils. The former is used as industrial oil, while the latter finds application in pharmaceutical preparations. Crude oils are used in painting of wooden boats, paint base and printing ink materials can also be prepared from industrial fish oils.

iii. Fish maws and Isinglass

Swim bladders in fish are also known as air bladders, sounds and fish maws. Fish maws contain purest form of collagen, and is named as isinglass, which is used in confectionery products and food products (forming as gelatin) and used mainly as a clarification agent in beverage industry for clarifying wine, beers etc. The preparation of isinglass is very simple. Swim bladders are removed from the fish, washed to remove blood and pieces of flesh and the cleaned air bladders are dried

by hanging in moderate sun. The dried bladders are soaked in water for several hours until they become soft and pliable. They are then cut into small pieces, rolled or compressed between cold steel rollers to form thin sheets or strips. These are dried in warm rooms, and the ribbon or leaf form isinglass is packed in polythene bags.

Isinglass swells in hot water forming gelatin. It dissolves readily in most dilute acids and alkalis; but does not dissolve in alcohol. A few grams of dried isinglass can clarify gallons of beer or wine.

Isinglass is first dissolved in tartaric acid and little alcohol forming as 'finings' and these findings when added to un-clarified beer, the collagen fibrous network formed enmeshes all suspended materials and impurities, slowly settles down leaving clear and sparkling beer / wines.

iv. Collagen chitin film

The film is prepared from collagen and chitosan obtained from fishery wastes and can be used as artificial skin. It is used for covering wounds / burns to prevent moisture loss and microbial contaminations. Purified air bladder is partially solubilised in hydrophilic solvent, viscous suspension obtained is spread on clean glass surface and evaporated to give thin film of collagen. Reformed chitin matrix is deposited on this exposed surface to give strengthened collagen film.

v. Surgical sutures from fish guts

Fine surgical sutures could be prepared from the fresh guts of some fishes. They have sufficiently long collagen filaments. The use of a collagen thread as surgical suture depends on its tenacity, durability, pliability, absorbability and certain

chemical properties. These properties of fish gut collagen make them suitable for preparing extra fine absorbable surgical sutures.

vi. Chitin

Chitin is a polysaccharide polymer of N-acetyl glucosamine. Chitin extraction involves crushing and washing the shells to remove the adhering meat. The material is then de-mineralized with diluted hydrochloric acid and hydrolysed with diluted sodium hydroxide to yield chitin. Chitin as such can be used for supplementing poultry feeds at 0.5% level to yield more growth and meat in broilers.

vii. Chitosan

Chitin is converted into chitosan by treatment with concentrated caustic soda (40 – 50%) at high temperature. Chitosan, the de-acetylated chitin, has many potential uses in food, medical, pharmaceutical, cosmetic and personal care, agriculture, biotechnology and Paper, films and textile industries.

- **Bioactive compounds (products) and functional foods**

There are very diverse pool of bioactive products from aquatic foods and wastes. They are organic acids, polyphenols, proteins, fatty acids, enzymes, peptides, monosaccharides, polysaccharides, trace elements, secondary metabolites, cartilage compounds etc.

The bioactive compounds can be used in many different applications such food ingredients, aquaculture, farm animals, nature medicine, food supplements, cosmetics, process aids and medical products.

7. LIST OF ACRONYMS

ADI: Acceptable Daily Intake

CCP: Critical Control Point

CFU: Coliform Forming Unit

EC: European Commission

EFSA: European Food Safety Authority

EU: European Union

FDA: Food and Drug Administration

FDF: Federal Department of Fisheries

GMP: Good Manufacturing Practices/Procedures

HACCP: Hazard Analysis and Critical Control Point

LDPE : Low Density Polyethylene

LLDPE : Linear Low Density Polyethylene

MAP: Modified Atmosphere Packaging

MDPE : Medium Density Polyethylene

NAFDAC: National Agency for Food and Drug Administration Control

NFL: Nigerian Fisheries Laboratory

NIOMR: Nigerian Institute for Oceanography and Marine Research

PAHs: Polycyclic Aromatic Hydrocarbons

RPP: Retail Ready Packaging

SCF: Scientific Committee on Food

SML: Specific Migration Limit
SON: Standard Organization of Nigeria

SPS: Sanitary and Phytosanitary

TDI: Tolerable Daily Intake

WTO: World Trade Organization

DELTA STATE GOVERNMENT

OFFICE OF THE CHIEF JOB CREATION OFFICER,

GOVERNOR'S OFFICE.

YOUTH AGRICULTURAL ENTREPRENEURS PROGRAMME

(YAGEP)

TRAINING MANUAL

ON

PREPARATION, CONSTRUCTION AND MANAGEMENT OF FLOW THROUGH (FLOWING WATER) PONDS

BY

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1.0 INTRODUCTION:

1.1 TYPES OF PONDS AND FISH FARMING METHODS

There are basically seven (7) types of fish farming methods, which are: -

2. Use of Elevated Fish Tanks: These may be: -
   (f) wholly concrete (As in ADP, Ibusa);
   (g) cement blocks and concrete hybrids (As in Koko and Umusam clusters)
   (h) fixed/flexible plastic containers
3. Earthen Ponds: These may be static or flow through systems.
4. Floating Cage Systems: Materials used may be Aluminum, or plastic meshes or of suspended wood.
5. Chicoko or Brackish Water Fish Farms.
6. Homesteads or All-go Fish Farms.
7. Traditional Fish Farms.
8. Capture Fisheries: Which includes artisanal and industrial capture systems.

Items 1 – 6 are often referred to as containment fisheries.

There are four (4) different technologies which may be adopted in the construction and management of containment fish farms. These are:

8. Green Water technology.

9. Intensive, Hyper-Intensive and Ultra Intensive Technologies.

10. Tidal or Brackish Water Technology.

11. Fresh Water Technology.

A. Green Water Technology: Is often adopted for static ponds. Irrespective of the mode of containment there is very little or no water change over the entire farming period except it becomes imperative due to adverse physio-chemical properties of the water. Stocking densities of green water fish tanks / ponds are typically low (3 – 20 fish/m^3).

Construction costs depends on whether one adopts elevated concrete (high cost), hybrid concrete/block (moderate costs, fixed/flexible plastic tanks or whether one chooses recessed earthen ponds).

Depth of green water containers varies from 1m – 1.5m (3-5 Feet) for elevated containers while that for recessed containers varies from 1.5m to 6m. (5-20 Feet). Cost of earthen ponds are determined by the:

- Depth (which in turn depends on the level of the sustainable clay bed),
- Environment and topography – A shallow clay bed in a grassland as opposed to a deep clay layer in a thickly and heavily wooded environment. The latter is often the case in Delta South and Central.

B. Intensive, hyper-intensive and ultra-intensive technologies

Intensive, hyper-intensive and ultra-intensive technologies often have stocking densities of 50 – 100, 100 – 250 and 250 – 500 fish/m^3 respectively. Although this system has very quick returns, construction and feeding costs are often prohibitive. This system is highly technology dependent and can only be built and run by experts.

C. Tidal/brackish water technologies:

This system exploits the variation in water levels due to the inflow and outflow of tidal water to clean toxins from ponds.

The ponds are often located in mangrove swamp areas (As in Ufuoma, Epkan, Egborodo Itsekiri, Ugborode Okpe, Isaba and Ogbe-Ijaw Farm Settlements).

Construction costs depends heavily on the age of the mangrove, the land tenure system and "deve" encumbrance by youths in the area. An acre of land in these areas vary from ₦1.6m to ₦2.5m depending on one's negotiating power.

These soils are highly acidic and have attendant management and cost implication. The stocking densities are slightly lower than those of flow through ponds but are quite higher than those of static fresh or green water technologies.

Special machines are used to carve out the chicoko blocks which are appropriately laid to prevent leakage. Further costs are incurred in constructing the extensive channels and walk ways needed by this system. Scientifically designed Chicoko ponds have separate inlet and outlet channels. Depths are

dual levels ($7^1 – 8^1$ for high tide and $4^1 – 5^{1)}$ for low tides. Predation by wild life must be considered during design, construction and maintenance phases.

D. Fresh water technology.

Fresh water technology is often adopted for flow through and elevated tank systems.

Elevated fresh water systems use either continuous slow running water changes or do partial daily or twice weekly water changes from taps (as in Songhai Delta Amukpe). Flow through systems on the other hand depend on channeling water from streams, rivers or surface aquifers (springs) through recessed containers. Containment may be by earth or concrete. The recessed earth maybe clayey by the river side (as in the proposed flow through ponds in Enhwe in Isoko South) or in sandy beaches (as in camp 74, Asaba.)

Recessed flow-through ponds in sandy beaches are cheaper and quicker to build. They require constant maintenance of channels, pond walls and inter-pond link pipes as blockage at any point will spell doom especially for over stocked ponds.

Stocking densities in flow-through systems are higher than those in static green water and elevated fresh water systems for this reason, they are neither to deep (1 – 1.5m = 3-5 feet) nor large in size (e.g. Camp 74).

Stocking densities vary from 20 – 50 fish /m^3 depending on the strength of water flow through and expertise of the farmer. Cost of feeding is also higher in fresh water and flow through systems since the fish depends entirely on the farmer for food.

The cost and choice of appropriate technology depends largely on the nature of the environment, the soil profile, intended level of stocking density and the socio-cultural bent or inclination of the people in a particular location.

2.0 DESIGN CONSIDERATIONS FOR FLOW THROUGH PONDS (FTP)

In designing flowing water systems careful consideration must be given to the flow rate of the river or stream. If our water source is of tidal nature then the maximum tidal flood height, times and frequency of tidal waves should be considered. Other considerations include the maximum flood levels in the flood plain, seasonality of the water source, nature of soil, vegetation.

A strong current flow supports higher stocking densities and pond carrying capacity, but the trade-off is a higher rate of erosion of pond and channel walls and hence higher maintenance costs and increased frequency of maintenance.

Water in-lets and outlets should be diagonally across the pond to ensure proper evacuation of toxins and potential pollutants. Although the practice of pond to pond interconnectivity lowers construction costs it should be discouraged as it promotes fast spread of disease and could bring flow rates below critical thresholds.

Scientifically designed flowing water ponds should have separate in-lets and out-lets. This may increase costs but it will reduce maintenance and running costs in the long run.

Constructed pond depths should be a minimum of 1.5m below the river bed for shallow streams, rivers or other water sources.

3.0 DIMENSIONS

Pond dimensions vary with pond depths. A 40ft x 20ft x4ft sized pond is ideal for 1000 adult fish for FTPs. However, where there are land constrains in terms of space or physical structures other encumbrances, then dimensions should be varied with proportionate increases in the average depth. This will help maintain the critical volume per thousand fish.

4.0 LAND PREPARATION AND CONSTRUCTION

Although FTPs are not as susceptible to the effects of underground roots, stumps and stubble in well prepared ponds as with other forms of earthen ponds, it is nonetheless a good practice to remove all trees, their roots and all debris before construction starts.

In Chicoko constructed ponds, after pegging the dug-outs are used to build the pond walls and walk ways. Inter pond trenches are also dug the same way. Very often, Chicoko laden areas are flat flood plains for this reason, one-way flow valves should be introduced in both in-let and out-let pipes.

Where the soil texture is sandy as in Camp 74, Asaba, the use of sand bags to build up the walkways, pond and dyke walls is advised.

5.0 MAINTENANCE

FTPs require constant maintenance of pond walls, dykes and walkways due to the dynamic state of the water. Wall erosion is common problem hence care must be taken to ensure adequate spacing between ponds.

- Pond bottoms of non-chicoko ponds should be packed once a month in order to maintain the critical water volume for the prevailing stocking density.
- A constant attention must be paid to the water in-let channel and pipes to make sure that neither is ever blocked. It is on these two items that the success of the entire project rests.
- The dikes and walkways should be regularly inspected to secure their structural integrity.
- Feeding should be done in an area about two meters from the out-let pipe so that left over food, decaying organic matter and toxins could easily be swept away.
- The floor around this feeding area should be suctioned about twice monthly.
- After initial stocking, a protective spread net is used to cover the ponds in order to limit bird predation.
- Ensure biogenic daily records are dutifully kept.
- A general inspection and maintenance should be carried out at the end of every cropping season.

DELTA STATE GOVERNMENT

OFFICE OF THE CHIEF JOB CREATION OFFICER,

GOVERNOR'S OFFICE.

YOUTH AGRICULTURAL ENTREPRENEURS PROGRAMME

(YAGEP)

TRAINING MANUAL

ON

BIOGENIC RECORDS KEEPING

BY

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OUTLINE

2.0 BIOGENIC RECORDS KEEPING 1

1.1 INTRODUCTION 1

1.2 FISHERIES DAILY POND REPORT 1

1.0 BIOGENIC RECORDS KEEPING

1.1 INTRDUCTION

Biogenic records are daily farm records of physio-chemical properties of the water environment, movement of fishes due to sorting, deaths, growth rates, average weights, diseases and actual pond conditions. These records help to keep track of sources fish seeds, predisposition to diseases, profitability and batch performance.

1.2 FISHERIES DAILY POND REPORT.

TANK NUMBER: XX SOURCE OF FISH: DATE STOCKED :

AGE : QTY:

Date	Partial Water Exch.	DO/ TURBIDITY	Ph	NH_3/ NO_2	Full Water Exch.	Wt of Feed per Ration	No. of Times fed	Total Daily Feed	Aeration	Deaths	No. of fish transfer	Final Quantity
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
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FINAL QANTITY TRANSFERRED TO NEXT MONTH:												

Report on diseases if any:

Action taken: