LECTURE NOTE ON FIS 501

FIS 501: FISH PRODUCTION AND MANAGEMENT (3 UNITS)

This course is taught by three (3) lecturers – Dr. I.T. Omoniyi, Dr. (Mrs) O.T. Agbeti and Dr. O.J. Olaoye.

The course synopsis is further outlined on lecture basis as follows:

Lecture 1: Practical handling and care of fish

2: Breeding of fish (Natural and Artificial breeding)

3: Management of fish seed (fry and fingerling)

4: Management of fish brooders and growers

5: Building of equipment needed in fish farm

6: Procurement of feeds

7: Types of feeding system

8: Harvesting and marketing

9: Problems of fisheries management

10: Management plan in fisheries projects

By way of introduction, students should understand the broad spectrum of the course as Pisciculture which is defined as an aspect of Aquaculture. It entails the husbandry of fin fish at densities greater than would normally occur under natural conditions purposely to enhance production for human consumption.

In Nigeria today, there is need to increase fish production because beef cost is exorbitant; ban on importation of frozen fish and stock fish for source of protein:- to auguement fish stocks in natural waters. Fish production in Nigeria is from 3 main sources:

a. By artisanal fisheries – These are local fishermen and women who fish either on part-time or full time basis employing all sorts of gears and techniques. Some of the methods are

destructive e.g. use of poisons-crushed fruits of *Raphia hookeri* (Rafia palm). The common feature of these approaches is that almost all the fishes irrespective of size are captured.

b. By industrial/commercial trawlers – Industrial fishing in in-shore and offshore water of the seas. The UN law of the sea allows Nigeria the exclusive right to fish in zone up to 200 nautical miles (320km) from her coast. This zone is known as the Exclusive Economic Zone (EEZ). The establishment of national jurisdiction in this zone offers each country the chance to exploit the benefits of the zone for its country. Intense and uncontrolled exploitation of the fishes in the EEZ has resulted in dwindling catches and remarkable reduction in the catches of some species e.g. the tongue sole. *Cynoglossus senegalensis* in Nigeria coast (Fagade, 1992).

c. By fish farming – Fin and shell fishes can be produced in some systems e.g. ponds, cages, pens, raceways etc as a result of over-exploitation from the wild. Any over-exploited species can be hatchery raised/reared and restock into the natural waters. In Nigeria, the technique is expensive and has been so far neglected.

Therefore, practical handling and care of fish is crucial in fish production to achieve the goal of providing enough quantity of fish for consumption especially through pisciculture.

Practical handling and care of fish

This is the very first step in fish production especially through aquaculture source because there cannot be harvest without recruitment. It entails all the precautionary steps and techniques to protect the fish especially from the seed stage to adult stage when it appears on the table for consumption. The fish seeds (fry and fingerling) are usually 'nursed' rather than reared to ensure proper recruitment or else the harvest will be low. All processes e.g. the contact materials with fish (fish seed), water treatments, fastness during operations etc are referred to as the practical handling and care of fish to ensure the success of each venture into fisheries management.

For example, as a rule, gear that is used for collecting fish especially fish seed is constructed of fine mesh (<10mm) netting materials and should inflict minimal physical injury on the body. These gears include drag net, lift net, cast net, clap net and traps. When using nets or traps to take fingerlings or adult fish out of ponds, care must be taken during seining since muddy water can stress the fish. To reduce mortality due to muddy seining, fish could be attracted with crumbles of feeds, light source or dewatering. Other practical handling and care of fish can be hinted as

- Always use wet hand/ contact materials e.g. nets
- Handle the fish gently
- Keep fish in water while counting
- Avoid overcrowding the fish in containers
- Avoid standing fish in the sunlight and for a long time
- Fill containers for transport with pond water
- Transport fish during cool weather
- Work fast and travel quickly
- Avoid squeezing, throwing or dropping fish
- Always check temperature and temper fish

Tempering is a pre-stocking treatment of especially fish seed. It involves homogenizing the water in which the seeds are transported with the water in the pond/system into which they are stocked. It is a crucial step in handling and care of fish to avoid high mortality.

FISH BREEDING

Fish breeding is synonymous to fish propagation which simply means multiplication. Breeding entails all the various techniques or methods which can be used or at least maintain a fish stock (i.e. methods of fish seed production).

This concept in fish production is important when an increase demand for fish and for culture is considered. Also, in tropical world, many fish species breed only once a year. Therefore, a continuous demand for fish seed makes fish propagation sine-qua-non. There are various techniques which differ from different parts of the world depending on local conditions and available local facilities. For instance, in developing world where facilities are not available, fish seeds are obtained from the wild while in advanced countries where there are facilities, propagation is completely artificial.

Basically there are 3 types of fish breeding/propagation

- Natural propagation/breeding techniques
- Naturally induced breeding/pond or enclosure propagation
- Artificial propagation through hypophysation.

Natural breeding technique: is a technique whereby fish are allowed to breed in their natural environment and their eggs, larvae, fry and fingerling are collected for pond stocking. The fry and fingerling (fish seeds) of Cichlids, *Clarias, Chrysicthys* as well as mullets (*Mugil sp*) are available in Nigerians waters fairly in large quantities all the year round. *Heterotis niloticus* is seasonal in abundance and can be obtained within a short period in a year usually at about the beginning of the rainy season. Many other species are known to be available during the rains (April to September) in the flood plains-inundated river banks and the estuaries. However, much

is still desired to be studied in Nigeria concerning the season and nursery grounds of other species. Accurate statistics of fish seeds obtained from the wild is not available in Nigeria.

The collection of fish seed is carried out with no physical damage to the seeds which entails the elimination of gill-nets and hooks as used gears. Gears for collection include the hand net; lift net, drag/seine nets, cash nets. Light is used to attract them at night, pieces of feeds, GNC can also be used to attract them to avoid mudding during seining. Special traps especially in streams and river could be used. Before transportation, the collected fry are fingerling are kept in Happa, net or pots and starve overnight in clean water to avoid defaecation which can utilize O_2 during transit. The collected fry and transported in well aerated, cool water to the pond for stocking.

Problems associated with natural breeding technique include:

- For many species, the seed may not be available as and when needed or required. Hence, there is shortage of fingerling for stocking leading to low fish production.
- Weed fishes and fish enemies e.g. Dragonfly larvae, water bugs which may feed on eggs or attack the fry or compete for the fish food may also be collected with the fish seed. Fish parasites e.g. leeches are collected with fish seed from the wild and introduced in-advertently into the rearing ponds.
- Difficulty of accurate identification of the fry/fingerling stages of certain species which results in the desired species being stocked with undesirable stunted species. e.g. observed in catfish with *Barbus*.
- There is high mortality during catch/collection and at transportation.
- May be uneconomical e.g. cost of going to the wild, pay workers to gain access to the spawning sites through trial and error methods.

However, natural breeding technique needs little or no skill which is an advantage.

Ponds or enclosure propagation

Essentially it is a naturally induced breeding technique that involves introduction of broodfishes or brooders into specially constructed ponds or tanks and allow them to breed. It is a common practice to leave the brooders breeding repeatedly. This is not ideal in terms of quality and is anti-selective since the age and parentage of the fish cannot be determined after some time. Therefore, a proper and systematic pond propagation technique that would ensure production of fry of known age is recommended. Usually, ponds used for propagation are small, about 0.1ha or $100m^2$ and shallow usually less than 1m. Cement/concrete tanks with measurements of 5x3x1m have been successfully used for pond propagation of Tilapias in Nigeria. Some fishes which reproduce easily in ponds are Tilapia, *Oreochromis, Sarotherodon, Lates, Heterotis, Clarias*, Carps and *Gymnarchus* breed in special ponds. Intensive efforts are going on to propagate *Chrysichthys* in ponds. For example, the propagation of tilapias in ponds does best in shallow waters and the pond must have sandy bottom. If tank is used, the floor of tank is usually covered with a layer of sand for making their nests (spawning area). The eggs hatch within 1-2days after external fertilization. These hatchlings/larvae are usually carried by one of the two parents until they are free to go or fend on their own. The fry move in shoals (school) along the edges of the water from where they can be collected. Discuss the newly designed special receptacle for propagating tilapias.

Also, discuss pond breeding of *Heterotis, Gymnarchus* which require some stimuli to effect breeding in enclosures. These species would not breed in ponds without submerged higher plants e.g. grasses. In case of *Clarias*, it requires moving water and hence an artificial water current of the water must be created. Carp requires a special pond called Hoffer or Dubisch pond and it must have a large bottom with grasses and it is shallow. Temperature and dissolved Oxygen are

crucially and optimally required in the ponds. In addition, the water must be free of other fishes especially the carnivorous ones e.g. *Hemichromis*. Also, mention the success story so far about *Chrysichthys* breeding in an enclosure.

The above techniques are simple and inexpensive in addition to achieving the best possible survival rate, good growth and health for the fish. The techniques require no sophisticated installations or tools and without difficulties and risks involved in artificial fertilization.

Artificial Propagation through Hypophysation

The hypophysation technique which uses the pituitary gland (the hypophysis) to induce spawning in fish can be carried out at any time of the year and under any environmental conditions. The technique ensures fish seed availability at all times of the year. For instance, using this technique a single common carp (*Cyprinus carpio*) has been induced to spawn five times within a year at intervals of 60,62,41 and 186 days between successive spawning, even though carp breeds naturally only once a year.

Artificial propagation was first described in 1765, but was neglected until 1842 when it was described again. A number of experiments were carried out and by 1937 artificial propagation at commercial level was attained. By 1964, it has spread to many parts of Europe, America, Japan, China, Israel but to date there are increased trials in Nigeria with varying degrees of success. It was first reported in Panyan fish farm and Agodi fish farm where carp propagation was successful. Other privately owned fish farms have tried hypophysation using catfishes e.g. *Clarias gariepinus, Heterobranchus bidaorsalis*.

For the purpose of easy description and discussion, artificial propagation can be divided into 6 stages as:

- Selection of brooders
- Maturation of the brooders
- Stripping i.e. obtaining eggs and sperms (milt) from the brooders
- Fertilization
- Incubation of fertilized eggs to ensure that they hatch
- Rearing of the larvae/fry up to fingerling stage.

Discuss each stage with good illustrations and examples with the students.

On the whole, more fry can be obtained from an individual fish through artificial propagation involving stripping after hypophysation when compared to what is obtained through other propagation techniques.

ADVANTAGES

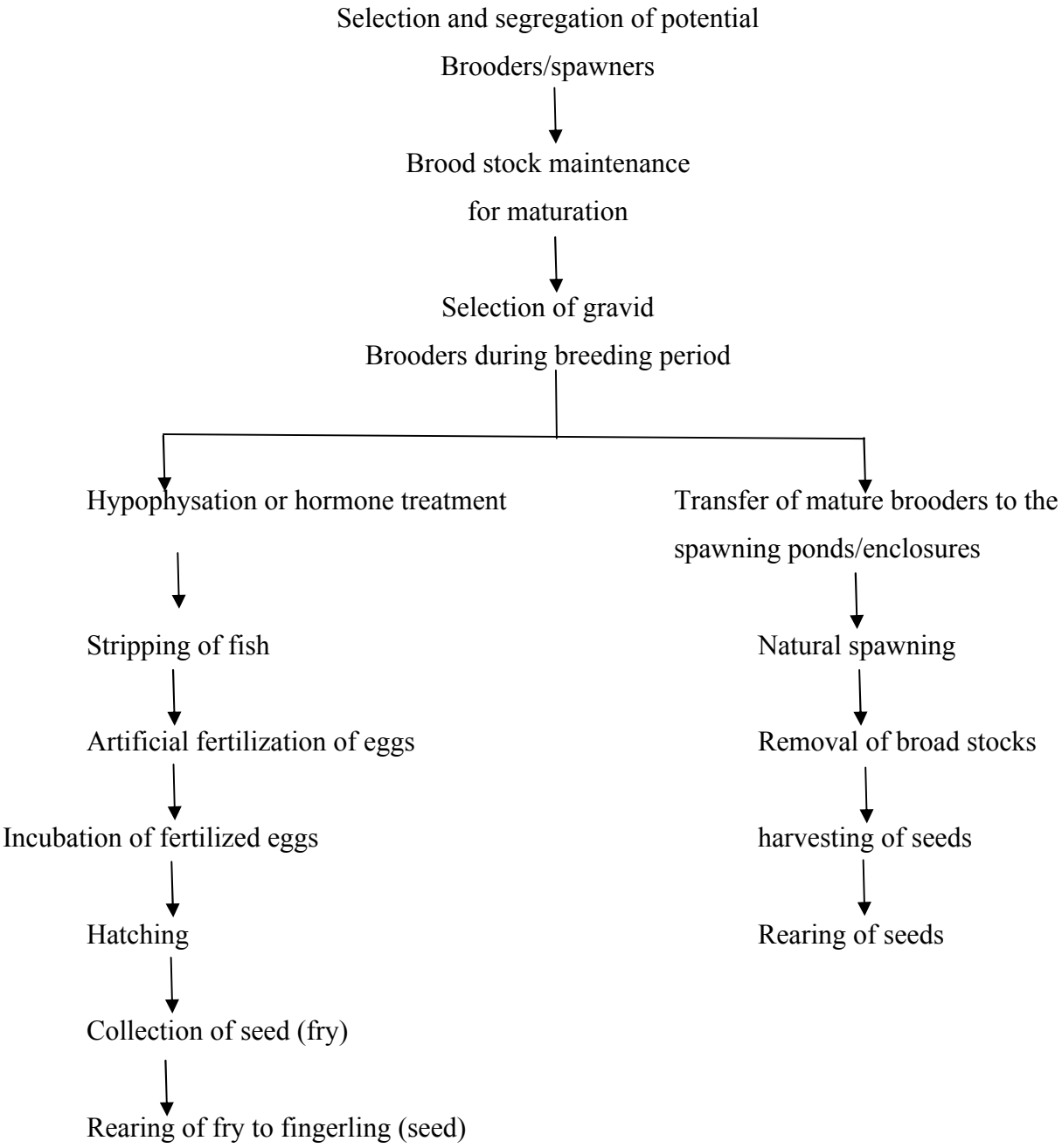
- Fish seed is guaranteed all the year round
- Fish seed is obtained outside the natural environment of fish.
- It increases the survival rate of the fry
- It improves quality by crossing two different species (i.e. hybridization) can be obtained.

DISADVANTAGES

- The donor fish has to be sacrificed in most cases and hence of loss of fish.
- The whole process is laborious and highly technical.
- Very expensive in that it requires proper housing, constructions of tanks, installation of jars in a close circulatory system.

It should be noted that artificial (i.e naturally induced or through hypophysation) production of fish seed are carried out in enclosures known as Hatcheries which may be an indoor or outdoor facilities and they require inputs such as brood stock, adequate water supply and suitable feed.

The sequence of steps involved in artificial production of seed can be schemed as:



Management/Maintenance of Broodstocks

Maintenance or management of broodstocks on a breeding farm is very necessary because it permits the build-up and selection of healthy, high quality brooders for stock improvement. In ponds for keeping broodstocks, they need to be simulated to that of the fish's preferred habitats in terms of O_2 content, temp, pH, tranquility, size and depth of the water, stocking density and quality and enough food.

Sharp fluctuations in the physico-chemical parameters of the water in the enclosures or ponds must be prevented especially temperature and O_2 as these are known to inhibit gonadal development. Overcrowding in the pond conditions must be avoided because it constitutes negative stress on the stock, though many cultured species are able to tolerate some degrees of crowded pond situations. For example, brooders of catfish (*Clarias*) are held at a stocking density of one fish in 2.-5.0m^2 of pond area with the depth of 1.0-1.5m.

Frequent disturbances also interfere with normal gonadal development and therefore care must be taken to restrict seeing or netting of the fish to the minimum. For example *Clarias* being hardy can withstand being netted out of water two or thrice a week, other fish species should not be seined more than once a week.

Provision of suitable and adequate quantity of food is equally of great importance. It has been known that brooders reared or maintained on adequate natural food and/or protein-rich artificial feed have a higher fecundity of larger eggs and thus yield best results.

To prevent outbreak of diseases in the stock used for breeding or subsequent transmission of any diseases to the offspring, brooders should be routinely treated and bathed in a 25% NaCl or 150ppm formalin solution for 10-30minutes. Malachite green can also be used.

Maintenance or management of brood stocks kept depends on the species, their size and the no of eggs per Kg per female, the survival from fertilized egg stage to the fry stocking phase and the demands for the fish from the grow-out units.

On principles of brood stock management solve the following problem with the students. Problem as:

As a fishery consultant, you have to supply one million Clarias gariepinus fry for restocking a Government farm.

i. How many eggs of this species will you require to produce the fry assuming that the average female brooder produces 5600eggs per kilogram body weight and that only 90% of eggs spawned are viable and of these, 86% will be successfully fertilized and out of these, only 78% would hatch?

ii. The average weight of each female *Clarias* as at the time of this contract was 3kg. Calculate the number of female brood stock to be maintained that would produce the above eggs to supply the required numbers of fry.

iii. If the sex ratio of male to female to effect the breeding was 2:3, how many male would be required, assuming each weighed 2.4kg to effect the above fry production?

iv. For proper management, at least thrice the required brood stocks must be maintained in a brood stock pond at a density of 600kg per hectare. Calculate the surface area of the pond required to maintain the brooders that would ensure the above fry supply.

Management of Fish seeds (Fry and Fingerling)

In fish life history, egg(fertilized) → Larva fry → fingerling → sub-adult/juvenile → adult. The larval stage ends when it fills up its air bladder with air, begins swimming in a fish-like manner and starts to eat external food that it becomes to fry. In addition to needing

all the essential requirements of the larva e.g. adequate O_2, suitable temperature, removal of waste matter etc, the fry also requires external food which should be adequate both qualitatively and quantitatively. The early fry may still have a part of the yolk left and can draw on it for sustenance from 1-4days depending on the species. The fry spends this period and learns to find its own food. Fry are said to require a more precise and careful nursing to ensure their survival and proper growth. Authors have remarked that lack of suitable food caused high fry mortality. Fingerling is bigger than fry e.g. 5-10cm and it is the stage that is usually stocked. Management of these developmental stages is based on their fragility and difference in sizes in terms of their habitats, stocking density, feeding and control of their infections and diseases. These stages are crucial because there cannot be harvest without recruitment. Hence, these stages are called fish seed or recruits.

Fry are nursed in small earthen ponds which vary from 100-200m^2 for about 3-4 weeks to attain fingerling stage. Fingerlings are reared rather than nursed in bigger earthen ponds. The pond is usually prepared to have a standing crop of rotifers and must be checked to exclude cyclopoid copepods which are natural enemies of fry. Food is crucial for growth which must be observed daily. Fry have two sources of food during the initial stage – yolk and external food to ensure better survival. Maintain these. It is part of the management that mixing of different age groups of same species should be avoided and it is advisable to use a monoculture of fishseed.

The most commonly provided artificial feed is finely ground and sieved through 100-150µm mesh called starter food. After two weeks, the size of feed particles is increased. Cutting the grasses on the dyke and throwing them around the shallow part of pond helps to increase natural food production in the pond. After about one month, the young fingerling have to be

removed from the small nursing pond and stock in a large pond. The artificial feeding continues but the size of food changes due to changes in the size of mouth. It is necessary to thin out the stock in order to provide sufficient space, O_2, food to the fast growing fingerling. Enemies of these stages must be managed too. These enemies change with the age of the fish. These are categorized as (i) enemies of fry (ii) enemies of advanced fry and (iii) of fingerlings.

Identify these enemies and treat adequately. For example enemies of fry include carnivorous Cyclops, insect and insect larvae (e.g. dragonfly), which predate largely on the fry. It has been stated that Cyclops are responsible for the highest mortality of fry at this stage next only to that caused by hunger. The advanced fry is less prone to predation by Cyclops since it is more agile and its skin in thicker and stronger. It is the insect larvae that pose greater danger at this stage followed by hunger if there is acute food shortage. O_2 deficiency may kill in heavily manured ponds. Abrupt changes in temperature and extreme cold may exterminate the fry population.

Enemies of the fingerling – Besides hunger, O_2 deficiency, sudden change in temperature, white spot disease caused by *Ichthyophthirius, Trichodina* and gill worm infections could exterminate the entire stock within a brief period in fingerling ponds.

Consult your note on Pathology for effective treatments. Preventive and control methods of these infections would be discussed during class interactions. Infection of a pond with any protozoan or bacteria or fungus can be diagnosed through certain indicative signs such as: (i) swimming of fry/fingerling in large school near the surface (ii) their accumulation below the water inlet (iii) the occurrence of dark specimens (iv) sudden occurrence of dead fish on the

surface. It should pointed out that fish that die because of parasitic infection only float on the surface while those that die due to dietary factors remain at the bottom.

Procurement of feed and system of feeding

Intensive fish culture involves a high/heavy stocking of water impoundments/enclosures and the use of artificial/formula feeds to improve production. Fish feed provide nutrients for optimal growth and this rapid growth achieved implies that fish feeds are essential for the economic use of time. Through shortened grow-out periods, a fish farmer can effect two croppings within a year. The increased number of croppings of table-sized fish imply that more profit can be generated by the fish farmer. Therefore, feed of adequate nutritional value is the foundation on which fish farming is built. Good and high quality feeds improve the quality of the edible portion of fish, enhances high protein retention and gives the flesh a firm consistency and delicate flavor.

Types of foods: Based on the source of origin, there are natural food and artificial feeds. Natural fish food can be of animal origin which include zooplankton e.g. rotifers, protozoans, cladocerans, copepods, larger zooplankton (arrow worms, crustaceans etc, benthic invertebrates e.g. polychaetes, molluscs, insect larvae e.g. Chironomids and Chaoborids, forage fish and aquatic insects.

Natural food could be of plant origin as an phytoplankton e.g. diatoms, desmids, blue-green algae, unicellular, filamentous and colonial algae and aquatic macrophytes. Dead plants and animals (i.e. decaying organic matter called detritus) also constitute an important natural food source.

Artificial feeds: Under commercial culture condition involving high stocking densities of fish, natural foods become limiting. It is the artificial or supplementary diets that fill the shortcoming of natural foods.

Early efforts to provide supplementary diets for cultured fish were based on attempts to duplicate composition of natural foods. This was labour-intensive involving the growing of earthworm and insects, harvesting small fish or tadpoles or by processing agricultural slaughter house by-products not readily consumed by man. Such diets had a number of drawbacks e.g. poor growth and nutritional diseases which led to the development of dry or semi-moist feeds commonly used nowadays. Artificial feeds are available in

Type I – meals, pastes or cakes

Type II – pellets

Type III – semi-moist feed

Type I is for plankton feeders, algae grazers, fry, small fingerling. They may be prepared as dry meal, colloidal suspension or soft cakes. Fish consume them by direct capture or by filtering water.

Type II – This type is convenient for storage, transportation and dispensing in automatic feeder or self feeder. Many fish feeds are prepared in pellet forms which can be hard (sinking), expanded (floating-encapsulated) or soft pelleted. Hard pellets may be used for fish with a mouth size capable of ingesting them, the stomach capacity to store them and the peristaltic action and enzymatic ability to digest them. Uneaten pellets disintegrate slowly in water and hence cause less water pollution. To discuss the merits and demerits in class.

Floating or expanded feeds enable the fish farmer to observe fish feeding at the pond surface. Floating feeds are acceptable to most surface-water feeders as well as catfish. Floating feeds are more expensive than hard pellets because they require extra energy in extrusion process and increased drying time. Soft pellets have water content between 8-20% and are preferred by fish which strike for their food.

Type III – Semi-moist have water content in the range of 37-40% and are prepared from frozen or fresh, wet ingredients. They are the most expensive feeds available hence fish farmers are not interested in using them.

Feeding systems or techniques

A feeding programme is successful when the required amount of nutritionally adequate feed is consumed. The feeding plan and techniques are affected by fish species and size, time of

the year and the type of production system. The best guide for the fish farmer is to place the feed where it can be obtained by the fish, offer it so that the fish will receive their share/rations. Floating feeds can be broadcast mechanically from specially designed feeding troughs or from mechanical feeders. For small ponds, the feed can be distributed by hand (self feeder). Feeding of fry and small fingerling poses different challenges. The experienced fingerling producer knows where the young fish are located in the pond. He may use containers or shelters to attract or hold the newly-stocked fry in an area. Note that feed placed in wrong location will not be eaten and will reduce overall water quality.

Mechanical feeders include the demand type which is activated by the fish and the automatic type which is activated by a time clock. Both have serious limitations, one of which is the tendency to less frequent observation of the culture system. The demand feeder is useful in extensive systems where fish do not have to be observed closely e.g. in lakes, reservoirs. The automatic feeder is designed to offer a measured amount of feed at predetermined time of the day.

Relationships between feeding and production will be discussed in class.

Test-cropping and Grading

Before harvesting, there is the need for test cropping and/or grading for at least once a month after stocking of the fish into the production ponds. A farmer needs to make direct assessment of the status of his fish stocks over the growth period because there are some species especially the carnivorous species e.g. *Clarias* which exhibit hierarchical dominance in its feeding behavior. As a result, the more aggressive will be at an advantage to receive more food than others bringing about marked differences in sizes of individual fish. Not only

this, test cropping allows to monitor the health status and adjustments in the feeding rates to account for growth especially if artificial feeding is practised.

The test cropping involves capturing a few number of fish using cast net or seine net early in the morning of a cool day and a bowl/bucket of water is kept nearby to keep or hold the fish during examination. The fish is held in a wet cloth or foam and any surface with which the live fish makes contact during the examination must be thoroughly moistened / wetted. If large variations in size among individual fish are observed, the stock should be graded into appropriate size groups and probably restocked into different ponds if not ready for harvesting.

Grading can be carried out by eye or where large numbers of fish are to be sorted out for harvesting, a box with a bottom that consists of a series of bars or slots appropriately spaced to segregate the specific size range of fish can be used.

Grading also functions to produce equal-sized fish for the market at the time of harvesting. However, it should be noted that test cropping and/or grading during production period should not be more than once a month because it is stressful to the fish and they tend to go off their food for a few days.

References or relevant textbooks would be recommended during the introductory lecture. Inter-net lectures are incomplete for your excellent performance in my examination. Therefore, attend my classes punctually and regularly for your own good.

Dr. I. T. Omoniyi