COURSE CODE: FIS309

COURSE TITLE: Aquaculture

NUMBER OF UNITS: 3 Units

COURSE DURATION: Three hours per week

COURSE DETAILS:

Course Coordinator: Prof. Yemi Akegbejo-Samsons

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COURSE CONTENT:

Aims and types of aquaculture. History, present organization and status of aquaculture in Nigeria . Principle of aquaculture, liming and pond fertilization; food supply; selection of culture species, introduction of exotic species and their implications. Water requirements. Stocking, feeding and harvesting practices. Fish farm design. Economic consideration of aquaculture

COURSE REQUIREMENTS:

This is a compulsory course for all 300Level Agricultural students in University. In view of this, students are expected to participate in all the course activities and have minimum of 75% attendance to be eligible to write the final examination.
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READING LIST:

LECTURE NOTES

What is Aquaculture

Aquaculture is fish farming. It is the art and science of controlled rearing of fish in ponds, farms and in some instances natural water bodies from hatchlings to matured size. Unlike fish that grow in the wild water bodies, without human interference, in aquaculture, activities such as feeding, fertilization, stocking, reproduction and harvesting are controlled.

Aquaculture has been defined by the Japanese Resource Council, Science and Technology Agency as follow:

Aquaculture is an industrial process of raising aquatic organisms up to final commercial production within properly partitioned aquatic areas, controlling the environmental factors and administering the life history of the organism positively and it has to be considered as an independent industry from the fisheries hitherto.

Aquaculture is organised production of a crop in the aquatic medium. The crop may be that of an animal or a plant. Naturally, the organism cultured has to be ordained by nature as aquatic.

Examples are:

Finfish:	Tilapia, carp, trout, milkfish, bait minnow, yellow tail, mullet, cat fish.
Shellfish:	Shrimps, prawns, oysters, mussels, pearl oyster for cultured pearls (eg. Japanese pearl oyster, *Pinctada fucata*).
Plants:	Water chestnut (*Trapa natans*). Red alga of Japan, "Norie" (*Porphyra*). Red alga of Philippines & U.S.A. (*Eucheuma*) Brown alga of Japan, "Wakame" (*Undaria*).

1. Food supply

Definition of food in the aquatic culture environment: Food in the aquatic culture system refers to the organisms which serve as food for cultured fish.

Examples of food: Major are the plankton, made up of 1) Phytoplankton (floating microscopic, unicellular plants). 2) Zooplankton (floating, microscopic unicellular animals). 3) **Others are:** multi-cellular plants like floating and submerged plants and multi-cellular animals like insect larvae, insects and crustaceans.

Supply

This is basically by the introduction of lime and fertilizer into the rearing pond and/tanks. This boosts the growth of the unicellular green plants (green algae) upon which the endemic unicellular animals and other phytophagous feeders feed.

For the culture of a desired food organism, the culture medium should be inoculated with the desired organism.

2. Selection of culture species.

Criteria for selection

1. Ability to accept artificial feed
2. Ability to breed in captivity
3. High growth rate
4. Should be marketable
5. Must be hardy

3. Introduction of exotic species and implications.

Definition of exotic species. They are species that are not indigenous to the local environment.

Some examples of exotic species that were introduced into the Nigerian culture environment are: The Chinese carp, *Cyprinus carpio,* mirror carp, koi carp, Indian carps like Mrigal *(Cirrhinus mrigala), Catla catla* and rohu *(Labeo rohita)*.

Conditions under which exotic species can be introduced

1. Must be able to occupy a niche in the environment without upsetting the environment.
2. It must be able to coexist favourably with other endemic species.
3. Must b able to reproduce in the new environment
4. Must be able to adapt to the physical and chemical parameters of the new culture system.
5. Must not be a vector to any parasite
6. Must have been quarantined before introduction..

STOCKING, FEEDING AND HARVESTING PRACTICES

STOCKING

Stocking refers to the release of fish seed into the culture system. The number and size of fish in ponds, tanks or cages is an important aspect of fish farming. Generally, the welfare of farmed animal in terms of **available space** for swimming, feeding e.t.c. have to be considered, vis-à-vis the size of fish or stage of development (either hatchling, fingerling, juvenile, sub-adult or adult) before stocking . Stock welfare is the major issue considered in determining stocking densities (i.e. number of fish per unit volume of water). Stocking in fish farming is synonymous with sowing in agriculture.

Farmed fish normally shoal or school together, however, under certain circumstances they may change their behaviour and start individually defending territories. These territories may be related to structures in the culture medium (pond, tank, cage e. t. c.) or to the source of food. In either case this can result in increased aggression and reduced access to feed, for at least some fish. There are many aspects of the fish's environment that affect the change from territorial to shoaling behaviour including: species and life stage, stocking density, the water velocity, water temperature and feeding system. However, in simple terms there may well be a lower limit to safe stocking density.

Fish health, welfare and productivity may suffer below certain stocking densities. Since fish do not normally occupy all the available space, overall stocking density (number of animals or biomass per unit volume) is not necessarily a good indication of what the fish experience, thus other indices of crowding or loading of the system is devised by practitioners. For tanks with water flowing through them these include **Carrying capacity, CC** (Kg of fish per litre of water per minute) or **Flow index** (Kg of fish per litre per minute per cm) and other indices.

FEEDING

Existing aquaculture feeding strategies include:

1) No fertilizer or feed input: This option involves a basic rearing system where fish/shrimp growth is totally dependent upon the consumption of live food organisms and plants naturally present within the water body. Fish/shrimp growth will therefore vary depending on the natural productivity of the water body and the density and total biomass of the cultured species present; fish/shrimp growth increasing with increasing natural productivity and decreasing stocking density. This feeding strategy is generally employed within extensive pond farming systems with low fish/shrimp stocking densities.

2) Fertilization: Here, chemical and /or organic compounds (termed 'fertilizers') are externally applied to the water body containing the cultured fish or shrimp so as to increase the production of live food organisms and plants naturally present, and so increasing the fish/shrimp production capacity of the culture system; fertilizers serving primarily as a direct source of essential nutrients for the resident natural food chain within the water body. Organic fertilizers are used here to include animal manures (applied by hand or through livestock integration), green manures (fresh plant cuttings), and fresh or composted agricultural by-products. This feeding strategy is typical of extensive and semi-intensive farming systems.

3) Supplementary diet feeding

When fish/shrimp stocking density and standing crop is such that the natural productivity of the water body alone cannot sustain adequate fish or shrimp growth, an exogenous supplementary diet can also be fed as a direct 'supplementary' source of dietary nutrients for the cultured fish or shrimp; the dietary nutrient requirements of the cultured fish or shrimp species being supplied by a combination of natural live food organisms and supplementary diet feeding. Supplementary feeds usually consist of low-cost agricultural/animal by-products, and may involve the use of a single food item in its fresh or unground state (i.e. such as mill sweepings, beer waste or rice bran) or the use of a combination of different feed items in the form of a feed mash or pellet. Although supplementary feeds are used as a direct source of dietary nutrients for the farmed species, when used in excess these products may also exert a fertilization effect on the water body. With this feeding strategy higher fish and shrimp stocking densities are possible and consequently higher fish/shrimp yield per unit area. This feeding strategy is typical of a semiintensive
farming system.

4) Complete diet feeding

In contrast to the previous feeding strategies, complete diet feeding involves the external provision of a nutritionally 'complete' high quality diet containing a predetermined nutrient profile. Traditionally, complete diets have taken the form of a dry or moist pelleted feed consisting of a combination of different feed ingredients, the overall nutrient profile of which approximates to the known dietary nutrient requirements of the fish or shrimp species in question under conditions of 'maximal' growth. Alternatively, complete diets may consist of a single food item of high nutrient value (i.e. trash fish, cultured live food organisms - *Artemia* nauplii), or a combination of both. In view of the high fish/shrimp stocking densities generally employed with this feeding strategy, no nutritional benefit is assumed to be gained by the cultured fish or shrimp from natural food organisms present within the water body. This feeding strategy is typical of an intensive culture system.

Choice of feeding strategy

A prerequisite to the selection of appropriate fertilizers and feeds for use within an aquaculture feeding strategy is first to conduct a survey of the fertilizer and agricultural feed resources of the area, district, state or country in question, where these resources are geographically located, how much is available and when, who is currently using this resource and how, and the composition and cost of these resources at source and with transportation.

In addition, many important economical, sociological, biological and environmental factors will have to be considered by the farmer before choosing an appropriate fertilization, supplementary diet or complete diet feeding strategy, including:

- Market value of fish/shrimp species to be farmed
- Financial resources of the farmer - amount of capital available for investment
- Farming traditions, 'taboos', and managerial ability of the farmer
- Time available for the farming activity - full or part-time farming activity
- Labour availability, training requirement and cost
- Service availability and cost - electricity, gas, water, fuel
- Fertilizer and/or feed availability and cost
- Fertilizer and/or feed transport and processing cost
- Feeding habit of fish/shrimp species to be farmed - carnivore, omnivore or herbivore
- Feeding behaviour and nutrient requirements of fish/shrimp species to be farmed
- Water quality requirements of fish/shrimp species to be farmed - oxygen, temperature, salinity, ammonia, pH, suspended solids
- Intended production system - cage, tank, earthen pond, recirculating aquaculture system, flow-through or stagnant water systems
- Intended fish/shrimp stocking density for all stages of the culture cycle
- Water exchange rate within intended production unit
- Natural productivity of the water body
- Food and feeding cost/unit of production/unit time
- Fixed and non-food cost/unit of production/unit time

However, the relative importance or value (if at all) of these factors will depend, in turn, on whether the proposed farming activity envisaged is geared toward a subsistence/home consumption farming activity, a commercial/market cash-income farming activity, or a combination of both.

FISH HARVESTING TECHNIQUES

Fin-fish

It is important to be able to apply humane dispatching methods to any fish that are to be harvested. Percussive stunning is considered a good approach provided it is done swiftly and delivered to the correct area.

Fish should be hit with a sharp blow to the head in the area just above the eyes (the area adjacent to the brain) using a special tool such as a heavy wooden handle or a priest. When applied correctly the fish's gill covers should stop rhythmically moving and the eye should remain still. Fish should only be bled after the fish has been dispatched.

Small to medium-bodied, warm-water fish species may be dispatched using an ice slurry. The slurry should contain equal volumes of crushed ice and water. Check the temperature using a thermometer.

A fresh water slurry should be 0_oC and a salt water slurry should be -4_oC. Monitor the temperature and add more ice as needed. Place the fish in the slurry, avoiding contact between the fish and the ice where possible. Leave the fish in the bath for 20 minutes or for 10 minutes after breathing has ceased.

Crustaceans

Procedures causing pain or distress to crustaceans must be avoided.

Crustaceans used in restaurant and catering industries include shrimps, lobsters and crabs. People who handle these animals are responsible for ensuring the most humane methods are used when catching, transporting, housing and killing them.

Salt water/ice slurry method

It is recommended that all crustaceans are immersed in salt water/ice slurry for a minimum of 20 minutes before boiling, broiling, pithing or cutting. This ensures the animal is immobilized before procedures that may cause pain are carried out.

The salt water/ice slurry is made by first filling a suitable container with normal crushed ice, then adding salt water (sea water salinity). The ratio of normal ice to salt water should be 3:1, which will give the consistency of wet concrete and a temperature of –1°C. It is important that enough ice is provided to maintain the temperature of the slurry.

Rapid destruction of nerve centres

If the above method is not practical it is suggested that the central nerves be quickly destroyed. Wherever possible, however, it is recommended that rapid destruction of the nerve centres be done after a 20 minute immersion in salt water/ice slurry.

Lobsters

Lobsters have a chain of nerve centres running down the central length (longitudinal midline) of the animal. For sashimi (raw) and broiling (grilling) methods these centres should be destroyed by rapidly cutting through the longitudinal midline (lengthways) of the lobster with a large sharp knife.

Two cuts should be made:

- start in the midline near the tail/chest junction and cut towards the head;
- from the midline near the tail/chest junction, cut towards the tail.

A mallet should be used to force the knife quickly through the animal. After cutting in half (lengthways) the chain of nerve centres at the front end (chest and head) of the lobster should be rapidly removed.

This procedure should not take more than 10 seconds and should only be done by a skilled operator.

Crabs

Crabs have two main nerve centres: at the middle front and rear of the animal.

When time is limited, crabs may be placed in salt water/ice slurry for a few minutes, to stop movement, before:

- rapid destruction of the front and rear nerve centres with a thick pointed, pithing instrument, or
- rapid removal of the carapace (top shell) and destruction to the front and rear nerve centres.

These procedures should not take more than 10 seconds and should only be done by a skilled operator.

Unacceptable Methods

The following procedures are not acceptable because they have the potential to cause prolonged or avoidable pain or distress to crustaceans:

- transverse sectioning, of lobsters (i.e., separating the head and chest from the tail of the lobster without first destroying all the nerve centres);
- cutting crabs into sections before destroying the front and rear nerve centres;
- boiling crustaceans before immersing them in a salt water/ice slurry for a minimum of 20 minutes.