LESSON 1 SCOPE AND NATURE OF AQUACULTURE

Aquaculture mostly involves growing fish in water, to harvest, either for commercial or personal purposes. It can involve growing other things as well though, including crustaceans (e.g. prawns, crayfish), shellfish, or seaweed. When focusing on marine aquaculture, the term “mariculture” is sometimes used.

The scale of operation may be small through to very large. Two most common reasons for a significant shift into aquaculture production is increased industrialisation and a global food crisis.

There are a lot of different terms used to describe growing fish, each with different shades of meaning. These include: pisciculture, aquaponics, aquaria or aquaculture:

- **Aquaculture** is an all embracing term, covering fish, crustaceans, shellfish and other species, including seaweed. It is farming fish and other water dwelling plants or animals in fresh water or salt water to harvest.
- **Pisciculture** is farming fish only (excludes crustaceans, molluscs, seaweed etc.)
- **Mariculture** is aquaculture in saline water.
- **Aquaponics** involves growing land plants such as vegetables and herbs together with fish, all in the same system (usually in tanks) using (nutrient loaded) water circulated from the plants to the fish, with the water then returned to the plants. It is a hybrid of hydroponics and aquaculture.
- **Aquaria**: Aquarium management or aquaria generally refers to growing plants or animals in water for purposes other than harvesting for food, such as conservation, research, or for a hobby or decoration.

Suggested Tasks: ▼

Throughout this course you will be provided with suggested tasks and reading to aid with your understanding. These will appear in the right hand column.

Remember: these tasks are optional. The more you complete, the more you will learn, but in order to complete the course in 20 hours you will need to manage your time well. We suggest you spend about 10 minutes on each task you attempt, and no more than 20 minutes.

FARMED VS WILD FISH

Almost 50% of the world's seafood supply comes from aquaculture. This is likely to increase as the global fish demand expands. Well-managed fish farms are essential for a healthy end product that will be used for human consumption. This strategy will depend on the amount, type and quality of fish food, antibiotics, preservatives, hormones and other additives that are generally included during their production. It is important to focus on production methods that minimise health risks in both the human and animal population, as well as the environment.

Contaminants can be found in both farmed and wild caught fish, and this can vary greatly upon geographical area, age and diet of the fish and, of course, the species. The pollutants of most concern include heavy metal bioaccumulation (i.e. methylmercury), radiation contamination (i.e. Fukushima nuclear disaster), agricultural pesticides, production drugs and other persistent organic pollutants (POPs) contaminating the land and the ocean. Methylmercury and POPs, on the other hand, may come from the atmosphere (and into the ocean) due to fossil fuel combustion.

Farmed fish accumulates toxins mainly from their diet via the intake of fish meal and oil sourced from wild pelagic fish. Apex predators like sharks, tuna and swordfish, are most likely to contain high levels of mercury and other heavy metals if caught in the wild. According to this point of view, farmed fish may be a safer option for human consumption, but only if their source of food comes from areas with lower levels of toxic pollutants. There are, however, alternative methods that can be used to reduce contaminants in farmed fish, such as the use of activated carbon filters, or simply by reducing the amount of fish meal and oils used in feeding.

Aside from the quality and origin of fish feed used in aquaculture, another concern arises as to whether consuming farmed fish is better than consuming wild caught fish. Farmed fish requires a constant dose of chemicals to treat and prevent fish from harmful diseases. These chemicals include antibiotics, probiotics, pesticides, algaecides, insecticides, herbicides and disinfectants, amongst others. Chemicals like these, if not managed properly, can concentrate in the sediments and end up affecting both aquatic and terrestrial wildlife, as well as the human population when they consume farmed fish contaminated from the oversupply of these chemicals.

A well-managed aquaculture farm will know the importance of using practices that maintain fish health through appropriate water quality but also protect the environment from the harmful effects of chemical residue and leachate by managing effluent discharges. There are many options available to attain and maintain a healthier aquaculture farm system, reducing the amount of chemicals (or using more natural alternative products) needed to support fish health and prevention of diseases is one such management practice. It is the degree of value given to researching these options and implementing them that will make a difference.

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Suggested Tasks

Write down (with pen & paper -not using technology) the difference between "Farmed fish and Wild Fish" Do not refer to your course notes.

Now discuss this for 5 minutes with someone else - friend, family, colleague - and note any additional or varied thoughts.

Spend around 10 to 15mins doing this.

COMMERCIAL AQUACULTURE SYSTEMS

Aquaculture systems are generally confined environments, where growing conditions have been optimised to support more animals being farmed in a smaller space than those found in nature — e.g., tanks (specialised systems) or fenced off areas of leased or owned bodies of water (e.g., parts of a coastal lagoon), rather than free-swimming in the natural environment. Although this can result in an increased harvest, it also presents problems. One common problem is that when fish are grown at such close quarters, competition can be strong, and cannibalisation may become an issue.

To protect against this, commercial systems must separate small or developing fish from larger specimens. This protects the long-term harvest.

As such, pisciculture — or fish only — systems tend to be one of three types:

1. Hatchery Systems that produce fertile eggs, larva or fingerlings.

Aquaculture seedstock are produced in hatcheries and these supply the industry. Depending on the industry approach, the technology needed can be complex for a successful hatchery. One critical element is ensuring the bloodstock are extremely well and healthy – this in turn ensures the seedstock are the best of health with the highest survival rates. The investment comes because the brood stock holding facility can take up a large area and require investment in pondage and water. Additionally many hatcheries are kept indoors and tend to run through intensive systems (using flow-through or recirculation technologies). This ensures the greatest control and ultimately the most reliable production. If the hatchery is outdoor production – open ponds – the infrastructure requirements are extensive, however the pond management is intensive. Freshwater species are easier to breed than saltwater species, therefore depending on the species, a hatchery system may not be required. It is suggested that an aquaculturist in that start of their career may find it most valuable to buy stock from an established hatchery.

2. Nursery Systems that nurse small larvae to fingerlings or juveniles.

   The purpose of the nursery system is simple – to allow for the safe growing stage in the young stock. In the wild this life stage has the highest mortality rate. Nursery technology differs again depending on the species. As in hatcheries, many nurseries will use the same intensive through-flow approach or recirculation technology. They are capital intensive systems. They great news is once functioning, the offer a high level of reliability. Having reliability in the system is necessary –this allows for purchasing seedstock on a broader scale production schedule. Other ways of growing stock include placing the fish in the plankton-rich ponds and leaving them for a number of weeks. When stock has grown to the right size, the pond is drained, and the juveniles are harvested. This is most often the cheapest approach at this stage in production. This stage is important for the early growth of the fish. Well fed fish in a correctly maintained system can achieve growth rates which outgrow the grow-out stage. The dietary management here is critical – whether natural of artificial – it is the deciding factor in maximising the growth at the nursery stage.

3. Grow-out Systems that grow fingerlings or juveniles to marketable sizes.

   This stage in the system allows the fish to grow only to a size that the market demands. This stage will take place in any system and the management of the system is less technically demanding. Although the fish can be left for a long time during the grow out stage, they still need looked after every day. When the fish have reached their size in this system, they are worth so much more value to the farmer and therefore the risk (potential loss) is also higher. Consider in the example of Murray Cod – the stock may have only been 1.5kg (total) when in the nursery, have now grown into an enormous 150 tonnes of fish as the final product.

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Suggested Tasks

Go Online and watch one or two videos on hatchery system (up to 10mins in total).

Search using phrases such as ‘fish hatcheries’ or ‘fish hatchery system video’ or fish egg hatching video or something similar

Make notes

Beyond these three stages which occur in a system, there are also processing and marketing stages worth remembering. Processing is a specialised industry in itself and is tightly governed and regulated under consumer health and food processing laws. Complying with this area can be costly – therefore a production and processing system is always separated from the other. The final stage of marketing the product is very removed from the production efforts. The grading and the management of fish is a full time job, leave the marketing side of the business to people who are trained in that area.

Land-Based Freshwater Aquaculture

Many aquaculture set ups begin as land-based ventures. This means that the fish are farmed in dug out ponds. For this type of aquaculture, the primary needs are:

- land for the ponds — high clay content helps ensure water is stored efficiently
- reliable source of good quality water — can be drawn from a river, bore hole, or nearby storage dam
- inexpensive source of fish feed, such as plants grown in ponds, fishmeal, or fish oil products.

There are two main kinds of aquaculture, each with pros and cons. These are:

- extensive production
- intensive production

The best type of production will depend on:

- the type of fish being cultured
- water and land available
- approach to stocking and feeding
- approach to particular types of agriculture and classifications (e.g., organic)
- any potential marketing advantages (e.g., use of terms such as “organic” and “natural”).

Aquaculture systems can also be classified based on the main inputs to the system, i.e., the water and nutrients, and how they are added or accessed. In this classification system, there are three categories:

- open
- semi-closed
- closed.

Each of these systems have advantages and disadvantages, and must be considered in terms of:

- land available
- species being cultured
- economic considerations
- marketing considerations.

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Suggested Tasks

Investigate the current state of freshwater aquaculture in your country. Do this by talking to someone who works in the industry (eg. sells fish at a fish shop or market).

Consider what fish species are grown, how they are grown and availability. What is the proportion of freshwater aquatic life production.