Fish for FRESHWATER AQUACULTURE AND AQUAPONICS

BY STAFF OF ACS DISTANCE EDUCATION

CONTENTS

CREDITS

Written By:
Staff of ACS Distance Education

Photos:
John Mason and Stephen Mason

Layout & Illustration:
Stephen Mason

Editorial Assistants/Contributors:

John L. Mason Dip.Hort.Sc., Sup'n Cert., FCIH, FPLA, FIOH

Barbara Seguel B.Sc., M. Aquaculture Eng.

Kara Wight BSc (Applied Bioscience and Zoology), HND (Animal Care)

Sarah Partridge B.Sc.Zool (Hons)

Adriana Fraser Cert.Hort., Adv.Cert. App.Mgt., Adv.Dip.Hort.

Published by:
ACS Distance Education

P.O. Box 2092, Nerang MDC,
Queensland, Australia, 4211
admin@acs.edu.au
www.acsbookshop.com

P O Box 4171, Stourbridge, DY8 2WZ,
United Kingdom
admin@acsedu.co.uk
www.acsebooks.com

ISBN: 978-0-9954356-7-4

The information in this book is derived from a broad cross section of resources (research, reference materials and personal experience) from the authors and editorial assistants in the academic department of ACS Distance Education. It is, to the best of our knowledge, composed as an accurate representation of what is accepted and appropriate information about the subject, at the time of publication.

The authors fully recognise that knowledge is continually changing, and awareness in all areas of study is constantly evolving. As such, we encourage the reader to recognise that nothing they read should ever be considered to be set in stone. They should always strive to broaden their perspective and deepen their understanding of a subject, and before acting upon any information or advice, should always seek to confirm the currency of that information, and the appropriateness to the situation in which they find themselves.

As such, the publisher and author do not accept any liability for actions taken by the reader based upon their reading of this book.

CHAPTER 1 INTRODUCTION TO AQUACULTURE

WHAT IS AQUACULTURE?

Aquaculture is by no means new. People have been growing fish and other things in water for thousands of years. Interest in the subject however has strengthened both among professionals seeking to farm fish, plants and crustaceans and among amateurs, sometimes prompted by nothing more than an interest, and sometimes in an effort to become a little more self-sufficient.

One of the big challenges for anyone seeking to 'do aquaculture' is choosing what to grow. This book is specifically aimed at helping you to be more informed when making that choice.

Pisciculture, Aquaponics, Aquaculture or Aquaria

There are a lot of different terms used to describe growing fish, each with a subtly different connotation. pisciculture, aquaponics, aquaria or aquaculture are all terms used for growing fish in controlled systems.

- Aquaculture is an all embracing term, covering fish, crustaceans, shell fish 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, and 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, a hobby or decoration.

Barramundi

COMMERCIAL AQUACULTURE SYSTEMS

Aquaculture systems are generally confined environments, where growing conditions have been optimised to support more animals in a given space, than what might occur in nature. One problem is that when fish (or other animals) are grown at such close quarters, competition can be strong, and often cannibalisation may become an issue.

Commercial systems therefore need to separate small or developing animals from larger ones.

As such, pisciculture systems tend to be one of three types:

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

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

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

Land-based Freshwater Aquaculture

The most basic need for fish farming is land that can be used for ponds. This land should preferably have a high clay content to hold the water efficiently. Next, a reliable source of good quality water is needed - this can be from storage dam, river or bore-hole. Finally, an inexpensive source of fish feed is a must. This can range from plant growth in a pond to fishmeal or fish oil products produced on the same farm or bought in as rough or processed feed. Fishmeal is made from fish flour produced from low quality fish that is in turn used to feed higher quality fish.

Two kinds of aquaculture are generally practiced:

1. Extensive Production

2. Intensive Production

Both have their place. Both have advantages and disadvantages. It is up to you to decide which of the two systems you prefer for the organisms you are culturing.

Another classification for aquaculture systems considers the origin of the main inputs to the system, water and nutrients. This classification defines three types of systems:

- Open
- Semi-closed
- Closed systems

As stated for production systems, each of those has advantages and disadvantages, and their use depends on the land available, the species being cultured and economic considerations.

Open systems use natural environments where aquatic organisms grow naturally to culture them. These are extensive production systems. Water enters and leaves the system without the need of pumps, and most of the nutrients come with the water. Nutrients may be added in certain cases or for certain periods of time, as in salmon cage cultures. Open system advantages are lower infrastructure costs and lower rate of diseases. Its disadvantages are higher quality variability, and loss by predation and poaching.

Semi-closed systems on the other hand, are systems where water and nutrients are added (to the system) by means of controlled and man-made structures or effort. Water is circulated once or more times through the system, and then discharged. These systems need additional equipment such as pumps and filters. The advantages are that environmental factors can be closely monitored and changed if need be - such as: water flow, temperature, quality and oxygenation. Also nutrient input is matched as much as possible to the need of the population being fed, so fewer wastes are produced. Disadvantages are the higher costs for infrastructure and manpower. These systems are ‘Intensive Production’ systems.

Closed systems are not as common as semi-closed systems, as they require high capital input, specialized structures and specialized staff to operate the system. They use mainly water tanks that in the majority of cases are circular. Closed systems are used nowadays to produce eggs, larvae and juveniles, which are then sold to ‘fish growing’ farms. Closed systems are being tested in the salmon industry with success, although they have not been implemented fully, due to costs, equipment development and staff training.

Could Farmed Fish From Closed Systems Be Better?

There is good reason to ask if farmed fish might be better to consume than wild caught fish. The natural population of fish sourced from the ocean is rapidly decreasing due to overfishing, pollution and acidification of the ocean, among other factors. This and other main reasons (such as population growth) are why there is a fast growing demand for more sustainable ways of farming. Because there are so ways in which the world’s oceans are being affected by contamination and in other ways affected by a fast decrease in fish population, it is reasonable to question whether people are better off eating fish that is bred in a controlled environment, or fish that is caught directly from

the ocean, lakes or other natural water sources.

Almost 50% of the world's seafood comes from aquaculture and it continues 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 or POP's contaminating the land and the ocean. Methylmercury and POP's, 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 as it comes directly from fish meal and oil sourced from wild pelagic fish, whereas apex predators like sharks, tuna and swordfish, will be 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, 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 for their feeding.

Studies have shown that lower concentrations of contaminants are found in the lower hemispheres. In today's fast growing economic society however, large amounts of imports and exports move throughout the entire world, which leaves us with the ongoing question of where and how these fish are being farmed or caught. So, unless we know the origin, as well as the production and manufacturing processes, we will be uncertain about the quality of fish we are consuming.

Aside from the quality and origin of fish feed used in aquaculture, another concern arises as to whether consuming farmed fish is better than 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.

Jade Perch

Which Fish Is Best?

Globally, many different freshwater fish species have been successfully farmed, on a small or large scale. Choices are frequently be limited though by what is legally able to be farmed, and what is available where you live.

Most developed countries do impose restrictions, banning some fish species and requiring licences to farm others.

All of the following have been farmed successfully somewhere:

- Trout (several species)
- Catfish (several species i.e. Asian Catfish or Pangasius - Pangasianodon hypophthalmus)
- Eels (several species)
- Carp (several species)
- Sturgeon (Acipenser and Huso)
- Tench *(Tinca tinca)*
- Roach *(Rutilus rutilus)*
- *Roho labeo*
- Milkfish (Chanos Chanos)
- Wuchang Bream (*Megalobrama amblycephala*)
- Northern Snakehead (*Channa argus*)
- Tilapia (Nile Tilapia) (*Oreochromis niloticus*)
- Largemouth Bass (*Micropterus salmoides*) and relatives *(Micropterus spp.)*
- Barramundi or Asian Sea Bass (*Lates calcarifer*)
- Golden Perch (*Macquaria ambigua*)
- Jade Perch (*Scortum barcoo*)
- Murray Cod (*Maccullochella peelii*)
- English Perch or Redfin (*Perca fluviatilis*) (same category as European Perch)
- Silver Perch (*Bidyanus bidyanus*)
- Sleepy Cod (*Oxyeleotris lineolata*)
- Sooty Grunter (*Hephaestus fuliginosus*)
- Red Drum or Corbine (*Sciaenops ocellatus*)

Some other species are farmed as baitfish e.g. Gold fish, Flathead minnows, Golden Shiner

Others are farmed for Ornamental fishponds or Aquaria.

WHY EAT FISH?

Fish and other aquatic animals contain a various amount of essential nutrients required for human brain development, and other important nutritional needs for the rest of the body and its daily functions. Nutrients like Omega-6, Omega-3 long chain fatty acids and iodine are amongst the nutrients found almost exclusively in fish and other aquatic animals (compared to other terrestrial animals). The reduction in the consumption of trans-fatty acids and saturated fats is crucial to human health, therefore, higher needs for healthy mono and polyunsaturated fats that come from seafood has been rapidly increasing throughout the time.

The intake of DHA and EPA (also known as Omega-3 LCPUFAs or long chain polyunsaturated fatty acids, are mainly sourced by oceanic aquatic species such as oily fish (i.e. salmonids, sardines, herring, anchovies, mackerel, tuna, among others), crustaceans, shellfish and algae. Algae are the main source of Omega-3 for fish, which they incorporate through their diet.

Iodine is another major source of human nutrition that comes from both wild caught and farmed fish and other seafood. Iodine is an essential trace element and a major component of thyroid hormones, which are needed for healthy growth and development of tissues in our bodies.

In recent studies they have found correlations between heavy metal contamination and a diminished ability to benefit from Omega-3 fatty acids. This just raises one of the many questions as to whether humans should prefer farmed fish to wild caught fish.

Farmed fish with an excess amount of Omega-6 need to be taken into consideration; a human diet with a lot more Omega-6 than Omega-3 is not the ideal ratio for a healthy balanced nutritional diet. An example of a farm-raised fish with these levels of fatty acids is Tilapia, mainly due to the inexpensive way to feed, which is commonly corn-based feed containing short chain omega-6 which eventually get absorbed in their tissues.

Also, the many different ways farmed and wild caught fish is processed and produced will reflect other effects to the nutritional value to the final product (i.e. canned fish with or without bones, whole fish, etc.).

Despite it being wild caught or farmed fish, not all fish provide the same nutritional value once consumed. For example, salmon is prone to have a large amount of Omega-3 (which can counteract the negative effects of too much Omega-6), Vitamin D and B, as well as magnesium, phosphorous, potassium and selenium (which may help counteract the negative effects of mercury). However, farmed salmon is found to have less concentration of Omega-3 compared to wild-caught salmon, as well as a higher level of toxins such as dioxins, PCB’s and DDT.