

WHAT SPECIES TO FARM

Aim

Compare the cultural requirements of different types of fish and choose the most suitable for aquaculture in your region.

In the mid 20th century, production of rainbow trout, oysters and ornamental fish were the most common commercially viable aquaculture industries in many countries. Other species cultured in smaller operations included carp and shrimps in Asia, eels in the Mediterranean, lobster in North America and Tilapia in Africa and Asia. Nowadays many more species are farmed, and some with great commercial success. Asia contributes to over 90 percent of global production, so when assessing aquaculture today a bias towards Asian countries and Asian species is difficult to avoid.

CHOOSING WHAT TO FARM

Your choice will depend on many considerations, including:

- Climate
- Water resources
- Finance
- Scale of operation
- Other resources: manpower, knowledge, support services etc.
- Market demand and access
- Ecological considerations: availability of animals, legislation on living animal trade
- Risk Considerations: disease, pest, reliability of growth rate, stability of markets.

Climate

Some animals are more environmentally sensitive than others. Some may require cold water, others hot water; and others water where temperature fluctuations are minimal. Some need deeper water; others are able to grow in shallower water. Some species need certain water salinity or alkalinity in specific periods of development. In general, cold freshwater fishes require more pristine waters and stable oxygen concentrations, therefore more control on water quality, than warm water estuarine fish.

Water resources

Water quality may be more important to some animals than others. Some may grow in poor quality or contaminated water, but the quality of the harvest (taste, levels of pollutants such as mercury, etc) can become an issue if water quality is poor. Oxygen levels can affect rate of growth in animals, as can chemicals in the water. High levels of nitrogen together with light can cause algal blooms which can block pipes, and may cause other problems as well –but may also provide food for aquatic animals.

Finance

Sometimes set up costs can be very high (e.g. creating dams, installing tanks, filtration systems etc) Some properties may already have dams or other previously built or naturally occurring water resources that can be used. Some animals may be grown to a marketable size quickly; while others take a lot longer. It is not only important to have adequate money to set up a venture but also the cash flow to maintain operations until a return on investment is realized.

Scale of Operation

Some types of aquaculture can be intensive, requiring relatively little land. Other types need to be operated on a much larger scale to be profitable. Your choice of animal may be determined by the scale on which you are able to operate.

Other resources (manpower, knowledge, support services, etc)

Larger scale operations will need more manpower. If something goes wrong, you either need the expertise yourself or experts help close at hand to deal with the problem. For farms that are located in isolated communities (for example), it may be difficult to obtain help from a veterinary expert, an engineer or irrigation expert, or some other expert, as and when you need it.

Market

Some products sell well, but that may be because they are difficult to produce; or perhaps because they are in fashion at the present moment. This does not necessarily mean you will sell them well, or make a profit on them if you start planning to grow them now. There may be others also starting aquaculture ventures targeting this market or perhaps the cost of production is so high that despite demand, there might not be a big profit.

Current demand is none the less an indicator of likely demand later on.

Demand is only one consideration when deciding whether the market opportunity will be strong. There are all sorts of costs involved in marketing as well. Consider how well the product keeps, the cost of processing, transport, packaging etc. Consider alternative options for marketing also. Some fish may be preserved by freezing, smoking, canning, pickling etc: thus extending the shelf life; but this may also change the nature of the product. Processing may add value to your produce; but it can also increase the overall production cost.

Availability of Animals

You may identify an animal species that would be ideal to farm, but if it is unavailable or illegal to grow in your region, there is little point in planning its production.

Risk Considerations

Some animals are more prone to disease, growth rates are more sensitive and variable, or market demand is less reliable. Drought, variations in water quality (or depth) and other factors can also be risks. You need to consider risks; and choose animals to farm that will be less risky for you in your situation.

OVERVIEW OF INDUSTRY AND MAIN SPECIES

According to statistics from FAO, there are around 450 species of fish, crustaceans, molluscs and aquatic algae cultured in aquaculture today, defined broadly, that is, including culture in seawater, brackish waters and freshwater.

In order of importance, fish are the most common, by volume and value (around 50%) aquatic plants are second in volume and fourth in value, crustaceans are in volume and second in value, and molluscs are third in volume and value.

By volume: The most common families cultured in the world are (1) Cyprinidae (fish) (2) Ostreidae (oysters) and (3) Laminariaceae (kelp algae).

By value: (1) Cyprinidae(fish) (2) Penaeidae (Shrimps and crabs) and (3) Salmonidae.

Asia

The main species cultured in Asia have been cyprinids (carps and barbs). Other freshwater species in Asia have included Tilapia, milkfish and mullet in smaller volumes. Marine species have included Seabream (*Labrus* sp) and carangids (jacks, caravelles and pompanos), and seawater and freshwater species include Salmonids (Salmon and Trout) and Eels (*Anguilla japonica* and *A. anguilla*).

South Africa

In South Africa the following have been grown commercially:

- Redbreast tilapia (*Tilapia rendalli*),
- Common carp (*Cyprinus carpio*),
- Grass carp (*Ctenopharyngodon idella*),
- Silver carp (*Hypophthalmichthys molitrix*) and
- Largemouth bass (*Micropterus salmoides*).

Australia

The main freshwater fish used in aquaculture is the Australian Bass (*Percales novemaculeatus* - also known as *Macquaria novemaculeata*) and Barramundi (*Lates calcarifer*).

Suitable fish for stocking dams may include:

- Eel-tailed catfish (*Tandanus tandanus*),
- Straight-backed catfish (*Neosilurus* spp.),
- Silver perch (*Bidyanus bidyanus*),
- Sooty grunter (*Hephaestus fuliginosus*),
- Murray cod (*Maccullachella peelii*),
- Mary River Cod (*Maccullochella* sp. nov.),
- Archer fish (*Toxotes chatareus*),
- Saratoga (*Scleropages* spp.),
- Golden perch (*Macquaria ambigua*), plus many more.

United Kingdom:

England and Wales: The main fin fish species farmed is rainbow trout. There is also limited production of other species, such as brown trout, carp, Atlantic salmon, turbot, barramundi, and tilapia. Shellfish farm production: the main species cultivated are mussels and oysters.

Scotland is responsible for 80% of the UK aquaculture production. Farmed Atlantic salmon are the most important species, followed by rainbow trout and shellfish. Brown trout, sea trout, halibut and Arctic charr are also farmed in Scotland.

European Union (EU)

Fish farming exists in every member state. The principal species in the E.U. is Trout, and the largest growth area is seen in mariculture (marine aquaculture), with the principal species being Salmon, Seabream, Seabass, and Turbot.

North America

The channel catfish, *Ictalurus punctatus*, remains the dominant species produced in North America. Salmon aquaculture contributes significantly to North American production, salmon being reared in the Northwest Atlantic (Maine, United States) and the Canadian Maritime Provinces, as well as in the North-eastern Pacific (Washington State, United States and the Canadian Province of British Columbia). Minor species include: Rainbow trout and golden shiners are the new most cultivated finfish, followed by coho salmon, chinook salmon, tilapia and sturgeon. The principal invertebrate products of North American aquaculture are molluscs and crustaceans. Mollusc production in North America includes a variety of species but is centred on oysters, hard clams and mussels, and includes both American and Pacific

cupped oysters. Other molluscs produced in North America include blue mussels, northern quahogs and abalone. The only crustacean produced significantly in North America is the red swamp crawfish (crayfish), cultured in the south-eastern United States.

South America

The most important aquaculture products of South America in volume terms are: Atlantic salmon, whiteleg shrimp, rainbow trout, Coho salmon and tilapia, Chilean mussel, and common carp.

Important Note: In many countries or areas of the world the release of non-indigenous fish (and other animals and plants) is regulated, and in some ecologically vulnerable areas, such as Australia, British Isles, Chile, many islands and other ecologically isolated areas, the culture or release of some species are not allowed.

Consult your local government authorities to ensure the species you intend farming is legal in your country.

From the various products discussed below you should get some idea of the viability and marketing potential of each of these.

TROUT

Trout belong to the family Salmonidae, and they can be from the genus *Onchorrhynchus* or *Salmo*. The fish called Salmon belong to the same family and to both genus. *Onchorrhynchus* come naturally from the Pacific, and *Salmo* live in the Atlantic Ocean. The three most common cultivated species are *O. mykiss*, *S. trutta* and *Salvelinus fontinalis* (Arctic char).

Trout production (the three species) is mainly for fresh consumption, i.e.: hotels, restaurants and supermarkets. The fish are grown-out for 9-12 months and harvested at 250-350g or larger, depending on the market requirements. Where production is for fish for stocking private and public angling waters fish are grown for 3-9 months with the marketed size depending on the needs of the client and the water being supplied with fish. Where production is for ova (local or export) no growing on is done.

Trout are an introduced species in many parts of the world, therefore its production and release in natural waters is regulated. Issues that are considered:

- the habitat is suitable
- natural reproduction is insufficient to handle fishing levels
- the fish are accessible to anglers
- anglers will use the area to justify expense

Stocking with trout will not occur if:

- a threat may exist to present fish populations of concern
- the habitat is unacceptable
- natural reproduction is sufficient for the angling demand
- In water east of the Snowy River catchments.

Trout culture is done in hatcheries. Once alevins (fry) hatch, they can be released into natural waters, or put into pond or raceways (growout facility). Trout are more commonly released as fingerlings or yearlings.

Trout culture requirements are:

- Need good quality water at least 2 metres deep
- Will forage for themselves but feeding is frequently done
- Light fertilization of dam will improve feed
- Initial stocking - 375 yearlings /ha of 50/50 rainbow and brown trout
- Mortality about 25% in first year. After that you can see the more successful species. Future restocking uses this species.
- Trout are cannibals, so they need to be separated by size.
- It is unlikely that trout will breed on a farm dam.
- Yearling fish of 7-10 can grow to 20-25cm and 200-250 grams within one year.
- Normal life span is 3-4 years.
- Harvest by rod and line or by seine net.

Rainbow Trout

The Rainbow trout (*Onchorrhynchus mykiss*) is one of the most widely introduced species in the world. It is a major recreational fish worldwide. It is also widely cultivated for commercial food production. It prefers a range of 10-22 degrees C with a low critical range of 0-9 degrees and an upper critical range of 22-30 degrees.

- Rainbow trout are known to reach 1.2 metres in length and 18 kilograms in weight in native North America. The best measurements known in Australia are 70 centimeters and about 9 kg.
- They are carnivorous: young eat aquatic and terrestrial invertebrates with worms, molluscs and crustaceans; adults feed on small fish such as Pigmy Perches, Goldfish and Galaxids.
- Breeding season is normally winter and early spring but spawning can occur from May to October.
- Females can produce up to 1,500 eggs per kg of body weight which are laid in a gravel substrate.
- Hatchings can occur in 3 to 12 weeks.
- The Impacts of introduction in non-native locations are: hybridization, competition for food resources with native species, disease transmission and predation.

Brown trout (*Salmo trutta*)

- Optimum temperature is 4-19 degrees C.
- Are known to reach 1 metre in native Europe and Western Asia. Is known to reach 90 cm and 14 kg in Australia.
- They are carnivorous: young feed throughout the water column; mature fish feed mainly on the bottom.
- Diet includes insects, crustaceans, molluscs, worms and small fish such as Galaxids.
- Males become sexually active at two years.
- Spawning commences during autumn and winter.
- Females produce up to 1,600 eggs per kg of body weight which are deposited into excavated depression in the gravel and covered by gravel.
- Hatchings can occur in 6 weeks.

BASS (*Micropterus salmoides*)

Largemouth black bass are being produced in some areas for recreational fishery market and for commercial food production, due to its tasty flesh. It has been introduced widely throughout the world, sometimes affecting local fish populations through predation. It is a carnivorous species. There is every reason to believe that the demand for bass will increase as recreational and sport fishing increases and as new strains of bass become available locally.

TILAPIA (*Oreochromis* spp)

Tilapia is an indigenous fish to Africa of very good quality. It is a Cichlid, therefore it is a mouth breeder. It has been widely introduced for culture worldwide; with sometimes serious consequences to the ecology of the location as it is omnivorous (eats plant, animal and residual matter). When Tilapia is cultured and fed in cages, local eutrophication may occur (contamination of the water with organic matter), causing oxygenation problems. It has white soft juicy meat. It is farmed in widely in Africa, where it comes from, and in high volumes in Asia. Fish are harvested at 200-300g after 1-3 years of growing-on. It can be produced in large numbers in warm, eutrophic conditions. It's culture is banned in many countries.

CATFISH

There are several species of catfish farmed throughout the world. Channel catfish (*Ictalurus punctatus*) is a very important species for freshwater aquaculture in the USA, Russia and some central and South American countries. It is used mainly for recreational fishing. In Australia it is not permitted to import brood-stock or to farm it.

The South African indigenous Sharptooth Catfish is considered by many to be the species with the greatest mass production potential in South Africa. Initially it seems catfish is to be produced as a cheap protein for the lower income market. However, the quality of the flesh is good and allows a variety of products to be prepared which could be quite suitable for more up-market consumers. It is a versatile and useable protein resource that can easily find a high consumer acceptance if correctly processed and marketed.

The Australian freshwater catfish (*Tandanus tandanus*) is a native fish, excellent for angling and good eating. They are predators and do best in mature dams with aquatic life. Will breed in some dams but require pebble bottom for nesting. Recommended stocking rate - 250 fish/ha. Only allowed to stock in Victorian waters north of the Great Dividing Range.

CARP

Carp is a standard production fish world wide and, although it is not given as much attention it is a good fish for intensive production conditions. It has been cultured in China for more than 2000 years and in Europe since Roman times. Various fresh and canned products are produced with high market acceptance.

The European carp (*Cyprinus carpio*) is a listed noxious fish in Australian waterways and must not be cultured. It is regarded as pests and declared a noxious fish in many other locations worldwide, as it reduces water transparency and disrupts aquatic vegetation. This ban also applies to Koi carp, leather and mirror carp. Carp can be cultured in extensive natural polycultural production as well as in intensive monoculture systems. It can be reared in natural ponds as well as in cages or recirculation systems.

MULLET (*Mugil* spp)

It is a saltwater or brackishwater fish. Various mullet species are used successfully in Israel under intensive polyculture conditions. For many years certain farmers have netted large numbers of small mullet in streams alongside their farms and stocked them in freshwater dams with good production results. This is a mass culture fish species for the future. Flathead grey mullet (*Mugil cephalus*) has been traditionally cultured in the Mediterranean region and Asia in semi-intensive and extensive ponds, mainly in polyculture as a subsistence food.

SUNFISH (*Lepomis macrochirus*)

They are produced mainly as fish meal, and cultured with carnivorous fish like Largemouth Bass to which they serve as feed. Bluegill sunfish are considered a pest in some countries but as a rough fish with a high breeding rate and production potential it cannot be ignored. However, production can be expected to be limited, thwart with red tape and the harvested product used either for fishmeal or fed live to more acceptable market fish, particularly catfish.

BASS - Australian (*Macquaria novemaculeata*)

Australian native fish that does best in established dams. Good for eating but grow slowly. It will not breed in ponds. They are predators so it is best to supply an environment where they can use their natural instincts. Light fertilizations may improve yields.

EELS (*Anguilla spp*) - Short-finned Eel, Silver Eel, Yellow Eel

Eels are native to Europe (*Anguilla anguilla*), US (*A. rostrata*), Australia, New Zealand and South Asia-Pacific (*A. australis*) and Japan (*A. japonica*). They are all anadromous species, that is, they live in freshwaters and reproduce in marine waters.

A. australis prefer slow-lying swampy streams and lagoons. It is known to reach 1.1 metres and 6.8 kg. Their culture starts with elvers capture in early to late winter. They are later cultivated in ponds, and sorted out by size as they are cannibalistic. They are fed fish meal, minced fish, Tubifex worms, and molluscs meat.

Eels go into hibernation when water drops below 10 degrees C. Has an omnivore eating habit (plants and meat). Flesh is good to eat particularly if smoked.

Other common cultivated species include Milkfish (*Chanos chanos*) in Asia, Flatfish (Sole, Plaice, Turbot and Halibut, Order Pleuronectiformes) in Europe, where they are marketed for the average and high quality market, Salmon (*Salmo spp*), and several others.

ORNAMENTALS

Large numbers of tropical and sub-tropical fish are imported in many countries every year. There is a great demand for pet fish and a relatively large market is already available.

CRUSTACEANS AND MOLLUSCS

Commonly cultured molluscs include mussels, oysters, clams, scallops and abalone. Crustaceans include Penaeid Shrimps, crawfish in the US (*Procambarus spp*, *Astacus*, *Orconectes*), freshwater prawns (*Macrobrachium rosenbergii*) in Asia, Yabbie (*Cherax destructor*) and Marron (*Cherax tenuimanus* and *C. quadricarinatus*) in Australia and crabs (*Callinectes*, *Cancer* and other species).

MARRON (*Cherax tenuimanus*)

Although there are necessary permits for the production and sale of this freshwater crayfish from Australia, this industry holds a good potential for growth and expansion and seems to be quite attractive economically. Export markets are already well developed. Local acceptability is seemingly high. Establishment costs are reasonable and running costs low. Marron populations are self-perpetuating, if given the correct living and feed conditions. (Note: It is illegal to grow marron in Victoria; however, yabbies are farmed in that state). Requires clean well oxygenated flowing waters. Usually farmed in 1 metre deep, still water ponds, and fed pellets or grain.

ALGAE

There are many species of algae that are cultivated worldwide, to be sold directly as food, food supplements or to be used as a food ingredient. They are also cultivated to be used as a food source for fish culture. The main one cultured in aquacultured semi-open systems is *Spirulina*.

RECREATIONAL FACILITIES

Recreation in the form of freshwater fishing is becoming more and more in demand. Suitable waters can be developed and made available to the public. There is a good potential return from relatively low inputs.

According to Masser and Wurts, from Kentucky State University, some fish to culture in recreational ponds include:

Largemouth bass	<i>Micropterus salmoides</i>
Black crappie	<i>Pomoxis nigromaculatus</i>
White crappie	<i>Pomoxis annularis</i>
Bluegill sunfish	<i>Lepomis macrochirus</i>
Redear sunfish	<i>Lepomis microlophis</i>
Green sunfish	<i>Lepomis cyanellus</i>
Channel catfish	<i>Ictalurus punctatus</i>
Blue catfish	<i>Ictalurus furcatus</i>
Black bullhead	<i>Ictalurus melas</i>
Brown bullhead	<i>Ictalurus nebulosus</i>
Yellow bullhead	<i>Ictalurus natalis</i>
Flathead catfish	<i>Pylodictis olivarius</i>
Golden shiner	<i>Notemigonus crysoleucas</i>
Fathead minnow	<i>Pimephales promelas</i>
Gizzard shad	<i>Dorosoma cepedianum</i>
Threadfin shad	<i>Dorosoma petenense</i>
Grass carp	<i>Ctenopharyngodon idella</i>
Rainbow trout	<i>Oncorhynchus mykiss</i>

Now you have some idea of the market potential of some of the products aquaculture has to offer, we will look at them more intensively from a production point of view. Remember, there are a good number we have not included because they are still young industries, fraught with many basic problems that still need to be addressed.

ADDITIONAL READING

Read any information you have obtained on species of fish, prawns and crayfish that can be used for aquaculture.



SELF ASSESSMENT

Perform Self Assessment Test 3.1

If you answer incorrectly, review the notes and try the test again.

SET TASK

1. Investigate the aquaculture of one type of salt water fish (e.g. salmon) or another animal or plant species important commercially today (by volume or value). If you cannot find information elsewhere, you may get some leads from the fisheries department in your state (or country). Attempt to determine differences in production of freshwater fish with saltwater fish (apart from the obvious difference of salt levels in the water).

Spend around 2 hours doing this. Make notes of what you found.

2. Go to FAO Fisheries – Aquaculture webpage and find culture information for any species that interest you or that could potentially be cultured in your region. Takes notes.



ASSIGNMENT

Complete Lesson 3 assignment