Setting Up a Fish Farm

Fish farming or **pisciculture** involves raising fish commercially in tanks or enclosures such as fish ponds, usually for food. It is different from aquaculture, which is the farming of aquatic animals such as fish, crustaceans, molluscs and so on. A facility that releases juvenile fish into the wild for recreational fishing or to supplement a species' natural numbers is generally referred to as a fish hatchery. Worldwide, the most important fish species produced in fish farming are carp, catfish, salmon, and tilapia. Demand is increasing for fish and fish protein, which has resulted in widespread overfishing in wild fisheries. China provides 62% of the world's farmed fish. As of 2016, more than 50% of seafood was produced by aquaculture. In the last three decades, aquaculture has been the main driver of the increase in fisheries and aquaculture production, with an average growth of 5.3 percent per year in the period 2000–2018, reaching a record 82.1 million tonnes in 2018.

Fish farms

Within intensive and extensive aquaculture methods, numerous specific types of fish farms are used; each has benefits and applications unique to its design.

Cage system

Fish cages are placed in lakes, bayous, ponds, rivers, or oceans to contain and protect fish until they can be harvested. The method is also called "off-shore cultivation" when the cages are placed in the sea. They can be constructed of a wide variety of components. Fish are stocked in cages, artificially fed, and harvested when they reach market size. A few advantages of fish farming with cages are that many types of waters can be used (rivers, lakes, filled quarries, etc.), many types of fish can be raised, and fish farming can co-exist with sport fishing and other water uses. Cage farming of fishes in open seas is also gaining in popularity. Given concerns of disease, poaching, poor water quality, etc., generally pond systems are considered simpler to start and easier to manage. Also, the past occurrences of cage-failures leading to escapes, have raised concern regarding the culture of non-native fish species in dam or open-water cages. Though the cage-industry has made numerous technological advances in cage construction in recent years, the risk of damage and escape due to storms is always a concern. Semi-submersible marine technology is beginning to impact fish farming.

Copper-alloy nets

Recently, copper alloys have become important netting materials in aquaculture. Copper alloys are antimicrobial, that is, they destroy bacteria, viruses, fungi, algae, and other microbes. In the marine environment, the antimicrobial/algaecidal properties of copper alloys prevent biofouling, which can briefly be described as the undesirable accumulation, adhesion, and growth of microorganisms, plants, algae, tube worms, barnacles, mollusks, and other organisms. The resistance of organism growth on copper alloy nets also provides a cleaner

and healthier environment for farmed fish to grow and thrive. Traditional netting involves regular and labour-intensive cleaning. In addition to its antifouling benefits, copper netting has strong structural and corrosion-resistant properties in marine environments. Extensive research, including demonstrations and trials, are being implemented on two other copper alloys: copper-nickel and copper-silicon. Each of these alloy types has an inherent ability to reduce biofouling, cage waste, disease, and the need for antibiotics, while simultaneously maintaining water circulation and oxygen requirements. Other types of copper alloys are also being considered for research and development in aquaculture operations.

Irrigation ditch or pond systems

These use irrigation ditches or farm ponds to raise fish. The basic requirement is to have a ditch or pond that retains water, possibly with an above-ground irrigation system (many irrigation systems use buried pipes with headers.) Using this method, water allotments can be stored in ponds or ditches, usually lined with bentonite clay. In small systems, the fish are often fed commercial fish food, and their waste products can help fertilize the fields. In larger ponds, the pond grows water plants and algae as fish food. Some of the most successful ponds grow introduced strains of plants, as well as introduced strains of fish. Control of water quality is crucial. Fertilizing, clarifying, and pH control of the water can increase yields substantially, as long as eutrophication is prevented and oxygen levels stay high. Yields can be low if the fish grow ill from electrolyte stress.

Composite fish culture

In this system, of both local and imported fish, a combination of five or six fish species is used in a single fish pond. These species are selected so that they do not compete for food among them by having different types of food habitats. As a result, the food available in all the parts of the pond is used. Fish used in this system include catla and silver carp which are surface feeders, rohu, a column feeder, and mrigal and common carp, which are bottom feeders. Other fish also feed on the excreta of the common carp, and this helps contribute to the efficiency of the system which in optimal conditions produces 3000–6000 kg of fish per hectare per year. One problem with such composite fish culture is that many of these fish breed only during monsoon. Even if fish are collected from the wild, they can be mixed with other species, as well. So, a major problem in fish farming is the lack of availability of good-quality stock. To overcome this problem, ways have now been worked out to breed these fish in ponds using hormonal stimulation. This has ensured the supply of pure fish stock in desired quantities.

Integrated recycling systems

One of the largest problems with freshwater pisciculture is that it can use a million gallons of water per acre (about 1 m^3 of water per m^2) each year. Extended water purification systems allow for the reuse (recycling) of local water. The largest-scale pure fish farms use a system derived (admittedly much refined) from the New Alchemy Institute in the 1970s. Basically,

large plastic fish tanks are placed in a greenhouse. A hydroponic bed is placed near, above or between them. When tilapia are raised in the tanks, they are able to eat algae, which naturally grow in the tanks when the tanks are properly fertilized. The tank water is slowly circulated to the hydroponic beds, where the tilapia waste feeds commercial plant crops. Carefully cultured microorganisms in the hydroponic bed convert ammonia to nitrates, and the plants are fertilized by the nitrates and phosphates. Other wastes are strained out by the hydroponic media, which double as an aerated pebble-bed filter. This system, properly tuned, produces more edible protein per unit area than any other. A wide variety of plants can grow well in the hydroponic beds. Most growers concentrate on herbs (e.g. parsley and basil), which command premium prices in small quantities all year long. The most common customers are restaurant wholesalers. Since the system lives in a greenhouse, it adapts to almost all temperate climates, and may also adapt to tropical climates. The main environmental impact is discharge of water that must be salted to maintain the fishes' electrolyte balance. Current growers use a variety of proprietary tricks to keep fish healthy, reducing their expenses for salt and wastewater discharge permits. Some veterinary authorities speculate that ultraviolet ozone disinfectant systems (widely used for ornamental fish) may play a prominent part in keeping the tilapia healthy with recirculated water. A number of large, well-capitalized ventures in this area have failed. Managing both the biology and markets is complicated.

Classic fry farming

This is also called a "flow through system" Trout and other sport fish are often raised from eggs to fry or fingerlings and then trucked to streams and released. Normally, the fry are raised in long, shallow, concrete tanks, fed with fresh stream water. The fry receive commercial fish food in pellets. While not as efficient as the New Alchemists' method, it is also far simpler and has been used for many years to stock streams with sport fish.

How to Start a Fish Hatchery

Hatching and raising fish in various capacities, and for various reasons, is rapidly growing in popularity. One reason for the rising number of hatcheries is increased demand for finned foodstuffs, as more and more people recognize the benefits of a diet with lots of fish. Based on your personal interests and intentions, you can choose to grow fish for your own enjoyment or at the commercial level for sale in various markets.

Determine the purpose of your hatchery. There are all sorts of different types of hatcheries that raise different types of fish for different purposes. In order to move forward on your intention to start a hatchery, there are some determinations you need to know up front. Most simply, know what type of fish you will raise – and why – in order to start setting up your hatchery or writing a business plan. In particular, consider the following, and have concrete answers to each before moving forward. What are you going to do with all the fish? Will you raise fish destined to be food, pets, or simply pond ornaments? Do you intend to take the backyard approach and build a custom fishing hole for you and your friends, or are you looking to build a business based on the for-profit production of the finest fish for the market?

Decide what specific type of fish you want to raise. The type of fish you raise will be determined in part by the type of hatchery you hope to start. While the system you hope to build may influence your decision about what fish you will raise, there are several factors to consider about your options regarding the fish themselves. Once you're leaning towards a certain type of fish, contact hatcheries that raise that type to see about the viability of going through with stocking your hatchery. Recognize that the costs associated with raising different types of fish will vary widely, for all sorts of reasons – including the amount of management different species require and the cost of the food they eat. Also consider the climate in which you will be operating your hatchery. Certain fish need certain temperature water to live in. If possible, you may want to avoid costs associated with heating or cooling water, which can be substantial.

One can decide to first try Tilapia fish farming. Tilapia are some of the easiest fish to raise, and are eaten around the world. As such, they are among the most profitable types of fish to raise. They are hardy enough to tolerate different water conditions, including low oxygen and high ammonia, and are even more resistant to illness than many other fish. Tilapia need to be raised in water as close as possible to 29 degrees Celsius. They will survive in water from18-32 C, but will die if the water drops far below. While there are many different types of tilapia, Bava, Blue, and Nile tilapia are the most appropriate for backyard and commercial hatcheries.

One could also decide catfish farming. Catfish are increasingly popular in people's cuisine, and they're some of the tougher fish there are in terms of resistance to disease and parasites. They also grow quite quickly. Channel catfish are one of the most popular – and profitable – choices for backyard farming, and there are several types to choose from. Recommended water temperatures for raising catfish vary based on the season and age of the fish. A such, catfish are commonly raised in outdoor ponds. Specifically, channel catfish fingerlings need to be stocked when water temperatures are between 18-20 C. As catfish, they will grow more quickly in water between degrees 28-30 C.

One could also consider raising trout, salmon, or perch. Trout and salmon are especially popular for human consumption, but they require more specific conditions than the other fish mentioned earlier in the lecture. When raised at sustainable, well-run operations, these types of fish can be reliably profitable options. Yellow perch is popular in some markets too, though perch does not have the global popularity of trout and salmon. All three can grow to harvestable size in only one season. Trout and salmon can be raised together, providing some variety in your production. Keep water in which you're raising trout and salmon between 13-16 C. If you're only raising trout, water can be a bit warmer, but monitor oxygen levels more closely.

Get the necessary permits and licensing. Before beginning construction of a hatchery of any size or type, account for the law in your area. There are lots and lots of laws about raising animals, and even more about raising animals to be consumed as food. Further, the ways in which your hatchery may affect the surrounding land or water need to be addressed before you move forward with starting a hatchery. Depending on the type, size, and location of your

hatchery, the paperwork will vary. If planning to operate a production hatchery, you'll need to get a business license as well. Then there's the whole other side of the law – and a whole new stack of paperwork.

Developing a Business Plan for a Production Fishery

Educate yourself about fish hatcheries. If you're not familiar with the industry, you'll need to acquire some first-hand experience before starting your own hatchery. Even if you do have some experience, owning and operating a hatchery of your own will require substantial knowledge of your specific operation and of the industry in general. If you only intend to own and oversee the business side of a hatchery, you still need to know enough to make business decisions or hire competent personnel to run your business.

Make a business plan. A solid business plan will be vital to acquire any necessary investment capital. Aside from a fair amount of commercial equipment, you'll also need the capital to get the business running and to pay employees to help you keep it running. Aside from luring investors, you'll need a business plan to help meet potential business partners, and to get loans. Include a clear and specific feasibility report in your business plan. This should include thorough calculations of your initial expenses, operating costs, and anticipated profits for the first few years of business. Know that the anticipated costs of starting a hatchery depends entirely on the type of hatchery you wish to start. Though small backyard setup may cost as little as a few hundred dollars, a production facility will require thousands of dollars of investment in equipment alone.

Focus on the financial considerations. The capital and operating costs of starting a business – especially a production business – can wind up being far more than expected. Prepare yourself fully to have accurate expectations and to acquire a sufficient amount of initial capital. Carefully weigh both general and specific considerations, and don't forget to consider important factors aside from the specifics of the hatchery itself. Ensure that there is sufficient demand in the market to meet the level of sales you need to be successful financially. Consider whether a hatchery is the best possible use of the specific real estate and capital you intend to use. Reflect honestly on whether you personally have the time and financial security to start a new business.

Forecast operating costs by having specific numbers ready for potential investors. Be ready to quote the anticipated costs of stocking your hatchery initially, fish food, electricity and other power, labour, water treatment chemicals, insurance, taxes, and extraneous things like maintenance and transportation. Knowing as much as possible will ensure you make accurate estimates of both initial start-up costs and operating costs. Unforeseen costs can greatly hinder a new company, and the best way to prevent them is by knowing you've thought of everything.

Ensure you've considered all construction and equipment expenses. Make sure you've considered potentially expensive necessities in particular. For instance, even if you already have the land, think about what needs to be done to it. Will anything need to be dug or built? Further, what will hold the fish? All costs need to be accounted for – down to the safety

equipment your staff will wear. Account for all the piping that will connect tanks and ponds and water equipment. Remember to also account for oxygen meters and other testing supplies

Develop a specific marketing strategy. Though raising fish may not seem like a business endeavour that requires advertising, a marketing plan will greatly help get your business up and running. If there is an established market, how are you going to break into it? Will demand be consistent year-round? Consider where will be ideal for focused sales efforts.

Round out your business plan with a healthy dose of risk assessment. Though unpleasant to think about, you have to account for the potential risks inherent to your business. One classic consideration is whether you could survive if you lost an entire crop of fish. You'll need the investment necessary to be able to do so, as losing an entire crop is a realistic possibility. Develop a plan for a backup water source if your current source drops below an allowable quality threshold. Assess and address the risk for contamination by pesticides, metal, or anything else at the location in mind. Develop and maintain contacts for advice and information, even before you need it - particularly in terms of fish health.

Setting up a small fish Farm

Dig the pond. A small pond is one of the cheapest and easiest ways to start a small fish hatchery, for either personal use or local sales. Still, it will likely cost at least a few shillings to get a pond-based hatchery up and running. Further, the size of your pond and the climate where you live will determine which fish will be most viable for you to raise. Municipal water is often okay to fill an artificial pond, though pumping water from a natural body of water near your home may be preferable. Make sure that you are not violating any laws or regulations by manipulating any natural bodies of water or watersheds by checking with your local fish, wildlife and environmental regulatory agencies. In areas where ponds may freeze, you can pump and cycle water through an artificial heater to keep the pond warm and liquid-enough for fish to survive in. Cold climates, however, will substantially increase the cost of operation and the risk involved in running your hatchery.

Stock the pond according to its size. When stocking your pond with fingerlings, use the capacity of your pond to determine the number of fish it can safely hold. Depending on the type of fish you choose to raise, maintain the pond at a certain size and depth. Take extreme care not to overcrowd the pond, as water quality and fish health can rapidly deteriorate in an overcrowded body of water.

Balance your pond to minimize the need for management. Aquatic plants are very helpful for multiple reasons. In an immediate sense, they provide cover for your fish during the day. Furthermore, plants help keep a pond ecologically balanced and will make a small pond a fish-raising haven with very little effort on your part. Determine the types of plants to include in your pond based on the type of fish you plan to raise, as well the types of plants that grow naturally in ponds in your area.

Feed your pond fish depending on several factors. Another benefit of backyard pond hatcheries is that you can likely feed your fish less often, since your fish will be able to eat

plants and insects. Even for rapid growth and a quick harvest, you'll only have to feed your fish once in a while. Be careful not to over-feed your fish, as this may contribute to illnesses, more bacteria in the water, and decreased water quality overall. To determine whether your fish are in need of more food, observe their behavior when you add food to the water. If the fish go into a frenzy and eat all the food extremely quickly, start to feed them slightly more regularly.

Farm fish via cage culturing. If there is already a body of water present on land you have access to, you can likely set up a small fish hatchery with readily available materials. For instance, a cage can be built with plastic piping and netting, and then anchored to the edge of a body of water and used to culture fish. Make sure the water you have access to is suitable for raising fish before deciding to start a hatchery in a natural body of water. Stock the cage with fingerlings and simply feed them until they are large enough to harvest. For a small cage culture, expect to pay for only cage materials, fingerlings, and food

Build a flow-through hatchery. Divert a continuous source of cold water, such as a natural stream or river, into corridors that can contain fish while allowing them to swim in flowing water. You will likely need less water than you think – but the flow must remain constant. In the right location, flow-through hatcheries can be a relatively simple way to raise fish. Be aware of additional regulations involved with diverting and benefiting from the use of natural resources. Contact local conservation authorities to discuss your plans. This is the method used to help many government-run conservation efforts. However, this method is harder to set up than many other options, is often not allowed, and is not as commercially viable as other options.

Starting a Commercial Hatchery

Scale up a pond-based hatchery. For larger-scale pond-based hatcheries, you will need several ponds, a good amount of land, and a substantial amount of additional equipment. Conceptualize scaling up a pond-based hatchery as the equivalent endeavour of going from having a garden to having a commercial farm – it will require a huge amount of planning, time and investment.

Raise fish in tanks, containers, or tubs. One of the limitations of ponds is the amount to literal space they take up. While ponds offer a great method of raising fish in limited quantities, container-based fish hatcheries can handle a higher production capacity within a relatively limited amount of space. Municipal water supplies are usually fine to fill tanks, though the water will likely need to be treated. Know that aquaponics systems come with far larger start-ups costs, a greater need for supplies and equipment, and a greater knowledge of commercial fish farming.

Install a pump and aeration equipment. Whatever the type of hatchery you intend to run – and especially for an aquaponics production hatchery – you'll need a pump to help you ensure that your fish always have sufficient fresh water. Similarly, the water in which your fish live will likely require a steady influx of oxygen provided by aeration equipment. Pumps

are also often necessary to cycle water from holding tanks to recycling pools or equipment that can clean the water and remove impurities. The more fish you're trying to raise, especially in an indoor hatchery, the more water cleaning and aeration equipment you'll need.

Figure out how you'll capture, handle, and grade your fish. For production fisheries, you'll need lots of equipment to deal with your product. In industry terms, you're going to need a seine. Seines are used to harvest fish, or collect them from the water. As you harvest the fish, you'll need to sort them by size. You'll also need a way to handle the fish and potentially a way to transport fish to buyers. For larger scale hatcheries, you'll need reels and other equipment that can be used to drag large nets. You'll likely need a tractor and hoists to handle nets full of fish. As fish are graded, they will need to be moved to different holding tanks. You can also use counting equipment to keep track of your crop.

Reference

J. Chen, W. Sung and G. Lin, "Automated Monitoring System for the Fish Farm Aquaculture Environment," 2015 IEEE International Conference on Systems, Man, and Cybernetics, 2015

Production and application of on-grown Artemia in freshwater ornamental fish farm by Lian Chuan Lim , Andrew Soh , Philippe Dhert & Patrick Sorgeloos

Food and Agriculture Organization (FAO) - https://en.wikipedia.org/wiki/Food_and_Agriculture_Organization

http://www.fao.org

Lawson T.B. (1995) Aquaculture in open Systems. In: Fundamentals of Aquacultural Engineering. Springer, Boston, MA. https://doi.org/10.1007/978-1-4613-0479-1_5