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# AQUAPONICS - AN INNOVATIVE TECHNOLOGY FOR FOOD PRODUCTION

**Dr. Rohit Shrivastava**
JECRC University, Jaipur

## ABSTRACT
*Aquaponics is an integrated production operation that encompasses recirculating aquaculture systems and hydroponics to produce fish and plants in a closed-loop system that mimics the ecology of nature. The fish produce nutrient-rich effluent that fertilizes the plants and the plants filter the water for the fish. Plant and fish growth is accelerated without the need of artificial fertilisers. Instead of typical farming, a compact space configuration is used. The water in an aquaponics system is well recycled and does not go to waste. It allows us to boost economic efficiency by growing vegetables and raising fish at the same time, allowing farmers to generate money in any season. Plants and fish of all kinds are being cultivated through this system.*

*Keywords: Aquaponics, Hydroponics, Plant and Fish, Environmental Friendly.*

## INTRODUCTION
Aquaponics is an environmentally friendly food production system that uses aquaculture and hydroponics to raise fish and crops without the use of soil in a single habitat. Aquaponics uses fish waste as nutrition for the plants while also cleaning the water for the fish. Aquaponics plays a significant part in the production of healthy, nutritious and safe food. Fish waste from the aquaculture portion of the system is broken down by bacteria into dissolved nutrients that plants then utilize to grow in the hydroponic component. This nutrient removal not only improves water quality for the fish but also decreases overall water consumption by limiting the amount released as effluent.

In the current situation, the world's population is growing at an exponential rate and technology is playing an increasingly important role in meeting all of humanity's basic necessities. Ornamental fish and hydroponics plants have become a part of daily life as technology and people's lifestyles have improved. Aquaponics is the farming of fish and plants in a single recirculating system, whereas hydroponics is the production of plants without soil. It's an environmental friendly approach to produce both fish and vegetables in a same habitat with no hedging. In this process we can produce safe food without any environmental hazards. It is the interrelationship environment between the fish and vegetable where fish provides fertillizer to the plant and also the plants in return helps to purify the water in which fishes live.

The aquaponics system is a closed-loop recirculating aquaculture system that is designed to remove toxic waste products and reuse them, while also accumulating non-toxic products and organic matter in the process. Denitrifying bacteria in the hydroponics system transform ammonia-based nutrients into forms that are easily absorbed by plants for energy and growth. The hydroponics system and its vegetables primarily function as a biofilter for fish waste water before it is returned to the fish tank and cleansed. Advantages of this closed-loop system over conventional crop production methods include:

- reduced land area requirements
- reduced water consumption
- accelerated plant growth rates
- year-round production in controlled environments
- operational efficiency with shared equipment
- reduced or eliminated effluents
- multiple crops produced simultaneously.

High-value herbs, vegetables, and leafy greens, as well as fish, crayfish, worms, and a number of other products can all be produced, which the producer can use to meet a highly diversified market.

## HISTORY
The development of aquaponics is clearly marked by the work of the New Alchemy Institute and the work of Dr. Mark McMurtry at the north California state university. And starting in 1979 Dr. James Rakocy and his colleagues at the university of the virgin Islands developed the use of deep water culture hydroponic grow in a large scale aquaponics system. In the year of 1990 the farmers of Missouri Tom and Paula Speraneo modified

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the NCSU system and introduced their bioponics concepts grew herbs and vegetables in ebb and flow irrigation cycle.

**Parts of an Aquaponic System**

The aquaponics system mainly consist of two parts, the first one is aquaculture parts which raising aquatic animals and the second one is hydroponics parts for growing plants. But there is some responsible subsystem is present for maintaining an effective system. These include:

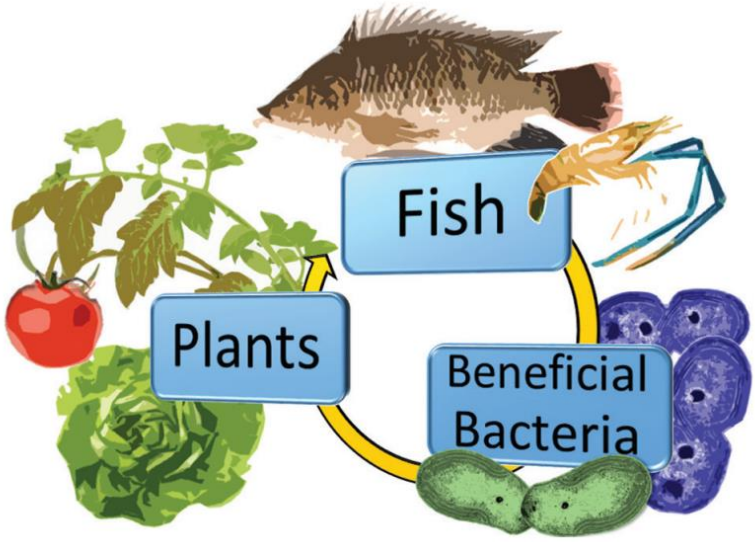


Figure 1: Aquaponics System

Bio filter is a place where the nitrification bacteria can grow and convert ammonia into nitrates, which is useable by plants. Fish tank is for raising and feeding fish. It may be round, oval, square in shape .material like cement, plastic, fibre glass and the colour of the tank should be white or any light colour. Mechanical filter is meant for separation and removal of solid and suspended fish waste from fish tank.Hydroponic components: - For plant growth in this unit and its design should be familiar with aquaponics design.

**Types of Aquaponics system**

The aquaponics system mainly 3 types based on the hydroponic components used.

**Deep water culture**

The deep water culture method is also known as raft method or floating system. It includes suspending plants in polystyrene sheets and their root is hanging down into the water. The water from the fish tank continuously pumped into the grows bed and flows back to the fish tank .In the deep water culture there are some discharge of water during the filtration process.

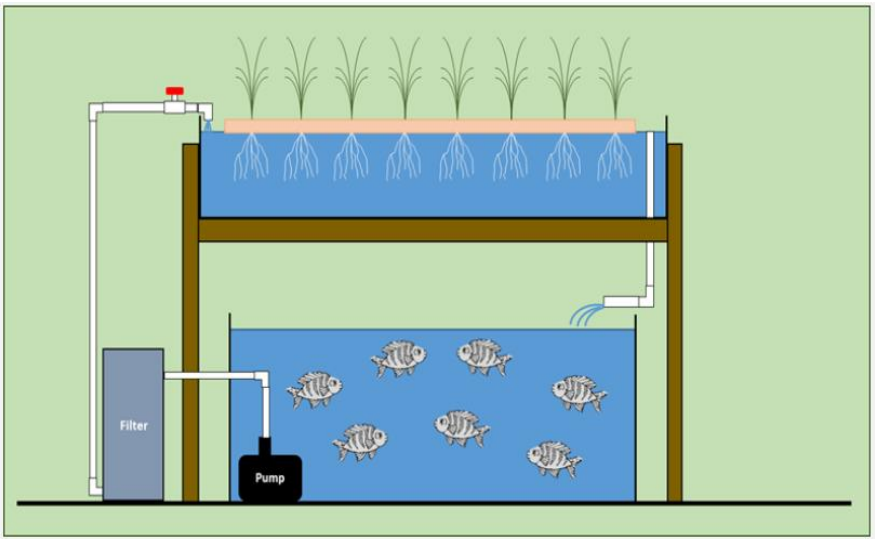


Figure 2: Deep water culture

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**Nutrient film system**

The nutrient film system is widely used in the commercial field. Nutrient flows in a thin film over the base of the growing baskets which supports or hangs the plants. And there is no growing medium other than the air.

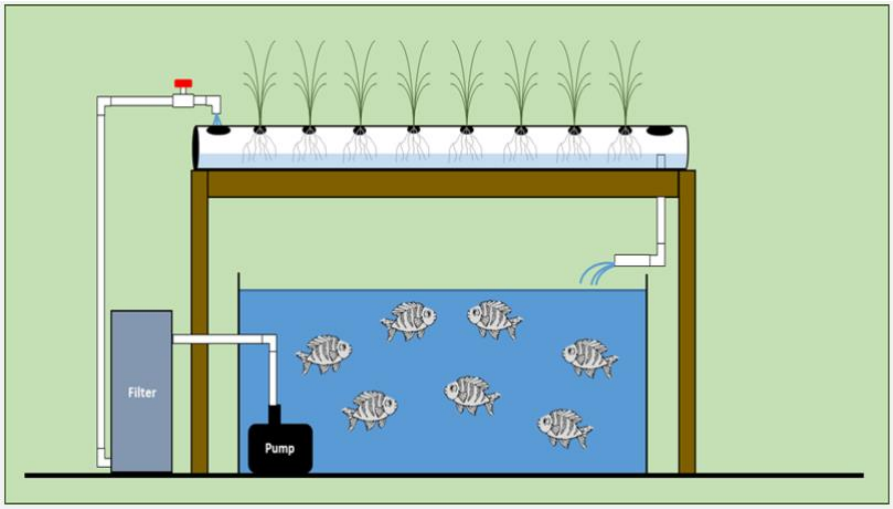


Figure 3: Nutrient Film Technology system

**Flood and drain system**

This is based on media where the plants are grown. Here the purpose of media is serves as mechanical and biological filter which provides supports to the plants .In this system during the flood the nutrient and water is brought from the plant root part and during drain air is drawn into root zone and water returns to fish tank.

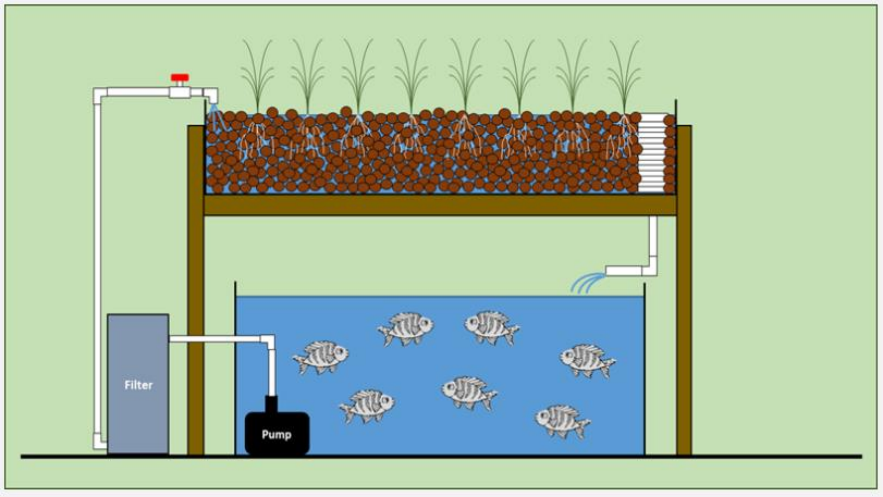


Figure 4: Flood and drain system

**Nitrogen cycle in aquaponics system**

Nitrogen is a fundamental needs for all forms of life in earth. Nitrogen cycle has a significant role in aquaponics that it is responsible for the conversion of fish waste into a nutrient for plant growth.Without this process the water quality of the system may not be maintain properly or become toxic to both for the plant and fish. And in this system the water does not need to chemically treated to make the safe water quality.Ammonia usually begins risingly by the third day after introducing fish to the system.after this the nitrosomonas bacteria oxidize the ammonia and change it to nitrite,which may be toxic to the fish.In the last stage of the cycle the nitrobacter bacteria convert the nitrites to nitrates , which is not toxic to the fish. And the established tanks should be teste for nitrates every few months to check that levels are not becoming high high. high. The bacteria will arrive automatically to a system and colonize the water column and biofilter

**Aquaponic System Types**

There are two main types of aquaponics systems: coupled and de-coupled. Coupled, or balanced systems, work on the premise that the incoming feed to the fish provide the exact nutrient requirements for the plants being grown. In theory, each time the water passes through the plant culture unit the nutrients, namely nitrate, are scrubbed from the water, and feed additions are necessary to provide for additional plant needs. Variability in

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feeding time, feed volume, fish and plant size, temperature, pH, and water chemistry all play a role in the rate of nutrient uptake

Figure 5: Overview of an aquaponic system

**Live components and species selection in Aquaponic system**

In aquaponics system the live components like fish, plants, and bacteria have so much impact to successfully running of a aquaponic system. The freshwater fish are suitable for aquaponics due to their ability to tolerate crowding, and in some cases saltwater fish and prawn may used .Fish like tilapia are used for commercial purposes. otherwise we can use goldfish,jade perch,murray cod and rainbow trout .Now for the plant we can take beans,broccoli,cucumbers,peas,spinach, for vegetable purpose and for hers like basil, thyme,lemongrass ,wheatgrass ,oregano, parsley,sage etc . strawberries, watermelon, tomatoes, cantaloupe etc for fruits puropose and also for flower purposes we can take all garden varieties.In case of bacteria there are two main types of bacteria mostly seen in case of aquapoic system like nitrosomonas which converts ammonia into nitrites and nitrobacter which then converts nitrites into nitrates.

**Water quality parameters for aquaponic system**

Ideal water qualiy parameters for aquaponic system are :-near neutral PH (6.5-7.5), ammonia and nitrite (<1 ppm),Nitrate about (5-150 pp),high dissolved oxygen about (6+ ppm).The temperature and Salinity ranges vary with depends upon fish and crop species.

In the current scenario of the world the human population is increasing day by day so we have to step forword for the aquaponics cultivation method so that we can easily get sufficient amount of both plant produt as well as the fish which is our daily need.The global aquaponics market is expected to be 15% during 2020-2025. But if we step forward to create technological and research awareness among the farmer then the percentage will be increased. If Goverment and some NGO support to the farmers and motivate them to enhance this technique for better result in future for food purpose.And this farming is set as indoor farming and can provide food which is free from chemical fertilizers, pesticides etc.It is also possible for commercial implementation of aquaponics on large scale basis, we can provide food for our future generation through this.

**Advantages of aquaponics**

The crops from the aquaponics system excellent in taste and apperance and provide 100% organic forms of nutrient for better plant growth and development.No soil borne disease is seen in case of plants and also zero application of artificial fertilizers.On an average of 95% of water in aquaponics system is recycled. Mainly the growth of plants and growth of fish is faster in this system because of proper nutrient supply .The hydroponic plants used as biofilter and the plant uses nutrients from fish waste to produce a valuable marketable product.Low electrical uses and low man power is needed.It requires small amount of space for easy set up and It gives more profit from traditional farming.

**Disadvantages of aquaponics**

Aquaponics system requires better skill as well as experience for maintain a good system and profitable food production.Its initial set up cost is very high because it needs some selected species to culture in it.Water quality must be checked properly , whenever the crop is in developing stage the water quality testing is useally carried out only once in a week if there is no problem in the system.If some components fails this could leads to the loss for both plants and fish.A green house is important for a maintaining a good aquaponics system , this is depends upon the climate condition in your area, a green house provides heat during winter seasons .

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## CONCLUSIONS

Aquaponic systems present a unique opportunity for year-round production of plants and fish. Out-of-season production of leafy greens, herbs, and vegetables can be a major source of income for aquaponic producers, as they can take advantage of much higher seasonal prices. The high quality and freshness of aquaponic produce is highly desired by chefs in metropolitan areas. If aquaponic producers can fill the seasonal gaps with fresh produce, buyers are more likely to keep them as a vendor, allowing producers to capture a larger market share. Additionally, the local foods movement and consumer willingness to pay more for a superior product is a major advantage to aquaponic producers. Aquaponics can be done on a wide range of scales; from a bench-top aquarium for the hobbyist to a multiacre commercial facility capable of producing substantial amounts of fish and plants per year. As in other agriculture operations, profitability in the aquaponics business model is related to scale and efficiency of production. Research conducted at Iowa State suggests that it may be possible to generate a profit when producing tilapia and basil in a greenhouse facility in Iowa. This system model demonstrates that the value of the fish (tilapia) produced has very little effect on profitability, but rather the price and amount of plants (basil) produced often determines economic viability.

Aquaponics may be an attractive opportunity for individuals wanting to change their lifestyle to a slower pace with a modest income. In a well-designed and efficiently run aquaponics facility, the ability to profit is greater as the plant growing area increases because of increased product output, efficient use of resources, stability of the system, and regularity of production. However, a larger facility does not necessarily mean more profit. One should consider supply and demand principles and wholesale versus retail pricing to determine the actual returns to the farmer. It is critical, therefore, for potential aquaponic farmers to do their due diligence in business planning and market research as well as hands-on education prior to investing in an aquaponics business to ensure success.

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