Agri Articles
(e-Magazine for Agricultural Articles)
Volume: 04, Issue: 01 (JAN-FEB, 2024)
Available online at http://www.agriarticles.com
©Agri Articles, ISSN: 2582-9882

Aquaponics: An Ecologically Sustainable Approach of Food Production

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Today, food security is a concern for populations all over the world on a scale unknown in recent human history. Despite considerable improvements in food production and our understanding of food nutrition and food safety, millions of people throughout the world still suffer from hunger. This is due to the evolution of how we feed our populations and the technologies we utilize to achieve it. A novel method called aquaponics, which incorporates technology and imitates a natural environment, has been developed to address these issues. Aquaponics is an environmentally friendly method of growing food that uses hydroponics and aquaculture to grow plants and fish without using any soil.

History

The Aztec Indians, who grew plants on the surface of the rafts above the lake, are the originators of the aquaponics farming concept. The idea was quite straightforward. The fish excrement in the pond will provide nutrients for the plant roots, and in exchange, the plants will purify the water so that it is suitable for fish to live in. This was the whole symbiotic interaction between aquatic life and plants.

What is the Meaning of the Word Aquaponics?

Aquaculture and hydroponics are the two words used to describe aquaponics.

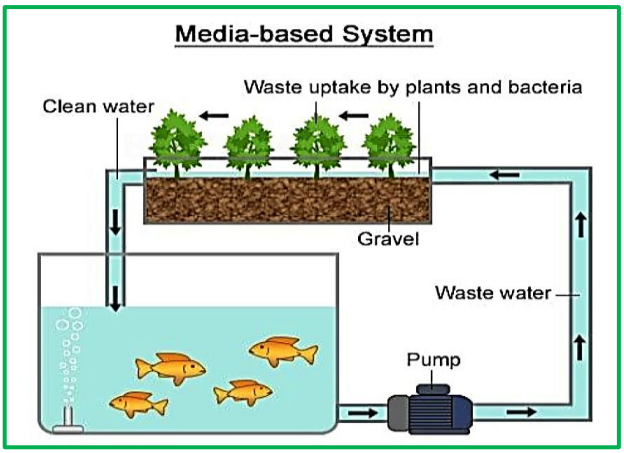
Aquaculture: The production of aquatic species like fish, molluscs, and aquatic plants is also referred to as aquaculture. The farmer creates a tiny lake or pond as an artificial arrangement and rears the fish by feeding them.The fish is raised and then sold in the market to generate income.

Hydroponics: We all understand that plants are grown in soil. However, in hydroponics, the plants are grown in water as a medium. The nutrients from the water are taken up by the roots. In comparison to traditional farming, this method consumes a little less water on the soil.

The aquatic environment and the plant work together in harmony in aquaponics. The fish are bred, raised, and harvested in this farming. Plants are raised in water that contains the waste products (excreta) produced by fish during the rearing process. The water containing fish excrement provides the plants with all the nutrients they need to develop. In exchange, the roots of the plants and the beneficial bacteria they contain purify the water. The fish can be raised using this cleansed water again. The farmer will be able to sell both the fish and the plants he has grown to the market, which will provide him with a second source of revenue that would otherwise be quite limited if only plants or fish were sold.

Different Farming Methods Include:

1. **Media Bed Method:** The plants are produced using this method on rock media, such as gravel and tiny round stones. This gravel filters the fish waste-filled water as well as providing nourishment for plant roots.Fish waste complex compounds will be broken down by the bacteria at the root region, releasing nutrients for the plants. While the fish tank can repurpose the water that has been filtered by the rocks. Many people who want to use aquaponics on a small scale accept this strategy. The setup is simple to set up in your garden, backyard, or terrace.



Components of the media bed aquaponic unit:

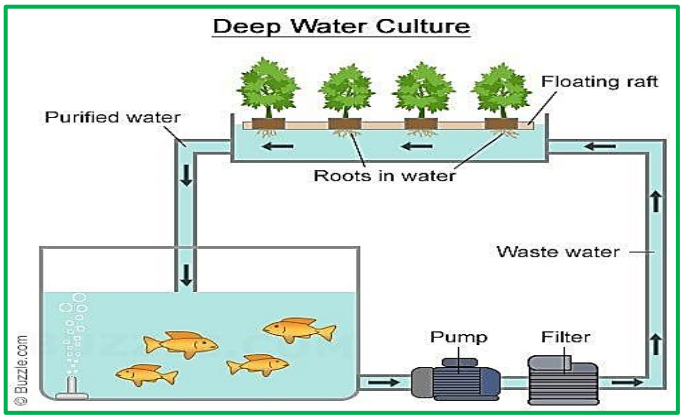
- Grow beds
- Grow media
- Fish tanks
- Filtration system
- Bell Siphon
- Water Pump

Advantages

- Comparatively easy and affordable
- Suitable for various types of plants, from smaller fruiting plants to larger leafy greens.
- There is not much cleaning needed.
- The media-based configuration can be altered to meet your requirements.
- Allows using recycled materials.
- Ideal for use in gardening at home, in hobby applications, and on commercial farms.
- Three filtering operations are carried out by the media bed:
- Mechanical filtration (solids removal)
- Mineralization (solids breakdown) (solids breakdown)
- Biofiltration

Disadvantages

- A high-quality medium could be rather pricey.
- Over time, the pore spaces in the medium may clog, which would harm your plants' ability to grow in anaerobic circumstances.
- The grow bed may need to be cleaned.
- Due to its reduced productivity and difficulties in implementing on a big scale, this form of technology is typically not appropriate for commercial use.
- The media beds require a strong, sturdy structure because they are heavy.



2. **Deep Water Culture:** In this method, the roots are suspended in the nutrient-rich solution via

floating rafts. Therefore, the technique is sometimes referred to as a float or raft system. Since gravels are not utilised in this method, the solid debris must be removed by passing the wastewater through primary filters. The aeration pump continuously aerates the water to increase the oxygen content. The water is subsequently transferred to the tank containing the plants, above which rafts are floating. To absorb the nutrients, the roots are soaked in water. Since the method needs a significant initial financial expenditure, it is frequently utilised in commercial environments where enormous quantities of plants are to be maintained.

Components of deep water culture:

- Fish tank
- Grow canal
- Floating Rafts
- Biofilter
- Filters
- Water Pump
- Aeration Method

Advantages:

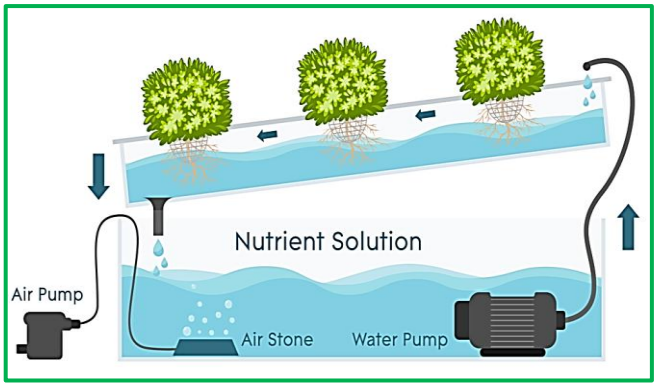
- Cost-effective.
- More water and nutrients are exposed to the roots.
- The most affordable and straightforward aquaponics system to construct.
- Since roots are not in any substrate and are instead submerged in water, plants are easier to harvest.
- Due to more water in a raft system than in other systems, the water quality and temperature are more stable.
- Simple management because raft beds are simple to clean. The effective utilisation of space is made possible by the fact that rafts can be put inside the tank itself.
- It is appropriate for commercial production, alternate activities, and home gardening.
- It facilitates a greater fish stocking.

Disadvantages:

- It is only capable of producing little leafy greens like basil and lettuce.
- Hazardous for some fruits, roots, and a few other plants.
- If not constructed properly, it may serve as a breeding place for mosquitoes. (These could be handled with the aid of guppies or mosquito fish).
- Between the raft's edges and the tank, it is kept in, water can evaporate.
- Being completely submerged, it requires filtration.
- The filtration method raises expenses and necessitates frequent filter cleaning. (If a filter is being used and not media beds)
- Roots are vulnerable to microbial contamination or could be eaten by fish that eat plants.
- There is minimal surface area available for the growth of helpful microorganisms.
- Aeration is frequently needed to give oxygen because the roots are entirely submerged.

3. **Using the Nutrient Film Technique (NFT):** Without the need for a substrate, the nutrient film technique requires maintaining a layer of nutrient solution around the roots to grow plants. When NFT originally came into existence, it appeared to be the perfect growth method since it seemed to provide the best control over the watering of the roots without the cost of a substrate.

In an NFT system, water travels between the growing channels (troughs) and the nutrient reservoir in the form of a very thin stream (film) that contains all the nutrients needed for plant growth. In the growing channels, plant roots are confined and in contact with the nutrient solution. To maintain uniformity and convenience, the growing channels are up to 15



metres long with a slope of 1% to 3%.The roots of the plants should receive an appropriate quantity of water, nutrients, and oxygen under a correctly constructed NFT system. A channel's length may impact the flow of the nutritional solution, resulting in localised depressions and an insufficient supply of oxygen for the roots. The secret is to create a thin "film" of nutrient solution to dissolve oxygen into the mixture. More of the roots are exposed to the air as they expand. Most short-term crops with small root systems, such as lettuce, herbs, and other leafy greens, are grown using an NFT method. Fruiting plants with deep roots shouldn't use this technique since the roots will clog the pipes and prevent the water from flowing freely.

Components of NFT Aquaponic System:

- Fish tank
- Filter tank
- Water pumps
- PVC Pipes, Rubber hoses, or PVC tubing, and fittings
- Rockwool or similar growing medium

Advantage:

- Roots are well oxygenated: Because part of the root is exposed, the roots receive lots of air, which helps avoid root rot.
- Constant Water Flow: The system's constant water flow keeps sediments from building up on the roots and makes sure that the plant always has access to nutrient-rich water, which promotes development and health.
- Continuous flow lessens the likelihood of fungus formation. Constant water flow helps to lessen the likelihood of fungus growth.

Disadvantage:

- The roots may clog the channels. Plants benefit greatly from having their roots dangling in the water. However, as the plants develop, larger roots may obstruct the channels, keeping water from reaching the other plants and potentially depriving them of nutrients.
- Temperature swings in the water: The water that is pumped through the channels can change abruptly from cold to hot. This is due to the fact that the thin and temperature-sensitive water film flows through the NFT channels.
- Pump malfunction can reduce yield: Plants will quickly wilt or die if the pump breaks down since they will not have access to water.
- Able to grow only a few plants: Small vegetable plants and leafy greens thrive in an NFT system, but larger plants and those with deep roots do not.

Conclusion

The development of an aquaponics system offers many advantages over either an aquaculture or hydroponic system used alone. Due to shared component costs and the recycling of waste products from one system into another, the system uses less water overall and necessitates fewer supplementary nutritional supplements. This provides a more sustainable technique for producing food. Engineering principles can be used to develop an action plan to reduce the amount of money and time lost as a result of poor sizing and design.