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Aquaponics: Uses, Cultivation and Beneficial Effects

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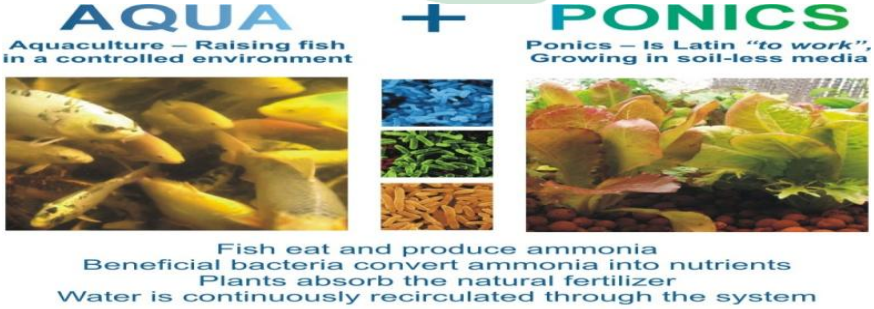
Introduction

In today's agricultural climate, without harming the environment there are better ways and new techniques developed to grow and provide healthy food for this generation and also to reach the future needs. For this purpose, there are several systems at present shaping our food production system. Aquaponics is a food production system that pair up with aquaculture (raising aquatic animals such as fish, crayfish) with hydroponics (cultivating plants in water) by which the nutrient-rich aquaculture water either freshwater system or salt contained or brackish water is fed to hydroponically-grown plants, where nitrifying bacteria converts ammonia to nitrite form and nitrite to nitrate form.

Keywords: Aquaponics, Aquatic, Aquaculture, Food, Hydroponics.

Why Aquaponics ?

As per the joint statement announced from Food and Agriculture Organization (FAO) and smart fish, aquaponics, is the technique which results from the combination of hydroponics and aquaculture systems i.e. growing plants in water instead of soil for cultivation of vegetable crops and balance them together. Plants purify the water through recirculation process by taking away fish waste out of it. The fish waste supply nutrients that the plants require for their growth and development. In most of the cases, the cultivator adds on additional nutrients to create ideal growing environment for aquaponic crops.



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An aquaponics system develops symbiotic relationship between freshwater fish and plants under controlled environment conditions in which the fish provide nutrients to the plants and the plants maintains the fish healthy by cleaning their water. Due to constant recirculation and exchange of nutrients in water system between plants and fish, there is no need to apply pesticides or herbicides artificially to support plant growth.

This symbiotic system gives environmental benefits of a traditional hydroponics system and put an end to factory fish farming's worst environmental issues. Mainly it gets rid of health problems associated while eating the factory-farmed fish. As the hydroponic and aquaculture farming techniques form the base of all aquaponic systems, the size, complication, and variety of foods grown in an aquaponic system can basically differ from any other systems under well defined farming direction.

History:

Aquaponics recently became popular again; however, this engineering and biological art began to be used by ancient civilizations. By the thirteenth century, the Aztec civilization was the first to use aquaponic technique of growing plants. They built complex agricultural islands called chinampas. These islands were located in the middle of a shallow pond and were mixed with animal waste. This setup allowed the Aztec people to take advantage of both waste disposal and food supply for aquaponics facilities. Polycultures were also created in China and Thailand where fish (as well as other species of swamp eel and pond snails) were introduced into rice fields to help produce crops and serve as another source of food.

What Are The Elements of An Aquaponic System?

1. An aquaponic system consists of a fish tank that put up the size of your garden.
2. Fish excrete waste containing nutrients is much more beneficial for plant growth.
3. The species of freshwater fish live in your aquaponic system will decide what kind of food does fish requires.
4. For example, bass should be fed high protein pellets or flakes while carp can be feed both insects and aquatic plants.

Size of fish (grams)	Amount of Daily feed (% of fish weight)
0-1	30-10
1-5	10-6
5-20	6-4

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20-100	4-3
Larger than 100	3-1.5

Main factors for a successful system:

- Optimum oxygen level (>3ppm)
- Suitable water temperature (28-32^{0}C)
- pH range 6.8- 7.0
- Required amount of nutrients both macro-micro nutrients for plant growth
- Regularly checking the condition of aquaponic system and maintaining records.



Some of the Components used to operate Aquaponic machine consists of:

a. grow beds
b. Fix Water pump
c. Plumbing fittings and pipes
d. Sumptank (for alternative purpose)
e. Grow lights (to be fixed at aquaponic gardens if sunlight is unavailable)
f. Heating elements to hold consistent temperatures
g. Fix Backup generator at the time of blackout
h. Choose active carbon filtration machine or different type of de-chlorination device
i. Leafy greens together with lettuce, spinach, basil and numerous herbs flourish in an aquaponic system at average nutrients requirements. Even though, they have higher nutrients values than leafy greens, other plants like bell peppers, cucumbers, tomatoes and strawberries also shoot up in an aquaponics garden.

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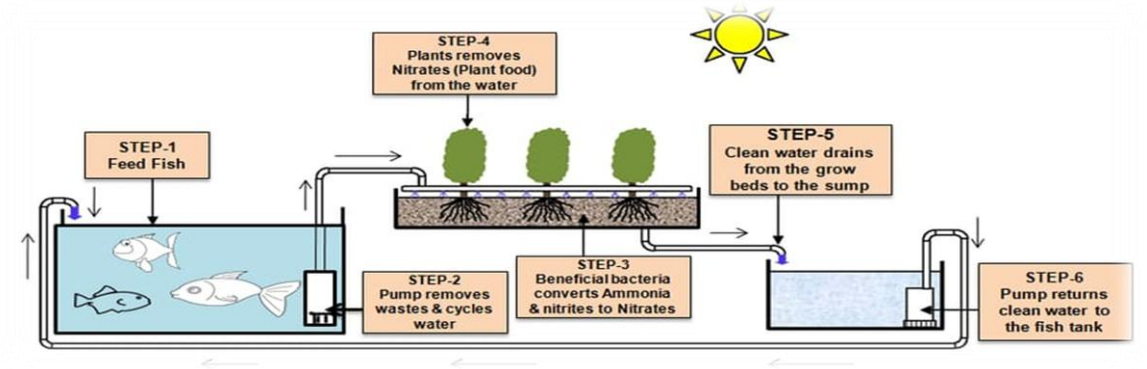

Mechanism of an Aquaponic System:

In an aquaponic system fish consumes food and excrete waste material in ammonia form, this ammonia is dangerous for fish even though it consumes it in smaller quantity hence, the toxicity level increases with pH and temperature. Nitrosomonas is the beneficial bacteria which convert ammonia (NH_3 or NH_4^+) into nitrite (NH_2^-) form this also toxic to fish. Nitrobacter bacteria convert nitrite to nitrate (NO_3^-) form. In this system, continuous flow of water is maintained which supply nutrients to the plants. So, in this process, combined relationship is created between fish, plants, bacteria, and other organisms that recycle nutrients and release polluted wastage. This reduces operating costs when compared to other systems.

There are few primary methods of growing aquaponics that are widely in use today:

1. **Deep water culture (DWC) or Floating Raft system:** This type of culture uses floating rafts they have small holes for plants to place and the roots hang freely in the water where uptake of nutrients occurs. The level of water varies from 10 to 20 inches deep. This method is most suitable for growing salad greens and other fast-growing, mostly low-nutrient plants. It is often used in larger commercial-scale systems.

1. Floating Raft Technique

2. Nutrient Film Technique

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2. **Nutrient Film Technique (NFT):** This works by flowing nutrient-rich water through a narrow PVC pipe and plants are placed in holes, so that roots floats freely in this stream of water. This type of method works very well for plants that require little support, such as strawberries and other herbs. NFT is also a great way to use leftover space because; they can be dangle above the ceilings than other growing areas.
3. **Vertical Aquaponics:** One of the greatest aspects of aquaponics is the ability to grow a higher quantity of food in a very small area. This is the best method compared to other systems. Here the plants are put together on top of each other in tower systems such as the AquaVertica and the water flows into the top of the tower and flows through a quick absorbed material so that the plants roots can absorb water and nutrients from it. The water then falls directly into the fish tank. This type of agriculture use most of the space that is available, and works very well with green leafy vegetables, strawberries, and other crop that do not require any support for their growth.

3. Vertical aquaponics

4. Media-based aquaponics

4. **Media-based Aquaponics:** In this type inert planting media such as expanded clay pellets or shale are used for growing plants. This media consists of both the biological filtration (conversion of ammonia to nitrates) and mechanical filtration (removal of solid wastes) in the same system. Media-based systems are easy method for cultivation at home as you can grow a wide variety of crops. Particularly, large fruiting plants can grow well apart from leafy green vegetables, herbs and other varieties. Examples of media-based systems are Harmony, the Aqua Urban 60 gallon system, and the Aqua Abundance system.

Life Cycle Assessment of Aquaponics:

Aquaponics is the newly developed sustainable food production technique. This system is the combination of fish farming and crop production and creates a favorable

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environment for both operations to be held. Some studies have analyzed the environmental and economic affect of aquaponics, while only a few studies have conducted social opinion. Lifecycle assessment was done to estimate the environmental, social, and economical impact of aquaponics from obtaining raw material, from production to distribution. Various kind of fishes are used in aquaponics, among them the most common fish species is Tilapia, for plant culture lettuce and herbs were chosen for cultivation and to be produced in hydroponics.

Benefits of Aquaponics:

It is beneficial to maintain an intensive food production system which is organic and nutritional benefit and is sustainable in nature.

- It requires less usage of chemical fertilizers and pesticides.
- Aquaponics is a soil less cultivation of plants hence, it is not susceptible to soil-borne diseases.
- It allows higher control (as it's easier than soil control) over the production system that leads to reduce economic losses, thus produces higher yields and qualitative production.
- Due to constant recirculation and exchange of nutrients in water system it creates less wastage.
- As it requires daily tasks like harvesting and planting and maintanence which are labor-saving and therefore, it provides employment by including all genders and ages. It also provides secure food and small incomes for landless and poor householders.
- Aquaponics generate fish protein which is beneficial to many people due to rich content of nutrients, it not only provides food in the form of protein (from the fish) and but also through vegetables.
- It is completely a natural process that looks similarly like all lakes, ponds, rivers, and waterways which are present on our earth surface.

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Conclusion:

Aquaponics is a game changer that deals with the best growing techniques by using the waste of one element for the beneficial growth of another it also mimics the natural ecosystem. Even though this new advanced system is considered environmentally friendly, it reduces fertilizer application and consumption of water at lower rate, previous studies conveyed that the overall environmental impact and cost of aquaponics were vigorously affected by electricity and fish feed. This chapter highlights the challenges to be faced by aquaponic systems and suggests future learners to work and establish the sustainability of these techniques.

Reference:

Joseph Masabni, Genhua Niu, In Aquaponics, digested, filtered and nitrified fish waste is the nutrients for plants, In plant Factory Basics, Applications and Advances, 2022.

Kamrun Naher Azad, M. A. Salam and Khairun Nher Azad,(2016), Aquaponics in Bangladesh: current status and future prospects, *Journal of Bioscience and Agricultural Research*, 7(2): 669-677.

Lina A. Kamareddine, Munjed A. Maraqa (2020), Life cycle Assessment of Aquaponics, Pollution Assessment for Sustainable Practices in Applied Sciences and Engineering, https://doi.org/10.1016/B978-0-12-809582-9.00022-0.

Sharad R. Surnar, O. P. Sharma, V. P. Saini, (2015), Aquaponics: Innovative farming, *International Journal of Fisheries and Aquatic Studies*, 2(4): 261-263.