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Aquaponics

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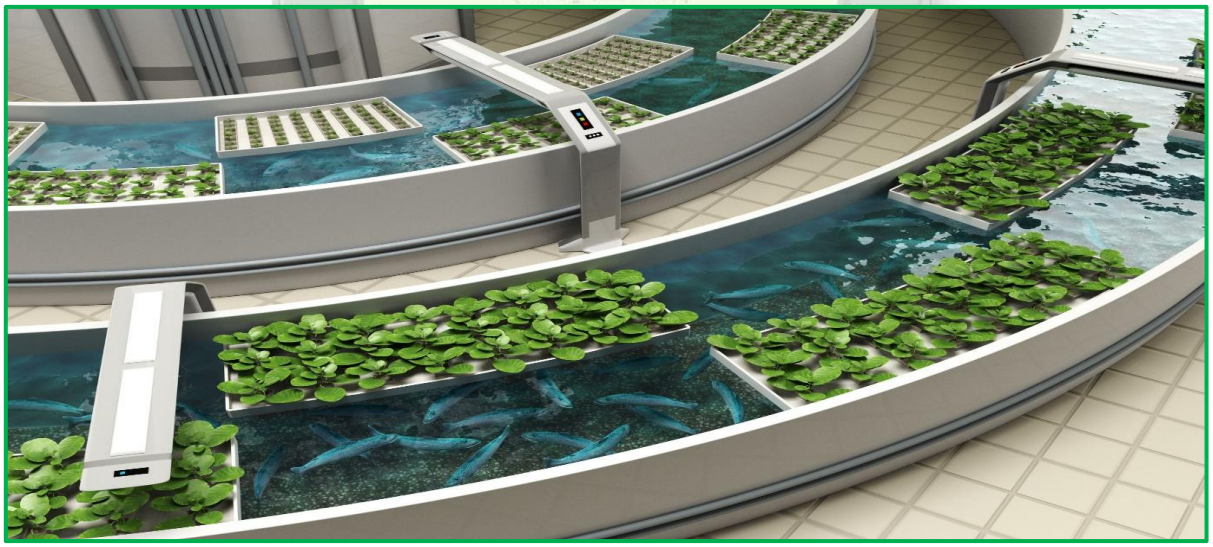
Aquaponics is a cooperation between plants and fish and the term originates from the two words aquaculture (the growing of fish in a closed environment) and hydroponics (the growing of plants usually in a soil-less environment). Aquaponic systems come in various sizes from small indoor units to large commercial units. and they can be either freshwater systems or contain salt or brackish water. In other words, according to the Aquaponics Gardening Community, cited by Thorarinsdottir, aquaponics is the cultivation of fish and plants together in a constructed, recirculating ecosystem utilizing natural bacterial cycles to convert fish waste to plant nutrition. This is an environmental friendly, natural food-growing method that harnesses the best attributes of aquaculture and hydroponics without the need to discard any water or filtrate or add chemical fertilizers.

Working of Aquaponics Design

Fish eat the food and excrete waste, which is converted by beneficial bacteria to nutrients that the plants can use. In consuming these nutrients plants help to purify the water. Aquaponics integrates aquaculture and hydroponics into one production system. Aquaponics relies on the food introduced for fish, which works as the system's input. As fish eat this food and process it, they transform it into urine and faecal matter, both rich in ammonia, which in sufficient quantities can be toxic to plants and fish. Afterward, the water (now ammonia-rich) flows, together with un-eaten food and decaying plant matter, from the fish tank into a biofilter. Afterward, inside this biofilter, bacteria break everything down into organic nutrient solutions (nitrogen-rich) for growing vegetables. As we can see, aquaponics freshwater systems rely on 3 main components: freshwater aquatic animals (the fish), nitrifying bacteria, and plants – and all three living entities depend on each other to survive. Without the bacteria to consumer the fish waste, plants wouldn't have a usable form of nutrients either – which is why biological filtration is crucial. And thanks to plant growth, nutrients are removed from the water, leaving it clean for the fish.



Aquaponics' Benefits

According to FAO,

1. One of the benefits of aquaponics is that it makes it possible to have an intensive food production system that's still **sustainable**.
2. Aquaponics encompasses two agricultural products (fish and vegetables) being produced from one nitrogen source (fish food).
3. Aquaponics is an extremely water-efficient system. Aquaponics only needs 1/6th of the water to grow 8 times more food per acre compared to traditional agriculture.
4. Aquaponics doesn't require soil and therefore it's not susceptible to soil-borne diseases.
5. Aquaponics doesn't require using fertilizers or chemical pesticides.
6. Aquaponics is a synonym of higher yields and qualitative production.
7. Aquaponics means a higher level of biosecurity and lower risks from outer contaminants.
8. Aquaponics allows a higher control (as it's easier than soil control) on production leading to lower losses.
9. Aquaponics can be used on non-arable lands such as deserts, degraded soil or salty, sandy islands. It also creates little waste, as it mimics nature's circular approach.
10. Aquaponics requires daily tasks, harvesting, and planting which are labor-saving and therefore can include all genders and ages.
11. Aquaponics can integrate livelihood strategies to secure food and small incomes for landless and poor households.
12. Aquaponics creates fish protein – a valuable addition to the dietary needs of many people.
13. Aquaponics is a completely natural process that mimics all lakes, ponds, rivers, and waterways on Earth.
14. From a nutritional standpoint, aquaponics provides food in the form of both protein (from the fish) and vegetables.

Managing an Aquaponics System

Aquaponics is a sustainable method of growing vegetables and other plants. It mimics nature as the plant "kingdom" reuses the leftovers from the animal kingdom (fish) to close a circular loop. However, achieving the system's balance, maintaining it, and securing optimal conditions for the fish and plants means a close control of different parameters.

The main production parameters which need to be perfectly set to meet the optimal needs of plants and fish are:

1. Air temperature;
2. Water temperature;
3. The concentration of macro and micronutrients
4. Dissolved oxygen in air and water – which depends on the filtration method used;
5. CO2 concentrations in air and in the water;
6. pH;
7. Light.

The more "perfect" these parameters are, the higher is the system's productivity. Paying attention to these details can help prevent insects, diseases and other types of pollution. Moreover, maintaining an appropriate balance between fish waste and vegetable nutrient demand, while ensuring an adequate surface area to grow a bacterial colony in order to convert all the fish wastes.

Applications of Aquaponics

1. Domestic or Small-Scale Aquaponics System: This is a fish tank of around 1000 liters and a $3m^2$ growing space, ideal for domestic production.

2. Semi-Commercial and Commercial Aquaponics: This means looking at an aquaponics system from a perspective in which there aren't many players in the market yet due to large start-up costs.

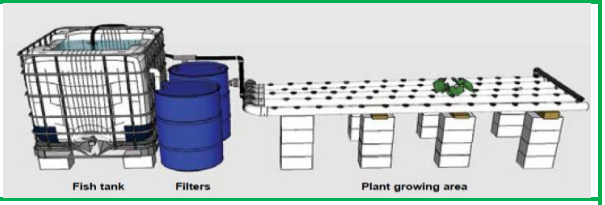
3. Education: Small aquaponics units are being used in educational sites as a way to bridge the gap between the general public and sustainable agriculture techniques.

4. Humanitarian Relief and Food Security Interventions: As aquaponics systems work anywhere in the world, they can be used as pilots in developing countries to meet the food security needs of local people

Design of Aquaponic Units

Worldwide, **Thorarinsdottir** says there are three main aquaponics systems being used: media beds, floating rafts or deep water culture (DWC), and nutrient film technique (NFT). The media beds utilize various substrates in an "ebb and flow" process while in the NFT (in a thin layer of water) and raft/DWC systems (floating rafts in large water tanks) the plant roots grow directly into the water.

Small media bed unit



Small nutrient film technique unit

Small deep water culture unit

Weaknesses of Aquaponics

Every coin has two sides. And based once again on FAO's report, we can also find some weaknesses that come along with adopting an aquaponics design. So the weaknesses of aquaponics are:

1. The very high initial start-up costs (compared with both hydroponics or soil production systems) of aquaponics is one of its weaknesses;
2. Aquaponics requires deep expertise in the natural world. In order to be successful, farmers need to have knowledge not only on growing vegetables but also on how fish and bacteria work. And technical skills regarding plumbing or wiring are also needed;
3. As a follow up from the previous point, it's often hard to find a perfect match between the needs (such as pH, temperature, substrate) of fish and plants;
4. Aquaponics has fewer management options (an issue developed ahead) compared with stand-alone aquaculture or hydroponics;
5. Mistakes managing the system can quickly cause its collapse;
6. Daily management is needed, which means the organization is crucial;
7. It's energy demand, which means it has energy costs;
8. Fish feed needs to be purchased on a regular basis;
9. The products of aquaponics alone aren't enough to ensure a balanced diet;

Moreover, an effective aquaponics system needs to have effective filtering of organic solid – which is the function of bacteria or algae. Over two-thirds of the failures in aquaponics systems happen because of ineffective solid waste removal.