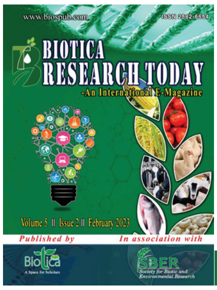
Bio. Res. Today 2023, 5(2):183-185



Biotica Research Today

e-ISSN: 2582-6654
February, 2023

Article ID: RT1247 Popular Article

Aquaponics: An Integrated Farming System for Food Security

Aitwar Vaijnath[1*] and Gurphale Nikita[2]

[1]*Karnataka Veterinary, Animal and Fisheries Sciences University, Bidar, College of Fisheries, Mangalore, Karnataka (575 002), India*
[2]*Late Shri Punaram Nishad College of Fisheries, Kawardha, (Dau Shri Vasudev Chandrakar Kamdhenu Vishwavidyalaya, Durg), Chhattisgarh (491 995), India*

Corresponding Author
Aitwar Vaijnath
✉: vaijuaitwar99@gmail.com

Conflict of interests: The author has declared that no conflict of interest exists.

How to cite this article?
Vaijnath and Nikita, 2023. Aquaponics: An Integrated Farming System for Food Security. *Biotica Research Today* 5(2), 183-185.

Abstract

Aquaponic farming systems find better ways for various agricultural industries. This farming system is not dependent on soil and requires no pesticides during farming. The system is suitable for cultivation throughout the year and can produce high-yield, good-quality vegetables. Vegetables using this technique grow much faster than conventional farming techniques. Aquaponics occurs in a closed system and does not release waste into streams. Compared to conventional farming using the same space, the system produces a 30% more yield. The system requires less water than conventional farming.

Keywords: Aquaponics, Fish, Integrated, Plants

Introduction

Primary food production generally depends on land, freshwater, fossil energy and nutrients. The world is focused on how future generations can produce more food sustainably. In contrast, aquaponics is one of the vital food production technologies that can change our lives. It's a food production system that combines intensive aquaculture with hydroponics. Aquaponics is a synergy between plants and aquatic ecosystems. In this type of farming, fish are nurtured, raised and harvested. During rearing, water containing waste produced by fish is used as a medium for growing plants. Nutrient-rich effluent from an aquaculture module is circulated through a hydroponic module where plants absorb nutrients before the water reverts to the fish tank. Improvements in design and functionality have transformed aquaponics from water reuse innovations to efficient energy and wastewater recovery systems (Obirikorang *et al.*, 2021). Aquaponics can simplify and increase sustainable and efficient food production (Colt *et al.*, 2021). Fish feed is a primary nutrient entry point in this system. Fish eat the feed and expel the leftovers as waste, which is subsequently divided among bacteria, plants, and system water (Lennard, 2017) (Figure 1).

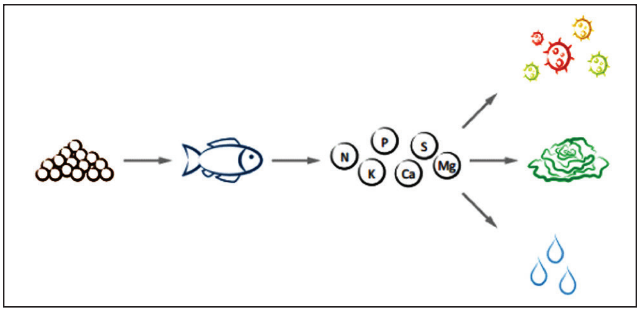


Figure 1: An aquaponic system's nutrient flow (Lennard, 2017)

Aquaponics: Key Elements and Considerations

Aquaponics combines a recirculating aquaculture system (RAS) and hydroponic components. In this system, water is circulated from the fish tank to the filtration unit and then pumped into the hydroponic bed as a water reprocessing unit (Figure 2). The filtration section includes mechanical filtration units (*e.g.*, rotary drum filters or sedimentation tanks) to remove solid particles and biological filters (*e.g.*, Trickle or moving biological bed filters) for the nitrification process. However, this configuration and complexity vary from system to system.

Article History
RECEIVED on 09th February 2023 RECEIVED in revised form 20th February 2023 ACCEPTED in final form 21st February 2023

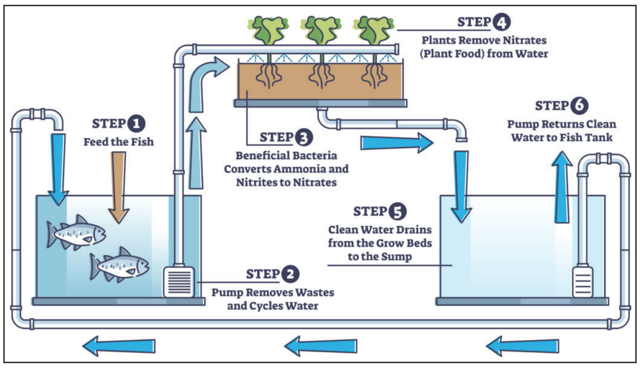


Figure 2: Design of aquaponic culture system (Anonymous, 2023)

Hydroponic System and Its Bed

It produces plants in a soilless medium, where the nutrients supplied to the crops are dissolved in water. Generally, three types of hydroponic beds are commonly used. A comparative study of these hydroponic beds versus soil culture is presented in table 1.

Structure/ Design

The suitable structure or design for the aquaponic culture system is shown in figure 2.

Components:

1. Rearing tank
2. Settling tank
3. Bio-filter
4. Hydroponic subsystem
5. Sump

Water Quality Management

Continuous tests of water quality will reveal information about the condition of water in the cultured system. The quality of water may fluctuate over a period of time and this can be noticed by testing it repeatedly. For aquaponic systems, water quality parameters such as dissolved oxygen, ammonia, alkalinity and nitrite are very essential. The required level of such parameters is shown in table 2.

Table 1: Comparison between different types of aquaponic farming techniques

Type	Structure	Soil
Media-based grow bed (MGB	A hydroponic trough filled with an inert substrate (*e.g.*, expanded clay, perlite, pumice, and gravel) serves as root support and a microbial substrate.	The traditional system where the soil is used as the prime medium for plant production.
Deep Water Culture system (DWC)	A large trough with perforated floating rafts, where net plant pots (are filled with media, *e.g.*, rock wool, coco, or pumice that support roots) are inserted. In this technique, plants are grown on floating or hanging supports in nutrient solution-filled containers.	
Nutrient Film Technique (NFT)	A narrow channel of perforated squared pipes where the roots are partially immersed in a thin layer of streaming water. Nutrient Film Technique (NFT). In this technique, a nutrient solution flows and circulates along with a tank with a 1-2 cm thick layer of water.	
Aeroponic system	This technique is specially used for horticultural species. Plants are supported by plastic panels lining the sloping top of the planter box. Plastic sheets support the panels to form closed containers in which hanging root systems can develop. The nutrient solution is sprayed over the roots, the roots are suspended in the airbox, and the sprayer is inserted into the pipe inside the box.	

Table 2: Suitable water quality parameters for the aquaponic culture system

Parameters	Ranges	Parameters	Ranges
DO	4-6 ppm	Nitrate	<5 ppm
Ammonia	<0.05 ppm	pH	7-8
Alkalinity	120-150 ppm	Water Hardness	60-140 ppm
Nitrite	<0.5 ppm	Water temperature	26-30 °C

Feed Management

The fish-feed ratio depends on the type of plant being grown. The type of feed also influences the feeding rate. On average, fish will consume 1 to 2% of their body weight daily during the growth phase. During the first two to three months, the fish are small (A tilapia fingerling weighs 50 g) and eats about 3% of its body weight daily. Therefore, initially stocked with 40 fingerlings weighing 2,000 g, they will consume approximately 60 g of fish feed daily. After two to three months of feeding, the fish consider about double in weight. At this point, they should be able to eat 80 to 100 g of feed day^{-1}. Aquatic animals are infected by trash and uneaten food. Contaminated food depletes all dissolved oxygen and can spread disease. To overcome this issue, feed the animals every day, remove any food that hasn't been consumed after a few minutes and then adjust the portion for the next day.

Suitable Plants and Fish Species Selection

Several fish species have recorded excellent growth rates in aquaponic units. Fish species and plants suitable for aquaponic farming include in table 3.

Table 3: Suitable plant and fish species

Plant	Fish
Leafy lettuce	Tilapia
Herbs	Blue gill/ Sunfish
Pak choi	Catfish
Kale	Carp
Swiss chard	Koi carp
Microgreens	Goldfish
Hemp	Pacu

Stocking and Harvesting

The recommended maximum stocking density is 20 kg of fish for 1,000 litres of water (fish tank). Higher densities are possible with further aeration and mechanical filtration, but this is not recommended for beginners. Approximately every three months, the mature fish (500 g each) are harvested and immediately restocked with new fingerlings (50 g each). This method avoids harvesting all the fish at once and retains more consistent biomass.

Economic Challenges

In developing the aquaponic system, specific key economic points must be considered to make this system profitable. These include: 1) the overall investment required to construct facilities and to purchase necessary equipment (investment cost); 2) the annual costs to operate the system; 3) realistic estimates of market prices. In general, the production cost of fish in an indoor system is two to three times higher than growing fish in outdoor/ ponds. Hence, suitable market development for this kind of indoor product (*i.e.*, producing an aquaponic system) is important. The consumers' willingness to pay will be a little higher than the average market/ market price. Besides these, the production cost is usually higher for producing fish in recirculating aquaculture units than growing vegetables from the hydroponic unit, which may lead to a net profit loss for the aquaponic system.

Advantages

• Free from chemicals and inorganic fertilizers that ensures natural food for consumers.

• Required less space and gives high production.

• An increase in farm productivity.

• Farm diversification in terms of production.

• Utilize farm resources that could be wasted (*e.g.*, nutrients and water).

• Decrease in net environmental effects.

Disadvantages

• High capital cost (For beds and hydroponic system).

• Hard to control climatic conditions.

• It required more energy for cultural operation.

• Maintenance and cleaning are complex.

• Heavy hydroponic infrastructure.

• Remote control of soil nutrients.

Conclusion

The agricultural sector is suffering to meet the demands of the growing food crisis at the lowest possible cost. As with any technology, this method has a few problems and disadvantages, but the advantages outweigh the disadvantages of conventional farming. Other benefits of this system include the production of nutrients that help promote plant and fish growth; therefore, in this system, expensive chemicals are replaced by less expensive fish feeds, which means significant cost advantages in farming. Thus, the system is closest to a natural ecosystem. The system produces zero waste, requires no drainage and is more productive than other farming techniques. Conversely, very few studies have endorsed that recirculating aquaculture units are profitable enterprises under this aquaponic system. In such a situation, additional costs and risks associated with this complex system must be analyzed before investing money in adopting the aquaponic technique.

References

Anonymous, 2023. Aquaponic 101. Targeted aquaponic growth. Available at: https://www.tag2grow.org/aquaponics101/. Accessed on 7th February, 2023.

Colt, J., Schuur, A.M., Weaver, D., Semmens, K., 2021. Engineering Design of Aquaponics Systems. *Reviews in Fisheries Science and Aquaculture* 30(1), 033-080.

Lennard, W., 2017. Talking Aquaponics: Lessons in A New Protected Cropping Methodology with Wilson Lennard; Part 1 - The Fish - Introduction. *Practical Hydroponics and Greenhouses* 184, 050-058.

Obirikorang, K.A., Sekey, W., Gyampoh, B.A., Ashiagbor, G., Asante, W., 2021. Aquaponics for Improved Food Security in Africa: A Review. *Frontiers in Sustainable Food Systems* 5(705549), 001-010.