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Aquaponics: Innovative farming

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Abstract
The aquaponics systems focused on increasing economically and sustainability of indoor and outdoor fish farming. Aspect like sustainability, development and economically efficiency improve of farmer health we must reconsider the agriculture sciences, by this we understand that we must develops technologies friendly for the environment. Combining aquaculture with hydroponics we obtain a new innovation named aquaponics which respects principles of sustainable agriculture (wastewater bio filtration by plants) and gives us the possibility to increase economic efficiency with an additional production (organic vegetables) to produce the nutrient rich food.

Keywords: Fish, Aquaponics, plant, hydroponics, aquaculture.

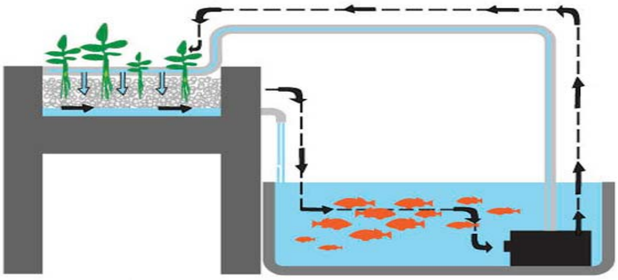
1. Introduction
Populations around the world face questions of food security today on a scale that has not been seen in recent human history. The evolution of how we feed our populations and the technologies we use to do it have created a unique set of circumstances that bring with them unique challenges, and despite significant advances in food production and our knowledge of food nutrition and food safety, hunger continues to millions of people around the world. It is thought that over a billion people in the world are currently undernourished (World Food Programme, 2010).

Agriculture's dependence on healthy soil presents another problem in food production, as current estimates are that 38% of global agricultural land is degraded. Soil degradation is the change induced by the natural decrease in the soils' potential for productive use, and normally results in reduced yields due to lack of or insufficient nutrients or water availability.

1.1. Aquaponics
Aquaponic systems combine the two forms of agricultural production mentioned above, recirculating aquaculture and hydroponics. Aquaponics provides a solution to the main issues these two systems face; the need for sustainable ways of filtering or disposing of nutrient-rich fish waste in aquaculture and the need for nutrient-rich water to act as a fertilizer with all of the nutrients and minerals needed for plants grown through hydroponics. Combining these two systems provides an all-natural nutrient solution for plant growth while eliminating a waste product which is often disposed of as wastewater.

This nutrient-rich effluent is used to irrigate a connected hydroponic bed while fertilizing its plant crops at the same time. The nutrients, largely in the form of ammonia are converted by denitrifying bacteria in the hydroponic grow bed into forms readily up taken by plants for energy and growth. Essentially, the hydroponic bed and its crops serve as a biofilter for the fish waste water before it is returned, cleaned back into the fish tank.

2. Aquaponic Systems
2.1 System Designs
There exist several system designs for recirculating aquaponics systems. The designs are based on hydroponic systems, the difference being that the water source for the aquaponics system come from the fish tank and is eventually returned to its source of origin.



Size of fish (grams)	Amount of daily feed (% of fish weight)
0 – 1	30 – 10
1 – 5	10 – 6
5 – 20	6 – 4
20 100	4 – 3
Larger then 100	3 – 1.5

2.1.1 Floating Raft System
Another system that has great potential for commercial use is the floating raft system. In this system plants are grown on floating rafts. The rafts have small holes cut in them where plants are placed into net pots. The roots hang free in the water where nutrient uptake occurs. A major difference between the raft systems and the NFT and media based systems is the amount of water used. The water level beneath the rafts is anywhere from 10 to 20 inches deep and as a result the volume of water is approximately four times greater than other systems. This higher volume of water results in lower nutrient concentrations and as a result higher feeding rate ratios are used. Bacteria form on the bottom surface of the rafts but generally, a separate biofilter is needed. Also, the plant roots are exposed to some harmful organisms that reside in the water, which can affect plant growth.

2.2. Water Quality
Good water quality must be maintained at all times in a recirculating fish tank to maintain optimal growth conditions and health of the fish. Regular water quality testing is essential and can be performed using water quality testing kits obtained from aquaculture supply companies.

2.2.1 Improve on Poor Water Quality
Ground water is considered or given a top priority as the best for fish culture because it is free of suspended materials, pollutants, and fish disease causing organisms; temperature and chemical composition are relatively constant over time. Though considered the best some will need to be treated to ensure suitability for use. Basic treatments may include:

- Aeration to increase dissolved oxygen concentration.
- Degassing to reduce total gas pressure, and to remove carbon dioxide and hydrogen sulphide.
- Temperature regulation using water heaters or mixing water of different temperatures.
- Sedimentation and filtration to remove iron and addition of calcium to waters of low hardness.

Unpolluted surface water supplies can be of enormous advantage as some of the above treatments don't need to be carried out. Surface water supplies however, suffer the major disadvantages of pollution, turbidity as well as variable quantity and availability.

2.3 Fish Feed
Fish are largely respond well to commercial fish feed. Their diets need to be well balanced in terms of amino acids, proteins, fats, vitamins, minerals and carbohydrates. Expertly formulated feeds that provide all of these components for fish are quite common. In natural environments, some wild fish may feed on algae (low in protein) and small animals such as worms (high in protein)and small-scale aquaponic growers may choose to feed their fish with a mixture of these materials, however optimum tilapia growth will be obtained by the use of commercial feed pellets.

2.4. Plant Crops
2.4.1 Nutritional Requirements
All plants may have different nutritional requirements; for instance leafy green vegetable require more nitrates than fruiting plants. However all plants in aquaponic systems need 16 essential nutrients for maximum growth. These come in the form of macronutrients, which in addition to carbon, hydrogen, and oxygen, which are supplied by water, carbon dioxide, and atmospheric air, include nitrogen (N), potassium (K), calcium (Ca), magnesium (Mg), phosphorous (P) and sulphur (S). There are seven micronutrients necessary as well and they are chlorine (Cl), iron (Fe), magnesium (Mn), boron (B), zinc (Zn), copper (Cu), and molybdenum (Mo).

2.4.2 Crop Selection
Many types of plants can grow successfully in aquaponic systems. Originally it was thought that only leafy green vegetable and herb crops could be grown, but it has since been proven that a wide variety of fruiting crops, beans, and flowers can be grown effectively.

2.4.3 Plant Growing Area
The growing area is the starting point for a system design because other parameters are based on the area over which plants can be grown. A growing area of 6 m^2 was chosen for the design arbitrarily, with dimensions of 2 m in width by 3 m in length. It was chosen because it was thought to be an appropriately sized area for families to maintain in a backyard. They were chosen arbitrarily simply because it was known that they were appropriate for tropical climates.

2.5 Fish Stocking and Harvest
Stocking density in a fish tank is measured in units of fish biomass per volume of water; kilograms per meter cubed in our case. The stocking density is an important aspect for fish growth for several reasons. Water quality decreases proportionally when stocking densities are increased, in part due to a higher production of waste, increasing the levels of potentially toxic substances, such as ammonia and nitrite. Another reason fish health is compromised when stocking densities are increased is because higher stocking densities result in more consumption of oxygen and a lack of oxygen will result in stunted growth and reduced fish health. Under stocking the system however will result in a lower feed conversion ratio and reduce the efficiency of the system.

2.6 Plant Stocking and Harvest
Higher plant densities often mean that the yield per plant will be lower while producing a higher yield per area. Based on experience, a density of 12 plants/m^2 will be used for both *spinach* and tomatoes. The 6 m^2 growing area will be split evenly between the two plant species with 3 m^2 being used to grow 36 *spinach* plants and the other 3 m^2 growing 36 tomatoes plants. Based on hydroponic and aquaponic studies, it is assumed *Spinach* can be harvested 12 times a year and tomatoes 6 times a year.

3. Conclusion

The additional design decision are expected considerably improve water quality, thereby positively affecting fish growth and production. Food security poses a very real and serious threat in the world today. What makes aquaponic food production so attractive is its ability to address these issues of resource conservation and access to a reliable and quality food source. In addition to this, the simplicity of an aquaponic system makes it accessible and user friendly so it has the potential to help families who are most in need of it.

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