

EXPERIMENTAL INVESTIGATION/ ON FERTIGATION IN OPEN FIELD AGRICULTURE

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Abstract - Fertigation is used in agriculture to refer to the combination of irrigation and fertilization, in one step. Now, an EU-funded project, called OPTIFERT, aims at developing an automatic system that enables farmers to use both water and fertilizers in a more sustainable way in open fields. Increasing the production by several combined engineering methodology of farming such as aquaponic hydroponic and micro irrigation. Aquaponics combines the culture of aquatic animals and therefore the cultivation of plants in recirculating systems, integrating aquaculture and hydroponics in a soil-less system. Toxic ammonia produced by unutilized feed, fish faces and excreted urea is oxidized by nitrifying bacteria (microbial breakdown) (mainly by *Nitrosomonas* and *Nitrobacter* spp.) into vital and usable nitrate for plants. Plants absorb nitrate and different nutrients, permitting purified water recirculate back to fish tanks. Aquaponics promotes an innovating system as a solution to possible environmental impacts of aquaculture, shortage of drinking water, climate change, loss of soil fertility and biodiversity. Aquaponic system vitality and prosperity is predicated on fish, plant and bacterial interactions and welfare. The relation between these square measure extremely complicated and square measure in direct association with water quality. Aquaponics food merchandise square measure chemical-free (no use of hormones, pesticides/fungicides or antibiotics).

Keywords: fish, aquaponics, plant, hydroponics, aquaculture.

1. INTRODUCTION

How square measure we tend to aiming to feed the quite nine billion those that can survive Earth by 2050? This is a significant question for farmers, ranchers, and food scientists around the globe. It's a big problem, considering that from 2019 to 2050 we will be adding 1.5 billion people and need 20% more food. Linked to the present downside of manufacturing enough food has enough land, water, and different natural resources to create that happen. 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 however we tend to feed our populations and therefore the technologies we

tend to use to try to it have created set of circumstances that bring with them unique challenges, and despite vital advances in food production and our data of food nutrition and food safety, hunger continues to millions of people around the world. It is thought that over a billion individuals within the world square measure presently underfed (World Food Programme, 2010).

Agriculture's dependence on healthy soil presents another downside in food production, as current estimates are that 38% of global agricultural land is degraded. Soil degradation is that the modification elicited by the natural decrease within the soils' potential for productive use, and normally results in reduced yields due to lack of or insufficient nutrients or water availability. The final answer can sure as shooting be created of many alternative approaches operating along —aquaponics could also be one a part of the ultimate answer

Aquaponics combines hydroponics with aquaculture. Hydroponics is that the science of growing plants while not soil in nutrient-rich water. The nutrients area unit precisely tailored to nourish and meet the expansion needs of the plants. Plants need nitrogen, phosphorus, potassium, and a variety of other micronutrients to thrive. Normally, in an exceedingly farming system, artificial (manufactured) fertilizers factitious to the water offer these essential nutrients. Aquaculture is that the breeding and farming of aquatic organisms, like fish, shellfish, and aquatic plants, usually for human consumption.

In an aquaponics system, the fish offer nutrients within the type of their "waste," or excrement. This waste contains gas within the type of ammonia (too a lot of which may be toxic to fish), beside a range of nutrients like phosphorus and metal. Nitrifying bacteria that live in the gravel in the fish tank and on the tank, walls convert the ammonia first into nitrites and then to nitrates which the plants can use. The water within the tank, that contains ammonia, nitrites, nitrates, phosphorus, potassium, and other micronutrients, is continuously pumped into a grow bed where the plants are located. The plants take away the nutrients from this water, and nitrifying microorganism within the grow bed (working along with the tank filter) clean the water by

changing excess ammonia into nitrates, which plants use to grow. The clean water is then sent back to the tank. The grow bed and plants act as a biofilter, cleansing the water in order that the fish stay healthy. In smaller, curtain aquaponics systems, the grow bed sits on prime of the tank and therefore the cleaned water from the grow bed drips back to the tank. In aquaponics, the fish, plants, and useful microorganism all depend upon one another to measure.

2. Aquaponics

Aquaponic systems mix the 2 sorts of agricultural production mentioned higher than, recirculating aquaculture and hydroponics.

Aquaponics provides an answer to the most problems these 2 systems faces; the requirement for property ways in which of filtering or getting rid of nutrient-rich fish waste in cultivation and therefore the need for nutrient-rich water to act as a fertilizer with all of the nutrients and minerals wanted for plants through farming. Combining these 2 systems provides AN all-natural nutrient resolution for plant growth whereas eliminating a waste material that is usually disposed of as waste water.

This nutrient-rich effluent is employed to irrigate a connected aqua cultural bed whereas fertilizing its plant crops at an equivalent time. The nutrients, mostly within the type of ammonia area unit regenerate by denitrifying microorganism within the aqua cultural grow bed into forms promptly up taken by plants for energy and growth. Essentially, the aqua cultural bed and its crops function a biofilter for the fish waste water before it's came, cleansed back to the tank.

3. The Nitrogen Cycle

The nitrogen cycle is well complimented by aquaponics. Feed is administered to the fish grow-tanks, which is digested to produce waste. Fish excrete ammonia through urine, faeces (approx. 17%) and their gills (approx. 80%). The nitrification cycle is the process by which the ammonia produced by the fish is converted by Nitrosomonas bacteria to nitrite and then by Nitrobacter to nitrate which acts as nutrient for the plants.

Ammonia (NH₃) in water exists as total ammonia atomic number 7 (TAN), described by the following equation:

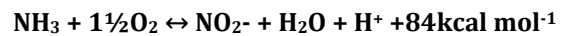


Feeding rate could be a crucial think about generation of ammonia in Associate in Nursing cultivation pool, and this can be described by:

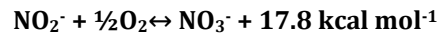
$$\text{PTAN} = (\text{Daily enclose Grams}) \times (\% \text{age of macromolecule Content in Feed}) \times 0.092$$

PTAN is that the total ammonia production in grams per day.

In aquaponics, the growth of plants from the aquaculture water fed system results in consumption of NH₄⁺ which in turn converts NH₃ to NH₄⁺ for balance according to equation (1). Nitrifying bacterium gift within the plant grow beds/bio filters convert ammonia to NO₃⁻ from that plants take up their atomic number 7 necessities in aquaponics. This method is catalyzed 1st by genus Nitrosomonas bacterium by the subsequent equation:



Follow by the second step conversion by Nitrobacter bacteria.



Hence the stocking density of plants could be a crucial issue to balance the nutrient necessities for crop production.

4. Aquaponic Systems

4.1 System Designs

There exist many system styles for recirculating aquaponics systems. The designs are based on hydroponic systems, the distinction being that the water supply for the aquaponics system return from the tank and is eventually came back to its source of origin.

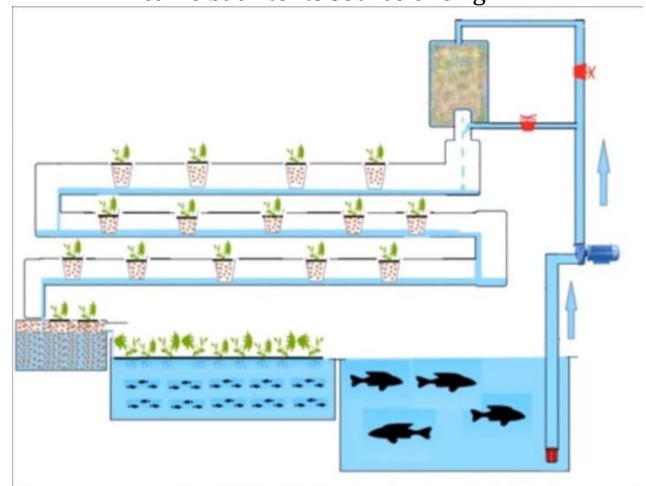


Fig1: system design

5. Types of Aquaponics and related Systems

5.1 Floating Raft System

Another system that has nice potential for industrial use is that the floating raft system. In this system plants area unit grown up on floating rafts. The rafts have tiny holes cut in them wherever plants area unit placed into web pots. The roots droop free within the water wherever nutrient uptake happens. A major difference between the raft systems and the NFT and media based systems is the amount of water used. The water level below the rafts is anyplace from ten to twenty inches deep and as a result the amount of water is about fourfold larger than different systems. This higher volume of water leads to lower nutrient concentrations and as a result higher feeding rate ratios area unit used. Bacteria type on very cheap surface of the rafts however typically, a separate biofilter is required. Also, the plant roots area unit exposed to some harmful organisms that reside within the water, which might have an effect on plant growth.



Fig 2: Floating Raft System

5.2 Gravel system method

It is a cheap and readily available growing media that is filled in the grow bed. To ensure adequate aeration of plant roots, gravel beds have been operated in a reciprocating mode, wherever the beds area unit alternately flooded and drained. This methodology uses the fewest elements and no further filtration, making it simple to operate. Gravel has several negative aspects. The weight of gravel requires strong support structures. It is subject to preventative with suspended solids microbe growth and also the roots that stay once harvest.



Fig 3.1: Charcoal system method



Fig 3.2: Gravel system method

5.3 Nutrient Film Technique (NFT)

This is a method in which the plants are grown in long narrow channels. A thin film of water unendingly flows down every channel, providing the plant roots with water, nutrients and oxygen. Troughs are used in this method which is lightweight, inexpensive and versatile. Troughs will be mounted over rearing tanks to with efficiency use vertical greenhouse house. Few drawbacks of NFT method are a separate bio filter is required, because there is not a large amount of water or surface for the beneficial bacteria to live. In addition, the plumbing used in a hydroponic NFT system is usually not large enough to be used in aquaponics because the organic nature of the system. The thin film of water that flows through NFT (nutrient film technique) channels absorbs O by diffusion, however dense plant roots and associated organic matter will block water flow.



Fig 4: Nutrient Film Technique (NFT)

6. Water

6.1 Water Quality

Good water quality should be maintained in any respect times in a very recirculating tank to keep up best growth conditions and health of the fish. Regular water quality testing is crucial and might be performed victimization water quality testing kits obtained from cultivation offer corporations.

6.2 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 thought-about the simplest some can get to be treated to confirm suitability to be used.

Basic treatments may include:

- Aeration to increase dissolved oxygen concentration.
- Degassing to scale back total pressure level, and to remove carbon oxide and element sulfide.
- Temperature regulation using water heaters or mixing water of different temperatures.
- deposit and filtration to get rid of 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 provides but, suffer the foremost disadvantages of pollution, turbidity as well as variable quantity and availability.

6.3 Fish Feed

Fish square measure mostly respond well to business fish feed. Their diets got to be balanced in terms of amino acids, proteins, fats, vitamins, minerals and carbohydrates. Expertly developed feeds that offer all of those parts for fish square measure 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 mix of those materials, however optimum tilapia growth will be obtained by the use of commercial feed pellets.

7. Plant Crops

7.1 Nutritional Requirements

All plants could have completely different biological process weldments; as an example, leafed inexperienced vegetable require a lot of nitrates than mature plants. However, all plants in aquaponic systems would like sixteen essential nutrients for optimum growth. These are available the shape 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 square measure seven micronutrients necessary still and that they square measure gas (Cl), iron (Fe), magnesium (Mn), boron (B), zinc (Zn), copper (Cu), and molybdenum (Mo).

7.2 Crop Selection

Many types of plants will grow with success in aquaponic systems. Originally it had been thought that solely leafed inexperienced vegetable and herb crops can be fully grown, but it has since been proven that a wide variety of fruiting crops, beans, and flowers can be grown effectively.

7.3 Plant Growing Area

The growing space is that the place to begin for a system style as a result of alternative parameters square measure supported the world over that plants may be fully grown. A growing area of 6 m² was chosen for the design arbitrarily, with dimensions of 2 m in width by 3 m in length. It was chosen as a result of it had been thought to be associate degree fittingly sized space for families to keep up in a very curtilage. They were chosen haphazardly just because it had been acknowledged that they were applicable for tropical climates.

8. Stocking and Harvest

8.1 Fish Stocking and Harvest

Stocking density in an exceedingly vivarium is measured in units of fish biomass per volume of water; kilograms per meter cubed in our case. The stocking density is a vital side for fish growth for many reasons. Water quality decreases proportionately once stocking densities square measure exaggerated, 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 once stocking densities area unit magnified is as a result of higher stocking densities lead to a lot of consumption of element and an absence of element can lead to stunted growth and reduced fish health. Under stocking the system but can lead to a lower feed conversion magnitude relation and scale back the potency of the system.



Fig 5: Tilapia fish

8.2 Plant Stocking and Harvest



Fig 6: Brinjal plant

Higher plant densities usually mean that the yield per plant are going to be lower whereas manufacturing a better yield per space. Based on expertise, a density of 12 plants/m² will be used for both spinach and tomatoes. The six m² growing space are going to be split equally between the 2 plant species with three m² being employed to grow thirty-six spinach plants and therefore the alternative three m² growing 36 brinjal plants. Based on aquaculture and aquaponic studies, it is assumed Spinach can be harvested 12 times a year and brinjal 6 times a year.

9. Conclusion

The additional style calls square measure expected significantly improve water quality, thereby positively affecting fish growth and production. Food security poses an awfully real and heavy threat within the world nowadays. What makes aquaponic food production therefore enticing is its ability to handle these problems with resource conservation and access to a reliable and quality food supply. In addition to the present, the simplicity of associate aquaponic system makes it accessible and user friendly therefore it's the potential to assist families WHO square measure most in want of it.

10. REFERENCES

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