Aquaponics – a smart fish-based solution to growing food using limited resources and little water

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WHAT IS AQUAPONICS?

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Aquaponics (Pronunciation: [akwə'poniks]) is the cultivation of plants and aquatic animals in a recirculating environment. It is a synergy between fish and plants and the term stems 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. They can be either fresh water systems or contain salt or brackish water.

Freshwater systems rely on three major elements	Saltwater systems also rely on three major elements
Freshwater aquatic animals;	Saltwater aquatic animals; and
Nitrifying Bacteria; and	Seaweed/Algae.
Plants.	Nitrifying Bacteria

Aquaponics systems can provide healthy foods (fish/herbs/vegetables) with high yields using minimal water, which can contribute to food and nutrition security, as well as being a successful commercial venture, appropriate to developing as well as developed countries.

WHY DO AQUAPONICS?

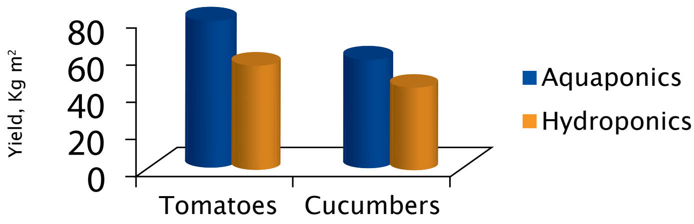
Aquaponics is a recirculating food production system that uses less than 10% of the water normally required for fish farming and plant production. It is therefore suitable for small-scale/domestic consumption as well as commercial fresh food production, particularly in communities where water is scarce. There is very little water loss, mainly due to evaporation and plant transpiration, there is also no need for plant chemicals, which would cause the fish to die, however some organic means of plant protection maybe required particularly if you are growing monoculture.

One of the main advantages of using aquaponics is that it is an excellent way of producing protein foods such as fish and vegetables in both impoverished areas (to support food security), as well as in areas where there is a high demand for good quality produce. High-priced organic produce can be produced for urban markets, for instance. Aquaponics systems conserve water and plants growing in these systems grow quicker, larger and with a higher yield (15%)[1] than those growing in a regular hydroponics system. Some say they even taste better!

The plants do not rely on water replenishments and by constantly using recycled water, it means that systems can be located almost anywhere including in close proximity to markets. From a business perspective this has the advantage of reducing distribution costs and lowering the carbon footprint of the enterprise. Also, the need for inputs is low once the system has been set-up, just some simple systems' maintenance along with fish, fish feed, seeds (or seedlings) and water to replenish the unit. Virtually no chemical fertilizers are needed for the plants, and all the nutrients the plants need come from the fish waste

[1] See table 1 of this document.

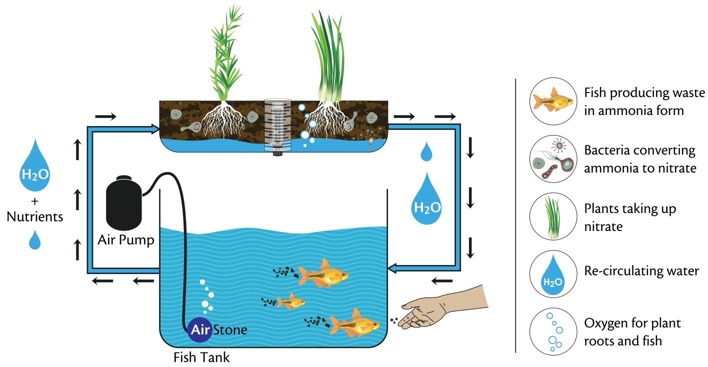
Table 1: Aquaponics vs Hydroponics - Yield 2004 (Year round production)



Source: The feasibility of Aquaponics in Mauritius (SmartFish publication)

HOW DOES AQUAPONICS WORK?

Aquaponics is the integration of aquaculture and hydroponics in one production system. This method relies on fish waste to be used as an organic nutrient solution to grow vegetables. In a system, water flows from the fish tank into a biofilter where bacteria break down the fish waste into an organic nutrient solution for the growing vegetables. The plants then absorb the nutrients from the water which essentially cleans it before being re-circulated back into the fish tanks.



The bacteria are fundamental to this process. They convert the ammonia, which is a major component of fish waste, into nitrate (a more accessible form of nitrogen for plants), preventing the water from becoming toxic to the fish (this conversion of ammonia to nitrate is known as the nitrification process). It is vital that every aquaponics unit has a biological filtration component to house the bacteria, allowing them to constantly convert the ammonia into nitrate.

Aquaponics units come in all shapes and sizes from small devices sitting on kitchen benches using goldfish and growing herbs, to larger systems growing silver perch or tilapia with tomatoes, zucchini, lettuce, etc. and even more complex units producing tonnes of fish and thousands of plants per month ideal for commercial scale production.

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INDIAN OCEAN COMMISSION

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Funded by *European Union*

PROGRAMME FOR THE IMPLEMENTATION OF A REGIONAL FISHERIES STRATEGY FOR THE EASTERN AND SOUTHERN AFRICA - INDIAN OCEAN REGION

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Aquaponics is suitable for a number of fish such as tilapia, Carp, Barramundi, Bass, Jade Perch, Golden Perch, Silver Perch and a huge range of plants such as tomatoes, cucumbers, lettuce and green leafy vegetables, high priced herbs and others. Tilapia is most commonly used due to the fact that they grow fast relative to other farmed fish (i.e. salmon, trout) and can tolerate poor water quality.

TYPES OF AQUAPONIC SYSTEMS

There are 3 main types of Aquaponics systems

1. Deep Water Culture (DWC) systems – This method involves suspending plants in polystyrene sheets that float in canals with air supplied from the bottom of the trough at roughly every square meter. This method is the most common for large commercial aquaponics growing one specific crop (stereotypically lettuce, salad leaves or basil)

2. Media-Filled Bed systems (Flood and Drain Systems) – Media-filled Grow Bed units are the most popular design for small-scale aquaponics as they are efficient with space, relatively low cost and suitable for beginners as they are a very simple design. In grow bed units, the media used to support the roots of the plants also functions as the means of filtration. This double-function is the main reason why grow bed units are the simplest.

3. Nutrient Film Technique (NFT) – The Nutrient Film Technique (NFT) employs the use of plastic pipes laid out horizontally to grow vegetables. Water is pumped from the biofilter into each hydroponic pipe with a small equal flow creating a shallow stream of nutrient-rich aquaponic water flowing along the bottom. The pipe contains a number of holes along the top of the pipe where plants are placed into to grow.

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SMARTFISH & AQUAPONICS

An initial study on aquaponics for the SmartFish programme was completed by JDR Resources Ltd. of Nova Scotia, Canada. The report which was entitled "The Feasibility of Aquaponics in Mauritius" highlighted the potential for the country to set up aquaponics systems on the island. The report also gave an insight to the variety of products that could be produced and their eventual markets, costs involved and finally suggesting that a way forward for aquaponics in the region would be to set up a pilot operation in the region (Eastern and Southern Africa and Indian Ocean (ESA-IO)).

Following this initiative a pilot project was initiated by SmartFish, titled "Support to rural community in the semiarid area of the Amhara Region in Ethiopia, which aimed at the promotion of micro-aquaponics systems for alternative income generation".

An agreement between SmartFish and the Department of Zoological Sciences of the Addis Ababa University (AAU) initiated the activity in January 2013. Various partnerships through the AAU in Ethiopia (including with Debrehanum University Campus in Shewa Robit and the Fisheries Research and Extension Institute of Ziway) had already undertaken some preliminary studies on the applicability of aquaponics in the country and these benefitted greatly from the technical backstopping provided by SmartFish through the recruitment of two international aquaponics experts.

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This area of Ethiopia was an appropriate pilot for the recirculation properties of aquaponics systems, due to water scarcity and a lack of local agricultural produce; food and nutrition insecurity is also very high in this area. The project, which was aimed at selected local fishers, was setup to promote micro-aquaponic systems as an alternative income generating activity for these fishers, with the objective of increasing food production in the area.

Project achievements so far include:

- Two aquaponics demonstration units have been established (Debrehanum University Campus in Shewa Robit and Ziway Fisheries Research and Extension Centre);
- Two training workshops on the management of small-scale aquaponic units were conducted in April 2013, when 50 aquaculture stakeholders were trained in the two different locations;
- A regional workshop on "Aquaponics as an innovative business in Africa" was held in Addis Ababa in December 2013, where a total of 25 potential investors /entrepreneurs attended the two day course.
- An "Aquaponics Open Day" was held at Addis Ababa University campus in December 2013, which showcased the demonstration unit installed within the AAU premises. This allowed for over 100 students, institutions and others to attend and get a glimpse of the potential that aquaponics had for the country.
- A manual on small-scale aquaponics is being prepared as an FAO Fisheries Technical Paper.

The pilot demonstration projects are using tilapia fish and are growing various vegetables such as tomatoes, peppers, lettuce, mint, basil, eggplants and cauliflower.

NEXT STEPS

SmartFish has recognized the potential for this semi-technical, but relatively simple production system. During the training in Addis Ababa for commercial systems, the investors immediately saw that it was within their reach and were keen to get a basic system started so that they could enter this exciting new opportunity that has not been developed in the region. As a result, SmartFish is planning to establish pilot projects for commercial scale aquaponics during its next Phase which commences in April 2014. These commercial systems will give SmartFish the possibility to further assess the commercial viability of the systems in the region, but more importantly to further communicate the potential and its benefits throughout the region. A typical small-scale commercial unit would look like the adjacent picture.

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