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Aquaponics - climate smart solutions to enhance food security in Namibia

Simon Goddek, Karel Keesman

Namibian agriculture facing climate change

Namibia is facing the worst drought in decades. In normal years about 2% of the country's surface receives sufficient rainfall to grow crops. With the severe drought entering its fourth year, much of the agriculture in Namibia has declined. The drought forced the government to take drastic measures such as denouncing a state of emergency and 30% water cuts. The water shortage cripples Namibia's economy, raises unemployment rates and makes the country highly dependent on food imports. Namibia is looking for opportunities to increase national food production fitting its harsh climatic conditions. Innovative measures would cut costs resulting from food imports as well as strengthen national food security, and generate employment.

Aquaponics - an opportunity for Namibia?

Aquaponics is an integrated aqua-agriculture system comprising a recirculating aquaculture system (fish) and hydroponics (soilless plant production), wherein the water flowing out of the fish tanks, enriched with nutrients, is used for plant growth and next returned to the fish tanks (Fig.1).

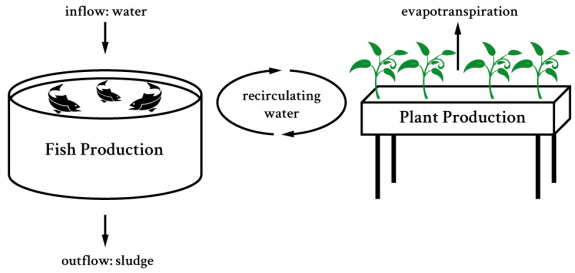

Figure 1. The one-loop aquaponic system

The appeal of aquaponics lays in the fact that it needs >90% less water than conventional agriculture. In an aquaponic system, fresh nutrients are continually brought to the plants roots in a very accessible form. Consequently, there is less need for the plant to expend valuable energy to 'mine' nutrients. Also, there is less root 'competition'. Hence, plants grow faster and often only need half the space of soil-based grown crops. Furthermore, one-loop aquaponics is energy efficient, requiring only energy input for a water pump.

However, the productivity of these conventional aquaponic systems, currently being applied in many countries such as Namibia, is far from optimal. Irrespective of varying water quality requirements in both components, the traditional aquaponics practice is based on finding a balance between the needs of plants and fish within a single water process loop. Thus, the trade-off in conditions in one-loop aquaponic systems prevent optimal growth environments for both fish and plants.

Improved opportunity: multi-loop aquaponics

Researchers at Wageningen University & Research (WUR), have developed a system that was able to overcome the disadvantages of a one-loop system. The novel multi-loop aquaponic system showed promising experimental results such as:

- Lower water requirements, saving >95% compared to conventional agriculture;
- Increased plant growth of up to 40% compared to state-of-the-art hydroponic systems;
- Lower fertilizer requirements;
- Lower disease rates compared to hydroponic systems;
- Saving costs, as pesticides, antibiotics, or hormones are not required;
- Desalination technologies could be applied to feed the system with fresh water, as well as increasing the nutrient concentration in the plant compartment, while decreasing it in the fish compartment;
- Application of solar power makes the system energy efficient, and independent of fossil fuels.

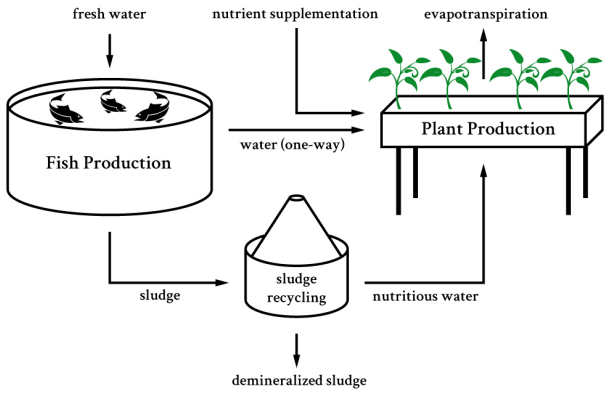

Figure 2. Contrary to a one-loop aquaponic system, a multi-loop aquaponic system aims at providing optimal conditions for both fish and plants, while remineralizing the sludge.

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Advantages of multi-loop aquaponics for Namibia

- This technology can ensure highly efficient fish and plant/fruit production, allowing precision farming with the resource-efficient application of both water and fertilizer;
- Multi-loop aquaponic systems provide higher crop yields compared to conventional hydroponic installations;
- Increasing local food production enhances the resilience to economic as well as food crises;
- As the multi-loop aquaponic system is suitable for more sensitive fish species such as trout, food diversity will grow;
- The system creates highly skilled job opportunities for both trained and educated staff within the system, as well as jobs with trade-companies selling the production;
- The initial cost of an aquaponic system are marginally higher than the sum of an aquaculture and a hydroponic system, while return benefits are continuously higher;
- By using solar power and desalinization systems, no continuous fossil fuel inputs (expensive & unreliable) are required;
- Anaerobic nutrient remineralization technology closes the cycle of the system to a high degree, while producing methane (useable for electricity & heat generation);
- The natural microbial process acts as a biofilter reducing diseases in both plant and fish production;
- If one subsystem fails, the other can still keep on going, which creates a more resilient economic system.

Multiple-loop aquaponics systems can consequently provide a solution for the Namibian drought crises, by producing fresh locally produced food, using a highly efficient system, and requiring a minimum of water, energy, and fertilizer. Because of the independence of scarce natural resources, the system requires no specific location. It would not only release the country from the expensive food imports, but also contribute to the economy by creating job opportunities.

The way ahead

The Namibian government is currently conducting its re-greening policy and is also confronted with a need for policies to confront the challenges on food security, water shortage, and rising unemployment figures. The multi-loop aquaponic system can contribute significantly to these challenges. Multi-loop aquaponics is a water-efficient production system and makes it possible to grow food in the most arid areas of the world using novel desalination technologies and solar power.

A 500-1000 m² system serves as a first pilot and as a showcase, developed together with Namibian stakeholders from government, research, and private sector. The pilot system is used for fine-tuning the system to the local circumstances, both physically and socio-economically. By including the stakeholders, conditions are created for scaling as soon as the system has shown its merits in Namibia.

Nearly 100 years of research experience

The Netherlands are the second biggest food exporter worldwide, while being the 131st country in surface area. This requires a highly efficient system, that incorporates new scientific insights continuously. A system in which research institutes collaborate closely with industry (incl. farmers), government and civic society enables a Dutch agricultural export of 90 billion euros. The Dutch horticulture is renowned for its high efficiencies with respect to water and energy, as well as ecological disease control. Dutch greenhouse technology is being applied worldwide.

Wageningen University & Research (WUR) represents nearly 100 years of research and innovation in agriculture. Combined with education and capacity building, impact is created in the fields of agriculture, food and living environment; working on the quality of life. WUR conducts thousands of innovative projects worldwide with over 2000 partners.

Wageningen University & Research
P.O. Box 17, 6700 AB Wageningen
Contact: Simon.Goddek@wur.nl
M +31 (0)6 11 22 82 51