#5

FACT SHEET ON:

Building & Maintaining Aquaponics & Hydroponics Systems

The purpose of this fact sheet is to share information on building and maintaining hydroponic and aquaponic systems. This includes materials, economics and yield potential.

Introduction

Namibia has been facing challenges of climate change throughout the past several years. Droughts and floods have had a harsh effect on the agriculture output in the country.

These extreme weather conditions have caused crop cultivation to fail and left poor grazing conditions for cattle. In 2019, it was reported that Namibia had its driest year in 90 years. If these poor weather conditions continue to persist, the food security* in the country will continue to worsen. It is important to take steps towards Climate-smart Agriculture (CSA) to improve food security (Namibia's devastating drought: Our strategy so far, 2019).

When used alongside other agriculture methods, hydroponics and aquaponics can greatly improve food security. These methods provide sustainable ways to produce crops, fish, and livestock fodder. Hydroponics and aquaponics do have some differences, but implementing either or both systems can provide many benefits.

Materials

Here is a general list of items needed when beginning to build your hydroponic or aquaponic system. The container for fish is not required in a hydroponic system. Most of these items can be purchased at hardware stores.

Water Pump:
This is to move water throughout the system.

Aerator:
This provides oxygen to fish and plants.

Large Container for Fish (Aquaponics):
A common tank or any large plastic tub or bucket.

Grow Bed:
This holds the growing material and crops. Any large bin can be used. PVC pipe can also be implemented by drilling holes for growing pots.

Growing Pots:
Small pots will hold each individual plant. Small pots can be purchased or the tops of plastic water bottles can be used.

Grow Material or Media:
This material surrounds the growing pots and allows a surface for bacteria to grow on. These can be clay pebbles, river rock or lava rock.

PVC Pipe:
A 7.5 cm pipe is usually sufficient to move water through a system.

Water Testing Kit:
This is to test levels of pH, ammonia, nitrite, and nitrate in your system to ensure the plants and fish have a suitable environment.

Support System (frame):
Wood, metal or concrete can be used. Wood and metal will deteriorate and rust over time and require more maintenance.

Cover:
This is to protect crops from insects and animals. A thin covering that allows light through is best (Brooke, n.d.).

*For underlined terms, please refer to the Glossary at the end.

Logistics

When starting your own hydroponics or aquaponics system, there are some important logistics you should consider. First, you want to choose an area that has stable and level ground to avoid the legs of the system frame from sinking into the ground, which causes disrupted water flow, flooding or collapse. You must also consider weather conditions and animals in the area. Heavy winds, strong sunlight, insects, birds or small mammals, can damage the plants. A 30-40% direct sunlight protection shade netting can be used to enclose and protect the entire system. The use of a greenhouse and a donkey for heat should also be considered to maintain the temperature of your water during cold months (Somerville, C. *et al.*, 2014).

For the layout of the design, you want to make sure the floating rafts with the plants are easily accessible, so a one meter width is preferred. It is also best to design the system so there is room to walk around on all sides, allowing for easy harvesting and maintenance. Finally, you should consider how you will power your system. The pumps require a large amount of electricity, so sustainable methods such as solar panels can be used in areas where electricity is not available or may be too expensive.

Economics

To determine if hydroponic and aquaponic systems are good options for investment, one must consider initial investment costs, market competitiveness, environmental impact, water quality, system complexity and maintenance costs.

The best hydroponic system to invest in commercially would be a Nutrient Film Technique system. Compared to a Deep Water Culture System it allows for better water conservation, is easier to maintain and has fewer maintenance issues (Danner *et al.*, 2019). For more information on individual systems see Feectsheet #1. Hydroponics could be used for producing a personal supply of fodder for livestock because it allows for continuous fresh green fodder throughout all four seasons, enabling livestock food security. Market prices of fodder can be an economic challenge, which a hydroponic system could greatly reduce (Brown, 2019). Aquaponics is a good investment as it is able to produce 4kg of leafy greens for every 1kg of fish farmed (Danner *et al.*, 2019).

When this goes to market, it is common to have a net loss in profit of fish production and a net gain in crop production (Engle, 2017). Overall, this does make the average system profitable. As with many business ventures, it takes an initial investment in a system to obtain a profit over time. In a commercial system model in Hawaii, it was found that the return on investment was 7.36% (Tokunaga *et al.*, 2015). Therefore, aquaponics is a viable investment.

Figure 1: Hydroponic and Aquaponic Economics Trends
(Aquaponics market - growth, trends, and forecast, n.d.; Hydroponics market - growth, trends and forecasts, n.d.)

Agriculture Industry

In Namibia, agriculture accounts for 31% of the labour force. Subsistence farming is also commonly practiced, since 34% of Namibians are unemployed and 55% of them live in rural areas (Central Intelligence Agency, 2020). Climate change continues to affect employment in this leading industry. The drought has greatly impacted agriculture in Namibia, with food insecurity worsening in early 2020. This was caused by the low 2019 harvest that severely affected subsistence farming (Food and Agriculture Organization of the United Nations, 2020). Drought has long been affecting Namibian agriculture, however. In 2013, drought killed 4 000 animals and affected 300 000 people (UNICEF, 2019). To avoid the continuing effects of climate change on the agriculture industry, new alternative practices are needed.

Yield

Hydroponics and aquaponics both have a higher crop yield than traditional agriculture. In these systems, plants grow much faster and produce more crops in a smaller amount of space. Typically once built, a hydroponics system will only take 6 weeks to be fully functioning and ready for harvest. In aquaponics, it typically takes up to 6 weeks before you can start growing crops due to the cycling process. It can then take up to a year to reach full capacity as the microbial populations are still developing (Storey, 2017). Once your system is at full capacity, crops can be harvested every three to four weeks.

Hydroponics vs. Aquaponics

Nutrient Source:

- **Hydroponics:** Nutrients for plants come from fertilizers put into the water.
- **Aquaponics:** Nutrients for plants come from fish waste that is broken down through bacteria.

Time to Harvest:

- **Hydroponics:** Plants grown hydroponically can be harvested as soon as 6 weeks after planting (Storey, 2017).

- **Aquaponics:** It may take up to 12 months from initial planting to see a system produce full yield so bacteria colonies can mature.

Crops Produced:

- **Hydroponics:** Ideal for growing leafy greens, salads or livestock feed like barley or oats.

- **Aquaponics:** Grows herbs and vegetables well and also produces fish for consumption.

System Cycling:

- **Hydroponics:** System requires no water cycling prior to planting as the chemical nutrients can be directly absorbed by the plants.
- **Aquaponics:** System must be cycled with fish waste water for 6 weeks prior to planting to allow bacteria colonies to grow.

Key Guidelines

- Monitor your system's temperature, dissolved nutrient levels, water levels, and pump functionality every day.
- Provide proper aeration and water circulation with pumps.
- Choose fish and plants based on the climate.
- Avoid overcrowding and overfeeding your fish.
- Keep the tank clean by removing solid waste for aquaponics and periodically renew your water in hydroponics to avoid the buildup of toxins.
- Restock the fish and replant at staggered times to help maintain the balance of plants, fish and size of biofilter in your system.
- Avoid harmful pathogens or animals in your system.

Future Opportunities

While aquaponics and hydroponics systems can work to address food insecurity and droughts, there are many other steps currently being taken to further address these nationwide challenges. Namibia's Vision 2030 is a long term plan which aims to address education, health care, a clean and productive environment, a profitable economy, rewarding employment, low crime rates, a just society and meaningful government (Government of the Republic of Namibia, 2004). The Ministry of Agriculture, Water and Land Reform in Namibia also has established a clear mandate to "promote, manage and utilise agriculture, water and land resources" (Government of Namibia, n.d.). Within Namibia's government, hydroponic and aquaponic systems have the opportunity to support these goals. On a global stage, the United Nations has created a set of Sustainable Development Goals such as zero hunger, sustainable communities, and good health that can support new practices in Namibia (United Nations, n.d.). These goals validate a sustainable change in industry and daily life to promote food security, economic stability and well being.

*For underlined terms, please refer to the Glossary at the end.

Conclusion

Due to their differences, implementing both an aquaponic and hydroponic system can be beneficial. Although aquaponic systems are more complex, the capability to provide fish as well as vegetables and herbs is beneficial for supplementing the human diet because it produces protein, vegetables and starches. Hydroponics is a simpler option that requires less maintenance and can operate on a faster harvesting schedule than aquaponics. This type of system is an ideal option for supplementing the diets of livestock. By using both systems, there is great potential to supplement security of food and livestock fodder. It is important to start taking action and use more climate resilient and sustainable methods of agriculture.

Glossary

Aquaponics – a system where fish and plants are grown together. Fish waste in the water produces nutrients for the plants and the plants use the nutrients and provide clean, filtered water for the fish (Bernstein, 2011).

Cycling – a process of establishing a biofilter for the nitrogen cycle to take place in the system (Bernstein, 2011).

Donkey – a donkey is a homemade, firewood-fueled water heater.

Fodder – this is livestock feed or food grown in hydroponics (Merriam-Webster Dictionary, 2020).

Food Security – having reliable access to a sufficient and healthy quantity of food (Government of the Republic of Namibia, 2004).

Hydroponics – this is a method of growing plants without any soil. The plants are placed in grow beds and use only water and chemical nutrients (Bernstein, 2011).

Mandate – an official command from a higher government law (Merriam-Webster Dictionary, 2020).

References & Resources

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