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TH!NK NAMIBIA
Aquaponics

FACT SHEET ON:

Producing Fish with Aquaponics

The purpose of this fact sheet is to provide information about the significance of fish in an aquaponics system. The system is designed with principles of biomimicry,* where the fish play a crucial role. Information included herein cover suitable species of fish, their breeding requirements, optimal water temperature and the benefits of fish production.

Introduction

There are several species of Tilapia fish that have a long history of cultivation through aquaculture across the African continent and other parts of the world. Threespot (*Oreochromis andersonii*), Redbreast (*Coptodon rendalli*) and Mozambique Tilapia (*Oreachromis mossambicus*) species, native to southern Africa, prove appropriate and best suited for aquaponics in Namibia (Tweddle & Marshall, 2007). Over many years of cultivation and propagation, Tilapia fish species have demonstrated to be quite tolerant and adaptable to varying methods of breeding and farming (Swilling, 2015; Genello, 2015).

***Figure 1: Threespot Tilapia* (Oreochromis andersonii)**
(Sources: Swilling, 2015; Medical News Today, 2020)

"In a world of plenty, no one, not a single person, should go hungry."
– UN Secretary General
Ban Ki-Moon (2015) -

Farming with Tilapia

The size of the fish tank will depend on the space available and the scale of the preferred aquaponics system. Typically, the sizes of the tanks may vary from 200 litre capacity to over 1 000 litre tanks. A tank divided into two or three components is recommended for this system. One could have one large tank that is divided into three separate sections. One large tank is ideal, because multiple tanks result in multiple connections and technicalities. Alternatively, two tanks with one split in varying sizes may be used. The rationale for the division of the tank is to create separation between the breeding (fry), juvenile (fingerlings) and adult fish (broodstock). This will prevent the fry and fingerlings from being eaten by the broodstock. This also ensures proper management of the breeding and control of the system. Once the fish are settled in the tank, it requires moderate to little cleaning. The fish require a fair amount of algae in the tank to survive and raise their young. Lastly, positioning the fish tank at the bottom leverages gravity and allows for easy back flow of water from the plants' grow bed (Swilling, 2015; Towers, 2017).

Figure 2: Threespot Tilapia Fry
(Source: Towers, 2017)

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

Temperature

Temperature plays a crucial role in the successful breeding of the fish in the system and must be monitored daily. Tilapia require an optimal temperature of about 29 to 31 ˚C for reproduction and growth. They stop feeding when water temperature falls below 17 ˚ C. During cooler temperatures, the fish require less food and the production of waste and their breeding activity drops. To maintain production levels consistently, the water must be heated. Therefore, the system comes with a build-in heating element. This is especially important during the winter months in Namibia, as temperatures can drop to freezing points (Swilling, 2015; Genello, 2015; Towers, 2017).

Figure 3: A Fish Tank for Aquaponics
(Source: Igadi, 2020)

pH (power or potential of Hydrogen)

The pH is the amount of acid (acidity) or salt (alkalinity) present in the water, as a result of Hydrogen ions. This ranges from 0 - 14 on a pH scale. Tilapia can typically handle a wide range of pH levels but the balance of the pH must be kept between 6.5 – 9 pH level. This level allows for algae growth, which the fish require as an alternative feeding source, and to raise their fry in (Genello, 2015; Towers, 2017; Go Green Aquaponics, 2019). Water pH is tested with a pH meter, which can be bought from local aquatic accessories stores.

Figure 4: A Water pH Meter
(Source: Amazon.com, 2020)

Dissolved Oxygen (DO)

The Dissolved Oxygen (DO) levels are crucial to monitor in an aquaponics system. If not monitored properly, low or high levels may result in the mass dying of fish. The recommended optimal DO levels to maintain at all times must be around 4 mg/l with the lowest, acceptable level being 2 mg/l. Tilapia may still cope at the later level but this may place stress on the fish. The water temperature and levels of DO affect each other. The water needs to be aerated more at night than during the day, as the algae produce oxygen in the day and carbon dioxide at night. The fish also require additional oxygen to digest their food at night (Swilling, 2015; Towers, 2017). When buying water quality testing instruments, it is recommended to buy a complete unit that measures multiple variables at once, such as the temperature, pH and DO.

Breeding Station

Fry and fingerlings can be bought from the Ministry of Fisheries' Aquaculture Department. The Ministry has five hatcheries in: Katima Mulilo, Outapi, Ongwediva, Divundu and Mariental. Local experts, like Manfred Grabow and others, suggest a breeding rule of one male to four females. Tilapia are mouthbreeders. Once the eggs are all fertilized, the female will collect the eggs in her mouth and brood the eggs until they hatch. The fry will still be swimming in and out of the female's mouth as she nurtures them and lets them out when they are big enough to be independent (Kibria *et al.*, 2013; Swilling, 2015; Towers, 2017).

Figure 5: Threespot Tilapia
(Source: Swilling, 2015)

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

Separation of Fish

Aquaponics does require a strong technical aspect. One such technical aspect is the separation of the fish according to their growth stages. Not only is this an efficient management technique, but it also serves to ensure that the bigger fish do not eat the small fish because Tilapia are omnivorous and will feed on their young. This is where the system requires properly demarcated stations; for fry, fingerlings and broodstock. The fry will be removed when they have grown into fingerlings and placed into the juveniles' station to grow out further. Once they are fully grown, they can then be placed into the adult tank. The separation of the adult fish is also important to avoid crowding and overpopulation (Kibria *et al*., 2013; Genello, 2015; Swilling, 2015).

Fish Feed

Based on aquaculture research and literature, feeding of fish and fry must be done manually at a frequency of five times daily. In their early growth stage, the fry are fed powder feed with a crude protein content of 38%. The second stage of fish, the fingerlings, are fed pellets of 2 mm diameter and that also contains crude protein of about 38%. Lastly, the broodstock may be fed 4 mm pellets with 30% crude protein (Kibria *et al*., 2013). Fish feed can be bought from aquatic centres and other speciallised outlets in the country.

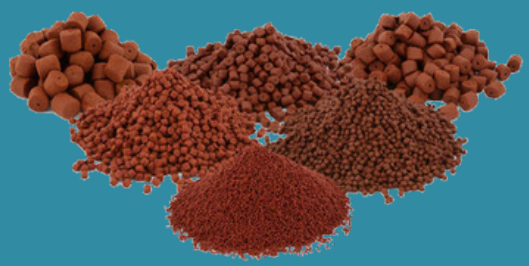

Figure 6: Pellet Fish Feed
(Source: Afrimash.com, 2020)

Tilapia Conservation

A major advantage of farming tilapia (specifically with Threespot Tilapia) is that the species is native to Southern Africa. This contributes to biological and ecological endemism. With this species of Tilapia listed as Threatened by the IUCN Red List, farming with them contributes to the greater conservation efforts of preserving the species (Tweddle & Marshall, 2007).

Harvesting Tilapia

Once the broodstock fish have matured and weigh 70g or more, they are ready for harvesting. A general rule for proper aquaculture practice and balance of the aquaponics system is that, no fish weighing less than 70g may be harvested from the system. Experts and aquaculture best practice suggest that before every harvest, it is necessary to move the fish into smaller holding ponds with clean water, and to refrain from feeding them for several days to ensure that the digestive systems of the fish are clear. This prevents any 'muddiness' in the flavour, according to Manfred Grabow. The fish may then be slaughtered and preserved using ice, with a method known as the "ice slurry". It is important to remain considerate of the ethics in any farming practice of live animals. Thus, the ice slurry method is generally accepted (Kibria *et al*., 2013; Swilling, 2015; Genello, 2015; Towers, 2017; Travis, 2018; Go Green Aquaponics, 2019).

Advantages of Tilapia

Tilapia are a common species of fish in aquaculture and aquaponics for a number of benefits that they provide:

- This fish species is a culturally preferred choice because they are a palatable and a mild-tasting culinary choice of fish.
- As a food security and smart-agriculture practice, the Tilapia fish provide an alternative food source together with the vegetables grown.
- From a farming perspective, Tilapia have a high tolerance and are resilient to surviving in poor water conditions, and they reproduce fast.
- Lastly, the fish in these aquaponics systems are free of pollutants and chemicals, providing an organic and healthy, lean source of protein for people (Kibria *et al*., 2013; Genello, 2015; Swilling, 2015; Towers, 2017).

Disadvantages of Tilapia

- Fish must be fed five times a day.
- Requires constantly warm water temperatures, especially during winter times.
- Fast reproduction may lead to overcrowding depending on the system size.
- Water temperatures for Tilapia must be kept above 17 ˚C at all times (Go Green Aquaponics, 2019).

Glossary

Algae – micro green plant growth present in water and in the fish tank (Swilling, 2015).
Aquaculture – refers to the raising of fish in tanks (Bernstein, 2011).
Biomimicry – a method and practice of replicating any natural process, system, or concept innovatively in that it mimics nature (The Biomimicry Institute, 2020).
Broodstock – the third and final stage of the fish growth, where they are adult fish (Swilling, 2015).
Dissolved Oxygen (DO) – this is the total amount of dissolved oxygen present in the water for fish (Swilling, 2015).
Endemism – a species widely distributed in a particular geographic area (Science Direct, 2020).
Fingerlings – are fish grown into juvenile stage and have grown to be about a finger in length (Swilling, 2015).
Fry – these are small, newly hatched small fish that are brooded in the mouth of the adult fish (Swilling, 2015).
Heating element – an external heating device specifically designed and placed into the water to keep the water temperature higher as preferred by the fish, especially during winter months (EcoSmart, 2020).
Ice slurry - a method of slaughtering fish quickly and humanely. While it is important to remain considerate of the ethics in any livestock farming practice, the ice slurry method, while still being debated as ethically sounds, is generally accepted. (Go Green Aquaponics, 2020).
Mouthbreeders – this is a method of incubating and brooding eggs until the fry hatch and stay a little longer until they are grown big enough in size to be independent (Swilling, 2015).
pH – refers to the levels of acid or salt content in the water (Swilling, 2015).
Tilapia – this is a commonly known carp fish with three species, native to Southern Africa (Swilling, 2015).
Temperature – this is how COLD or HOT the water is.
Threatened – means a plant or animal species is reduced in number and is in danger of going extinct (Safeopedia, 2020).
2 mg/l – 4 mg/l – this is the milligram per litre measure of the level of DO present in the water for the fish from the lowest to the optimal level they require their oxygen to be at (Swilling, 2015).

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