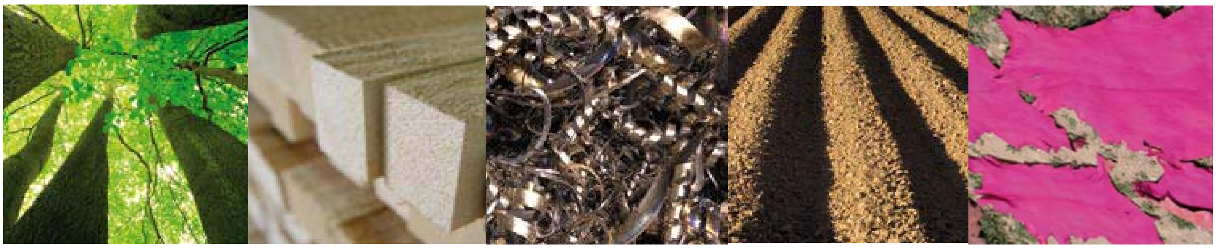

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Start-up of pilot production – report on design and choices of species D4.2

Ecoponics

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Project coordinator: Dr. Ragnheidur Thorarinsdottir

WP4-leader: Dr. Ragnheidur Thorarinsdottir

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Start-up of pilot production

The objective of WP4 is to design a large scale aquaponics production system utilizing the abundant geothermal and water resources in Iceland and establish the first pilot production unit. The first pilot units built in Iceland are based on simple setups to learn about the nutrient balances, mass balances and energy use, and how to maintain a healthy and well-functioning aquaponics system.

There are three main aquaponics techniques for growing plants; grow-beds, floating rafts and nutrient film technique (NFT). The grow-beds are media-based systems while the plant roots grow directly into the water in the NFT (in thin layer of water) and raft systems (floating plates in large water tanks). Further description of each type is shown in Figure 1 and Table 1.

Figure 1. From left: Grow beds, nutrient film and floating raft aquaponics.

Table 1. Hydroponics systems; Grow bed, Nutrient Film Technique (NFT) and Raft.

Grow bed The grow bed technology is probably the simplest and most used technique for small scale systems. The grow bed is a media-filled bed system, filled with e.g. gravel or pumice. This can serve as the filtration system for the waste products. Nitrification bacteria becomes a vital part of the grow bed and moreover, worms can be added to enhance the break-down of organic materials. The grow bed is periodically flooded with water from the aquaculture and drained back again to the fish. The grow bed is excellent for larger plants such as tomatoes, cucumbers as well as strawberries and can also fit for smaller plants.
Nutrient Film Technology (NFT) The NFT system is based on growing plants in long narrow channels with a thin film of water flowing through from and to the fish tanks. The NFT system needs good mechanical filtering systems, as accumulation of solids at the roots needs to be avoided. NFT systems are suitable for large scale systems as they are easy to handle and clean. They are also popular as small hobby systems and show cases.
Raft The raft system also known as deep-water culture (DWC) can also suit for large scale. It provides a well-balanced environment but may be more difficult to maintain and clean in industrial scale. The plants are started in media cubes, which are fixed into a floating board. The rafts are pushed forward and the plants are usually harvested at the other end. This provides a space-efficient and productive system. However, the water volume may be of concern in larger scale greenhouse systems.

The system setup for the hydroponic part for different producers depends on the choices of species and the size of the system. NFT and Raft systems are convenient for smaller plants as salad, greens and herbs while the grow-bed suits well for larger plants such as tomatoes, cucumbers and peppers, especially in smaller systems. For large industrial production units the NFT provides certain advantages with a compact system easy to clean and handle. However, the buffer capacity is lower in these systems and it is more difficult to handle without good automatisation. The first pilot unit built by Svinna was based on a hybrid system with 50% grow-bed and 50% raft and the next systems being built are raft for leafy greens and grow bed for fruity plants.

Design

The first aquaponics hybrid system built included a 600 L fish tank, a 1.2 m^2 grow bed filled with hekla pumice and a 1.2 m^2 raft. The grow bed and the rafts are 35 cm deep. The water exchange rate is approximately 20 minutes with continuous flow through the raft and with an ebb and flow system in the grow bed.

Based on the experience from the first tests it was concluded to build the next systems for leafy greens on raft systems. A sediment filtration unit and a biofilter unit were added to the system. Two different designs have been made:

Design 1: The fish tank is 600 L and the raft system is 2.4 m^2. The water is pumped from the fish tank to the 100 L sediment tank and then runs with gravity through the 100 L biofilter filled with biofilter media and through the raft system to the fish tank again. The water exchange rate is appr. 30 minutes.

Design 2: The fish tank is 1000 L and the raft is 6.0 m^2. As the raft in this case is at a lower level a 500 L sump tank is included in the system. The water is pumped from the sump tank to the fish tank and runs through gravity through the 100 L sediment tank, the 200 L biofilter and the raft system and being turned into the sump tank again. The water exchange rate is appr. 30 minutes.

Furthermore a grow bed has been designed for fruity plants. The grow bed is built on an ebb and flow system. The water is pumped from a 500 L sump tank to the 1000 L fish tank and runs through gravity through a 200 L sediment tank and to the 2.4 m^2 grow bed and being returned to the sump tank again.

Choices of fish species

The tests so far have been running with Nile tilapia, (Oreochromis niloticus) imported from Fishgen in UK, as the fish species. Tilapia is a tolerant warm water fish and is the most popular fish in aquaponics systems. It is easy to breed, grows fast, tolerates a wide range of environmental conditions and has a nice white flesh of good quality. Heating the water with geothermal heat serves as an advantage for farming warm water species in Iceland. Thus, tilapia has been the chosen fish species for the system.

Choices of plant species

The plant species that have been chosen are leafy greens for the raft system and fruity plants for the grow bed. The leafy green includes salad, basil, mint, rucula, coriander and dill and the fruity plants include tomatoes, peppers, aubergine and strawberries. The first tests have shown good results on basil and mint.

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