Hydroponic-Aquaponic Food Production System for the Mars Desert Research Station

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54 growth sites in raft in aquaponic mode (with fish) - 190 L of nutrient rich wastewater for soil crop irrigation every 2 - 3 days

18 additional growth sites in tanks if used as hydroponic system (no fish)

ideal continuous range of 21 - 24 °C via submerged ceramic heaters
What Are Aquaponics and Hydroponics?

Aquaponics

- Combination of recirculating aquaculture and hydroponic growing method.
- Nutrient-rich water from raising fish provides nutrients for plants.
- Nitrifying aerobic bacteria convert $NH_4^+$ to $NO_3^-$

Hydroponics

- Growing plants rooted in a nutrient solution.
- Plants are provided with tailored growth conditions with synthetic nutrient solution
Benefits of an Aquaponics/Hydroponics System

- **Fish Tank:** 16 to 20 fish per tank
  - Harvest in 30 weeks from fry stage to filet size

- **Leafy Vegetable:**
  - Harvest between 45 to 55 days (lettuce, kale)

- **Nutrient Rich Wastewater**
  - Irrigate soil-based crop (tubers, trees)
Hybrid Aquaponics System at ERAU
Hybrid System for the Mars Desert Research Station

Design Criteria:
- Design a system that was capable of aquaponics (fish) or hydroponics (no fish) while using as many recycled parts as possible.
- System must fit within an 8 ft by 8 ft square
  - Ease of assembly and disassembly
  - Minimize energy use
- Materials used are nonflammable.
Reducing Energy Sources

- The system is suitable for natural sunlight or supplementation by LED plant lights.
- Use one pump to provide aeration and recirculation of water.
- Use ceramic water heaters.
Frames: Iron and Aluminum

System parts: Recycled from an existing system.

Piping: Recycled PVC

Air pump donated by tag!

The St. Augustine Children’s Museum
Embry-Riddle goes to the Mars Desert Research Station in Hanksville, Utah
Expected Results

- Conduct research on sustainable food production.

- Crews will become familiar with maintaining and harvesting the system.

- Future expansion of system.
Nutrient-Film Technique
Questions?
Thank you!
One aerated tank of floating rafts has 54 growth sites; two 190 L aerated tanks support fish or plants. A settling tank removes solid fish waste, and two aeration sumps support airlifts for water circulation.

Submerged ceramic water heaters provide short-term survival for fish and plant under minimum water temperature conditions (13 °C), with an ideal continuous range of 21 - 24 °C.

In October 2015, the system was designed and fabricated from recycled parts of an existing system, disassembled, shipped, and re-assembled, with supplies for pH testing and initial water conditioning. Utilities were unavailable for system leak test and startup.

The fish capacity (blue tilapia, *Oreochromis aureus*) is 16-20 fish per tank, with growth from fry stage to 0.7 kg harvest size in 30 weeks from stocking.

Leafy vegetable harvest time from seed should range from 45 to 55 days for lettuce and kale. The system will provide approximately 190 L of nutrient rich wastewater with settling tank drainage every 48 hours, for use in irrigation of other plants in the greenhouse. If operated as a purely hydroponic system without fish culture, the fish tanks will provide 18 additional growth sites.

Expansion of the system growing capacity with a vertical nutrient-film technique growing rack may be achieved by airlift from the sump tanks.