The Potential of Aquaponics in Space

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Abstract/Introduction: With advancements in space technology, and the increasing drive to get humans into space and on the planetary bodies that inhabit it, come a lot of questions. One of those questions being: How can we sustainably create and supply food in space? Aquaponics may be a potential solution to this problem for its self-sustaining properties as well as its ease of use. Consisting of only a few steps, aquaponics includes having vegetable plants that are fertilized by fish waste, which in turn, clean out the water that the fish reside in. This process eliminates the need for soil, making it a compatible solution for space stations and places like Mars with no readily available soil (Dunbar, 2009). This research project focuses on the potential pros and cons of applying aquaponics systems during space missions as a means of self-sustainment during prolonged missions.

Objective: This project discusses how aquaponics can be beneficial to long term space travel as well as the shortcomings and potential problems involved in aquaponics within a space environment. This will be done through research of the topics involved which, will then be used to come to a conclusion on how aquaponics may be applied or fixed in certain areas. Two potential aquaponics environments will be assessed: Mars, and a space station scenario. Within these two environments, aquaponics will be discussed in a pros and cons format which will consist of topics such as: scale, effectiveness, overall usage, and survivability.

Fig. 1

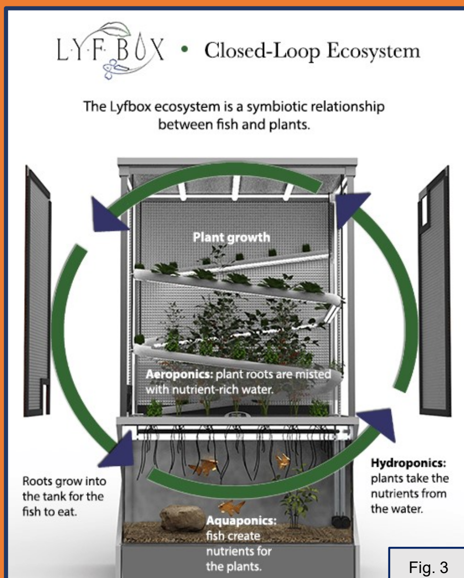

Fig. 3

Fig. 1. Courtesy *Mars for the Many.* This figure shows a theoretical design for an aquaponics system on a space station or base.
Fig. 2. Courtesy *Bryan Versteeg/spacehabs.com*, retrieved from article by Joel Ammons. This figure depicts a theoretical greenhouse on Mars.

Fig. 2

Fig. 3. Courtesy Lyfbox Ecosystem. This figure shows the process of aquaponics as well as how compact the entire process can be.

Mars: One of the most forthcoming problems about Mars and a sustainable habitat is the toxic soil on Mars surface. This makes aquaponics a safer solution than traditional farming, as it does not involve soil and will not need to be placed on Mars' surface. Assuming that a Mars base will rely more heavily on the sustainability of aquaponics (due to less frequency of supply shipments), a reasonably large aquaponics farm will be needed to maintain the well-being of those stationed there as they will need to wait for each growth cycle to receive a new surplus of food (Fig. 2). One benefit to having an aquaponics farm instead of the traditional soil farm is its ability to effectively use space because of its potential for verticality (Azam, 2017). In the limited space habitats that will be used to set up Mars bases, this becomes especially important. One concern that does arise from the use of a larger scale aquaponics farm on Mars is its need for constant power in order to keep the water aerated and the temperature under control. Although solar power will be especially effective when establishing a presence on Mars, it may not be enough to support a very power taxing system like those used in aquaponics.

Space Station: In a space station setting, an aquaponics system will have to be scaled down considerably due to room/space constraints within somewhere like the ISS. Although the size will have to be trimmed down, that does mean that the overall cost of the materials as well as the cost of power will be trimmed as well. While there will presumably be less people on a space station than there are on a Mars base, the size constraint is not a huge concern. Where the main concern lies is with the lack of gravity. With fish being a very fundamental part of the aquaponics system, the lack of gravity can take a significant toll on the bone density and overall well-being of the fish (Hays, 2015). Due to this problem involving the fish's health, a traditional soil farm may be the only option; though, this does require regular shipments of water and soil which can be heavily taxing on finances. While aquaponics does have some noticeable benefits to long term space travel, further research is needed to ensure longer lifespans or healthier conditions for the fish that are fertilizing the plants.

References:

Ammons, Joel. "Farming on Mars - What the First Settlers Will Need to Know." *Mars for the Many*, 21 Jan. 2016, marsforthemany.com/project/living-on-mars/farming-on -mars/.

"Aquaponics Lab Explores Food Production for Earth And Possibly Mars." *Embry-Riddle Newsroom*, 27 Mar. 2017, news.erau.edu/headlines/aquaponics -lab-explores-food-production-for-earth-and -possibly-mars.

Dunbar, Brian. "Aquaponics." *NASA*, NASA, www.nasa.gov/audience/foreducators/9 -12/features/aquaponics.html.

Hays, Brooks. "Space Fish Detail Effects of Microgravity on Bones." *UPI*, UPI, 23 Sept. 2015, www.upi.com/Science_News/2015/09/23/Space-fish--detail-effects-of-microgravity-on-bones/4071443013609/.

"Small Space Smart Combo Aquaponic, Hydroponic, Aeroponic Indoor Garden." *Urban Gardens*, 2 Apr. 2017, www.urbangardensweb.com/2017/04/01/plug - ngrow-urban-farms/

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