IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (A1)
Interactive Presentations - IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (IPB)

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AGRICULTURAL SYSTEM ON MARS: A LIFE-SUPPORT SYSTEM FOR MARTIAN'S SETTLERS

Abstract

Humankind is driven by a sense of curiosity, inspiration, and by the innate need to ensure the long-term survival of humans while searching for other habitable planets. With a travel time of at least six months, Mars is the second most habitable planet in the Solar System - despite its environmental conditions being different from the ones on Earth. For example, Mars' gravity is one-third that of Earth's, its temperature variations are larger and radiation levels higher. Therefore, to sustain life on Mars, an ad hoc permanent human settlement on the planet is required; one critical component of which is an agricultural system.

The Mars settlement presented in this paper contains a diverse and balanced group of 100 settlers whose ages range between 25 and 60 years old, and whose arrival on Mars will be spread over 20 years.

As part of the settlement, this paper foresees the following: 1) a biodome to produce food - including yeast, fish, insects, algae, and plants - using hydroponics and aquaponics; 2) a life support system - closed-loop to the near closed-loop system - based on in-situ resource utilization (ISRU).

The goal of the biodome is to ensure a self-sufficient life-support system that produces food for humans, and a source of energy to feed fish, yeast, insects, and to grow plants. This is possible by rigorously recycling any type of waste product and using local resources, whilst taking into consideration the variety of food which answers all the settler's nutritional needs.

Within the life support system, this paper takes a multi-faceted approach. Should water be available in sufficient quantities, organisms such as algae, invertebrates, or fish could be grown using human waste and ISRU of Martian Regolith with diatoms and cyanobacteria. Due to the scarcity of Nitrogen in the Martian atmosphere, it is essential to identify resupply routes. Oxygen, on the other hand, can be produced in-situ using regolith and the Martian atmosphere. Rhizobium, a soil bacterium that fixes atmospheric nitrogen into valuable compounds like N-NH3 or N-NH2, may help to increase Martian soil productivity and soil fertility. Carbon dioxide from the Martian atmosphere can also be used. Fish are especially attractive in this sense, as their poikilothermic physiology means they consume less oxygen than mammals and also generate significantly less carbon dioxide.

Finally, this paper investigates the multi-disciplinary demands required to build an agricultural system on Mars for a long-term settlement. These include the necessary engineering tools and structures, vital redundancy, and financial means to secure such a self-sustaining settlement. We believe that the technology required for such an endeavor will have a pivotal spillover effect on Earth, driving major advances in areas such as water scarcity and land use, and automation of agricultural techniques.