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REVIEW AND PERSPECTIVES OF PLANT CULTIVATION FACILITIES AND TECHNOLOGIES FOR SPACE EXPLORATION

Abstract

Future habitation of space will necessitate engineering of complex systems capable of performing critical tasks for life support, including atmosphere revitalization, water purification and food production. Bioregenerative Life Support Systems represent an integrated solution to these problems, with higher plants cultivation facilities as a key element capable of providing a variable percentage of the astronauts' diet. A Food Complement Unit is a potential solution for providing fresh crops and dietary supplements for the crew on the International Space Station (ISS) and future space exploration vehicles. Larger greenhouses are envisaged on planetary surfaces for longer missions, providing percentages of astronauts diet up to 40 - 50Safe, sustainable and reliable operations of such systems in their relevant environment, mission and associated spacecraft is challenging and requiring an organized technological development approach. Critical subsystems necessitating further technological development include: - Nutrient Delivery System – with root zone interactions, multi-phase flows and biocontamination issues, optimization of growth substrates - Plant Illumination System – responsible for optimal plant growth and production, associated high energy consumption, via alternative light delivery strategies and technologies - Air Management – featuring air composition, trace contaminants, temperature and humidity control for optimal plant health and facility's reliability Exploitation of the ISS is an opportunity to be pursued for such critical technologies demonstration, to provide a solid baseline for exploration architectural studies. This paper reports a brief summary of existing plant growth facilities, a review of the most critical plant production technologies and a roadmap for necessary further developments, focusing on the potential of ISS exploitation for their demonstration.