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Challenges for Life Support Systems in Space Environments, Including Food Production. Raymond M. Wheeler. NASA Surface Systems Division, Kennedy Space Center, FL 32899 USA

Environmental Control and Life Support Systems (ECLSS) refer to the technologies needed to sustain human life in space environments. Historically these technologies have focused on providing a breathable atmosphere, clean water, food, managing wastes, and the associated monitoring capabilities. Depending on the space agency or program, ELCSS has sometimes expanded to include other aspects of managing space environments, such as thermal control, radiation protection, fire detection / suppression, and habitat design. Other times, testing and providing these latter technologies have been associated with the vehicle engineering. The choice of ECLSS technologies is typically driven by the mission profile and their associated costs and reliabilities. These costs are largely defined by the mass, volume, power, and crew time requirements. For missions close to Earth, e.g., low-Earth orbit flights, stowage and resupply of food, some O_2, and some water are often the most cost effective option. But as missions venture further into space, e.g., transit missions to Mars or asteroids, or surface missions to Moon or Mars, the supply line economics change and the need to close the loop on life support consumables increases. These are often referred to as closed loop or regenerative life support systems. Regardless of the technologies, the systems must be capable of operating in a space environment, which could include micro to fractional g settings, high radiation levels, and tightly closed atmospheres, including perhaps reduced cabin pressures. Food production using photosynthetic organisms such as plants by nature also provides atmospheric regeneration (e.g., CO_2 removal and reduction, and O_2 production), yet to date such "bioregenerative" technologies have not been used due largely to the high power requirements for lighting. A likely first step in testing bioregenerative capabilities will involve production of small amounts of fresh foods to supplement to crew's diet. As humans venture further into space, regenerative life support technologies will become more important, and gathering accurate data on their performance and reliabilities will require long lead times. As we learn more about sustainable living in space, we almost certainly learn more about sustainable living on Earth.