

Life Support and Greening Space: From Multidisciplinary Research to Sustainability in Extreme Environments

Karl H. Hasenstein, Univ. Louisiana Lafayette

The quest to unravel how plants respond to their environment started more than 300 years ago, and one of the central questions, namely how gravity affects plants, faced the conundrum that this force is ubiquitous on earth and cannot be eliminated. Many creative approaches were evaluated, but only space flight provided compensation of gravity for sufficient time. Therefore, early space studies focused on the mechanism of gravi-detection and response but were soon supplanted by studies of other environmental responses such as the lack of buoyancy, photon flux, water, gas, and ion gradients. Research progressed and plant cultivation in space could be reliably achieved. Parallel endeavors focused on the ability of plants to support life by purifying water, absorbing waste material, providing edible biomass, reducing CO₂, and providing organic material for soil enrichment and industrial use. This research includes space and lunar constraints such as low-pressure, high UV and ionizing radiation, scarcity of water, lack of carbon, nitrogen, and other minerals but abundant toxic compounds in extraterrestrial soil and excess CO₂ and volatile organic compounds (VOCs) in spacecraft. Plants are the organisms of choice to tackle the challenge of changing environmental conditions in space, Moon, Mars and on Earth. Corresponding research will address and eventually succeed in enabling extraterrestrial exploration and human habitation away from Earth.