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特集：宇宙に生きる—基礎から応用まで—
(解説)

火星をめざす宇宙農業構想—日本・アジアからの発信—

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Space Agriculture for Habitation on Mars—Perspective from Japan and Asia

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Abstract

Manned Mars exploration at a large and long scale inevitably requires recycle of materials to support human life on a distant isolated outpost. A conceptual design is developed for Martian agricultural system based on biologically regenerative functions. Environment in a green house dome will be maintained at sub-atmospheric pressure with proper partial pressure of oxygen and other gas species. Photosynthetic conversion of carbon dioxide and water to oxygen and biomass is the major driving mechanism for habitation on Mars. Water recycle, at a quantity required for human life, can be made by respiration of plant leaves. It should fully utilize a solar energy received on the Martian surface for the photosynthetic reaction. Sub-surface water and atmospheric carbon dioxide mined on Mars should be also associated with the plant cultivation system. We selected rice, soybean, sweet potato, and green-yellow vegetable for the core food materials in space agriculture. From nutritional viewpoint, animal origin material should be supplemented to the diet with lipids, including cholesterol, vitamin D, and B_{12}. Insect eating is proposed for the best use of the limited resource available for space agriculture. Silkworm and hawkmoth pupa are candidate for this purpose. Co-culture of rice, *Azolla* (aquatic fern), and loach fish is promising as well. One of the core technological functions in the concept is hyper-thermophilic aerobic composting bacterial ecology. It plays a role of processing human metabolic waste and inedible biomass and of converting them to fertilizer for plants cultivation. One of the characteristics of the technology is the processing temperature high at 80–100℃. The quality of the compost has been shown essential to create a healthy regenerative system. In the materials recycle loop, handling of sodium, which is required for human physiology but negatively affects on ordinary plant growth, is another challenge in space agriculture. Cultivating salt accumulating plant species, such as ice plant, or harvesting potassium made by marine algae is promising candidate for this. Space agriculture, with our perspective from Japan and Asia, might be beneficial for solving the global problems of food shortage and loss of agricultural land at increasing human population.