

## Concept of space agriculture and agricultural resource exploration of Mars

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[http://surc.isas.jaxa.jp/Space\\_Agriculture](http://surc.isas.jaxa.jp/Space_Agriculture)

Space agriculture is a concept to create livable environment on an extraterrestrial planet Mars, and support human life on it with biological and ecological functions. It enables long and large scaled manned exploration by recycled use of biomaterials. On site resources are employed to replenish materials and bio-elements, which are dropped from the recycling loop in ecological system. On site resources are also effective to enlarge the scale of space agriculture without transporting materials for it from Earth or other bodies. This approach allow to reduce the strict requirements for operating closed ecological system at 100% recycled use of the initial inputs of materials resource. Such strictness of 100% criteria should be imposed on the life support system on spacecrafts or distant planetary bodies for mission with a long duration and at expecting on-site resource not available. On Mars, water was found at sub-surface layer even in equator zone. Carbon dioxide, another chemical for photosynthesis, is the major component of thin Martian atmosphere. Bio-elements, such as K, P, Ca, Mg, and Fe, are contained in minerals of Martian regolith. In order to synthesize agricultural soil from regolith, organic materials are mixed into it after composting human waste and inedible biomass. Soil microbial ecology helps to convert P and Fe to the form that can be taken by plant roots. Hyperthermophilic aerobic composting bacteria enable fast composting process at reaction temperature high as 80-100 degree C, and prevent propagation of pathogenic bacteria by natural autoclaving. It also excretes physiologically active substances in soil, and enhances growth of crop plants.

At the early stage of space agriculture, the hydroponics is taken for the crop production. For enlarging scale of the production, agricultural soil will be formed, and the hydroponics will be turned over to the soil based agriculture. Feasibility of employing Martian regolith should be carefully examined for its use as substrate of agricultural soil synthesized. Form of water and its distribution are explored as well. We should define the roadmap of Martian exploration in terms of finding on site agricultural resource availability and feasibility to modify them for the use in agriculture. For mineralogy of Mars, differentiation is in the middle of Earth and Moon. Clay minerals are found on the surface, and  $\text{CaSO}_4$ , jarosite, and carbonates distribute on the surface. Since some of those information is contradictory each others, we should plan future examination to clarify it.

Space agriculture shall meet requirements to avoid contaminating Mars, in terms of astrobiology. Risk should be evaluated on spread of Earth originated organisms and organic substances. Based on this evaluation, effective measure should be prepared against expected contamination. On Moon base or Earth orbiting station, verification test will be conducted for space agriculture.