

Space Farming Mars and Moon

Jagdish Kumawat✉, Sushmita Sain

Division of Seed Science and Technology, HNBGU Srinagar Garhwal

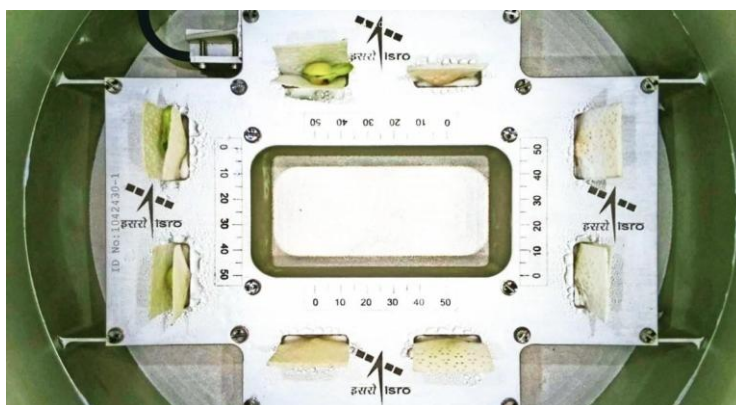
High Altitude Plant Physiology Research Centre, School of Agriculture and Allied Science, HNBGU Srinagar Garhwal

✉ kumawatjp2002@gmail.com

This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>)

Introduction

Space farming refers to the practice of growing plants in extraterrestrial environments such as space stations, the Moon, or Mars. It is an essential component for long-duration space missions, as it provides fresh food, oxygen, and psychological benefits to astronauts. Unlike traditional agriculture on Earth, space farming must operate under unique conditions including microgravity, limited water, artificial lighting, and controlled environments. Advanced techniques such as hydroponics, aeroponics, and controlled environment agriculture are commonly used to cultivate crops without soil. Experiments conducted by organizations like NASA have successfully grown crops like lettuce, wheat, and potatoes in space, proving the feasibility of sustainable food production beyond Earth.



The Need For Space Farming

- Astronauts on long-term missions, such as trips to Mars, cannot rely entirely on pre-packaged food, which degrades in nutritional value over time. Space farming offers several critical advantages.
- **Fresh Food Supply:** Provides fresh, nutrient-rich vegetables to improve astronauts' diet and health.

- **Life Support:** Plants act as a natural, bioregenerative system that recycles carbon dioxide (CO₂) into breathable oxygen and treats wastewater.
- **Psychological Benefits:** Caring for plants offers a calming effect and a connection to Earth, which improves the mental well-being of crew members.

Techniques And System

Space farming requires specialized technology to overcome the lack of soil, natural sunlight, and gravity.

- **Hydroponics & Aeroponics:** Plants are grown in nutrient-rich water solutions (hydroponics) or misted with nutrients (aeroponics) rather than soil, allowing efficient water and nutrient usage.
- **LED Technology:** Light-emitting diodes (LEDs) are used to provide specific light wavelengths tailored for photosynthesis, ensuring efficient energy usage.
- **Controlled Environment Agriculture ✓ (CEA):** Automated systems regulate temperature, humidity, and atmospheric conditions, similar to advanced greenhouses.
- **Veggie System:** NASA's "Veggie" plant growth system on the International Space Station (ISS) uses "pillows" to hold rooting substrate and has successfully grown lettuce, cabbage, and zinnia flowers.



Recent Advancements And Future Outlook

- **ISRO's CROPS Mission:** On December 30, 2024, India's ISRO successfully germinated cowpea seeds in space using the POEM-4 platform, marking a significant step in space agriculture.
- **Lunar Soil Growth:** Experiments have demonstrated that plants can grow in lunar soil, although additional nutrients are required.
- **Future Focus:** Researchers are focused on selecting high-yield, compact plants, such as lettuce, tomatoes, and dwarf wheat, and perfecting the ability to grow plants in space for multi-year missions.



Future Scope

The future of space farming is very promising and will play a key role in long-duration space missions and human settlement beyond Earth. As space agencies plan missions to the Moon and Mars, sustainable food production systems will become essential.

Long-term Human Survival in Space

Space farming will help astronauts produce their own food instead of depending on Earth. This is important for future missions to Mars and deep space.

Establishment of Space Colonies

Countries and organizations like NASA and European Space Agency are working on projects to establish human habitats on the Moon and Mars, where farming will be necessary.

Advanced Farming Technologies

New technologies like Hydroponics, Aeroponics, and vertical farming will be improved for use in space.

Closed-loop Life Support Systems

Space farming will help in recycling waste materials. Plants will convert carbon dioxide into oxygen and purify water, making space missions more sustainable.