Growing Food on The Moon

Summary

For short-term missions, NASA sends astronauts to space with all of the food that they will need. As missions get longer, it will become more difficult and costly to send all of the food they will need. In this MO, teams will consider the resources (inputs) that will be required for astronauts to create an agriculture plan and grow their own food (output) on the Moon.

Materials Needed	Resources from Companion Course Lesson 4:
• Various materials for plant investigation: • Digital scale • Rulers • Camera • Grow light • Seeds and/or dried beans • Soil • Fertilizer • Cups, baggies, or grow trays	• Engage Section: An activity where students think about why we eat and and slides with locally and culturally important foods of the Pacific Northwest. • Explore Section: Scaffolding tips and a template to help students plan and carry out their own investigations, as well as ideas for locally and culturally important seeds to use. • Elaborate Section: Guidance, examples, and a template to help students describe their agricultural plan. • Extend Section: Activities to help students learn about local crops and food.

Getting up to Speed

Astronauts will need lots of food to stay energized - and alive - while living and working on the Moon. To prepare, scientists at Kennedy Space Center in Florida and astronauts on the International Space Station have been doing many experiments to learn which plants grow best, how to grow plants in zero or low gravity, and how to provide plants with light, energy, and water like they get on Earth. They even get to taste the produce they grow.

Mission Guidance

In this MO, teams will use both research and their own experiments to create an evidence-based agricultural plan for growing food for astronauts on the Moon.

First, teams will create and run experiments to see how different factors (like water, time, fertilizer, light, number of seeds, and type of seeds) affect the number of calories they can grow from an edible plant. To do this, teams should design an experiment around a question like, "How does (independent variable) affect the (measurable quantity/dependent variable) of my (type) plant?"

The experiments completed by teams should only change one factor at a time (independent variable) while keeping all other factors the same (controlled variables). They should also carefully record the results. The Explore section of the associated Companion Course lesson has a template that can help students develop their experiment.

Next, teams will use what they learned from their experiments to design an agricultural plan for growing food for four astronauts living on the South Pole of the Moon. The plan should explain how many calories they need to grow to support the astronauts and include details about the time, number of plants, greenhouse size, and the amount of water, soil, fertilizer, or grow lights needed to produce those calories. (See the Elaborate section the Companion Course lesson for examples.)

Teams should support their agricultural plan using the Claims-Evidence-Reasoning model:

CLAIM - Make a specific statement that describes how much of a resource is needed to produce a certain amount food or - even better - calories per day.

EVIDENCE - Describe data from their experiments or other investigations they have learned about to support each of the claims above.

REASONING - Explain why the evidence supports the original claim. This should include a description of:

- **CALCULATIONS**: Any calculations the team made to figure out the calories grown in their experiments and how that would scale in the plan.
- **ASSUMPTIONS**: Any assumptions the team made to scale up their experimental results or how they think what they observed on Earth might be different on the Moon. Of course, teams can't test every variable on the Moon! Team members can use their own knowledge, do research, and make reasonable assumptions to fill in the gaps. But remember, every claim should be supported by evidence and reasoning.

Teams are encouraged to use locally and culturally important seeds in their plant investigations. They can also research and explore crops produced in their area and exported elsewhere or investigate how far the food at their local grocery store traveled. See the Companion Course Engage portion for examples of locally and culturally important foods of the Pacific Northwest, the Explore portion for examples of local seeds, and the Extend portion for activities to help students make local connections to food.

Deliverables

As they work, teams should keep track of their results in their Science and Engineering Notebooks (SEN). At the end of the Challenge teams will be asked to submit a Mission Development Log (MDL) to NESSP that shows how the students worked through the Mission Objective and summarizes their results. NESSP provides a Mission Development Log Template to help guide what teams should include in their MDL. Please see MO-1 for guidelines on the format and length of the MDL.

MO-4 What must be in your Mission Development Log (MDL)?

Every MDL must include:

- A description of the team's experiment(s) that includes:
  - A drawing or picture of the experiment with the independent, dependent, and controlled variables labeled.
  - Information on the frequency of measurements and when measurements were taken.
  - At least three photographs of their experiment in progress that are dated with a description or caption.
  - The experimental data in table or graphical form.
- A description of the team's agricultural plan that includes :
  - A list of claims that describe the number of calories they need to produce, the time, the number of plants, greenhouse size, and the amount of water, soil, fertilizer, or grow lights needed.
  - Evidence and reasoning to support each of the listed claims, including:
    - A description of any calculations the teams did to scale up the measurements from their experiment.
    - Teams should describe any and all assumptions made when designing their agricultural plan. For example, teams might need to assume that NASA won't be able to grow plants in pure Earth soil.

Middle and high school team's MDL must include:

- Citations for external references used as evidence in your agricultural plan, including at least one reference from the "Getting up to Speed with Artemis" document OR other NASA publications.