The Future of Agriculture: Space & Beyond

Growing Beyond Earth®

Curriculum Activity

This classroom activity is part of a series of educational materials intended to supplement Growing Beyond Earth® experiments. This material is in the public domain and may be freely used, copied, modified, and distributed without further permission from Fairchild Tropical Botanic Garden or NASA.

Author(s):

Alexander Eden
GBE® Graduate Fellow
Fairchild Tropical Botanic Garden

Partner

This material is based upon work supported by NASA under cooperative agreement number NNH21ZDA001N-SciAct. Any opinions, findings, conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration (NASA).

Type of activity: Gro
Duration: At least 2
class
Target audience(s):

Learning Objectives

Students will be able to...

- Summarize the unique challenges of farming in space versus on Earth, such as differences in gravity, light sources, and atmospheric conditions.
- Compare traditional farming methods with controlled-environment agriculture, analyzing benefits and challenges for each system.
- Develop a persuasive argument to advocate for a chosen farming method (Earth-based, space-based, or a hybrid system) based on research and data.
- Present findings to the class, integrating visuals and quantitative data to support their argument.

Connections to Standards

This project supports the teaching of multiple standards, including:

Next Generation Science Standards

MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing human impact on the environment.

HS-ESS3-4: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

Common Core State Standards for Mathematics and ELA-Literacy

CCSS.ELA-LITERACY.RI.6.7: Integrate information presented in different media or formats.

CCSS.ELA-LITERACY.W.6.1: Write arguments to support claims with clear reasons and relevant evidence.

CCSS.ELA-LITERACY.SL.7.4: Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence.

CCSS.MATH.CONTENT.6.SP.B.5: Summarize numerical data sets in relation to their context.

The Future of Agriculture:

Space & Beyond

Materials

- Access to the internet or pre-selected articles on farming challenges in space (such as those from NASA's Veggie project and Mars plant growth research).
- Chart paper or poster boards
- Markers, pens, and rulers
- Calculators (if needed)
- Graph paper for mathematical comparisons
- Printouts of resources on space and Earth-based farming challenges and benefits
- Presentation tools (optional): projector, computer, or poster board for students to present findings

Background Information

As humans explore the possibility of long-term space habitation, scientists are developing ways to grow plants beyond Earth. This involves using controlled environments (like NASA's Veggie project on the ISS) where factors such as light, temperature, and humidity are carefully managed. These conditions contrast sharply with traditional Earth farming, which relies on natural sunlight, soil, and other terrestrial resources. This activity allows students to explore how controlled-environment agriculture can be applied both on Earth and in space, the sustainability of these methods, and the data-based predictions that can guide decision-making in future food production.

Special Considerations

- Differentiation: Provide more structured resources for students who need additional support (e.g., pre-printed data sets for calculations).
- Technology Needs: If possible, access to devices for online research and presentation tools for creating digital visuals.
- Group Dynamics: Ensure balanced roles within groups, allowing all students to contribute to research, analysis, writing, and presenting.

The Future of Agriculture:

Space & Beyond

Recommended Procedure (Can be extended over days):

Step 1: Introduction for Students (10-15 minutes)

1. Begin with a discussion on traditional farming and its challenges (e.g., climate variability, water shortages, soil health).
2. Introduce the concept of space farming and explain the unique challenges of growing food in space (lack of soil, limited water, dependence on artificial light, etc.).
3. Explain controlled-environment agriculture (CEA) and its applications both on Earth (urban farming, vertical farming) and in space.

Step 2: Research and Data Collection (20-30 minutes)

1. Divide students into small groups and assign each group one of the following to research:
   - Earth-based controlled-environment agriculture (vertical farming or hydroponics).
   - Space-based agriculture (farming on Mars or the ISS).
2. Each group will gather data on:
   - Resources required for their method (water, energy, nutrients).
   - Benefits and challenges of their method (e.g., yield, sustainability, feasibility).
3. Provide printouts, articles, or internet access for students to gather data on these topics. Encourage them to take notes on key points and record numerical data they find.

Step 3: Data Analysis and Mathematical Calculations (20-30 minutes)

1. Have each group analyze the collected data by summarizing numerical information (e.g., water usage per plant, energy consumption).
2. Ask students to make proportional comparisons (e.g., comparing water use per kilogram of crops grown on Earth versus in space).
3. Using calculators and graph paper, students create simple charts or graphs to represent their data visually. For example, they can compare space vs. Earth resource consumption in bar charts.

Step 4: Argument Development (15-20 minutes)

1. Each group will write a persuasive argument advocating their assigned method as a sustainable future solution for farming.
   - The argument should include at least three points supported by the data they gathered.
   - Emphasize using quantitative evidence to make a compelling case (e.g., "Farming in space requires only X amount of water per plant compared to Earth-based farming").
2. Groups should also prepare visuals (charts, graphs, images) to reinforce their argument.

Step 5: Presentations (20-25 minutes)

1. Each group will present its argument to the class, using visuals and data to support their points.
2. Allow time for a Q&A session after each presentation, where classmates can ask questions or challenge assumptions.

Step 6: Class Discussion and Reflection (10-15 minutes)

1. After all presentations, lead a discussion on which farming method seems most feasible and sustainable.
2. Ask students to reflect on the following:
   - What was the most surprising finding about farming in space?
   - How do they think space farming could benefit Earth's food systems?
3. Wrap up by discussing the importance of data-driven decisions in agriculture, especially as it applies to

The Future of Agriculture:

Space & Beyond

future food security challenges.

The Future of Agriculture:

Space & Beyond

Rubric for Assessment

Criteria	4 – Excellent	3 – Good	2 – Needs Improvement	1 – Unsatisfactory
Data Collection	Collected comprehensive, relevant data and clearly summarized it for analysis.	Collected relevant data, some minor gaps in summary.	Collected some data but lacking relevance or clarity in summary.	Minimal or irrelevant data collected, summary unclear or missing.
Mathematics & Analysis	Conducted thorough calculations with accurate results; used visuals effectively.	Performed basic calculations, mostly accurate; visuals somewhat effective.	Limited calculations, some inaccuracies; minimal use of visuals.	Calculations are missing or mostly incorrect; no use of visuals.
Argument Development	Persuasive, well-supported argument with quantitative data and clear reasoning.	Logical argument with some support, includes some quantitative data.	Argument lacks sufficient support, missing quantitative data.	Argument lacks clarity and evidence, does not include data.
Presentation	Clear, engaging presentation; visuals and data strongly support argument.	Presentation is clear, some use of visuals/data; fairly engaging.	Presentation lacks organization; visuals and data do not strongly support it.	Presentation unclear or disorganized, visuals/data do not support argument.
Participation	Worked collaboratively, each member contributed significantly.	Worked collaboratively, most members contributed.	Some collaboration, but one or more members contributed minimally.	Minimal collaboration; few members contributed effectively.
				Total: ____/20

This lesson encourages students to analyze, evaluate, and communicate scientific data, providing valuable skills for understanding and advocating for sustainable food production solutions. The focus on both mathematical and communication skills supports a well-rounded approach to STEM education

The Future of Agriculture: Space & Beyond!
(Student Handout)

Overview

In this activity, you will explore the future of farming in space and on Earth. With a growing need for sustainable food sources on our planet, and potential future habitats in space, scientists are developing new farming methods, including controlled-environment agriculture. Your team will research and compare different farming systems, analyze data, and develop an argument supporting a farming approach that could be part of a sustainable future for Earth and beyond.

Procedure

Assigned farming system (circle or highlight one): Earth-based Agriculture   Space-Based Agriculture

1. Research and collect data on your assigned farming system
    a. Resources needed (water, energy, light, nutrients)
    b. Environmental challenges and solutions
    c. Benefits and limitations
    d. **Data focus:** record numerical data (such as water usage per plant, crop yield, energy requirements) to support your findings
2. Analyze your data and summarize observations
    a. Compare your mathematical data across the different methods (example: how much water does each method require? How much energy does each method need?)
    b. Create graphs/charts/tables/visuals to support any arguments
3. Develop an argument for why your method is a sustainable solution for future food production
    a. Your argument should contain at least three main points, supported by data and observations from your research. In addition, use visuals!!
4. Presentation: your group will present your findings and arguments to the class.
    a. Be prepared to answer questions and challenges to your chosen method

Resources to get Started: NASA's Growing Plants in Space Vertical Farming Hydroponics

Note-Taking Area

Key Data Points:

Resource	Space Farming Method	Earth-Based Method
Water Usage		
Energy Usage		
Yield		
Other Notes		

Argument Outline:

Main Point	Supporting Data
1.	
2.	
3.	

Checklist for Presentation

- Clear argument with three main points
- Data to support each point
- Visuals (charts, graphs) that clarify your data
- Engaging delivery and readiness to answer questions

Reflection Questions

1. What did you find most surprising about farming in space versus on Earth?
   Answer:
2. How do you think the technology developed for space farming could benefit agriculture on Earth?
   Answer: