Continued Environmental Microbiology Monitoring of the International Space Station (ISS) Veggie Unit Used for In-Flight, Crop-Based Food Systems

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2022 NASA Human Research Program Investigators' Workshop

Veggie Hardware

- Veggie system initial hardware use on ISS since 2014
- Long duration missions
- Advanced Plant Habitat (APH)

Astronaut Jessica Meir working on Mizuna mustard grown in the Veggie System.
NASA iss061e022796

Microbial Veggie Monitoring

- First microbial sampling session conducted Fall 2019
  - 8 sampling sessions to date
- Environmental Health System (EHS) sampling

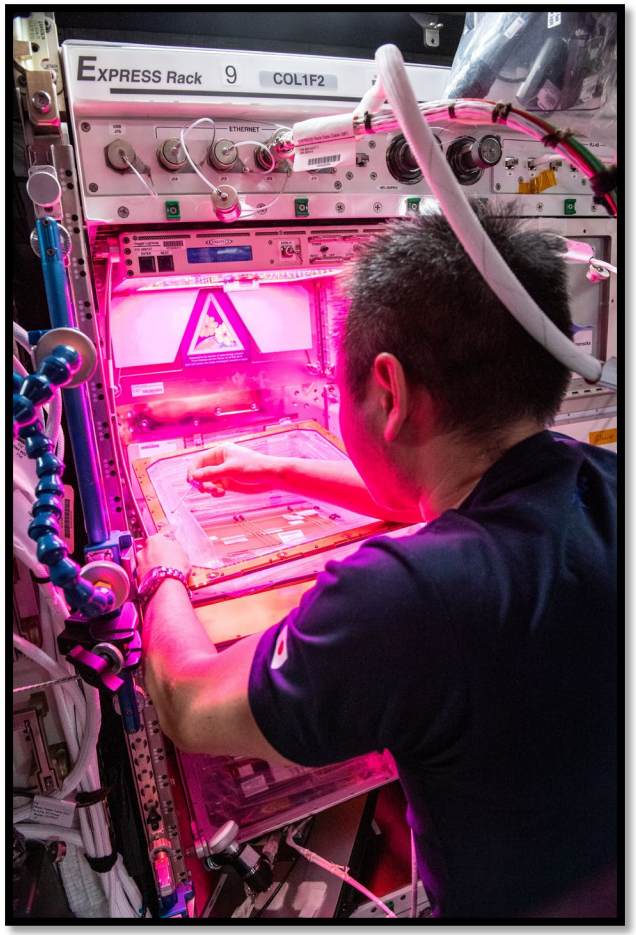
Peggy Whitson watering Chinese cabbage. NASA iss051e029143

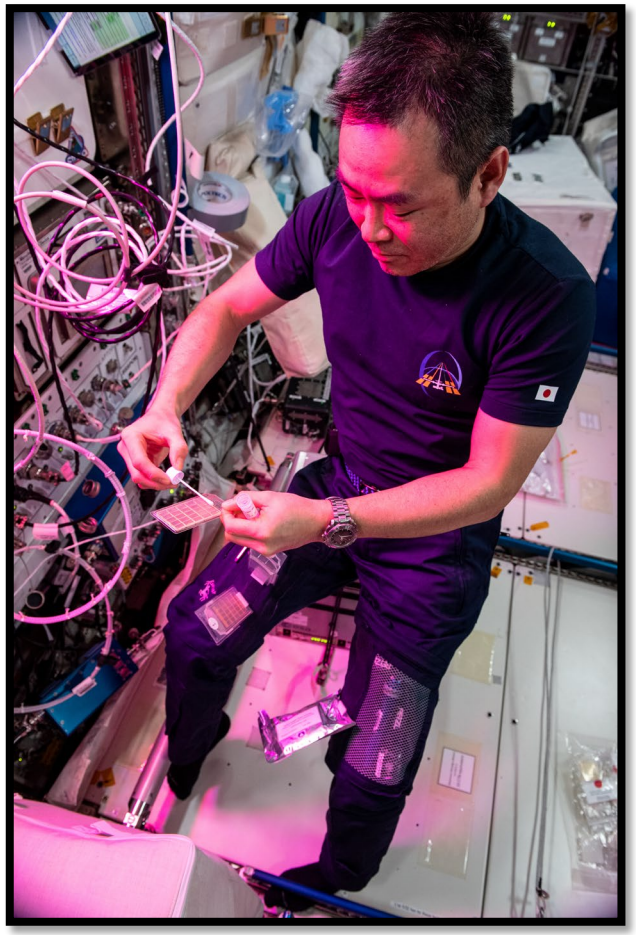
Microbial Monitoring Objectives

- Characterize the microbial community of the Veggie system to yield a **baseline of microorganisms** that can be used to develop **microbial requirements** for spaceflight-grown produce and provide inputs to **future plant system design**.
- The data collected in this study may be used to get a better understating of the **sources of plant system contamination**, which may include the ISS environment, pre-flight hardware contamination, water/nutrient supply, plant growth matrix and seeds.

Sample Collection

- 4 sampling locations are preselected
- Surface Sampling Kit (SSK)
- Eight Veggie slides
  - 4 Bacterial
  - 4 Fungal

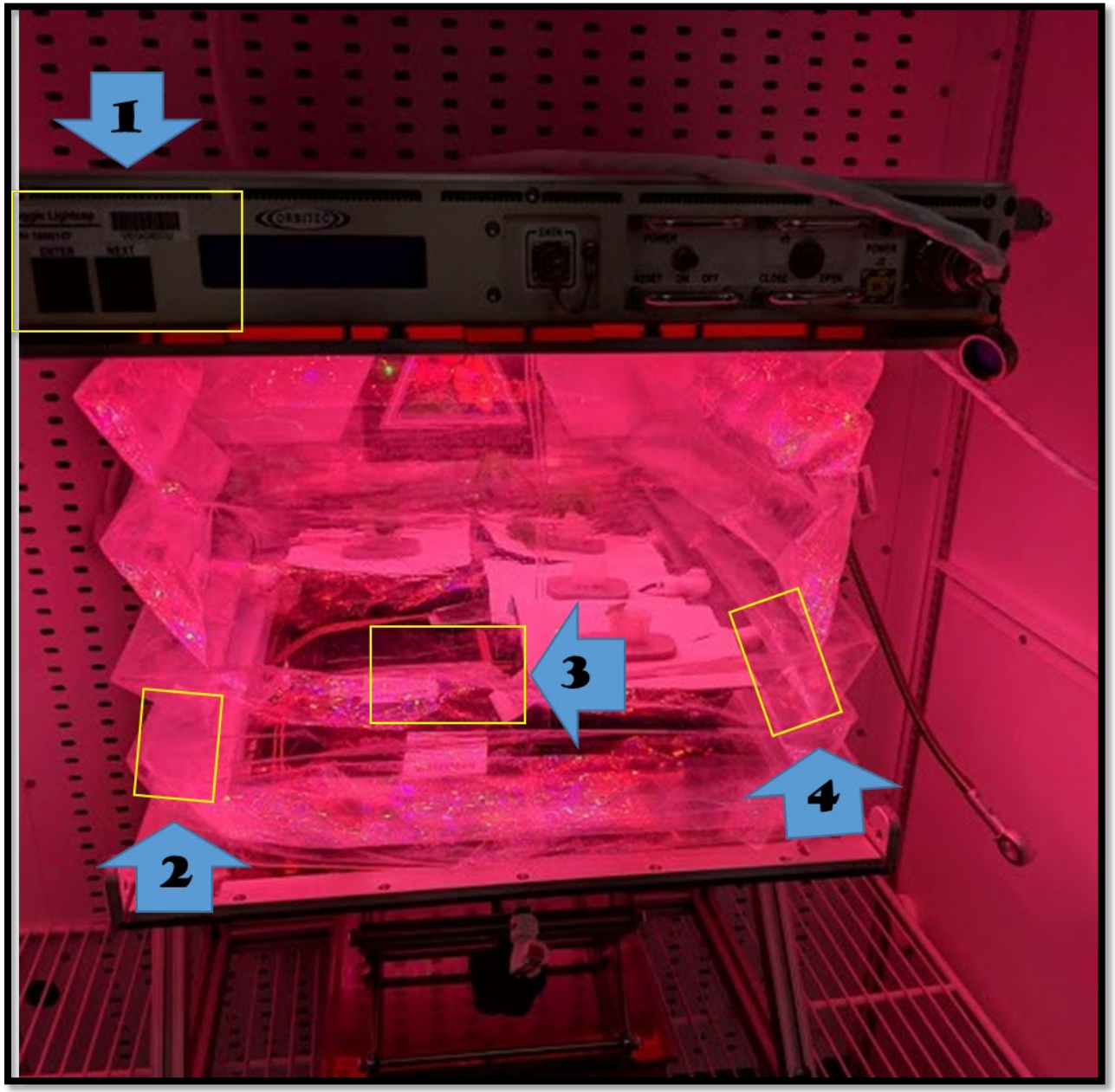




Astronaut Akihiko Hoshide sampling Veggie System. NASA iss065e376473 & iss065e376481

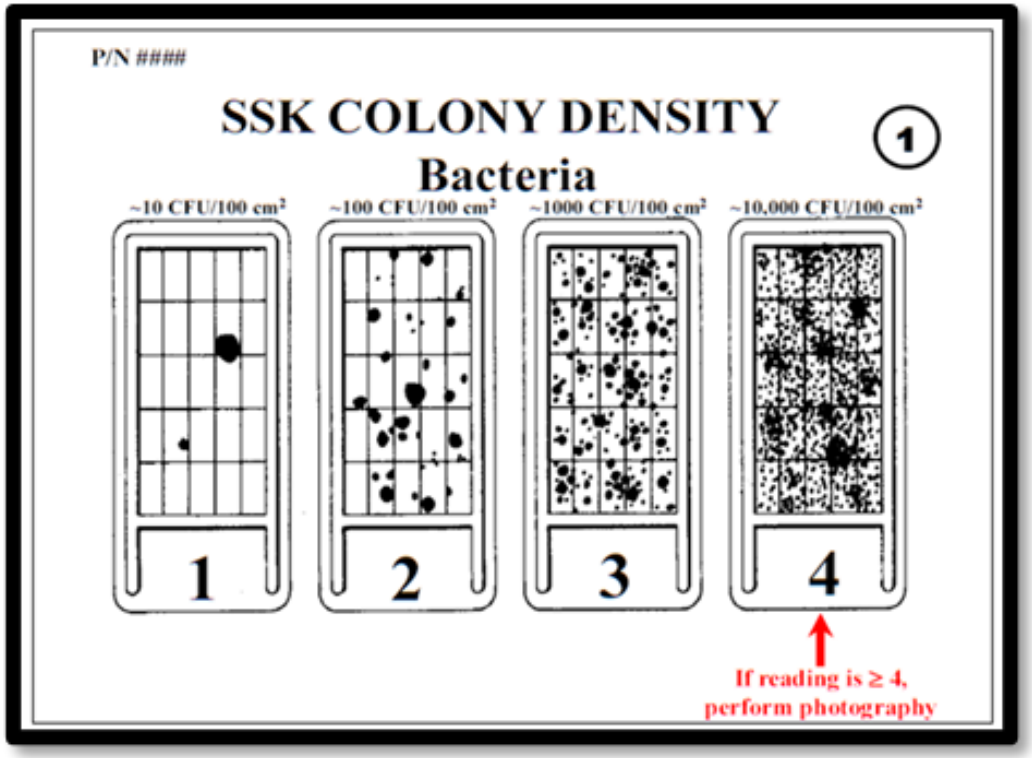
Recent Sample Sites

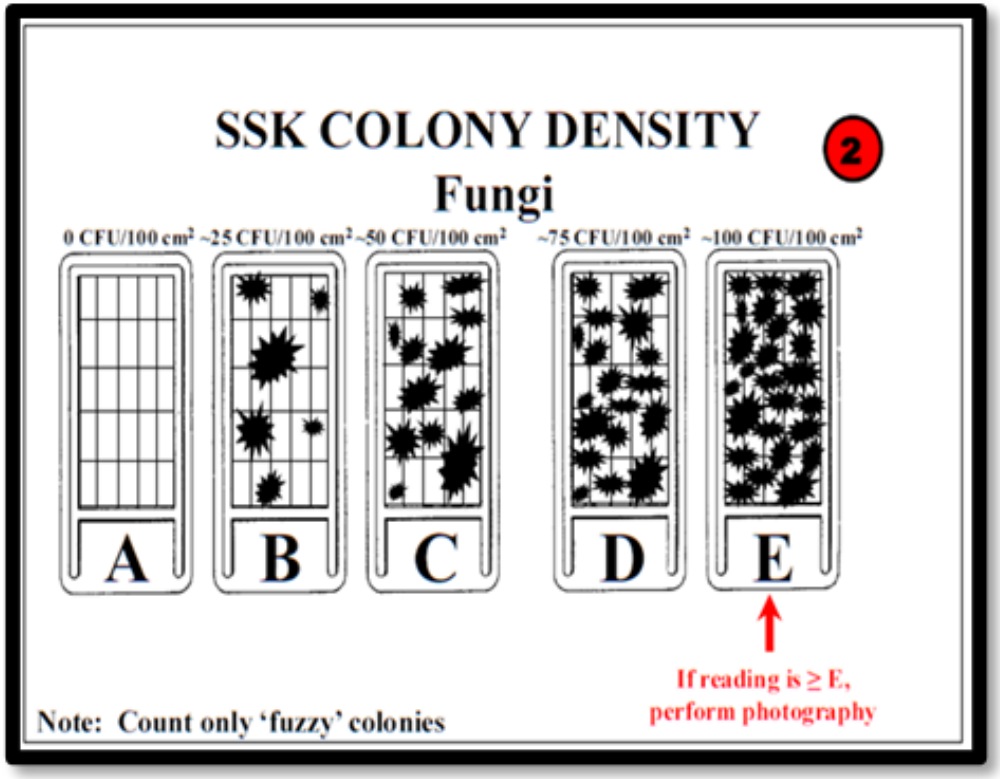
- **Veggie Facility Sample Locations**
  1. Veggie Light cap Control Panel, top-left
  2. Interior Vent Screen for the Bellows Chamber
  3. Interior black backing and orange straps surface
  4. Interior Surface of Bellows Chamber



In Flight Analysis

- Approximate microbial concentrations



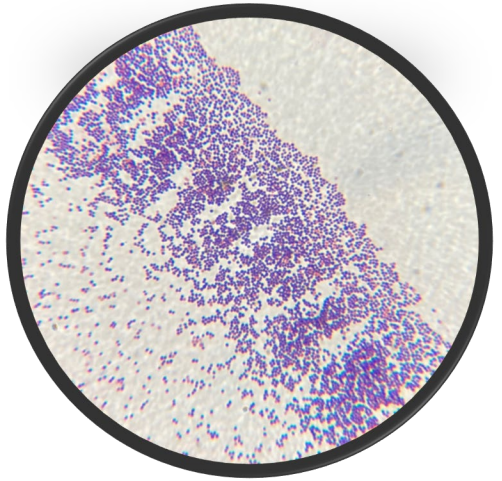


Ground Analysis

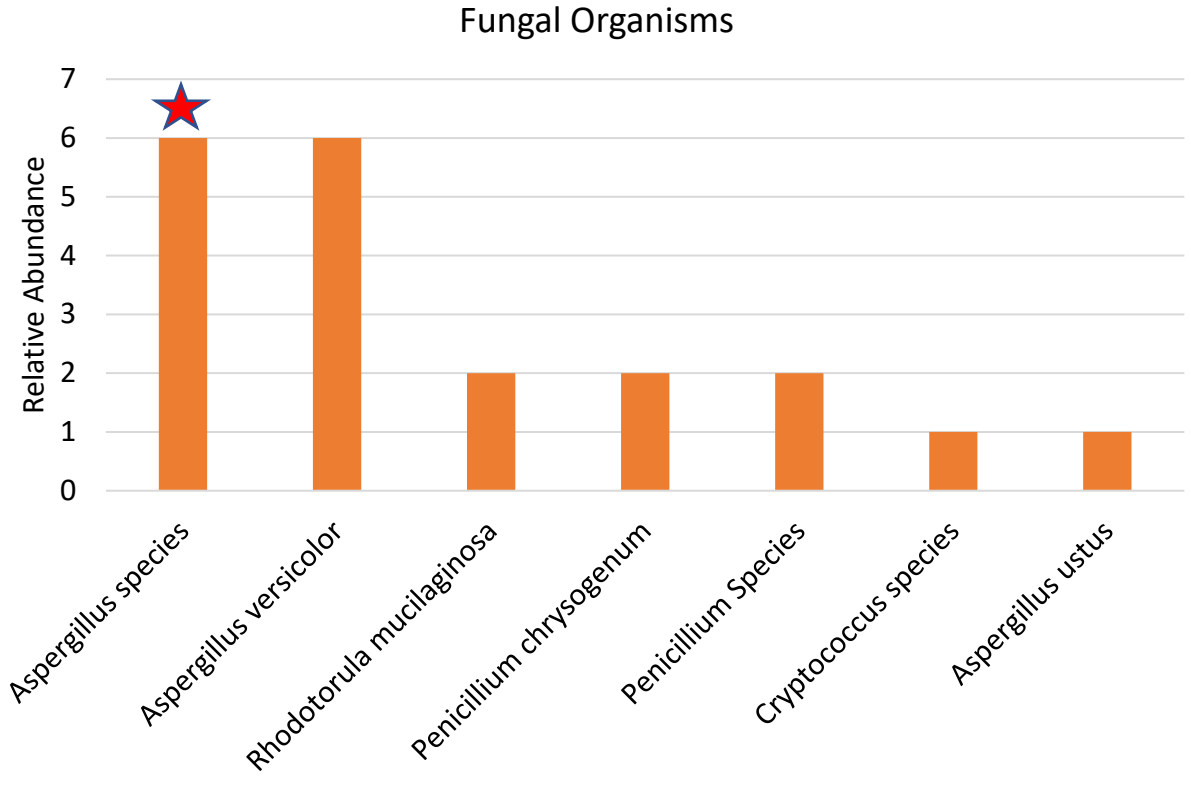
- Samples arrive at NASA JSC Microbiology Lab
- Distinct macroscopic morphology
- Subculture on optimal growth media

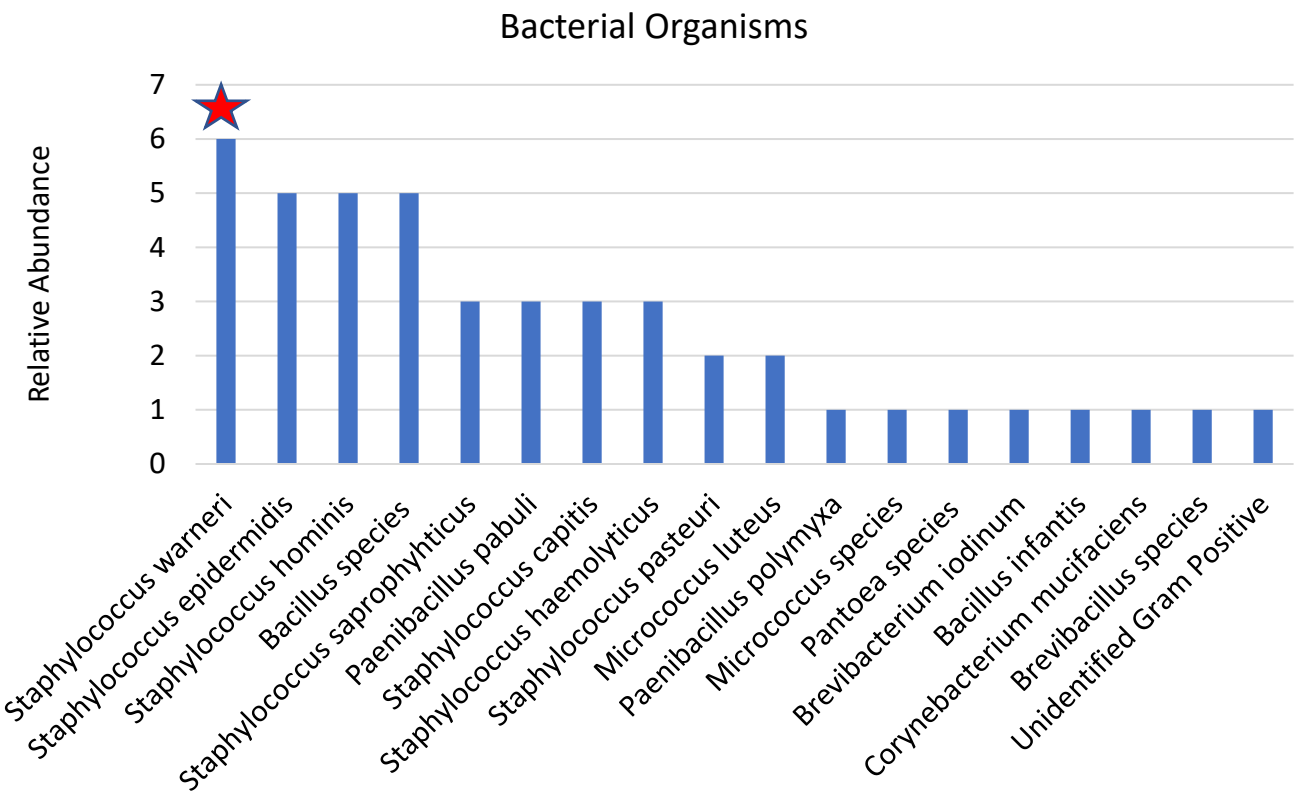
Identification

- Microscopic morphology
- Biochemical analysis
- Sanger Sequencing
  - 16S and LSU



Results To Date





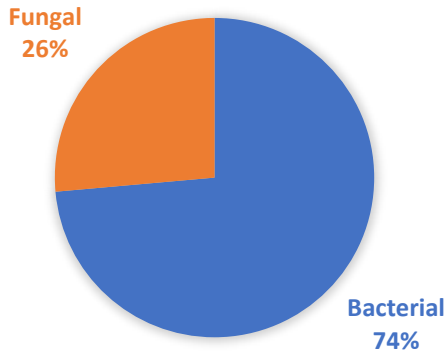
* Relative Abundance = Times organism recovered

Result Comparison

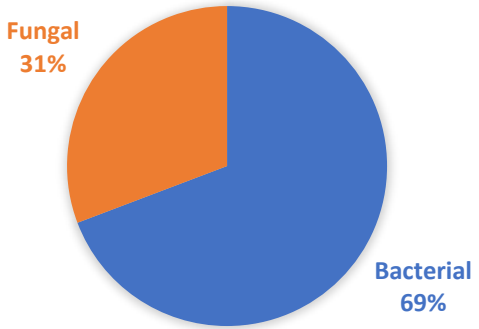
Collection Date	Mission
Sep-19	Soyuz 58
Jan-20	Soyuz 59
Apr-20	Soyuz 61
Oct-20	Soyuz 62
Dec-20	SpaceX-21
Apr-21	Soyuz 63
Jun-21	SpaceX-22
Sep-21	SpaceX-23

* 4 sampling sessions expected in 2022

EHS ORGANISMS



VEGGIE ORGANISMS



Discussion

- Veggie microbial sampling results comparable to other microbial results.
- Most common fungus: *Aspergillus* species
- Most common bacteria: *Staphylococcus* species
- To date results show no evidence of harmful contamination to crops or crew.

Future Work

- Internal site sampling in the presence of crops.
- Randomized sampling sites for a more accurate microbiome representation.
- Develop a baseline microbial community for Veggie unit to help assess risks, create in-flight crew health requirements, and develop strategies.
- Collaborations to make use of data when designing an updated crop-based food system.

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