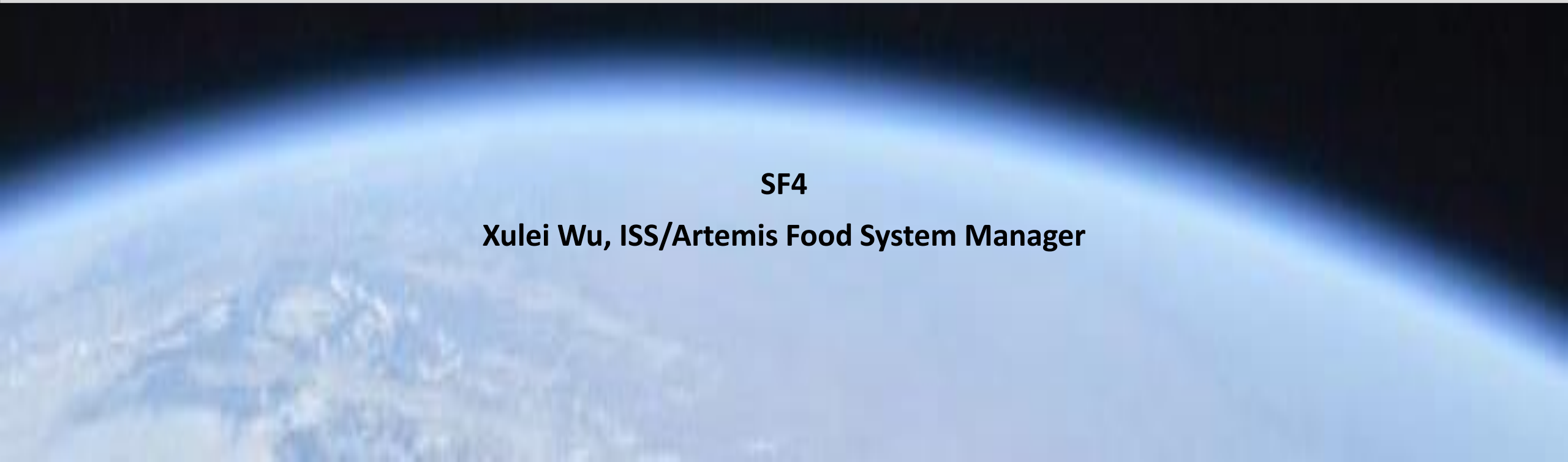
Space Food System Overview



SF4

Xulei Wu, ISS/Artemis Food System Manager

Supporting Astronauts

10 Food Scientists, 1 Dietitian, 12 Technicians, 3 Logistics Personnel, 2 Equipment Engineer, 1 Quality Personnel

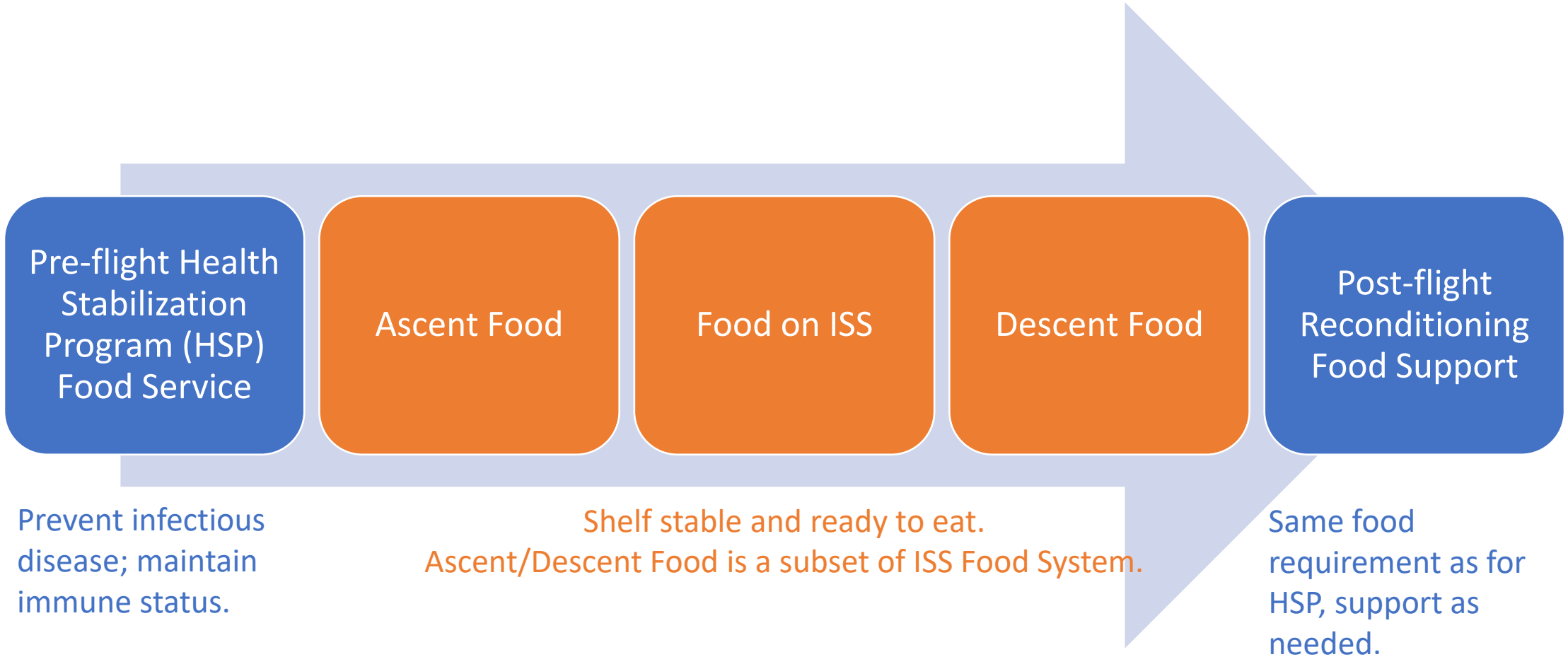
JSC Space Food System Laboratory (B17)
Space Food Research Facility – College Station



Why is Food Important?

- Food and Nutrition
  - Macronutrients and Energy
    - Insufficient calorie – body mass loss
    - Insufficient water – dehydration
  - Vitamins
    - Insufficient Vitamin D – bone density loss
  - Minerals
    - Excess calcium intake – kidney stone
    - Excess sodium intake – effects on bone and other systems
  - etc.
- Mental Wellbeing
  - Crewmembers in control of food options
  - Taste of home
  - Social during group meals – sharing food and conversation

Food Supporting Space Flight



HSP Food Service



Avocado Toast, Egg Your Way, Choice of Meat



Steak Salad, Poppyseed Fruit Salad



Chicken w Kiwi Mango Salsa, Coconut Rice, Broccolini Carrots



Chocolate Cake with Crew-4 Logo



BBQ

Space Food History



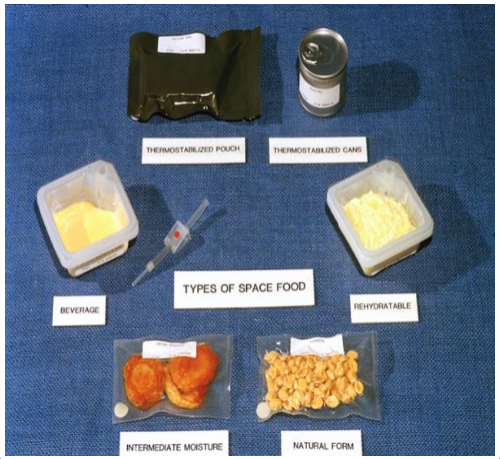
Mercury & Gemini



Apollo



Skylab



Shuttle

ISS Food System Overview



Bulk Overwrap Bag



Thermostablized Food



Rehydratable



Intermediate Moisture



Utensils



Natural Forms & Condiments



Beverages



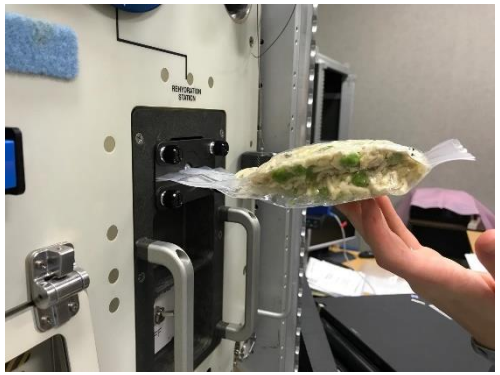
Crew Preference & Holiday



Fresh Produce

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implied, by the National Aeronautics and SpaceAdministration.

Dining on International Space Station



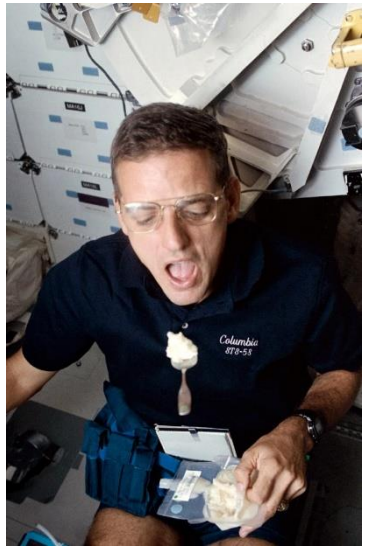


Galley



S129E007955





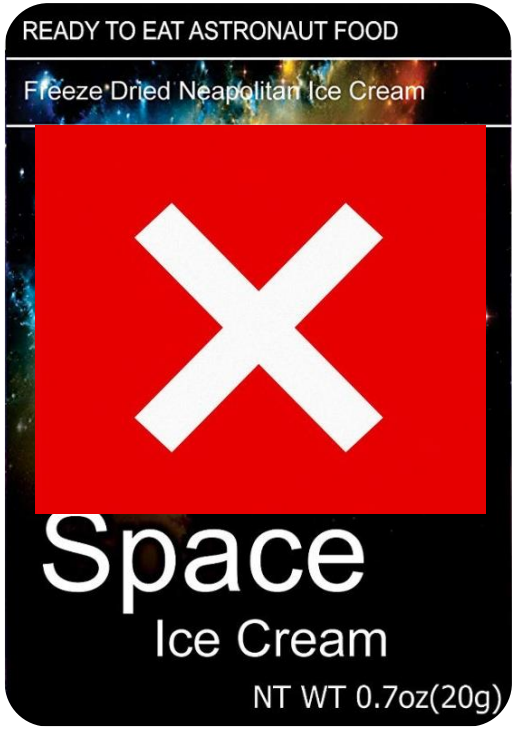
Micro Gravity

Space Food Trivia

NASA invented Tang?



Astronauts eat freeze-dried ice cream?



Today's urine is tomorrow's coffee?



Courtesy Reference: https://www.mondelezinternational.com/Our-Brands/Tang
https://www.amazon.com/Space-Ice-Cream-Count-Neapolitan/dp/B07CGXDNNW/ref=sr_1_13?keywords=Space+Ice+Cream&qid=1580003410&sr=8-13
https://www.justpo.st/channel/astronaut+in+space+coffee+art

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ISS Food System Composition

- Standard Menu Containers ~75%
- Specialty Containers ~25%
  - Crew Specific Menu (including IP foods)
  - Coffee Tea Preference
  - Shelf Stable Food Kit
  - Fresh Food Kit
  - Cold Stowage Kit
  - Holiday BOB
  - Science Containers (Food Physiology, Vascular Aging)
- Others (subject to SFSL approval) ~1%
  - Crew Care Package
  - Frozen Treats



BOB, 2~8kg
(14.875”x12”x4.875”)





12”x12” Zippers



½ CTB

Containers and its corresponding packaging types are color coded.

ISS Standard Menu Containers

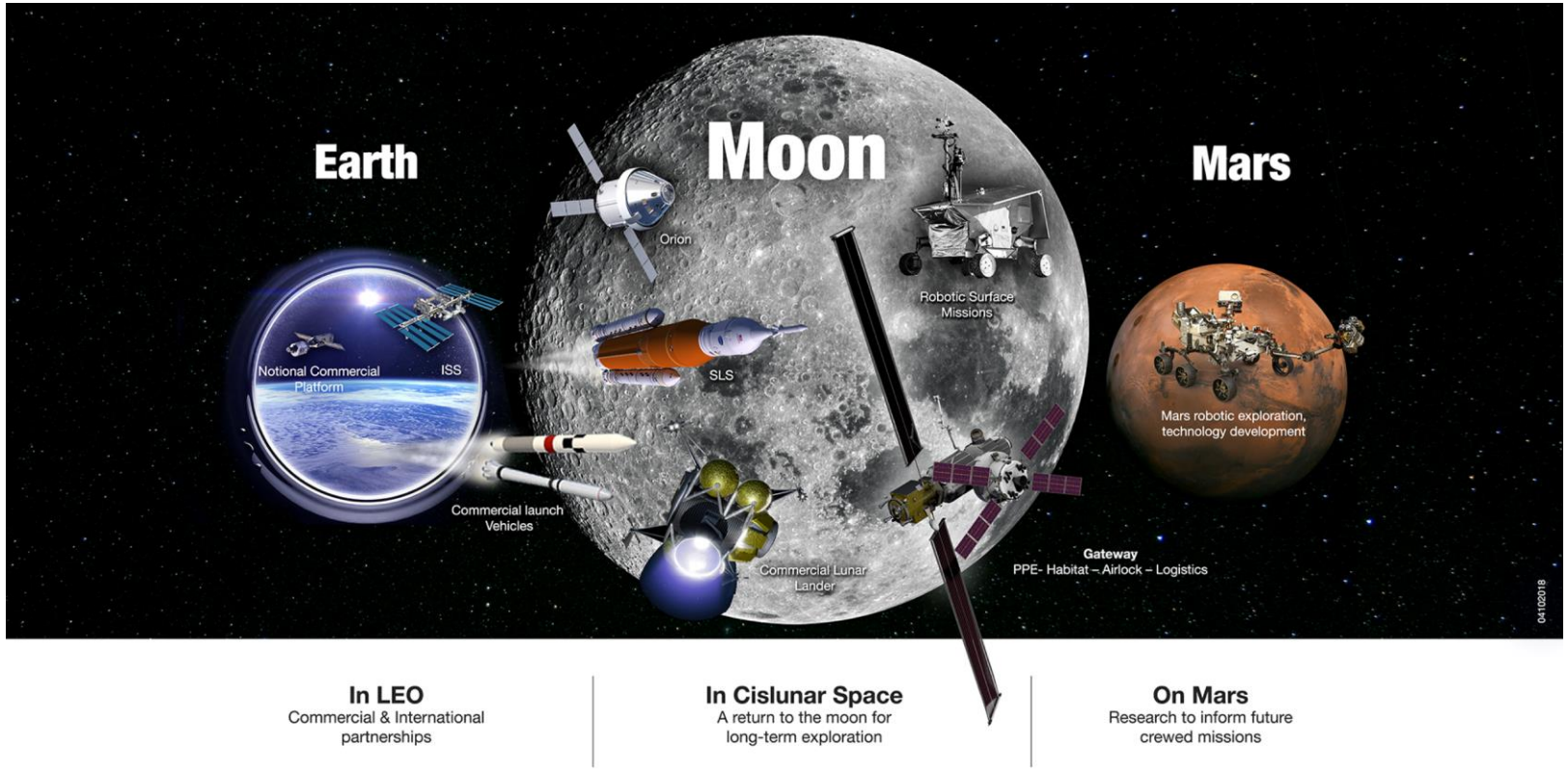
- “Pantry” shared by all USOS crewmembers
- Pre-packaged shelf stable foods with 3-year shelf life
- About 200 items on the Standard Menu
- 10 Categories
  - Beverage and Straws
  - Breakfast
  - Desserts & Snacks
  - Fruit & Nuts
  - Meat & Fish
  - Rehydratable Meats
  - Side Dishes
  - Vegetables & Soups
  - Nutrition Bars
  - Tortillas
  - Condiments
- Inventory and resupply rate are tracked at container level by each categories



Challenges for Space Food System

- Providing safe, nutritious, palatable, and sufficient food throughout shelf life.
  - **Safety**
    - ✓ Safe to **consume** throughout 3-year shelf life for ISS (micro, aw/moisture, packaging integrity, etc.)
    - ✓ Safe for space **flight** (FOD, ethanol, packaging material test, etc.)
  - **Nutrition**
    - ✓ Nutrient retention while meeting **safety** requirement
    - ✓ A food system with **balanced** nutrition
    - ✓ Nutrient degradation throughout **shelf life**
  - **Palatability**
    - ✓ Relatively small but diverse target consumer group with personal **preference**
    - ✓ Maintaining acceptability while meeting safety and nutrition requirement throughout the **shelf life**
  - **Sufficiency**
    - ✓ **Variety** needed to overcome menu fatigue – opposite of food industry (less variety, bulk quantity)
    - ✓ Sufficient reserve **inventory** in the event of cargo vehicle slip
    - ✓ Weight and volume constraint on cargo vehicles limiting food quantity

Challenges for Future Space Food System

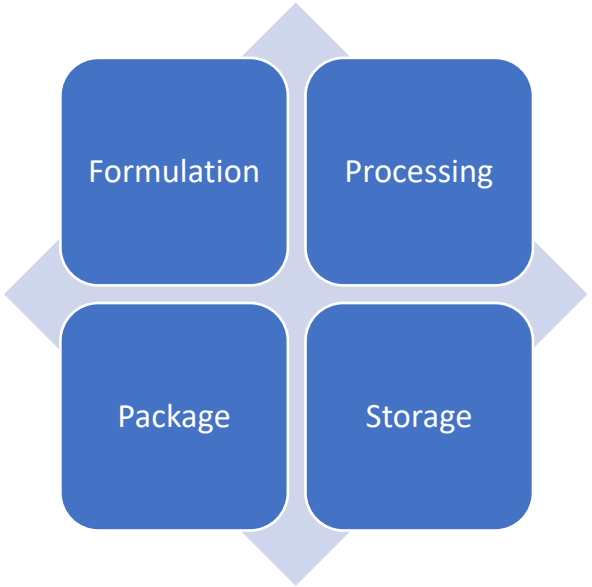


- 5 year shelf-life
  - Acceptability
  - Nutrition
- Variety scarcity
- No crew preference
- No resupply

Future of Space Food System

A **COMBINATION** of pre-packaged shelf stable food, bioregenerative fresh produce, and potentially other technologies to address nutrient degradation and variety scarcity.

Pre-packaged shelf stable food



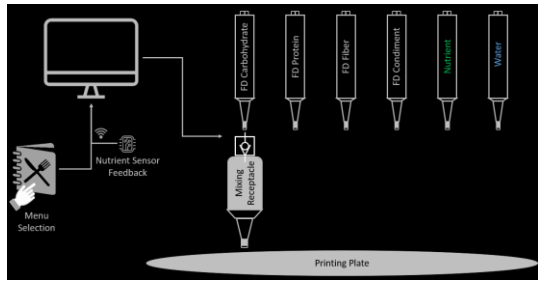
Bioregenerative food



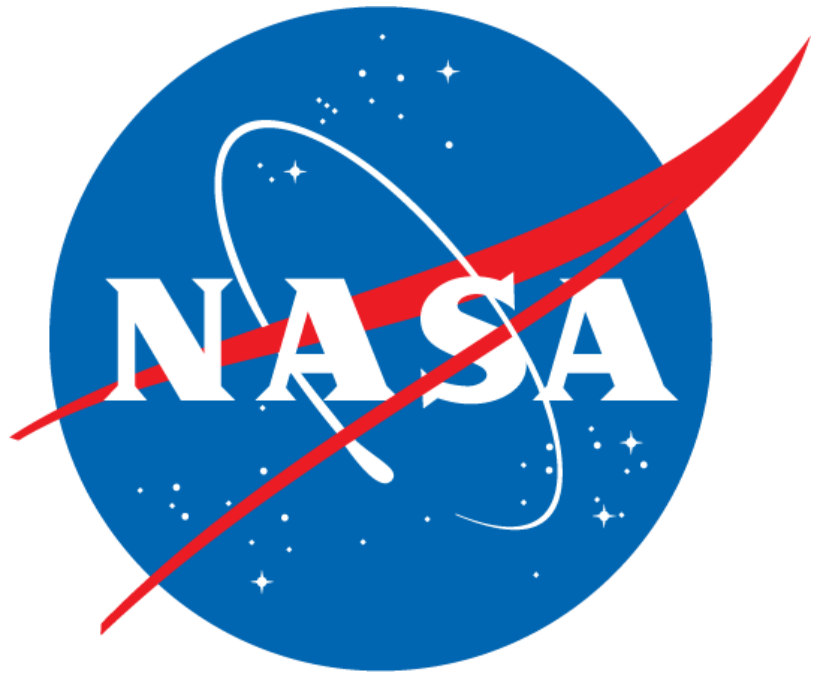




3D Printing of Freeze-Dried Ingredients



Thomas Marshburn: It's nothing short of miraculous y'all can put this all together and send it all around the world not knowing where it's going to launch from and still be good even after a year after sitting up on orbit. So really appreciate all the amount of expertise and work that goes into that.


NASA