NASA

The following equipment needs to be miniaturized and made more efficient:

- Ovens and microwaves
- Extruders, mixers, grinders, and extruder-expellers
- Fermentors/bioreactors
- General-purpose mills
- Soybean processors
- Wheat processors
- Refrigerators and freezers

The Challenge: Food Packaging

To ensure extended shelf life and food safety and to minimize weight and waste, new packaging methods and materials are needed. In developing new packaging concepts, solid waste management, food and packaging mass and volume, and crew preparation time need to be taken into consideration. Research and development are needed in the following areas:

- High-barrier packaging materials for three to five year shelf-life foods
- Multi-use package types and styles to minimize inventory and supplies
- Reusable/recyclable or degradable packages
- Flexible packaging for easier storage
- Bulk packaging for dry flowables
- Microwave-compatible packaging for three to five year shelf-life foods

The Challenge: Food Preservation

Food products for planetary outpost must safely maintain a shelf life of up to five years under ambient storage conditions. Some storage for refrigerated and frozen food items may be available for long-term missions, but the majority of resupply items will need to be stored in ambient temperatures. In order to ensure a three to five year shelf life, new food preservation methods need to be explored. Potential food preservation methods include:

- Emerging technologies such as high and medium pressure processing, ohmic heating, ultrasound, pulsed electric field, arc discharge, light pulse, ultraviolet light, oscillating magnetic field, induction heating, ozone, modified atmosphere system, chemical and biochemical methods, radio frequency, plasma, and microwave sterilization
- Advances in conventional technologies such as retort sterilization, hot fill and hold, membrane filtration, aseptic processing, irradiation, dehydration, refrigeration, and freezing

For more information

Visit NASA's Advanced Life Support program at http://advlifesupport.jsc.nasa.gov.

To learn how your company can participate in meeting the Advanced Food System challenge, contact:

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http://www.ag.iastate.edu/centers/ftcsc/

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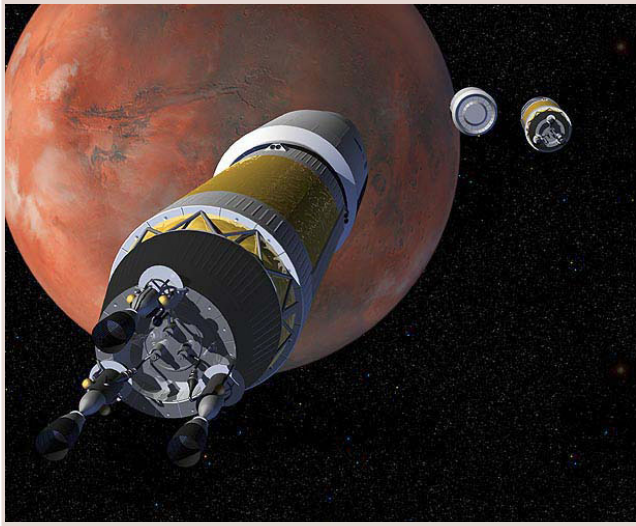
The Advanced Food System Challenge

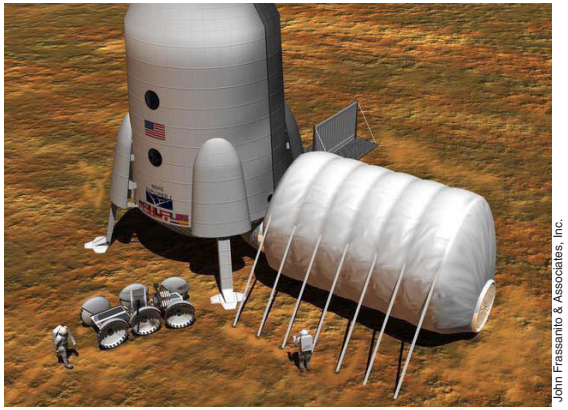


John Frassanito & Associates, Inc.

for Planetary Exploration

Food Technology Commercial Space Center
Funded by NASA

The Advanced Food System Challenge for Planetary Exploration



John Frassanito & Associates, Inc.

The mission of the NASA Food Technology Commercial Space Center (NASA FTCSC) is to lead a national effort to develop foods and food-processing technologies that enhance space missions and advance commercial food products through cooperative efforts with NASA scientists and technologists, commercial companies, and academic researchers.

To accomplish this mission, NASA FTCSC is developing partnerships with commercial companies to meet the challenges of developing an Advanced Food System (AFS) for long-term space exploration and habitation of the Moon and/or a planetary outpost such as Mars. Our commercial partners commit research staff, facilities, and materials to specific product and process development projects that address the unique requirements of long-term space missions and have applications on Earth as well. Commercial partners share the experience of working on a national/international project and maintain the patent rights to potential developments.

The AFS needs to provide a diet that is safe, psychologically satisfying, nutritious, and acceptable. A mission to Mars could extend for three years; including a six to eight month transit to Mars, an 18-month stay, and a six to eight month transit home. The food system on a lunar or planetary outpost will consist of a combination of packaged foods that have a three to five year extended shelf life (resupply items) and foods grown and processed at the outpost (regenerables). The transit vehicle food system will include a combination of packaged foods and salad crops grown during flight in a microgravity environment. On the reduced-gravity planetary outpost, prepackaged foods will play a smaller part in the diet with the majority of foods coming from grown crops.

To meet the unique requirements of an AFS, NASA needs to

- Minimize mass for packaged foods
- Minimize energy and water usage for processing foods on outposts
- Develop packaged food products with a shelf life of three to five years
- Develop a food supply that heavily depends on regenerable crop production (crops to be grown in space could include bell peppers, cabbage, carrots, dry beans, herbs, lettuce, onions, peanuts, potatoes, radishes, rice, soybeans, spinach, strawberries, sweet potatoes, tomatoes, and wheat)
- Develop food-processing systems that operate in reduced gravity

In addition to developing foods with a longer shelf life, NASA needs

- Packaging materials with high barrier properties to ensure a longer shelf life
- Food preservation research and development to extend shelf life and improve quality
- Packaging and preservation technology integration
- Miniaturized food-processing equipment

The Challenge: New Food Products

To maintain the health of astronauts, foods must be safe, nutritious, palatable, flavorful, and psychologically satisfying. Product research and development are needed in the following areas:

- New packaged foods with improved nutrition and quality
- New food recipes for site-grown crops
- New meal menus and recipes
- Products that maximize utilization of plant byproducts

The Challenge: Post-Harvest Food-Processing Equipment

Once the planetary outpost is established, crops must be harvested and processed into edible ingredients and/or menu items. In order to harvest and process foods on planetary outpost, current processing technologies will need to be miniaturized and new technologies developed. Environmental constraints require that equipment be compact, multifunctional, and lightweight. NASA needs post-harvest food-processing equipment that

- Manufactures palatable food ingredients and/or finished products from raw crops on planetary outpost
- Produces multiple food ingredients from one piece of equipment
- Provides food that is acceptable, nutritious, and safe
- Works in partial gravity
- Requires minimal crew time and energy for operation and cleaning
- Produces minimal solid waste, air pollution, and odors
- Demands low levels of consumable materials
- Generates minimal waste water and can be easily cleaned and sanitized