As NASA begins to look beyond low-Earth orbit and to plan for future exploration missions, such as to the Moon or Mars, new food science technologies will be needed. The impossibility of regularly resupplying a Mars crew means that the prepackaged shelf-stable food, ingredients, and equipment to provide a complete diet for six crewmembers for more than three years will have to be carried with them. As the crew remains on the Moon or Mars surface, crops will be grown to supplement the crew’s diet, using plants to revitalize the air and water supply. Methods are needed, therefore, for processing potential food crops. Areas in which innovations are solicited follow below.

Long-Duration, Shelf-Stable Food

An initial trip to the Moon or Mars will require a stored food system that is nutritious, palatable, and provides a sufficient variety of foods to support significant crew activities on a mission of at least three years duration. Development of highly acceptable, shelf-stable food items that use high-quality ingredients is important to maintaining a healthy diet. Foods should maintain safety, acceptability, and nutrition, for the entire shelf life of 3±5 years. Shelf-life extension may be attained through new food preservation methods and/or packaging. Once on the lunar or planetary surface, it may be possible to use bulk packaging of meals or snack items. These food products will require specialized processing conditions and packaging materials.

Advanced Packaging

The current food packaging technologies represent a potentially significant trash-management problem for exploration-class missions to the Moon or Mars. New food packaging technology is needed that minimizes waste by using packaging with less mass and volume and/or by using packaging that is biodegradable or recyclable. Another opportunity would be development of a packaging material that can readily be reused by the crew to make objects of value to the space flight mission.

Food Processing

Advanced life-support systems, which use chemical, physical, and biological processes, are being developed to support future human planetary exploration. One such system might grow crops hydroponically and then process them into edible food ingredients or table-ready products. Variations in crop quality, crop yield, and nutrient content may occur over the course of long-duration missions, posing further requirements to the food processing and storage system. Such variations might affect the shelf stability and functional properties of the bulk ingredients and...
ultimately, the quality of the final food products.

Equipment to process crops on missions to the Moon and Mars should be highly reliable, safe, automated, and should minimize crew time, power, water, mass, and volume. Equipment for processing raw materials must be suitable for use in hypogravity (e.g., 1/6g on Moon, 3/8g on Mars) and in hermetically sealed habitats. Some potential crops for advanced life-support systems include minimally processed crops such as lettuce, spinach, carrots, tomatoes, onions, cabbage, bell peppers, strawberries, fresh herbs, and radishes. Other baseline crops that require processing would be wheat, soybeans, white potatoes, sweet potatoes, peanuts, dried beans, rice, and tomatoes. There is a need to develop one or more pieces of food processing equipment for each of these crops.

**Food Safety**

Assurances of food quality and food safety are essential components in the maintenance of crew health and well-being. Food quality and safety efforts should be focused on monitoring the shelf stability of processed food ingredients and on identification and control of microbial agents of food spoilage, including the development of countermeasures to ameliorate their effects. Determination of radiation on crop functionality and the stored food system shelf life is also needed in the development of the food system. For all food production and processing procedures, Hazard Analysis Critical Control Points (HACCP) must be established.