Lunar Amended Regolith Gardening Experiment (LARGE). P.E. Clark¹, John Elliott¹, Gerald Voecks¹, Max Coleman¹, Don Ruffato¹, Barry Nakazono¹, Nitin Singh¹, Paul Briggs¹, Eric Sunada¹, David Eisenman¹, Simon Gilroy², ¹Jet Propulsion Laboratory/California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA 91109, ²University of Wisconsin, Department of Botany, Madison, WI 53706 Email: pamela.e.clark@jpl.nasa.gov.

**Purpose:** We are devising the Lunar Amended Regolith Gardening Experiment (LARGE), to demonstrate that lunar regolith collected in situ, as opposed to Earth soil amended with lunar regolith [1] or a lunar regolith simulant [2], could support plant growth on the lunar surface. LARGE will demonstrate the feasibility of sustainable food production for lunar colonists using in situ lunar resources.

**Nature of the Experiment:** We will test the hypothesis that lunar regolith will release measurable quantities of nutrients that are sufficient to support plant growth. Radish seeds will be deposited into collected regolith, the sample hydrated and the rate of germination and plant growth monitored alongside measurements of the amount of inorganic nutrients released to the water. Thus, we will determine the bioavailability of minerals in up to 12 independent samples of the same size, including fully wetted lunar regolith, under controlled temperature and pressure conditions (STP), radiation exposure (shielded container) and illumination (LED, Earth diurnal cycle). The proportion of organic nutrients added to each cell would vary, allowing determination of minimal as well as optimal organic supplementation required. The following would be monitored in each cell:

- Atmospheric CO₂, T, P, humidity
- Soil oxygen, pH, eH, selective ion (Mg²⁺)
- Visual time lapse images

**Instrument Concept and Operation:** LARGE consists of a carousel chamber with ~12 cells comprising an upper (organic nutrient and radish seed containing) and lower (sampler) portions. The system also contains the requisite sensors, water and compressed air chambers, along with supporting subsystems. One or more 'control' cells (for which regolith will not be collected) will include the specific lunar regolith simulant we will use to test the experiment on Earth. Results from these control samples will provide key comparisons to allow us to more fully interpret results from regolith samples on the Moon. We would maintain organic components in a freeze-dried vacuum sealed pouch located in the upper portion of each cell for transit to the Moon.

The current automated version of LARGE is deployed vertically from the bottom of a lander deck to within ~10 cm of surface via a simple pulley mechanism with feet at each corner. Individual samples are then collected sequentially. A fiberoptic microimager attached to the sampling device takes an image to assess mineralogical composition just before each sample is taken. Simple direct movement, to minimize dust issues, comparable to Apollo’s small drive tubes for sampling, thrusts the sampler down into the regolith and then pulls it up into the currently active cell. A bottom seal is moved into position and the bottom and top portions of the cell are united, capturing a regolith sample of ~10 g in a sealed chamber. Following sample collection, the box containing the carousel is sealed to maintain temperature and pressure and diurnal lighting begins.

A vacuum sealed water-soluble membrane pouch is then broken, and the contents released into each cell as it is pressurized, mixing the cell’s contents of water, seeds, nutrients, and regolith. Reduction potential (eH), pH, selective ion (Mg²⁺), and oxygen sensors attached to the top cell now contact the water/regolith mixture and are able to record changes within the water/regolith phase. Depending on the nature of the measurement, hourly to daily time points are taken. Time lapse images will allow the monitoring of seed germination and plant growth. The experiment will run for a minimum of 7 Earth days to allow sufficient time for germination (~2 days) and seedling growth.

**Instrument Requirements:** Current best estimates, are summarized below. High-performance thermal components now being developed at JPL should further reduce power and mass requirements. The experiment would run during lunar day.

- Mass: 35 kg
- Power: Peak (initial set up including sample acquisition only) 10W, typically <5W (in use)
- Volume: ~24 U
- Bandwidth: Low
- Cost: $30 million

**Crew Involvement and Operation:** Though this is currently designed as a fully automated package, crew deployment could simplify the design. Crew monitoring could also contribute to our understanding of the unit’s performance and enhance educational outreach possibilities. Another option would be to run the LARGE experiment in the crew habitat, simulating how Lunar colonists could have 'greenhouses' employing in situ resources inside their habitats.