Biology/Technology/Engineering Synergisms Needed to Enable Productive & Affordable Plant Growth in Space to Support NASA's Missions

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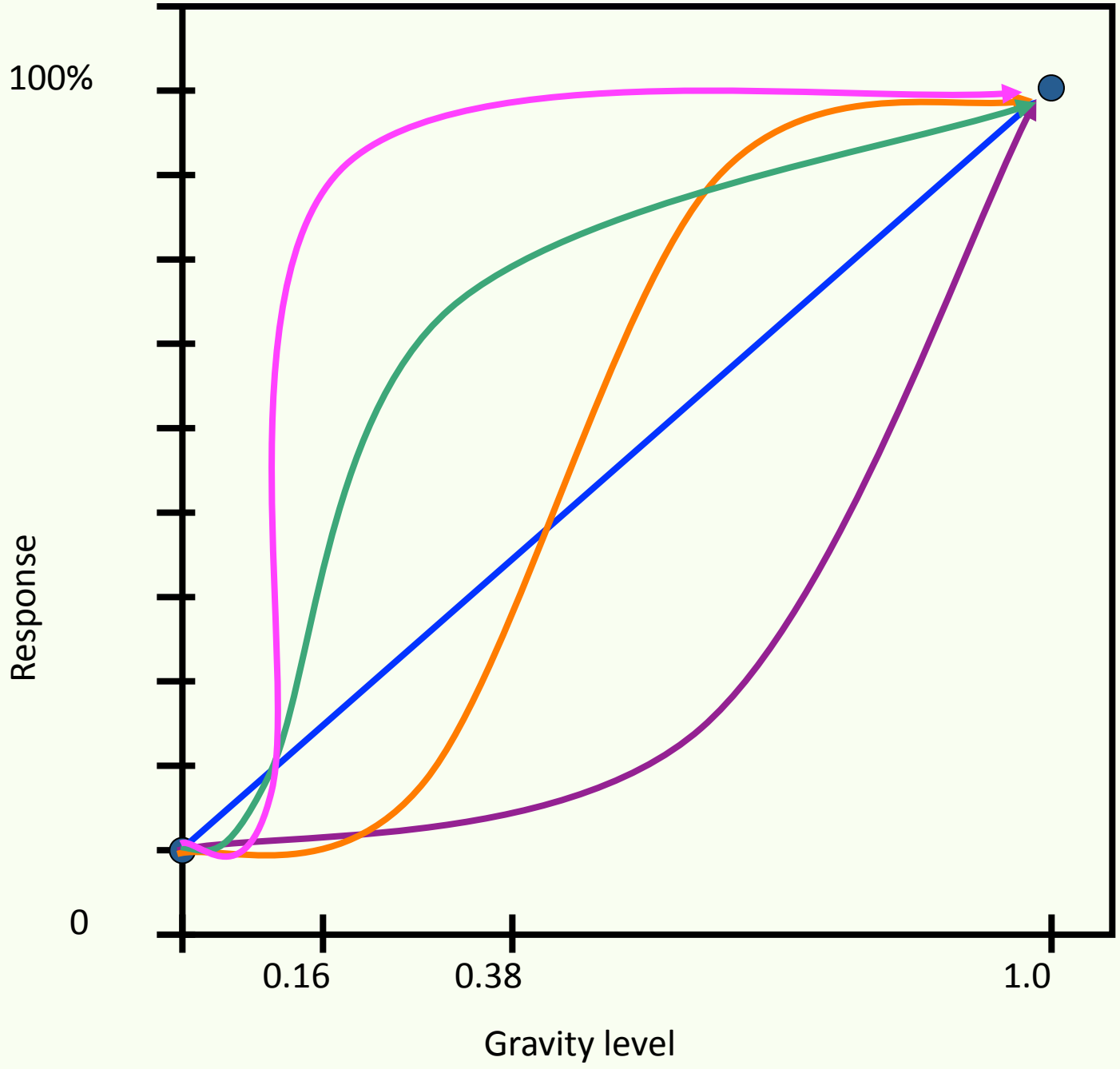
Plant Parameters Likely Affected by Hypo-Gravity and Space Radiation

- polarity
- apical dominance
- root : shoot orientation
- water uptake
- long-distance assimilate translocation
- leaf and root gas exchange
- transpiration
- partitioning biomass between edible / non-edible parts
- lignification
- mechano-stress sensitivity
- anti-oxidant levels
- cell division / enlargement


100%
Response
0
0.16
0.38
1.0
Gravity level

Micro/nano-devices for tissue detection and monitoring of

- Oxygen concentration
- Ethylene concentration
- Nutrient content
- Vibration profile
- Photosynthetic responses

Leveraging technology to solve problems related to plant responses to spaceflight conditions

- With help of in planta nano-accelerometers, create artificial mechanical environments in space to counteract negative μg effects
- Create transgenic plants with improved stress tolerance

Life-support Plant Research Needs

- Determine productivity potential of space life-support candidate crop species at 0.16 x g compared to 0.38, 1.0 x g

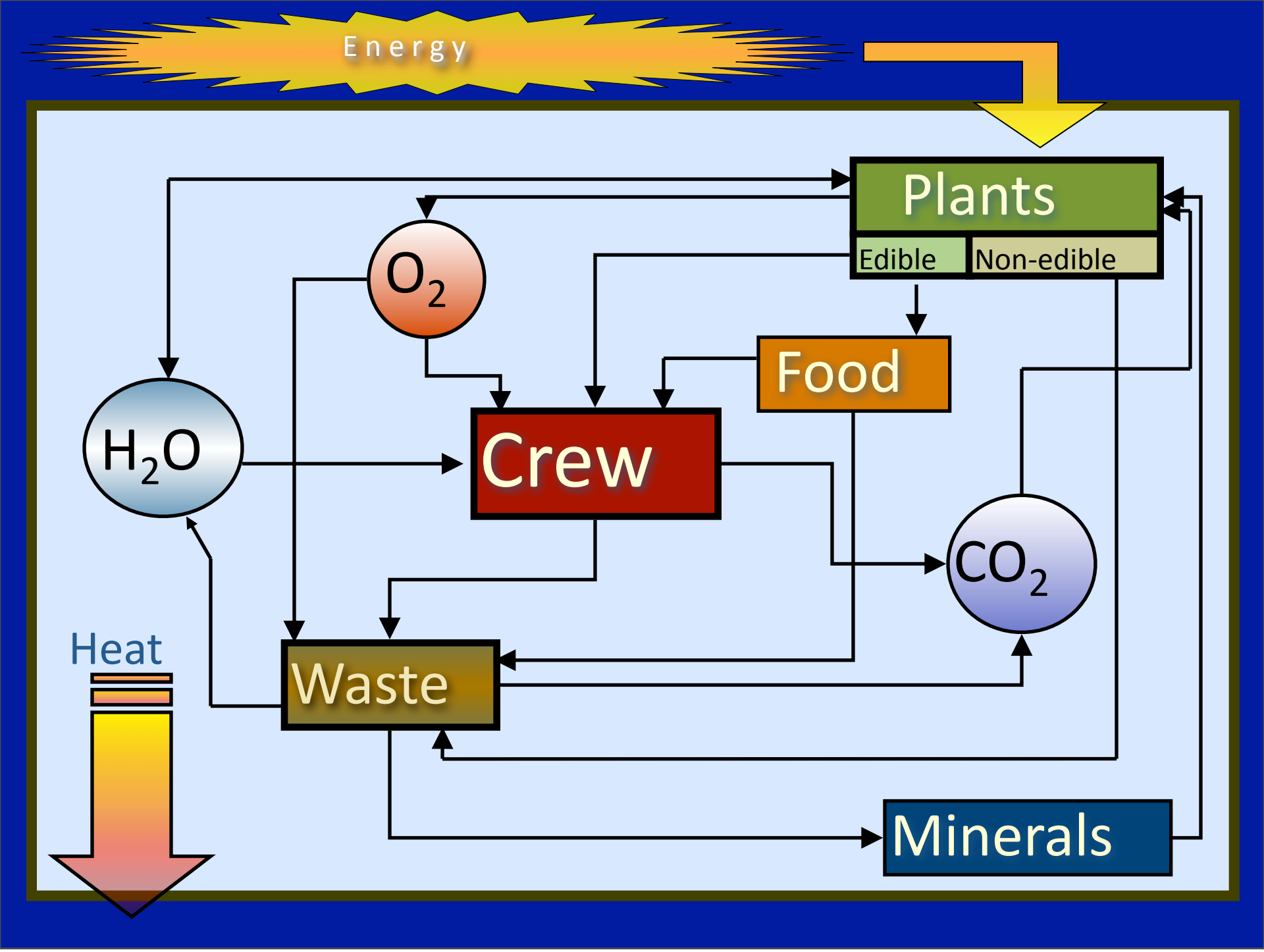
- Determine radiation tolerance / shielding requirements for candidate crop species

- Minimize Equivalent System Mass (ESM) requirements:

  - mass (M) - volume (V) - power (P) - cooling (C)

  - crew time (CT) - mission duration (D)

$$ESM = M + (V \bullet V_{eq}) + (P \bullet P_{eq}) + (C \bullet C_{eq}) + (CT \bullet D \bullet CT_{eq})$$

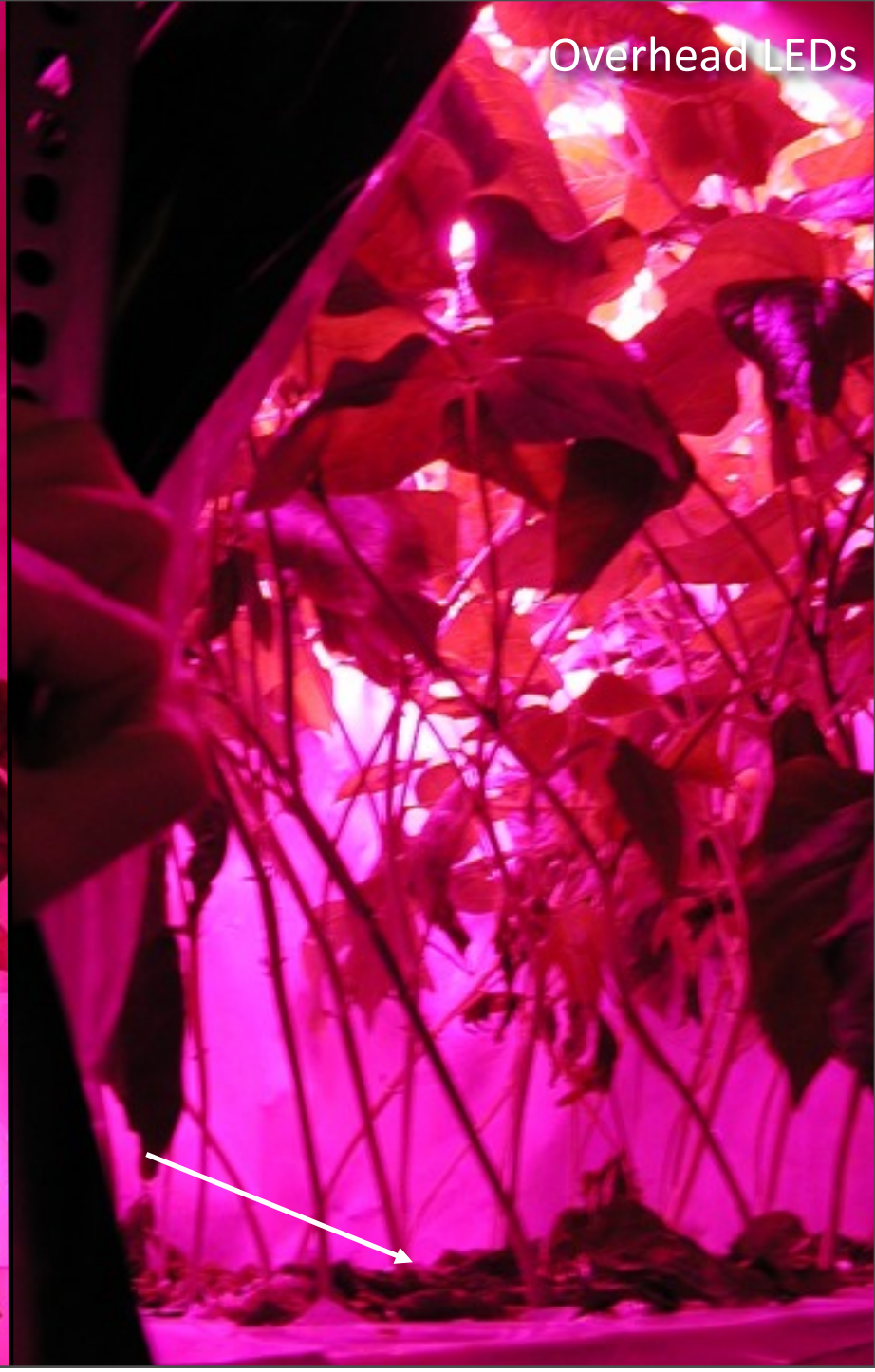

Energy
Plants
Edible
Non-edible
O_2
Food
H_2O
Crew
CO_2
Heat
Waste
Minerals

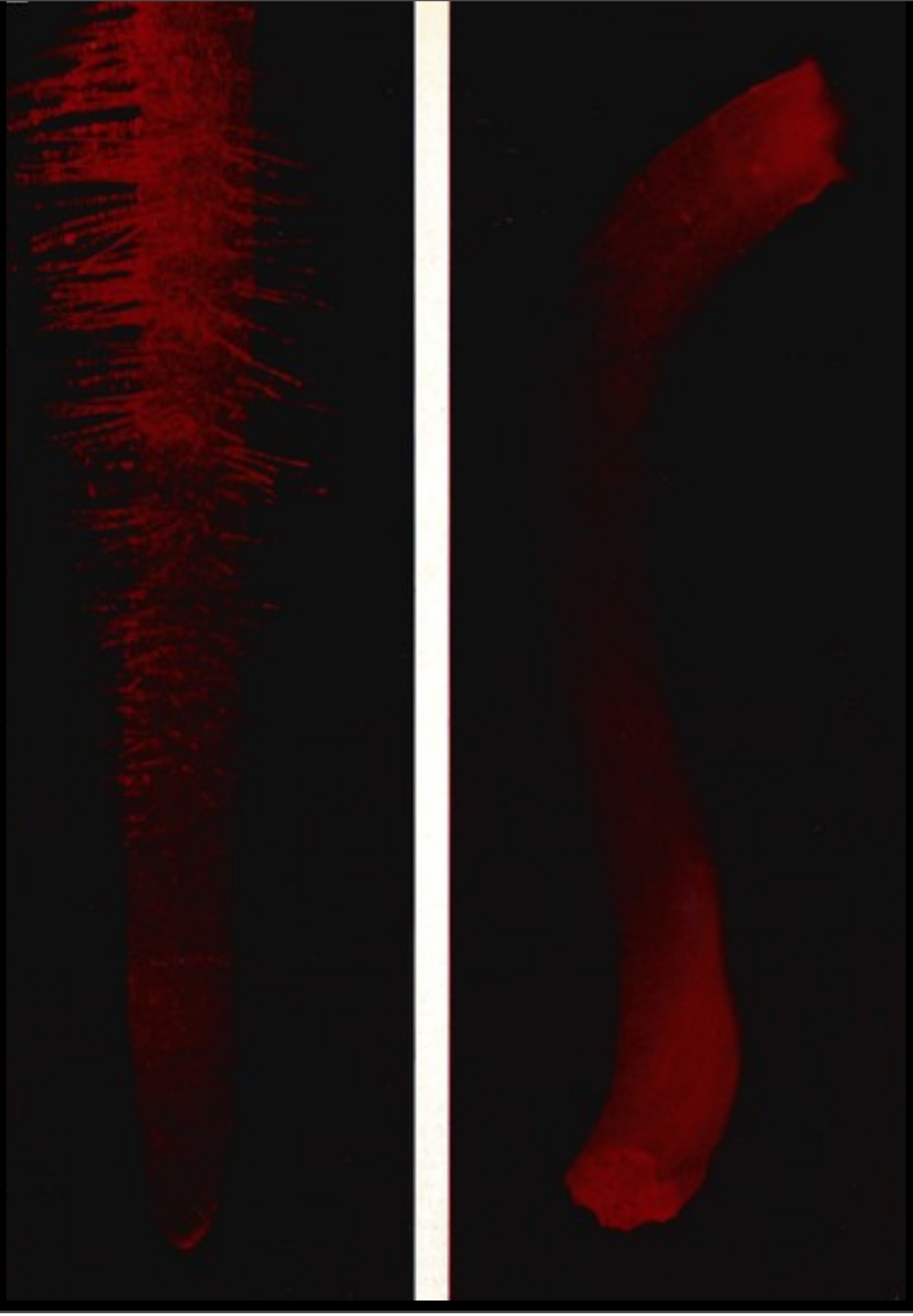
Lightsicle LED Array

Intracanopy

Overhead

Intracanopy LEDs


Overhead LEDs



Mandoli & Briggs. 1984.Fiber optics In plants. Sci. Amer. 251 (2): 90-98.

FARMING ON THE MOON