ARC CENTRE OF EXCELLENCE IN PLANTS FOR SPACE

CONTROLLED-ENVIRONMENT AGRICULTURE (CEA)

The ARC Centre of Excellence in Plants for Space (P4S) is developing technologies to enable humans to survive and thrive in space, reducing the dependence on constant resupply, and using this lens to transform the sustainability of food and bioresource production on Earth.

One of our core missions is to develop zero-waste plants optimised for controlled environments.

Tightly controlled CEA environments provide a unique opportunity to exceed assumed limits in plant performance. P4S will redesign crops to generate bespoke CEA plant varieties by co-optimising plant traits and growth environments, i.e., humidity, light, temperature, CO2/O2, and nutrition. Our aim is to develop fast-growing, zero-waste plants by:

- Accelerating growth under longer day lengths and optimal nutrition;
- Removing energy-intensive processes not required in CEA (e.g., drought, starvation, defence against insects) and re-directing that energy to improve growth;
- Converting all plant parts to be usable, whether for food or other end-uses, to achieve near to zero-waste production);
- Enhancing nutrient and water use efficiency to minimise required inputs, while also removing anti-nutrients that would impact the bioavailability of key nutrients for consumers; and
- Improving salt tolerance without reducing yield by directing salt accumulation into plant components that don't affect growth, but can improve taste.

Parameters for CEA environments will first be optimised via process-based modelling in digital twins to ensure sustainability of energetic and other inputs. Digital twins will also be used for iterative calibration of plant and environment design to ensure suitability for robust autonomous propagation, growth, and quality control. Finally, plants will be tested at-scale in industry production facilities via P4S partners.

CASE STUDY: OPTIMISED STRAWBERRY TRAITS

Leveraging untapped genetic variation from wild varieties, we are optimising strawberries for greater on-Earth productivity through:

- Soilless growth, by making roots smaller but more efficient, tolerant of salts in hydroponics, and tolerant to wet (low oxygen) and dry cycles. Relevant genes are currently being tested in model plants.
- Better fruit yield and flavour, by allocating more biomass and sugars to fruit, and introducing new flavour traits from alpine strawberry ancestors. We are also extending the fruiting season by making varieties neutral to daylength.
- Zero-waste. Larger fruit will increase the harvest index, and we are also making the edible leaves more nutritious in tea or as greens, e.g., by adding proteins, oils, starches, and flavours.

P4S researchers are also working on tomato, lettuce (pick & eat), and duckweed (as a biofactory).

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ABOUT PLANTS FOR SPACE

The ARC Centre of Excellence in Plants for Space (P4S) is a transdisciplinary endeavour involving multiple skillsets from systems and process engineering, plant biology, food chemistry, psychology, education and space law. Our international and national consortium has representation across a wide range of industries. This includes space, controlled environment agriculture, and food manufacturing.

We will have a standing load of 200 Australian based researchers by 2026 located in our foundational universities of the Universities of Adelaide, Flinders, Melbourne, La Trobe and Western Australia, and aim to train over 400 researchers by 2031. We will encourage entrepreneurship, and a spin in and spin out culture, to support growth in the Australian space industry. We also have a large outreach program to schools and the general public, with all of our researchers spending at least 10 days per annum on engagement activities.

We provide a nucleus of activity, network and pathway to collaborative industry-academic partnerships globally to perform transformative research, develop plant and food technologies to enable long-term space habitation, and provide new sustainable high-value bioproduction on Earth. We are open to leveraging our skillbase to engage in new opportunities. Contact us for more information.

PLANTS FOR SPACE PARTNERS

Australian Universities
The University of Adelaide
The University of Western Australia
La Trobe University
The University of Melbourne
Flinders University

International Universities
University of California, Berkeley
University of California, Davis
University of Wisconsin-Madison
Rice University
University of Cambridge
University of Nottingham
Research for Agriculture, Food and Environment - INRAE
ETH Zürich

Education and Engagement
The Andy Thomas Space Foundation
Dr Joanna McMillan
The Victorian Space Science Education Centre (VSSEC)
One Giant Leap Australia Foundation
South Australia Botanic Gardens and Herbarium
FOODiQ Global

Controlled Environment Agriculture
Vertical Future
Space Lab
Gaia Project Australia

Government
South Australian Space Industry Centre (SASIC)
Defence Science and Technology Group (DSTG)
Department of Primary Industries and Regions, South Australia (PIRSA)

Space Agencies
National Aeronautics and Space Administration (NASA)
Australian Space Agency (ASA)
German Aerospace Centre (DLR)

Space Enablers
Axiom Space
yuri
Saber Astronautics

Technology Providers
Twist Bioscience
BioPlatforms Australia
Australian Genome Research Facility (AGRF)
Australian Plant Phenomics Network (APPN)

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