3D printed aeroponic tray nutrient delivery system for bioregenerative life support systems

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Introduction

- Higher plant based biological life support systems present advantages for long duration human spaceflight missions [1]
- DLR is investigating aeroponic nutrient delivery systems to maximize crop yields per unit area and to minimize waste (Figure 1)
- Possible application in medium to large scale microgravity and planetary surface plant production systems [2]

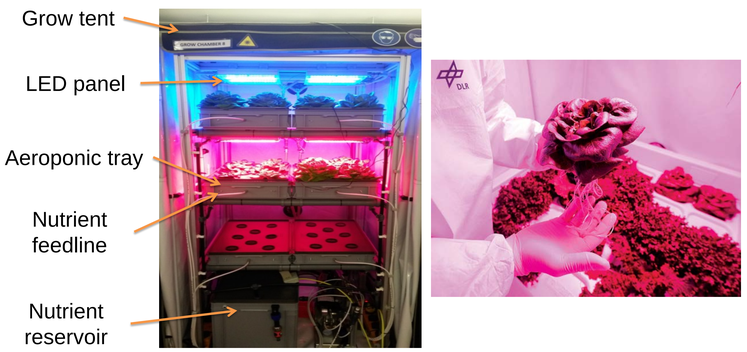


Figure 1: EDEN laboratory plant growth trays employed in a multilevel plant growth system (left) and cultivation through aeroponic method (right).

EDEN research team Eurobox trays

- Eurobox trays have been used in past EDEN team crop growth experiments (Figure 1 left)
- These are standard boxes modified into aeroponic trays
- Current limitations are seed pinching, stray light in the root zone and non-adjustable plant spacing

Design selection

Holder type	Screw holder	Plain holder
Body color	Black color	White color
Plant spacing adaptation	Modular root compartment	Fixed height root compartment
Type of tubing line	Internal line	External line
Root support structure	For individual holders	For the whole tray
Materials	ABS + HIPS	PLA + PVA
Number of misters	4	2

Final design

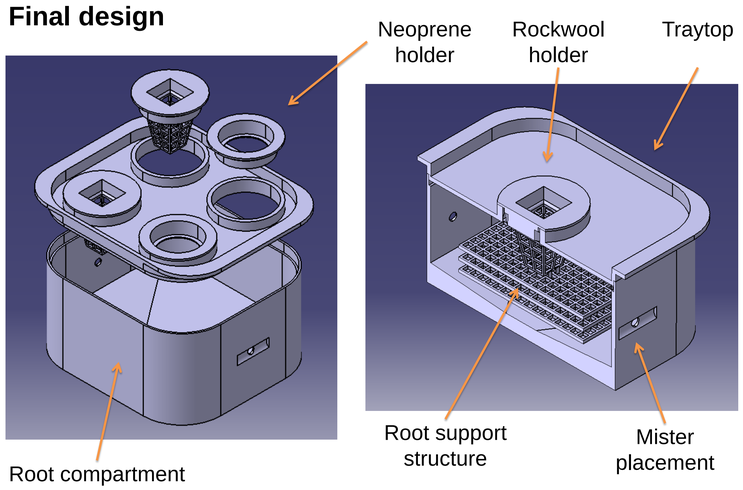


Figure 2: Completed CAD design of EDEN custom aeroponic tray (left) and tray cross section showing root support structure (right)

Manufacturing method

- New aeroponic tray produced using additive manufacturing, Fused Filament Fabrication (FFF)
- Economically and operationally feasible for research and planetary applications (in-situ food production)

Results and conclusion

- The EDEN team has designed a custom 3D printed aeroponics tray (Figure 3)
- This custom tray and used for research within the EDEN laboratory and is planned for use within the EDEN ISS greenhouse in Antarctica
- Possible applications on planetary surfaces of Moon and Mars

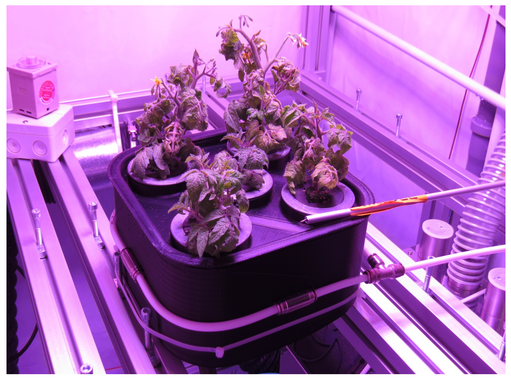


Figure 3: Tray under test in EDEN laboratory

Further Developments

- Large size 3d printing, for 400 mm x 600 mm root compartments and tray tops (Figure 4, Table 1) for EDEN ISS greenhouse
- Selection of 3D printing materials for closed environment plant growth systems
- Recycling technique of printed units

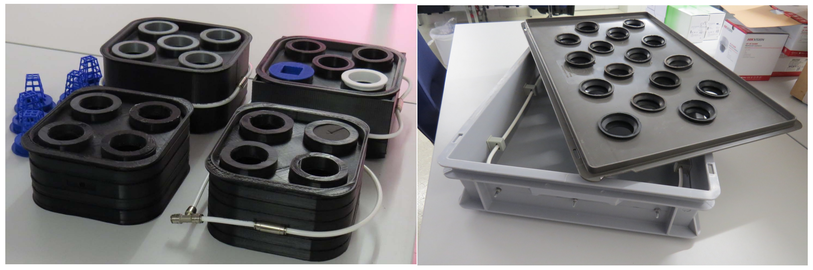
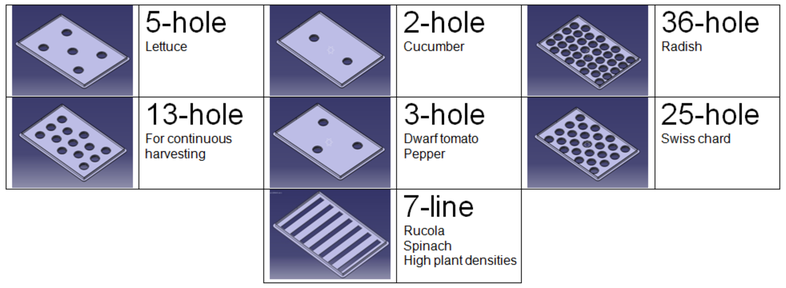


Figure 4: New trays (left) and Eurobox 400 mm x 600 mm tray (right)

Table 1: 400 mm x 600 mm tray layout for EDEN ISS project with their respective target crop



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References

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