EDEN ISS – The Antarctic Space Greenhouse and its Terrestrial Spin-offs

Institut für Raumfahrttechnik
Dr. Daniel Schubert

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In the future...

...Mankind will travel to Moon & Mars, eventually!
Building a human outpost!

Mars Habitat (NASA)

LavaHive

Sinter Hab for Moon (ESA)

Lunar Mission Concept (NASA)
Greenhouse Modules in future Habitats on Moon and Mars

Fresh Food
Atmosphere Revitalization
Water Recycling
Well-Being

NASA Food Production Facility Concept (2015)
EDEN ISS Built-up Phase and previous Campaigns

- European research project (14 partners from 8 countries)
- EDEN ISS greenhouse system in Antarctica
- One year analogue mission in 2018
- Two Delta-Missions (DLR/AWI) in 2019 & 2020

Built-up Phase of the system in Jan. 2018

Tomato plant tray inside the FEG

Deployment team group picture Feb. 2018
Analogue Testing at Neumayer Station III
Similar Challenges to Moon and Mars

- Crew size
- Isolation & resupply once a year
- Harsh environment
- Technology dependency

Antarctica
Controlled Environment Agriculture CEA
Air Management System (AMS):

- Exact control of humidity & temperature
- Active CO2 injection
- Complete water recovery
- Air purification (UV & HEPA & Carbon Filters)
Nutrient Delivery System (NDS):

- Exact control of nutrients
- Soiless cultivation (Aeroponics)
- Recirculation => no water loss
Illumination System (ILS):

- Extended day durations (18/6)
- Exact control of light composition (r/b/fr/w)
**Controlled Environment Agriculture:**

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- Artificial cultivation independent from outside environment
- Faster production & higher yields than in nature
- Exact control of phenotype, taste and useful substances
- Closed-loop principle
Designed for Space - Used on Earth!

Tokyo (source: The Guardian)
Vertical Farming
Benefits

- Extreme high plant density on a small footprint (vertical stacking)
- Faster production and higher crop yields due to CEA
- No use of pesticide/ insecticide (sealed-off system)
- Year-round crop production (even during winter- & dry summer periods)
- Less resource consumption with respect to fertilizer and water (closed-loop principles)
- No weather related crop failures due to hail and heavy rain storms
- Reduction in vehicular transport and food spoilage (in-situ near end consumer)
- Elimination of unwanted discharge (no pollution of soil and ground water)
Incubator for Vertical Farming

- Market Analysis: CEA-Technologies
- Feasibility study "Vertical Farming"
- Feasibility study "Vertical Farming 2.0"

Deutsches Zentrum für Luft- und Raumfahrt
German Aerospace Center
The Situation

- Food provision organized by international organizations
- No- or little fresh food
- Mid-term food source needed
- Hybrid food strategy is envisioned
Main R&D Objectives of MEPA

Provide the possibility to produce fresh food within an emergency use case.

- Develop soilless plant cultivation unit
- Compact transport
- Fast deployment
- Reusable system
- Fast production (first harvest after 4-6 weeks)
- Individual & simple usage
Possible Areas of Deployment

Refugee camps

Earthquakes

M.E.P.A.

Floods

Inner city areas

Droughts
Mobile Cultivation System
Deployment Scenario

- Transport

International Aid Organisation

- 75 units per 40 ft Container

- ~530 m² of total grow area

- ca. 3.5 tons of lettuce every ~4-6 weeks
Summary & Cost

- Using Controlled Environment Agriculture (CEA) for independent & faster food production
- In-situ production in mega cities and arid regions
- Key step towards a sustainable Circular Economy
- DLR EDEN group has profound knowledge in CEA
Designed for space - used on Earth!

Thank you for your Attention!