CO2 Monitoring and Reduction in Food Systems Through a Circular Economy

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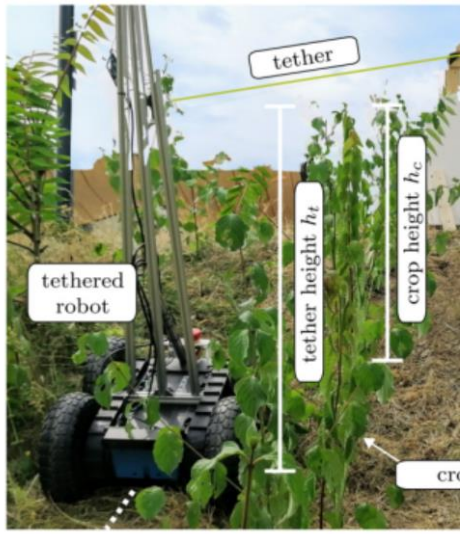
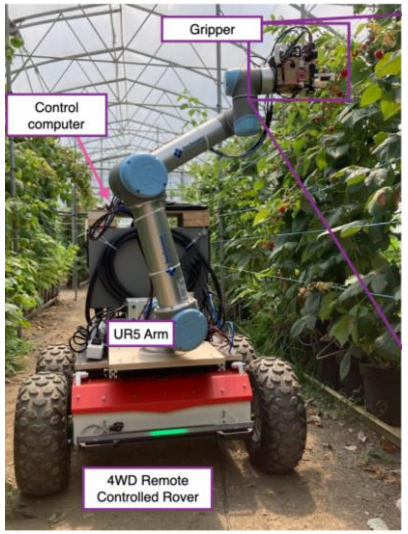
CREATE Lab

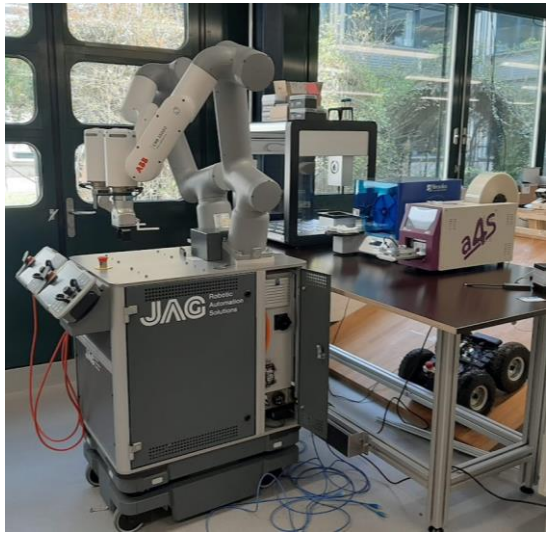
Quick Introduction

CREATE Lab, IGM, STI

Robots for Science & Sustainability







Expertise in Robotics for & Optimization for:

- Agriculture
- Intelligent Automation
- Previously have worked with anerobic digesters

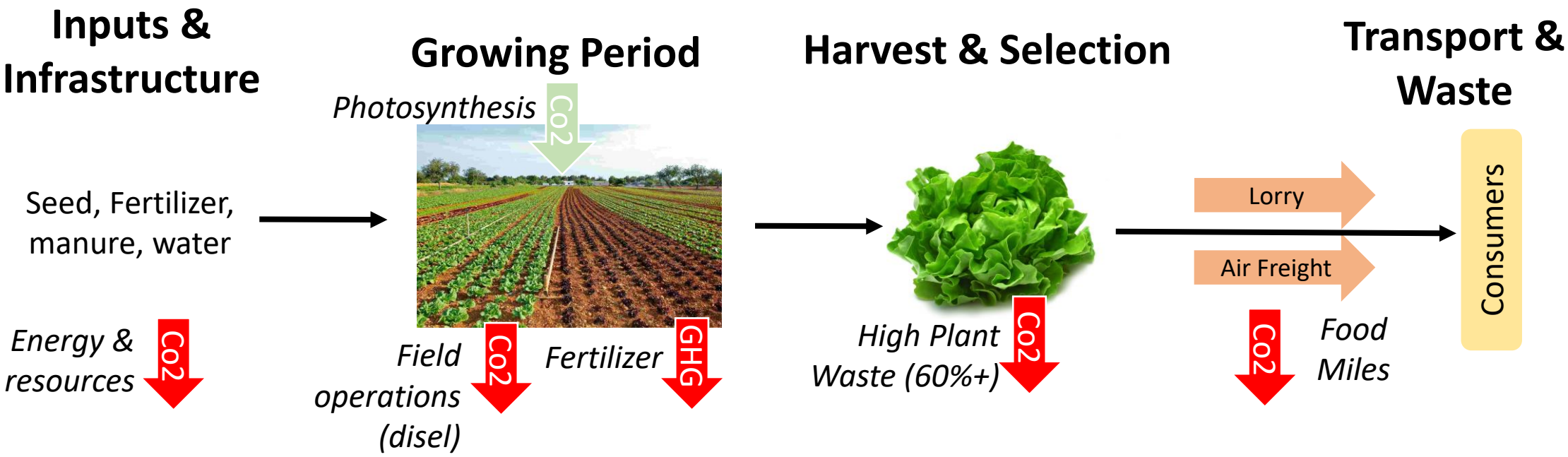
Industry/Research Partners

- Agroscope
- Anero Technologies (Anaerobic Digesters)
- Clear Greens
- Nestlé

Life Cycle Analysis: Food Generation

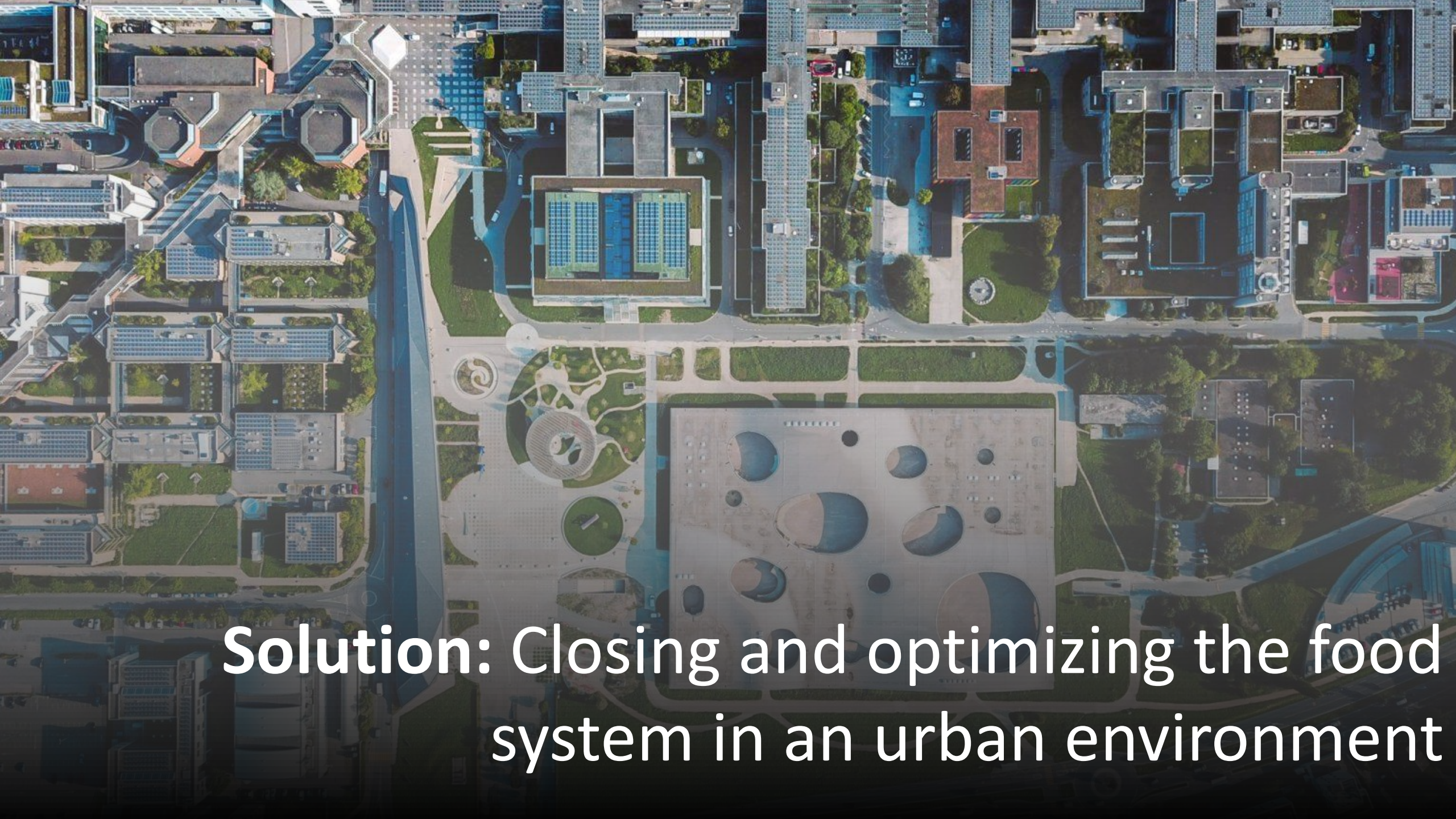
‘Conventional’ Arable Agriculture

- Agriculture contributes to 12.4% of greenhouse gas emissions in Switzerland (IPCC)[1].
- For Food production, this increases to ~25% [2].



- Leaky, inefficient, wasteful system
- Significant losses from waste and food miles
- Significant green house gas creation (Methane, nitrous oxide, CO2)
- Significant water and fertilizer resource use

[1]IPCC Report (via. Agroscope)
[2] BAFU Swiss Climate Reporting

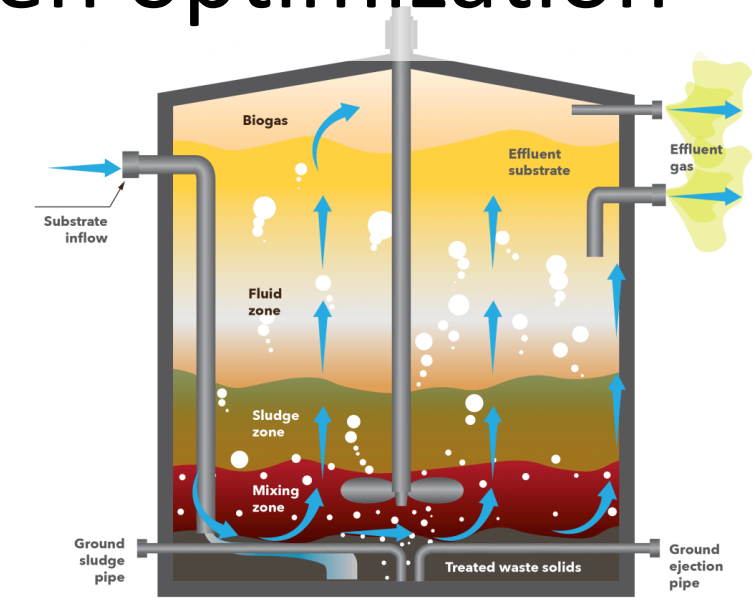


Solution: Closing and optimizing the food system in an urban environment

Aeroponics. Grow plans with roots exposed which are exposed to a mist for watering.

Food

Automation & data-driven optimization



Life Cycle Analysis: Food Generation

Proposed ‘Closed’ Food Generation

Inputs & Infrastructure

Growing Period

Harvest & Selection

Transport & Waste

Embodied CO2 in new infrastructure

Co2

Seed, Fertilizer, manure, water

Photosynthesis Co2

Lights, heating

Co2

Co2

Robot/data-management

Only Root waste

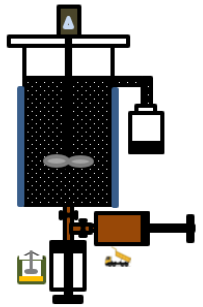
Produce to local consumer

0 Food Miles

Consumers

Health Benefits

Anerobic Digester



Bio-gas

Root waste

Digestate (Fertilizer)

Aeroponics: Current State of the Art

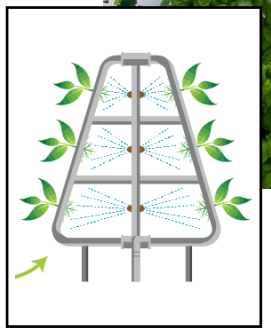
Horizontal Aeroponics

Aeroponics. Grow plans with roots exposed which are exposed to a mist for watering.

- High Yield, minimal waste.
- Growth accelerated by x3
- Water Use reduced by 80-90%
- Crops grow in a highly uniform way (easy to predict yield)
- Fertilizer use reduced by 60-80%

Currently Primarily focused on Horizontal Growth

Vertical Aeroponics



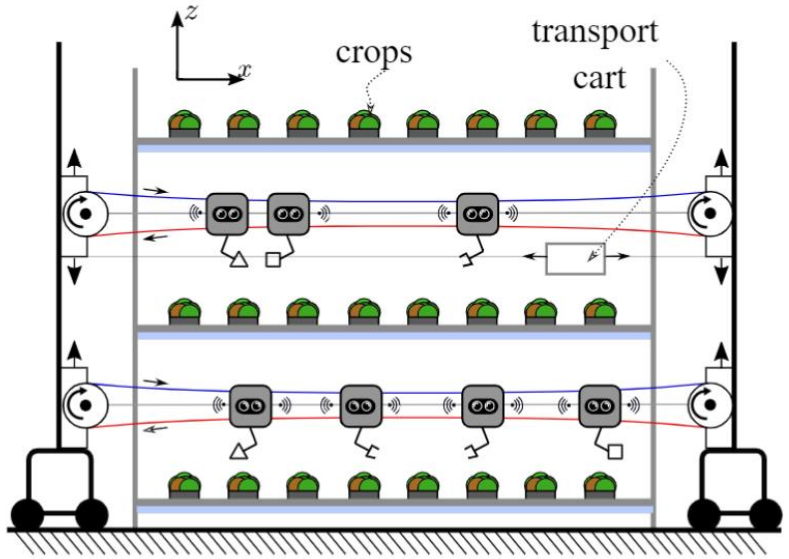
Example Crops well suited for aquaponics: salads, beetroots, tomatoes, herbs, kale, peppers

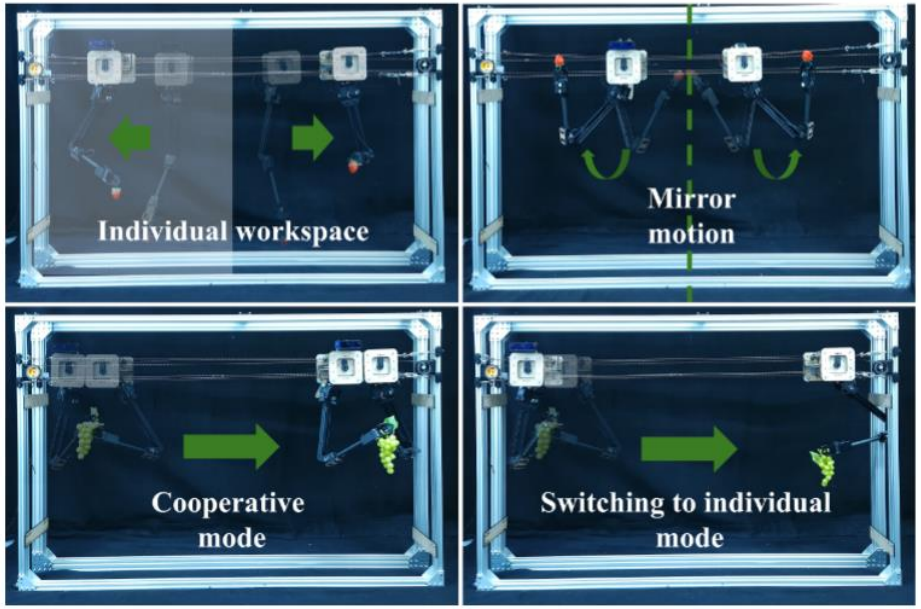
Leverage vertical aeroponics and gantry robots for:

- Control of moisture
- Automated data-collection and harvest

Automation of Aeroponics

Modular Units (recyclable materials)





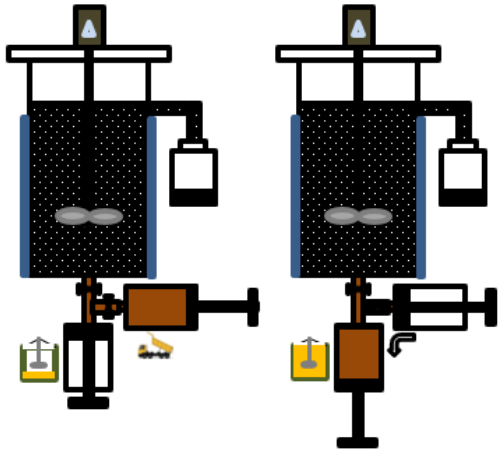
- Plant electrophysiology for health monitoring (real time)
- Modular growth units
- Computer vision based analysis
- Low-powered robotic harvesting system.

Anerobic Digestors

Open Research Questions & The Need for Robotics

Plant Waste/
Food Waste

INPUTS

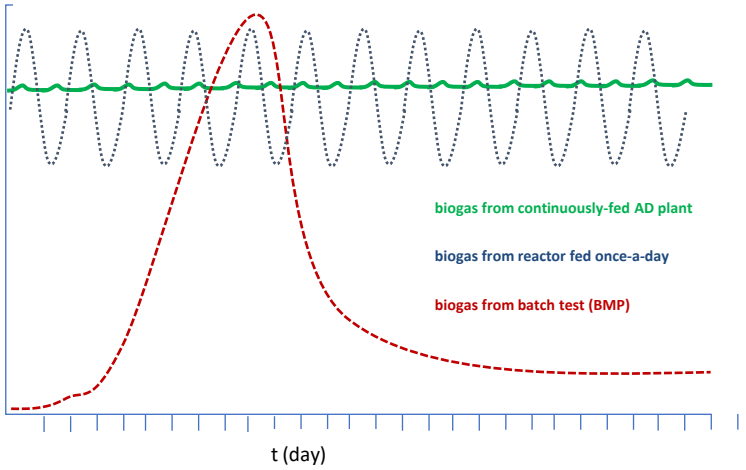


OUTPUTS

Suited for fertilizer in field

- Digestate (Bio-fertilizer)
- Bio-Gas

60% methane, 30% CO2, + Traces



- Need for continuous feed, closed-loop control and automation to optimized gas production
- Currently, there is limited data sets, and analysis of output gas

Anerobic Digestor

Automated, sensorized & data-driven

- 10 parallel digesters with 2 different feeding rates
- Agitators
- Mixers (mixing rate and occurrence)
- Heating jackets

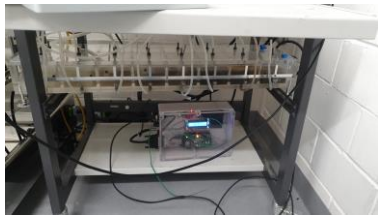
Anerobic Digestion

Data Generation

Inputs

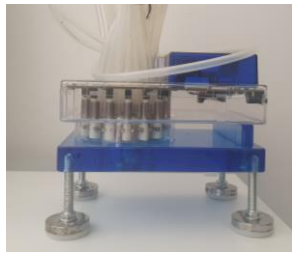
Substrate composition

Control parameters
- Temperature
- Motor mixing rate
- Feeding rates



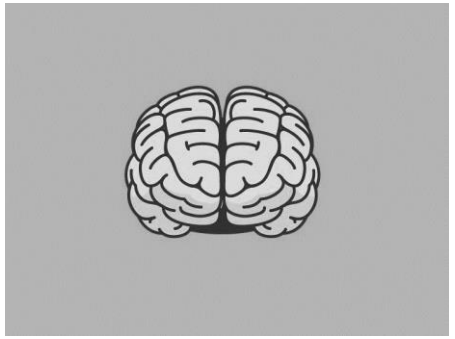
Processing

Output



Biogas
- Gas Flow Rate
- Gas Composition

Digestate
- Composition and amount



Data-Driven Predictive models:
- Optimize gas composition and volume
- Optimize digestate composition and volume

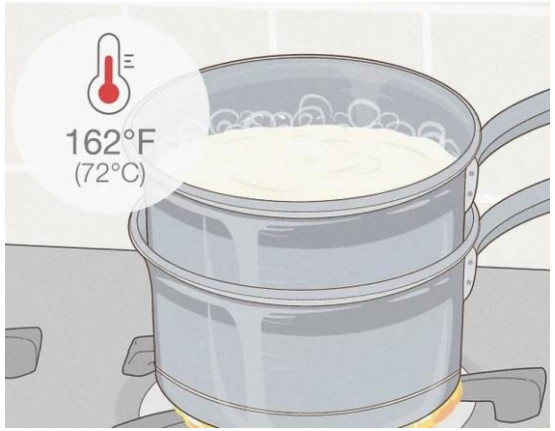
→ Dynamically respond to substrate and needs of agriponics

Anerobic Digestion

Data Generation

Substrate
(Food Waste, Alpine Food Labs)

Homogenization



Pasturization

Feeding Digester

We’re starting to generate bio-gas and data!

Next steps…

Vertical Aeroponics

Anerobic Digestion

Optimization & Monitoring

Data collection, analysis and modelling

- Demonstration of individual components early summer 2024
- Integration and optimization of each of the sub-systems
- Life cycle analysis and system wide optimization

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