Latest R&D developments in autonomous greenhouses

Netherlands-Japan Horticulture Webinar

12 Nov 2020 - Rick van de Zedde & Anna Petropoulou

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Introduction

- **Rick van de Zedde**, 15 years at Wageningen University & Research

  Senior scientist/ business developer Phenomics and Automation.
  Project manager Netherlands Plant Eco-phenotyping Centre (NPEC).
  March 2020: Vice-chair International Plant Phenotyping Network (IPPN)

Background: Artificial Intelligence.
Focus: computer vision/ robotic

- **Anna Petropoulou**

  Researcher Greenhouse Technology / coordination Autonomous Greenhouse Challenge @ WUR.

Background: Agriculture and Biosystems Engineering
Focus: time series data in horticulture

Aim of this presentation:
To inspire and share applied research projects and ideas

The Netherlands and Japan

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Wageningen University & Research

- 2 organisations - a university plus R&D organisations. Mission statement:

  "*To explore nature and to improve the quality of life*"

- 5,600 employees/ 12.800 students

- Two research greenhouse locations in NL: Bleiswijk & Wageningen Campus

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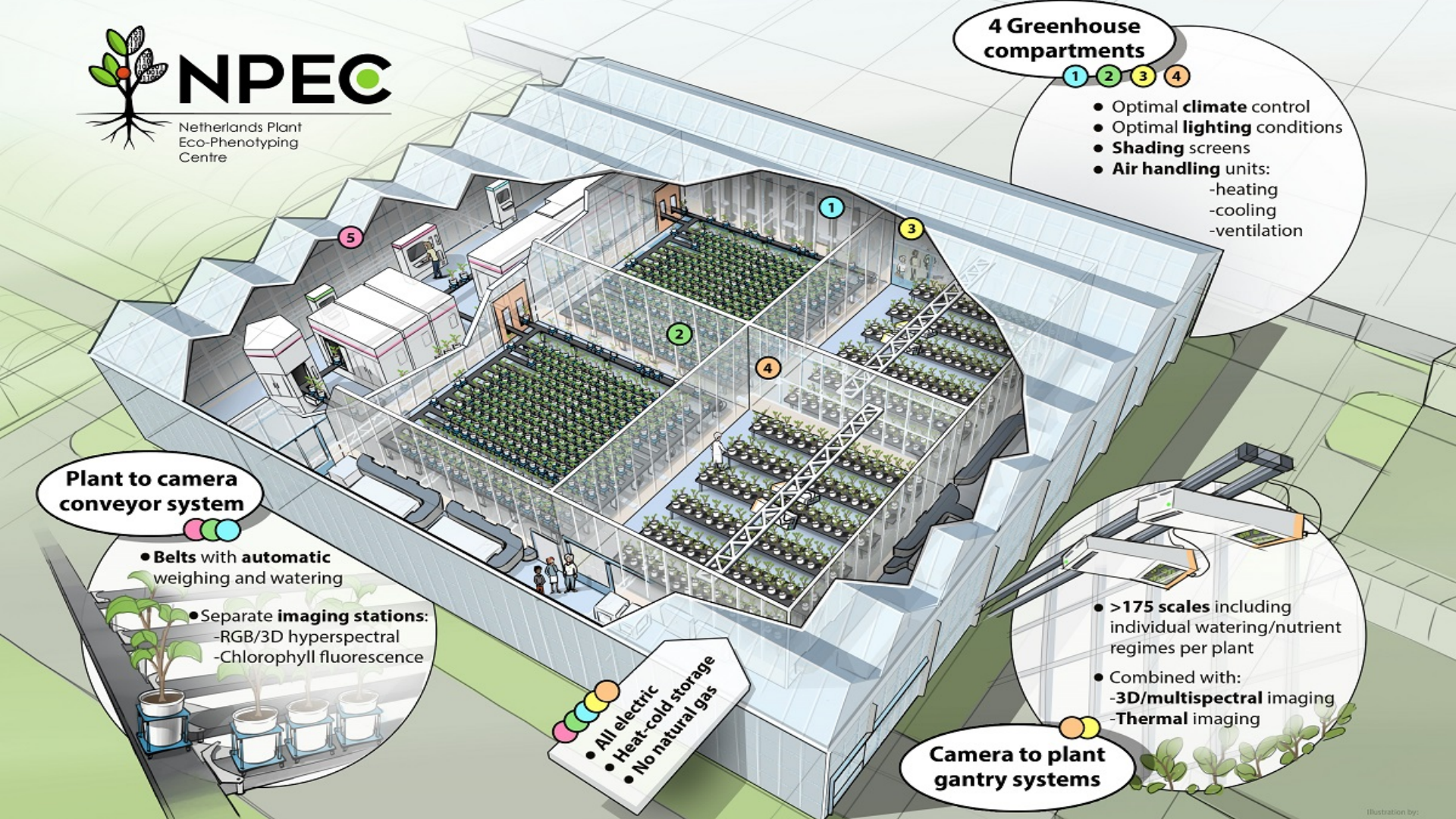
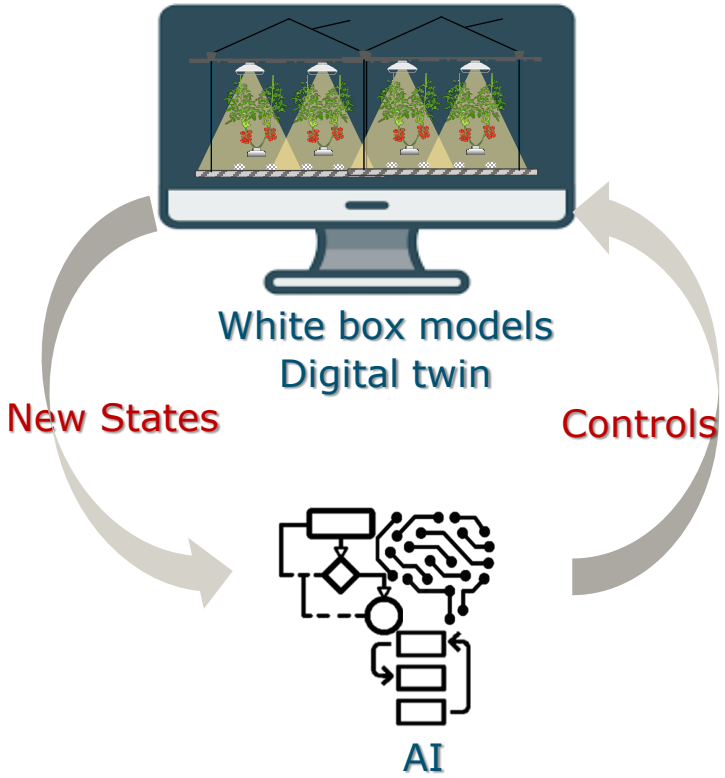
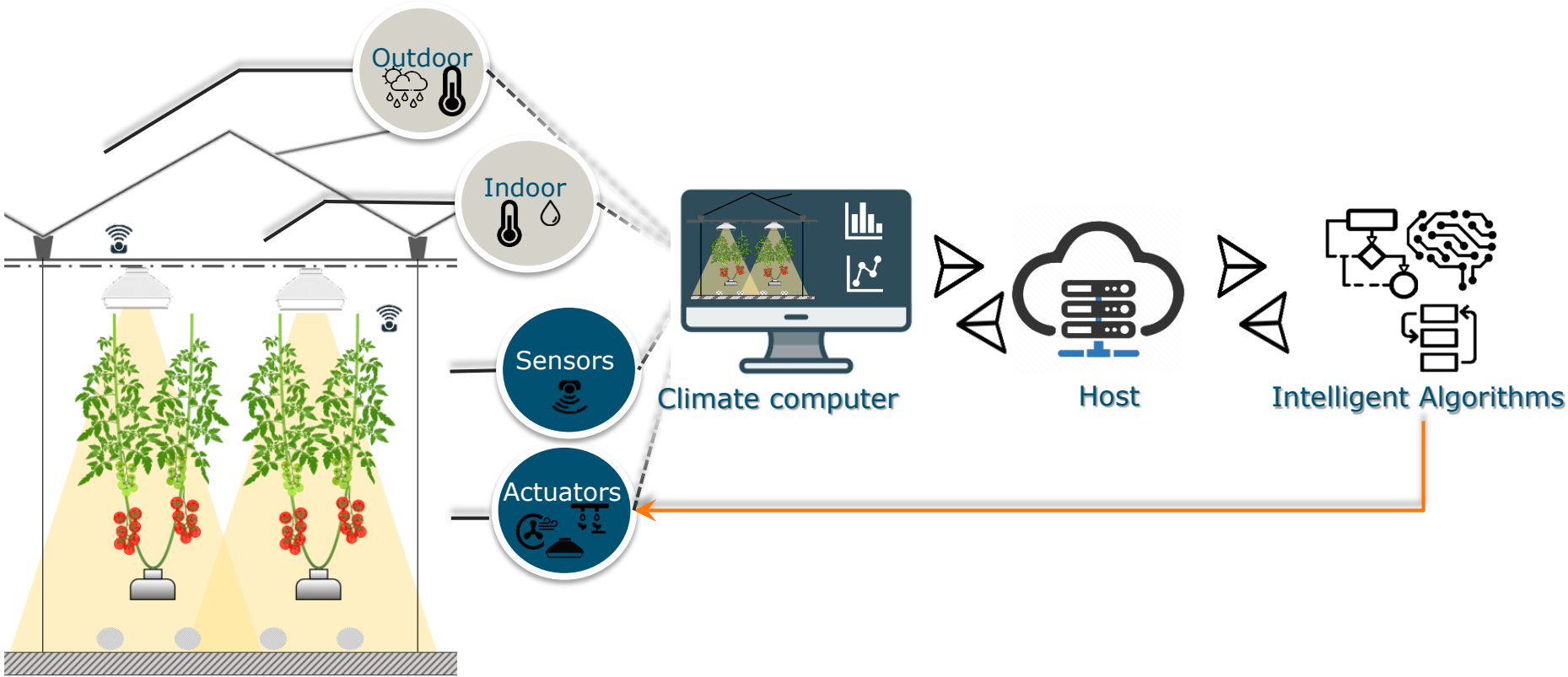

NPEC
Netherlands Plant Eco-Phenotyping Centre
4 Greenhouse compartments
1 2 3 4
• Optimal **climate** control
• Optimal **lighting** conditions
• **Shading** screens
• **Air handling** units:
-heating
-cooling
-ventilation
Plant to camera conveyor system
• **Belts** with **automatic** weighing and watering
• Separate **imaging stations**:
-RGB/3D hyperspectral
-Chlorophyll fluorescence
• All electric
• Heat-cold storage
• No natural gas
• **>175 scales** including individual watering/nutrient regimes per plant
• Combined with:
-**3D/multispectral** imaging
-**Thermal** imaging
Camera to plant gantry systems
Illustration by:

Towards Autonomous Greenhouses

- Data greedy algorithms
- Lack of available data
- Limited real-world try- outs
- Delay in reward
- Well validated models (climate & crops as tomatoes, cucumbers)
- Synthetic data on greenhouse climate and crop



Remote & Autonomous Control of Greenhouses



Autonomous Greenhouse Challenge

- Benchmark experiment
- Artificial Intelligence & cucumber production[1]
- Artificial Intelligence & cherry tomato production

[1]Hemming et. al. ”Remote Control of Greenhouse Vegetable Production with Artificial Intelligence-Greenhouse Climate, Irrigation, and Crop Production”,2019.

Timeline: Autonomous Greenhouse Challenge

Subscription

Selection
22/7/2019

Hackathon
12-13/9/2019

Sowing
19/10/2019

Transplanting
16/12/2019

Real Challenge
20/12/2019

1st Harvest
13/2/2020

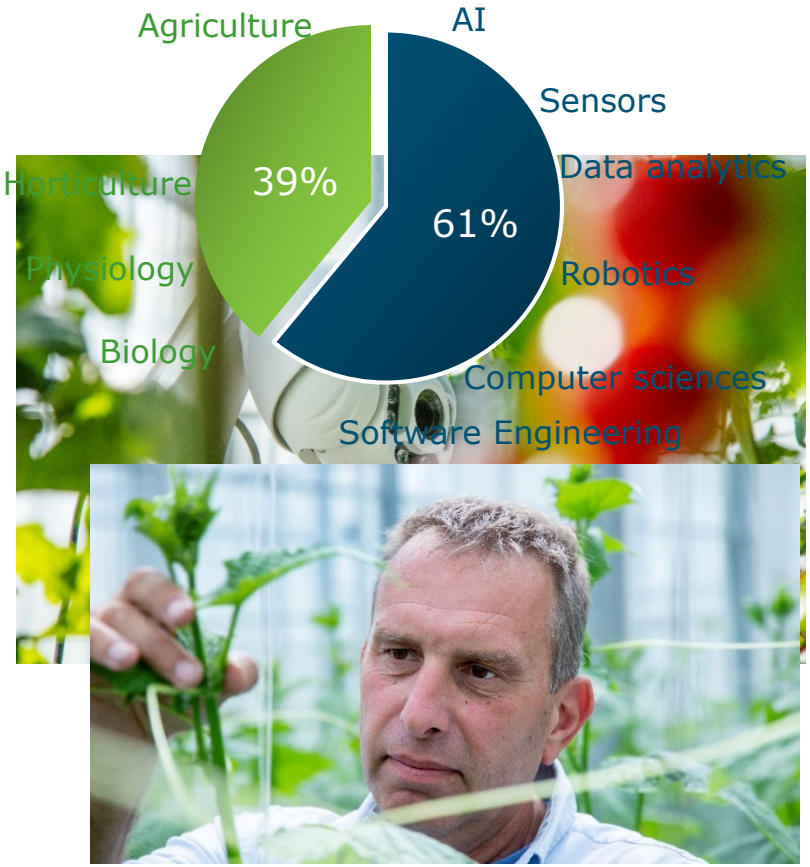
Last Harvest
29/5/2020

Final Event
8/6/2020

May 2019 | July | September | October | December | February | May | June 2020

The Challenge

- 5 multidisciplinary teams
  - >60 participants
  - 10 nationalities
- Dutch growers-Reference
- The goal of the experiment was to **maximize net profit**, while **controlling** growth of the greenhouse crop, **cherry tomato** remotely with different **sensors** and **intelligent algorithms**



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Challenge set-up

- Sponsors
- 6 identical compartments (equipment, actuators and sensors)
- Cherry tomato cv. Axiany
- LED Heliospectra Elixia
- Interface data reading and control LetsGrow
- Internet connection KPN

WAGENINGEN UNIVERSITY & RESEARCH Tencent heliospectra LETS GROW COM kpn Grodan axia vegetable seeds

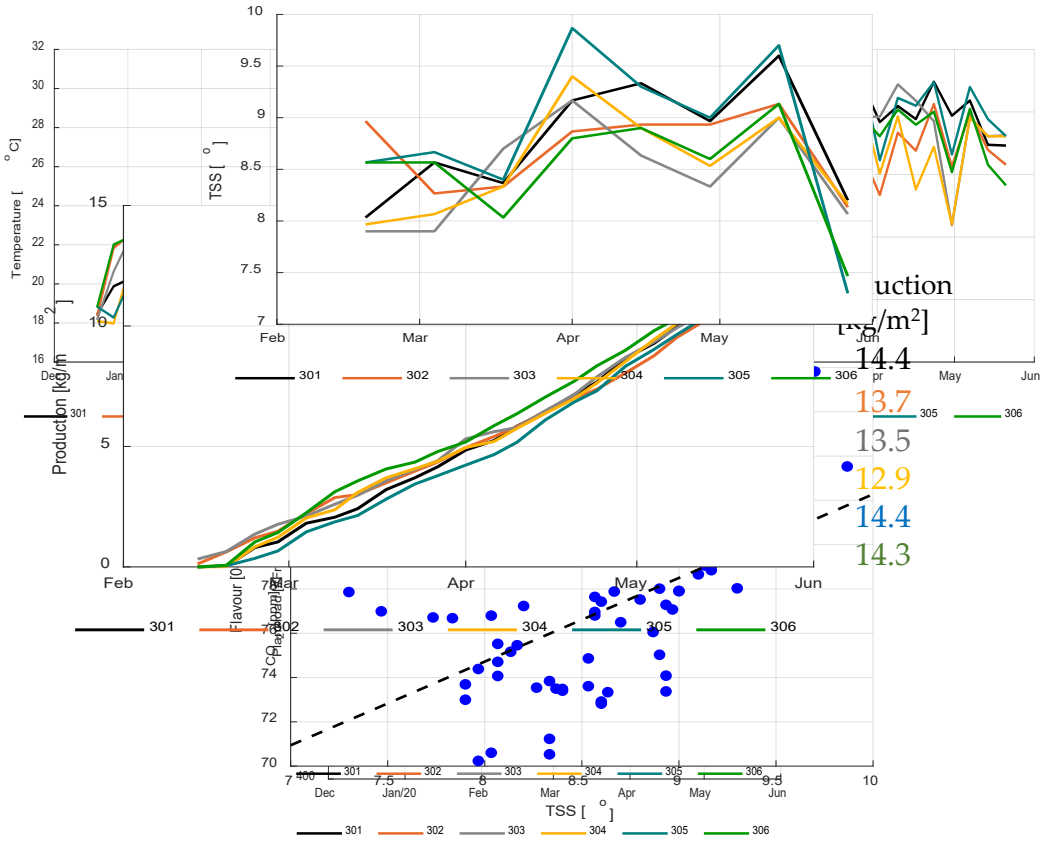
Autonomous Greenhouse Challenge



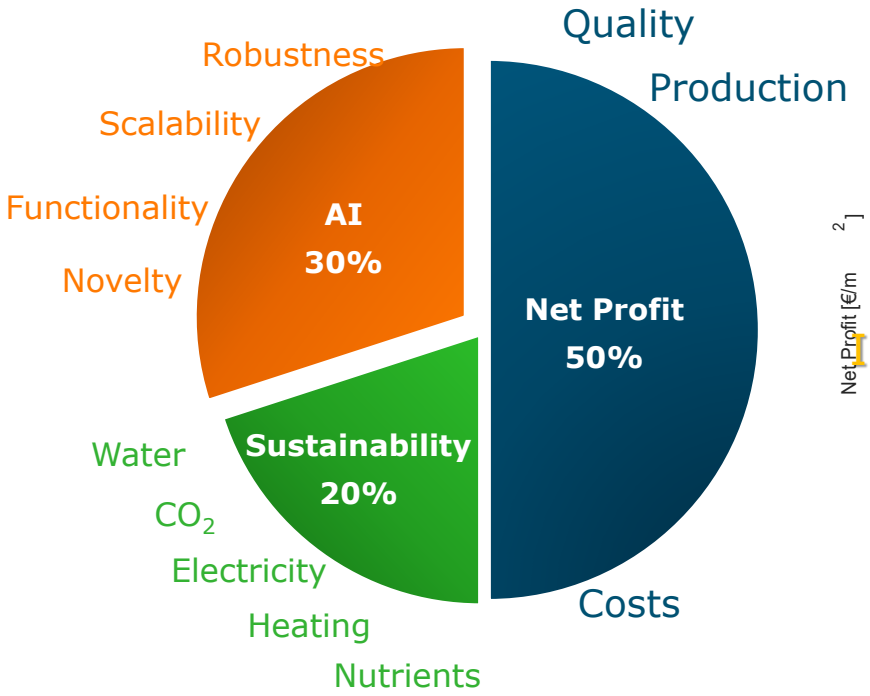


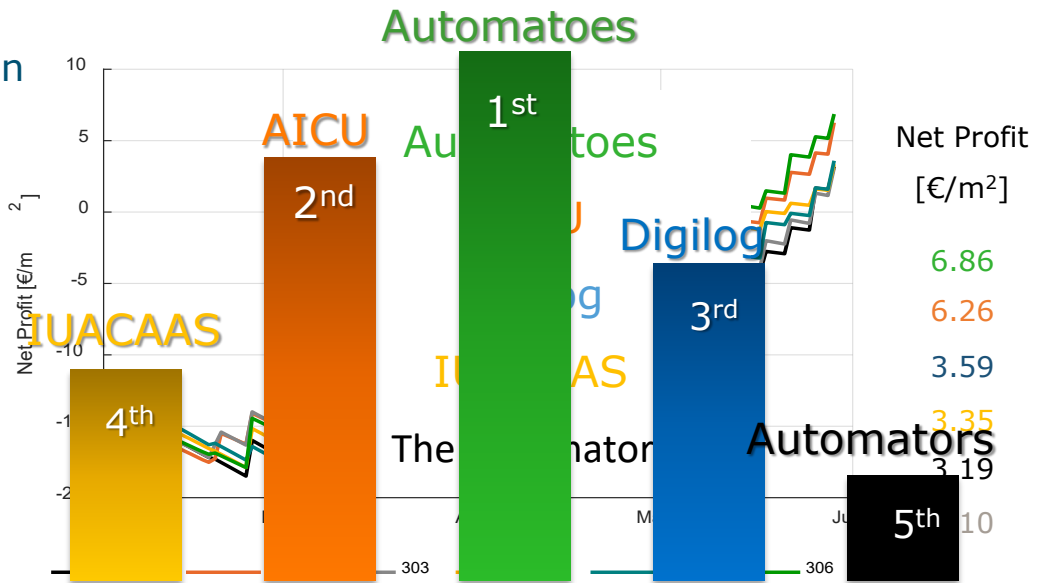

Greenhouse climate control

- Greenhouse climate
- Greenhouse crops
- Quality of fruits (TSS)



Criteria - Results





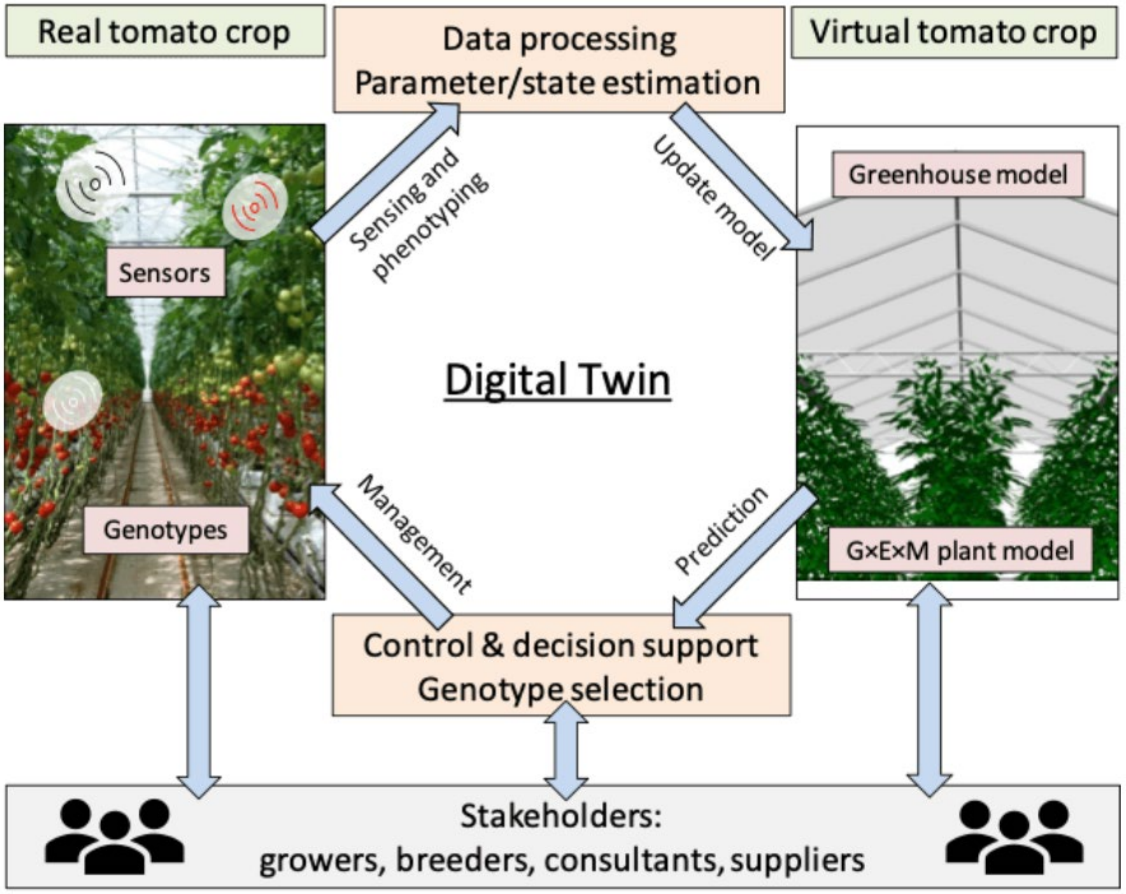
Lessons learned

- Importance of crop management for high (quality) production
- Systems complexity, late reward
- Data needed on all aspects of growing towards further development of AI/ data driven controls
- Replace laborious crop registrations with non-invasive crop sensing techniques (computer vision, deep learning)
- Automated handling, robotics towards fully autonomous concept

What's next

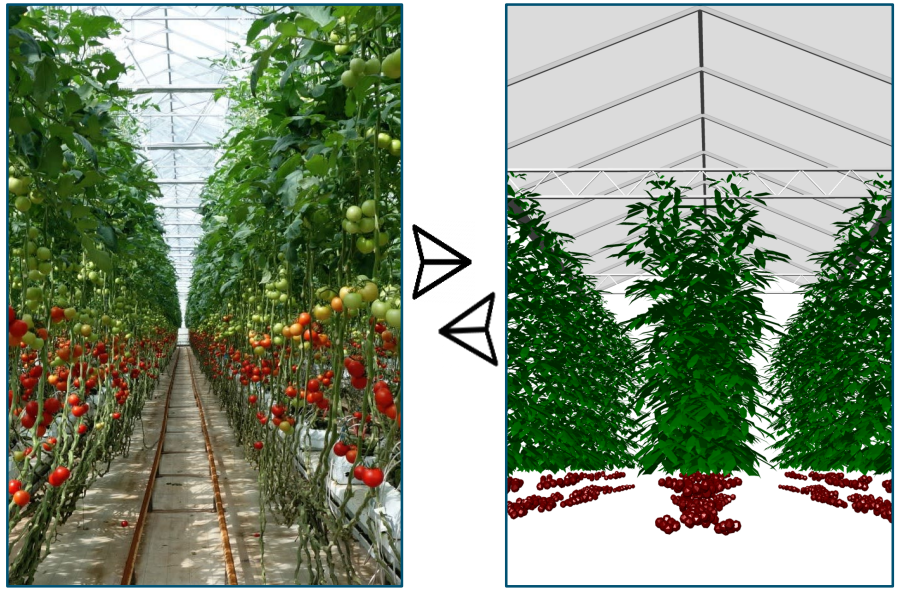
- Challenges for which we are searching for new partners are:
    - Explore plastic tunnels in Japan and autonomous GH.
    - Explore tools within NPEC to understand and measure plant performance.
    - Novel AI tools for the agrifood domain
    - Augmented Reality to let users interact with captured data inside the greenhouse.
    - Harvesting robots for bell peppers, gerbera cut flowers, etc.
    - Digital Twin development for greenhouses and vertical farms.

Digital Twins- Virtual Tomato



Digital Twins- Virtual Tomato Crops

- Simulated greenhouse climate And the crop growth.
- Syncing real and digital twin using cameras & sensors.
- Run experiments with different scenarios to validate models
- Predict plant growth and yield, translation to large scale greenhouse production systems



Digital Tomato Twin

Thank you for your attention!

Questions?

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