AGROS knowledge event
“The road towards sustainable data-driven agriculture”

April 24, 2024, Wageningen University & Research, Wageningen, The Netherlands

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Program network and knowledge event

13:00 Keynote Marc Jacobs – Digitalisation in agriculture, integrating human and technological processes

13:45 AGROS – Examples of horticulture, arable farming and dairy

14:30 Workshop session 1

15:10 Coffee and tea break

15:40 Workshop session 2

16:20 Workshop session 3

17:00 Closure with drinks

AGROS “To sustainable agricultural systems”

Integration of biology and technology in arable farming, dairy and horticulture

Anja Dieleman, István Fodor and Jan Kamp, Wageningen, April 24, 2024

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Challenges in agriculture

- Economic viability
- Resource use efficiency:
    - Energy (consumption and production)
    - Water and nutrients
- Availability of skilled labour
- Animal and crop health
- Greenhouse gas emissions
- Biodiversity

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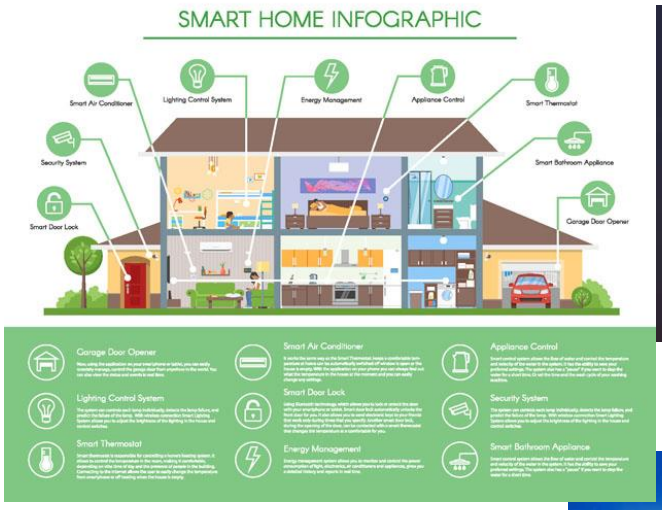
Fast developments in automation, AI, etc.



Next step: data-driven agricultural production systems, based on sensors, vision technology, and intelligent algorithms to support decisions

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- “Technology for ecology” concept
- Three use-cases: horticulture, arable farming and dairy

Challenges:

- Greenhouse horticulture: resource use efficiency, labour and economic viability
- Dairy farming: GHG emissions, resource use efficiency, and animal health
- Arable farming: crop health, energy production and biodiversity

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AGROS “Towards an autonomous greenhouse”

- Terminology “autonomous cultivation”
- In AGROS: Development of intelligent algorithms for autonomous control of greenhouse climate and crop management
- Based on sensor data
- Using an objective goal function.

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Steps towards an autonomous greenhouse”

Understand crop physiology and cropping system Under changing conditions

Models for
- Analysis
- Interpretation
- Prediction

Sensors for automated crop measurements
- Digital
- Robust
- Interpretable

AI algorithms
- Selection
- Prediction
- Control

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Steps “to an autonomous greenhouse” - AGROS

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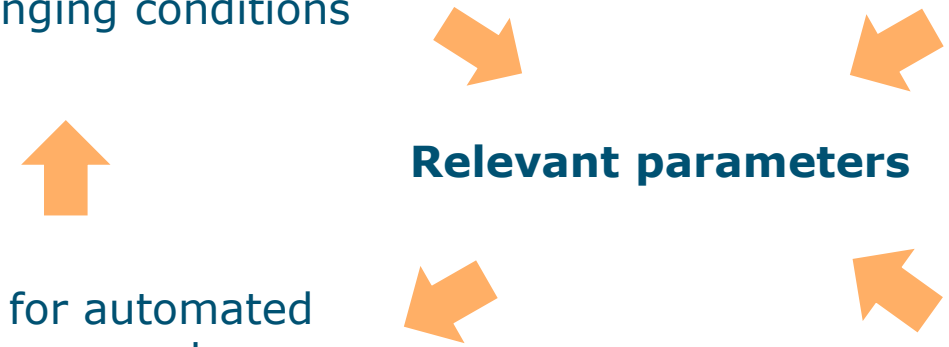


Sensors for automated crop measurements
- Digital
- Robust
- Interpretable

AI algorithms
- Selection
- Prediction
- Control

Data required for control

Greenhouse climate

Set points
Realized climate

Crop

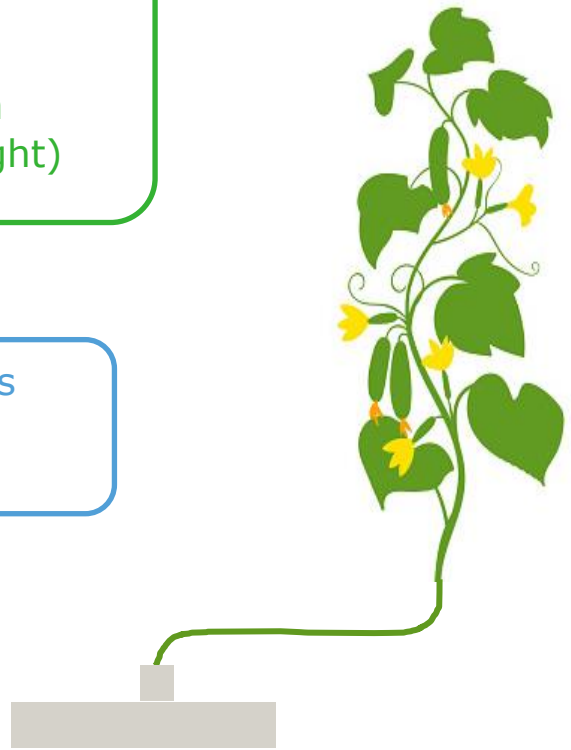
Light interception
Leaf formation rate
Fruit growth duration
Harvest (no and weight)

Crop management

Leaf picking - LAI
Fruit pruning strategy
Average fruit weight
No of harvests/week

Irrigation

No of irrigation shots
Shot size
% drain



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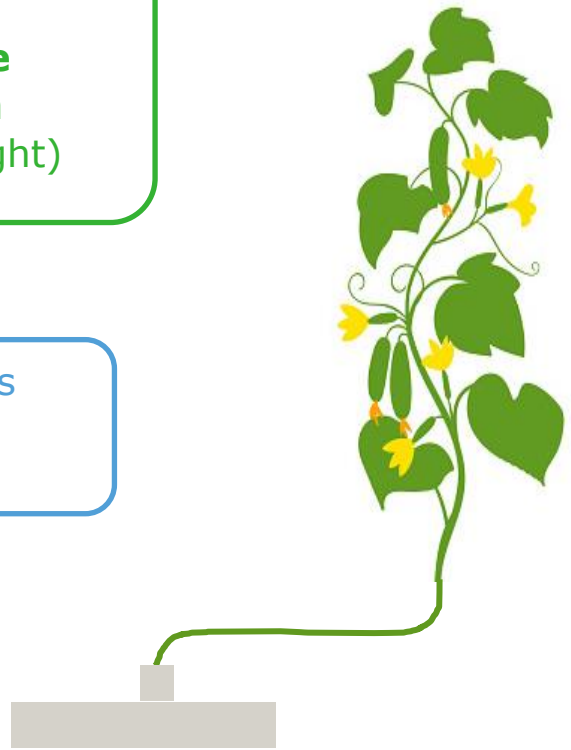
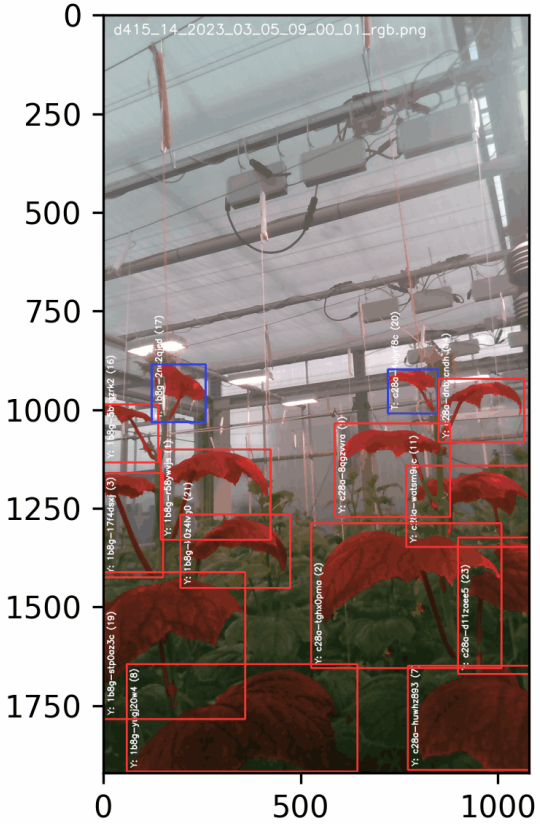
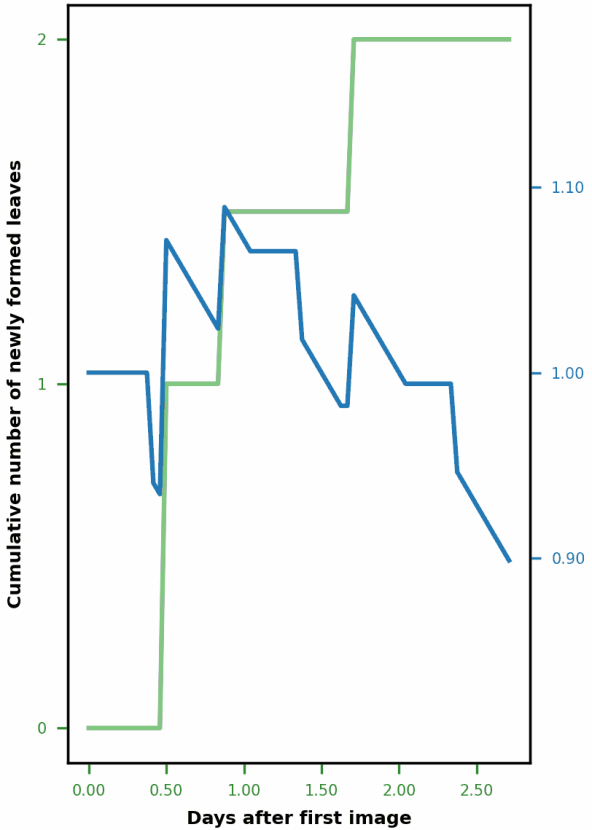


Vision technology: plant development rate

- No of newly formed leaves crucial for control
- No sensor available
- Trained object detection network to monitor and count leaves
- Provides daily value





WS Session 3

Vision technology

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Intelligent algorithms

- Development of intelligent algorithms for autonomous control of greenhouse climate and crop management
  - Based on mechanistic greenhouse climate model and crop models: Digital Twin
  - Based on AI: Reinforcement Learning

Proof of concept “autonomous cultivation”

- Three cucumber crops were controlled by:
  - Reference “growers”
  - Digital Twin
  - AI - Reinforcement learning
- Cultivation January - March 2023
- Goal function: maximize net profit (costs: heat, electricity and CO_2, benefit: cucumbers)
- Data collection by cameras and sensors, validation by manual measurements

Results “proof of concept” autonomous cultivation

Successful autonomous cultivation strategies:

- Full autonomous control of cultivation by Digital Twin
- Autonomous control of climate during 2 months by Reinforcement Learning
- Reference: cultivation according to cultivation plan, little adjustments required
- Vision technology: good results in measurements of crop characteristics
- Datasets of greenhouse climate, crop and sensor data generated.

Future perspectives

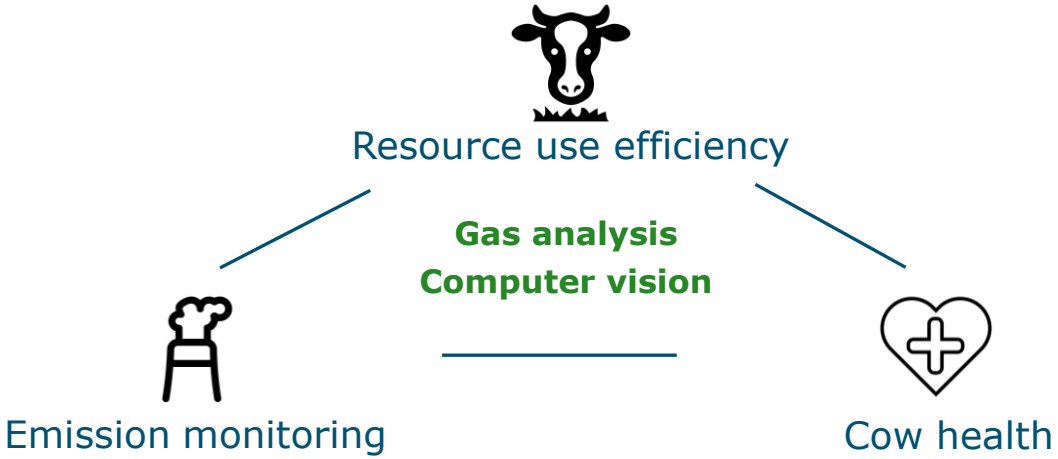
- Autonomous greenhouse control is feasible
- Can deal well with uncertainties – weather forecasts, variable prices of inputs and products, …
- Challenges: reliability of data (input in control), cyber security, availability of internet, adoption by growers, ..
- Future steps: determine crop boundaries, vision development, AI algorithms, growers' involvement, application of concept.
- AGROS II.

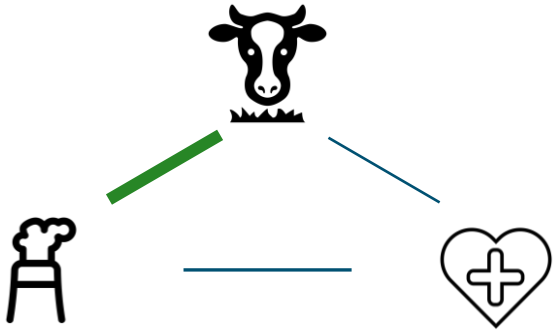
AGROS “Towards a sustainable dairy farming”

Develop methods for *individual* monitoring

→ Improve sustainability of dairy production

→ Improve animal health





Improved **feed efficiency** (~ kg feed/ kg milk)

↓ environmental impact

↓↓ costs (feed >50% of total costs)

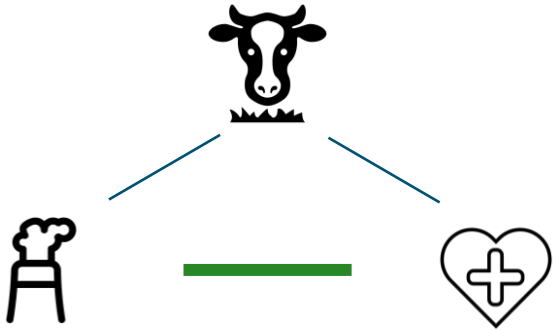
How are these linked?
Relationship with health?

Emissions from cows

→ Global warming

→ *Loss of energy from feed*

WS Session 2
Detection and intelligent control of diseases



* Dairy until December 2024

Breath analysis as a **non-invasive** **early** disease detection tool in cows

Use breath to "look into blood composition"

Volatile Organic Compounds (VOCs)

Pilot – results available

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Radboud Universiteit

HAS green academy

WS Session 2

Detection and intelligent control of diseases

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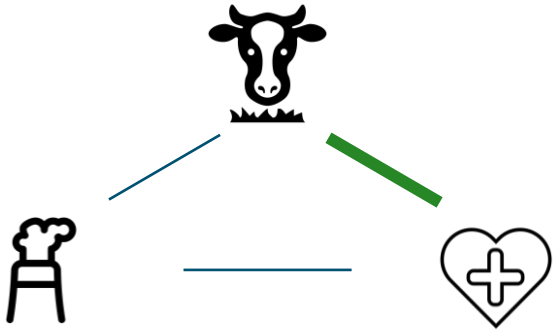
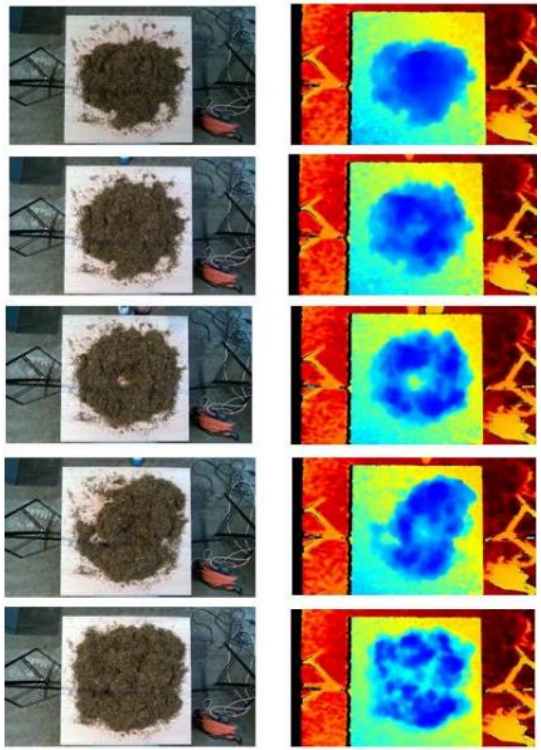


2D & 3D computer vision applications on farms

- Disease detection (e.g., lameness)
- Behaviour
- Feed intake
- ...



RGB-depth imaging to estimate feed weight

WS Session 3

Vision technology: monitoring cows and cucumbers

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Future perspectives

- Emission monitoring
    - Scaling up
    - More information than GHG ~ global warming
- Computer vision – wide range of applications
- Individual cow-level information
    - → Monitoring (e.g., disease)
    - → Breeding (e.g., emissions, resource use)

AGROS: “Towards sustainable arable farming”

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AGROS: “Towards sustainable arable farming”

- **T4E concept** as a central focal point

- Fast developments in farming:

  + highly productive

  + reduction of labor / ha

  ↓

  - soil compaction

  - loss of biodiversity

  ↓

  Ecology to the background

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Translation T4E in AGROS – Arable Farming

- What is needed in the near future? Main challenges related to T4E?
- Our reference: Farm of the Future concept
- How can technology support ecology in new farming systems?

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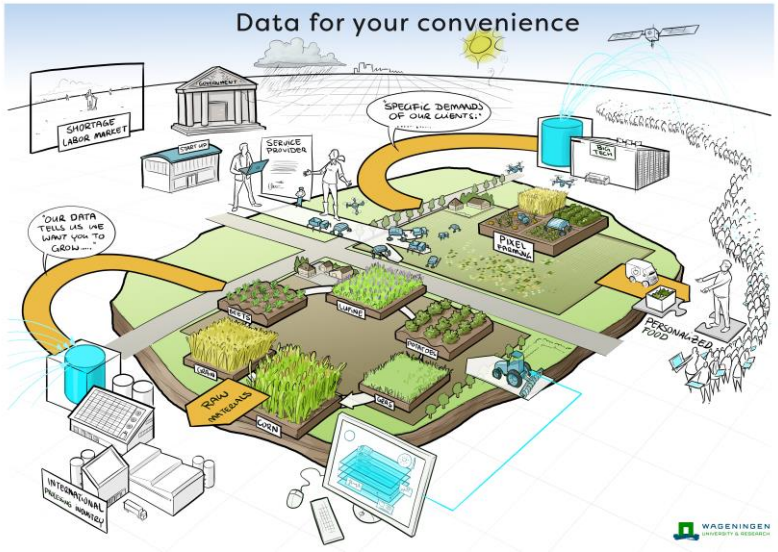
Future scenarios – Ellen Bulten / Herman Schoorlemmer

3 scenarios for future mixed cropping systems in 2040

- Data for your convenience
- Ecology at the wheel
- Crisis for action



Each scenario describes:

- Socio-societal and climatic context
- Arable value chain
- Arable farm

Interested??
Go to: Session 3 - #1 (Herman Schoorlemmer)
Meidoornzaal

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Control of pest and diseases in crops –

Corne Kempenaar / Jos Tielen

- Biologicals on Farm of the Future
  - Serenade experiment (*Bacillus amyloliquefaciens*) in potato
- Sustainability evaluation
  - Environmental Impact Reduction CP and Milieu Indicator Gewasbescherming interactions → CPI's → Session 3 - #3
- Digital farming on Farm of the Future.
  - FieldView – Akkerweb connection (FV movie https://www.youtube.com/watch?v=vDlp1PbdjtY)
  - HortiView voor EU

Interested?? Go to:
Session 3 - #3 and/or Session 1 - #1
Lijsterbeszaal / Lijsterbeszaal

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BAYER

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Weed control & Disease detection Seed potatoes

Disease control: Jan Kamp

- Develop a robust prototype for smart disease detection (viruses, Erwinia) that is able to detect these diseases

Weed control: Bram Veldhuisen

- integrated weed control system
  - volunteer potato control
  - combining mechanical weed control and onions/weed detection
  - Spot spraying

Interested??
Go to: Session 1 - #3
Meidoornzaal

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Innovative sensor technology for arable farming – One Planet

- One planet / IMEC sensor
    - Optical sensor technology for nitrate detection (handheld, NO3 in solution)
- Decision to stop this development

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OnePlanet Research Center

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Future infrastructure – Energy & Data

Energy: how to become self sufficient? Jan Kamp

- Analysis of several scenario's: 100ha farm + storage on farm
  - Current energy use (based fossil fuels)
  - Energy use in future mixed cropping system – Fossil free
    - Battery powered
    - Hydrogen powered

Interested??
Go to: Session 2 - #1 Energy & Grid solutions → Meidoornzaal

Data: Corne Kempenaar / Johan Booij

What is needed due to developments in and around the farm?

- in-depth analysis of current data infrastructure
- connection with EU data act / Data infrastructu

Interested??
Go to: Session 1 - #3 Farmers Data Space → Lijsterbeszaal

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Public private partnership - partners

Questions