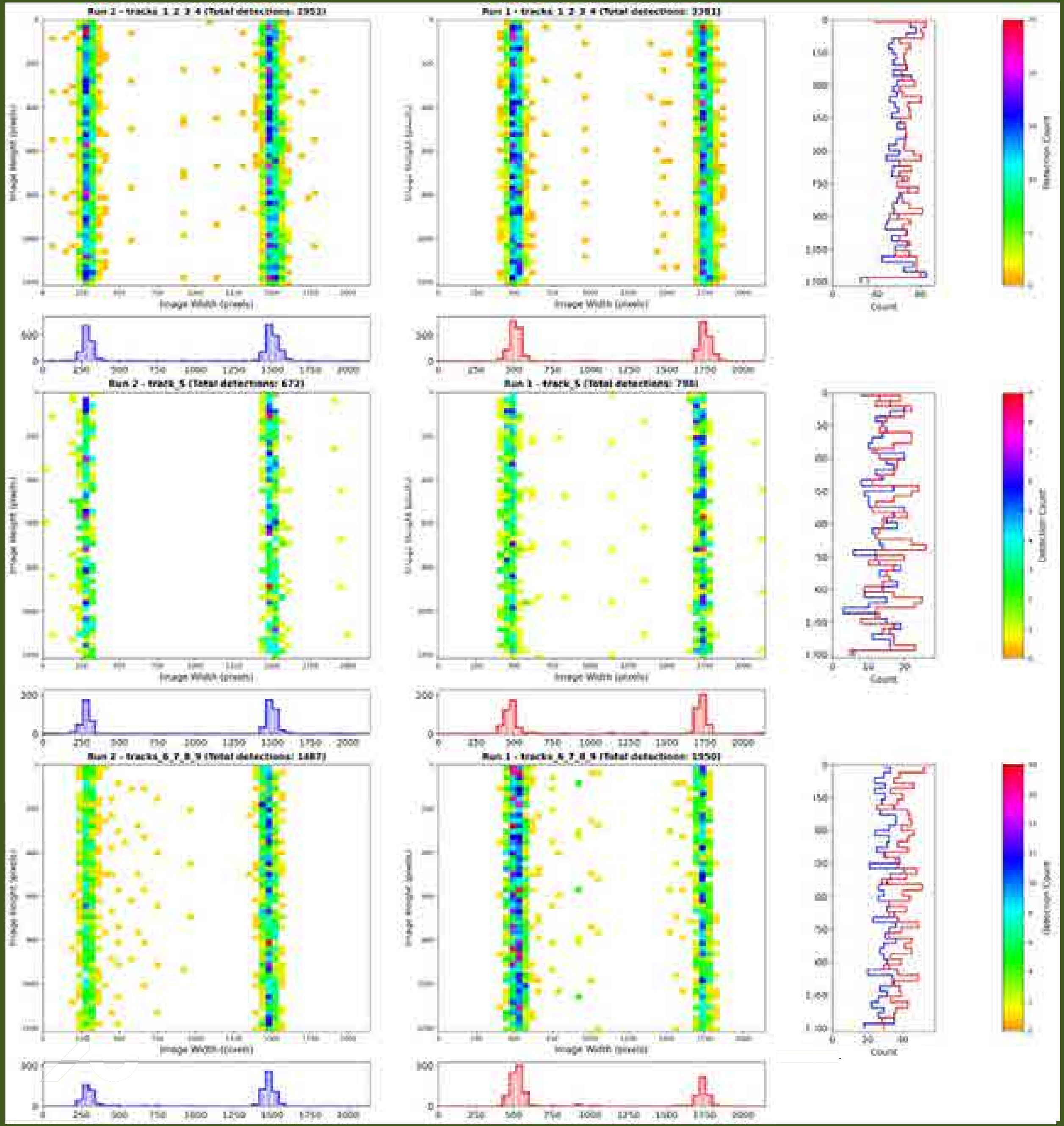
TRACKING OF SUGAR BEETS VISUALLY



TRACKING
N >= 4 TIMES

MICHAEL SØNDERGAARD NØRBO MADSEN*, SØR
RASMUS NYHOLM JØRGENSEN

TRACKING OF SUGAR BEETS VISUALLY

Raw vs Tracked - Key Findings

- Initial Sugar Beet detection: 40.31% → 44.69% (4.38% accuracy increase) with tracking
- 8.75% of detections are improved with tracking in early-stage detections
- Sugar beets often confused with Dicot Weeds
- Tracking improves stability of classification
- Monocot and dicot weed detection remains highly accurate (>95%)
- Tracking helps maintain consistent classification across frames

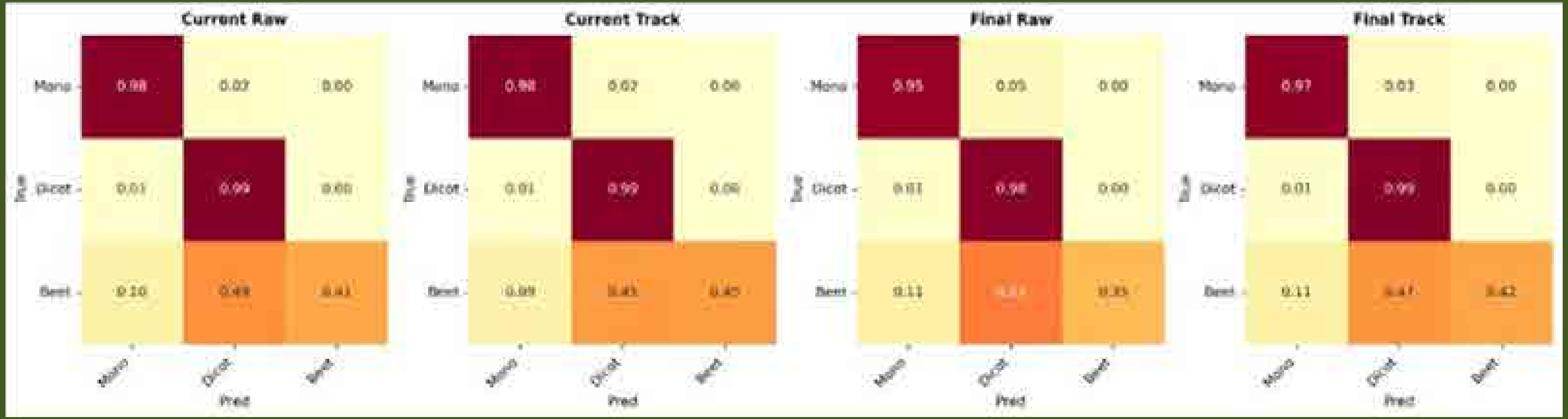
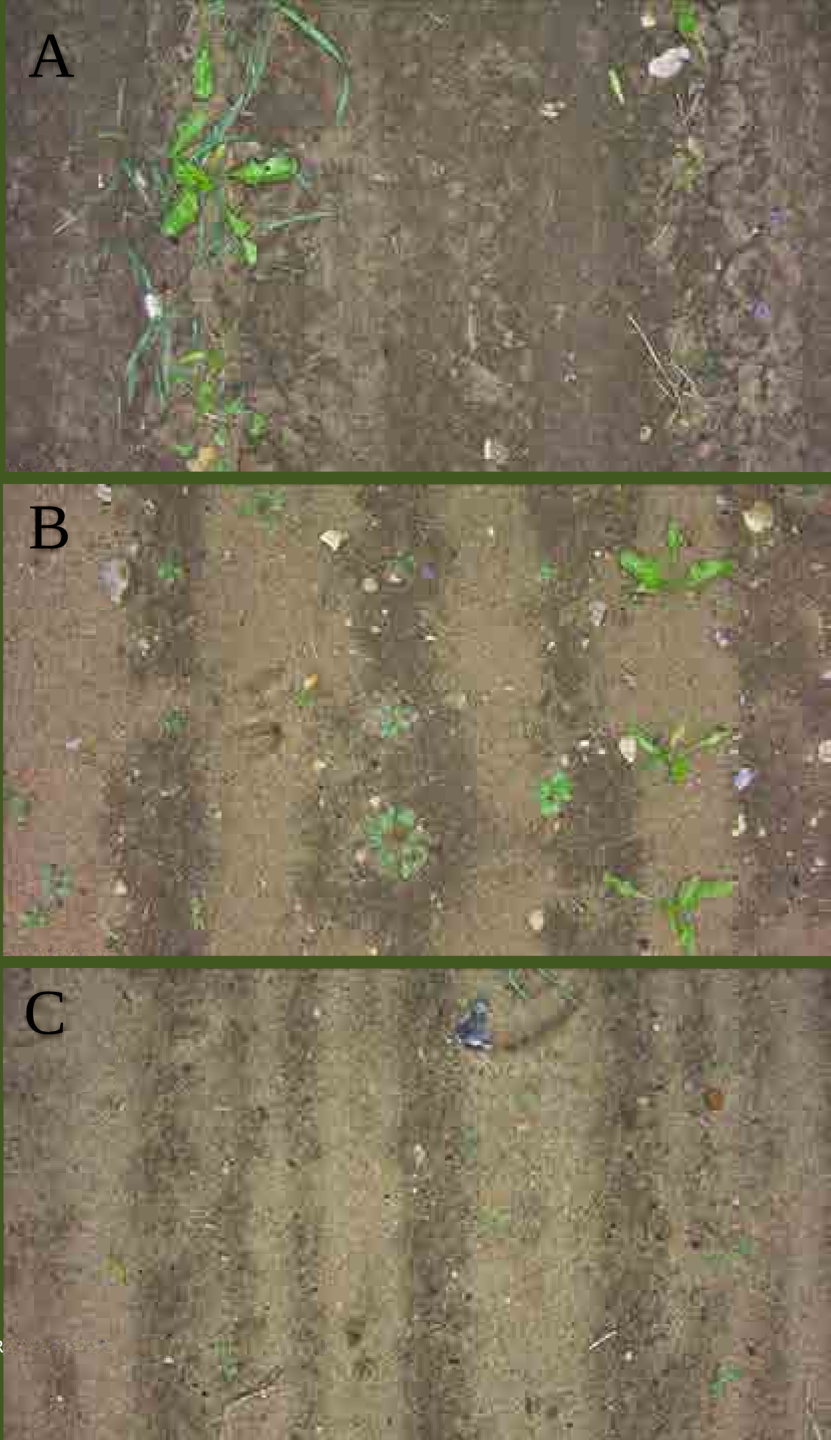


Figure 6: Confusion matrices for Treatment C (late sown sugar beets)



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RASMUS NYHOLM JØRGENSEN

TRACKING WITH YOLOV11 WAS NOT STRAIGHTFORWARD!

Classic Yolo v11 tracking cases

Source: https://docs.ultralytics.com/modes/track/#why-choose-ultralytics-yolo-for-object-tracking

Enhanced YOLOv11 Tracking in Our Study

- **Constrained Motion Tracking:**
  - Leverages FarmDroid FD20's consistent forward motion.
  - Predicts frame-to-frame displacement (RMSE: 4.92 pixels).
- **Custom Weighted Cost Function:**
  - Factors for track association:
    - Position displacement (35%).
    - Object size (20%).
    - Aspect ratio (20%).
    - Class confidence consistency (25%).
- **Row Awareness Component:**
  - Clusters sugar beet detections to track crop rows.
  - Validates positions against expected row geometry.
- **Improved Multi-Frame Tracking:**
  - Maintains object identity across 4+ frames.
  - Filters uncertain detections for better accuracy.

MICHAEL SØNDERGAARD NØRBO MADSEN*, SØREN KELSTRUP SKOVSEN, BO MELANDER, RASMUS NYHOLM JØRGENSEN

KEY TAKEAWAYS

Early-stage crop detection

- Early-seeded beets (larger): 75.84% detection accuracy
- Late-seeded beets (smaller): 44.69% detection accuracy
- Bigger plants = Better detection

Tracking Benefits

- Improves detection of smaller plants (8.75% of cases)
- Increases stability (81.56% → 85.31%)
- Reduces classification volatility (0.44 → 0.26 changes)
- Better performance in challenging conditions

Practical Implications

- Foundation for 2025 organic spraying trials

Source: Wesley Moss – OREI Project

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ACKNOWLEDGMENTS

We extend our gratitude to the following collaborators and supporters:

FarmDroid:

For providing the test field and enabling the FarmDroid FD20 to carry the OREICam during trials.

RoboWeedMaps Service:

For access to their crop and weed instance detection model, significantly simplifying the annotation process.

Funding Support:

The Organic Research and Extension Initiative (OREI) grant:
“Building Resilient Organic Weed Management Systems with Precision Smart Technologies and Autonomous Robots” (Tracking Number: GRANT13005541).

Team and Colleagues:

For their invaluable contributions to research and development.

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For more information, please visit:

https://www.youtube.com/watch?v=1xF7YKUcBSE

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INTERPRETING AND ADAPTING REGULATORY STANDARDS FOR COMPLIANCE OF DISRUPTIVE AGRICULTURAL TECHNOLOGIES: A CASE STUDY ON HIGH-PRECISION HERBICIDE SPRAYING ROBOT

Inhouse development and production


Located at Langhus in Norway (30 min from Oslo)
29 full-time employees

Current herbicides practice are damaging and inefficient

- Current herbicide spraying practices do not yield sufficient results and require **manual weed control at later stages**, which is costly and labor-intensive.
- Available herbicides for vegetables have **phytotoxic effect on crops** because they are not tailored to vegetable use.
- Farmers are dependent on easy access to labor in order to perform weed control, which is **becoming increasingly challenging**
- Pests **reduce global potential crop yield by up to 40%**; That could be twice as large if no agrochemicals were used

There is a **political push** towards reducing use of chemical herbicides by 50% in weed control, limiting farmers' ability to perform effective weed control.

As of today, farmers are covering the field with herbicides <u>4 times per season</u> (average) which causes soil, crop and water contamination

Kilter is here to optimize the area we lend of nature. We accelerate the transition to sustainable food, by delivering products that make farmers superheroes

Kilter

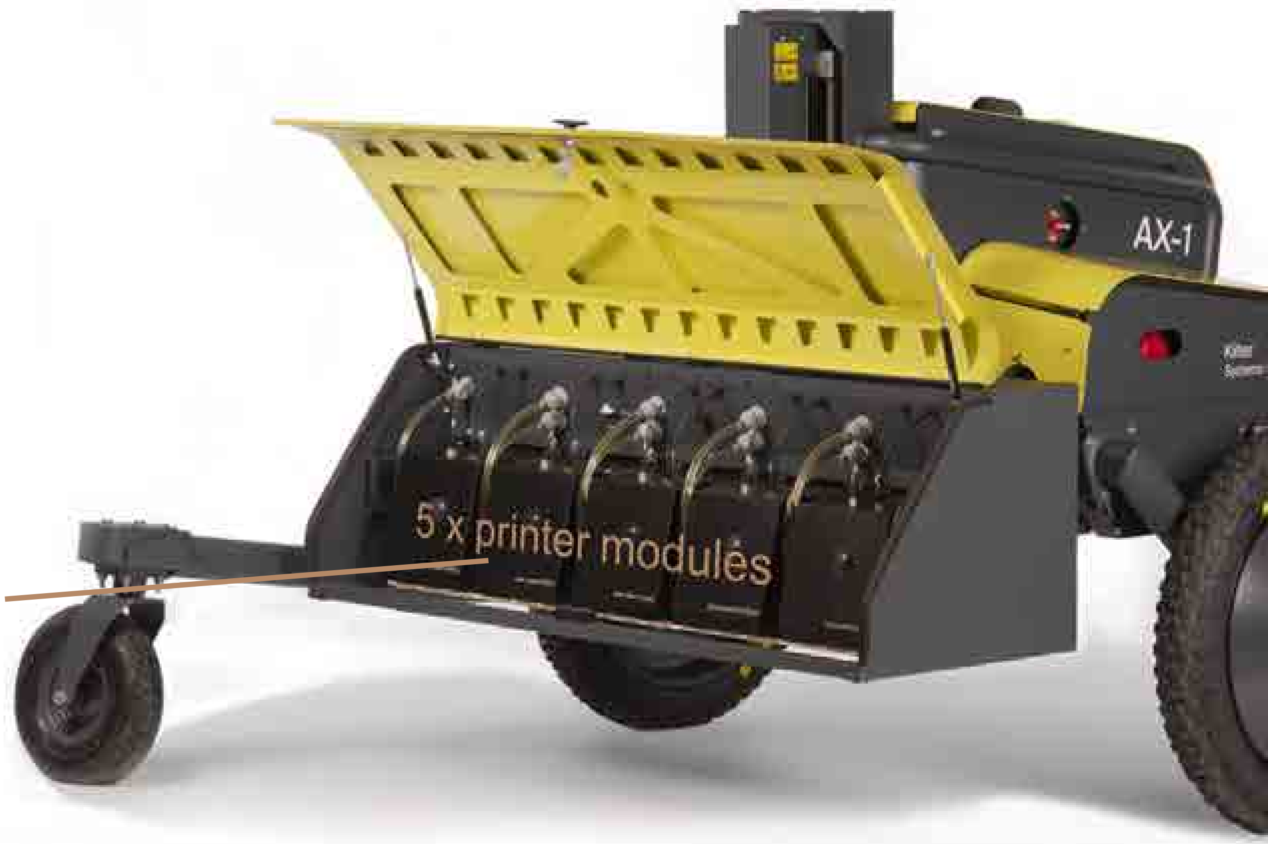
Kilter manufactures the AX-1, an herbicide spraying robot that enables farmers to perform more efficient weed control by:

- Targeting weed, not the crop, nor the soil.
- Ejecting 1µL droplets with a 6x6 mm resolution, at up to 100 Hz per nozzle outlet, having 210 nozzle outlets per robot.
- Being completely autonomous.
- Reducing herbicide usage, reducing manual labor, and increasing crop yield.

Underlying magic

Artificial Intelligence

Patented, single droplet tech.



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Take picture

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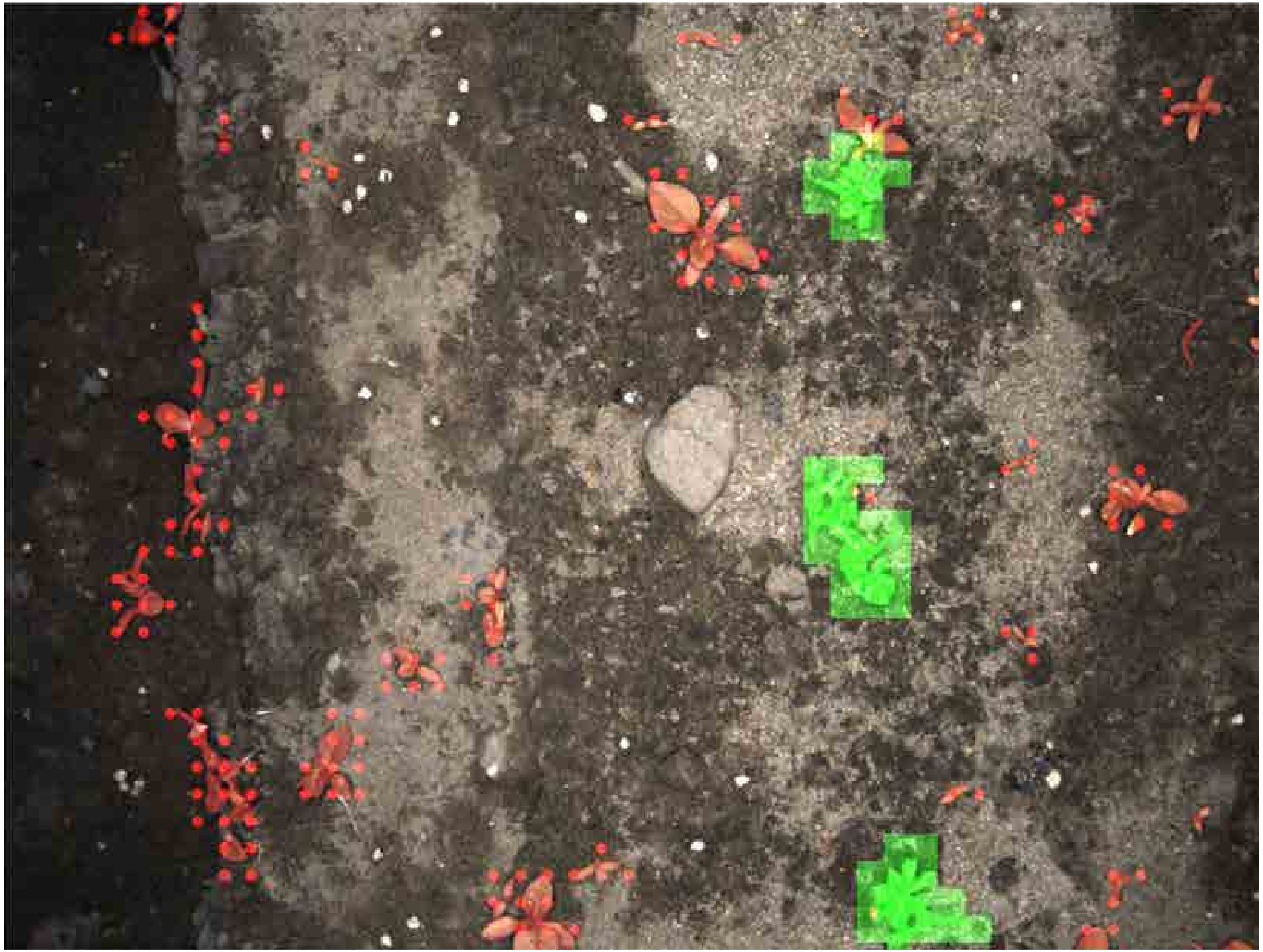
Distinguish weed, crop, and soil



Spraying decision

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SDT

Single Drop Technology

Generate individual droplets on demand

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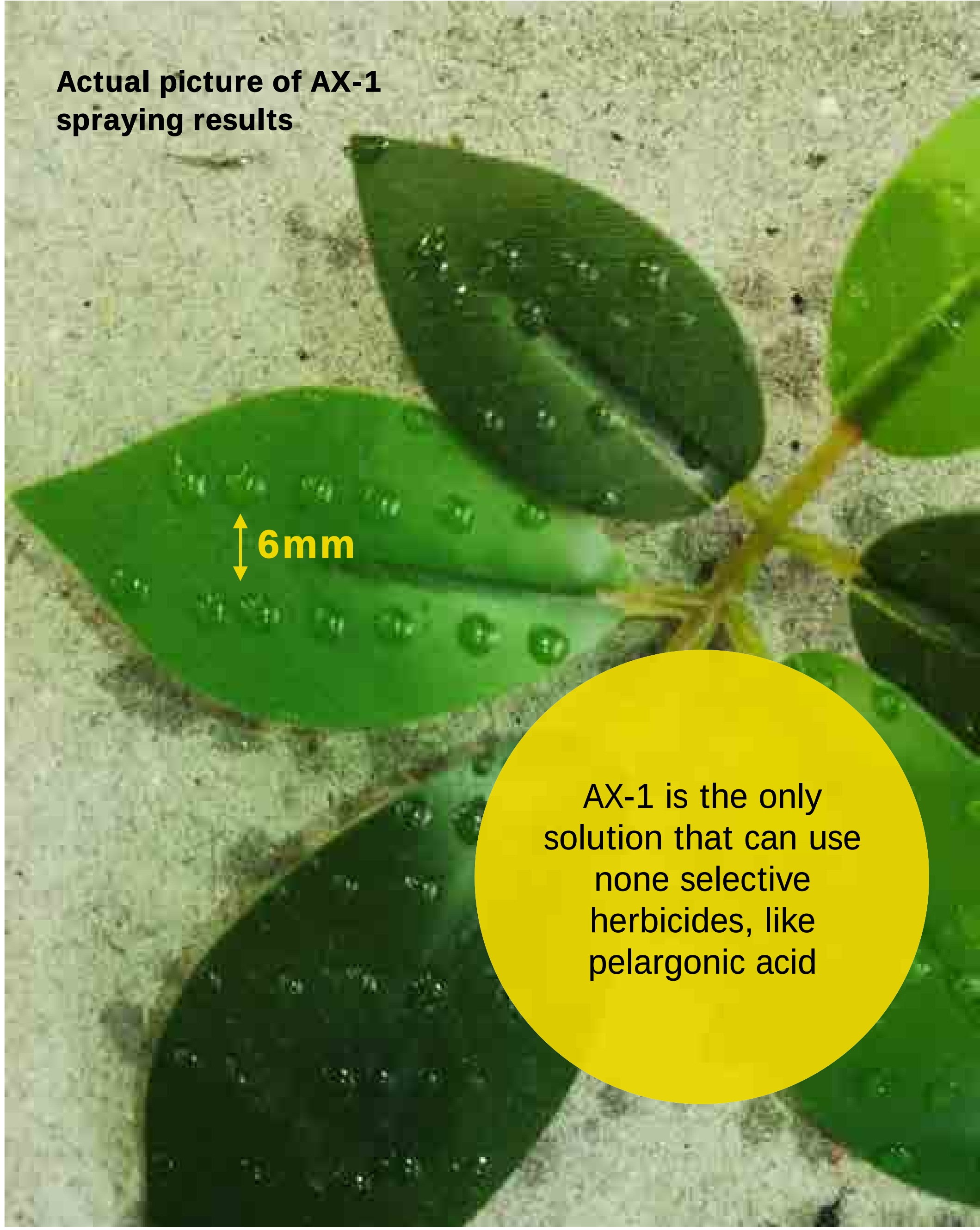
Proven technology

- Already in use at farms; 20 units sold in Norway, Sweden and Germany, as well as 3 on their way to Australia
- Deep learning neural network (in-house developed AI technology)
- Patented (Norway, USA, China, Europe, India, Eurasia) droplet generator with revolutionizing spraying precision
- AX-1 can be used in all open fields

Kilter's **tested, proven** and **patented deep-tech** droplet technology drops a precise amount of herbicide onto weeds, also **allows the use of alternative, less polluting, herbicides** such as pelargonic acid, vinegar, or citrus oil without touching and killing the crop

Actual picture of AX-1 spraying results



AX-1 is the only solution that can use none selective herbicides, like pelargonic acid

Available classifiers

Infrastructure in place to develop new classifiers quickly.

Parsnip

Shallots

Onion

Celeriac

Parsley root

Carrot

Sweede

Beetroot

Ruccola

Spinach

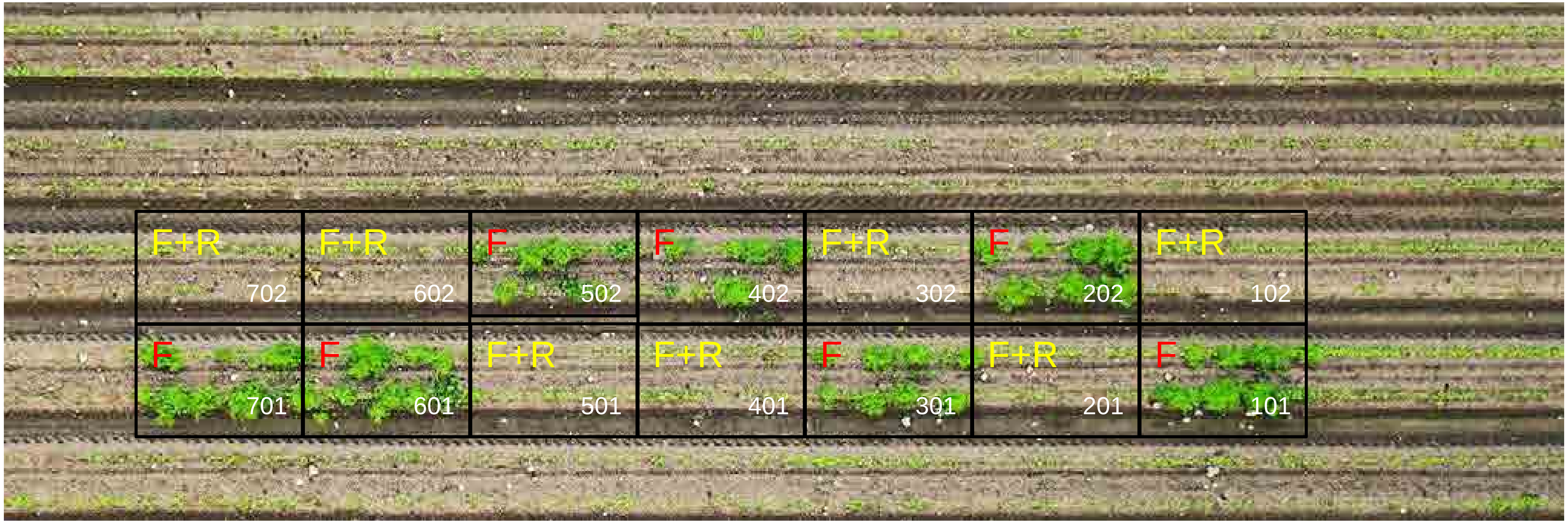
Basil

Corn salad

Proven technology

The image below is **drone footage of a customer's field** (July 2023) where the robot has treated weeds in parsley (mid-season). Based on **automated tests performed** by the machine, some areas are left untreated by the robot to demonstrate the effectiveness of the treatment. The large plants in the squares labeled **"F" are all weeds**, whereas the small plants in the rest of the image are all crops, indicating the high precision and effectiveness of the treatment. The consistent outcomes have been **verified through third-party testing** conducted by SGS and NIBIO.

"F+R" indicates where the farmer is aerating the soil + robot application.
"F" is where aeration has been applied with no robot application.



F+R: Farmers + Robot spraying practice

F: Farmers spraying practice

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3rd party field trial

Farmer – NIBIO -NLR

Kilter AX-1 with Finalsan in parsley root

Kilter AX-1

v.s

Farmers practice

Norsk Landbruksrådgiving

NIBIO NORWEGIAN INSTITUTE OF BIOECONOMY RESEARCH

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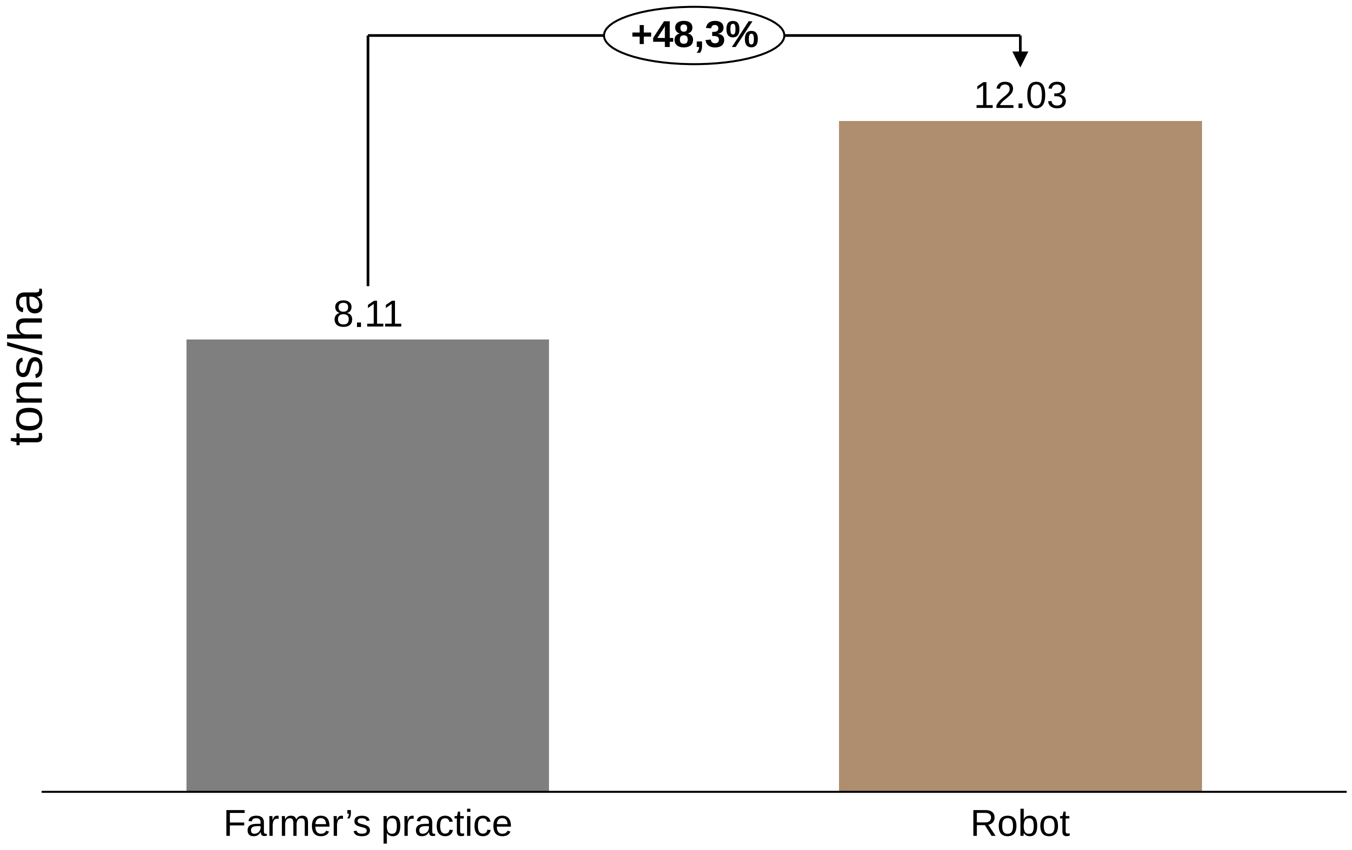
Field trial

Crop yield



The mean sellable crop yield in weeding strategy 'Robot' (**12.03 tons**/ha) was significantly higher (paired t-test, p=0,042) than the mean yield of Farmer strategy (**8.11 tons/ha**). The number of sellable roots of strategy Robot (120 486 roots/ha) was significantly higher (p= 0.025) than the strategy Farmer (86 806 roots per ha)

Norsk Landbruksrådgiving
NIBIO NORWEGIAN INSTITUTE OF BIOECONOMY RESEARCH
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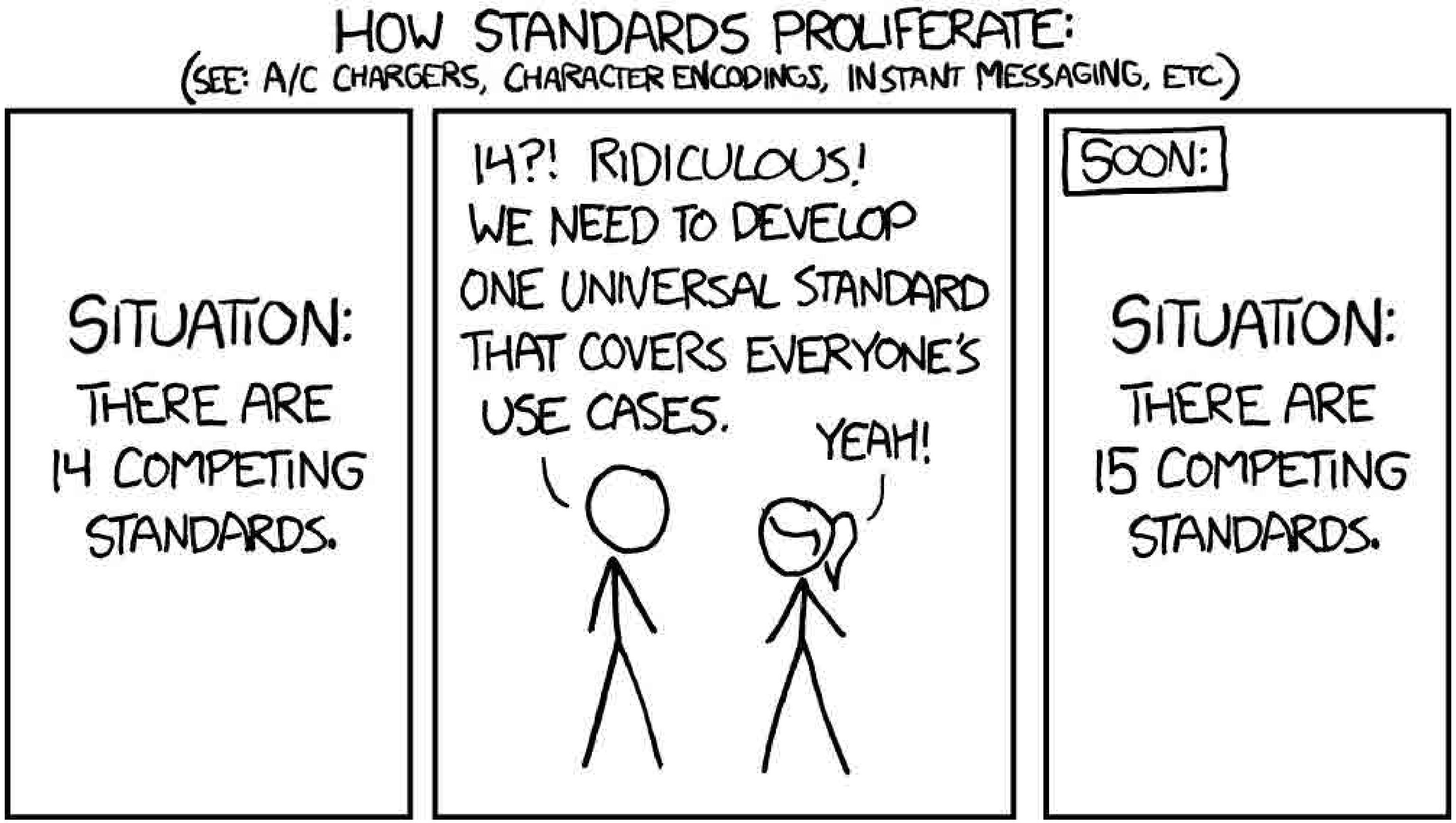
Farmer's practice

Traditional blanket spraying

Fenix and Sencor

AX-1 with Glyphosate

Standards
URL:https://xkcd.com/927/
Accessed 26.11.2024



Regulation, Standards and tests

CE - Standards

Standards relevant for AX-1

- ISO 5681. Equipment for crop protection — Vocabulary. 2020
- ISO 16119-1. Agricultural and forestry machinery - Environmental requirements for sprayers - Part 1 General. 2013
- ISO 16119-2. Agricultural and forestry machinery — Environmental requirements for sprayers — Part 2: Horizontal boom sprayers. 2013
- ISO 5682-1. Equipment for crop protection — Spraying equipment — Part 1: Test methods for sprayer nozzles. 2017
- ISO 5682-2. Equipment for crop protection — Spraying equipment — Part 2: Test methods to assess the horizontal transverse distribution for hydraulic sprayers. 2017
- ISO 5682-3. Equipment for crop protection — Spraying equipment — Part 3: Test method to assess the performance of volume/area adjustment systems. 2017
- ISO 10625. Equipment for crop protection — Sprayer nozzles — Colour coding for identification. 2018
- ISO 16122-1. Agricultural and forestry machinery — Inspection of sprayers in use — Part 1: General. 2015
- ISO 16122-2. Agricultural and forestry machinery — Inspection of sprayers in use — Part 2: Horizontal boom sprayers. 2015
- ISO 4254-1. Agricultural machinery — Safety — Part 1: General requirements. 2013
- ISO 4254-6. Agricultural machinery — Safety — Part 6: Sprayers and liquid fertilizer distributors. 2020
- ISO 12100. Safety of machinery — General principles for design — Risk assessment and risk reduction. 2010
- ISO 4102. Equipment for crop protection — Sprayers — Connection threading. 1984
- ISO 22369-2. Crop protection equipment — Drift classification of spraying equipment — Part 2: Classification of field crop sprayers by field measurements. 2010
- ISO 22856. Equipment for crop protection — Methods for the laboratory measurement of spray drift — Wind tunnels. 2008
- ISO 22866. Equipment for crop protection — Methods for field measurement of spray drift. 2005

CE - Standards

Standards relevant for AX-1

- Inspection of sprayers in use

- ISO 5681. Equipment for crop protection — Vocabulary. 2020
- ISO 16119-1. Agricultural and forestry machinery - Environmental requirements for sprayers - Part 1 General. 2013
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- ISO 22866. Equipment for crop protection — Methods for field measurement of spray drift. 2005

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Periodic inspection of sprayers

- From a legal standpoint, it is considered a field sprayer
- Guidelines have been developed to align with the current periodic inspection regime
- Some of the main differences include
  - Velocity calibration
  - Testing of nozzle performance
  - Additional tests due to differences in the working principles

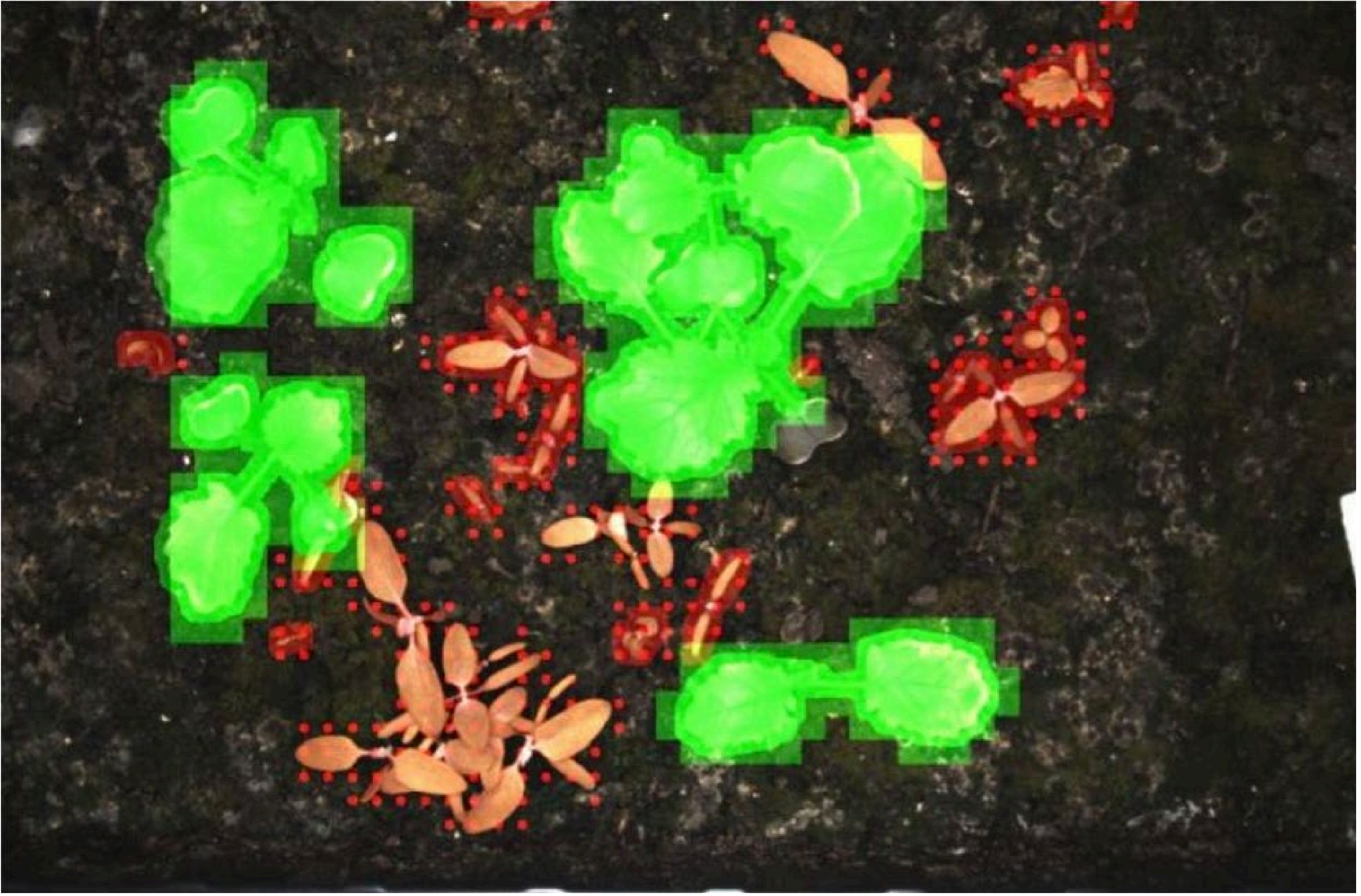
Spray-module vs a standard nozzle

Kilter's spray module

- Discrete droplets with defined droplet volume
- Precise positioning of every shot
- Areal dosage controlled by droplet size, and spacing between droplets

Standard nozzles

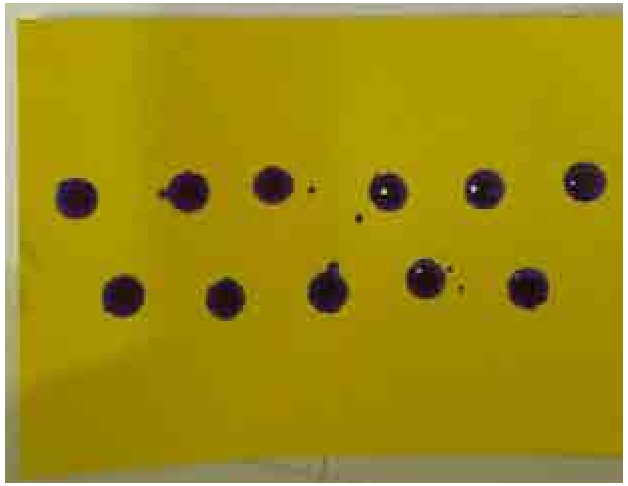
- A continuous flow of droplets (size characterized by a distribution)
- Continuous application of spray over a width
- Areal dosage controlled by flowrate, distribution, and velocity of the nozzle



Kilter AX-1

Software variable droplet size.

- Areal dosage controlled by:
  - Droplet volume
  - Droplet spacing

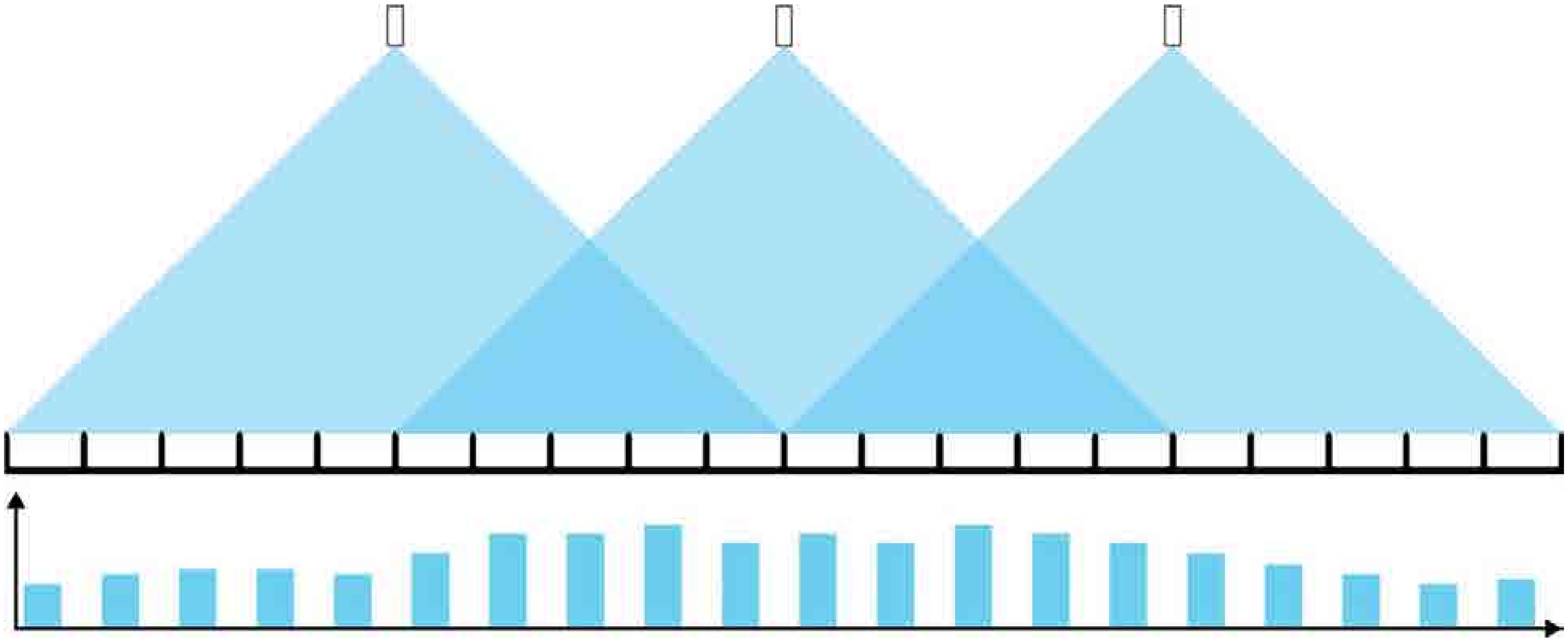


$$Areal\ dosage = \frac{1.0\mu\mathrm{L}}{(6\mathrm{mm})^2} = 278\mathrm{L/ha}$$

Inspection of Pesticide Application Equipment

Traditional equipment

- ISO 16119-2
- ISO 16122-2
- ISO 5682-2



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Systems in balance

Containers with scale mounted on Kilter AX-1 spray unit. In this test, each container have accumulated the volume from 1000 droplets, proving even distribution (photo: Kilter)

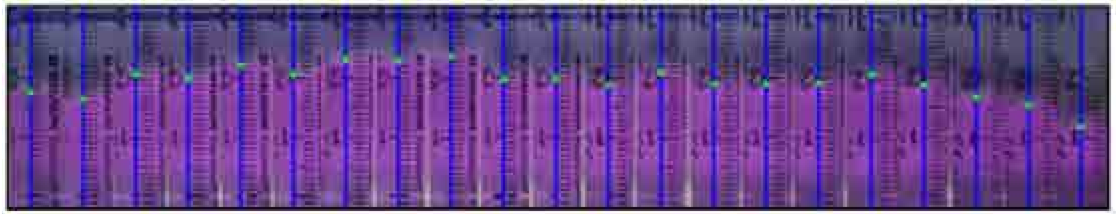


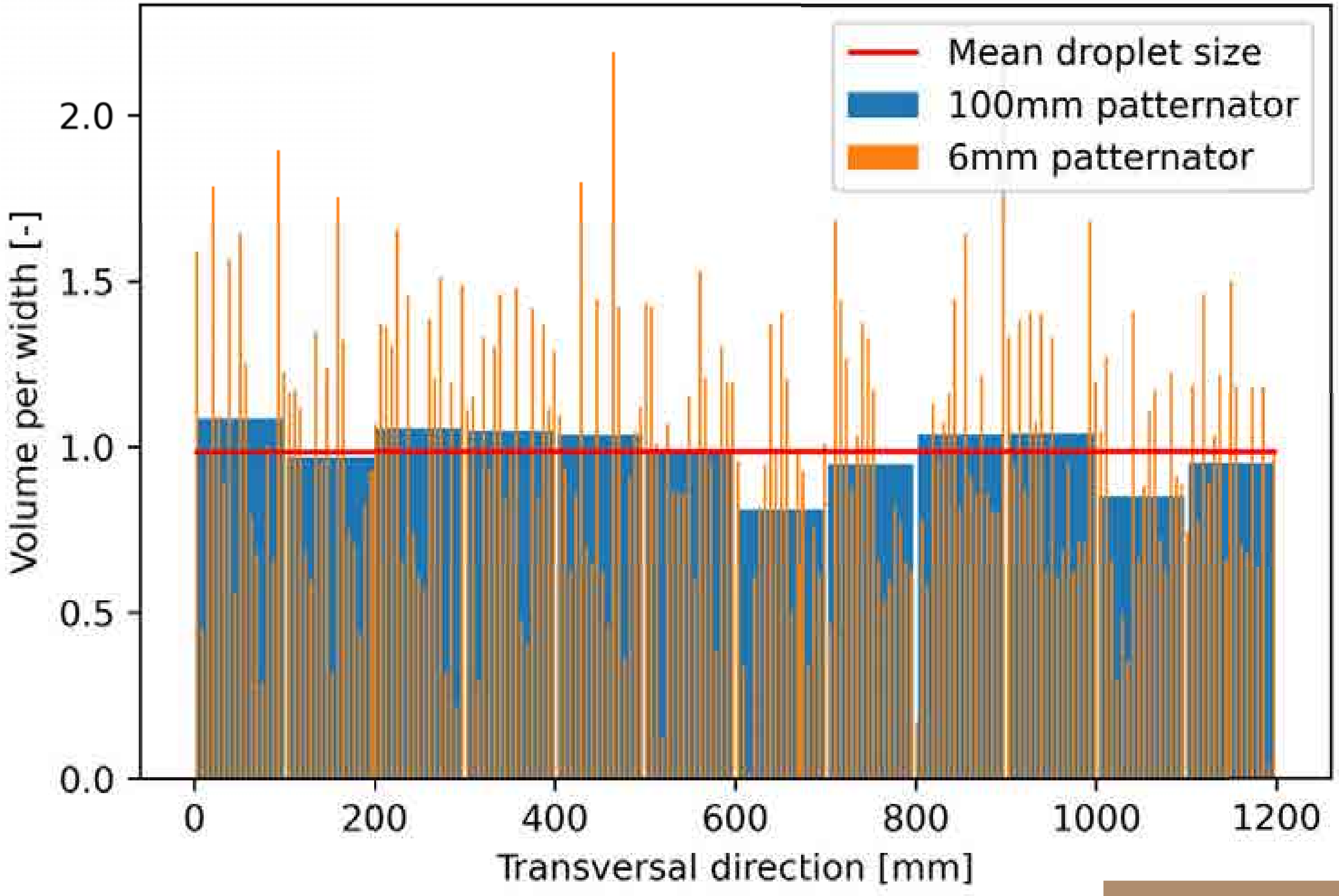
Figure 4 Automatic read-out of an uneven distribution. The green dots are levels that the vision-based system reads out and converts to numerical values (photo: Kilter)

Example solution for SDT systems

Measuring droplet volume and distribution

- Measure the accumulated droplet volume from each droplet generator
- Array with containers with scale
- Test program on the robot
- Vision-based system for automatic reading and documenting the results.

Obtaining allowed standard deviation for 6mm patternator from sample mean and standard error



$$\hat{\mu}_{100} = \mu_6$$

$$SE_{100} = \frac{\sigma_6}{\sqrt{n}}$$

$$n = \frac{100}{6}$$

	100mm patternator	6mm patternator
COV for new equipment	7%	28.6%
COV for used equipment	10%	40.8%

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Interval approach

If none of the 42 (or 210) observed values exceed the limit of (μ ± x), there is at least a 99.9% certainty that the COV is below 41% on a 6mm patternator.

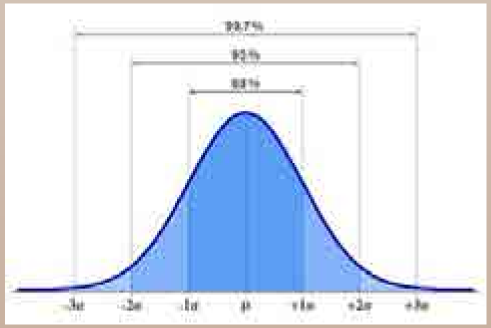
Assuming normal distribution

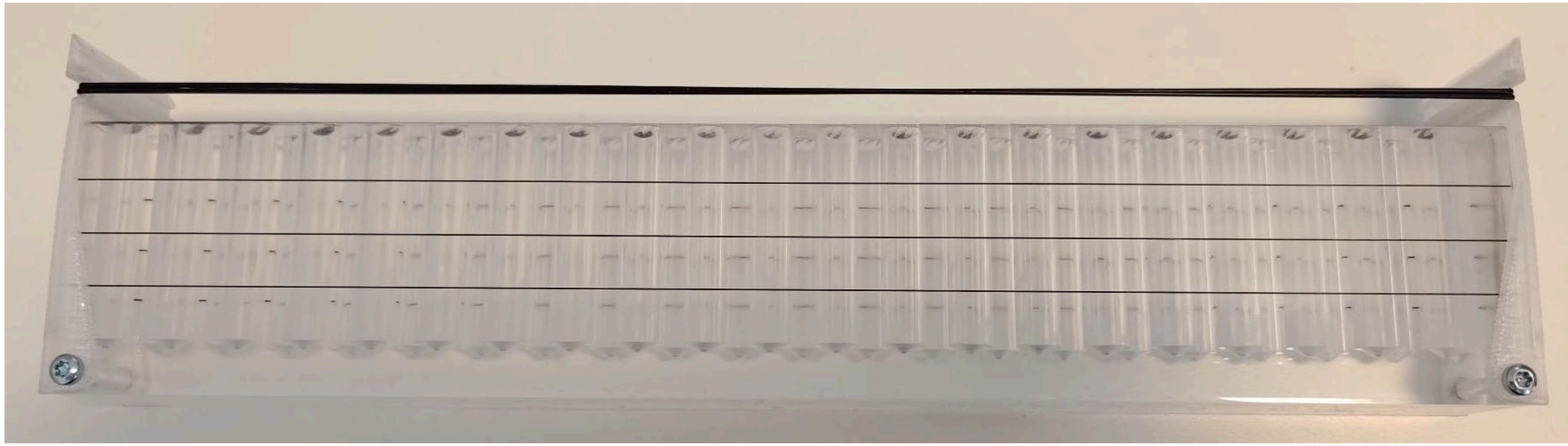
$$P_{all} = 0.001$$

$$P_1 = \sqrt[n]{P_{all}}$$

n	P1	Allowed deviation
42	0.848342898…	58.8%
210	0.967641053…	87.7%

n refers to the number of measurements (nozzle outlets)





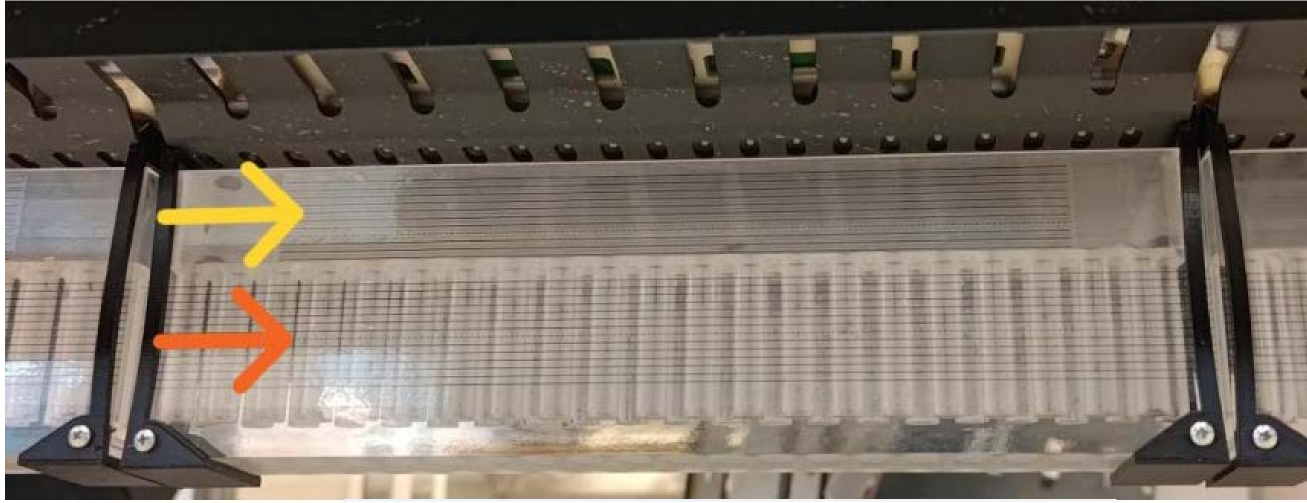
Key differences from a pure COV approach:

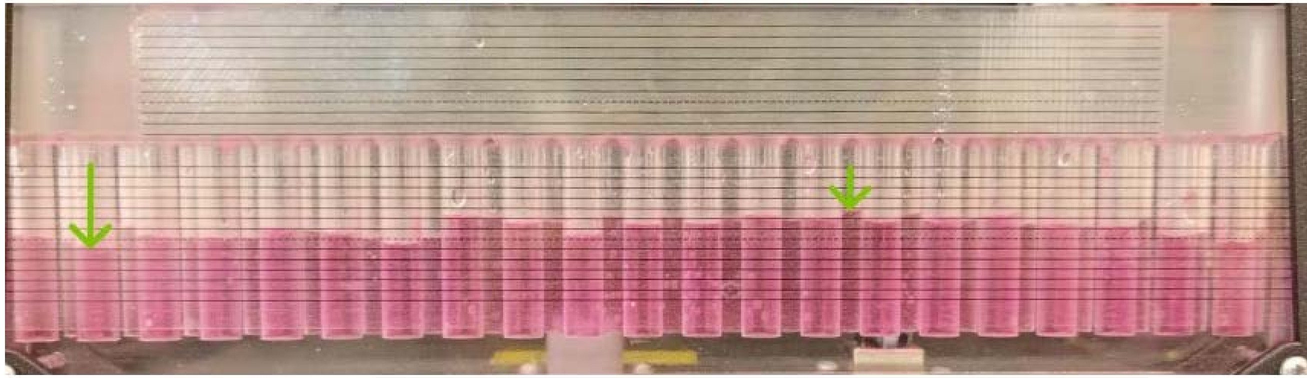
- More conservative
- More sensitive to outliers
- Criterion applied to every single droplet generator

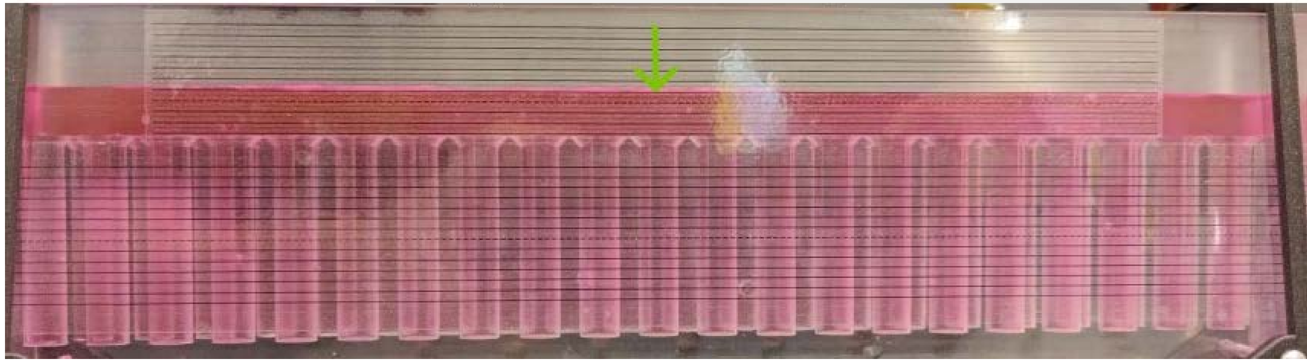
Interval approach: visual tool

2 in 1 tool:

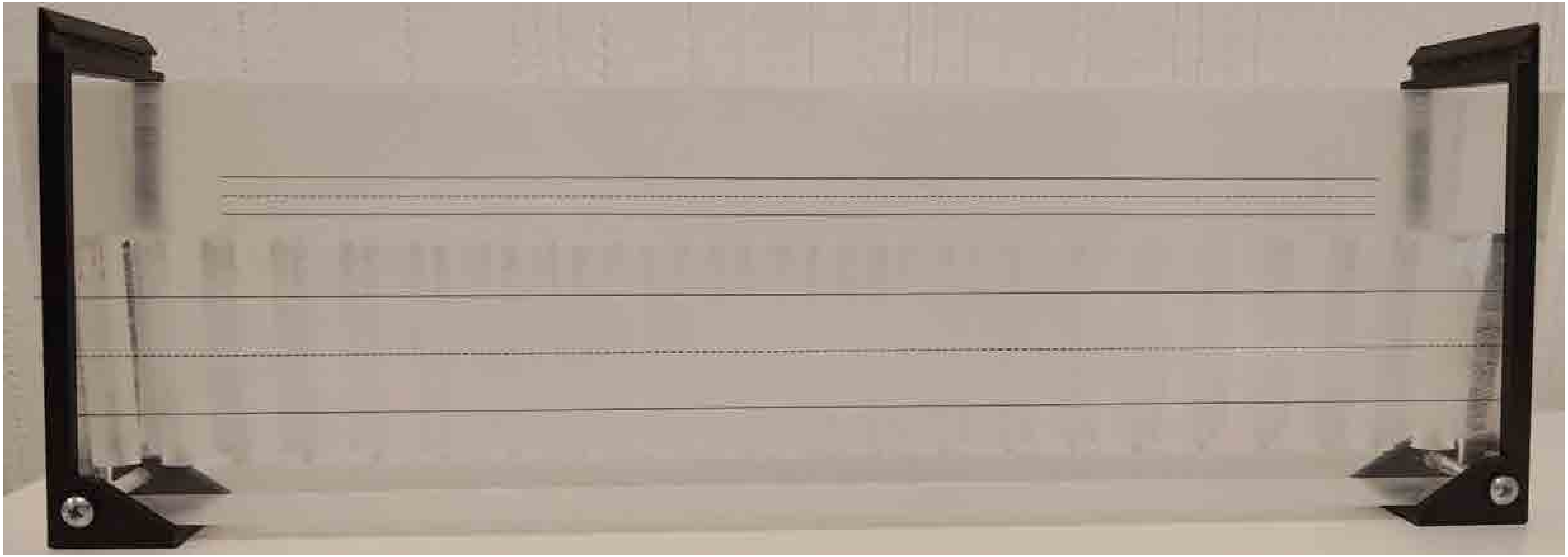
- Assess COV with lower part
- Measure average droplet volume in the upper part



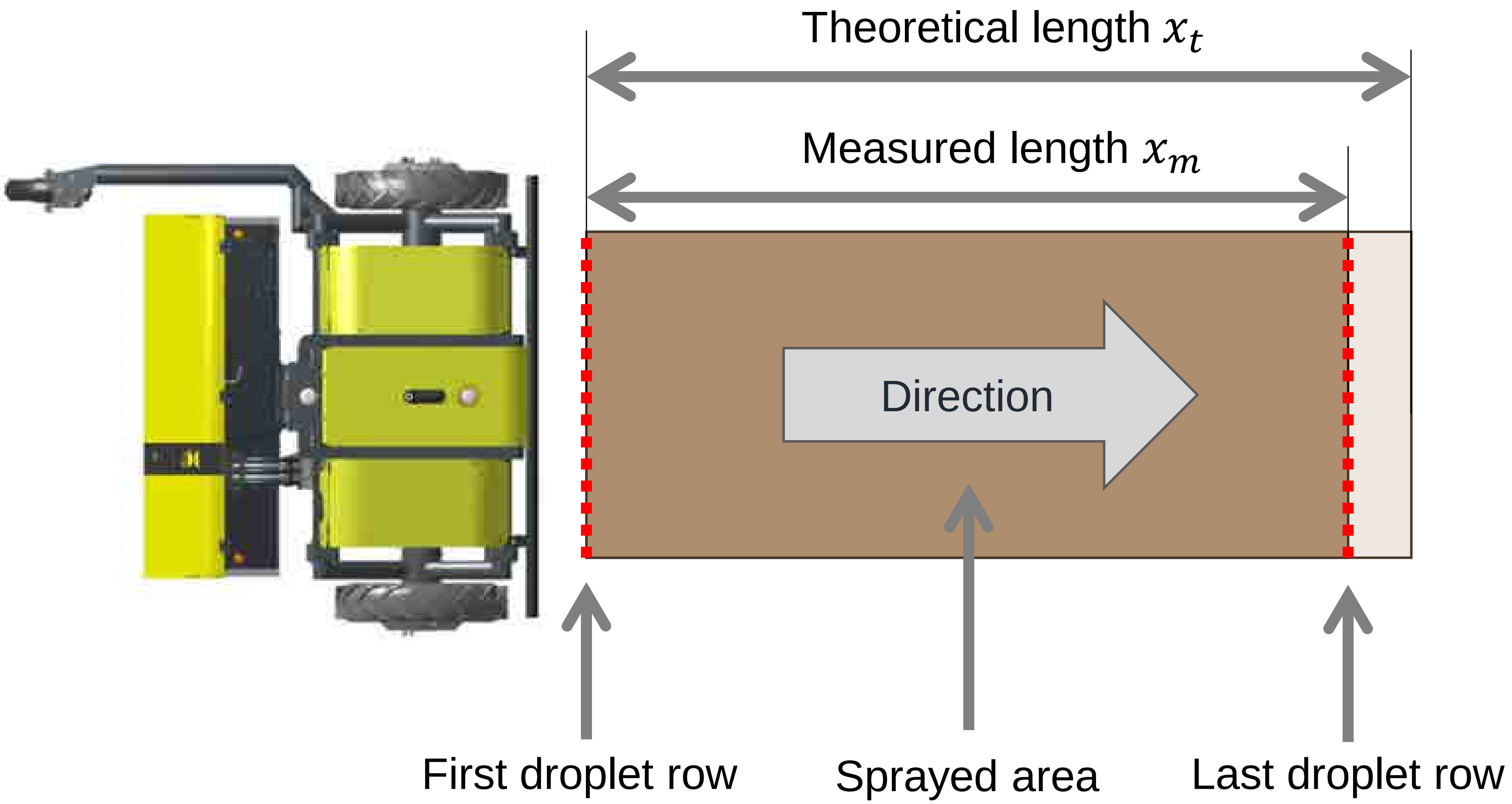




Interval approach, simplified version



Velocity calibration



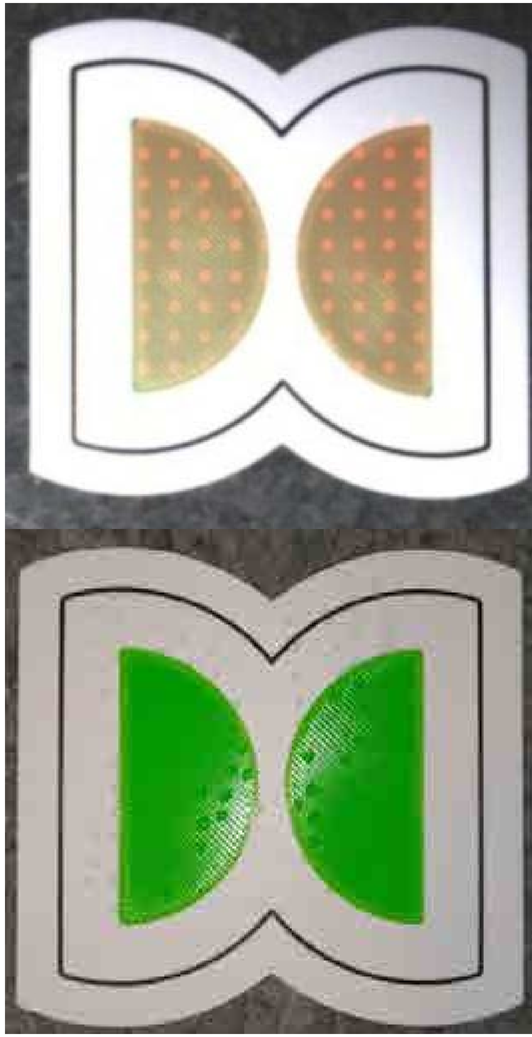
Criterion

$$\frac{x_m - x_t}{x_t} < 0.025$$

x_t - number of droplets per nozzle outlet times 6mm(200 droplets →120cm)

Positioning of droplets

- Standards were not developed for precision sprayers
- There are more tests which should be governed by the standards
- Due to missing guidelines, we develop our own test procedures
- This test should be done by the machine by itself



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Systems in balance

Automated self-testing

Key to suksess?

- Barrier and cost for conducting the inspection can be lowered
- Test frequency can be increased
- Dys-functional systems will be detected as soon as possible

AX-1 marks a paradigm shift

- Selectivity moved from chemistry to software (AI)
- Precision allows early treatment
- Patented droplet generator with revolutionizing spraying precision

Kilter's **tested, proven and patented** droplet technology drops a precise amount of herbicide onto weeds, **which allows for the use of bioherbicides** such as pelargonic acid without touching and killing the crop.

UAV-BASED VEGETATION BIOMASS ANALYSIS WITH RGB, THERMAL AND MULTISPECTRAL IMAGERY

Mikael Änäkkälä, Asko Simojoki, Pirjo Mäkelä, Laura Alakukku, Antti Lajunen

INTRODUCTION

- UAVs are versatile tools for data collection, offering the ability to carry a range of sensors
- UAVs have been utilized in agricultural research, including studies on crop water balance, yield and biomass estimation, as well as weed identification (Crusiol et al. 2020, de Camargo et al. 2018, Li et al. 2022, Viljanen et al. 2018)
- The aim of this research was to investigate how different cameras installed on UAV can be used to estimate the amount of crop dry matter biomass. The key advantage of this study is the wide variety of crops and the use of multiple types of cameras to capture images from the crops during the growing season.

RESEARCH AREA

- Located in Haltiala, Helsinki, Finland
- Two different field trials
- 72 plots in total
  - Plot size 1.5 m x 15 m (22.5 m^2)

- The crops:
  - wheat (*Triticum aestivum* L.)
    - Winter wheat (n=8)
    - Spring wheat (n=8)
  - oats (*Avena sativa* L.) (n=32)
  - rapeseed (*Brassica napus* L.) (n=16)
  - pea (*Lathyrus oleraceus* Lam.) (n=4)
  - faba bean (*Vicia faba* L.) (n=4)

EQUIPMENT - UAVS

DJI Phantom 4 Advance

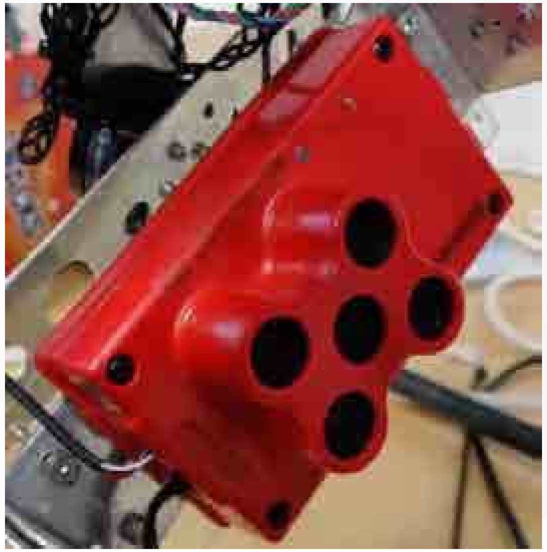
Tarot T960

EQUIPMENT - CAMERAS

- RGB camera:
  - DJI Phantom 4 Advance
- Thermal camera:
  - Flir Duo Pro R
- Multispectral cameras:
  - Micasense Rededge 3 (Red, Green, Blue, NIR and Rededge)
  - Mapir Survey3W RGN (Red, Green and NIR)

Flir Duo Pro R

Micasense Rededge 3



DJI Phantom 4 Advance

Mapir Survey3W RGN

FLIGHT MISSIONS

- Softwares: Mission planner (Tarot), Pix4Dcapture (DJI)
- Flight altitude
  - 50 m: multispectral (Micasense) and Thermal (Flir)
  - 20 m: RGB (DJI) and multispectral (Mapir)
- Double grid for RGB image collection
- Simple grid for multispectral and thermal imaging
- Overlap ~80%

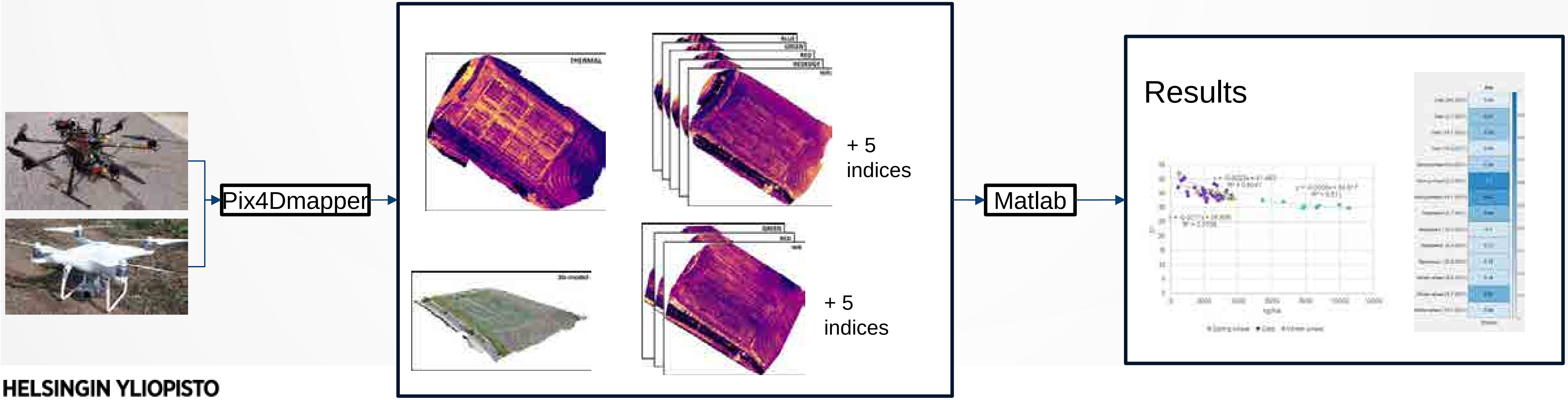
- 5 ground control points for georeferencing

DJI Phantom: RGB and Mapir

Tarot T960: Micasense and Flir

DATA PROCESSING

- All the images were processed with Pix4Dmapper to create orthomosaic images and pointclouds/3D models
- Multispectral images were calibrated with their own reflectance panels
- Matlab was used to extract pixel values and height values from the tiff files



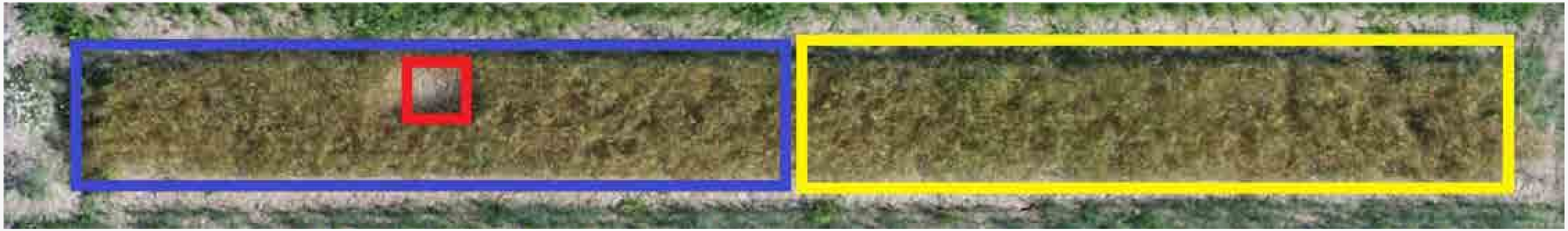
DATA COLLECTION

Date	Cameras				Field measurements					
	DJI	Flir	Micasense	Mapir	Pea	Faba bean	Oats	Spring wheat	Winter wheat	Rapeseed
1.6.2021	x	x	x							
9.6.2021	x	x	x		x	x	x	x	x	
20.6.2021	x				x	x	x	x	x	
5.7.2021	x	x	x	x	x	x	x	x	x	x
19.7.2021	x	x	x	x	x	x	x	x	x	x
6.8.2021	x	x	x	x						x
16.8.2021	x	x	x	x	x	x	x			
30.8.2021	x	x	x	x						x

UAV data was collected 1-2 days before/after the field measurements

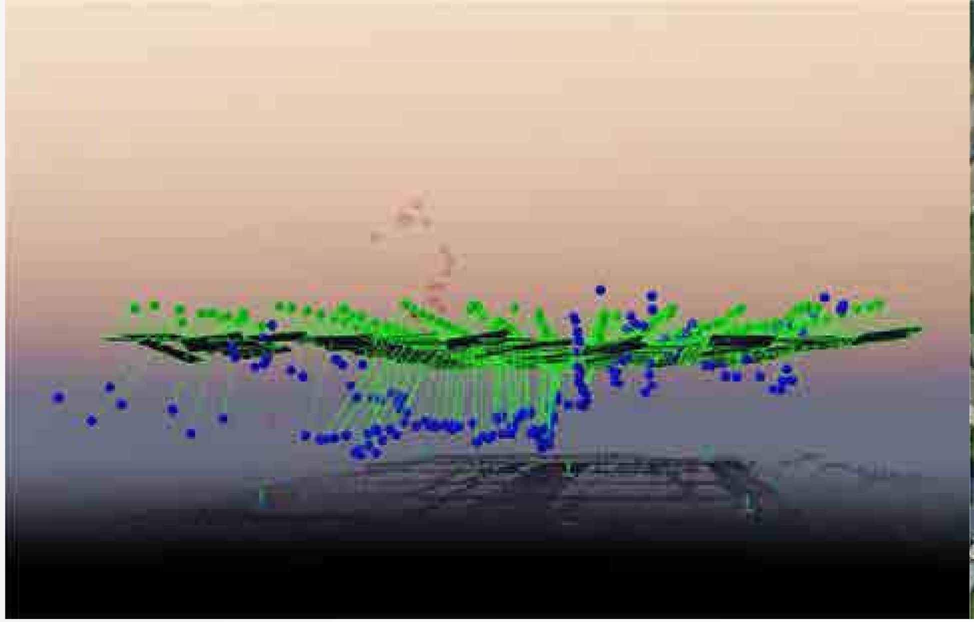
DATA COLLECTION

- The plots were divided into two sections for analysis
- One of the sides (Blue rectangle) where used to collect biomass samples
  - Crop samples (Red square) were collected from a area of 0.25 m^2 from each plot
- The other side (Yellow rectangle) was left untouched and was analyzed from the UAV images



CHALLENGES WITH MEASUREMENT

- GPS drift problems with Mapir camera
- A very dry summer caused uneven growth in the experimental plots



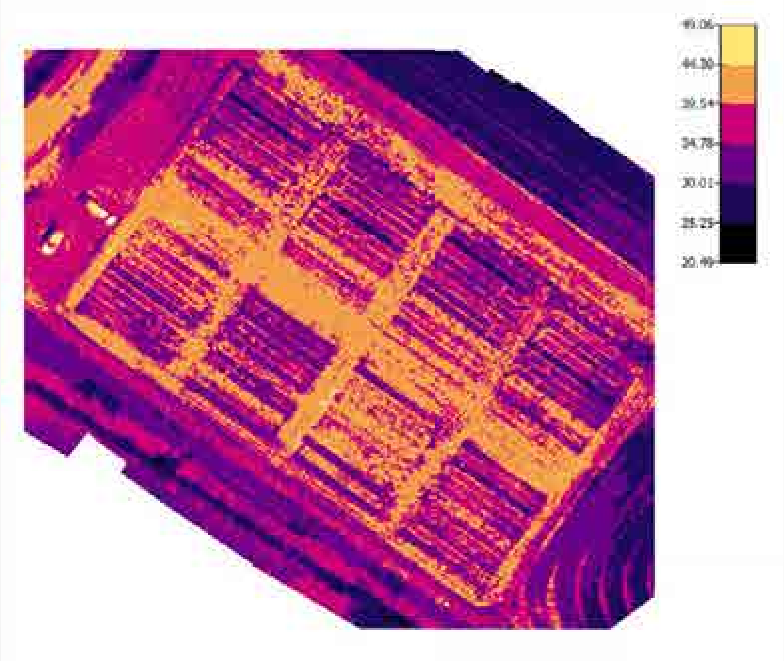
Mapir 6.8.2021

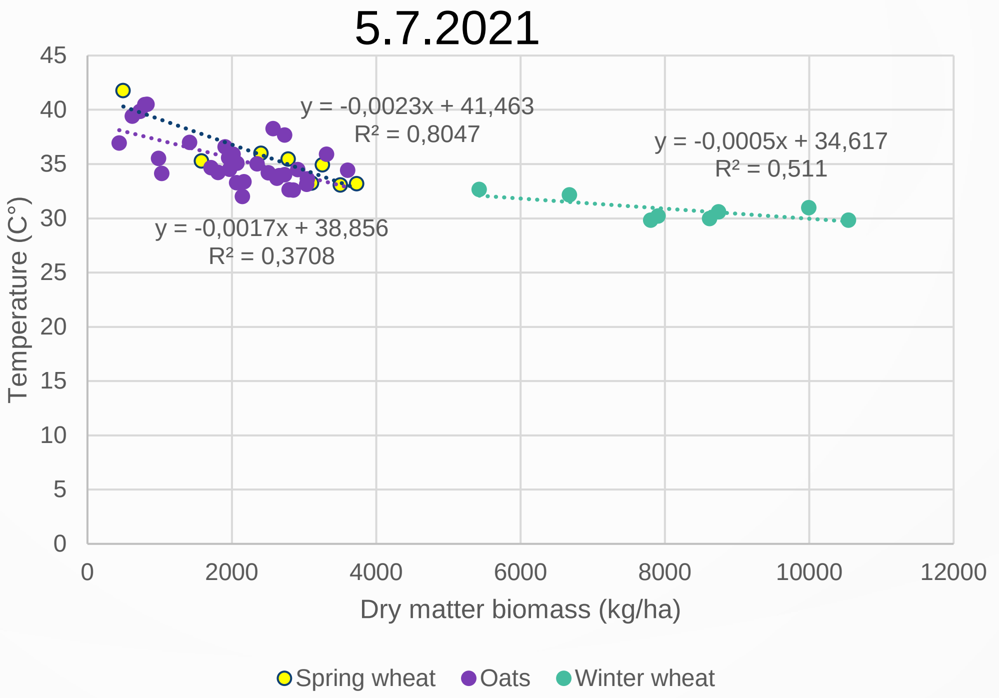
DJI 6.8.2021

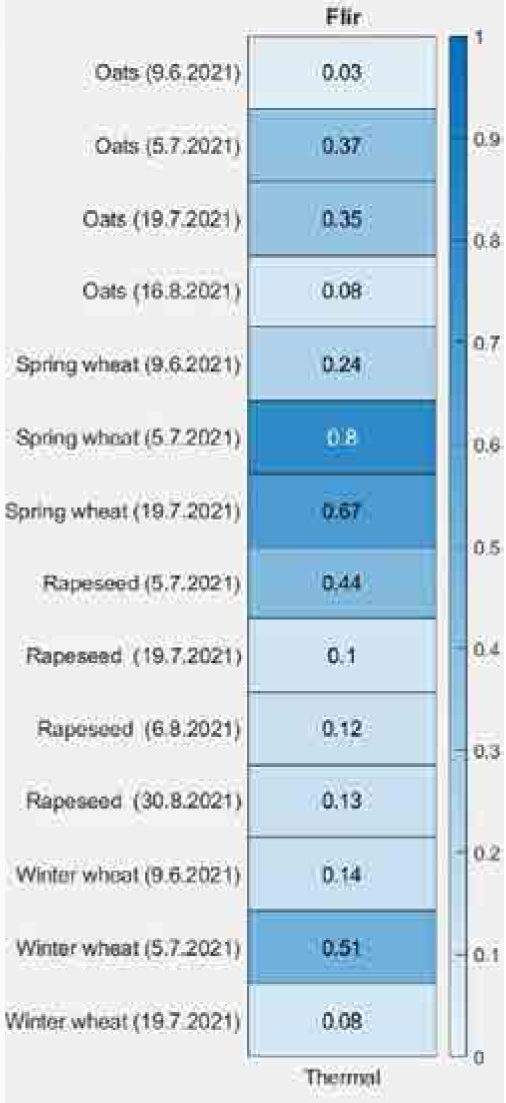
RESULTS - THERMAL

- Many of the Pearson correlations (R) were negative
  → plots with higher biomass had lower temperature

Thermal map 5.7.2021



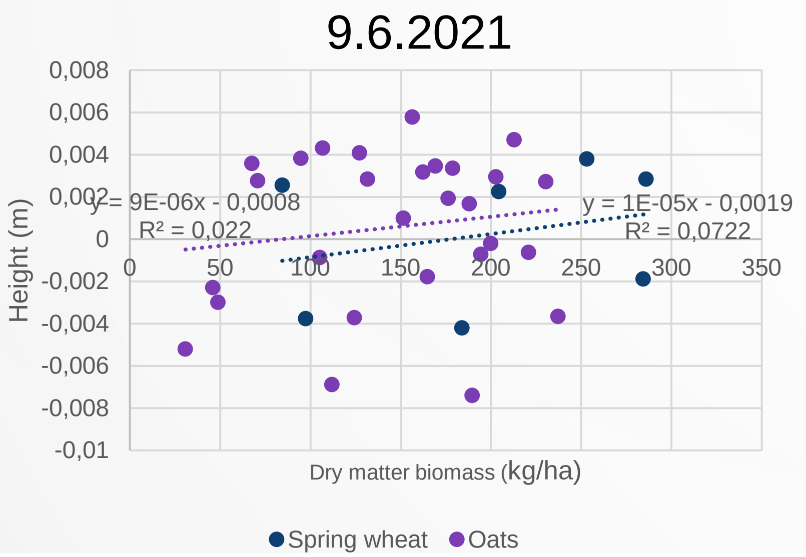


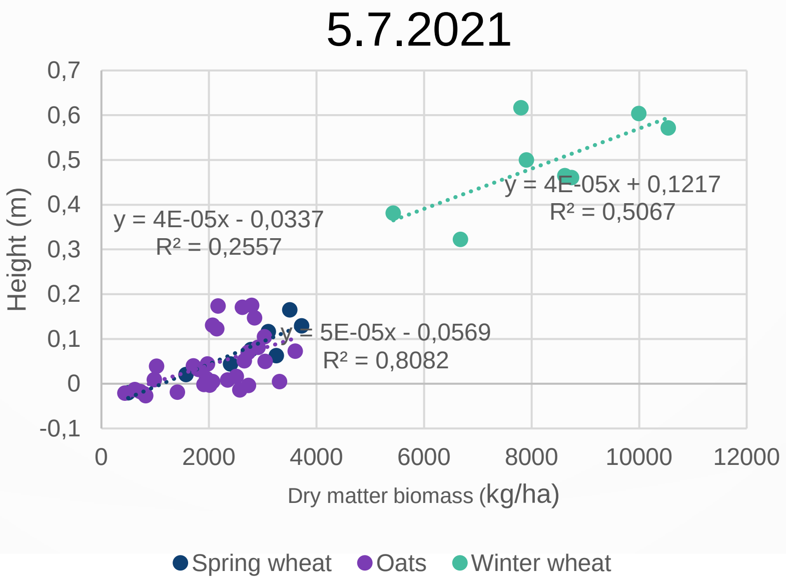


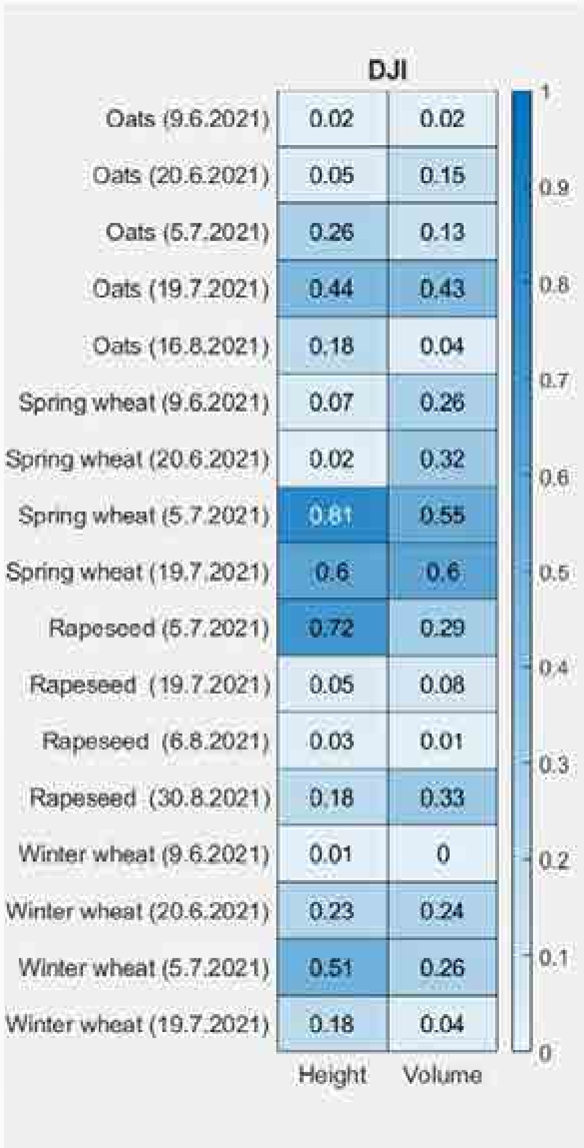
Coefficient of determination (R^2) values

RESULTS – 3D MODEL

- Negative height values are possibly caused by inaccuracies in georeferencing or in the creation of 3D model/pointcloud
- Height model performed weaker at the beginning of crop growth. Bareth et al (2018) had similar results with their CHM model for grass swards



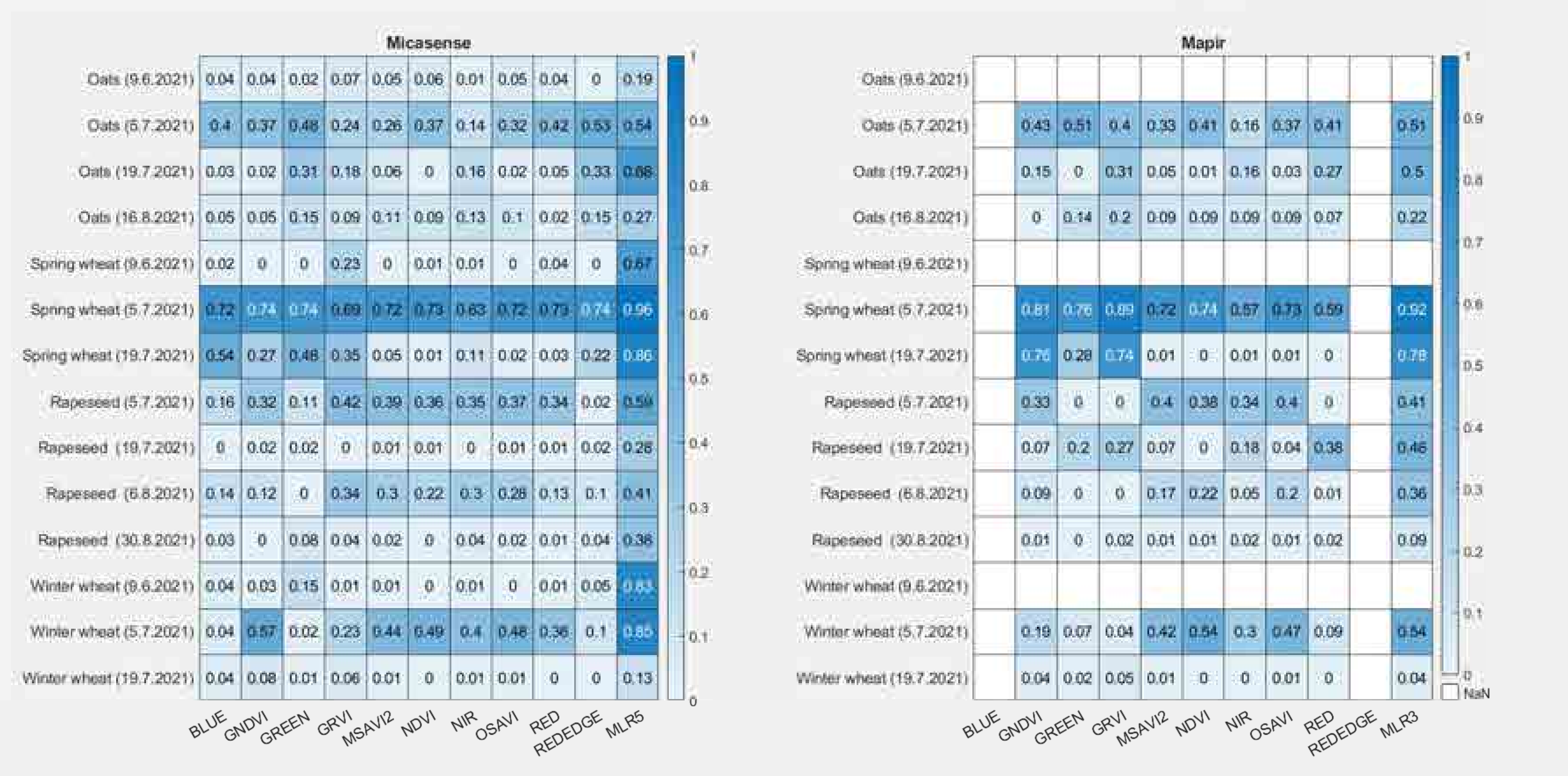




Coefficient of determination (R^2) values

RESULTS – MULTISPECTRAL CAMERAS

- Small differences between the correlations of two multispectral cameras

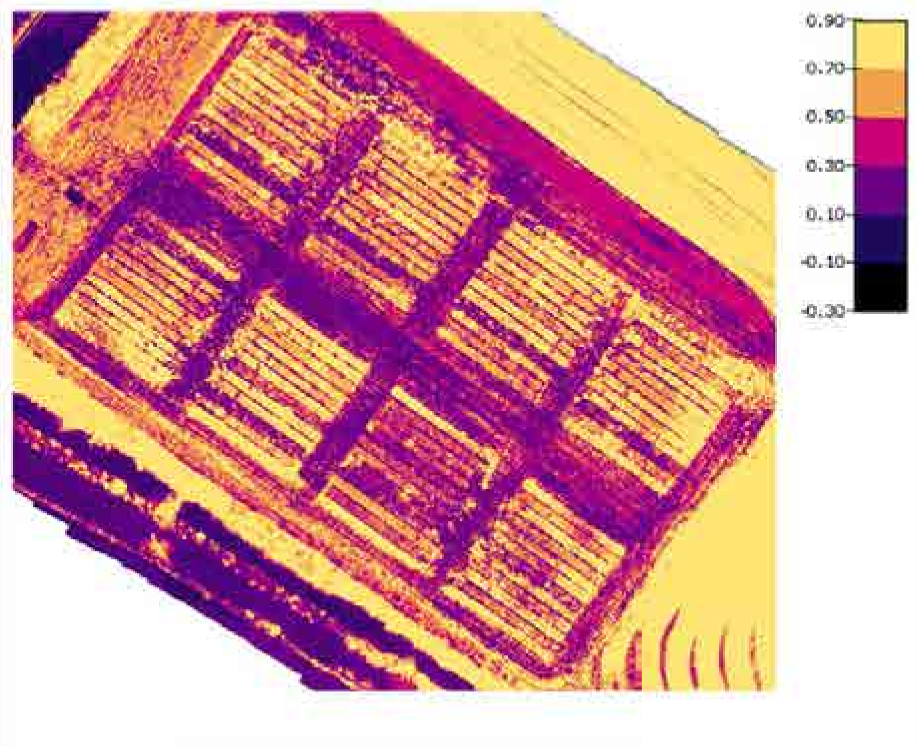


Coefficient of determination (R^2) values
MLR5 = Multiple linear regression using the five spectral bands (Blue, Green, NIR, Red and Rededge)
MLR3 = Multiple linear regression using the three spectral bands (Green, Red and NIR)

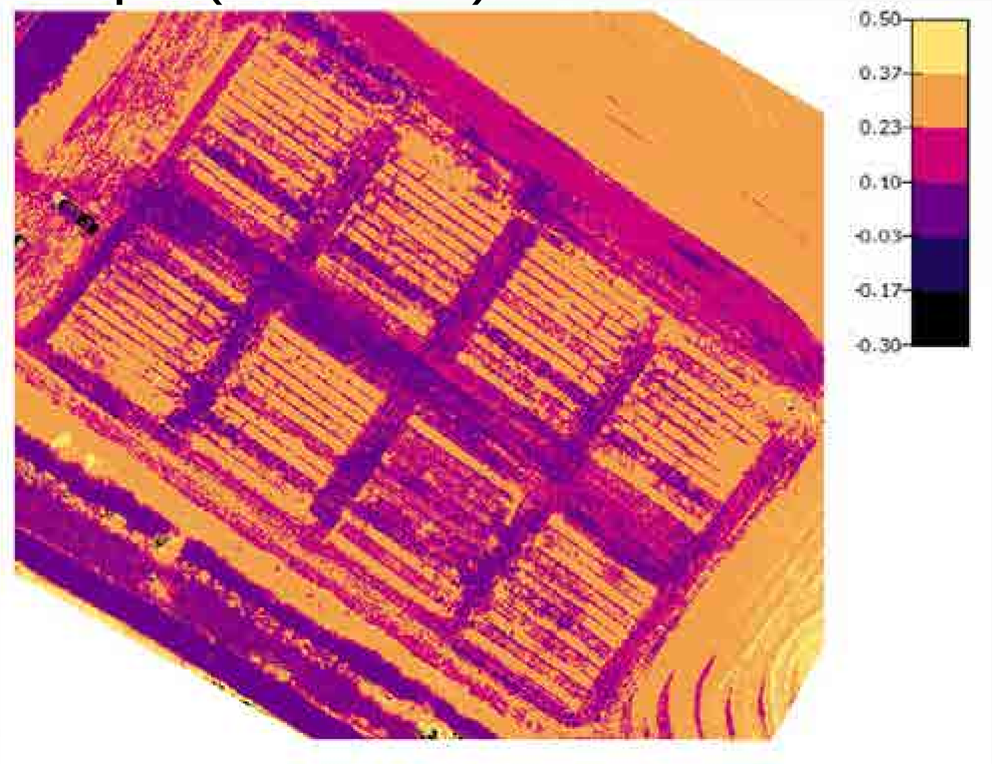
NDVI MAPS (MICASENSE AND MAPIR)

- Mapir showed smaller NDVI values than Micasense

Micasense (5.7.2021)

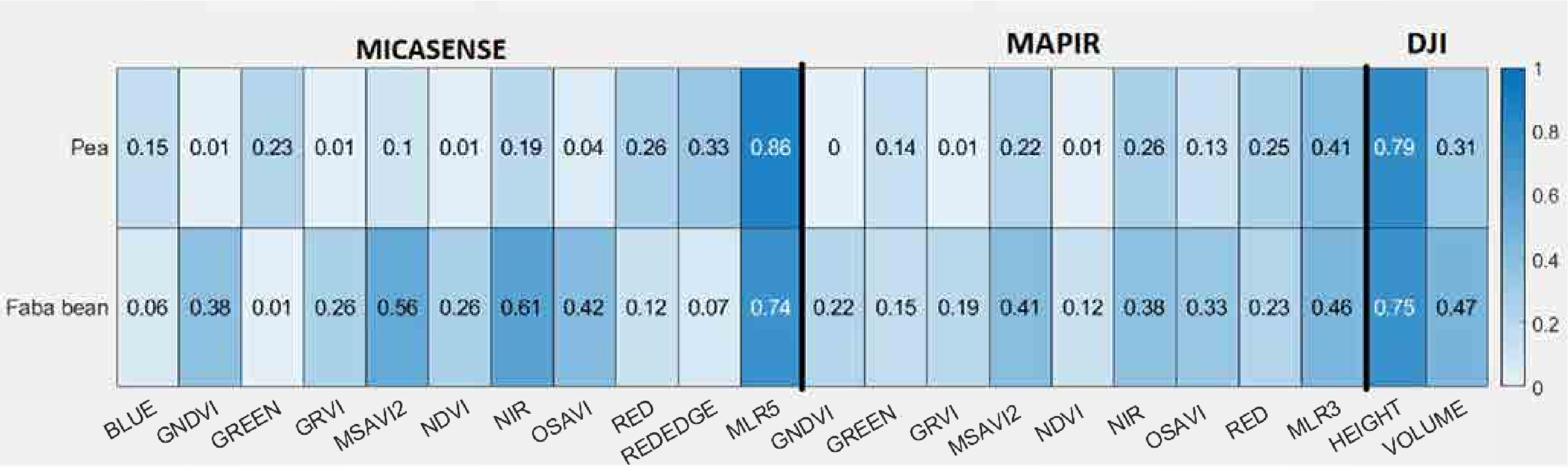


Mapir (5.7.2021)



PEA AND FABA BEAN

- The correlations are calculated from 5.7, 19.7 and 16.8 measurements



Coefficient of determination (R^2) values.
MLR5 = Multiple linear regression using the five spectral bands (Blue, Green, NIR, Red and Rededge)
MLR3 = Multiple linear regression using the three spectral bands (Green, Red and NIR)

CONCLUSIONS

- Height model performed better on later growth stages of the crops and thermal in the beginning/middle growth stages
- Quite small differences between the two multispectral cameras
- Multiple linear regression achieved highest correlations with the five spectral bands
- The UAV data needs closer inspection for potential issues, and further preprocessing could improve its quality

ACKNOWLEDGMENT

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The field trials were part of Leg4Life STN-project. Plant samples were collected by Jaakko Haarala, Saana Hakkola, Jenni Orjala ja Noora Vihanto.

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THANK YOU

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DEVELOPMENT OF A LOW-COST TELEMATICS SYSTEM FOR SMART FARMING OPERATIONS

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Advances and Innovations in Agricultural Engineering The 5th NJF - EurAgEng - Agromek Joint Seminar, November 26-27, 2024, Herning, Denmark

BACKGROUND

Soil scanning

Soil sampling

Crop sensor

Field operations

Field conditions

Automatic penetrometer

Aerial imaging

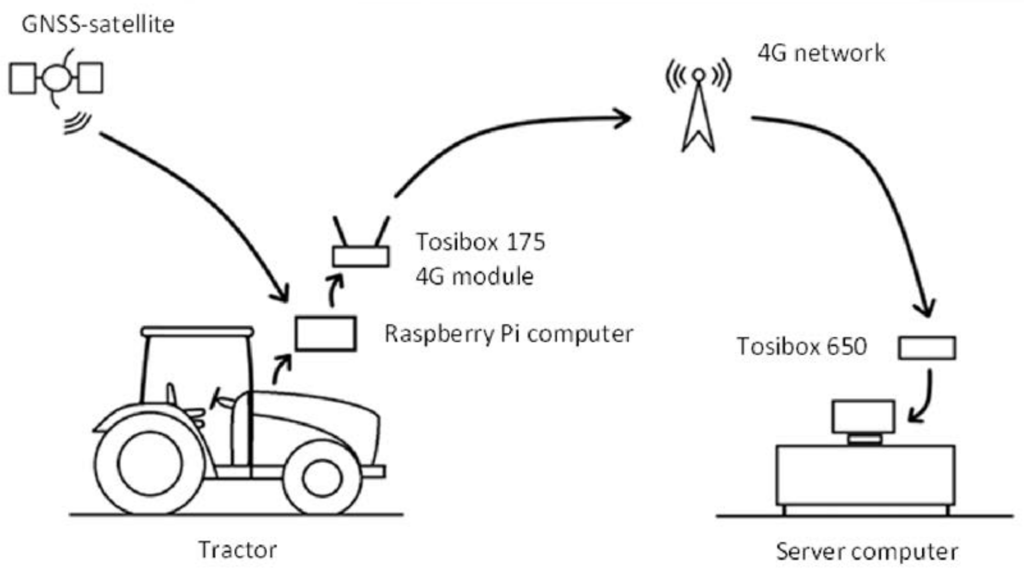
Crop yields

RESEARCH OBJECTIVES

- Evaluate the technical requirements for a telematics system that can be used to monitor farming operations from tractors in real time.
- Automatically saving measurement data on a server and using the database for continuous analysis.
- Efficient and secure methods for transferring measured CAN bus data and other sensor data from the tractor to the server for storage.
- Using open-source software and low-cost system components.

MEASUREMENT SYSTEM

- The measurement system consisted of three main elements
  - CAN bus served as the source of information.
  - Raspberry Pi decoded and sent the messages with location data using the MQTT protocol.
  - Data was stored in a server computer and could be monitored in real time.
- The data was transferred using Tosibox
  - Tosibox devices created closed and protected network connection from the tractor to the server (https://www.tosibox.com/).



HARDWARE

- Raspberry Pi 3B+
- CAN shield: PiCAN 2 - CAN-Bus Board for Raspberry Pi 2/3 with SMPS
- GNSS card: SparkFun GPS-RTK2 ZED-F9P
- GNSS antenna: u-blox, ANN-MB-00-00
- 7-inch touch screen
- Power supply from a power bank (or tractor’s 12V outlet)
- Tosibox 175 remote connection device with 4G sim card
- A Linux computer acting as the database server
- Tosibox 650 remote connection device for the server

SOFTWARE

Kvaser Database Editor
- Generating DBC file for python program

GPSD
- Receiving positioning data from GNSS card
- Positioning data processing for Node-RED

Node-RED
- Data acquisition, processing and transfer to database in Raspberry Pi
- Graphical interface (dashboard) and sending data in a database in the server computer

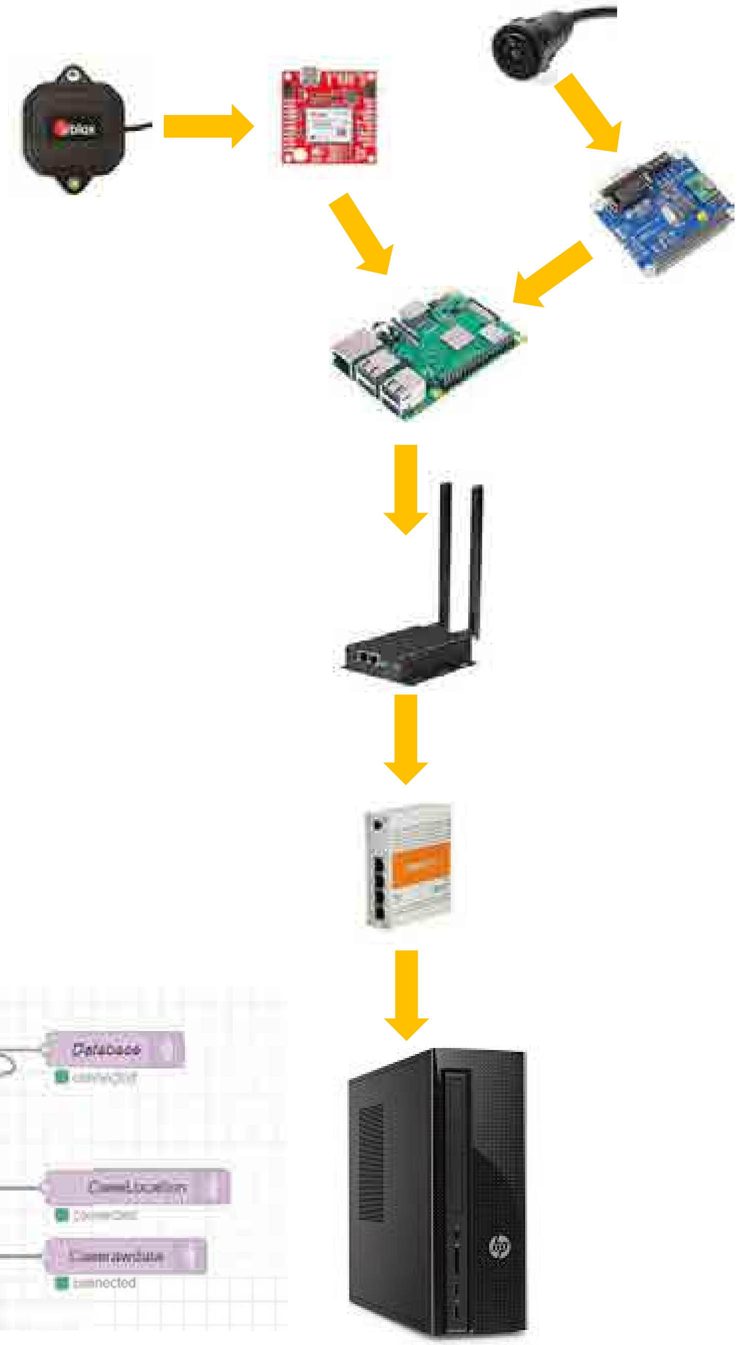
Eclipse Mosquitto
- Message broker for MQTT

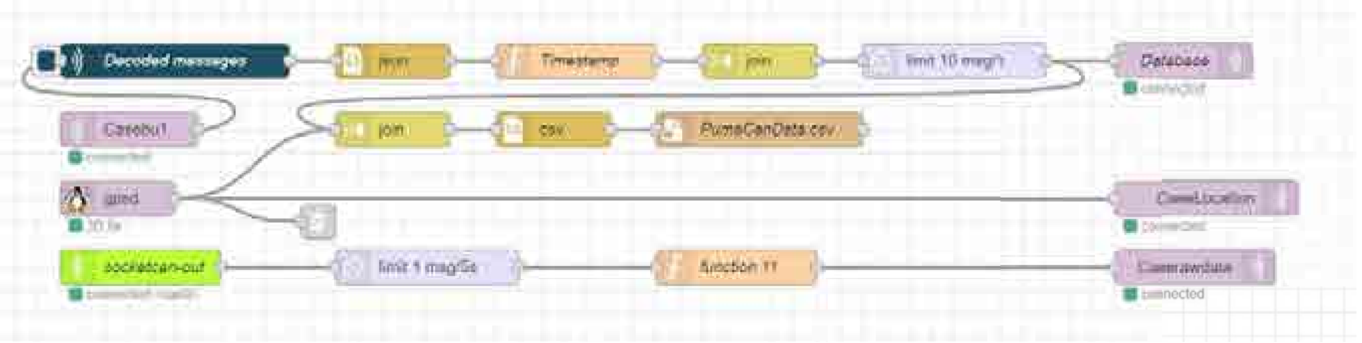
MySQL
- Database for measured data

phpMyAdmin
- Graphical interface for database

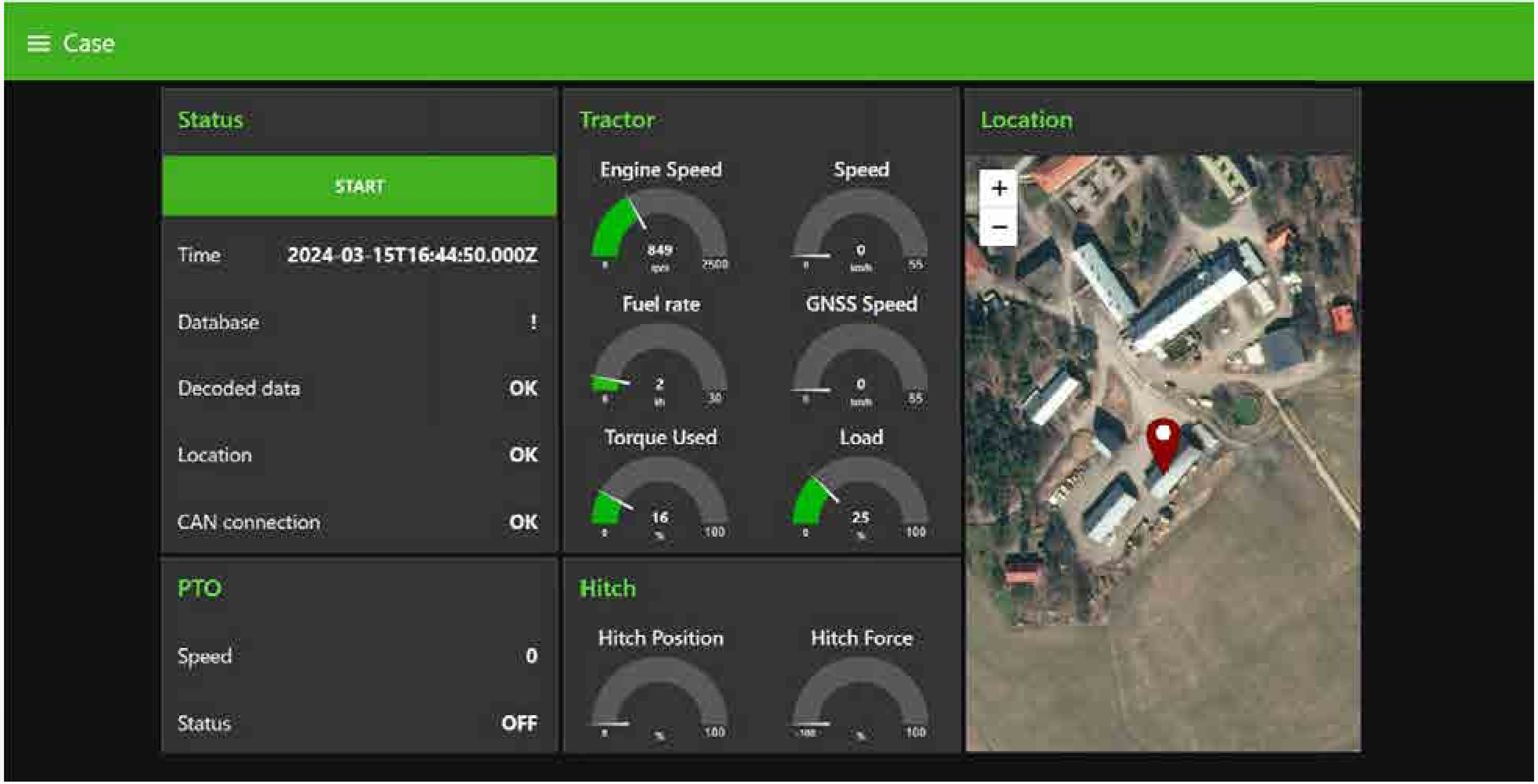
DATA PROCESSING

- Raspberry Pi
  - Data: location (GNSS), CAN bus
  - Processing: python code for CAN message interpretation and GPSD for location data processing. Local Node-RED code for saving data locally and sending it to the database as JSON-object format.
- Tosibox 175 and 650
  - Sending data securely from tractor to the server computer
- Server computer
  - Running Node-RED for real-time dashboard
  - MySQL database





DATA MONITORING



FIELD MEASUREMENTS

- Operational data was measured from two different tractors during silage production:
  - 2014 Case Puma 160 CVX
  - 2008 Valtra N141
- Tractors were used for mowing, baling and pulling a forage wagon.
- The measurements were performed at the University of Helsinki's Viikki research farm during the 2023 growing season.
- Measurements were done in five different fields.

MEASUREMENT RESULTS – TRAJECTORY

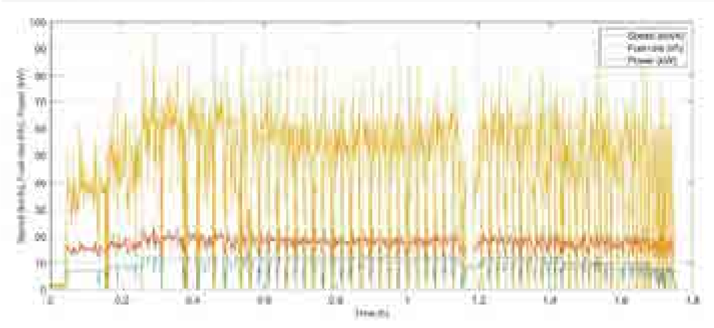
Mower

Forage wagon

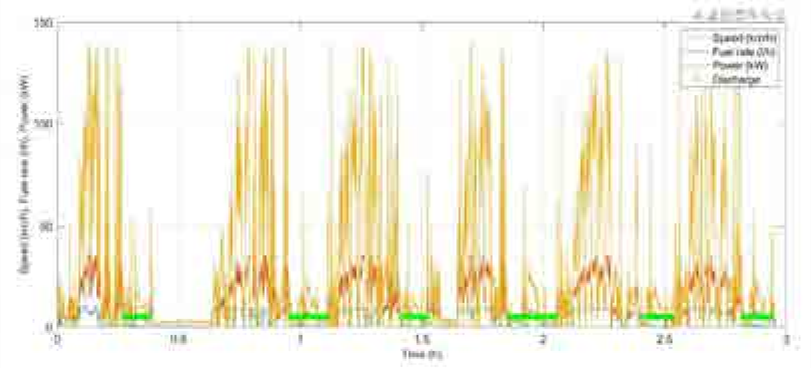
Baler

MEASUREMENT RESULTS – DATA

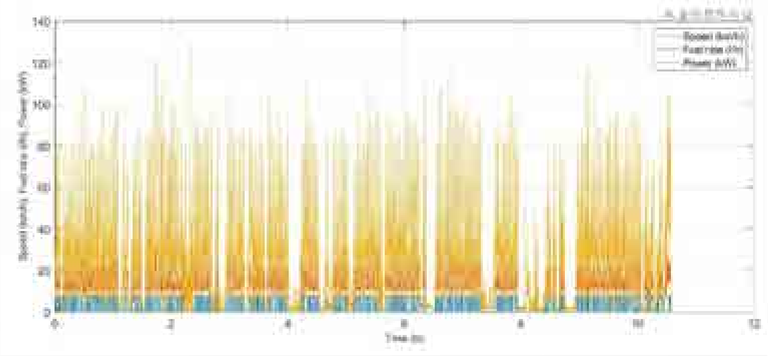
Mower



Forage wagon



Baler



MOWER DATA SUMMARY

	Field A	Field B	Field C
Duration (h)	2.8	1.8	0.5
Average speed (km/h)	8.9	8.8	10.8
Distance (km)	23.6	15.5	5.7
Average engine power (kW)	41.5	43.0	55.1
Fuel consumption (l/h)	14.7	15.9	18.3
Area (ha)	5.5	3.8	1.3

CONCLUSIONS

- The developed measurement system fulfilled the research objectives
- Data processing and transfer required most of the work
- Except for Tosibox devices, low-cost system components were used
  - Tosibox devices was considered very robust solution for secure data transfer
- Open-source software were rather easy to use and well available
- Only basic level of programming experience was required
- Database needs to be further developed e.g. using PostgreSQL
- Recorded data was high quality and can be used multiple purposes

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Finnish Future Farm

Innovating Smart Agriculture: How Finnish Future Farm is shaping the future of farming

Hannu Haapala
DrSc , Assoc Prof (University of Helsinki)
Leading Smart Bioeconomy research
@ Jamk Institute of Bioeconomy

Co-funded by the European Union

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Finnish Future Farm

Our motto: sustainability though digitalization

How to do it?

→ Finnish Future Farm

→ Speeding up the uptake of the needed technologies

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Bioeconomy

The Finnish Future Farm

Finnish Future Farm

Making data-based decisions
Speeding up uptake of the needed technologies

1. **Smart Bioeconomy Testbed* with physical and virtual farm environments.**
2. **Biosystems Engineering Education**: Comprehensive training in biosystems engineering.
3. **BioBoosters** : Incubation, mentorship, funding, and global market opportunities tailored for AgriTech startups.

Own data!

jamk

Finnish Future Farm 2023-2026

(JTF, 3.5 M€) KESKI-SUOMEN LIITTO Co-funded by the European Union

The co-development environment promotes the adoption of new Smart Farming technologies and methods.

This involves both physical and virtual co-development environments.

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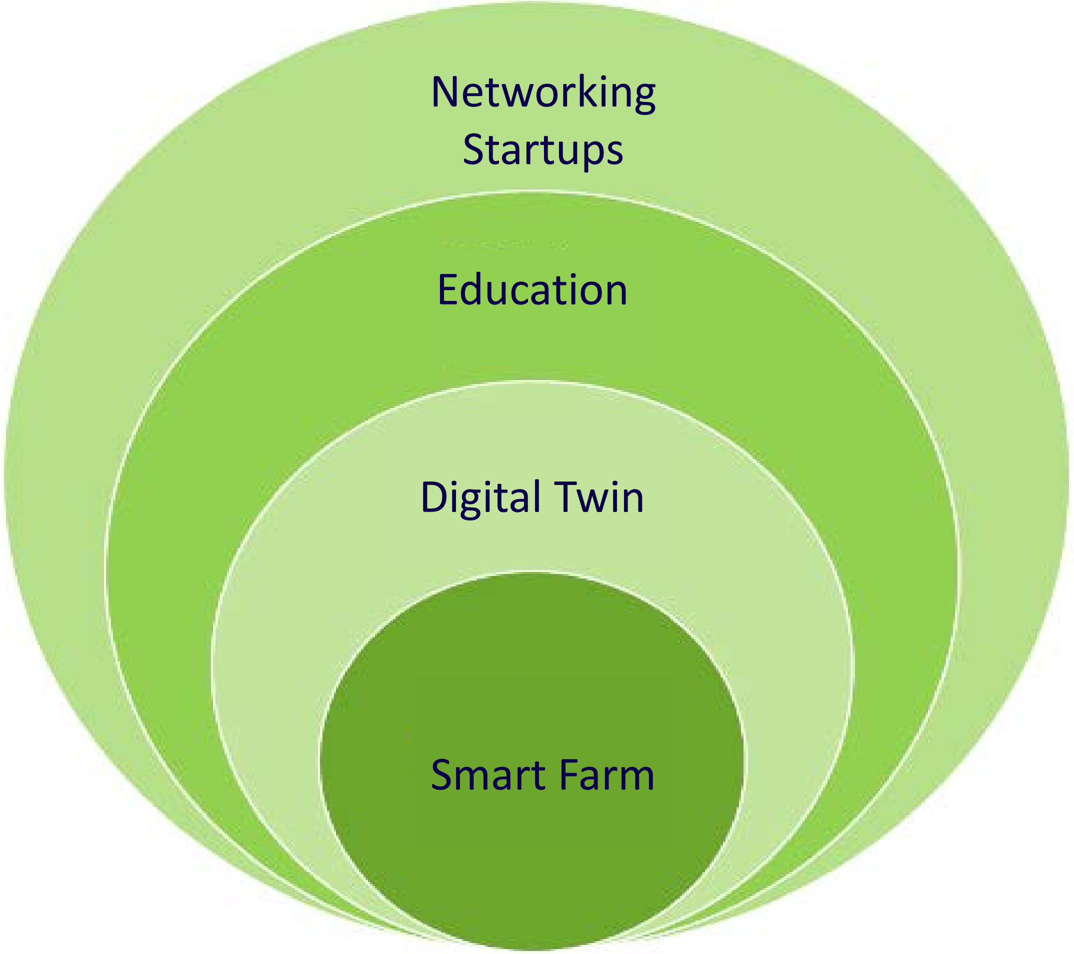
poke POHJOISEN KESKI-SUOMEN AMMATTIOPISTO

VALTRA AGCO POWER NESTE Saarijärvi

Valio Luke MTK ProAgria Keski-Suomi nokian TYRES DataSpace Europe

HRV Farm Oy



https://www.jamk.fi/fi/projekti/finnish-future-farm

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Finnish Future Farm (FFF)

- develops a unique co-creation platform for RDI, education, and startup acceleration in precision farming and smart farming technologies.
- both an existing physical smart farm and a digital twin are utilized.