Importance and methods for an accurate canopy characterisation

AAB – Dose expression, Barcelona, 07-11-2018

Jan van de Zande, Dirk de Hoog

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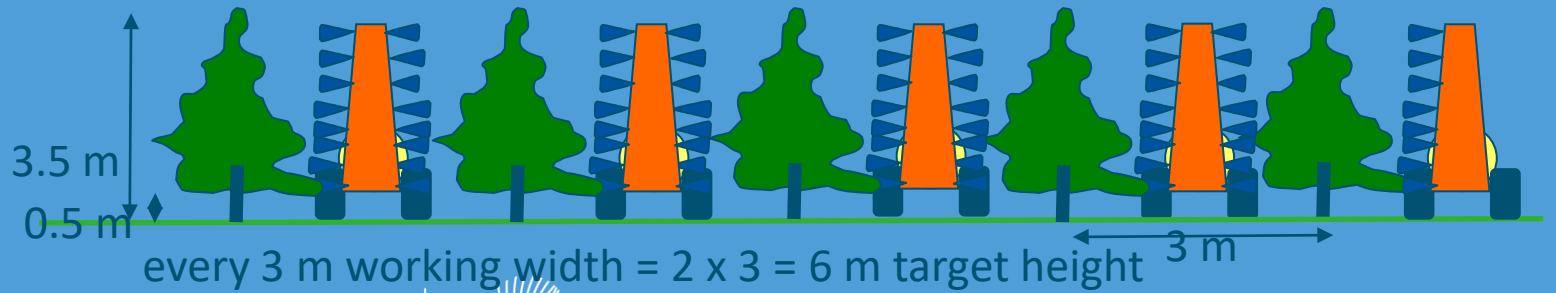
100years
1918 — 2018

Application of PPP

- **Field crops** – boom sprayers; downward directed spray. Spray volume and dose directly related to the treated area. E.g. L/ha spray vol. and kg/ha dose of PPP.

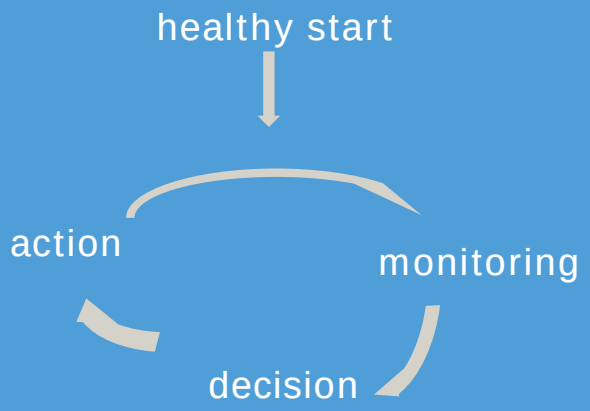
- **Bush and tree crops**; sideways and upward directed spray. Spray volume and dose related to the to be treated tree/bush canopy. L/ha spray vol., kg/ha or concentration (mL/L or %) dose of PPP.



1 ha ground = 2 ha vertical target area

Ideas behind targeted application

- Reduce environmental load
- Keep a high efficacy
- Reduce risk of residue



- Apply only there where it is needed and with the amount adjusted for the crop canopy size and structure

Introduction of Crop Adapted Spraying

- Sensing of the crop status / density
- Decision taking on the spray volume
- Actuating for the right application rate
- Based upon the knowledge of
  - Precispray *1999-2003*
  - SensiSpray project within potatoes *2007-2008*
  - Variable rate spraying in flower bulbs *2006-2009*
  - CASA sprayer from EU project ISAFRUIT *2006-2010*

Crop Adapted Spraying – steps

- Steps in CAS
  1. Gap-detection: On/off switching of nozzles
  2. Spray volume / Dose determination

Plant densities, trail and pruning systems

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Apple orchard over years

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14/03

18/04

02/05

16/05

16/06

18/07

16/08

12/09

17/10

14/11

Apple 2011 development

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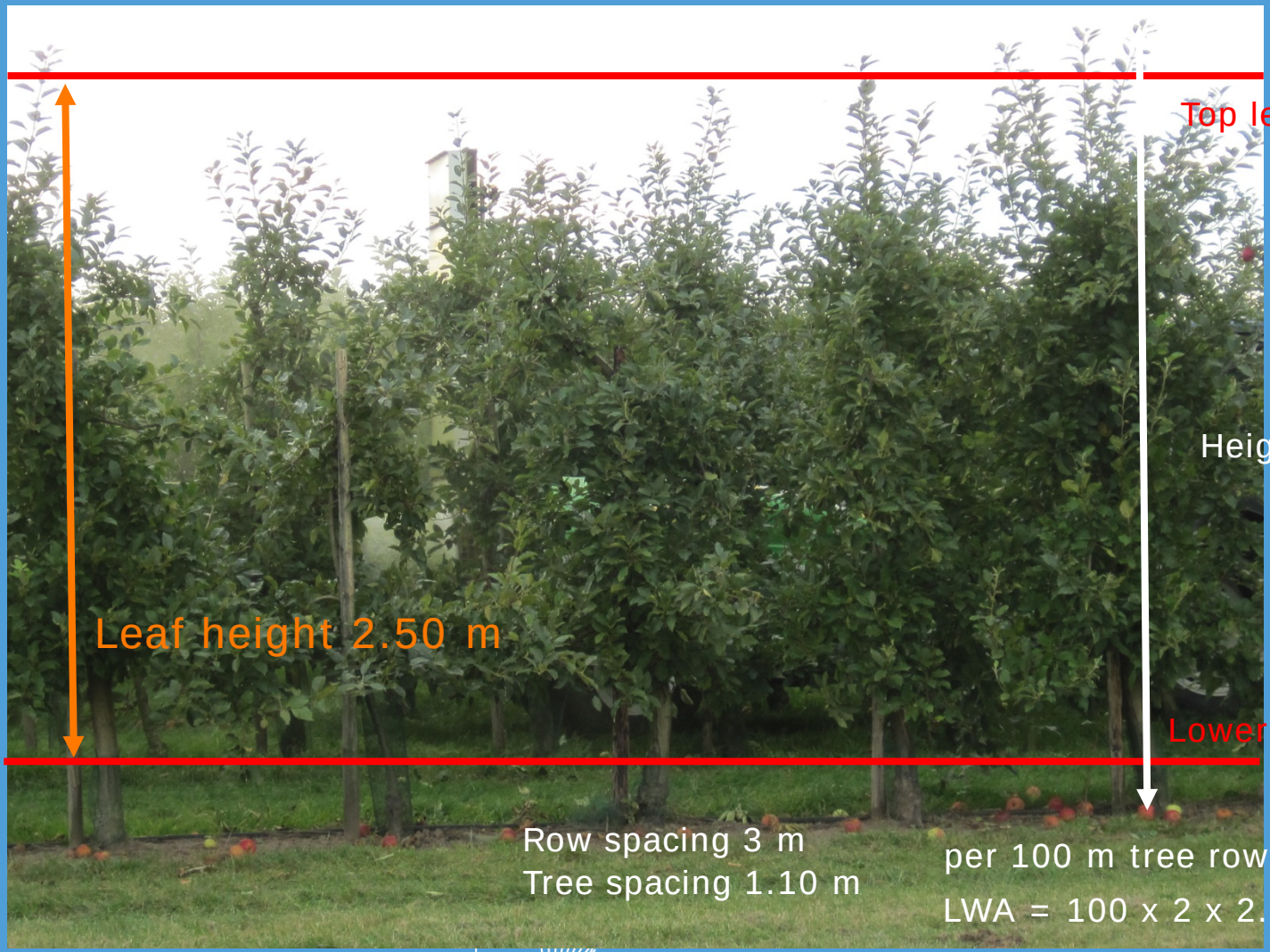
Target area?

Target area? LWA



Target area? Effective LWA with sensor

4.4 x 2.5 = 11.0 m^2

25 x 25 cm grid
180-38=142 cells with
Leaves = 8.7 m^2

effective sensor LWA
= 80%
of calculated LWA

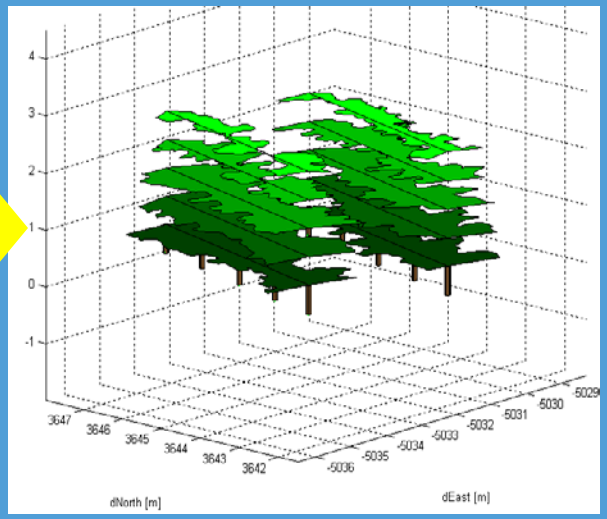
Sensors and their use

- **Ultrasonic sensor, Laser scanner** (LIDAR) – for the detection of objects and measuring distance to the object, able to measure canopy position and canopy contour at different heights and to determine canopy volume;
- **Chlorophyll sensing** – detecting of green leaf area, able to determine green leaf position;
- Different **vision sensor** types like – RGB, depth-RGB, stereo vision, for blossom detection and (small) fruit detection for thinning activities, detection of alternation years of trees
- **Hyperspectral** images – for detection of flowers, fruits and plant stress in the leaves and potentially plant diseases.

Crop protection – fruit crops

dose related to development stage and biomass crop

1



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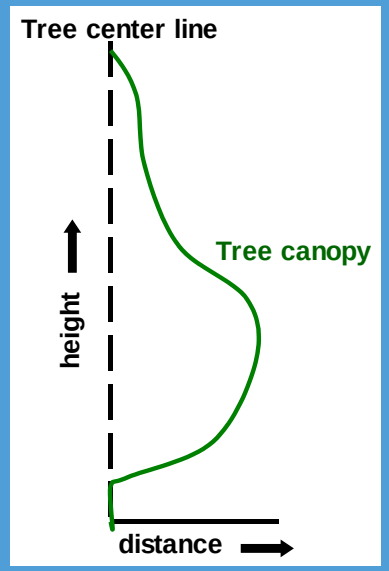

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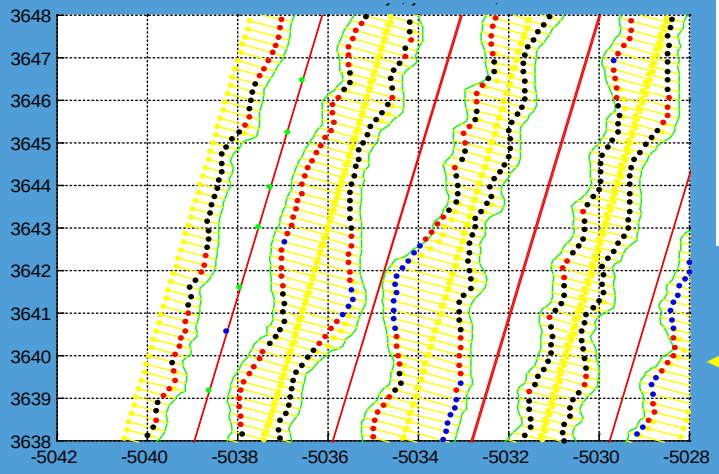

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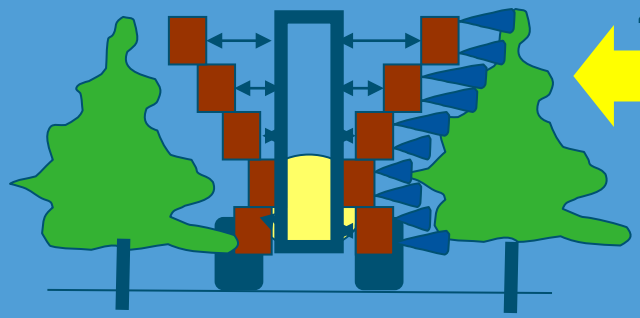

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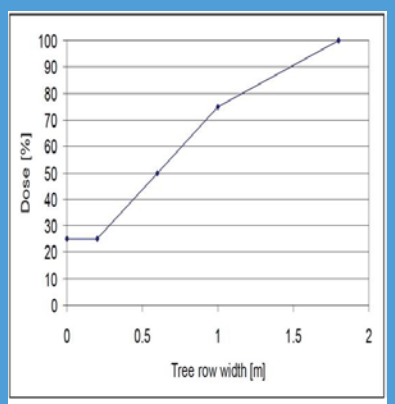
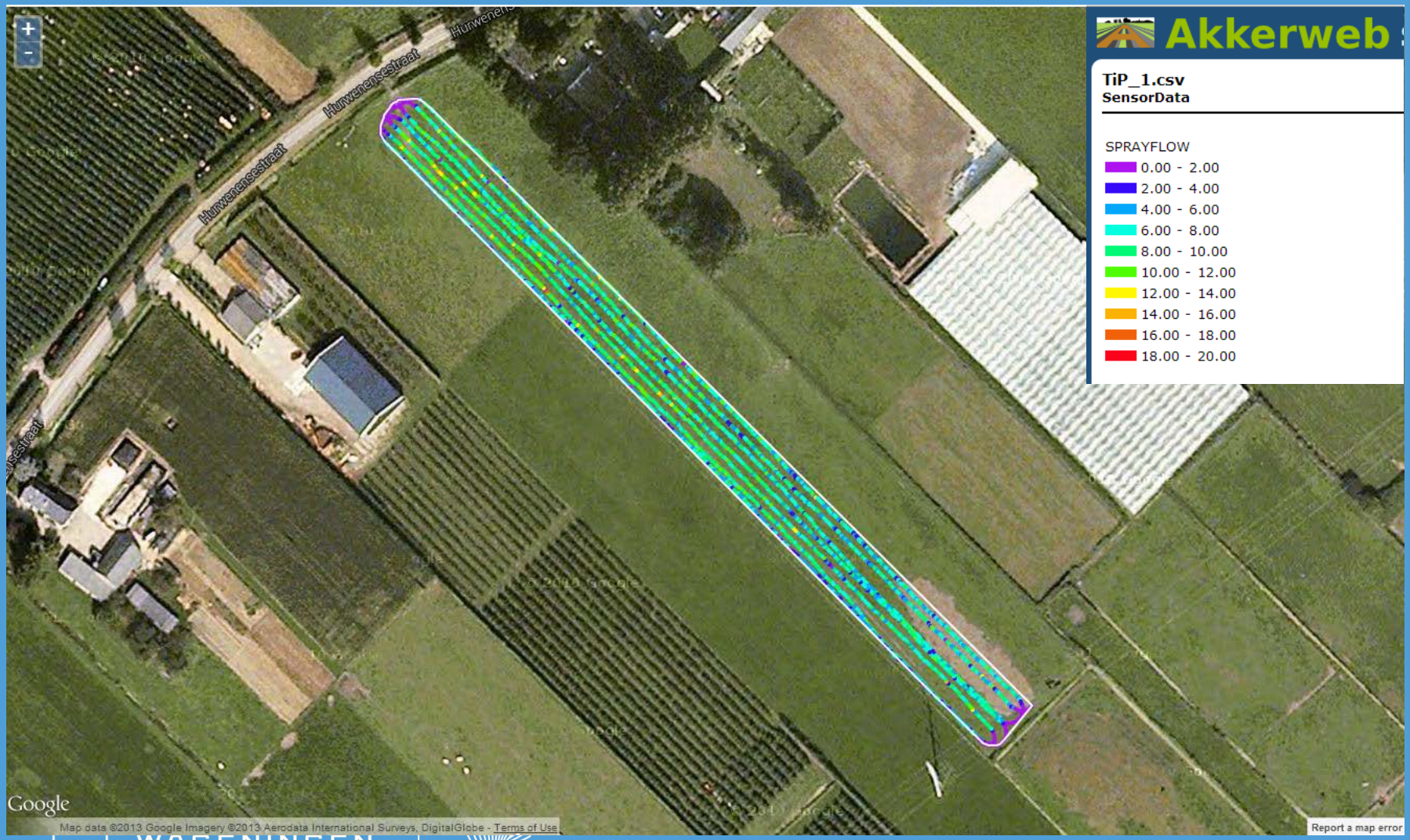
Canopy Density Spraying (CDS) in apple and pear

- Laser ranger scanner measures distance and density of leaves
- Decision algorithms adjust number of nozzles spraying
- Varioselect nozzle bodies activate one or more nozzles
- Variable air amount depending on wind speed, wind direction driving speed and direction



CDS tested in practice by the grower - 2012

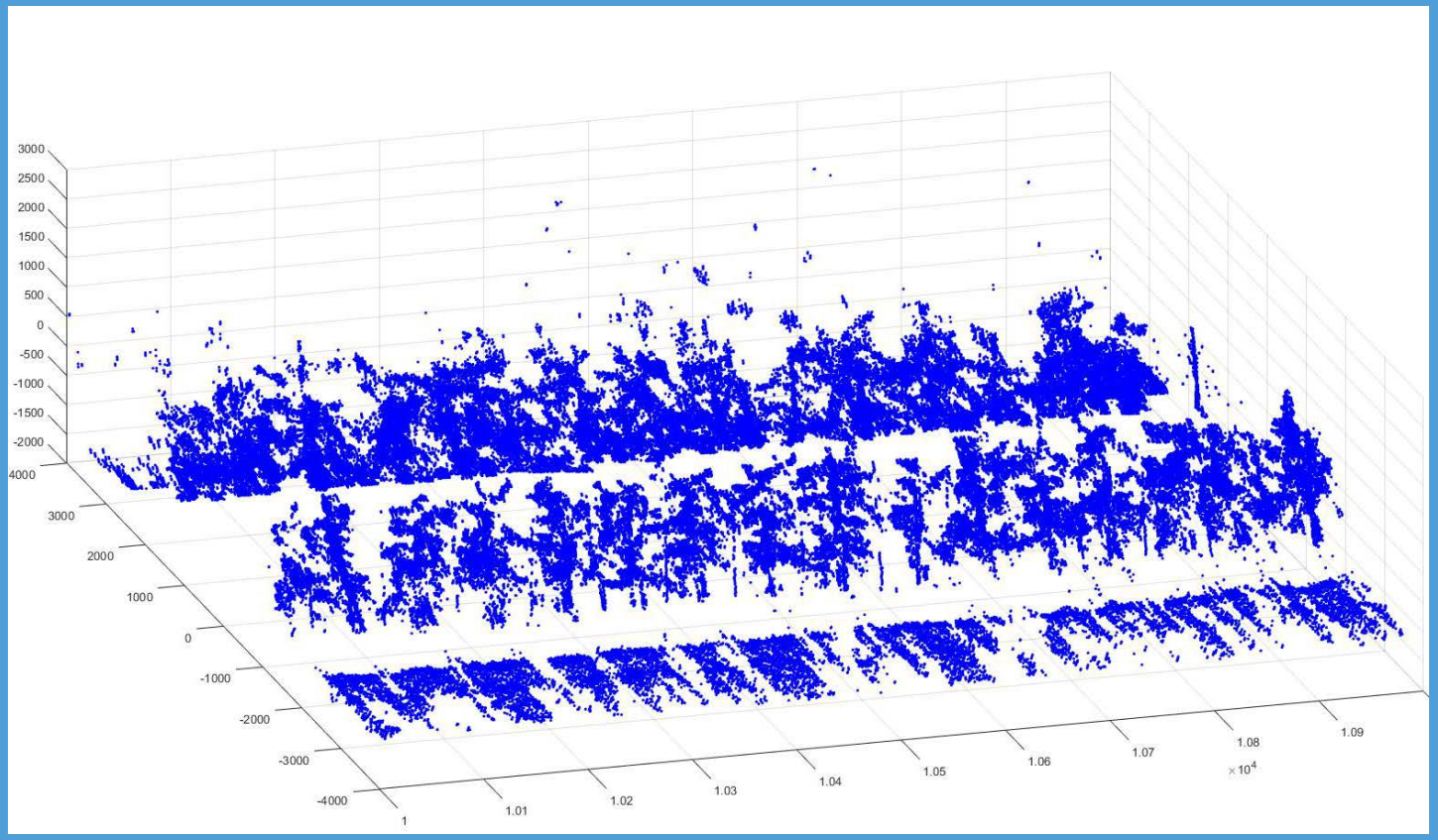
sprayflow [*L/min*]



Results CDS 2012 – spray deposition

- Deposition of CDS comparable to Munckhof reference = 0.40 µL/cm^2
- Deposition of the CDS was lower than of the KWH crossflow sprayer (0,80 µL/cm^2)
- Deposition of CDS was more homogeneous
- Spray volume reduction was 46% (BBCH 71)

Lidar images - apple orchard



Crop growth stages during season

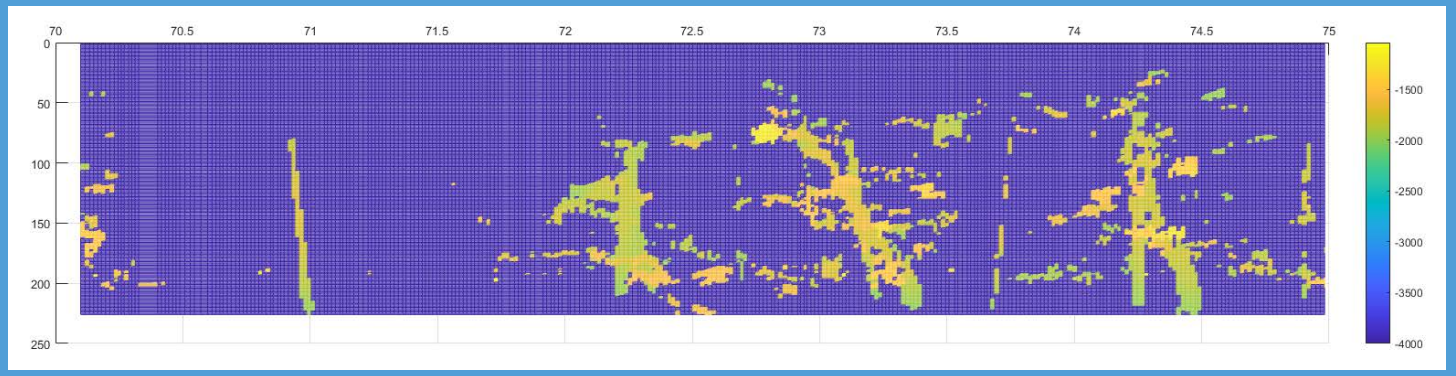
2 May 2017; blossom

30 May 2017; hazelnut

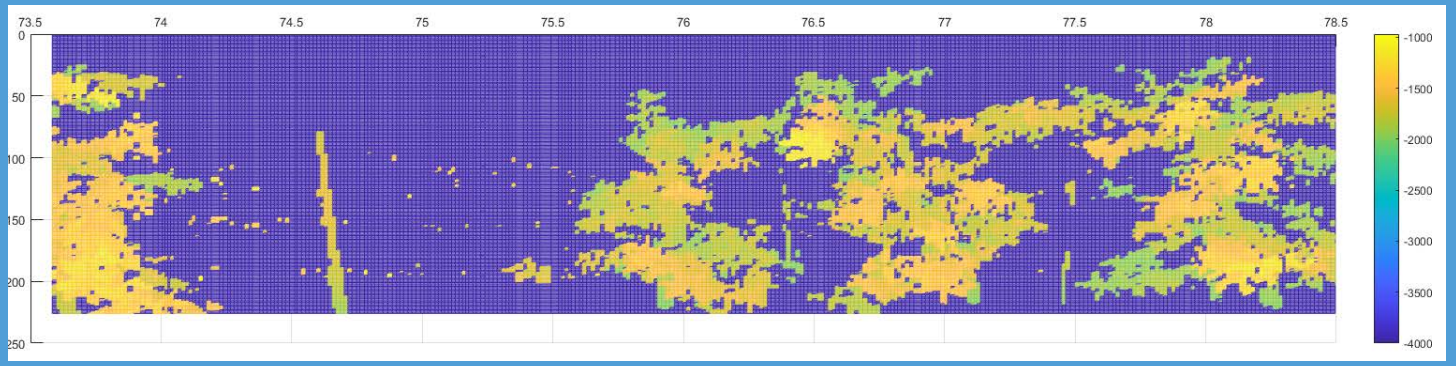
3 July 2017; small apple

Lidar images - apple orchard at 3 dates

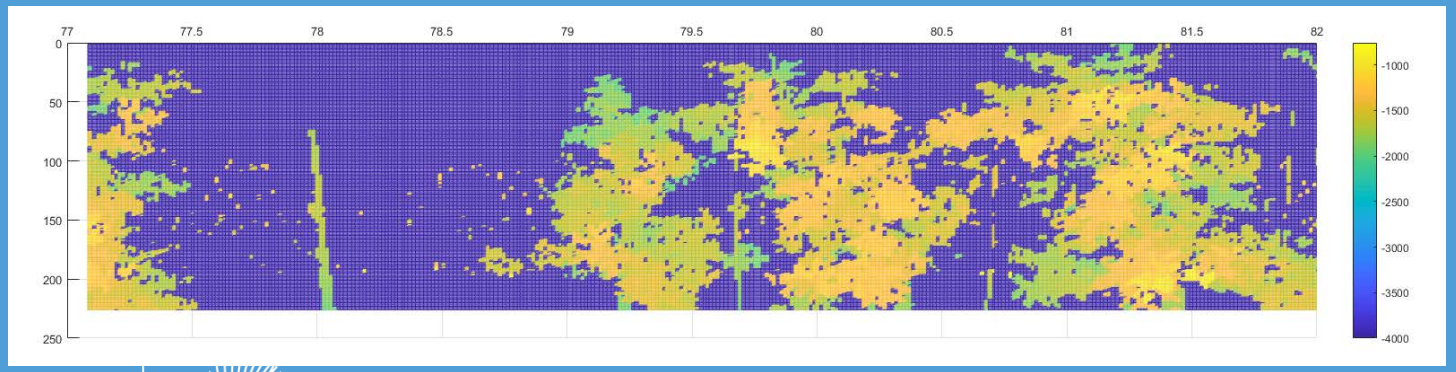
2 may



30 may

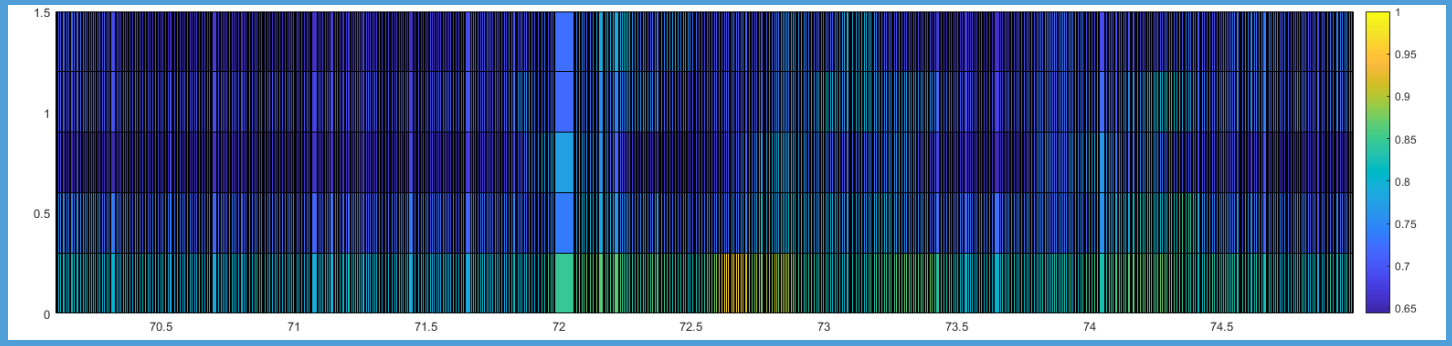


3 july

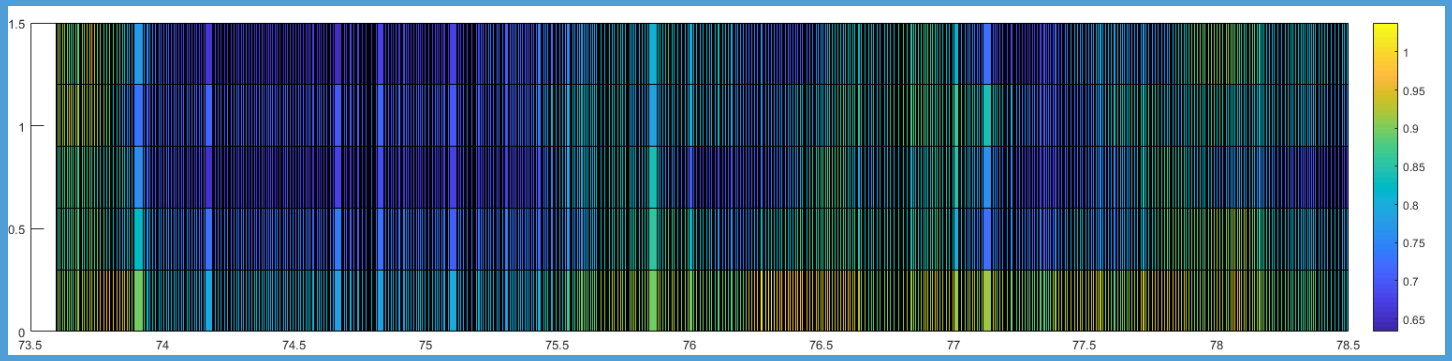


Chlorophyll sensor - apple orchard at 3 dates

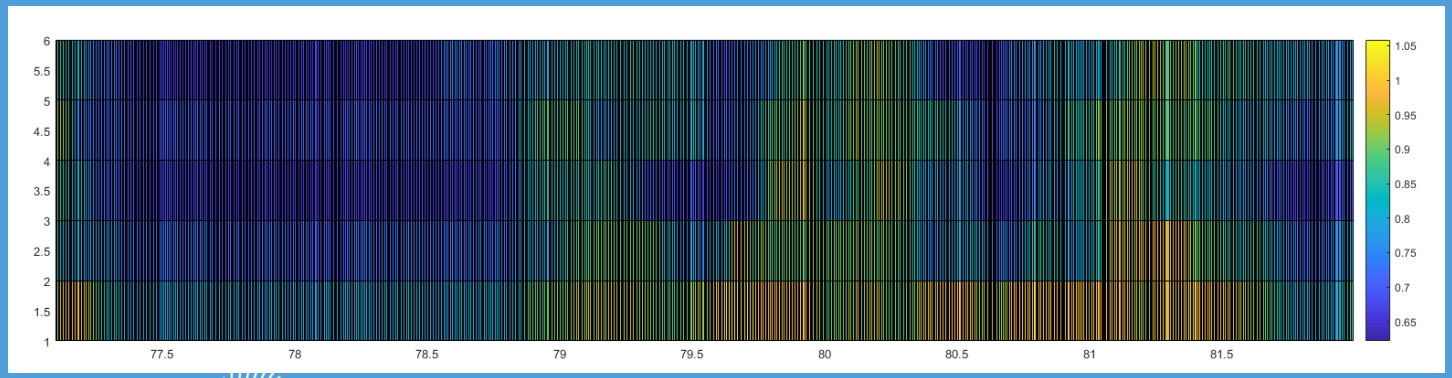
2 may



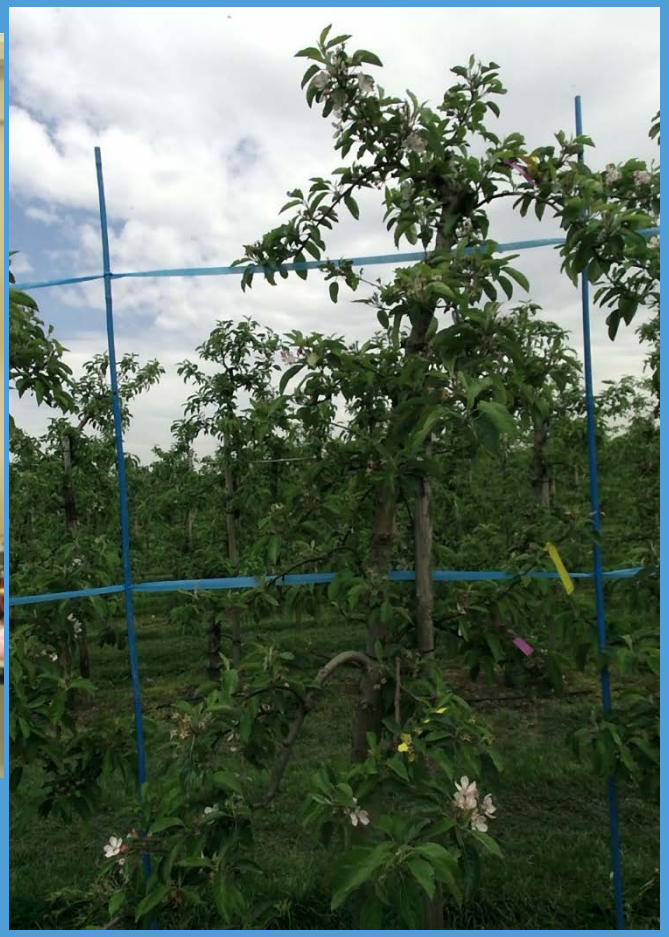
30 may



3 july



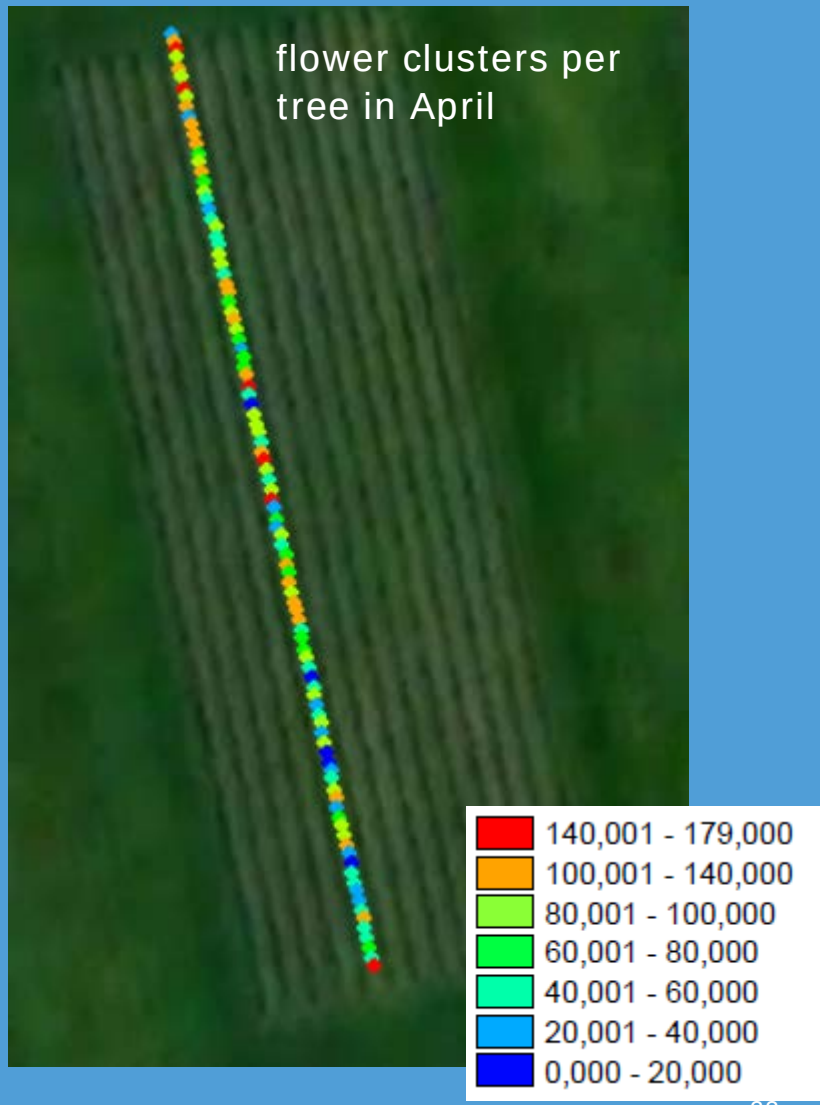
RGB camera – depth information canopy



RGB camera - Blossom detection

Flower clusters per tree

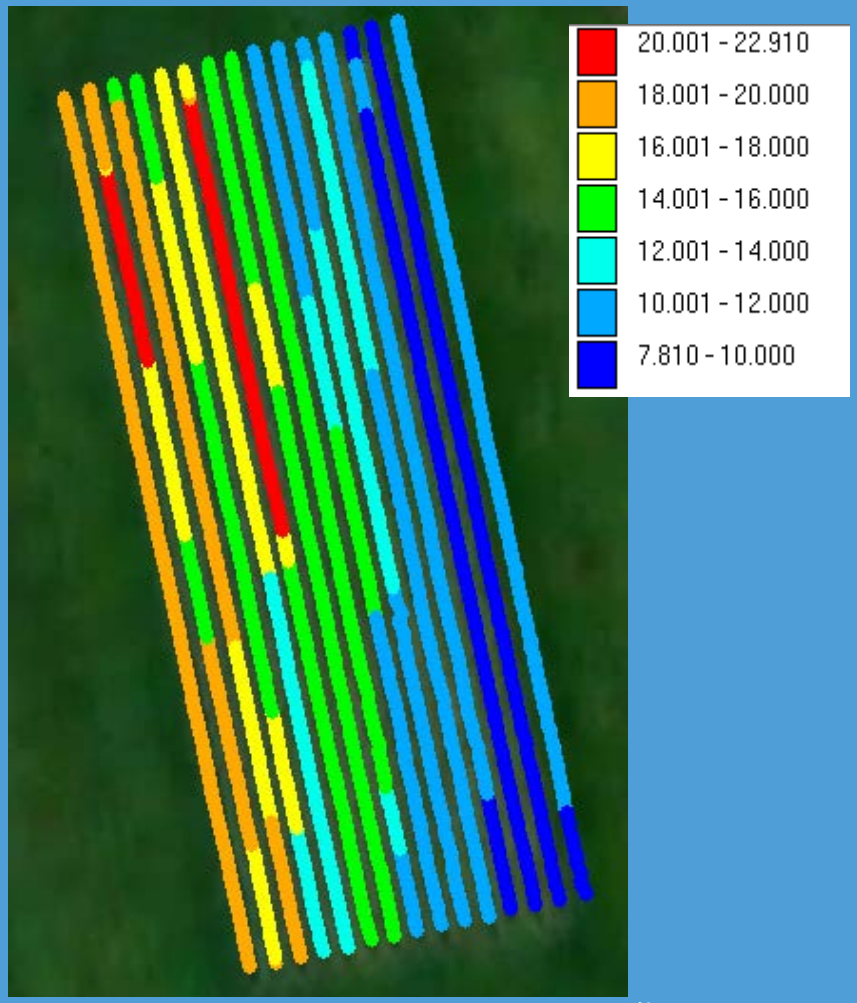
- Large variation between individual trees
- Aim to generate task map for thinning based on this information
- Decide to thin tree on number of flower clusters;
- spray individual tree yes/no (not pollinator trees)
- Adapt dose to number of flower clusters per tree



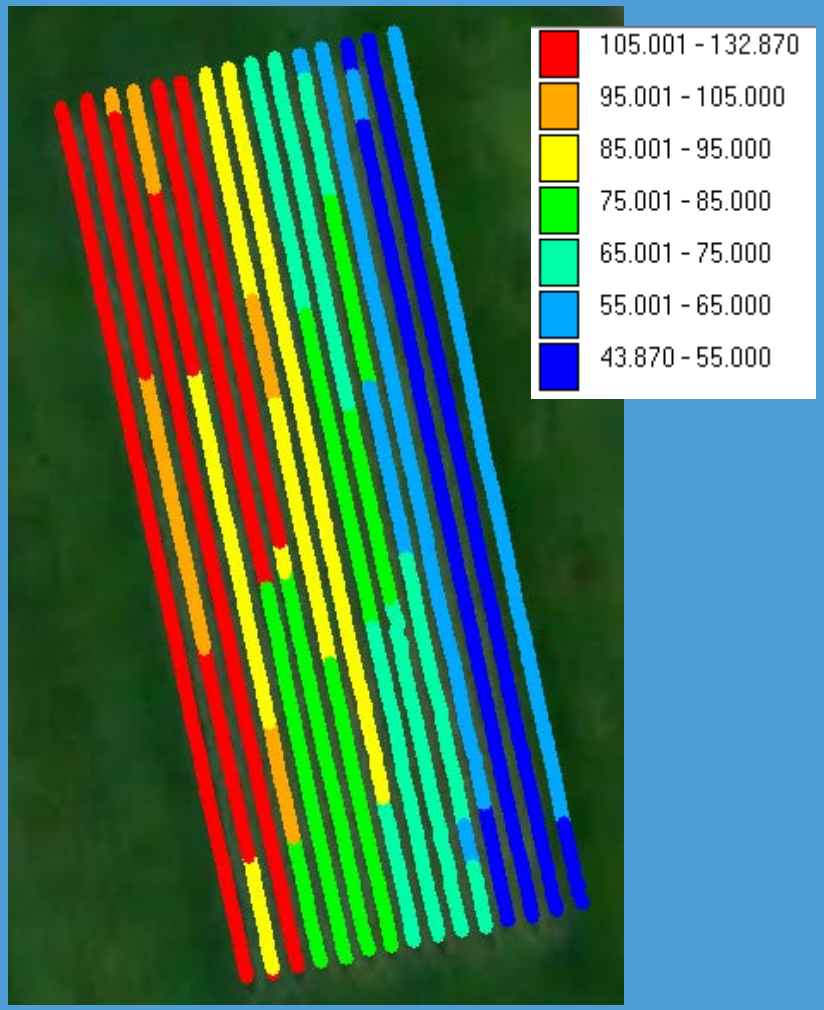
RGB camera -Fruitlet detection (>10 mm)

Number of fruits per tree and apple yield

Total yield (kg/m)

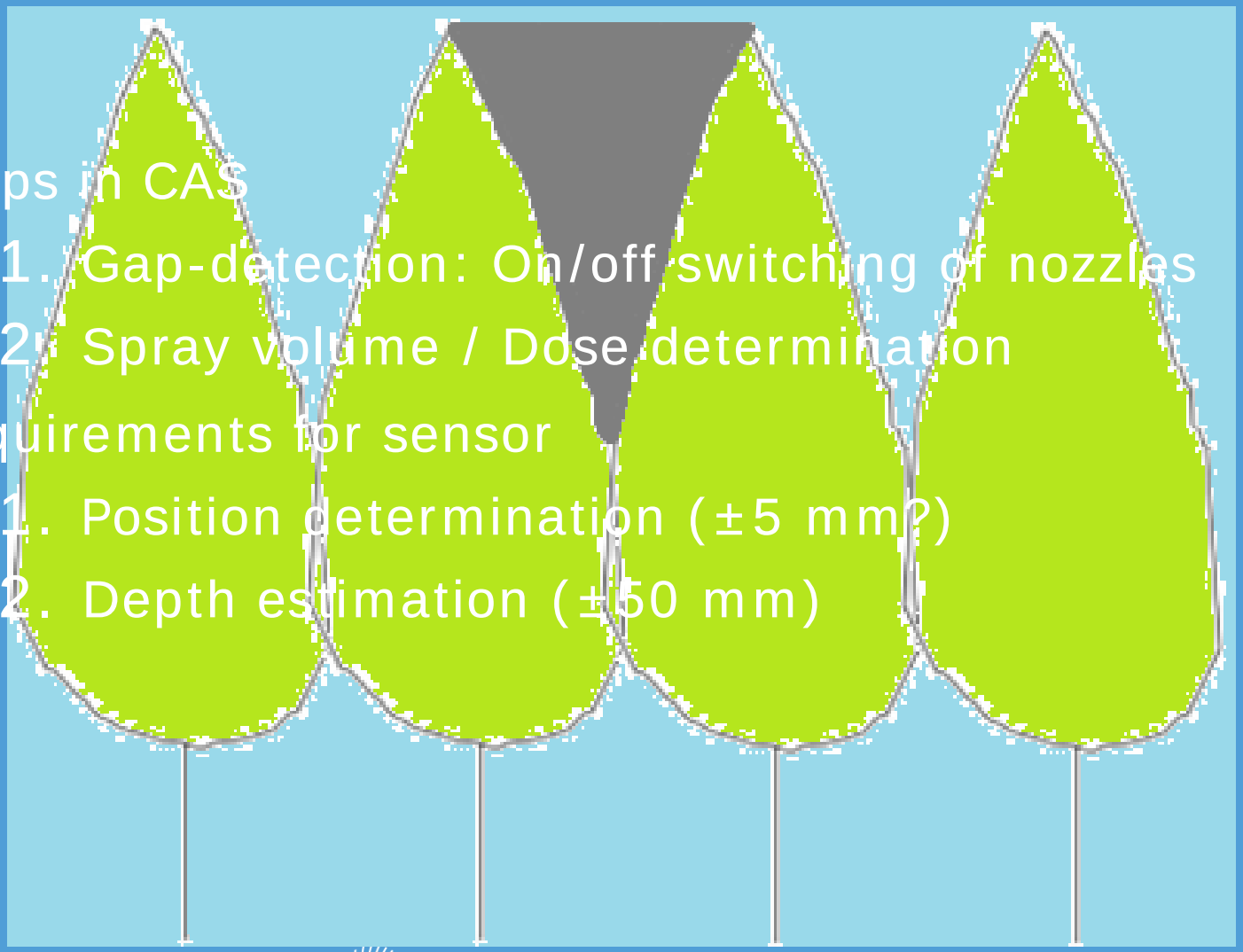


Number fruits / m tree row



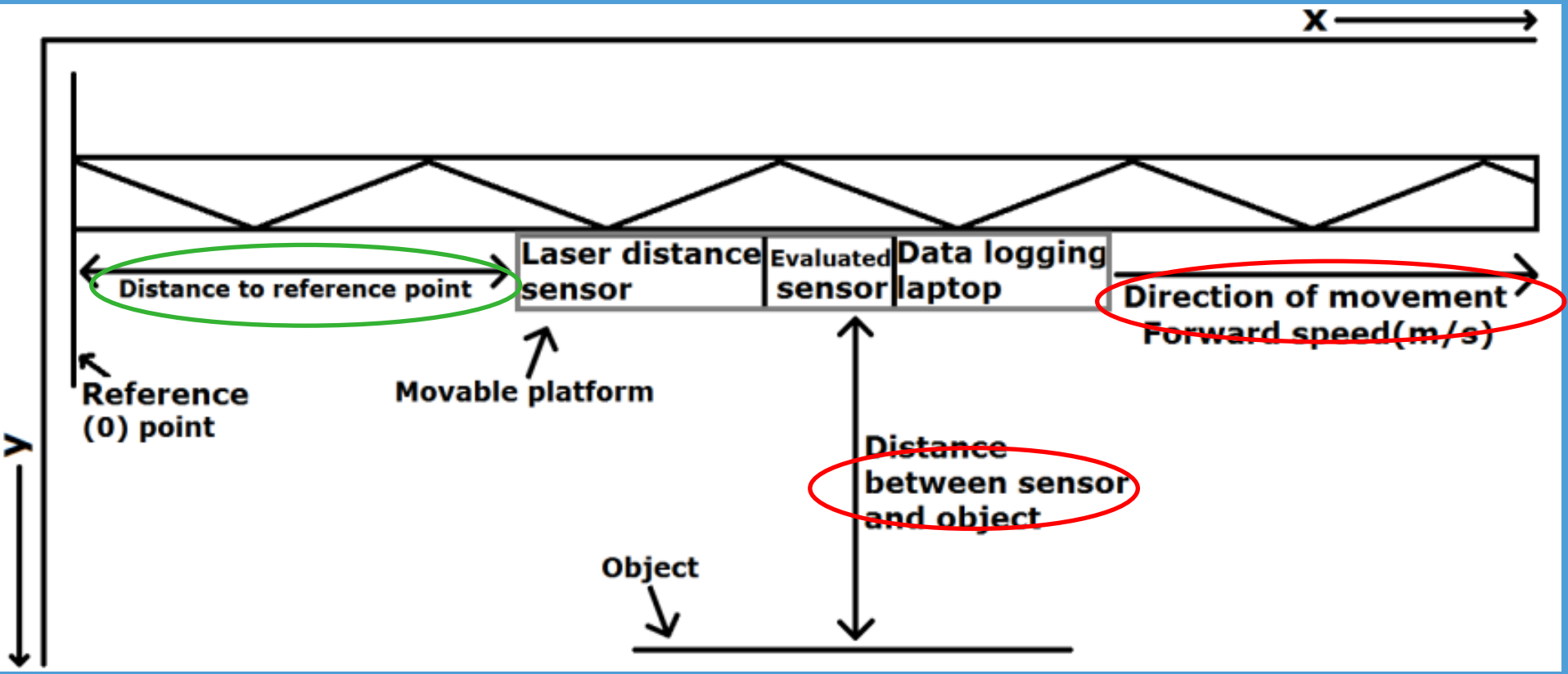
Crop Adapted Spraying – desired situation

- Steps in CAS
  1. Gap-detection: On/off switching of nozzles
  2. Spray volume / Dose determination
- Requirements for sensor
  1. Position determination (±5 mm?)
  2. Depth estimation (±50 mm)



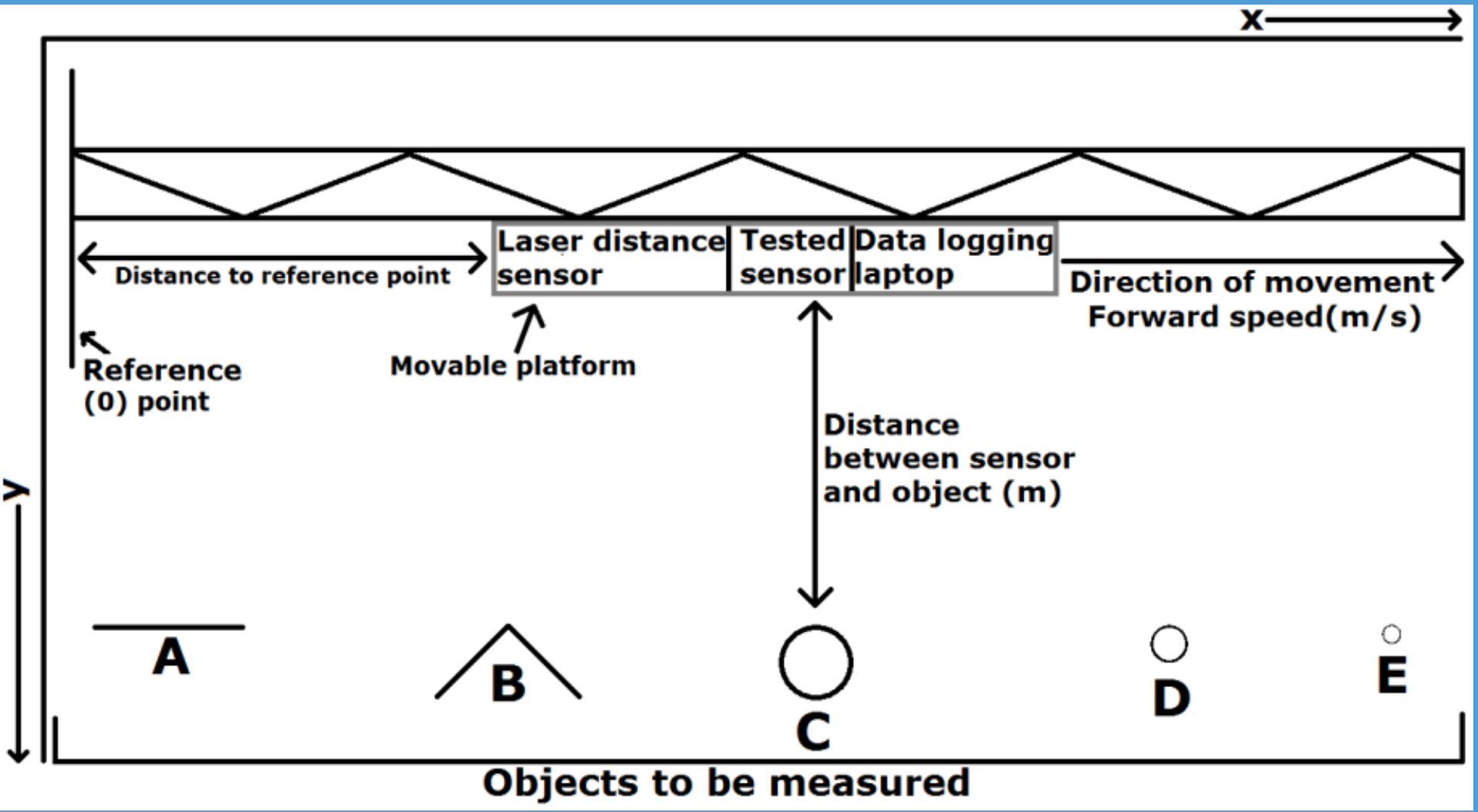
Testbench sensors - calibration

1. Position determination (±5 millimetres)



2. Depth estimation (±50 millimetres)

Testbench sensors - evaluation



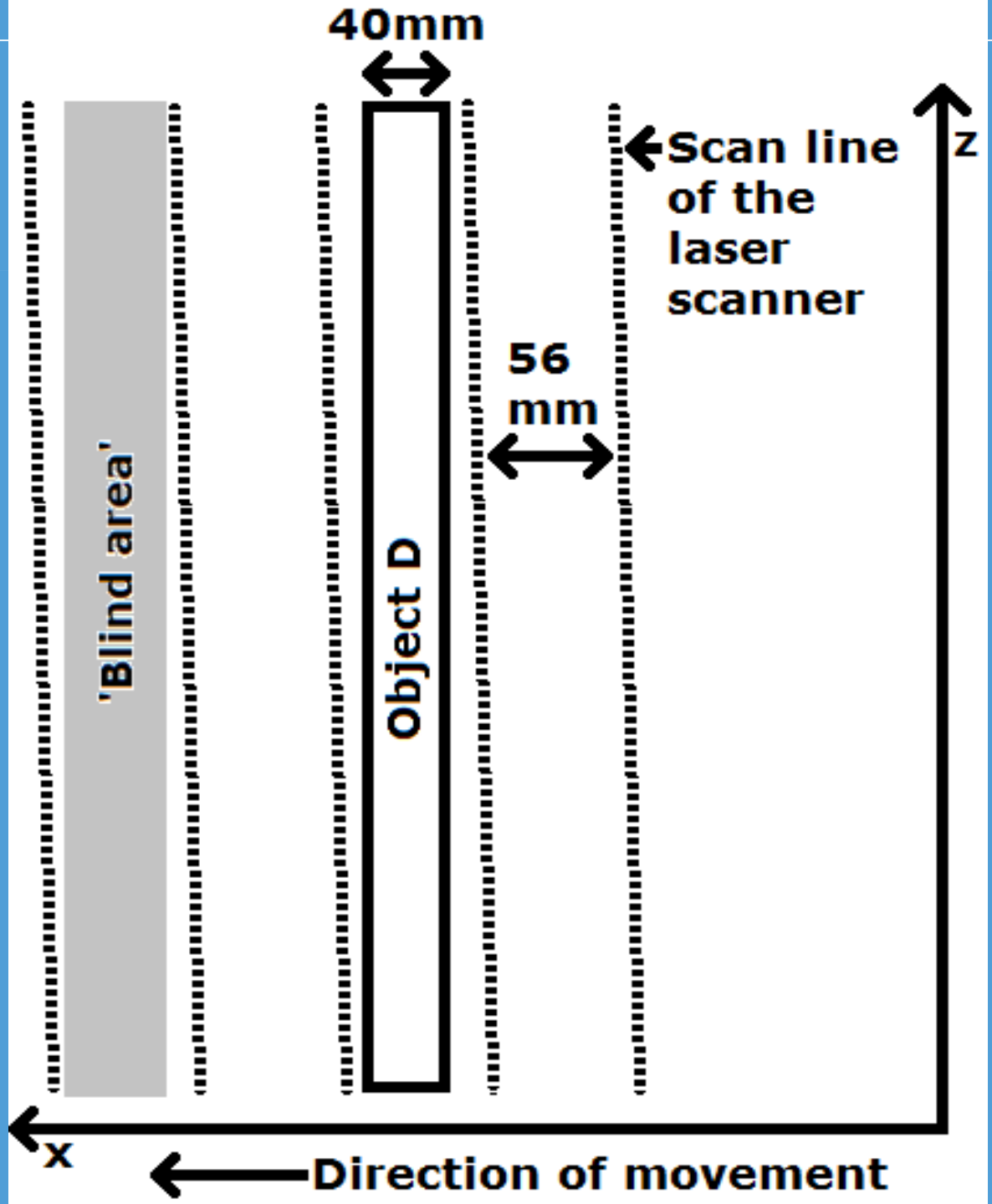
	Ultrasonic	Laser scanner	WeedIt	Kinect
Position determination (mm)	±246	±13.5	±16	±35.6
Depth estimation (mm)	±36	±25		±8

- *Maximum forward speed for detecting object E, with a diameter of 16 millimetres, at least 9 out of 10 times when objects are placed at 750mm*

Ultrasonic	Laser scanner	WeedIt	Kinect
0.1m/s	0.1m/s	1m/s	2m/s

Laser scanner

- Rotating; not looking at one side while looking at the other side;
- Needs time to transfer data after one rotation;
- Not looking at all to crop



Disease & pest control → support of crop health

- Detect crop vitality with sensors
- Detect plant stress in an early stage
- Increase plant natural resistance
- Support the plant against diseases and pests

- Development of Canopy Density & Health Sensor
- Apply agrochemicals only on the areas where they are needed

What to apply?

- Adaptation of spray volume to canopy structure
- Adaptation of dose to control pest & disease

- From kg/ha to kg/LWA product, is this the solution to all problems? Or just a first step in the direction of canopy adapted dose expression?
- Essential is: What is needed on what position in the tree to do the job!

The challenge

- How to come from ng/cm^2 product being effective to µl/cm^2 spray volume to be applied and deposit on the target.

  Especially when in-tree deposition differs per spray technique and sprayer and nozzle settings.

Thank you for your attention!

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Acknowledgement:

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TOPSECTOR TUINBOUW & UITGANGSMATERIALEN

Productschap Tuinbouw

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