

Positioning of barley ears in gluten free oat production fields using drone imaging

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Why gluten free production?

Coeliac disease is a condition than when eating gluten containing food the person's own immune system damages small intestine leading to that gut is unable to take in nutrients and cause a range of symptoms. About one percent of Finnish population is diagnosed to have coeliac disease and another percent to suffer undiagnosed. **Wheat, barley and rye grains and flour contain gluten** but oat does not contain gluten.



**One limit is less than 20 mg gluten/kg product.
Aim is zero.**

Gluten free food production requires the prevention of contamination in all production chain phases on farms and in the processing industry.



On farm gluten contamination prevention requires

To prevent wheat, barley and rye seeds to get into oat harvest by

- Using (ultra) clean sowing seed
- Weeding the barley, wheat etc plants from oat fields 3-4 times in season and etc
- *If max 2 seeds of barley in kg the oat yield is allowed it means 1 seed out of 10000 oat seeds.*
- *If the yield is 5000 kg/ha and 20 seeds in barley ear so maximum one barley ear by 20 m².*
- *The average oat yield is 3390 kg/ha so one barley ear by 30 m².*



To provide material for imaging and modelling oat and barley stands were established with unwanted cereal in seed mixture at rate 1 seed/m² when main crop's seed rate was 500 seeds/m².

Field trials with 2,5 m wide sowing strips and 30 cm wide observation paths between the strips.



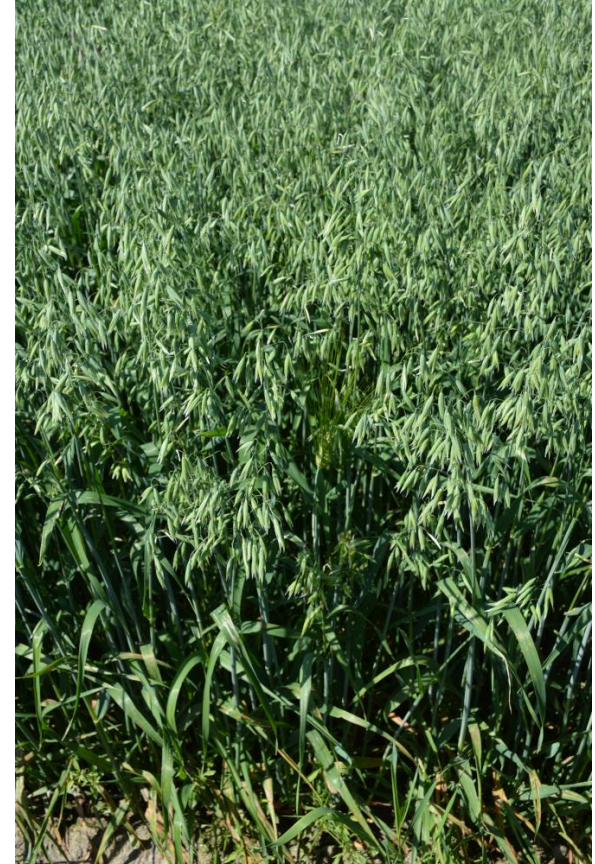
Markku Niskanen and Roope Näsi are positioning the observed barley plants by in oat stand at Ilmajoki on 4.7.2022.

2,5 m to one direction was quite maximum to observe barley plants in the oat stand. Checking 1 ha would mean walking of 2000 m and checking an average size 5 ha field means walking 10 km in cereal stand on variable and soft soil surface.

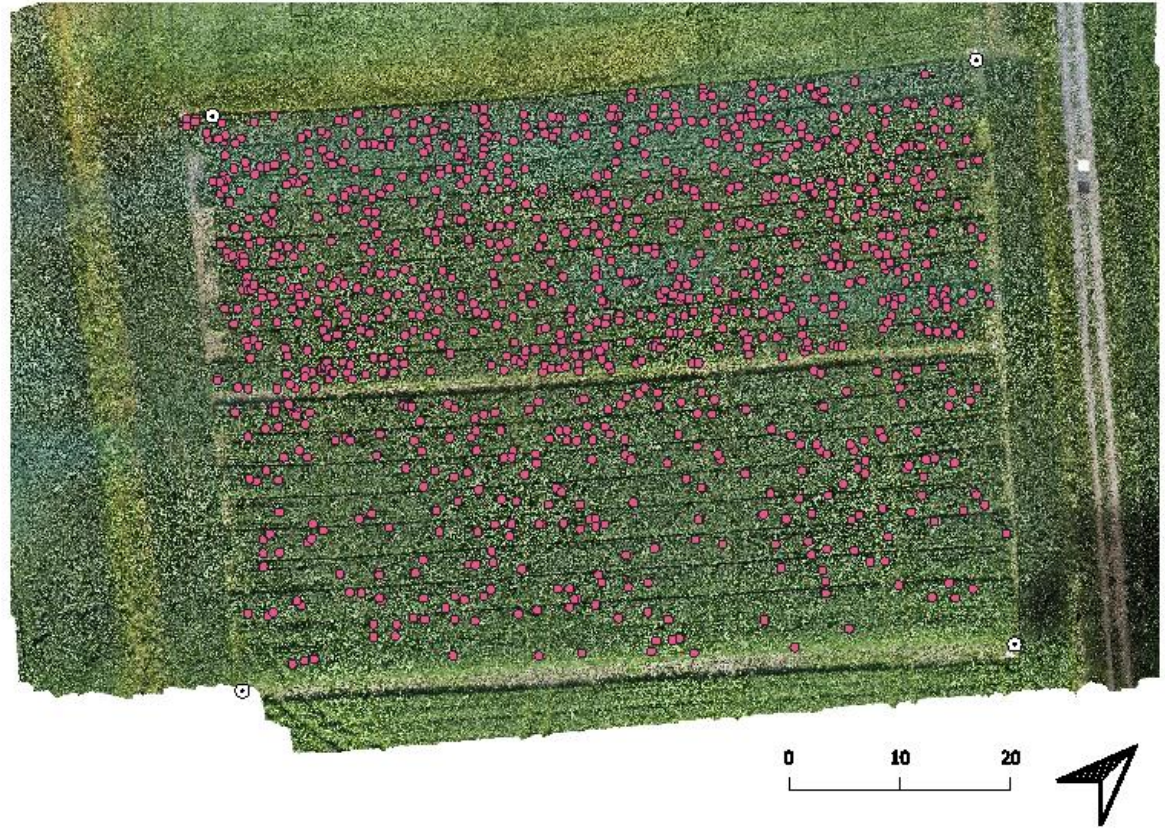
Markku Niskanen and Roope Näsi are positioning the observed barley plants by in oat stand at Ilmajoki on 4.7.2022.

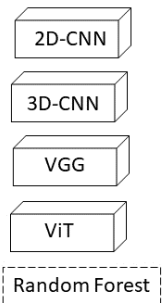


Some of the barley plants are more difficult to observe than some others



**Positioning of the
barley plants in oat stand
at Ilmajoki on 4.7.2022.
Length of the sown stripes
are 70 m and width 2,5 m.
Photo: Roope Näsi.**





Drone
data
capture

DATA
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Images
and 3D
data

ANNOTATI
ON

Labeled
data

TRAINING
AND
MODEL
EVALUATI
ON

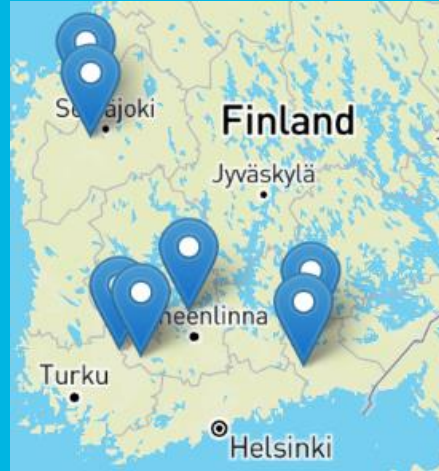
Estimati
on
models

DETECTIO
N MAPS

Deep learning - concept

Drone data collection

- Trial fields in Ilmajoki and Jokioinen
- Real farm parcels in Etelä-Pohjanmaa, Häme, Kaakkois-Suomi
- In 2022 altogether 35 flights
- 12m flying height, 1,5mm GSD (in nadir)



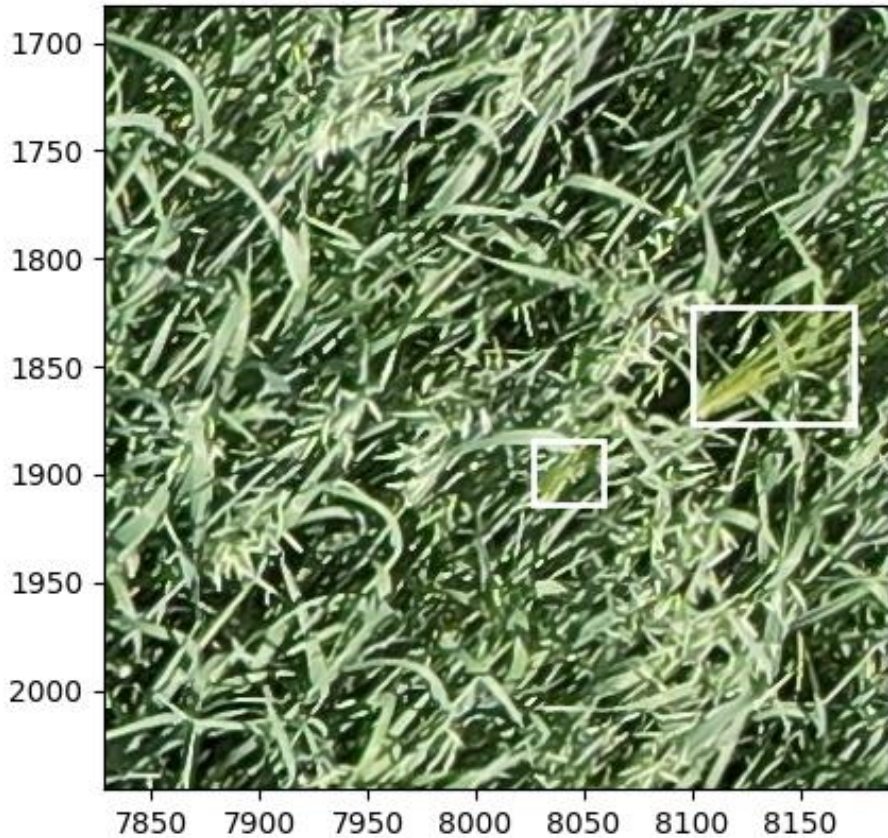
- Flight time 20-50min, payload up to app. 2kg
- Easy to fly
- Integrated sensors, P1 RGB (**smart oblique**)

Annotation tool

- The aim was to produce preliminary boundary boxes as a training data for deep learning algorithms
- Input
 - Image orientation parameters
 - Object coordinates
 - Image size
- Outout
 - Location of the barley as boundary box in the original drone image

Alien barley in the oat field





Preliminary results

- Data: Ilmajoki 9.7.2021
 - 2495 drone images
- 529 alien barleys
 - Every barley visible in more than 70 images
 - About 40 000 image observations
- 3000 barley observations annotated and confirmed manually and used for training

Preliminary result:

AP = Average Precision >90% in image level and >80% in object level

Method development and readiness for service

The results are encouraging.

Testing will continued from the farms already obtained material from years 2021 and 2022.

Further tests on farms in summer 2023.

Searching possibilities to provide fast results.

