Delaktivitet 3d)

Underlag för webbaserat beslutsstödesystem för smart växtodling

Jakob Geipel, NIBIO

Innovationer för hållbar växtodling

Research goals

Using state-of-the-art remote sensing technologies to
- estimate actual crop biophysical properties and
- predict expected crop yield.

Sensors and sensor platforms

UAV &
Rikola hyperspectral camera

Satellite
Sentinel 2a & RapidEye

https://en.wikipedia.org/wiki/Sentinel-2A#/media/File:Sentinel_2-IMG_5873-white_(crop).jpg

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Spring wheat field trials

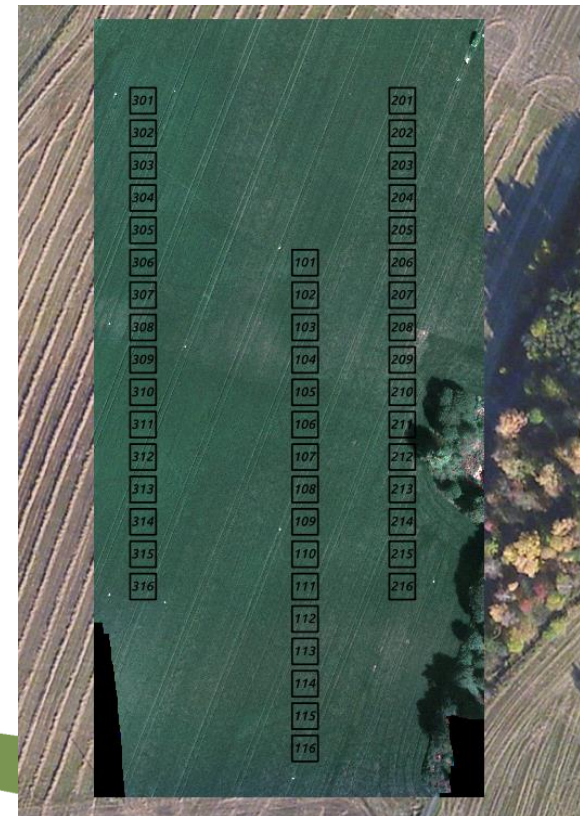Decision support for split-fertilization and yield estimation

2016

Trial:

- Heterogeneous organic matter content

Samples:

- Biomass (48 at GS 39)
- Yield (42 at harvest)

Sensor data:

- RapidEye (GS 32)
- UAV / Rikola (GS 39)

Spring wheat field trials

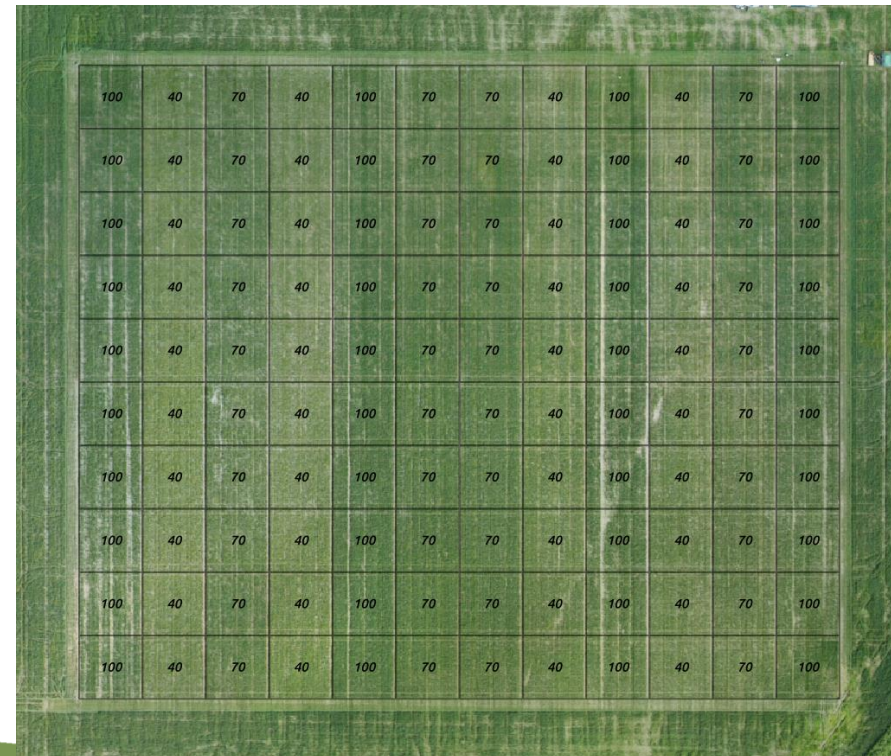Decision support for split-fertilization and yield estimation

2017

Trial:
- Homogenous organic matter content
- 3 base N-levels (40, 70, 100 kg N ha^{-1})

Samples:
- Biomass (180 at GS 39)
- Yield (180 at harvest)

Sensor data:
- Sentinel 2a (GS 31, 39)
- UAV / Rikola (GS 39, 52, 61, 65)

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Spring wheat field trials

Regression strategies

Simple linear regression (SLR):

GS	Response	Predictor
39	Dry matter (DM)	Various vegetation indices
H	Grain yield	Various vegetation indices

Multiple linear regression (MLR):

GS	Response	Predictor
39	Dry matter (DM)	Selected wavebands
H	Grain yield	Selected wavebands

Powered partial least squares (PPLS) regression:

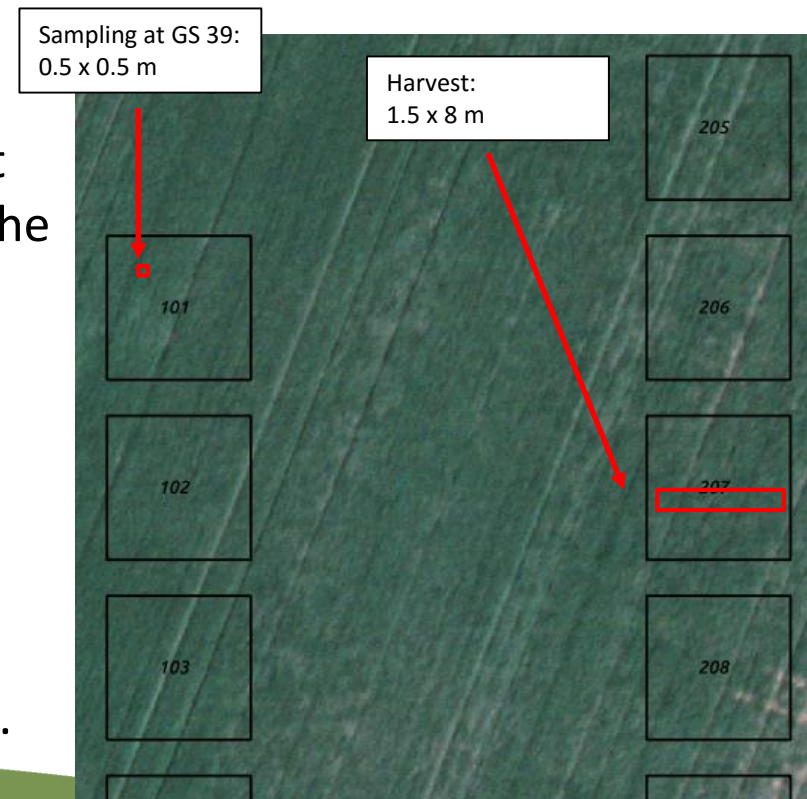| GS	Response	Predictor
39	Dry matter (DM)	All wavebands
H	Grain yield	All wavebands

PPLS regression coefficients for 'dm_kg_daa_yield'
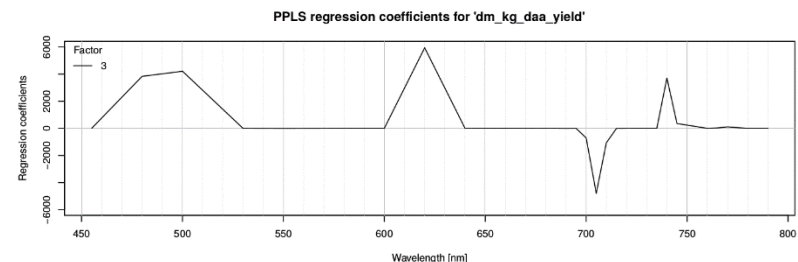
Spring wheat field trials

Results

2016

We found some correlations but were not satisfied with the prediction accuracy of the tested regression modeling strategies, neither for the UAV nor for the RapidEye data.

Sampling size was not adapted to the minimal area of interest (10 x 10 m). Therefore, groundtruth data is not representative for the measurement data.

Sampling at GS 39:
0.5 x 0.5 m

Harvest:
1.5 x 8 m

205

101

206

102

207

103

208

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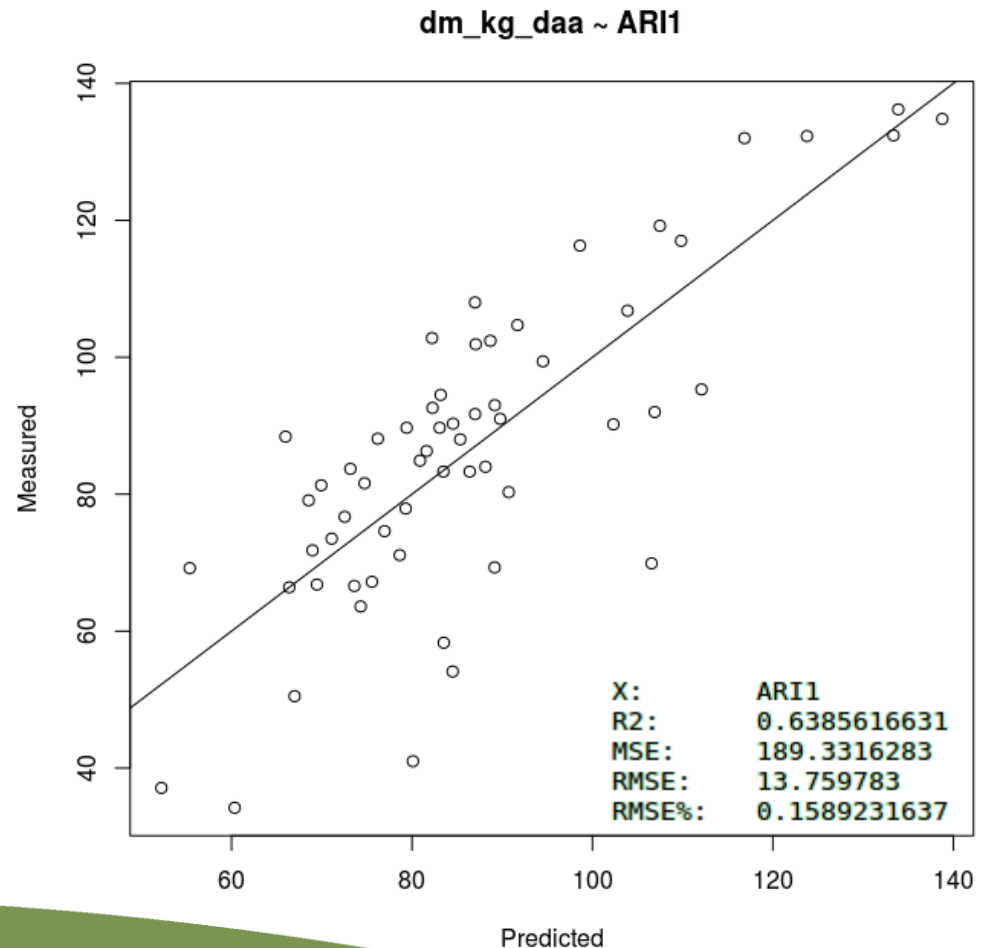
Spring wheat field trials

Preliminary results Sentinel 2a

2017

All bands were resampled to a **10x10 m** resolution (GS 31)

Biomass data DM (GS 39)

Best prediction accuracy with the ARI1 (Anthocyanin Reflectance Index) with an RMSE of 15.9 %

dm_kg_daa ~ ARI1

X: ARI1
R2:   0.6385616631
MSE: 189.3316283
RMSE: 13.759783
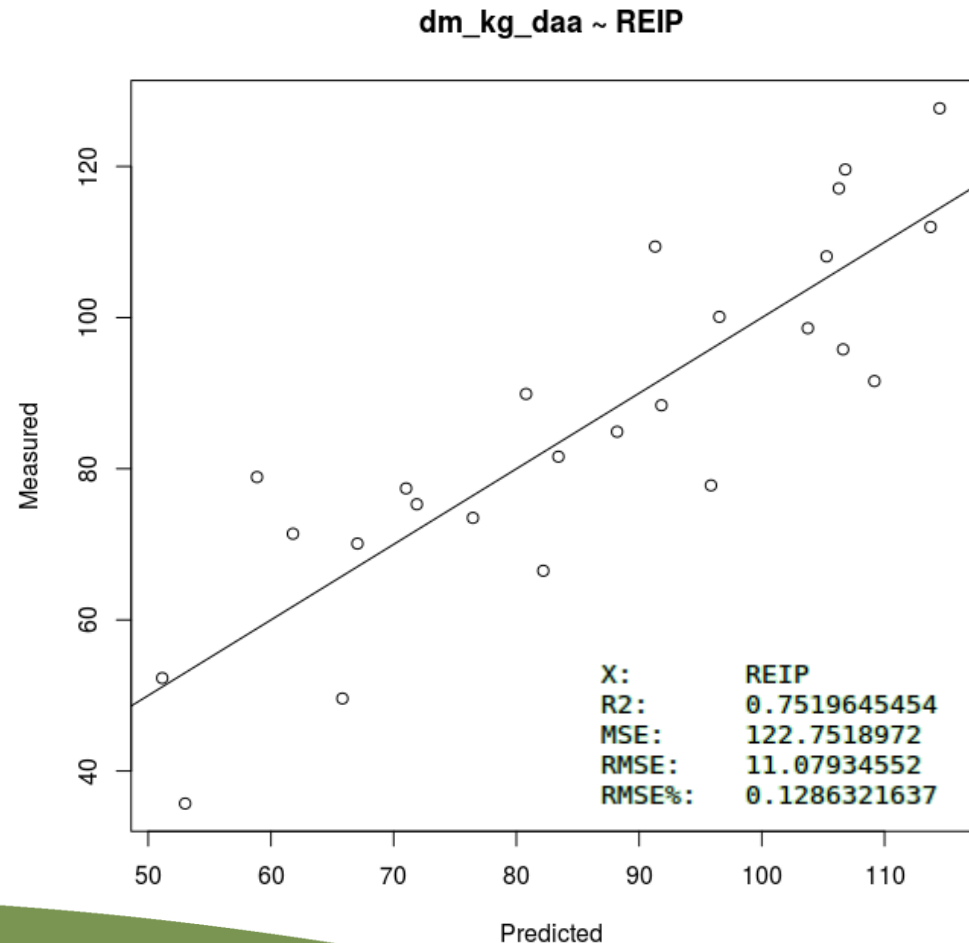RMSE%:   0.1589231637

Spring wheat field trials

Preliminary results Sentinel 2a

2017

All bands were resampled to a
20x20 m resolution (GS 31)

Biomass data DM (GS 39)

Best prediction accuracy with the
REIP (Red-edge inflection point)
with an RMSE of 12.9 %

dm_kg_daa ~ REIP

X:	REIP
R2:	0.7519645454
MSE:	122.7518972
RMSE:	11.07934552
RMSE%:	0.1286321637

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Spring wheat field trials

Preliminary results UAV & Rikola

2017

Model: PPLS
Data: **Biomass DM** (GS 39)

RMSECV:
9.6 kg DM daa^{-1} (11.4 %)

Dominant wavebands:
Red-edge

dm_kg_daa, 6 comps, validation

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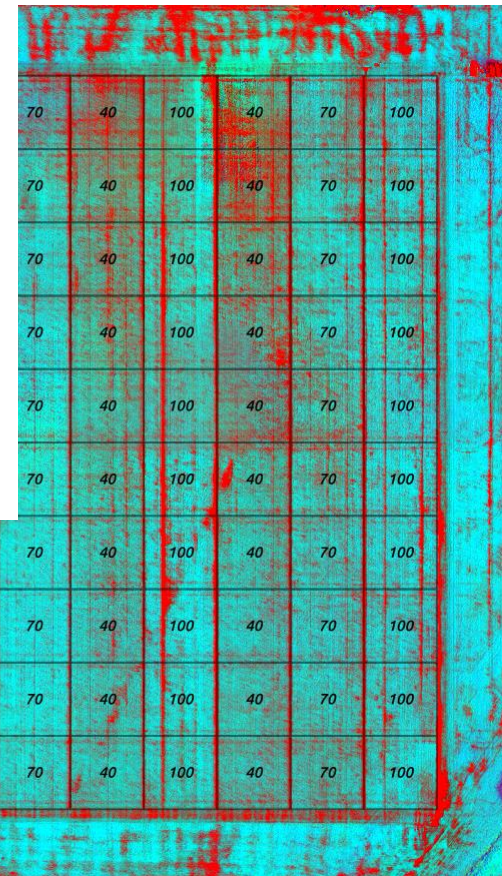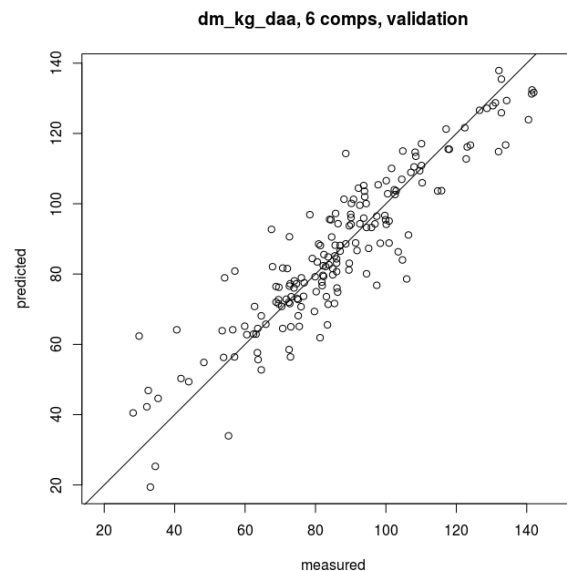
Grassland field trial

Decision support for forage production in terms of yield estimation
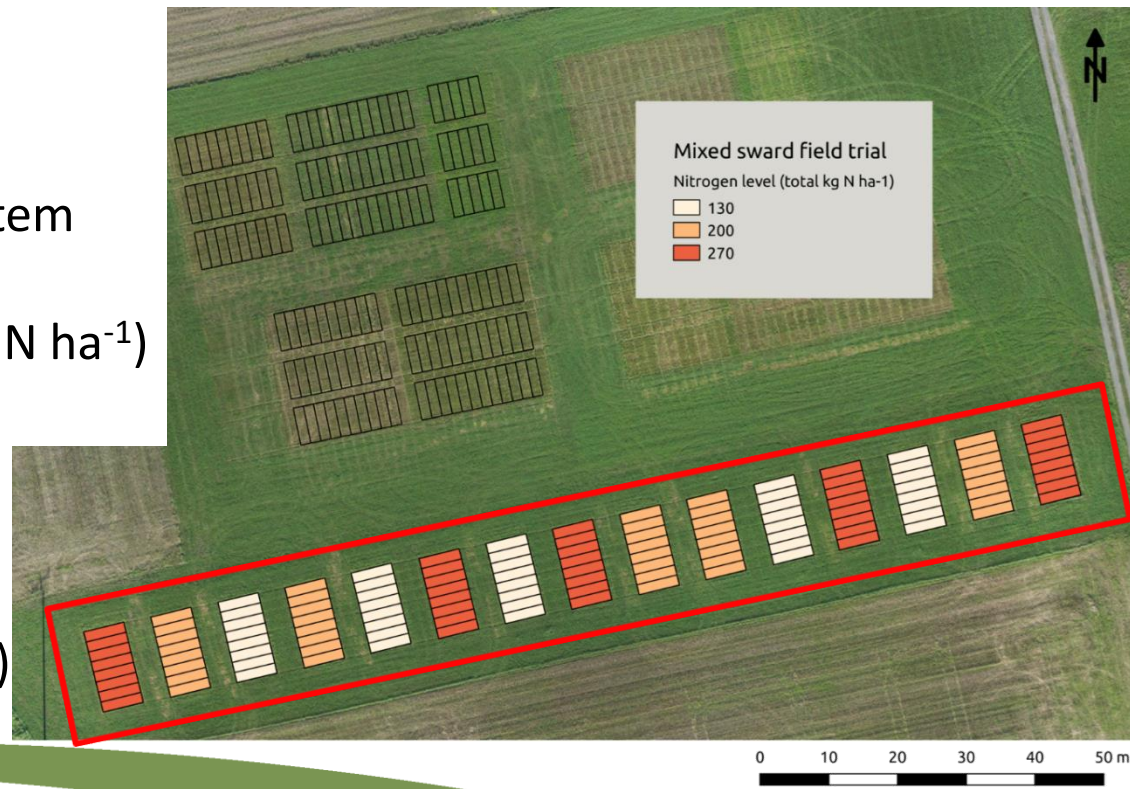
2016

Trial:

- Typical Norwegian 3 cut system and sward composition
- 3 N-levels (130, 200, 270 kg N ha^{-1})

Samples:

- Yield (120 at 1st cut)
- Yield (120 at 2nd cut)

Sensor data:

- UAV / Rikola (1st and 2nd cut)

Mixed sward field trial
Nitrogen level (total kg N ha-1)
☐ 130
☐ 200
☐ 270

0 10 20 30 40 50 m

Geipel & Korsaeth, 2017

Grassland field trial

Results

2016

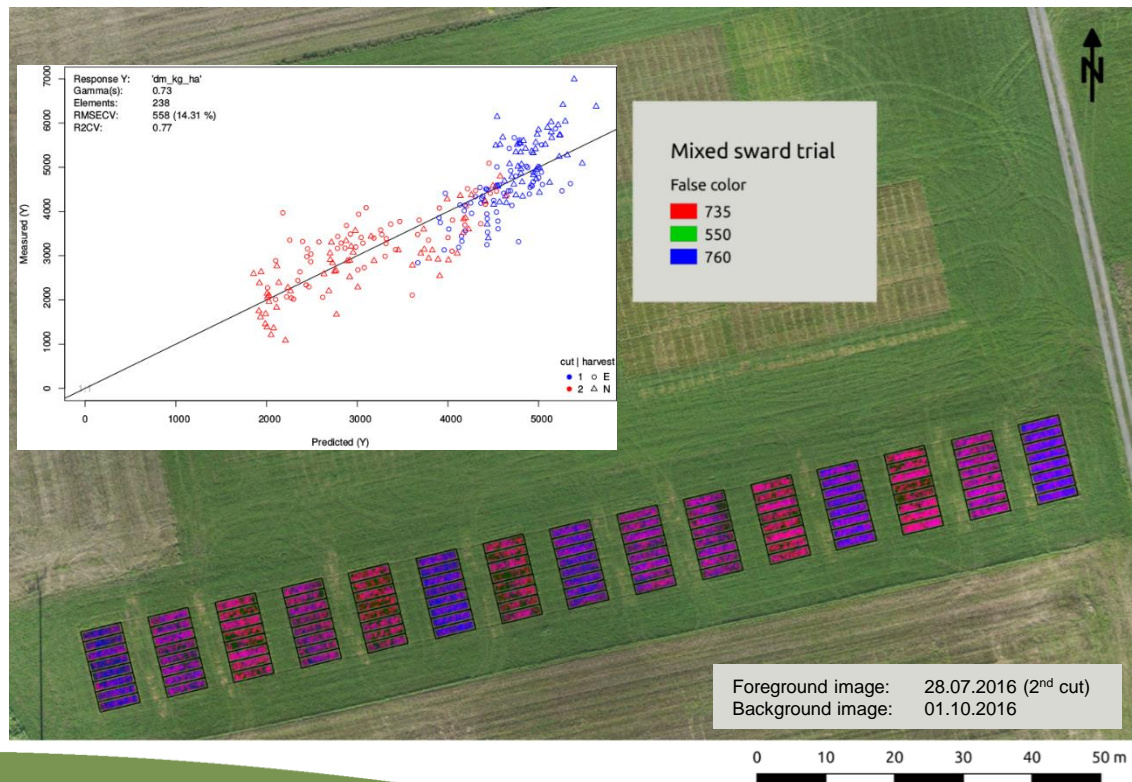Model: PPLS
Data: **Pooled data set (DM)**

RMSECV:
558 kg DM ha^{-1} (14.3 %)

Dominant wavebands:
530, 695, 735 and 760 nm

MLR models, containing only a few wavebands as predictors, performed almost equally well.

Mixed sward trial
False color
735
550
760

Foreground image: 28.07.2016 (2nd cut)
Background image: 01.10.2016

0   10   20   30   40   50 m

Geipel & Korsaeth, 2017

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Conclusions

- Cloud-free satellite scenes are rare in Norway.

- Sampling size should be adapted to the minimum area of interest.

- Satellite imagery were appropriate to model actual above ground biomass (DM) around GS 39 in spring wheat.

- UAV & Rikola hyperspectral images were well suited to model actual above ground biomass (DM) around GS 39 in spring wheat and forage mass (DM) in grassland at the first two cuts.

- The best model results were achieved with PPLS, but MLR based on selected wavelengths performed almost equally well.

- Standard vegetation indices showed lower predictive ability.

Status of work

Field trials
- Spring wheat 2016 finished
- Grassland 2016 still needs analyses
    - Forage (N-content and other quality parameters)
- Spring wheat 2017 still needs analyses
    - Biomass samples (DM and N-content)
    - Grain yield (DM and protein content)

Planned publications
- Spring wheat field trial 2017

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Projektets finansiärer

Förutom Interreg Öresund-Kattegat-Skagerrak har projektet
även följande finansiärer:

promilleafgiftsfonden
för landbrug