Welcome

Yield prediction in cereals

By Mette Kramer Langgaard
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15-12-2022

STØTTET AF
Promilleafgiftsfonden for landbrug
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Agenda

- Welcome and Introduction – Mette Langgaard, SEGES Innovation (5 min)
- Work of Omran Alshihabi, researcher at the Department of Soil and Environment, Swedish University of Agricultural Sciences (40 min).
- Yield prediction in Winter wheat, Mette Kramer Langgaard, special consultant, SEGES Innovation (40 min)
- Assimila and yield prediction, Jon Styles (Director of Assimila) or Andy Shaw (Director and Principal Consultant) (40 min)
- Time for discussion

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Presentation round

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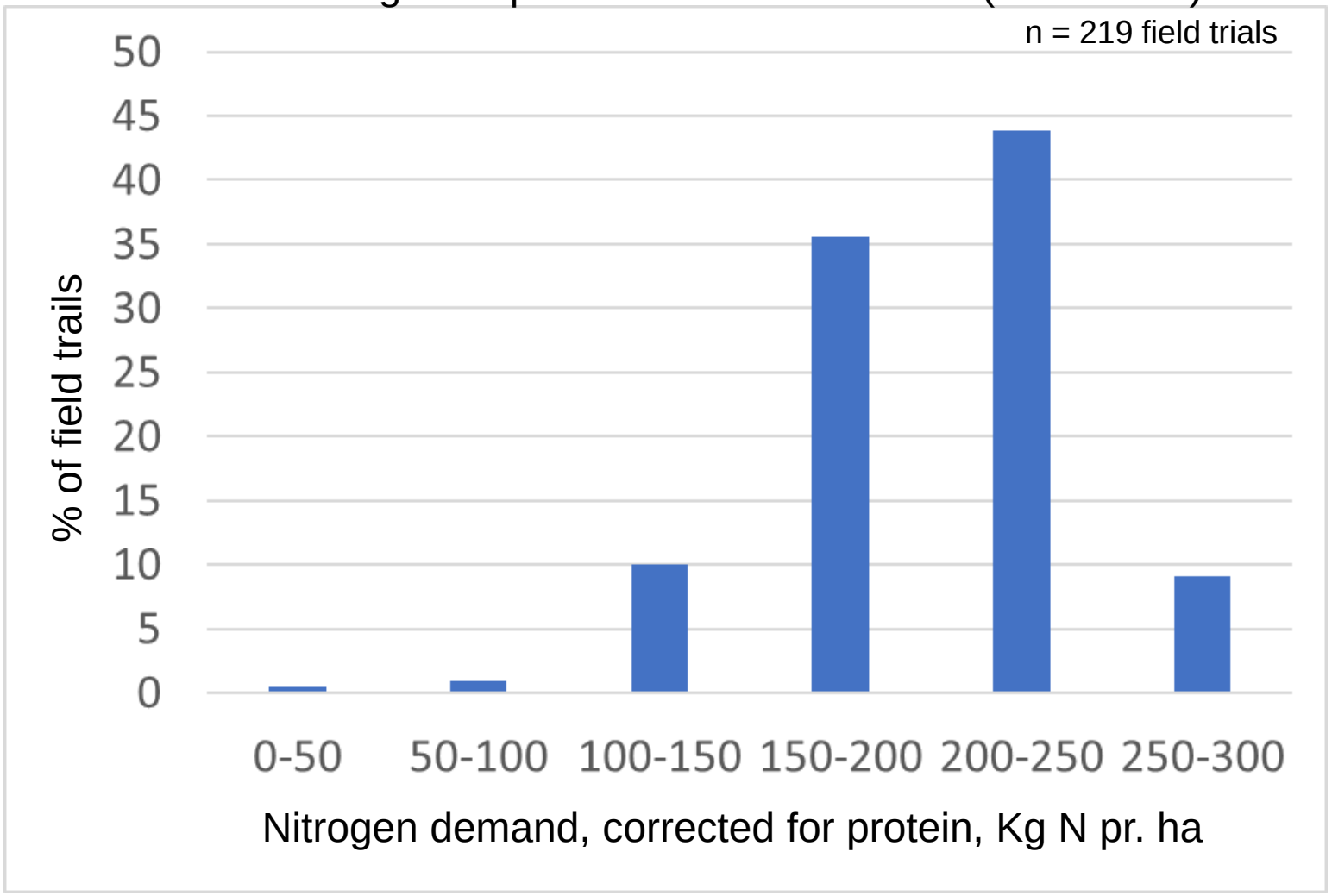
Yield prediction – why is it interesting?

The variation in nitrogen requirement of winter wheat (2011-2020)



Danish model for calculating the N requirement in Mark Online:

- Preceding crop
- Soil type
- Expected yield
- Cultivation history
- Cover crops
- N-min in the spring

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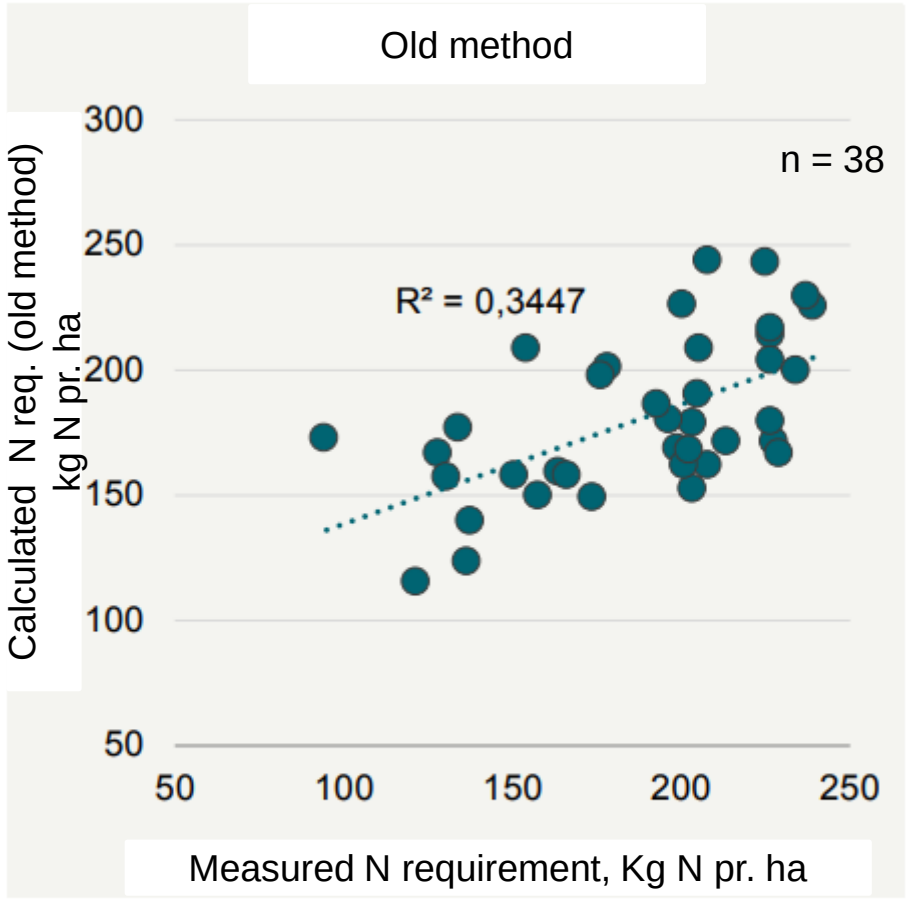
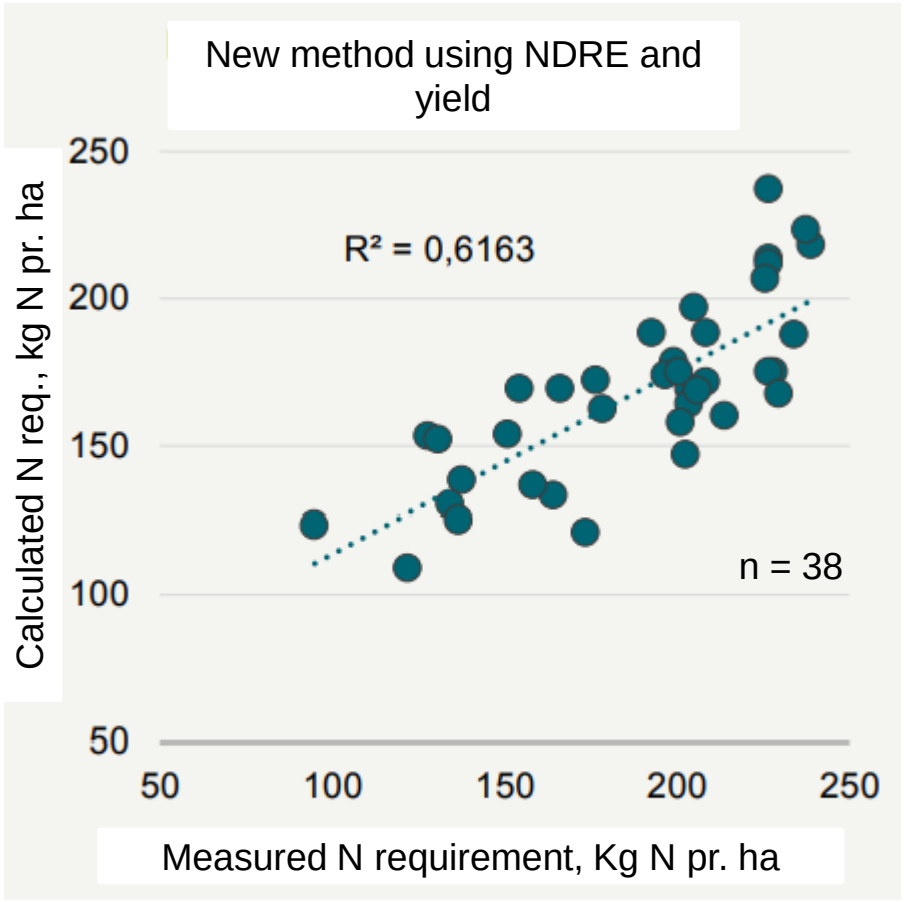
Optimal N using NDRE and expected yield



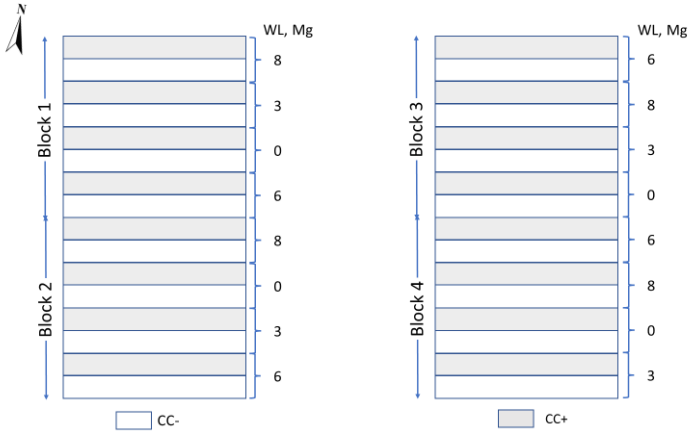
FIGUR 19. Sammenhæng mellem kvælstofbehov ved beregningsmetoden til indstilling af kvælstofnormer og det målte kvælstofbehov.



FIGUR 20. Sammenhæng mellem kvælstofbehov beregnet ud fra NDRE og udbytte og det målte kvælstofbehov.

Source: Oversigt over landsforsøgene 2020, side 206

Yield prediction in spring barley from RVI and weather data using machine learning (not yet published)



9 Years with spring barley

Features:

- RVI_{max},
- The difference between RVI of the plot and a dry soil surface (Int)
- accumulated precipitation (P_6) in May
- accumulated evapotranspiration (ET_6) in May

MAE = 3,8 hkg pr. Ha 30 June

Reference (not yet published): Petersen, C. T., Langgaard, M. K., Petersen, S. D., (2022).Yield prediction in spring barley from RVI and weather data using machine learning

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Yield prediction in winter wheat

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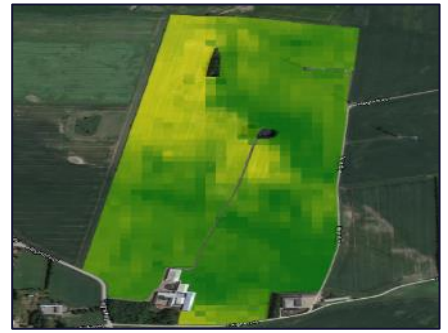
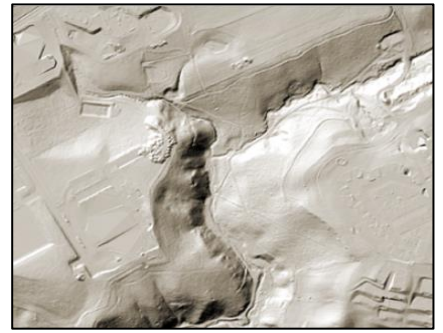
Prediction dates:

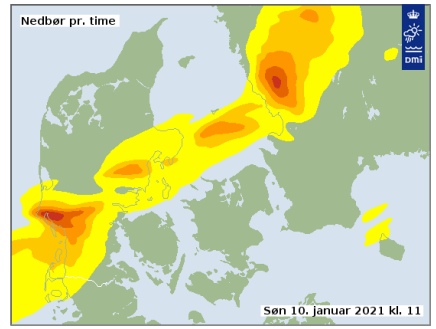
- April10th
- May10th
- June 5th
- August 1st

Data

- Yield maps from combine harvesters
- Satellit data (L1C Sentinel data)
- Terrain Elevation (The Danish Terrain Elevation model)
- Weather data (DMI)
- Crop Variety (new)
- Soil type, crop rotation (new)







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Results from 2020 (data from 2016 and 2017 only)

Prediction date	All data included	Satellit data	
	MAE, t/ha (5x5 meter)	MAE, t/ha (5x5 meter)	MAE, t/ha (markniveau)
April 10th	1,469	1,7296	0,8357
May 10th	1,441	1,7144	0,9263
June 15th	1,273	1,5869	0,8046
September 6th	1,217	1,4252	0,6694

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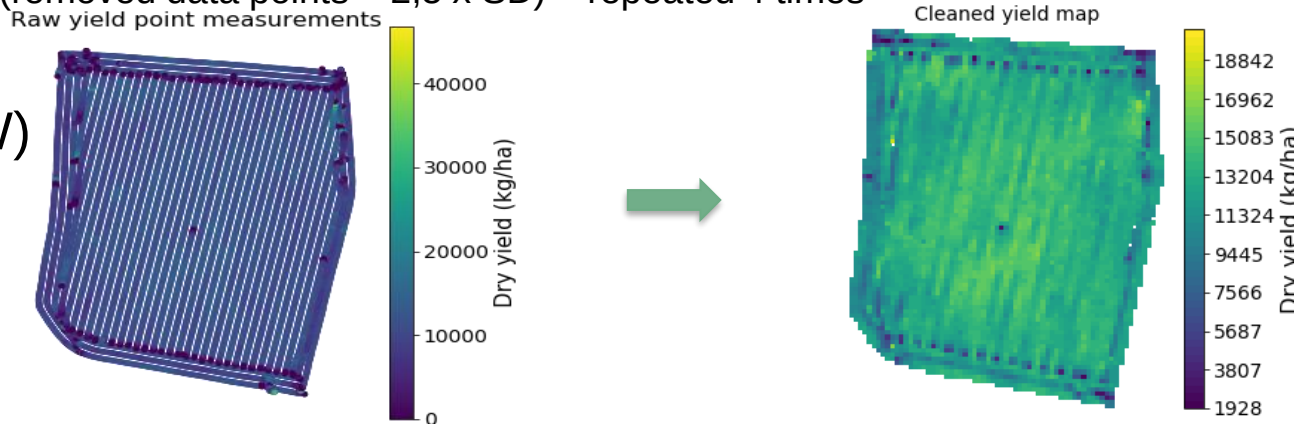
Yield data from combine harvesters

- Collected yield data from farmers
- Converted yield data to shape-files in FarmWorks
- Standardized data and verified crop type
- Cleaning yield data – outlier detection
  - Sorted yield measurements by timestamp
  - Removed thresholds exceeding 1-25 t/ha
  - Removed statistical outliers using distance-to-yield ratio (-log(distance/yield))
  - Moving average – (removed data points > 2,5 x SD) – repeated 4 times
- Interpolation (IDW)

År	Udbyttedata	
	Antal marker	Hektar
2021	171	3.611
2020	41	438
2019	51	619
2018	51	647
2017	64	826
2016	21	190
Total	**400**	**6.352**

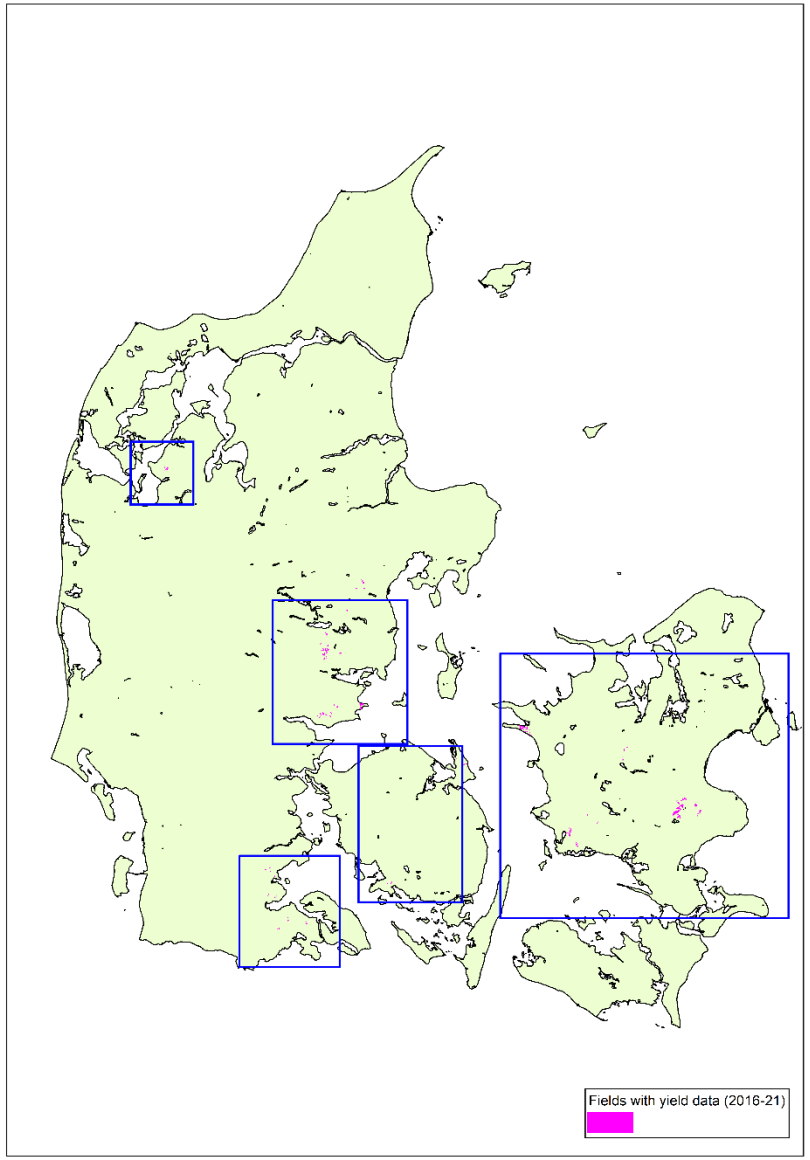


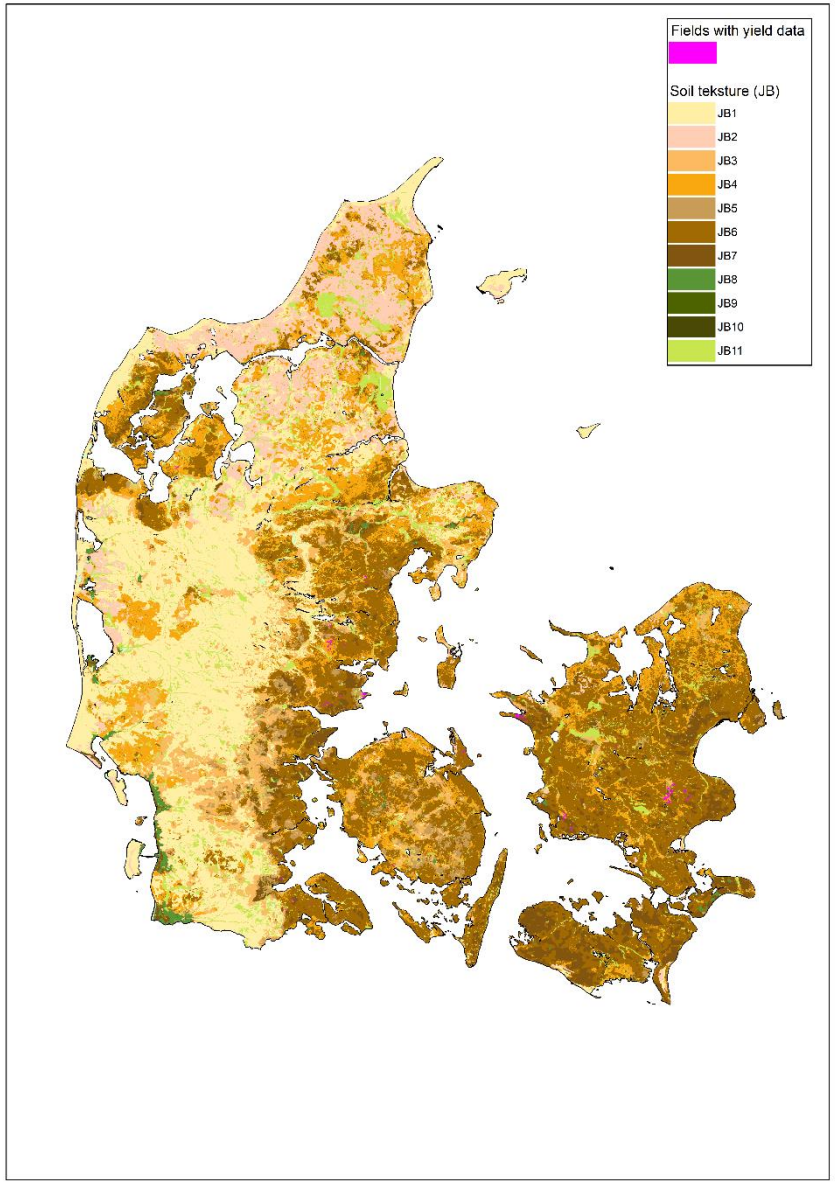
Distribution of yield data

In total

- 300 fields and 4360 ha

Year	Area, ha	number of fields
2016	379	35
2017	1205	95
2018	498	35
2019	415	37
2020	343	29
2021	1520	69
Sum	4360	300

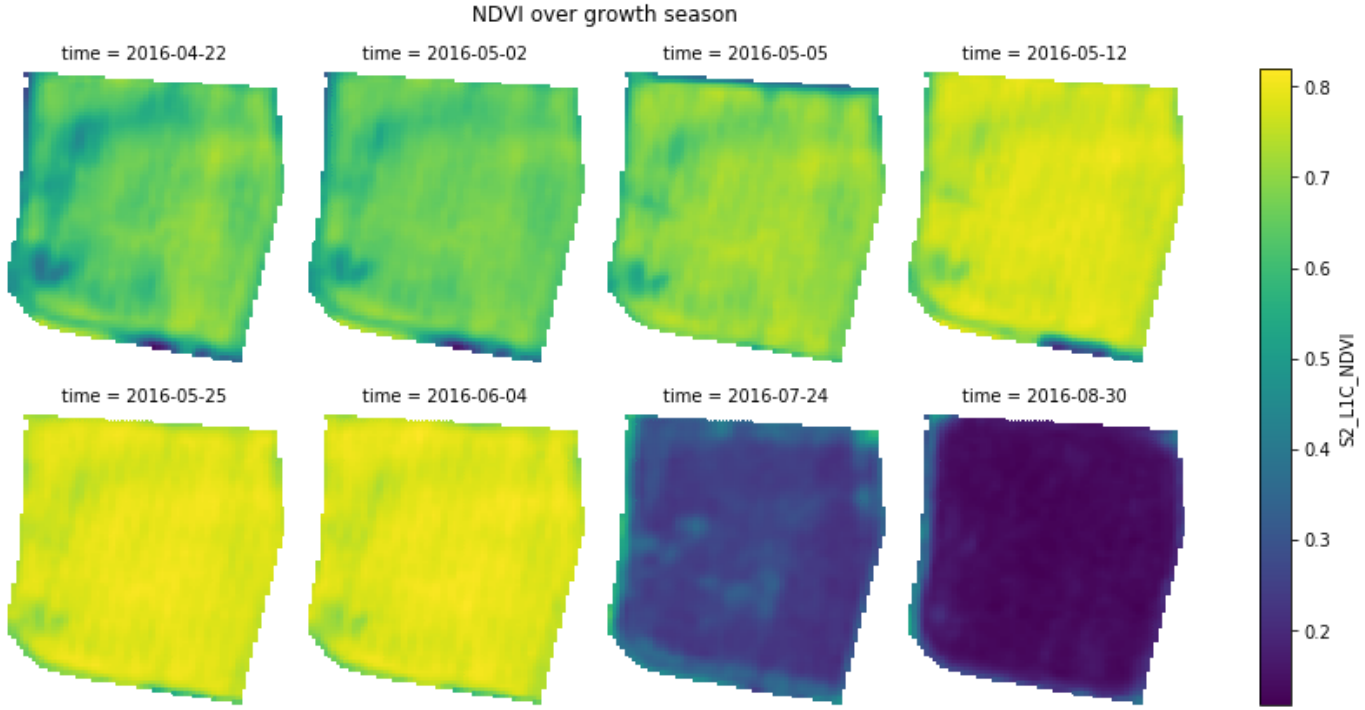




Satellit data - Sentinel-2 L1C

from 9. Marts – 27. Juli from 2016-2021

- B01
- B02
- B03
- B04
- B05
- B06
- B07
- B08
- B08a
- B09
- B10
- B11
- B12
- NDVI
- NDRE
- MSAVI2



Sentinel 2 features were linearly interpolated in the time dimension using IWD and then resampled to 14 days' interval.
Furthermore, the relative changes from 9/3 for all variables were used as features.

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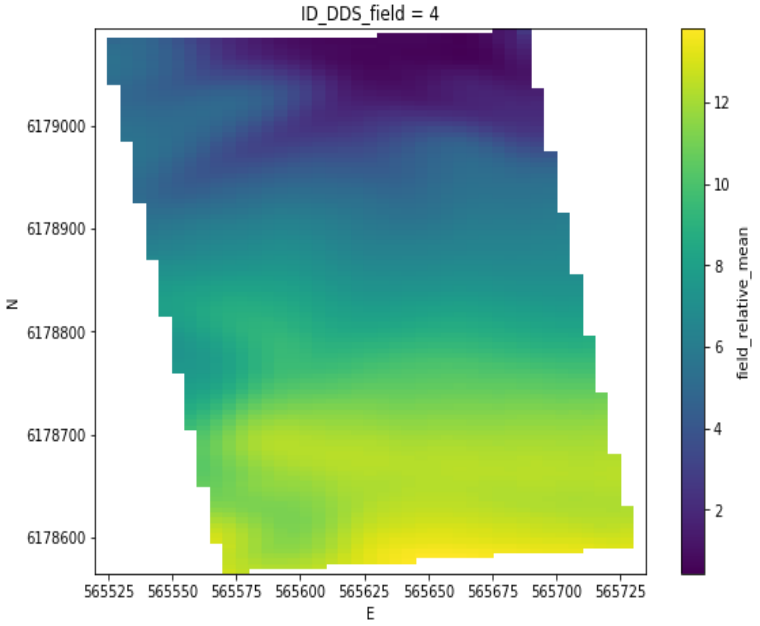
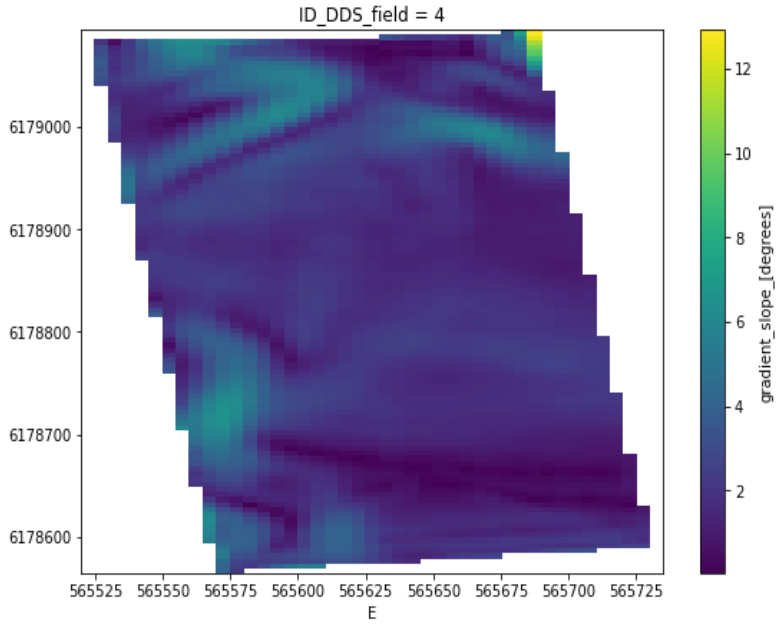
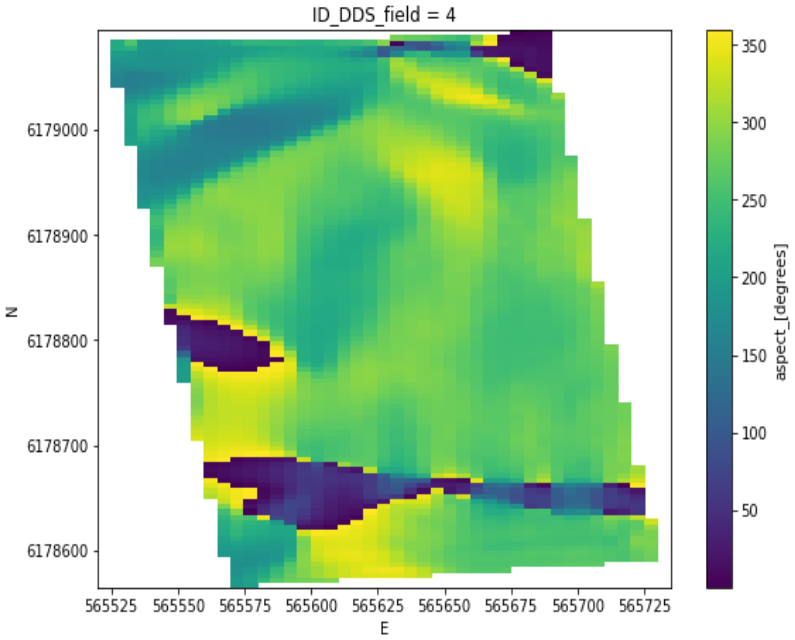
Terrain elevation

Den Danish Terrain Elevation model (DEM) with a resolution of 0,4 meter

- The field relative mean
- Slope percentage
- Slope angle (0-90°)
- Slope aspect (0° = north, 90 °= east, 180° = south og 270° = west)







Weather data

Were available from the Danish Meteorological Institute (DMI) in a 10 x 10 km resolution

- Air temperature
- Soil temperature
- Precipitation
- Global radiation

The mean, standard deviation (SD), minimum, and maximum was calculated for all climate variables.

Weather data was aggregated at intervals of 14 days

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Observations and ML model

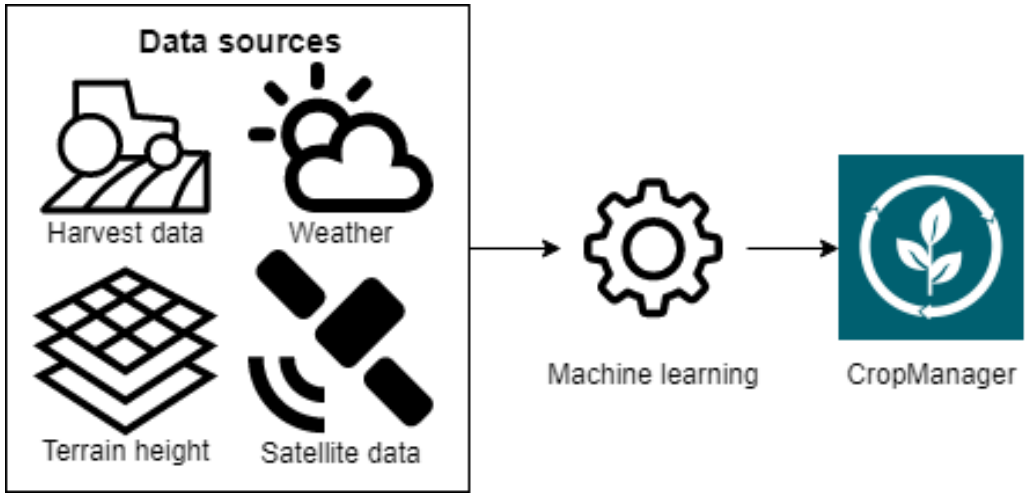
Approx. 302.612 observations

- Training data: ~ **80%** 10x10 meter pixels.
- Validation data: ~ **20%** 10x10 meter pixels.

792 features in the model

ML algorithm:

Gradient Boosting Regressor



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Brand new results

Experiment	Model	Algorithm	Features	Split	MAE, hkg/h				RMSE				R^2				Std. of AE			
					Point		Field		Point		Field		Point		Field		Point		Field	
					Validation	Train	Validation	Train	Validation	Train	Validation	Train	Validation	Train	Validation	Train	Validation	Train	Validation	Train
1	April 6	Gradient Boosting	S2, DTM, DMI, crop type, crop history, JB, sort, coordinates	Split on entire fields, 40 fields in validation	9,65	8,56	6,72	3,43	12,6	11,44	9,34	4,87	0,56	0,74	0,74	0,95	8,09	7,59	6,5	3,46
	May 4				9,42	8,69	6,23	3,82	12,17	11,58	8,45	5,2	0,59	0,73	0,79	0,95	7,71	7,66	5,78	3,53
	June 1				9,31	8,69	5,86	3,88	12,15	11,6	7,87	5,14	0,59	0,73	0,82	0,95	7,8	7,68	5,25	3,37
	July 27				9,21	8,57	5,64	3,81	11,93	11,49	7,54	5,31	0,61	0,74	0,83	0,94	7,58	7,65	5,01	3,7
2 (haven't done any hyperparameter tuning)	April 6	Gradient Boosting	S2, DTM, DMI, crop type, crop history, JB, sort, coordinates	Split on years, 1 year (2021) in validation																
	May 4																			
	June 1																			
	July 27				13,56	7,34	11,34	1,4	17,55	10,11	13,59	2,51	-0,32	0,85	-0,11	0,99	11,14	6,94	7,5	2,08

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