

The farmer of the future uses artificial intelligence, climate mitigation measures and provides traceability

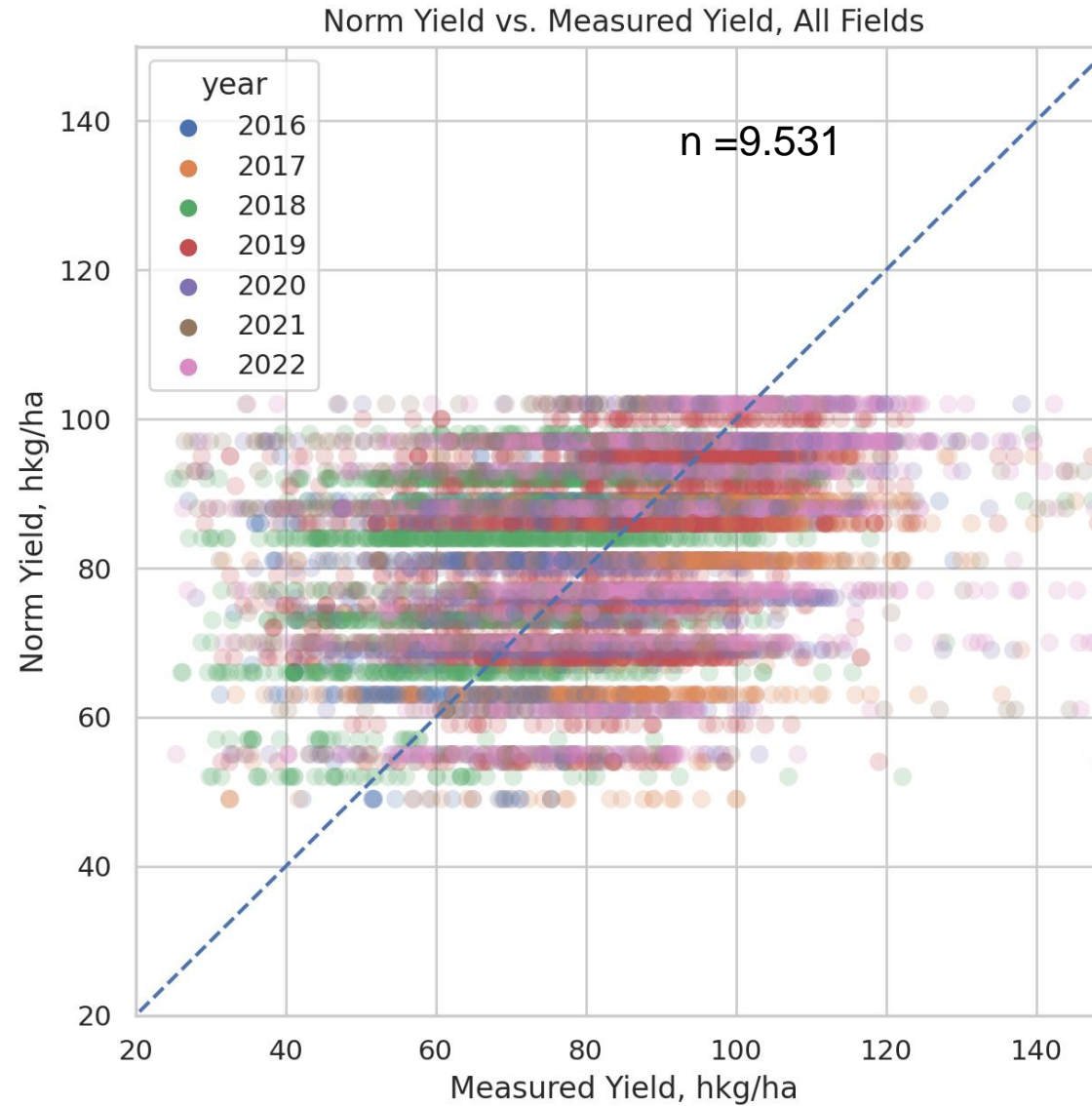
By Mette K. Langgaard, SEGES Innovation

04-06-2024

STØTTET AF
Planteafgiftsfonden

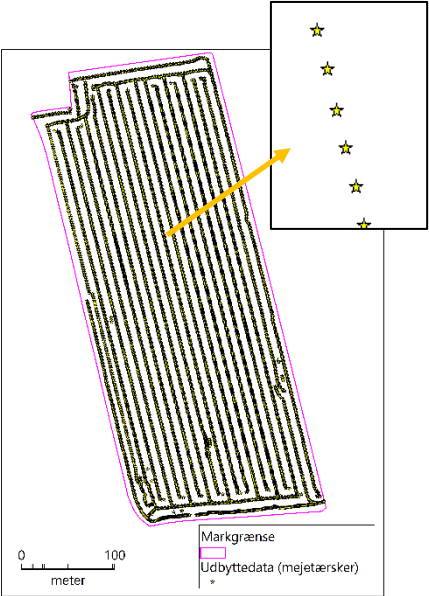
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INNOVATION

Yield prediction – why is it interesting?

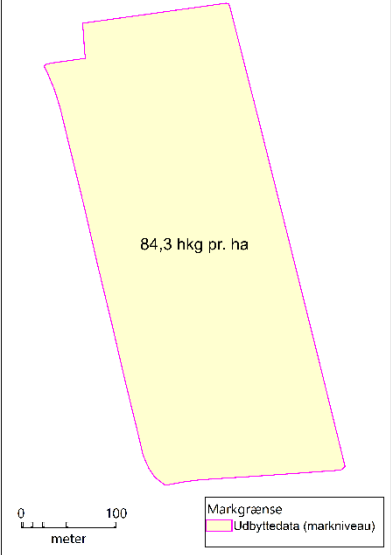


Goal: MAE < 1 ton pr. ha

Data used



Part A	Part B
Yield data from combine harvesters <i>(10 x 10 meter pixels)</i>	Yield data from FDB <i>(Field level)</i>
2016-2021	2016-2022
Satellite data (L1C Sentinel data)	
Terrain elevation (The Danish Terrain Elevation model)	
Weather data (DMI)	
Soil texture (JB)	
Variety of winter wheat	
Crop rotation (five years)	



Models

ML algorithm:

Gradient Boosting Regressor

Prediction dates:

May 4-10th and before harvest (July 27th or August 1st)

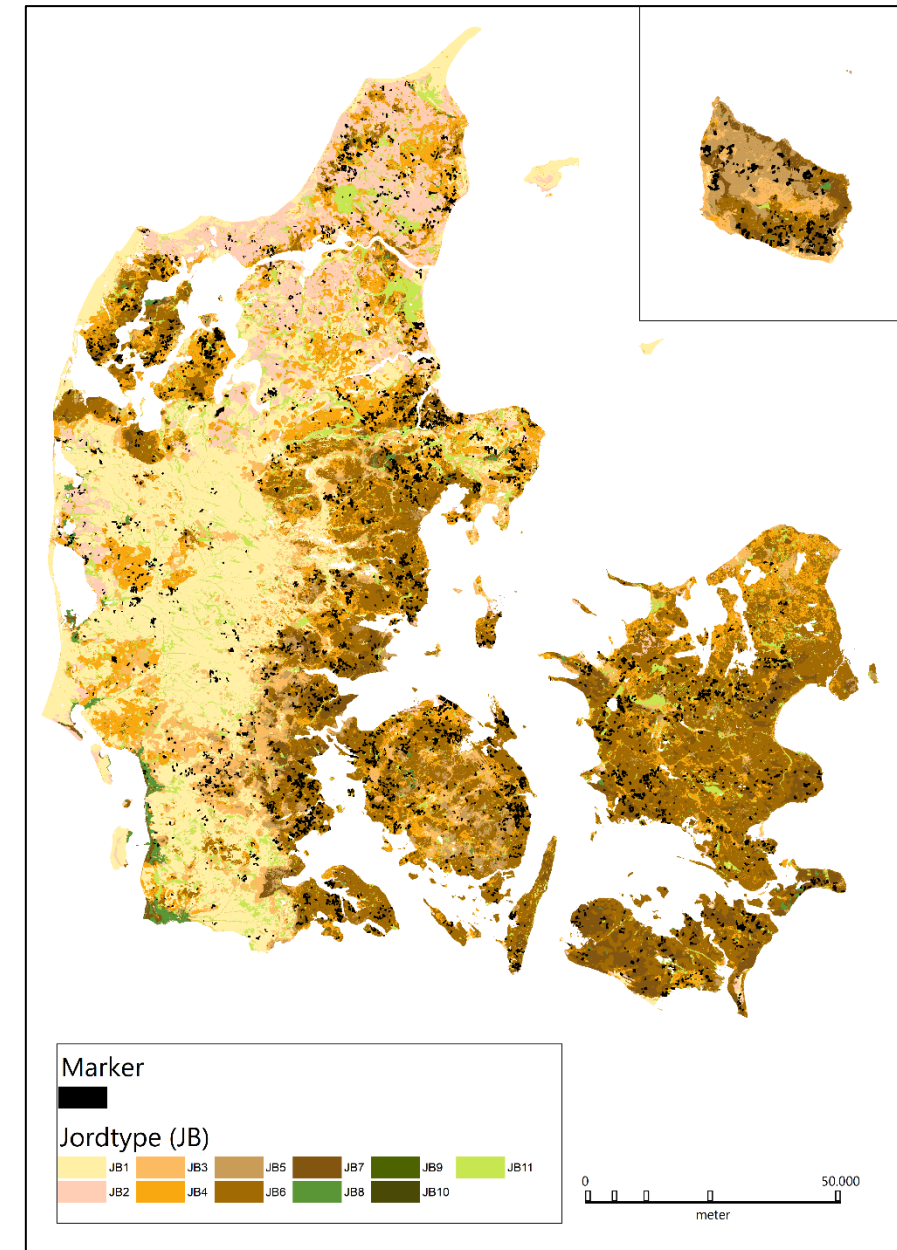
The prediction performance was evaluated using mean absolute error (MAE) and R²

$$\text{MAE} = \sum_{i=1}^n \frac{|h_i - p_i|}{n}$$

h is measured yield,
p is predicted yield
n is number of observations

Part B – Yield data (*FDB*)

År	Udbyttedata			
	Antal Marker	Antal Bedrifter	Areal, ha	Gns. udbytte, hkg pr. ha
2016	906	234	10.927	74,1 (15)
2017	1.084	284	12.380	88,4 (16)
2018	1.063	313	12.345	66,0 (17)
2019	1.470	362	17.838	85,8 (16)
2020	1.554	386	18.746	85,9 (17)
2021	1.706	412	20.257	79,5 (17)
2022	1,748	422	19.891	89,1 (18)
Sum	9.531		112.383	



Part B - Analysis

Model type	Prediction date	Observationner	Split of data
Field level	Maj 10 th	9.531	Cross-validation with years as fold
	August 1 st		
Field level	Maj 10 th	158 [*]	Cross-validation with years as fold
	August 1 st		

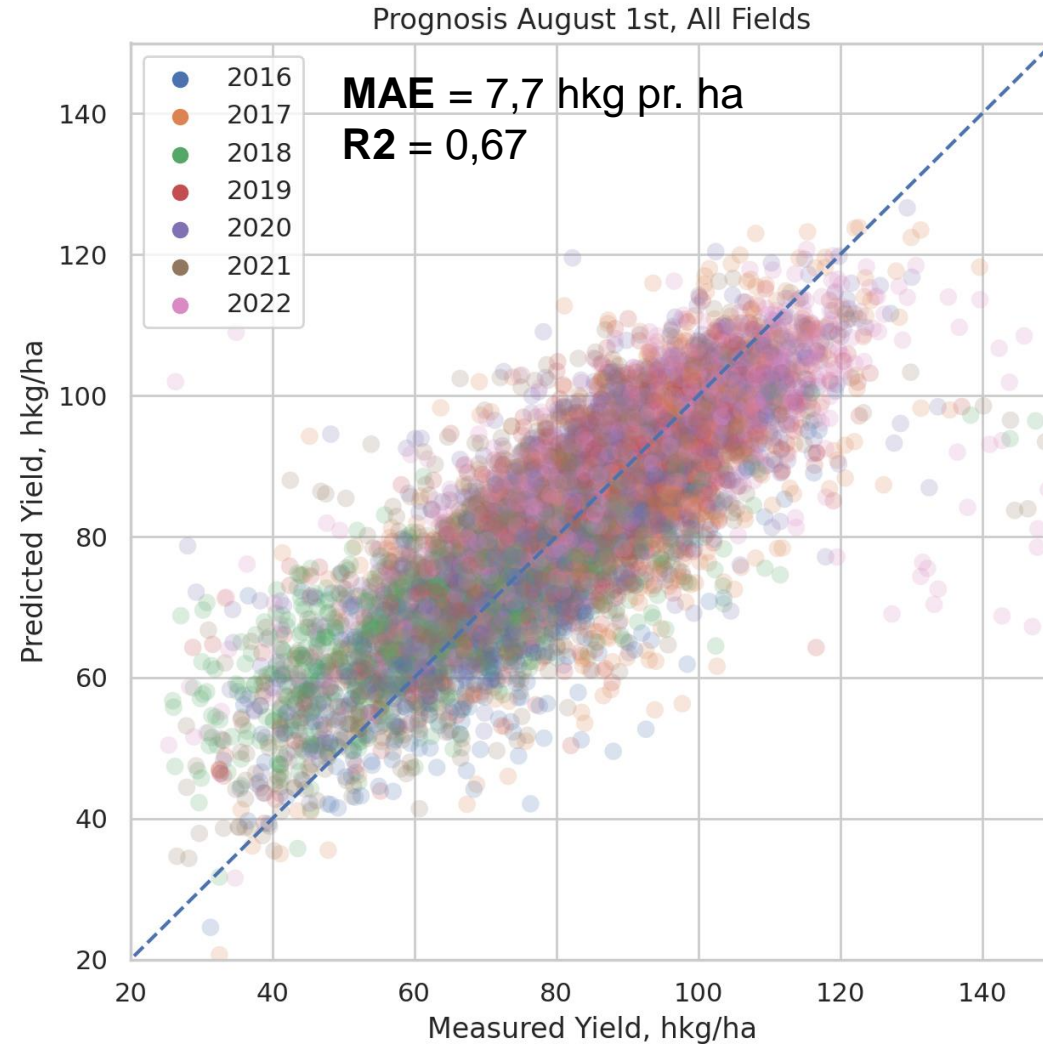
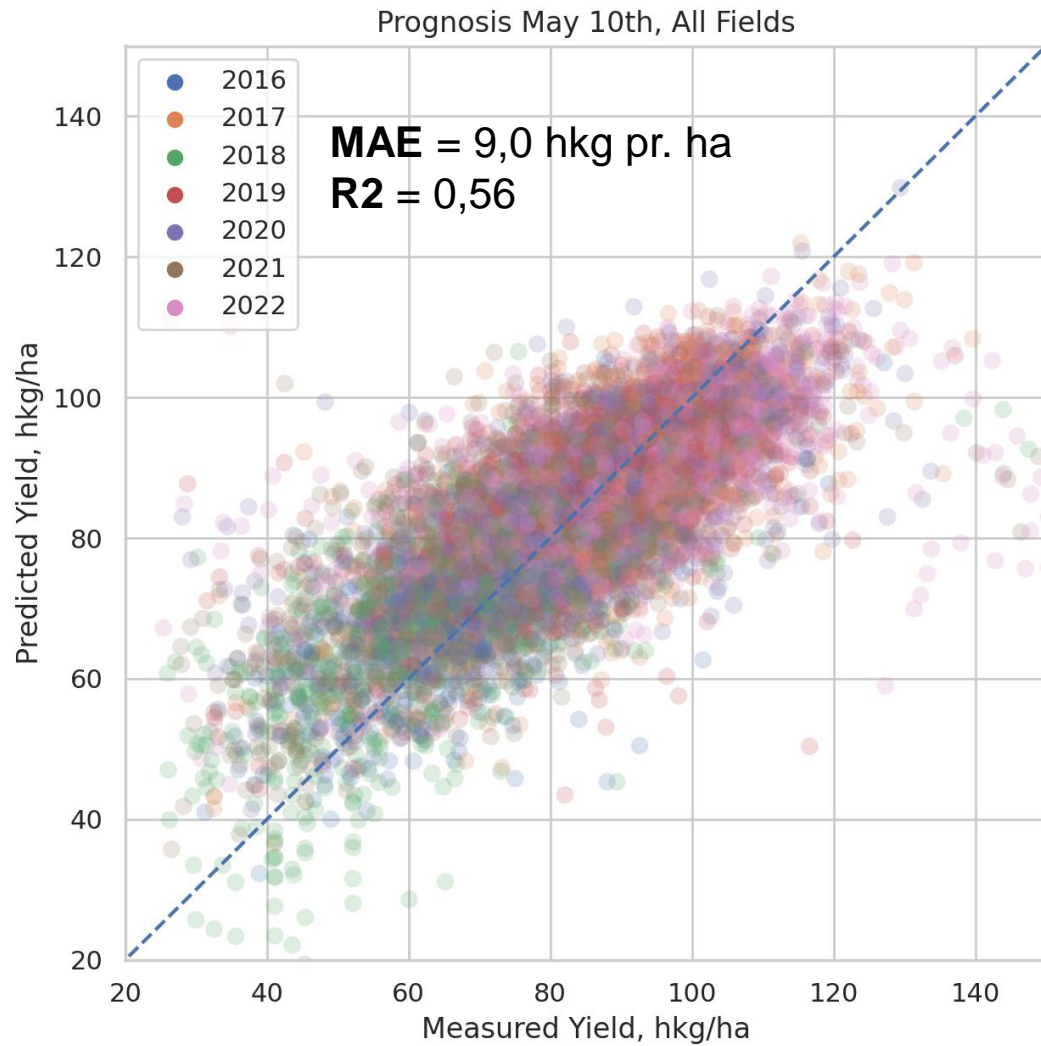
** Fields with $5 \leq$ yield registrations from 2016-2022 in FDB.*

Results- part B

STØTTET AF
Promilleafgiftsfonden for landbrug

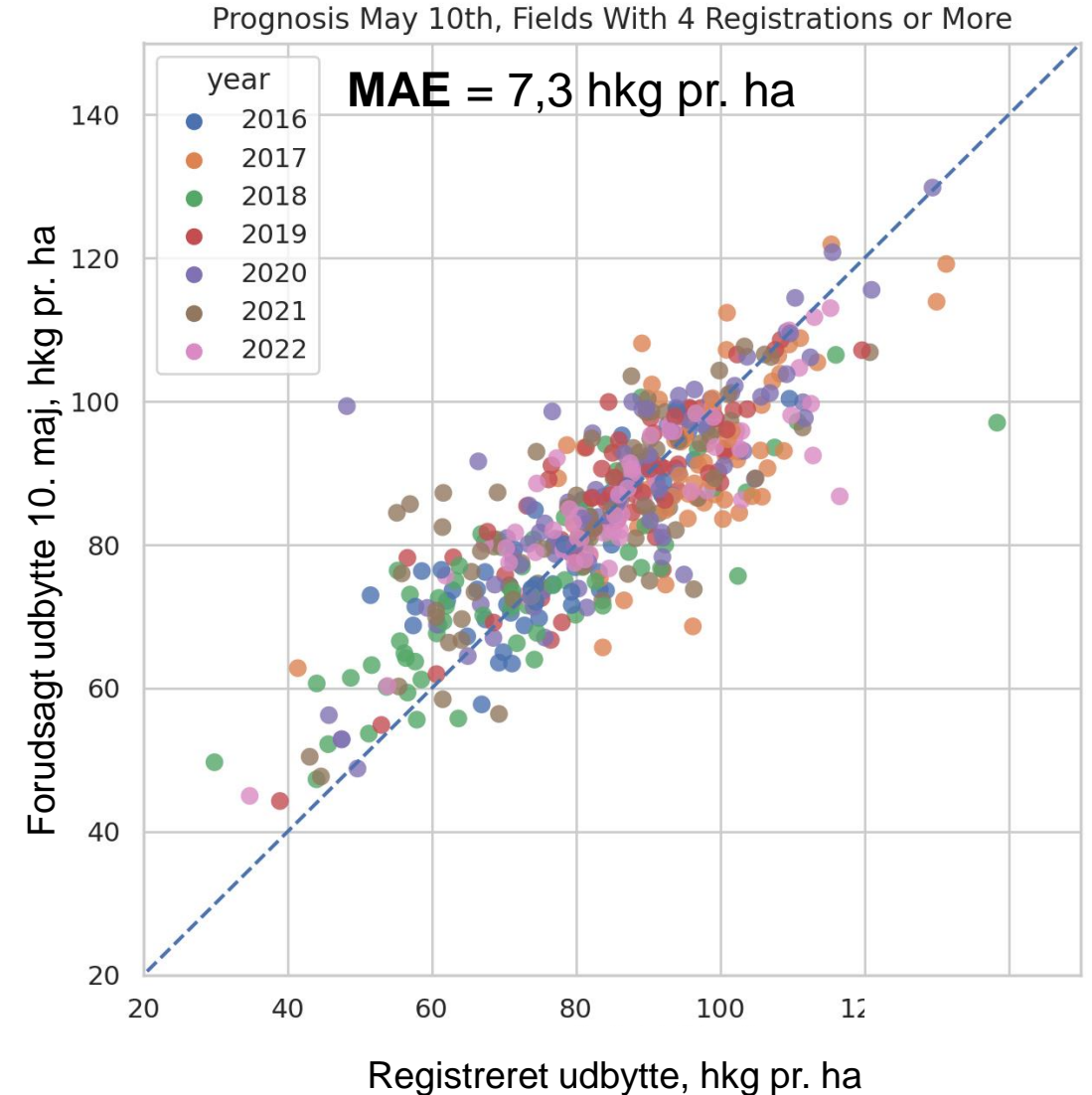
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Yield prediction at field level

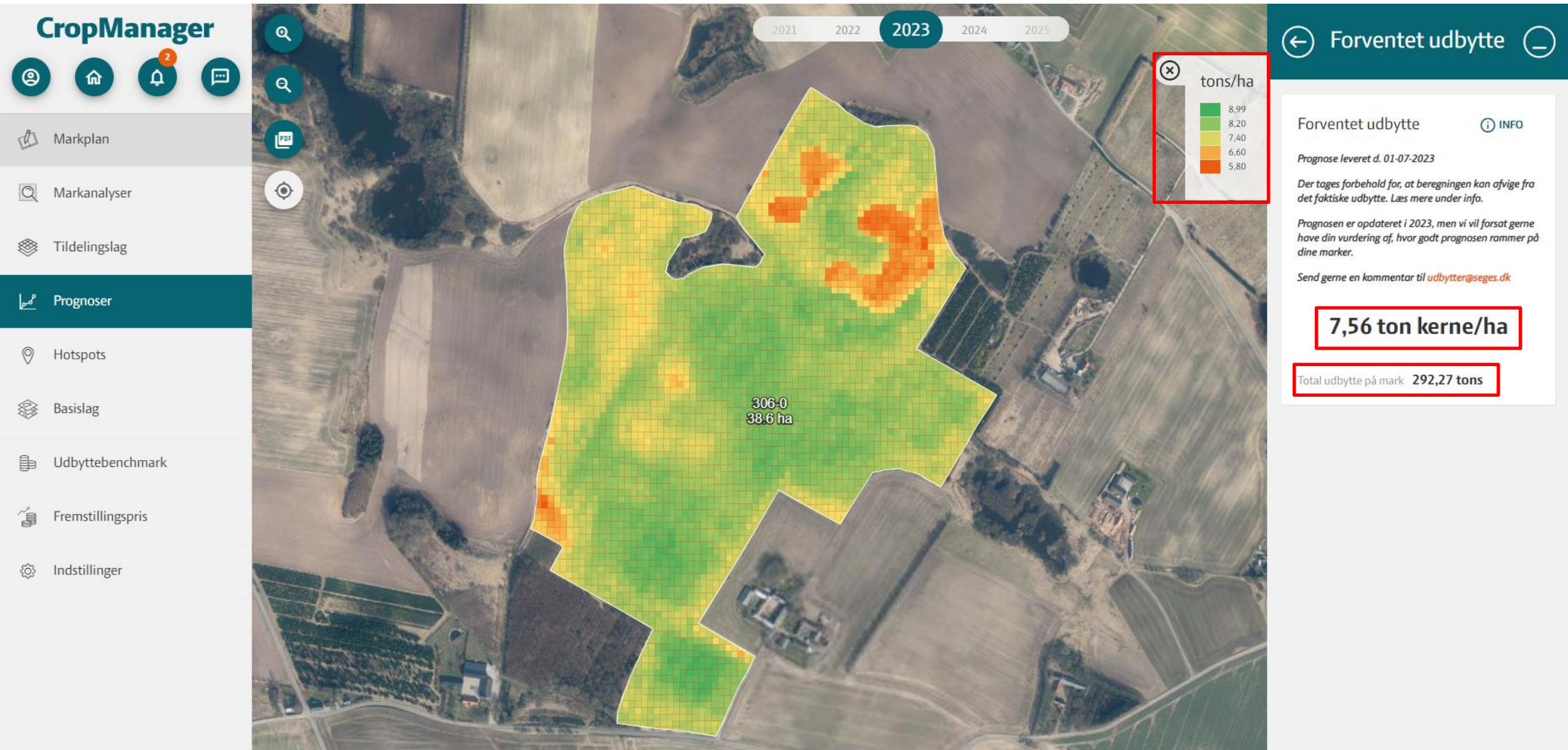


The number of yield registrations is important for prediction accuracy

Number of registrations on a field	Fields	MAE Maj 10 th (hkg pr. ha)	MAE August 1 st (hkg pr. ha)
1	5433	9,4	7,9
2	2568	9,0	7,6
3	1047	8,2	7,2
4	324	7,3	7,0
5+	158	6,2	6,2



Yield prognosis in winter wheat

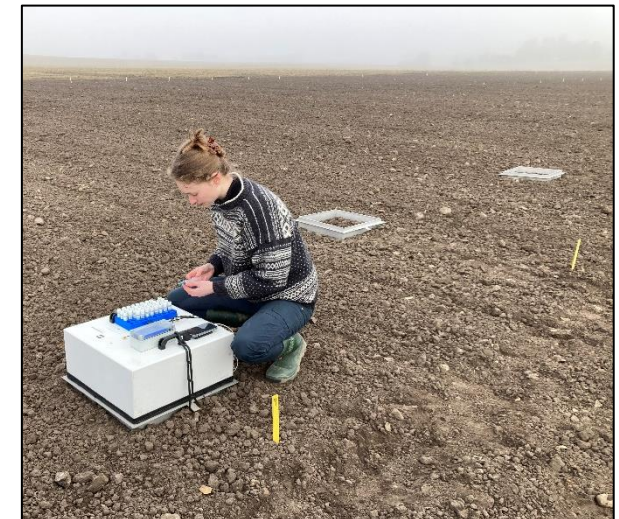
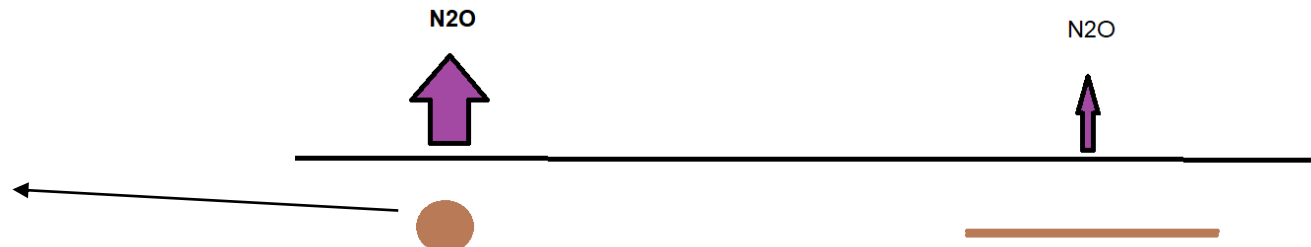
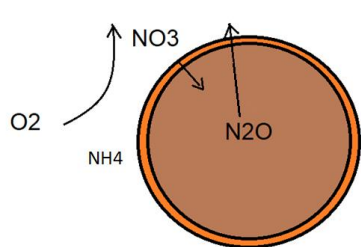


Climate mitigation measures – field trials in spring barley

Effect of different application techniques

Treatments

- 1-5: 0-160 kg N ha⁻¹
 - 6: Injection followed by ploughing
 - 7: Ploughing followed by injection
 - 8: Goosefoot injection followed by ploughing
 - 9: Ploughing followed by goosefoot injection
 - 10: Injection followed by ploughing + NI
 - 11: Goosefoot injection followed by ploughing + NI
- (40 + 80 kg N ha⁻¹)



Climate mitigation measures – field trials in spring barley

Effect of slurry treatments

Treatments

- 1-5: 0-160 kg N ha⁻¹
- 6: Cattle slurry
- 7: Anaerobically digested slurry from Videbæk (≈ 8% DM)
- 8: Anaerobically digested slurry from Maabjerg (< 8% DM)
- 9: Liquid fraction from Videbæk
- 10: Anaerobically digested slurry from Videbæk + NI
- 11: Anaerobically digested slurry from Videbæk + Eminex (Calcium cyanamid)



Product Vision

1) *Provide traceability and documentation from the primary production to food companies*

2) *Ensures an easy and transparent transfer of data between the farmer and the buyer of the product.*



Why TracelT?



Consumers demand traceability and transparency



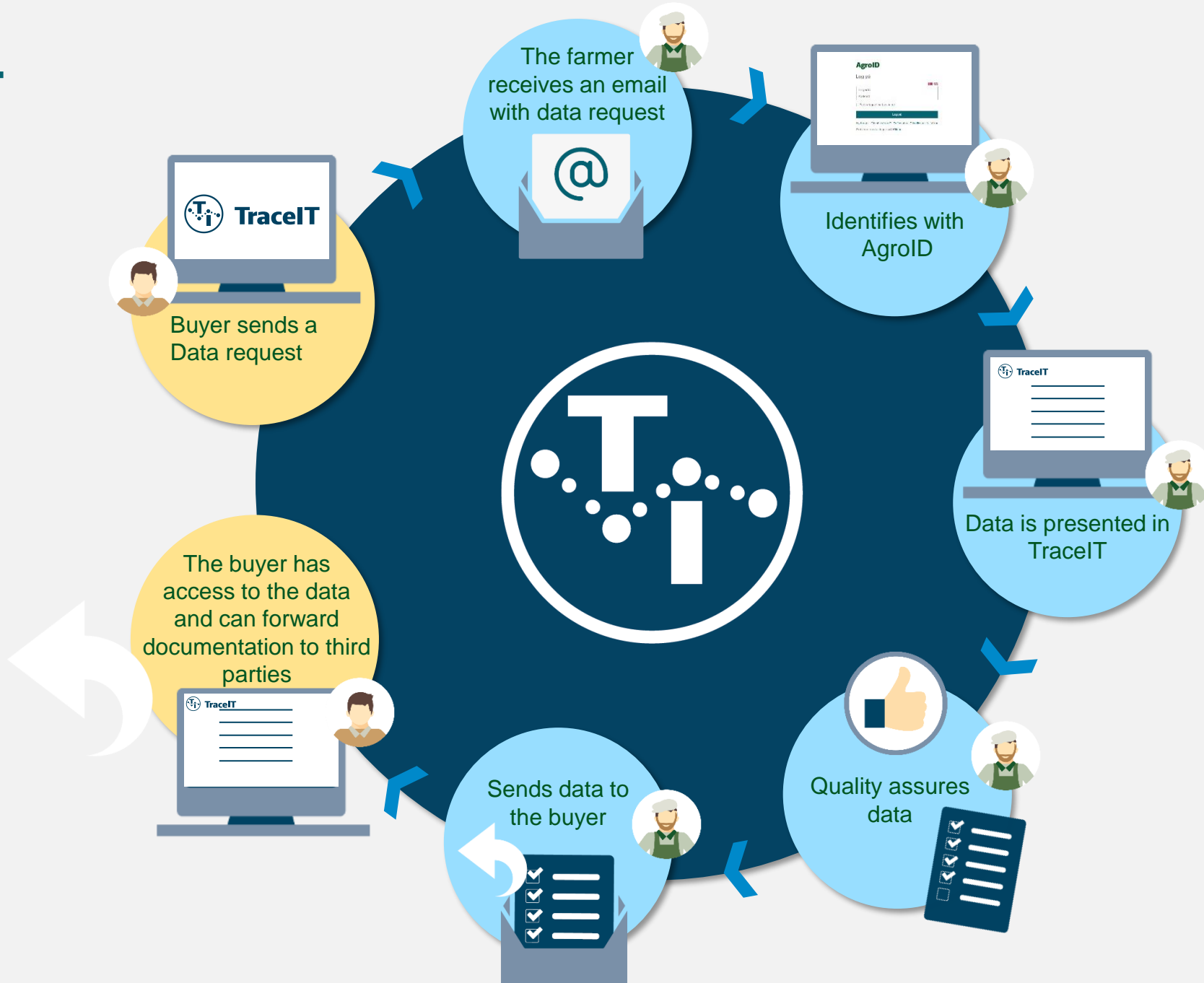
Increasing demand for documenting climate footprint, sustainability etc.



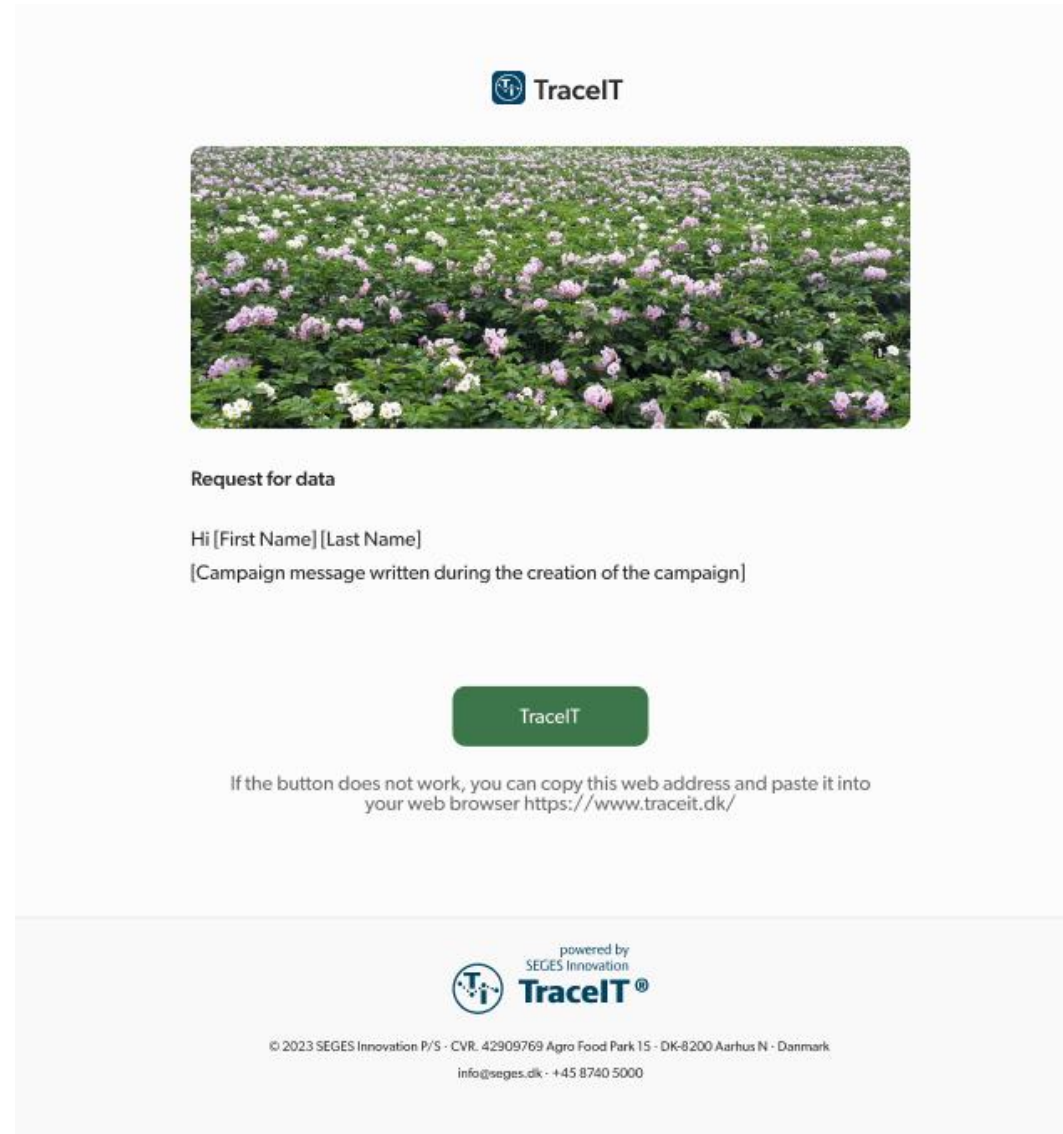
Buyers of the primary production want to support their suppliers through field/farm analysis

DATA

TraceIT



Farmers user journey



[Ready for dev - TracelT \(figma.com\)](#) in Danish

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- <https://www.figma.com/proto/YC2qOE3uChcQARXVdn7EPh/TraceIT?type=design&node-id=1103-3017&t=W2RDWbHrFetnWtPB-0&scaling=min-zoom&page-id=916%3A2426&starting-point-node-id=1103%3A3017>



Request for data

[Company] has requested access to your data. The request concerns selected data from a limited time period, and the data transfer is a one-time transaction. If you make subsequent corrections in your field programs, [Company] does not have access to this information. The data set is a snapshot from the time you transfer data to [Company]. Once data is obtained, you will have the opportunity to review the information before sending it to [Company]. [Company] wants quality-assured data.

The transfer of data takes place in three stages

1. Retrieve data from your databases
2. Ensure your cultivation information is correct
3. Send data to [Company]

If you are not interested in giving [Company] access to your data, close this window. Contact [Company] at [Contact Information] if you have any questions about the request. If you need help, you can contact customer support on +45 1234 5678

Select System 

Get data



Request for data

[Company] has requested access to your data. The request concerns selected data from a limited time period, and the data transfer is a one-time transaction. If you make subsequent corrections in your field programs, [Company] does not have access to this information. The data set is a snapshot from the time you transfer data to [Company]. Once data is obtained, you will have the opportunity to review the information before sending it to [Company]. [Company] wants quality-assured data.

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Dansk Markdatabase



Get data



Send data

Review your fields and approve data retrieved from the database. When all fields have been reviewed, you must send data to the company via the button at the top right

Crop

Variety

View

Data request

History

Benchmark

Obtained fields

Select all

				Lægning	Gødskning	Plantebeskyttelse	Høst	
	14-4	2023	Kartoffel, lægge (cert.)	1	4	10	2	<input type="checkbox"/> <input type="checkbox"/>
	10-5	2023	Potato, powder	4	10	8	2	<input checked="" type="checkbox"/> <input type="checkbox"/>
	10-5	2023	Potato, powder	4	10	8	2	<input checked="" type="checkbox"/> <input type="checkbox"/>
	10-5	2023	Potato, powder	4	10	8	2	<input checked="" type="checkbox"/> <input type="checkbox"/>
	10-5	2023	Potato, powder	4	10	8	2	<input type="checkbox"/> <input type="checkbox"/>
	10-5	2023	Potato, powder	4	10	8	2	<input type="checkbox"/> <input type="checkbox"/>
	10-5	2023	Potato, powder	4	10	8	2	<input type="checkbox"/> <input type="checkbox"/>
	10-5	2023	Potato, powder	4	10	8	2	<input type="checkbox"/> <input type="checkbox"/>
	10-5	2023	Potato, powder	4	10	8	2	<input checked="" type="checkbox"/> <input type="checkbox"/>



Send data

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Crop

Select crop

Variety

Select variety

View

All

Fertilization

Plant protection

Send data

Data request

History

Benchmark

Obtained fields

Select all

	14-4	2023	Kartoffel, lægge (cert.)	Lægning 1	Gødskning 4	Plantebeskyttelse 10	Høst 2		
	15-04-2023		Machine operation, Plant protection		Horsch Leeb 8300 PT_E, Glyphomax 48 HL (756-7), DLG Contact, PH Control				
	11-06-2023		Machine operation		Horsch Terrano 5-10cm_E				
	01-10-2023		Machine operation		Stenstrelglægning Grimme CS 1500_1_E				
	02-10-2023		Machine operation		Kuhn Prolander_E				
	15-05-2023		Machine operation, Fertilization, Plant protection		kartoffellægning m. gødningsplacering (kali, flyd_E, NS 20-2 (bionutria), P12 (bionutria), KS 33-4 4Mg 3Na (korn-kali), Maxim 100 FS (1-194)				
	01-06-2023		Machine operation		Kørsel m. Newholland hjullæsser_E, Transport m. Hvamø kroghejsevoغن_2_E				
	09-06-2023		Machine operation		Bedplejning_E				
	01-06-2023		Machine operation, Plant protection		Horsch Leeb 8300 PT_E, PH Control, Fenix (18-417), Proman (632-2), Centium 36 CS (421-2), Penol 33E				
	09-06-2023		Machine operation, Plant protection		Sprøjtning - Danfoil_E, BioCrop Potato P, Revus (1-195)				
	01-06-2023		Machine operation, Plant protection		Sprøjtning - Danfoil_E, PH Control, BioCrop Potato P, Shirlan Ultra (352-13)				
	09-06-2023		Machine operation, Plant protection		Horsch Leeb 8300 PT_E, PH Control, BioCrop Potato P, Revus (1-195), Shirlan Ultra (352-13)				
	01-06-2023		Machine operation, Plant protection		Horsch Leeb 8300 PT_E, PH Control, Ammoniumsulfat-opl., Reglone (1-299) Disp. kartofler 2023, DLG Contact				
	09-06-2023		Machine operation, Plant protection		Horsch Leeb 8300 PT_E, PH Control, Revus (1-195), Shirlan Ultra (352-13)				
	01-06-2023		Plant protection		Reglone (1-299) Disp. kartofler 2023				
	09-06-2023		Machine operation, Plant protection		Horsch Leeb 8300 PT_E, PH Control, Revus (1-195), Shirlan Ultra (352-13)				
	01-06-2023		Harvest		Tubers, sorted				
	09-06-2023		Harvest		Tubers, unsorted				
	01-06-2023		Machine operation		Unclogging_E				
	10-5	2023	Kartoffel, pulver	Lægning 4	Gødskning 10	Plantebeskyttelse 8	Høst 2	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	11-0	2023	Kartoffel, pulver	Lægning 4	Gødskning 10	Plantebeskyttelse 8	Høst 2	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	12-1	2023	Kartoffel, pulver	Lægning 4	Gødskning 10	Plantebeskyttelse 8	Høst 2	<input checked="" type="checkbox"/>	<input type="checkbox"/>



Send data

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Crop

Select crop

Variety

Select variety

View

All

Fertilization

Plant protection

Send data

Data request

History

Benchmark

Obtained fields

	14-4	2023	Kartoffel, lægge (cert.)	Lægning	Gødskning	Plantebeskyttelse	Høst		
	15-04-2023		Machine operation, Plant protection	1	4	10	2		
	11-06-2023		Machine operation						
	01-10-2023		Machine operation						
	02-10-2023		Machine operation						
	15-05-2023		Machine operation, Fertilization, Plant protection						
	01-06-2023		Machine operation						
	09-06-2023		Machine operation						
	01-06-2023		Machine operation, Plant protection						
	09-06-2023		Machine operation, Plant protection						
	01-06-2023		Machine operation, Plant protection						
	09-06-2023		Machine operation, Plant protection						
	01-06-2023		Machine operation, Plant protection						
	09-06-2023		Machine operation, Plant protection						
	01-06-2023		Plant protection						
	09-06-2023		Machine operation, Plant protection						
	01-06-2023		Harvest						
	09-06-2023		Harvest						
	01-06-2023		Machine operation						
	10-5	2023	Kartoffel, pulver	Lægning	Gødskning	Plantebeskyttelse	Høst	✓	⌵
	11-0	2023	Kartoffel, pulver	Lægning	Gødskning	Plantebeskyttelse	Høst	✓	⌵
	12-1	2023	Kartoffel, pulver	Lægning	Gødskning	Plantebeskyttelse	Høst	✓	⌵

Send data til KMC

Når du videregiver disse data til KMC, ejer KMC datasættet. Det betyder, at KMC kan vælge at sende data til tredje part som dokumentation for dyrkningspraksis uden dit samtykke.

Vil du fortsætte?

Afbryd

Send



Send data

Review your fields and approve data retrieved from the database. When all fields have been reviewed, you must send data to the company via the button at the top right

Crop

Variety

View

Data request

History

Benchmark

Obtained fields

Select all

				Lægning	Gødskning	Plantebeskyttelse	Høst	
	14-4	2023	Kartoffel, lægge (cert.)	1	4	10	2	<input type="checkbox"/> <input type="checkbox"/>
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	10-5	2023	Potato, powder	4	10	8	2	<input type="checkbox"/> <input type="checkbox"/>
	10-5	2023	Potato, powder	4	10	8	2	<input checked="" type="checkbox"/> <input type="checkbox"/>



New campaign

Create a new campaign. Enter campaign settings and vendors to create a new campaign

- ✔ Campaign
- 2 Suppliers
- 3 Confirm

Data

Data request

Analysis

Suppliers

Certifications

Campaign settings

Campaign name

Give your campaign a name

My first campaign

Harvest year

Select harvest year for campaign

2023

Data

Select the data you want collected with this campaign

Vælg alle

- | | | |
|---|---|--|
| <input checked="" type="checkbox"/> Planned/executed | <input type="checkbox"/> Dirt | <input type="checkbox"/> Oli % |
| <input type="checkbox"/> Seed | <input checked="" type="checkbox"/> Stone | <input checked="" type="checkbox"/> Clover % |
| <input type="checkbox"/> Commercial fertilizer | <input checked="" type="checkbox"/> Pure weight | <input checked="" type="checkbox"/> Sugar |
| <input checked="" type="checkbox"/> Livestock manure | <input type="checkbox"/> Dry matter % | <input type="checkbox"/> Ash |
| <input checked="" type="checkbox"/> Weed | <input type="checkbox"/> Protein % | <input type="checkbox"/> FK org. fabric |
| <input checked="" type="checkbox"/> Pests | <input type="checkbox"/> Starch % | <input type="checkbox"/> NEL20 |
| <input checked="" type="checkbox"/> Diseases | <input type="checkbox"/> ADF % | <input type="checkbox"/> FEN per kg TS |
| <input checked="" type="checkbox"/> Growth regulation | <input type="checkbox"/> NDF % | |
| <input checked="" type="checkbox"/> Yield | <input type="checkbox"/> Yield measurement accuracy | |
| <input checked="" type="checkbox"/> Irrigation | <input type="checkbox"/> Water % | |

Campaign text

Campaign text for suppliers

Potato campaign to investigate new Kim's Chips |

Cancel campaign

Next step

Summarization

Campaign

Campaign name

My first campaign

Harvest year

2023

Data

Data objectives for this campaign

- Planned/executed
- Livestock manure
- Weed
- Pests
- Diseases
- Growth regulation
- Yield
- Irrigation
- Stone
- Pure weight
- Clover %
- Sugar

Campaign text

Number of suppliers and the total area

Potato campaign to investigate new Kim's Chips |



SEGES INNOVATION

- non-profit research and development organization

We deliver

**INNOVATION, RESEARCH
& KNOWLEDGE**

for future farming and food
production

