Estimating Maturity & Yield:
A Prediction Model For Vining Peas

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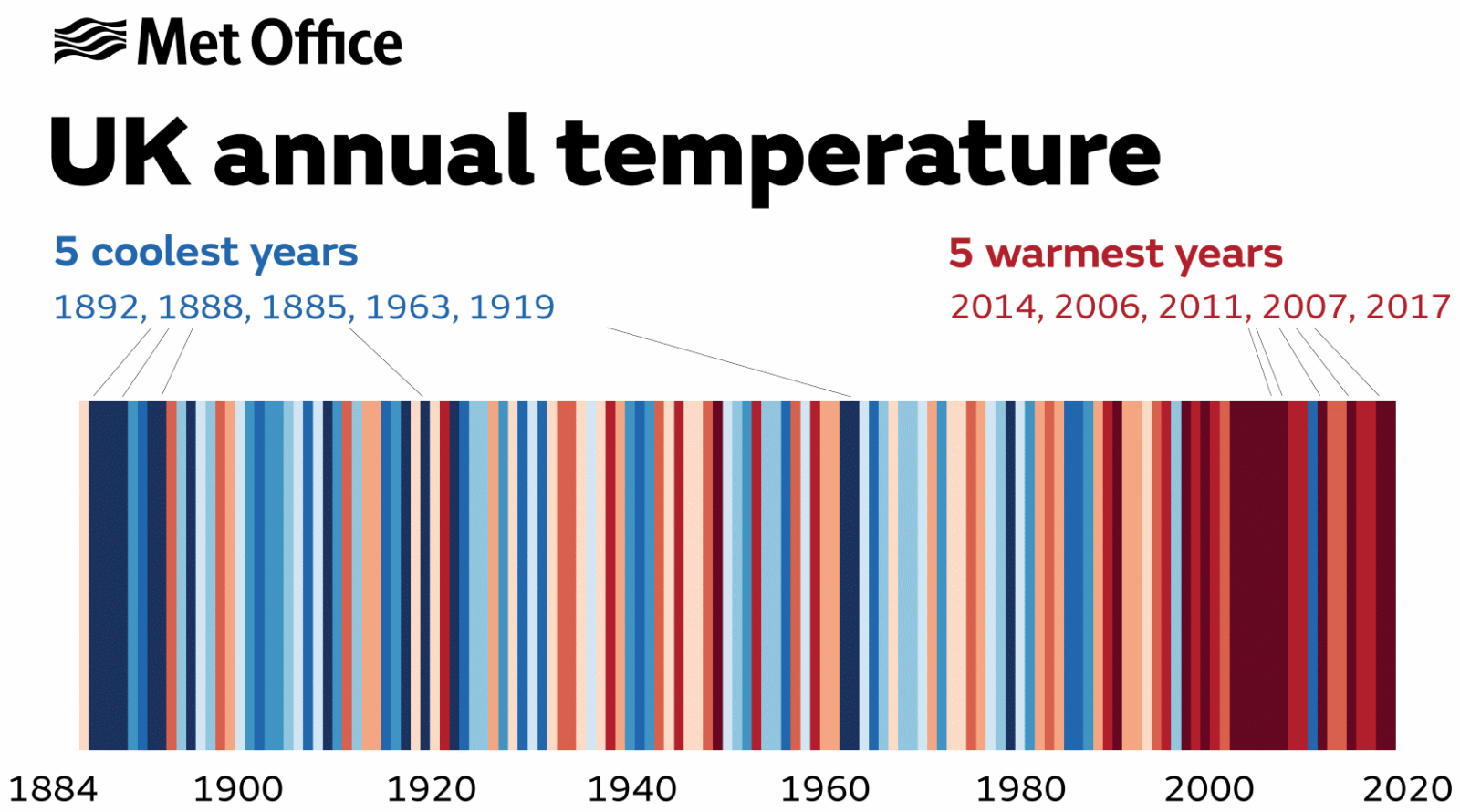
Introduction

Project started in 2019 and is partially funded by: 

- Predicting yield and harvest dates of vining peas is difficult
- Optimal harvest window is narrow & timeliness is key
- Heavy reliance on accumulated heat units (AHU)
- Physiology-based forecasting requires in-person field sampling

Objective: development of a forecasting system for vining pea maturity & yield, with a focus on machine learning and remote sensing.

Background

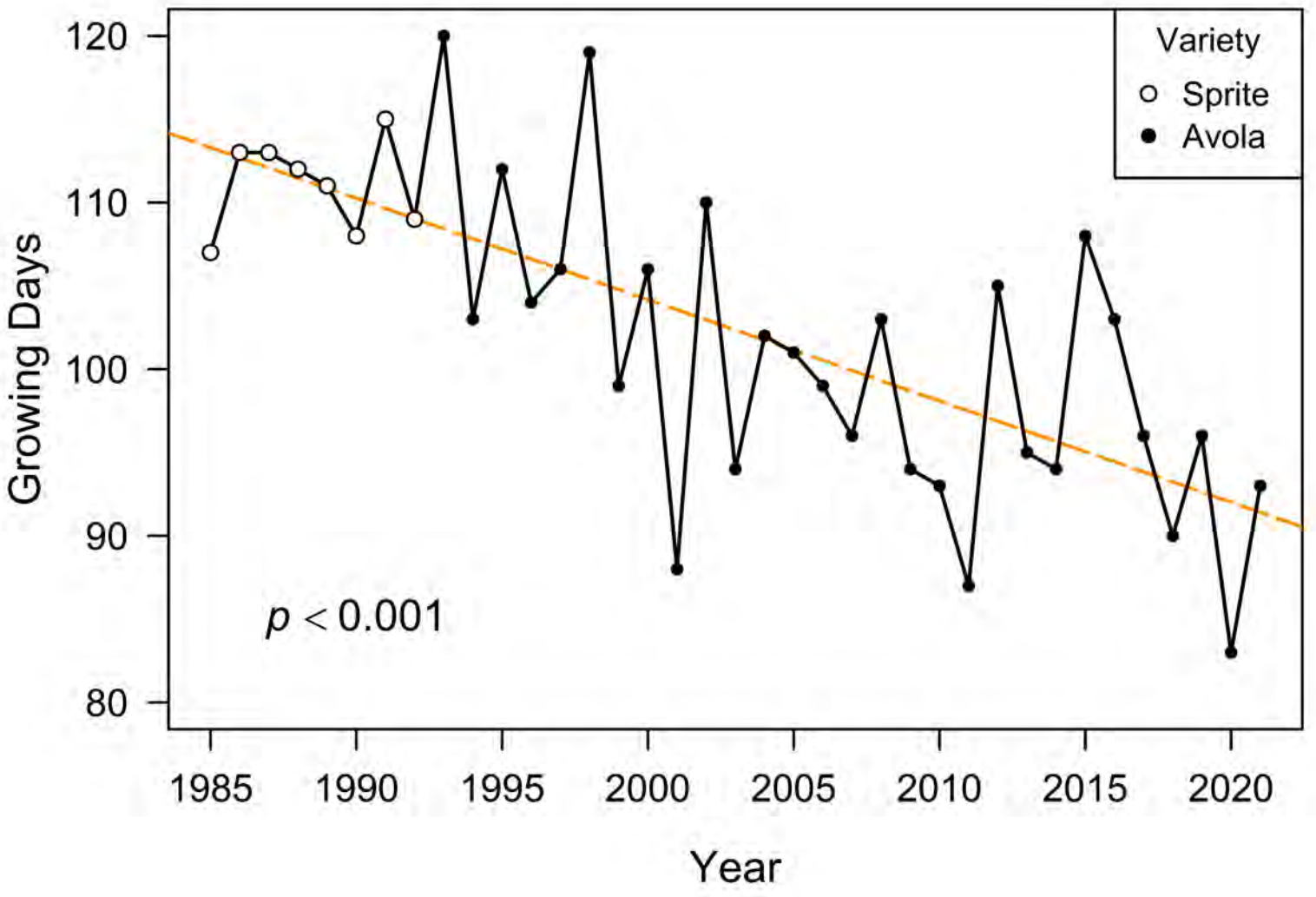


Source: https://www.metoffice.gov.uk/weather/climate-change/what-is-climate-change

Background

Source: https://www.esa.int/Applications/Observing_the_Earth/Copernicus/Earth_from_Space_UK_heatwave

Background



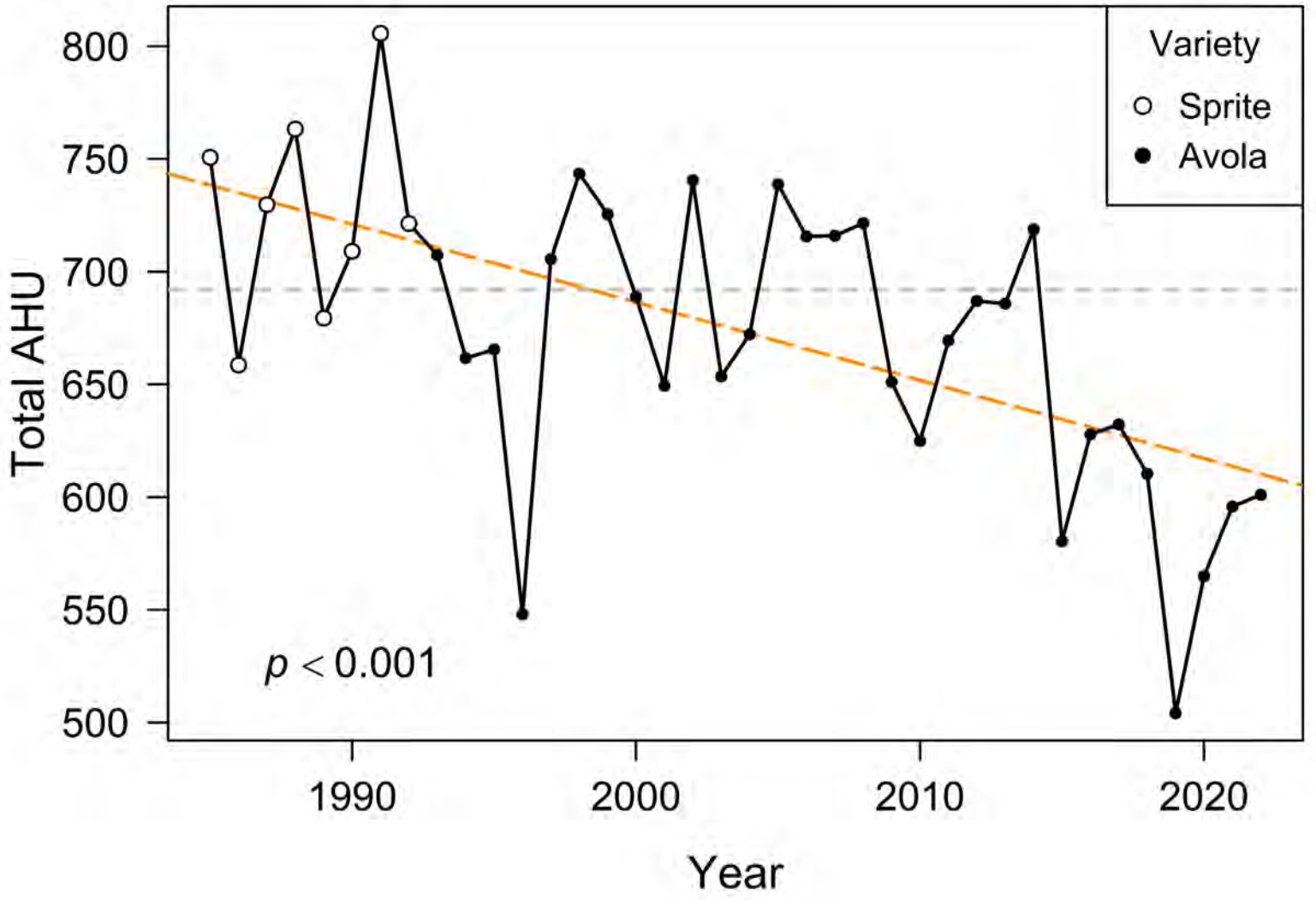
PGRO vining pea trials 1985 – 2021

Decrease of approximately 21 days between drilling and harvest (TR 100) from 1985-2021

Background

At the same time, total accumulated heat units (AHU) building up between drilling and harvest has decreased.

Heat-based prediction methods are increasingly unreliable as a primary measure of crop maturity.

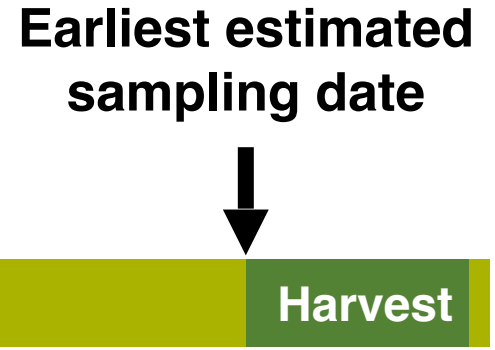


What can we do about it?

Machine learning is a flexible, robust forecasting method which takes into account the many complex variables which affect pea crops.

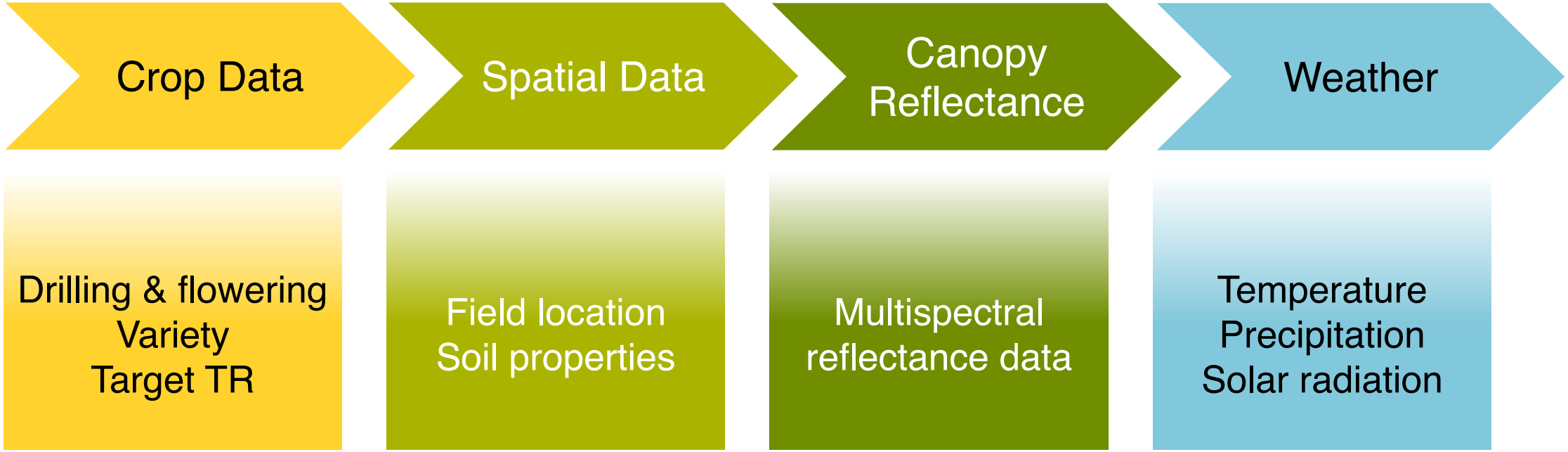
- Complex problems with many interacting factors
- Interactions are not necessarily linear by themselves
- Not a process-based/ physiological model

Could we model crop development and minimise field sampling prior to harvest?



Feature Selection

Model components- how are forecasts generated?

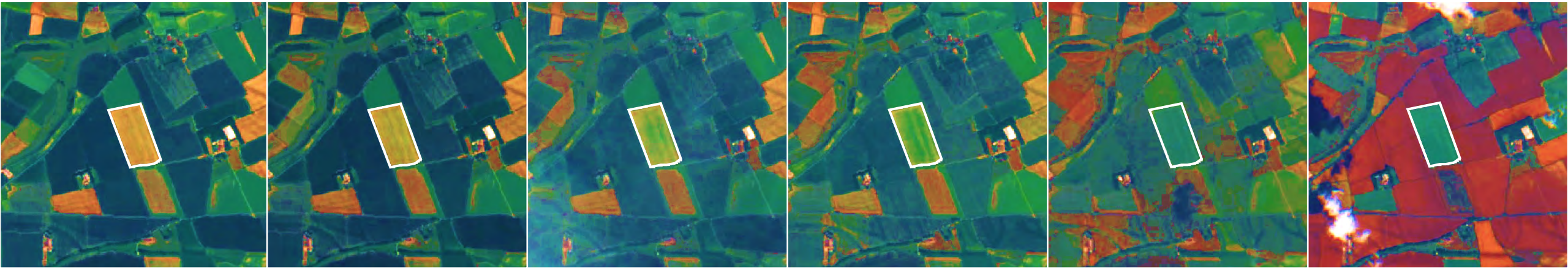


Data collected for over 17,000 individual crops between 2001 and 2022.

Models updated annually to incorporate new data.

Canopy Reflectance

Crops reflect different amounts of each waveband at different growth stages and stages of canopy closure.



Canopy reflectance can detect plant pigments (e.g. chlorophyll) and water content, as well as structural differences.

All give an indication of crop health, development, and yield potential

Sentinel-2 Satellite Data

ESA's Copernicus Programme

Satellite flyovers every 2-3 days

Images & raw reflectance data

Data collected at a 10m resolution: satisfactory for field-scale forecasting

Bulk data for hundreds of crops at once

And the best part? No drones required

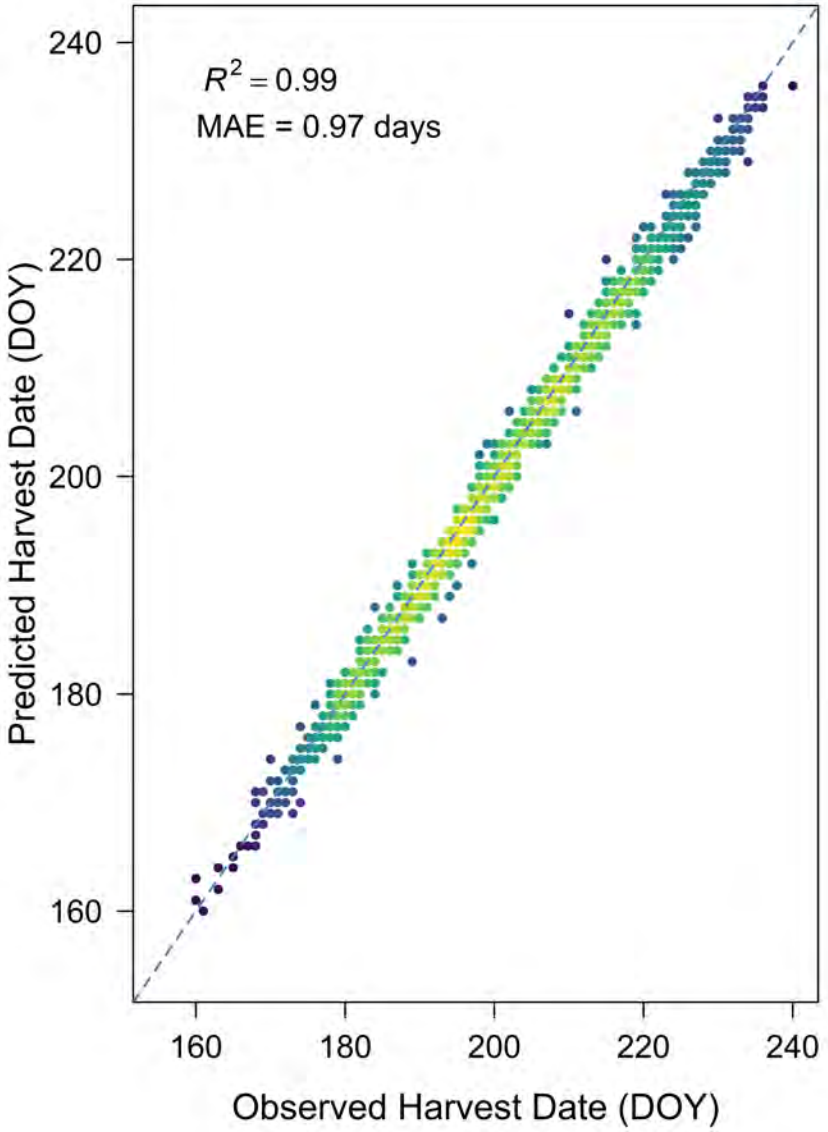
Climate Data

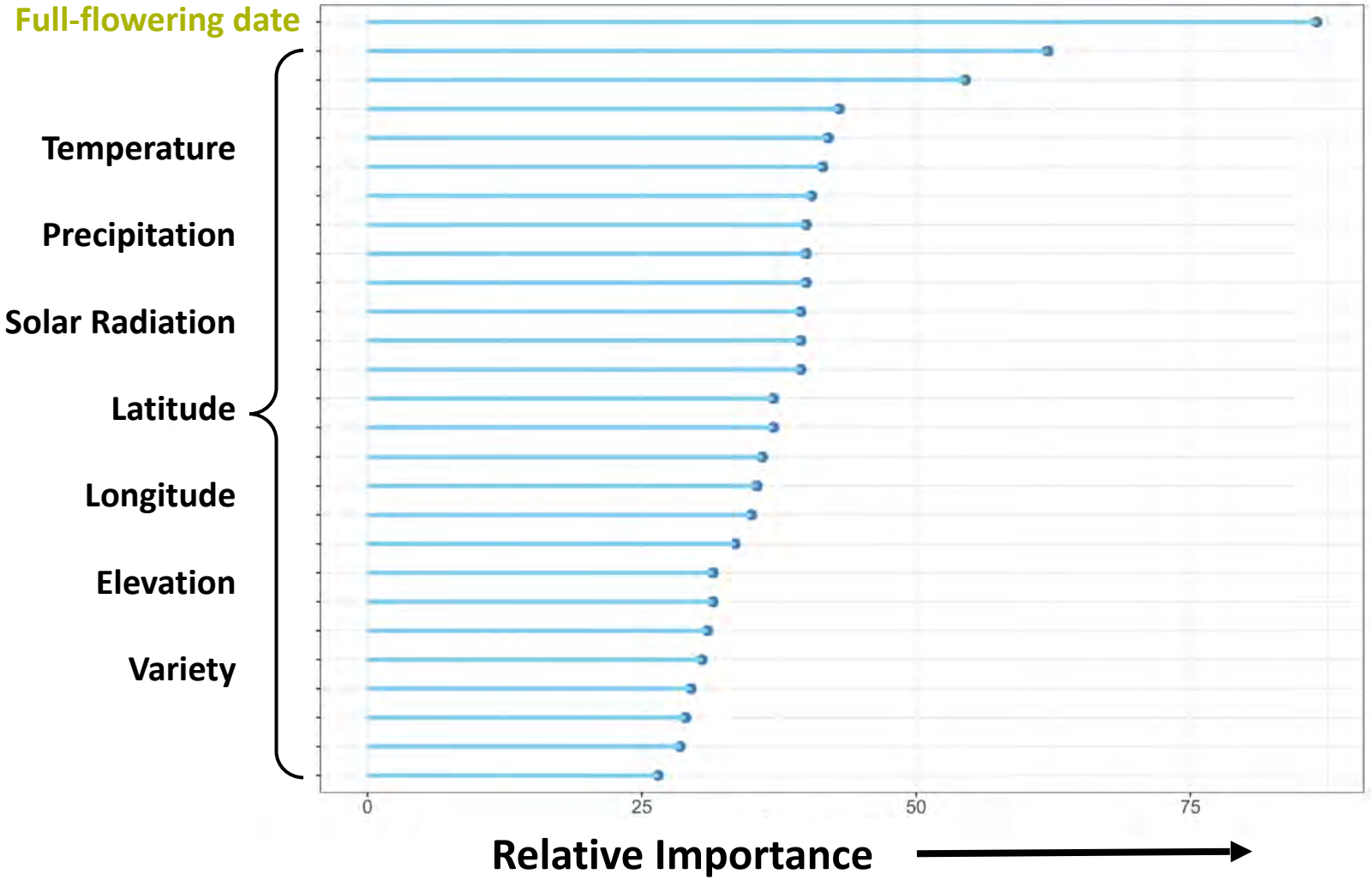
Historic weather data for a 20km network of locations sourced from OpenWeather (2001- present)

Derived from Met Office weather station data

Recorded data and daily weather forecasts automatically incorporated into prediction models

Model Performance





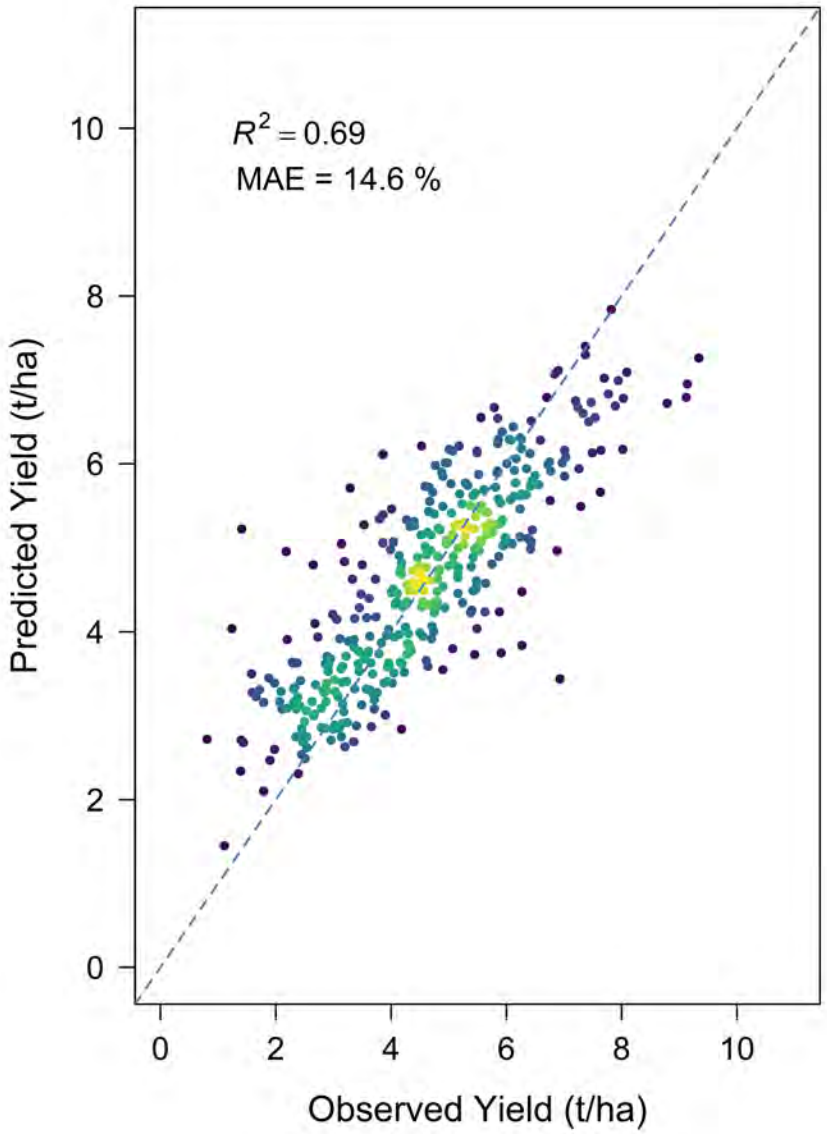
Feature Selection

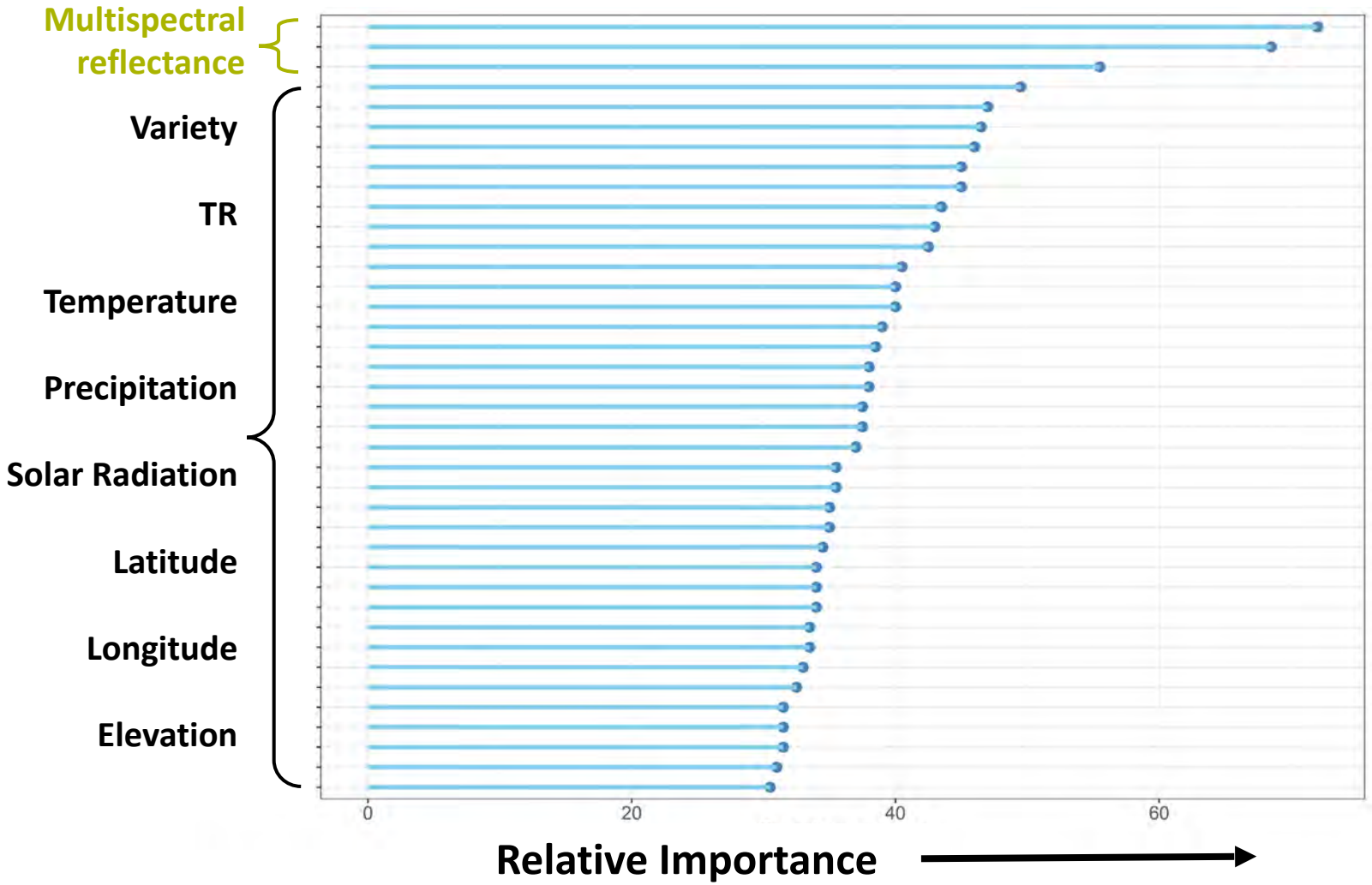
Data from around full-flowering is the most informative for forecasting in pea crops.

Where *'full-flowering'* = the date on which every plant has at least 1 open flower

Around BBCH growth stage 61

Model Performance



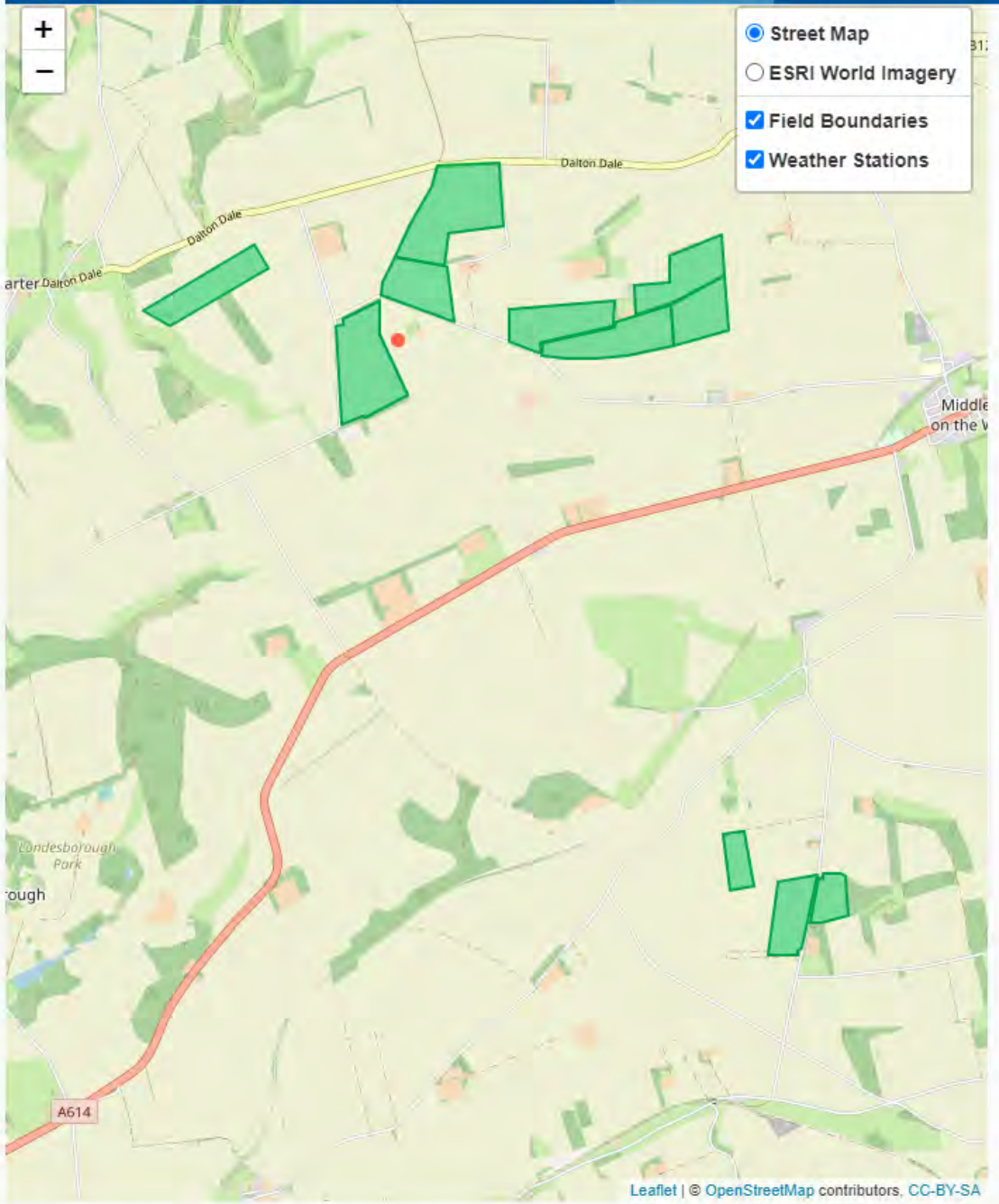


PGRO Vining Pea Tool

PGRO aims to expand the services it offers processors & growers of vining peas through development a web app for crop forecasting

- Access to the prediction models online
- Management tool throughout the vining pea season

ID	Variety	Maturity	Drilled	Flower	TR
Field_1	Avola	1	28/03/22	31/05/22	100
Field_2	Ambler	2	10/04/22	07/06/22	100
Field_3	Ambler	2	16/04/22	08/06/22	100
Field_4	Avola	1	15/04/22	04/06/22	100
Field_5	Terrain	15	30/05/22	01/06/22	100
Field_6	Ashton	9	10/04/22	15/06/22	100
Field_7	Ashton	9	26/04/22	24/06/22	100
-	-	-	-	-	-
-	-	-	-	-	-



Data Input

Select field boundary file format: KML shapefile(s)

Upload KML field boundary files: Browse... 123 files

Boundary processing complete

View on map | Clear map

124 crops detected

Upload crop data CSV file: Browse... VP_Example_Data.cs

Data preview:

Field ID	Maturity	Hectares	Drill date	Full-flower date	TR
Field_1	1	6	19/04/2022	18/06/2022	100
Field_2	2	25	23/04/2022	14/06/2022	100
Field_3	1	3	17/04/2022	10/06/2022	100
Field_4	2	9	20/05/2022	NA	100
Field_5	2	4	21/04/2022	20/06/2022	100
Field_6	2	4	15/04/2022	04/06/2022	100
Field_7	15	3	08/05/2022	NA	100
Field_8	9	6	09/04/2022	07/06/2022	100
Field_9	9	2	06/05/2022	NA	100
Field_10	2	5	28/05/2022	18/07/2022	100
Field_11	9	32	19/04/2022	19/06/2022	100
Field_12	10	13	19/05/2022	NA	100
Field_13	10	3	06/05/2022	NA	100

Submit

Results Table

Show 16 entries

Search:

	FieldID	Maturity	Hectares	Drill Date	Full-flower Date	TR	Harvest Date	Yield (t/ha)	Tonnage
1	Field_1	1	19.3	2022-03-28	2022-05-31	100	2022-06-23	3.9	75.27
2	Field_2	2	25.6	2022-04-10	2022-06-07	100	2022-06-27	3.38	86.528
3	Field_3	1	36	2022-04-15	2022-06-04	100	2022-06-25	3.72	133.92
4	Field_4	2	11.2	2022-04-16	2022-06-08	100	2022-06-28	3.19	35.728
5	Field_5	2	12.7	2022-04-11	2022-06-07	100	2022-06-27	3.11	39.497
6	Field_6	2	7.4	2022-04-10	2022-06-07	100	2022-06-27	3.2	23.68
7	Field_7	15	11.9	2022-05-30	2022-06-01	100	2022-06-29	1.88	22.372
8	Field_8	9	14.8	2022-04-10	2022-06-15	100	2022-07-05	4.7	69.56
9	Field_9	9	3.7	2022-04-10	2022-06-16	100	2022-07-06	5.55	20.535
10	Field_10	2	11.8	2022-04-17	2022-06-10	100	2022-06-30	3.83	45.194
11	Field_11	9	11	2022-04-26	2022-06-24	100	2022-07-13	5.19	57.09
12	Field_12	9	1.9	2022-04-11	2022-06-15	100	2022-07-05	4.36	8.284
13	Field_13	9	9.3	2022-04-11	2022-06-15	100	2022-07-05	5.01	46.593
14	Field_14	9	8.1	2022-04-28	2022-06-25	100	2022-07-14	4.83	39.123
15	Field_15	9	8.2	2022-04-28	2022-06-25	100	2022-07-14	5.17	42.394
16	Field_16	2	8.7	2022-04-29	2022-06-18	100	2022-07-08	3.97	34.539

Showing 1 to 16 of 119 entries

Previous 1 2 3 4 5 … 8 Next

Download results

Summary of the next five days:

	Date	Forecasted hectares	Forecasted tonnage
1	2023-01-17	0	0
2	2023-01-18	0	0
3	2023-01-19	0	0
4	2023-01-20	0	0
5	2023-01-21	0	0

Summary statistics:

AVERAGE FORECASTED YIELD
4.43 t/ha

EARLIEST FORECASTED HARVEST
22 June 2022

(●) Tonnage ( ) Hectares

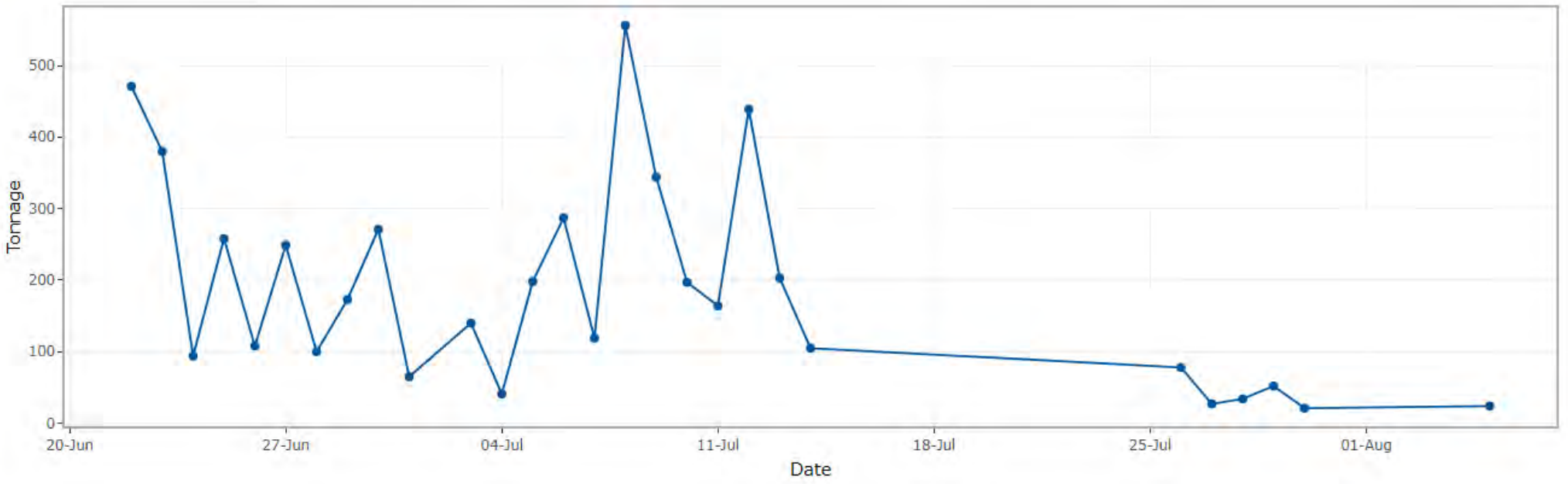


Image Viewer

Select field ID and date to view Sentinel-2 true-colour image at 10m resolution

Choose a field to view

Example_field

Choose date

16 June 2021

View Sentinel-2 image

Currently displaying:

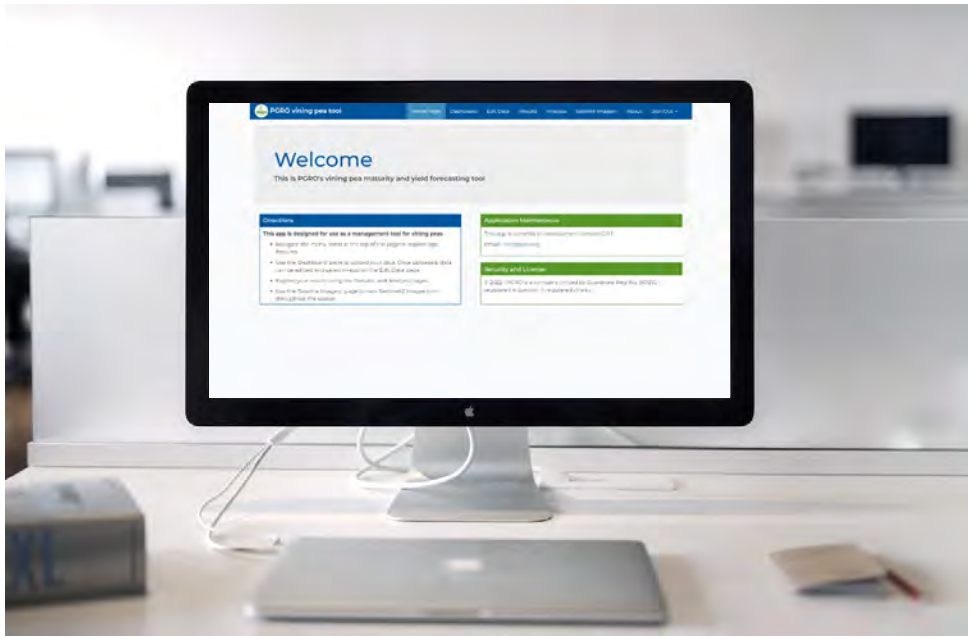
Example_field from 16 June 2021

PGRO Vining Pea Tool

Make decisions with greater certainty based on forecasted sampling windows, harvest dates, and yields.

Limited test launch in February 2023 (Beta)

Official launch the following year



The Future of Yield Prediction

Nature of machine learning means a model can adapt to any data

Potential for future use in other legumes and non-legume crops

Accuracy is dependent on accessibility and volume of historic data

Thank You

PGRO

Dr Becky Howard
Roger Vickers

University of Nottingham

Prof. Debbie Sparkes
Prof. Neil Crout

Birds Eye
Swaythorpe Growers
Scottish Borders Produce
Caudwell Produce
Stemgold Peas

for your cooperation & provision of data

Innovate UK

The University of Nottingham
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Any Questions?

Contact for questions, suggestions & feedback:

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