Oat breeding and Research in Wales

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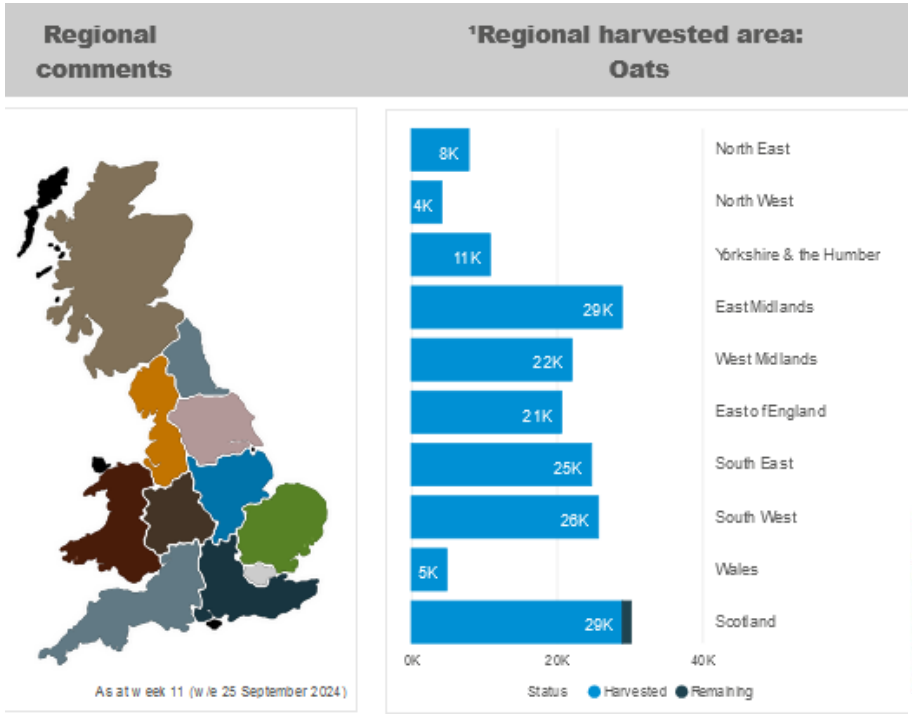
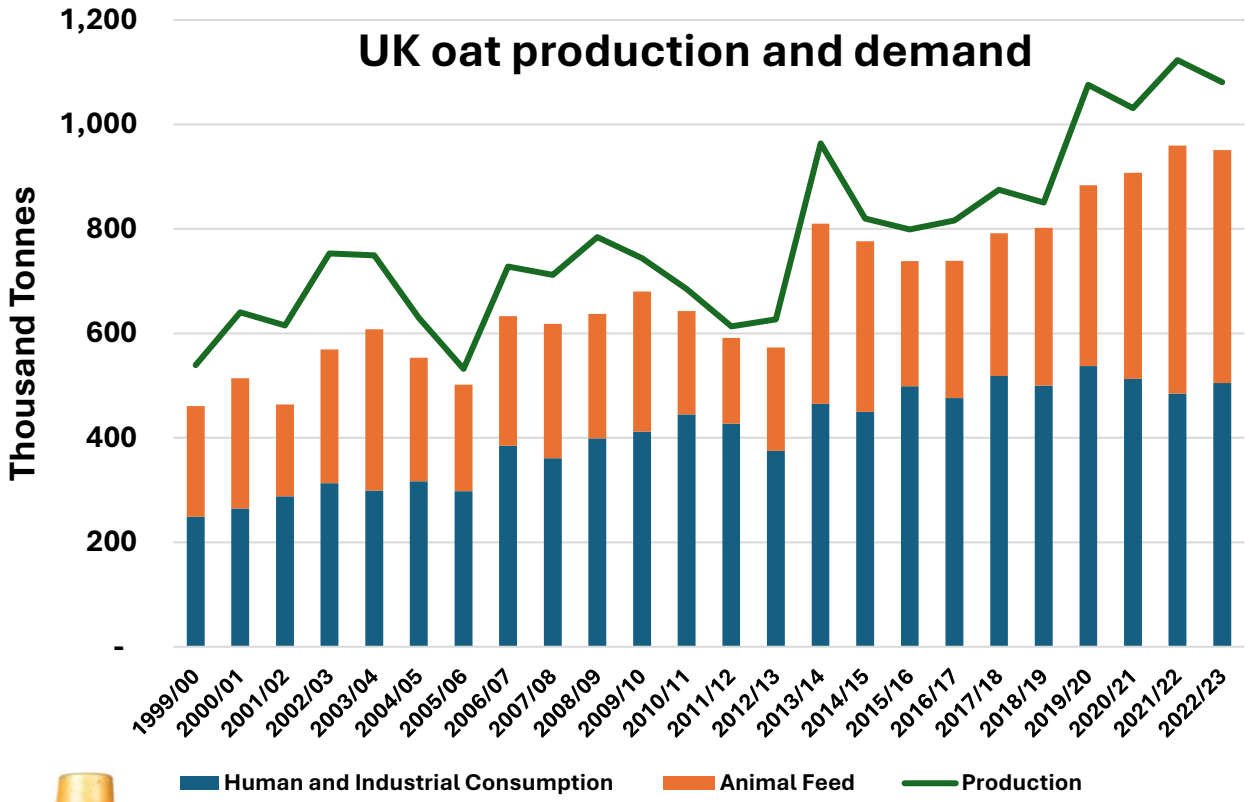
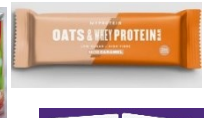
In the U.K. oats are grown primarily for human food

Consumed as a wholegrain







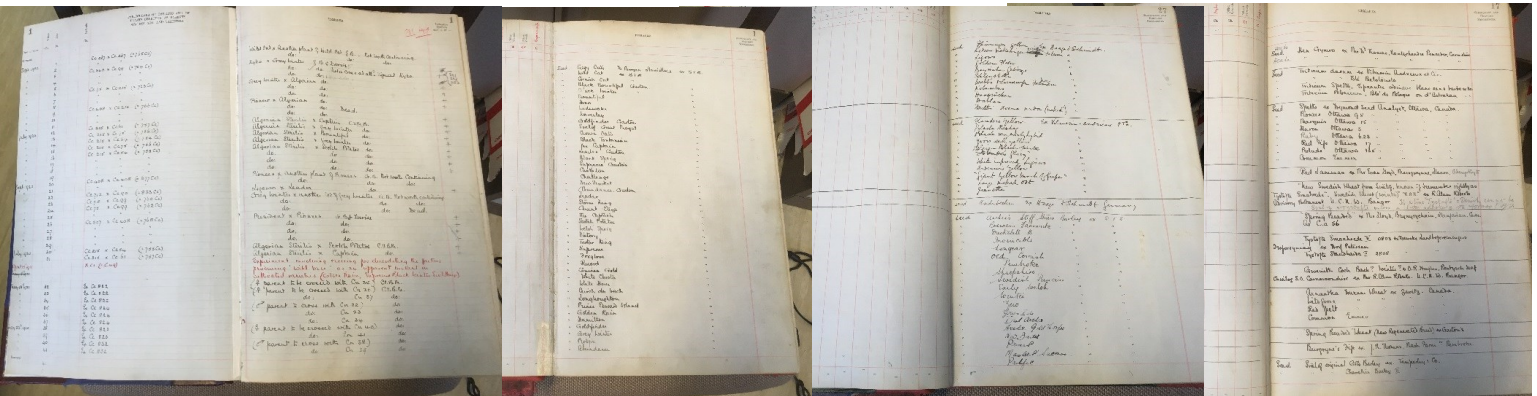
Plant Breeding at Aberystwyth University

Over a century of development, experience and investment






We develop innovative varieties of **oats, beans, peas, forage and amenity grasses, forage legumes and Miscanthus** that have a significant impact in the market and on end use that are marketed by our commercial partners via long-term relationships



senova

Germinal

terravesta
Energy, naturally.

Aim of breeding programmes

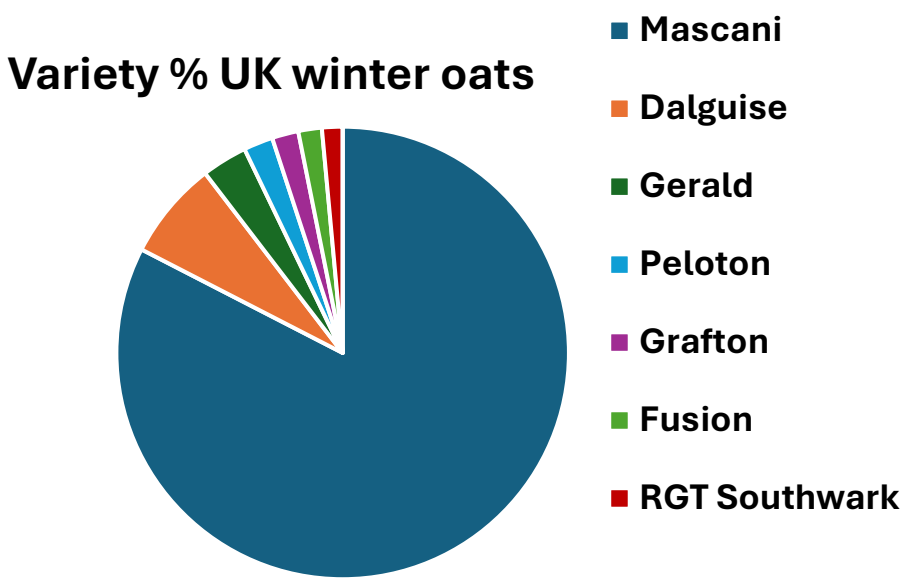
- To develop new improved varieties used by farmers and taken up by industry

What is needed?

- Improved varieties
- Improved uptake of new varieties by farmers and industry

How?

- Optimisation of breeding pipelines- improve genetic gain
- View breeding process as product development
- Work with end-users (e.g. millers, feed producers etc.)
- Innovate to add value

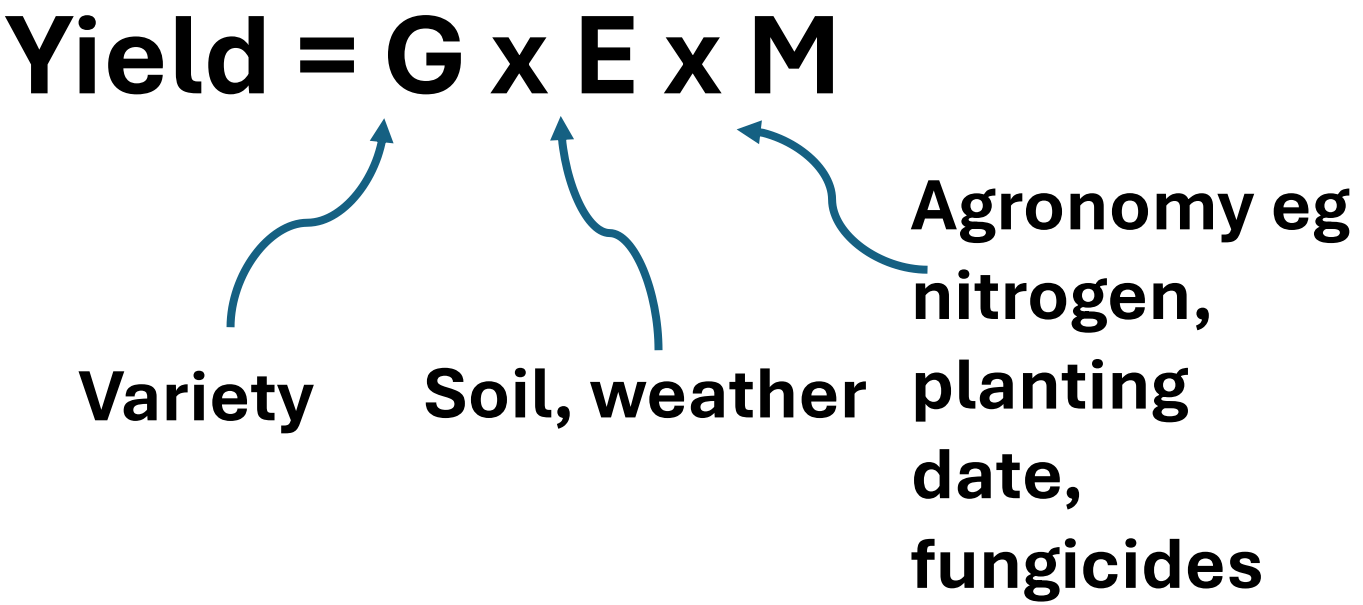


Very successful long-term partnership between Industry and Aberystwyth University

By embedding the breeding programme in a University Department, it provides access to the latest ideas and additional funding opportunities

Grain yield v Grain quality

- Increasing grain yield is a major objective of growers and breeders
- However, must not compromise grain quality
  - Processing quality
  - Nutritional quality



Grain yield v Grain quality

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- However, must not compromise grain quality
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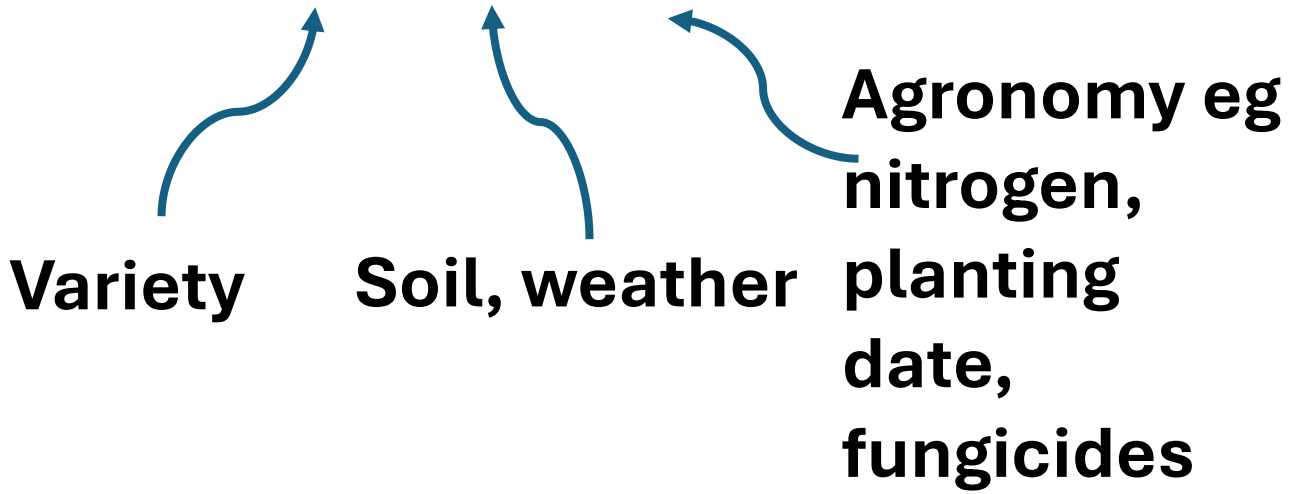
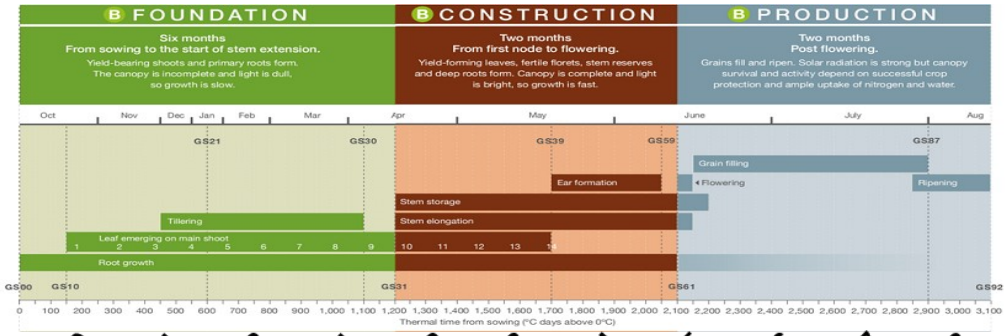
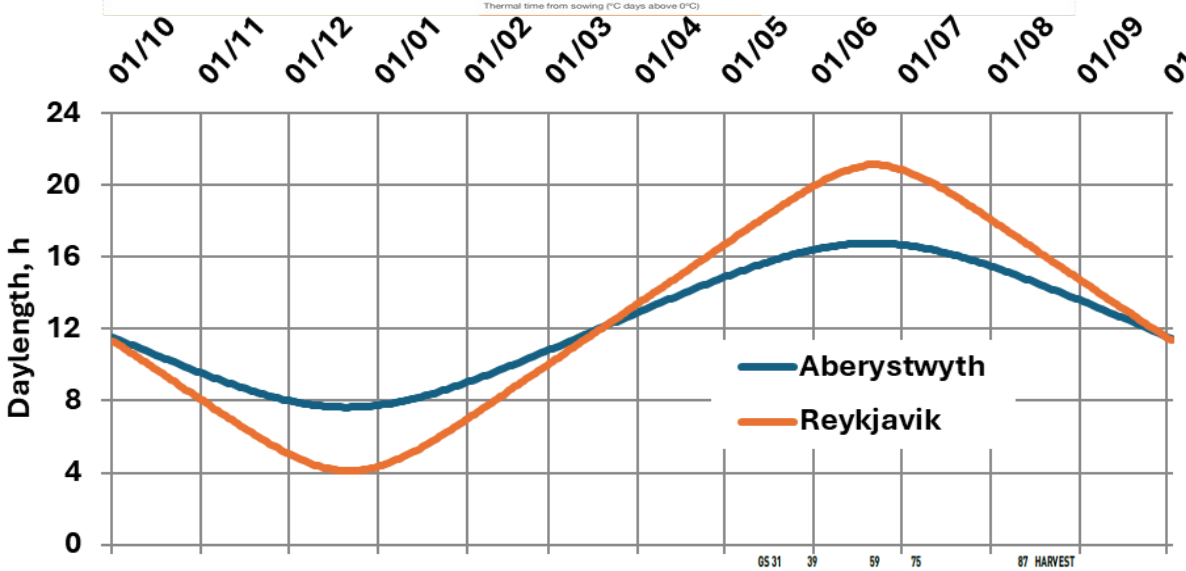
  - Nutritional quality

Quality = G x E x M

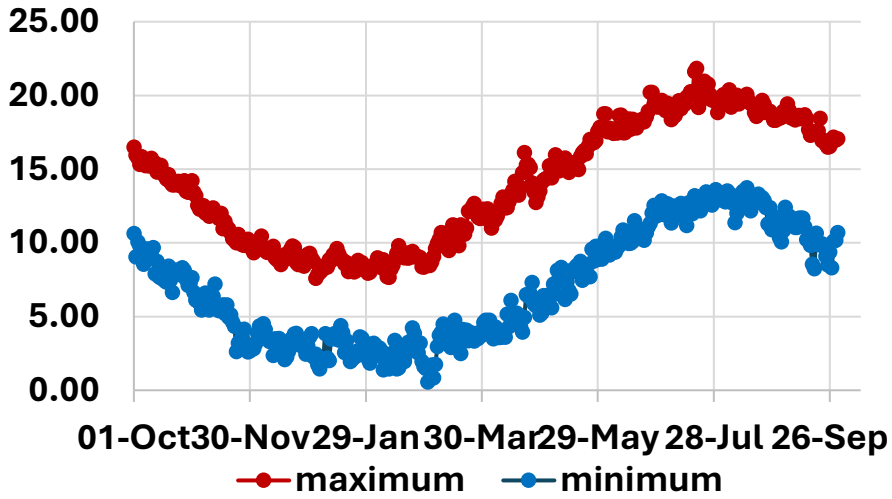


In the U.K., winter oats are sown in October and harvested the following August

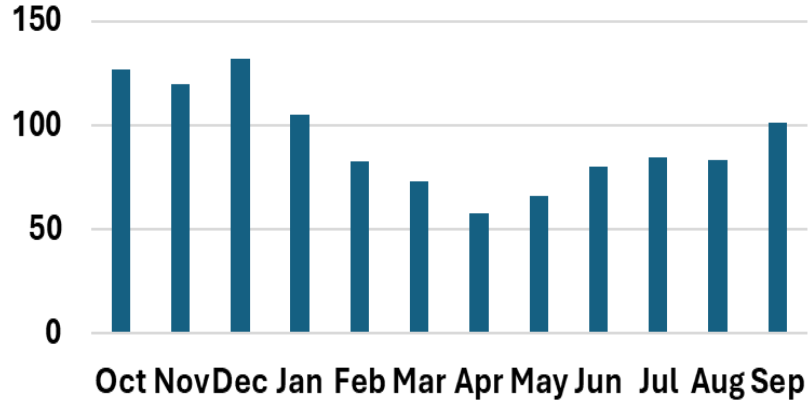




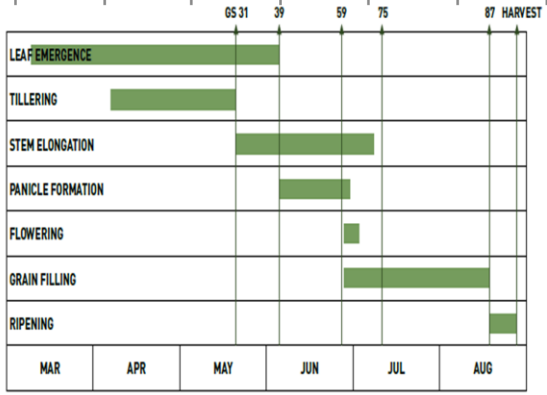
Daily minimum and maximum temperature, °C average 2001-2021



Mean monthly rainfall, 1993-2023

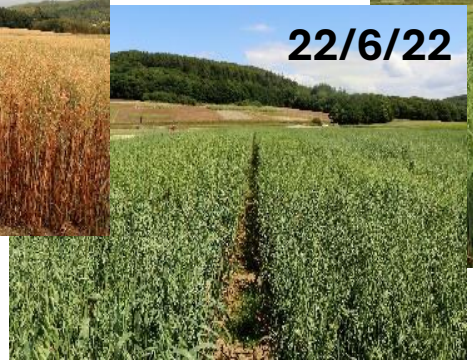


Spring oats are sown in March and harvested in August

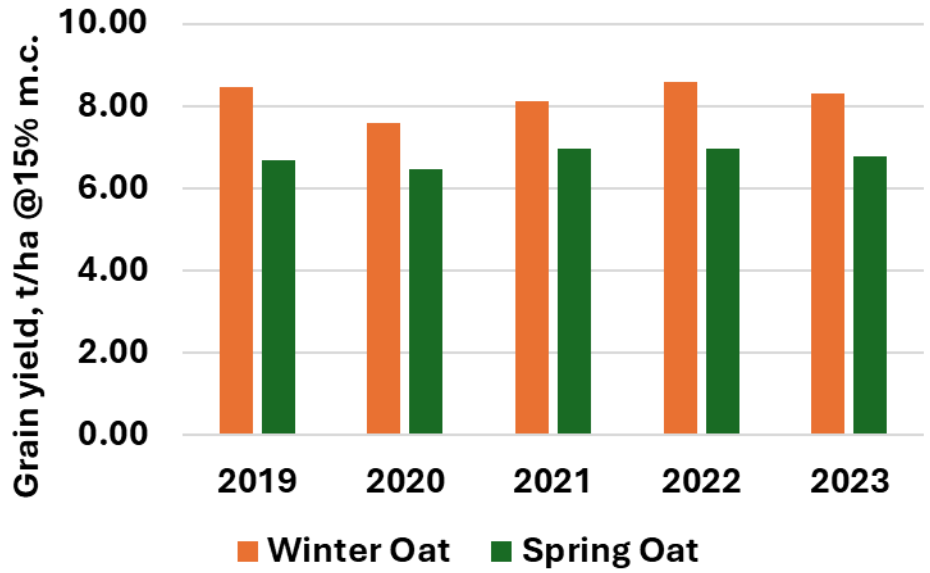


Winter Oats
sown 14th October
harvested 2nd August

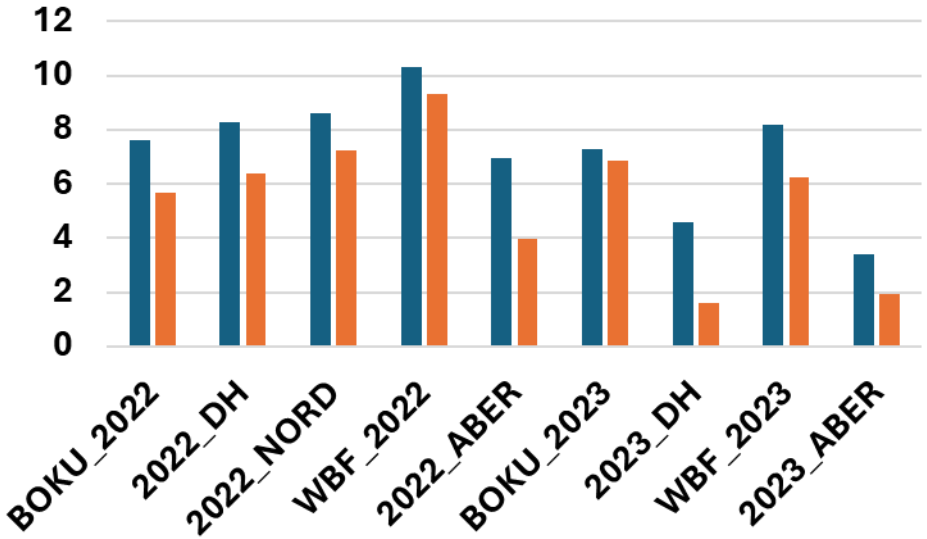
Spring oats
sown 21st March
Harvested 8th
August



Yield advantage of autumn sown oats



Official UK multi-site trials (AHDB) for variety recommendation



CropDiva multi site trials (same 250 varieties)

Genetics and physiology of flowering in oats: Development of tools to breed for improved adaptation and yield potential

In winter cereals a range of flowering genes are known:

- **Vernalization**
  - Earlier flowering in response to prolonged cold treatment
- **Photoperiod**
  - Response to the length of the day
- **Earliness *per se* (*eps*)**
  - Response to endogenous signals not influenced by environment

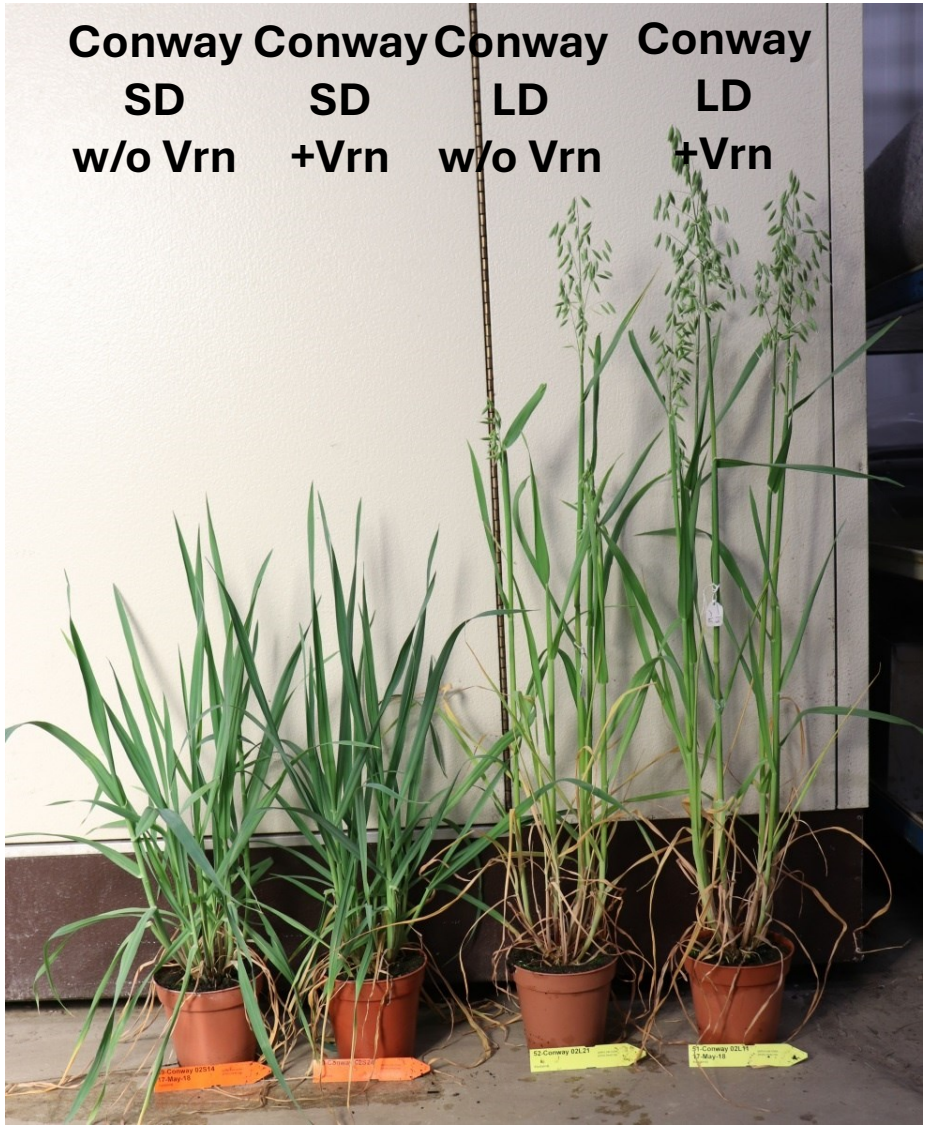
Most winter wheat varieties require > 4 weeks of exposure to temperatures < 10°C for this vernalisation requirement to be met.
The situation is different for most modern winter oat varieties- indeed often said that winter oats do not require vernalisation and can be sown in the spring

51 days (840 GDD) from start of experiment

Mascani SD w/o Vrn | Mascani SD +Vrn | Mascani LD w/o Vrn | Mascani LD +Vrn

Winter oat

Conway SD w/o Vrn | Conway SD +Vrn | Conway LD w/o Vrn | Conway LD +Vrn



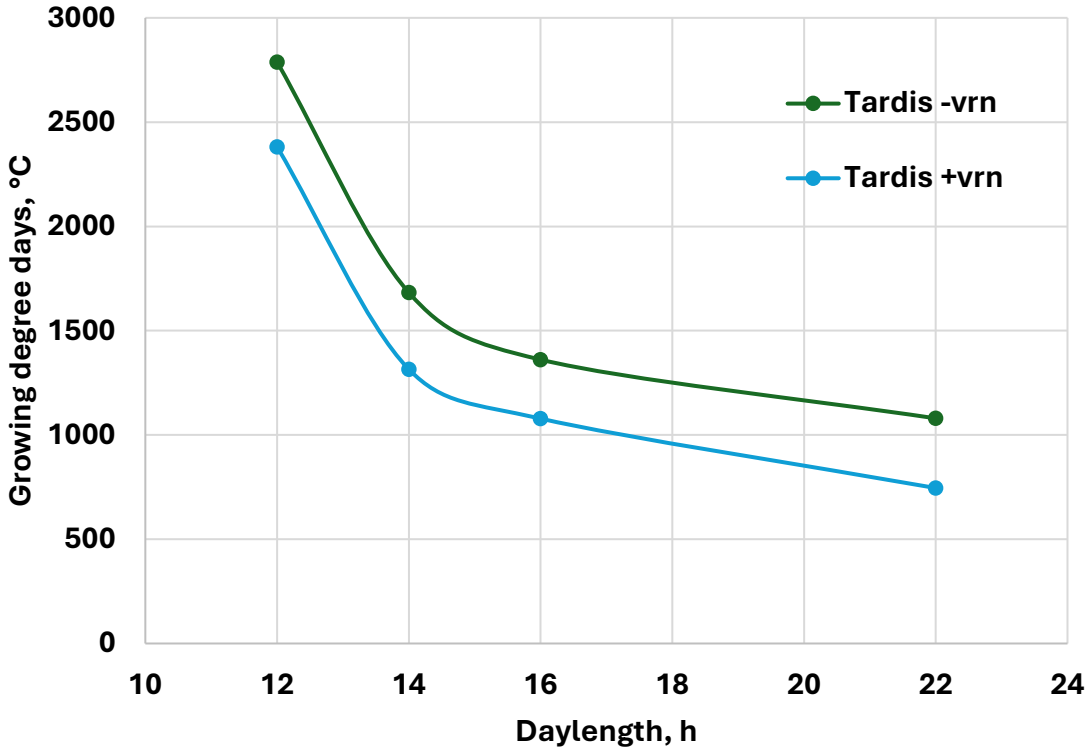
Spring oat

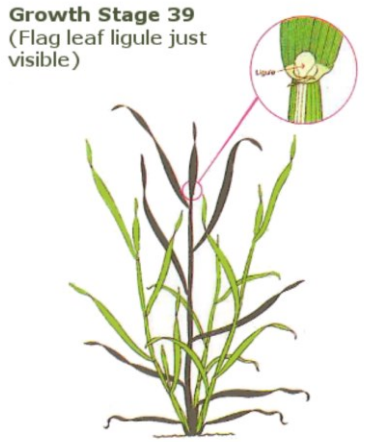
SD 12h day
LD 16h day

Vernalisation 21 days @ 5°C

Data Alys Reid Bacon

Effect of photoperiod and vernalisation on GDD to GS39

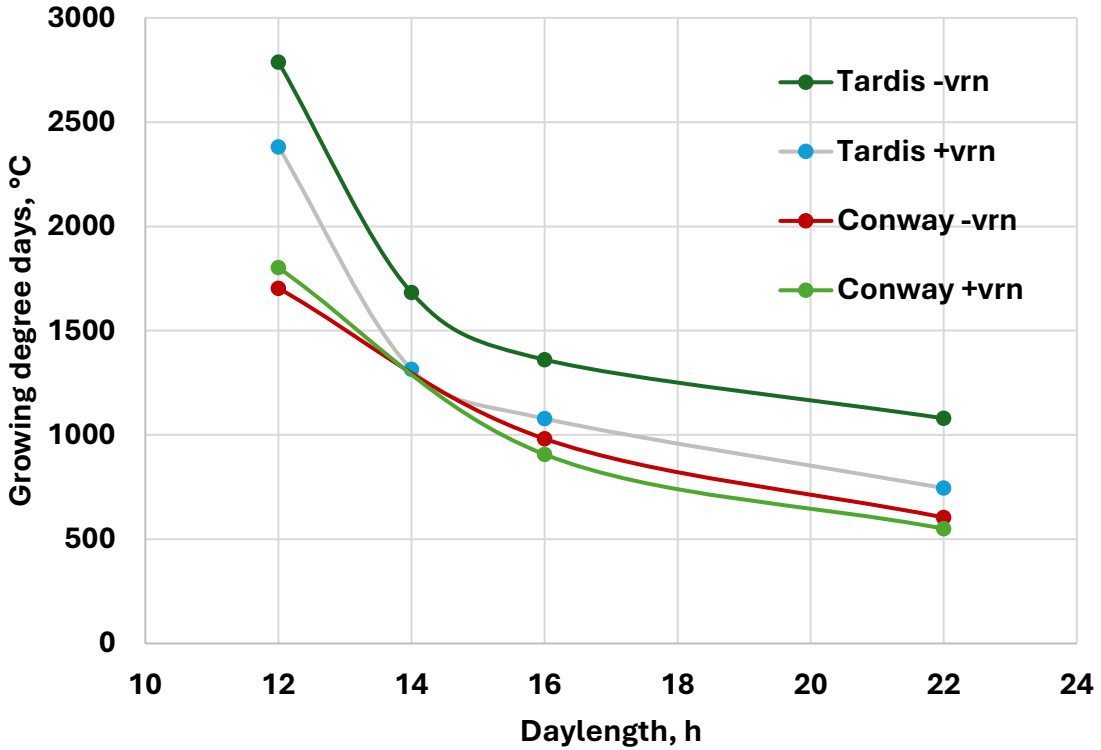


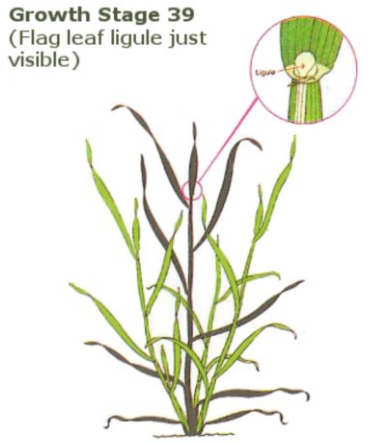


Vernalisation 21 days at 5°C

Increasing day length, shortens time to flowering

Effect of photoperiod and vernalisation on GDD to GS39



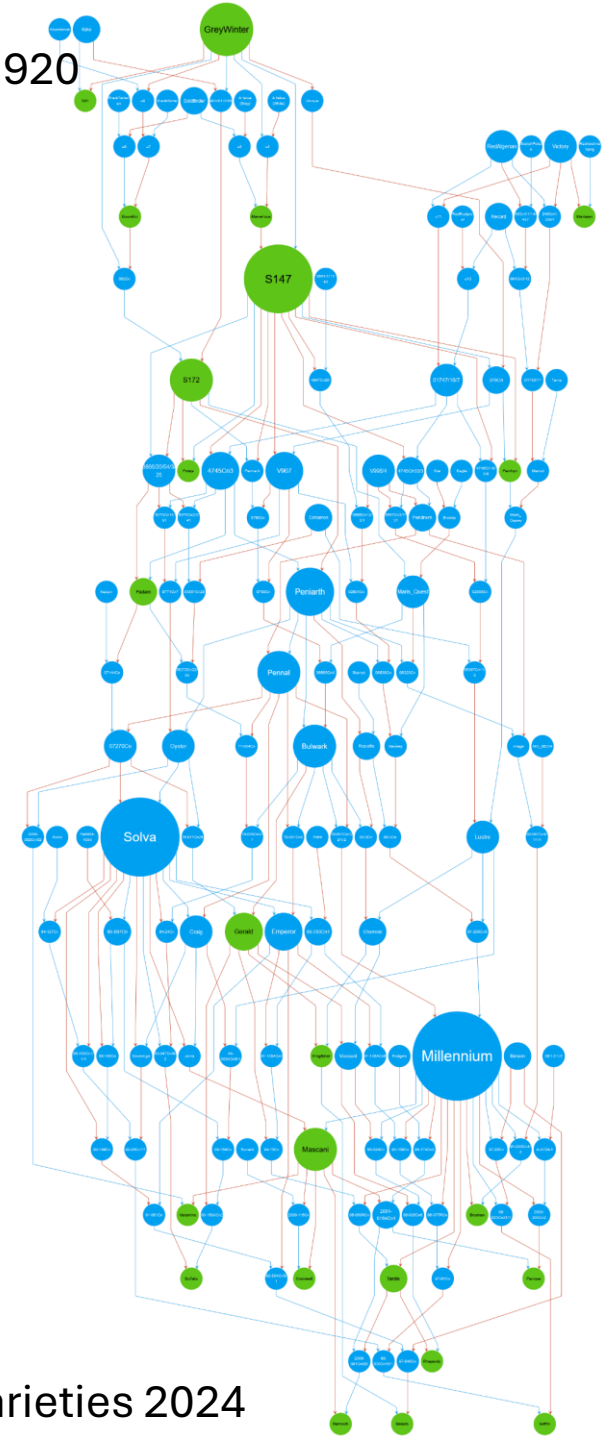


Vernalisation 21 days at 5°C

Increasing day length, shortens time to flowering

Conway (spring oat) less photoperiod sensitive than Tardis (winter oat)

Crosses made in 1920



New varieties 2024

Exploring genetic diversity to identify germplasm for future climate resilient oats.

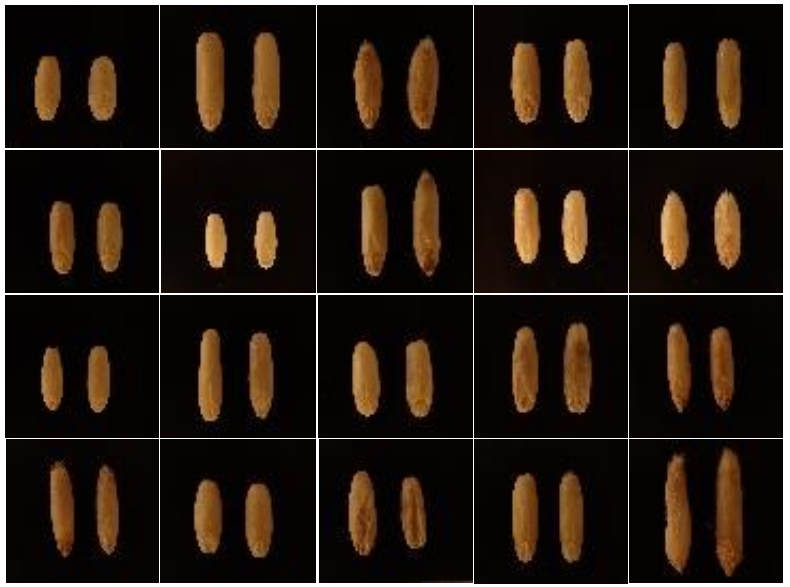
Can the past help inform the future?

Association Mapping Population (SAMP)

- Advanced lines from IBERS spring oat breeding programme
- Parental lines and heritage material
- World-wide diversity including IBERS winter oats

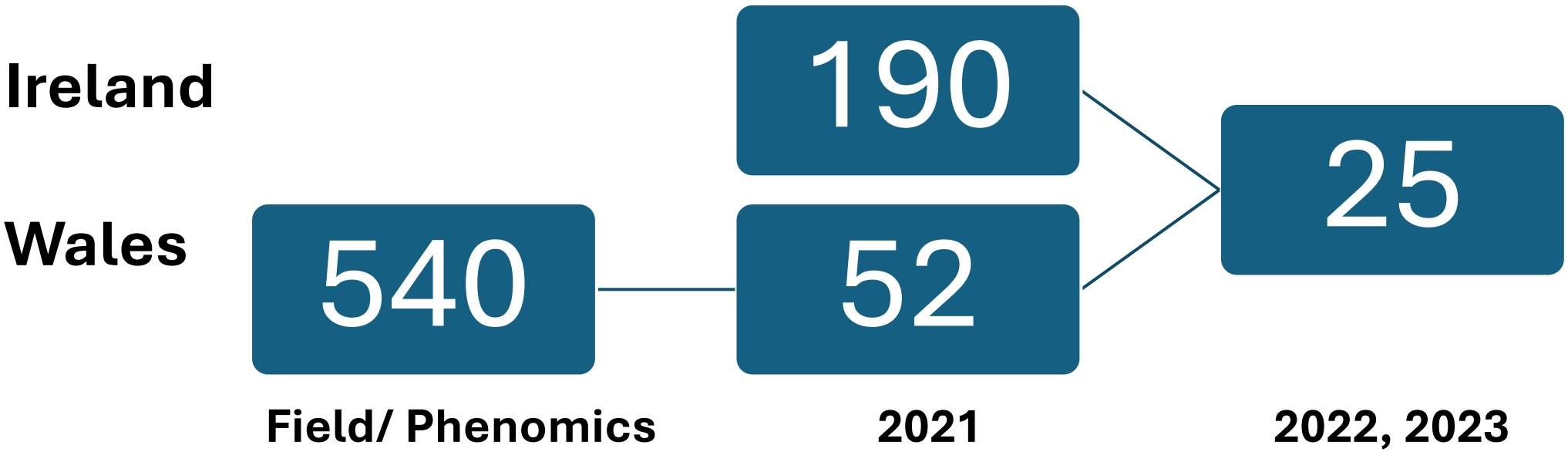
- 540 lines grown as single plants (and sampled for DNA) in and in the field over 4 growing seasons both spring and autumn sown

- Subset grown in AU phenomics facility under control and water limited conditions
- Powdery mildew susceptibility screened in glasshouse

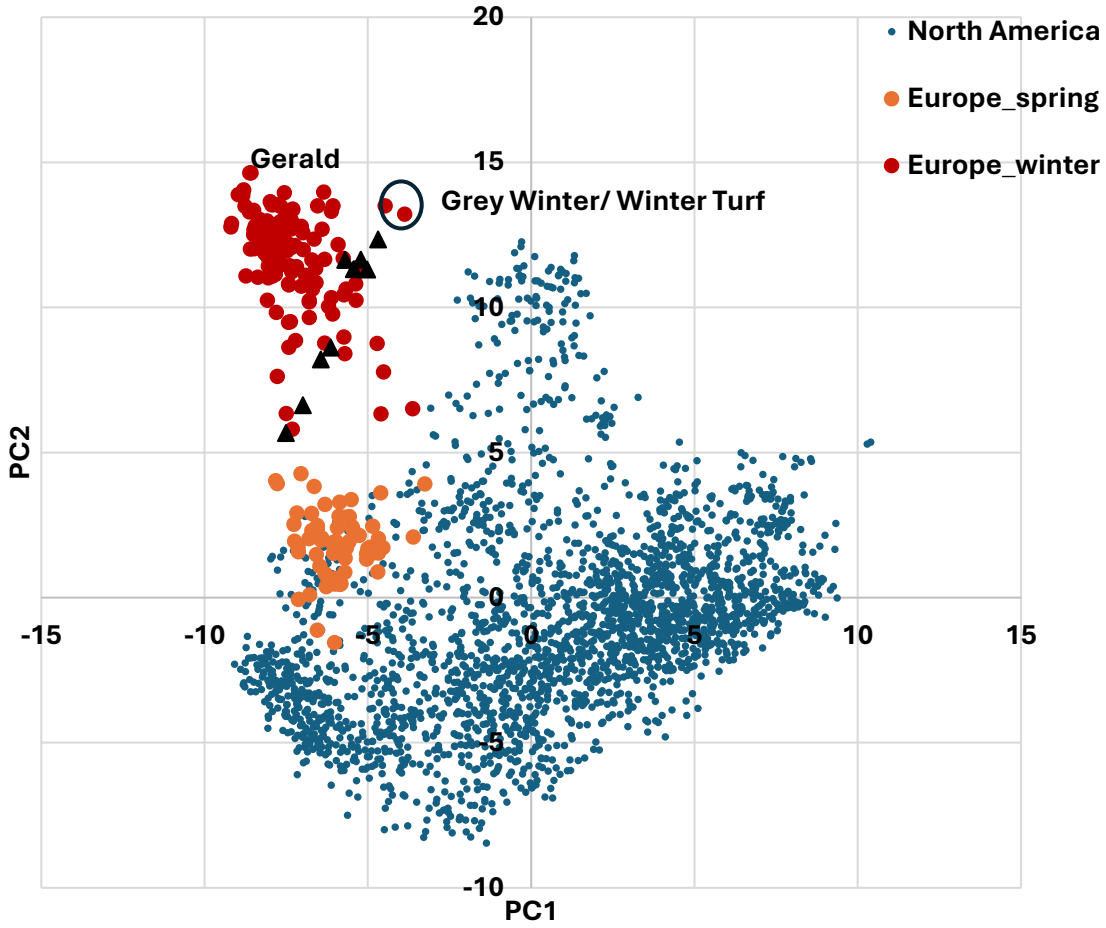


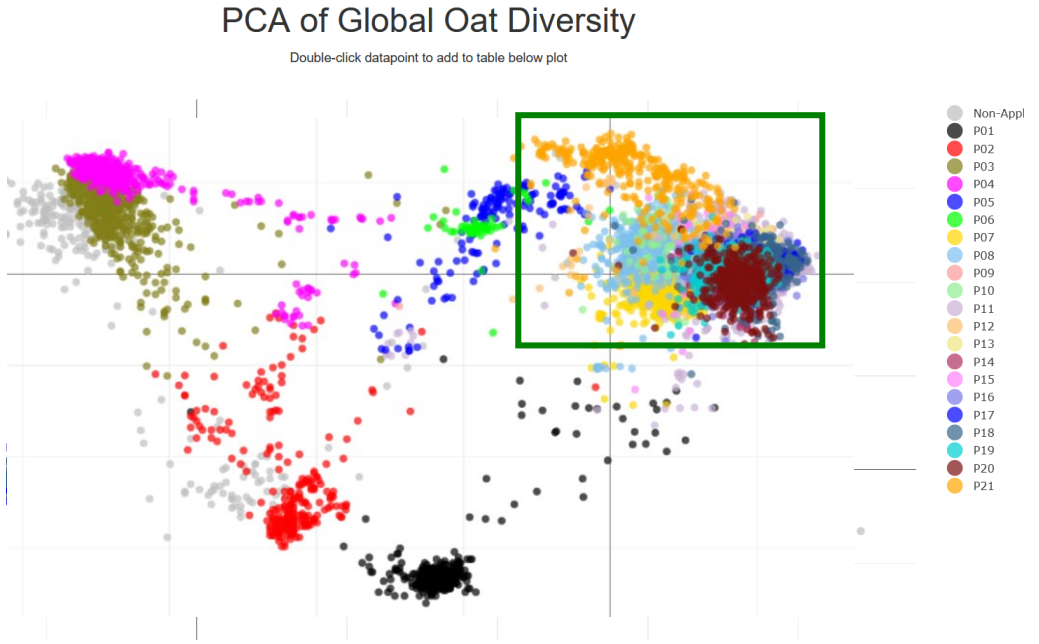
Healthy Oats - Germplasm assessment

- IBERS germplasm collection grown in Aberystwyth screened for milling quality (kernel content, hullability), thousand grain weight, protein, oil, β-glucan and Avenanthramide content, 52 selected for multiplication and further analysis
- UCD germplasm collection grown in Ireland in the field and in Aberystwyth under controlled conditions



PCA analysis of SNP data comparing UK varieties to global oat diversity

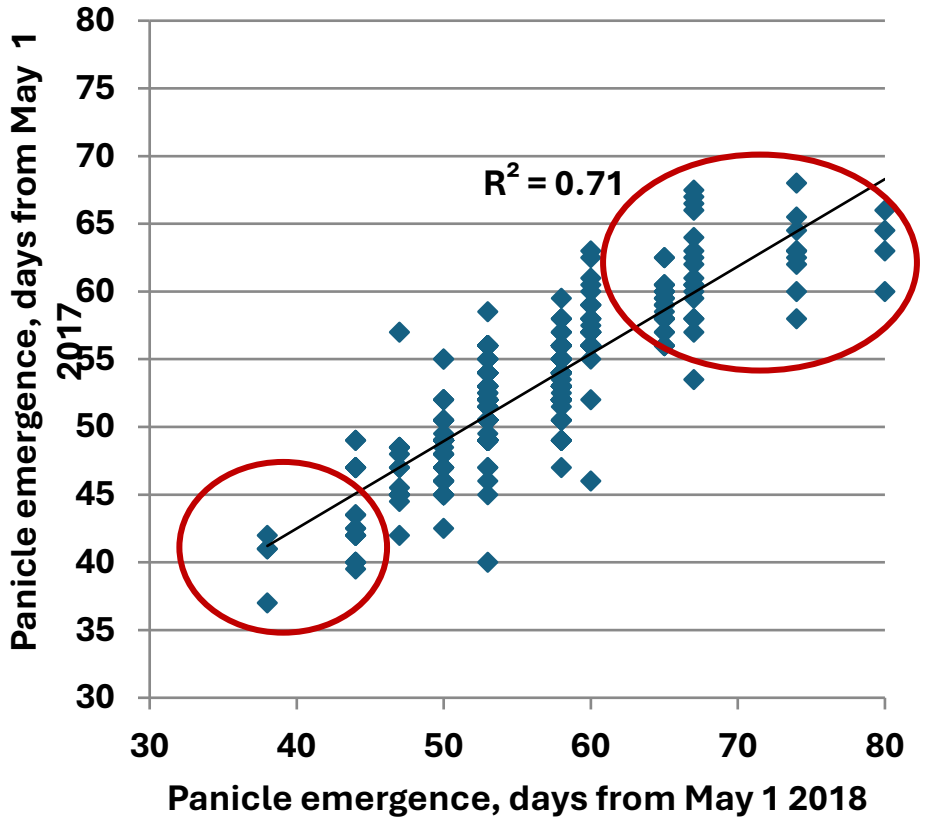




Collaboration with
Nick Tinker, and Wubishet Bekele, AAFC Ottawa
Jason Fielder, USDA Fargo

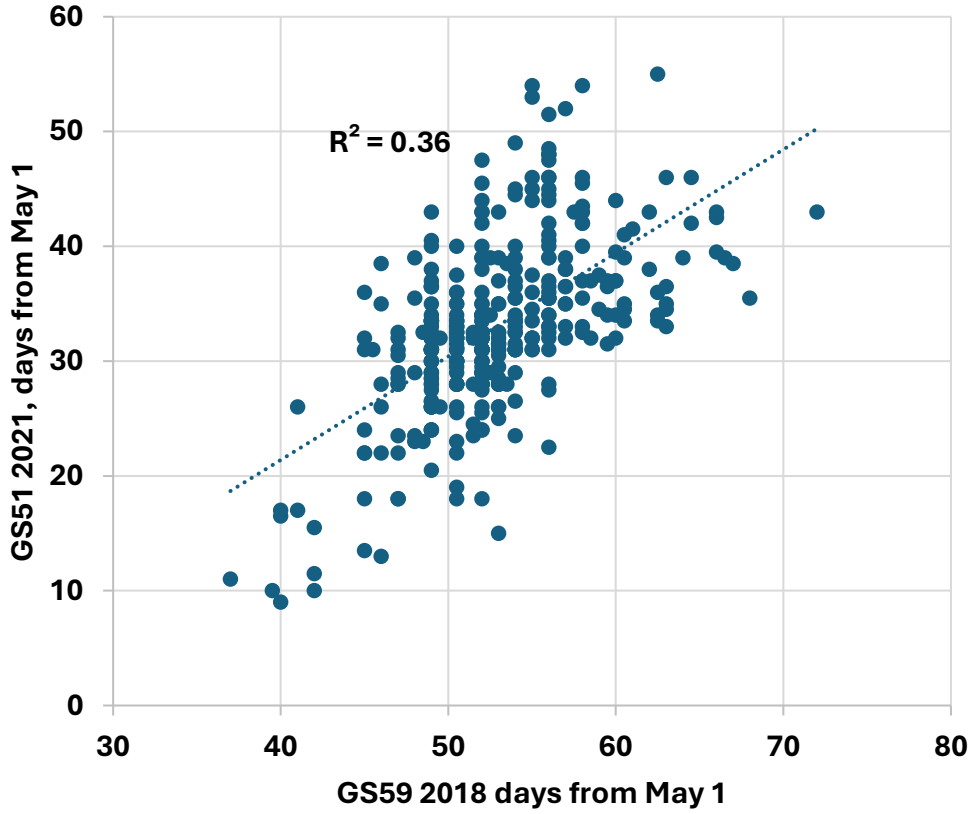
Panicle emergence variation in genetic diversity population

When spring sown, good relationship found between trials for panicle emergence

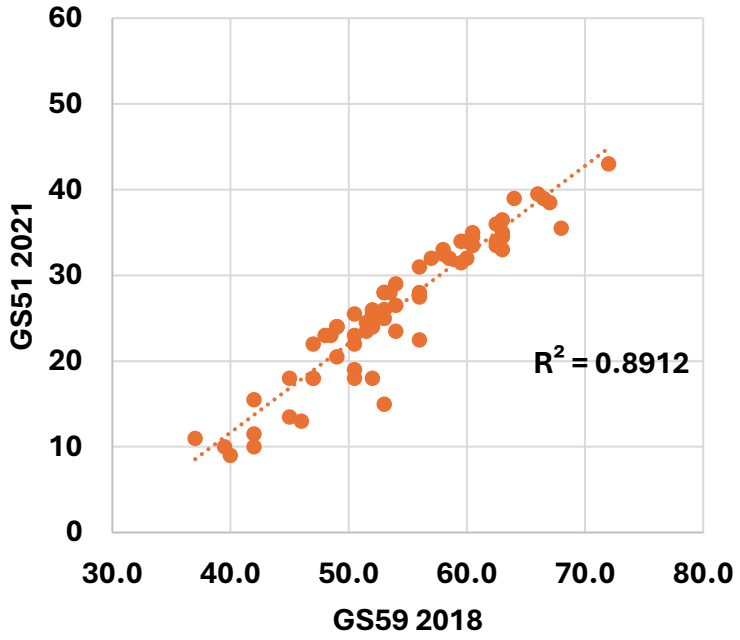


Both trials sown 27th March

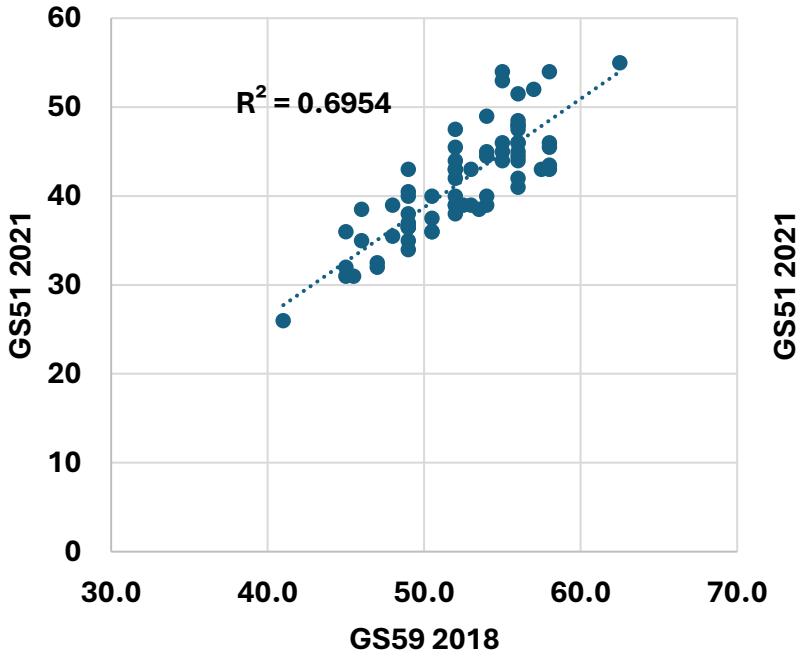
Poor relationship found between spring and autumn sown panicle emergence



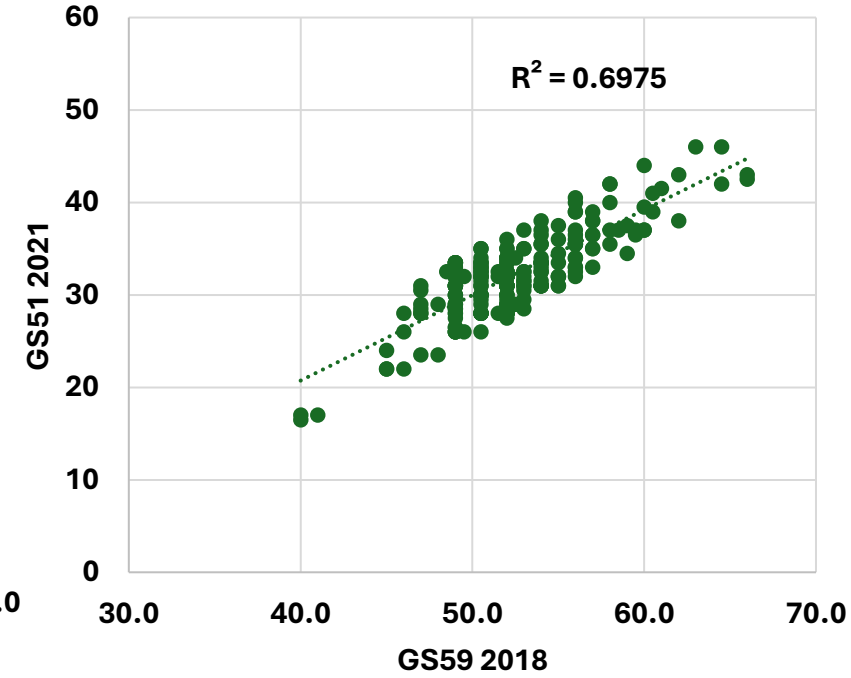
2018 trial sown 27th March 2018
2021 trial sown 16th October 2020



Varieties that flower much earlier when autumn sown



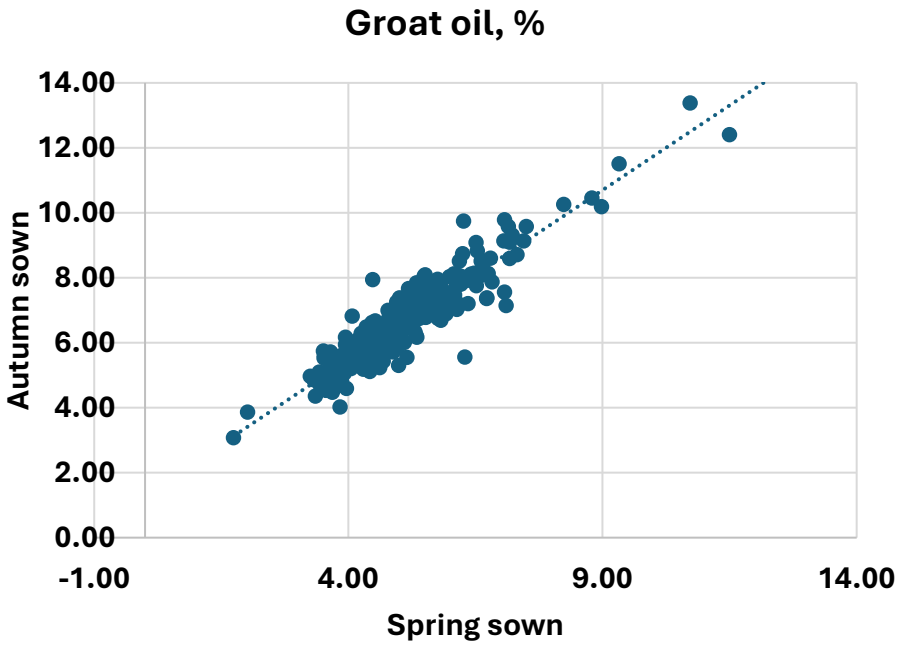
Varieties that flower later/ similar time whether autumn or spring sown

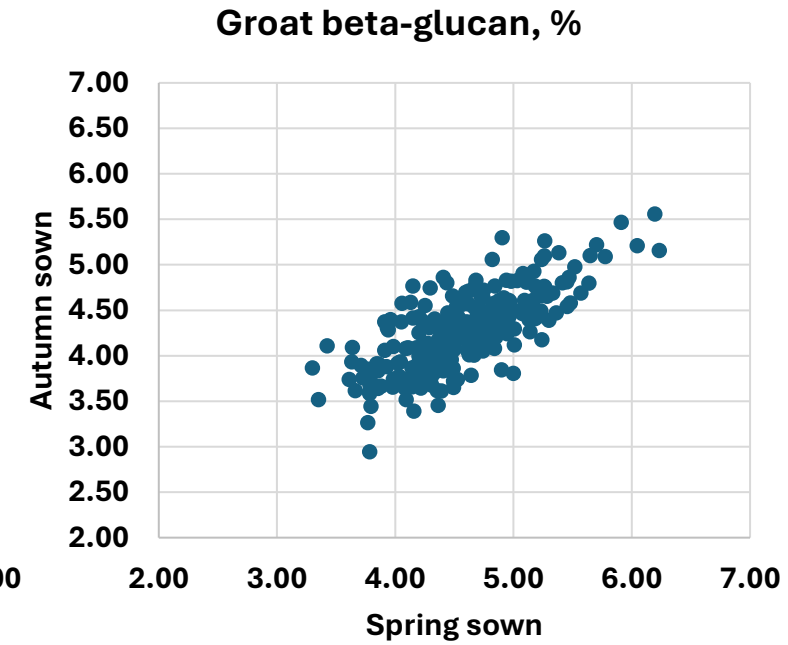


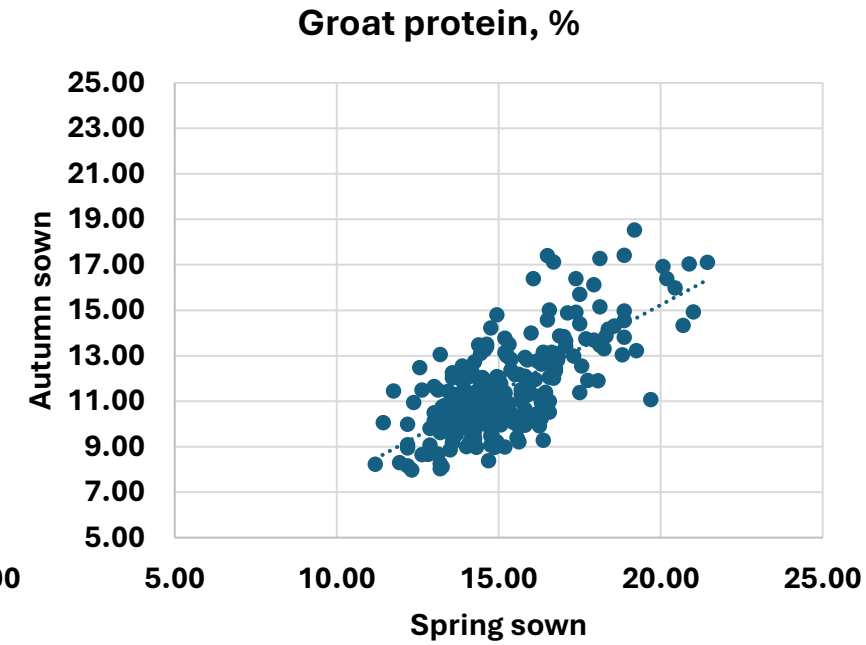
Varieties that flower c. 10 days earlier when autumn sown

However, 3 groups of varieties apparent when compare spring and autumn sown panicle emergence

Comparison of grain composition of SAMP autumn v. spring sowing



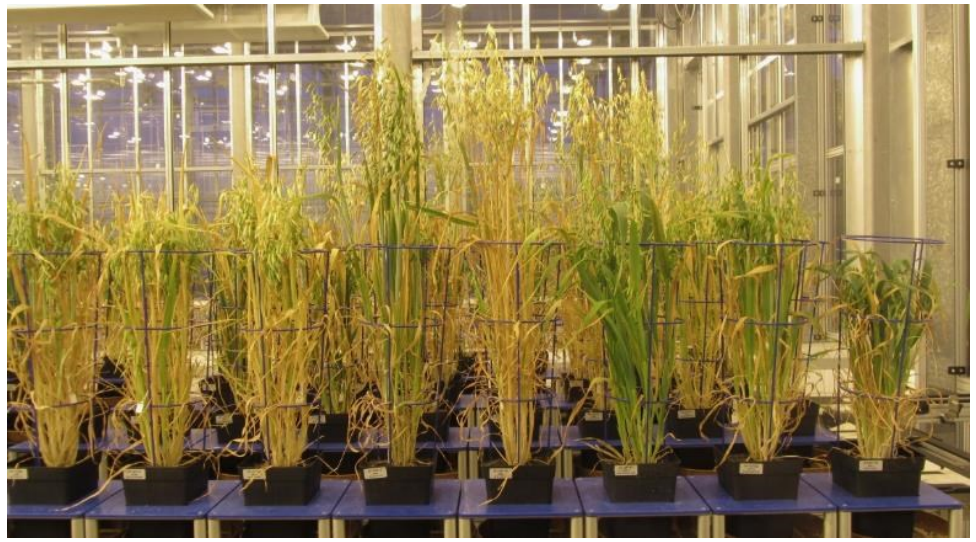


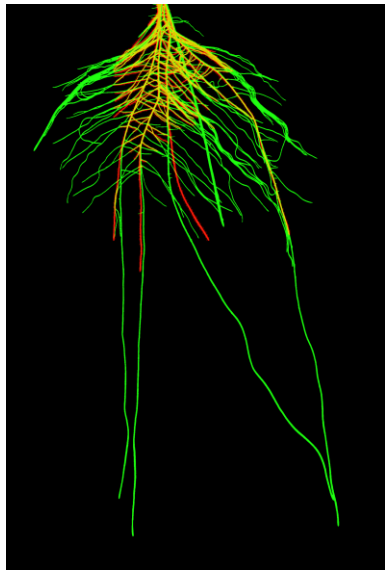


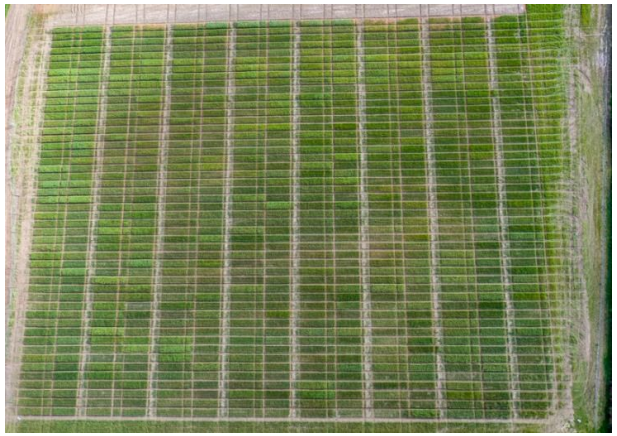
- Wide range in grain composition found
- When the same varieties are sown in the spring they tend to have lower oil and higher β-glucan and protein contents than when sown in the autumn

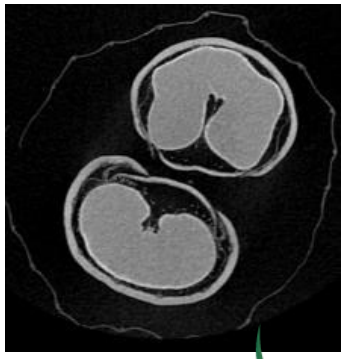
Future climates? Developing resilient crops

Developing Precision Phenotyping tools





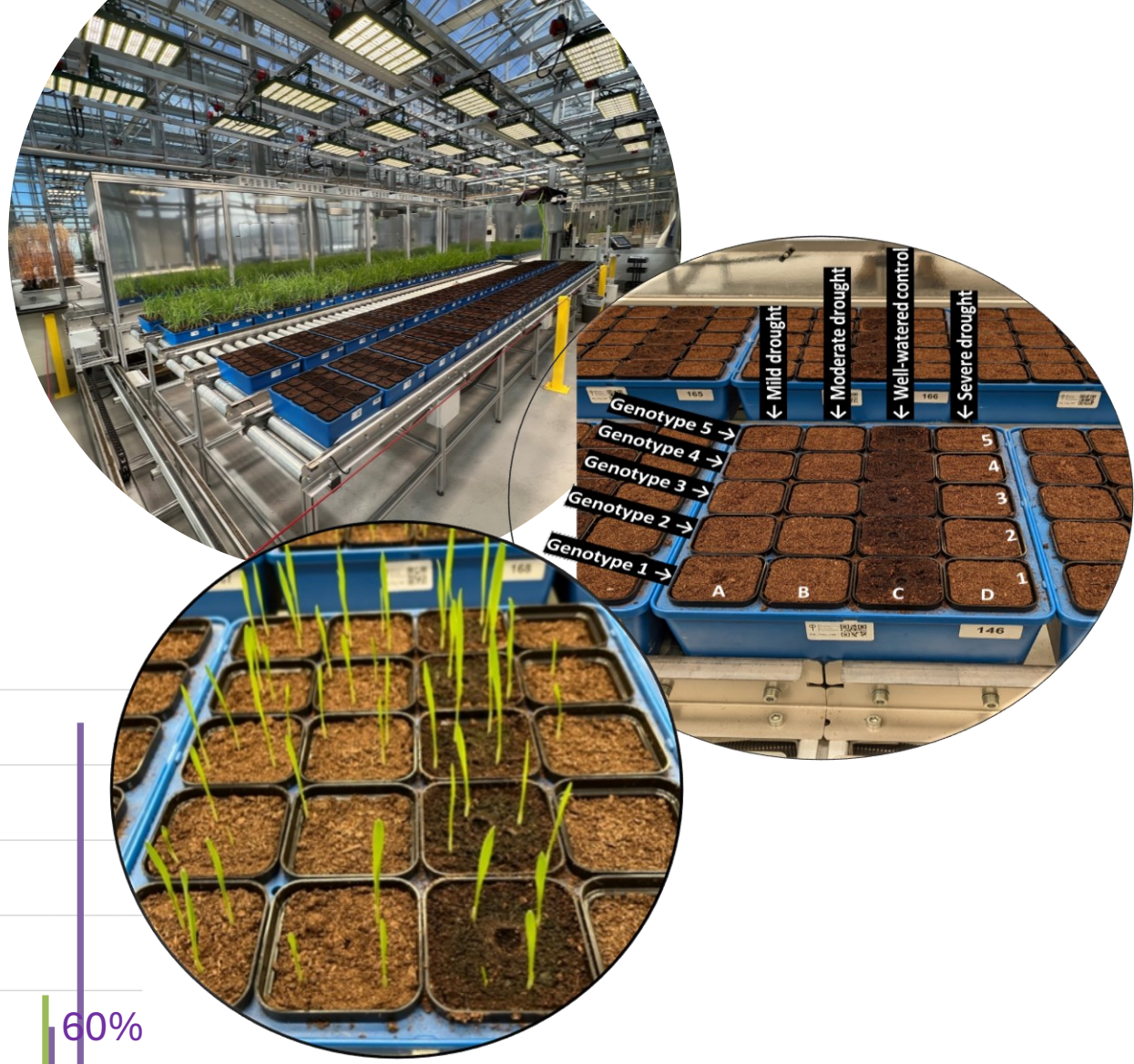


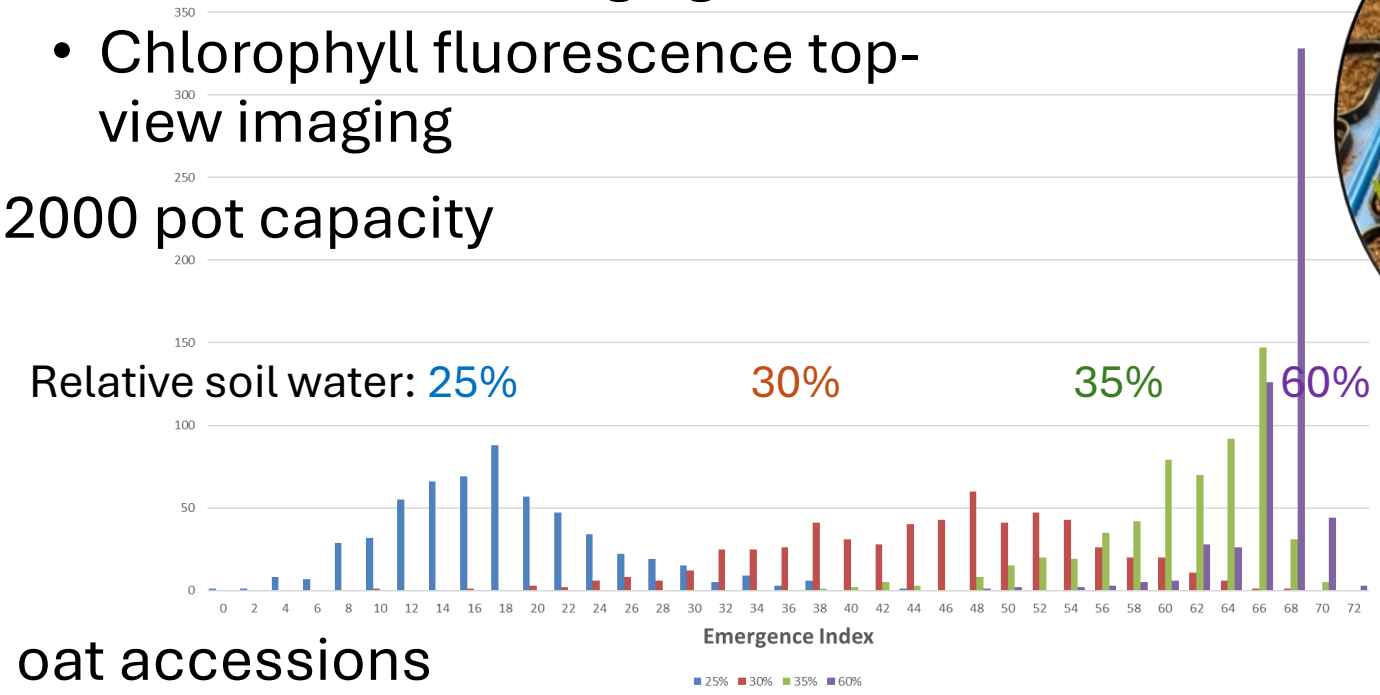


National Plant PHENOMICS Centre

Small Phenotyping System

- For the assessment of seedlings and plants up to 30cm
- Automated watering and Imaging
  - RGB top-view imaging
  - RGB side view imaging
  - Chlorophyll fluorescence top-view imaging
- 2000 pot capacity

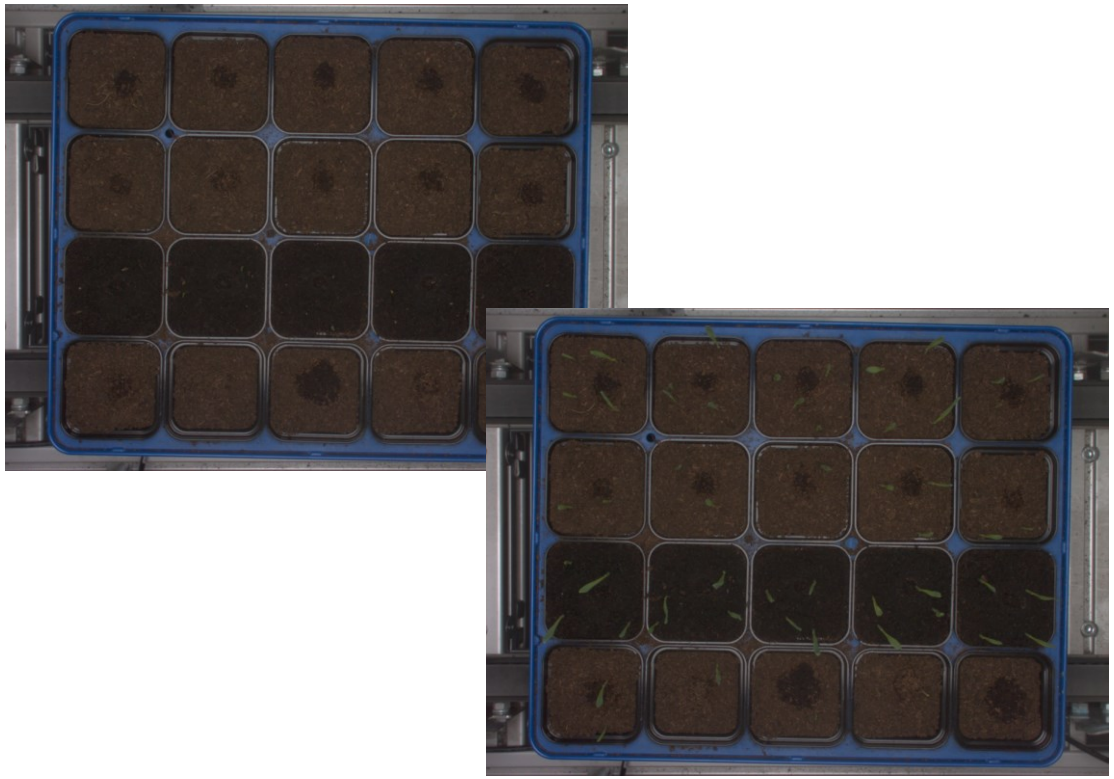


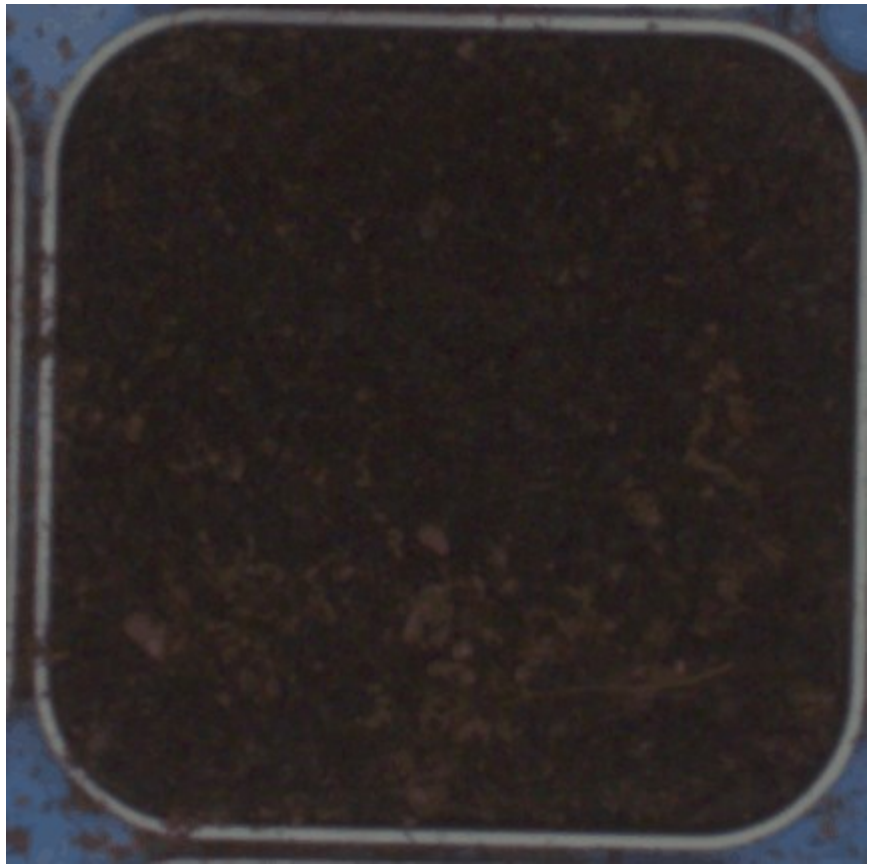


595 oat accessions

On-going: Applying AI to Image analysis

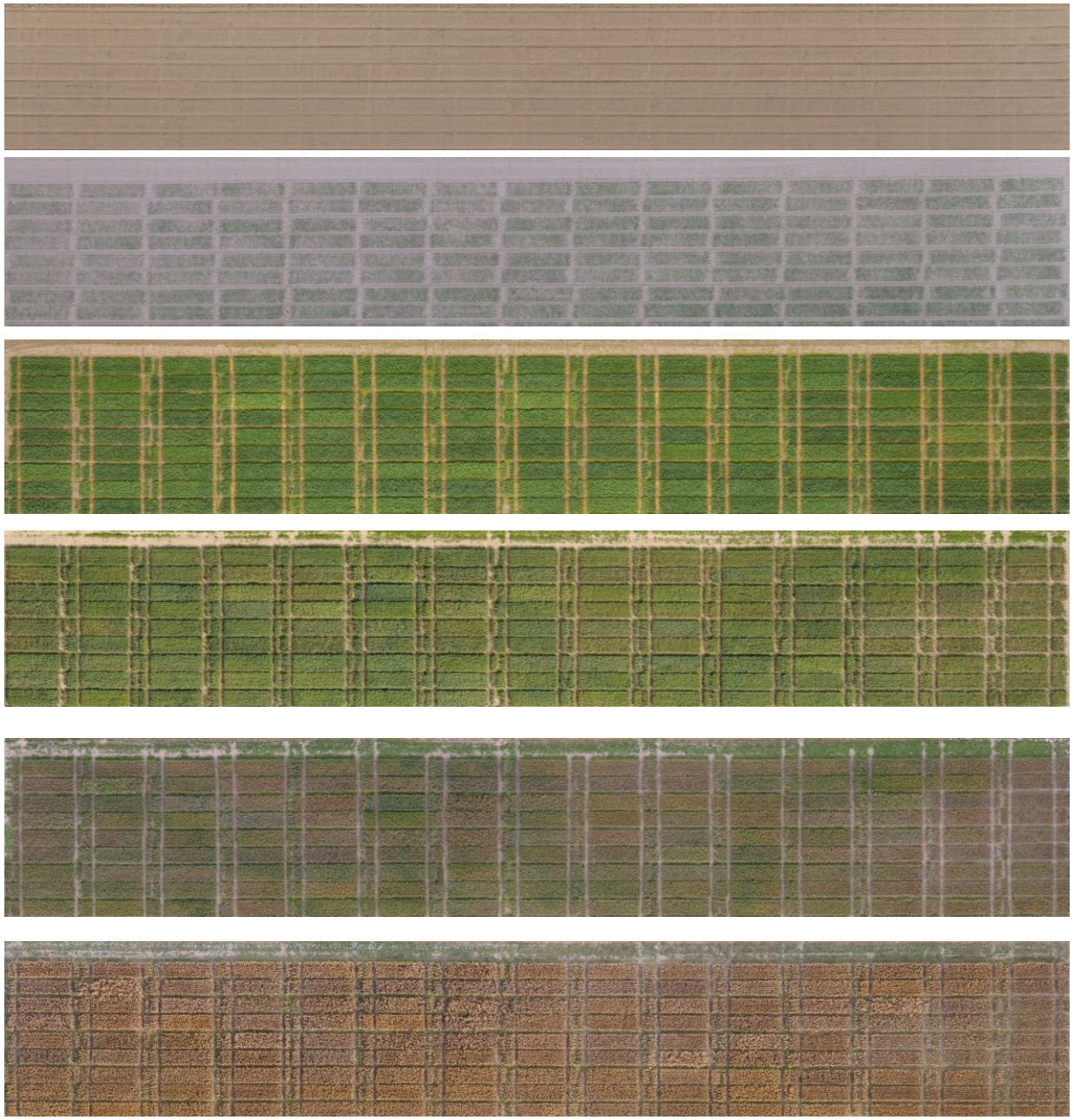
Each tray can be imaged at several time points throughout each day.





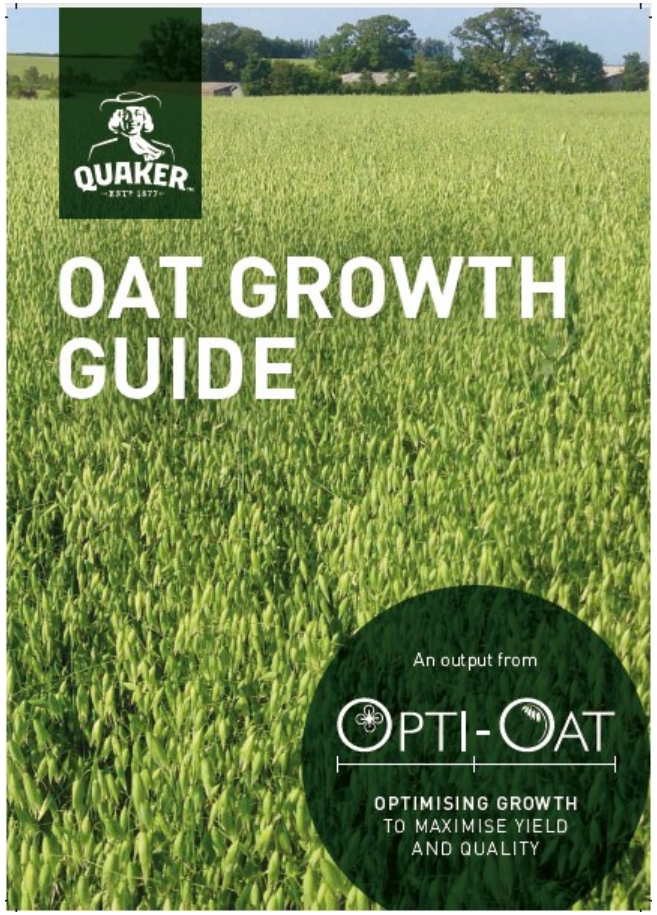
Training an AI to measure emergence
Kieran Atkins

Development of tools for remote sensing



Improving oat agronomy

- Understanding responsiveness to nitrogen
  - Effect on grain quality and yield
- Interaction of variety and environment
- Working with and developing tools for farmers
- Providing policy advice on RB209



Conclusions

- Important to match varietal phenology to environment oats are grown in
- Grain yield highly influenced by environment and management
- High yield does not necessarily mean high grain quality
- Grain quality has a strong varietal component
- Emphasis on grain yield can result in compromises in quality resulting in a 'quality gap' where the crop fails to reach threshold levels of quality required by the end-user.

Thank you

Acknowledgements

Sandy Cowan, Irene Griffiths, Sara Tudor, Aiswarya Girija, Tim Langdon and all in the oat breeding team

John Doonan and the AU phenomics team

Fiona Doohan, Atikur Rahman, Cathal McCabe and all in the Healthy Oats project

Nick Tinker, Wubishet Bekele

Biotechnology and Biological Sciences Research Council