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Molecular markers to machine learning – a United Kingdom policy perspective

UPOV Technical Committee 2025

Geneva

Dr Sigurd Ramans-Harborough

Senior Policy Advisor, Plant Varieties and Seeds

Department for Environment, Food and Rural Affairs, United Kingdom

Published: September 2025
Classification: OFFICIAL

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To support farmers in adapting to climate change and boost food security

A Defra Priority Outcome

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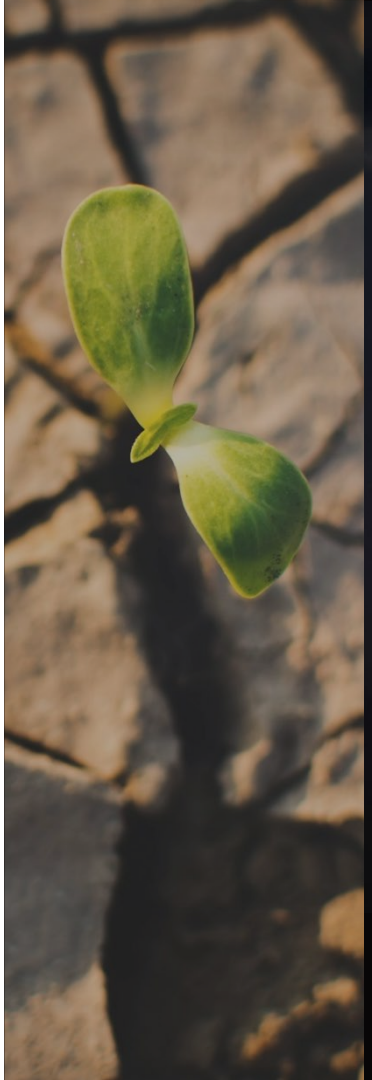

- We need to continue to advance crop productivity,
- We need to adapt our agricultural systems with more resilient plant varieties to extreme weather conditions, plant pests and diseases.

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Opportunities

Advances in fundamental plant science,

Tailoring crops through gene editing,

Making use of global plant genetic diversity to support food security.

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To accommodate the opportunities from plant science for the benefit of society:

- We need to support plant breeders to bring new varieties to the market and allow them to reach farmers more quickly,
- The DUS examination process for Plant Breeders' Rights (PBRs) has a fundamental role to meet this challenge.

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To support innovation, the United Kingdom is exploring opportunities to improve the efficiency of the DUS growing trials and variety collection management.

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Previous Defra funded R&D projects have achieved:

1. Expansion of the current United Kingdom DUS database system to safely and securely store molecular data.

2. Validation of a smaller subset of molecular markers that can uniquely distinguish varieties from the United Kingdom barley variety collection.

3. Exploration of machine learning genomic prediction approaches to optimise molecular marker-informed selection of similar varieties from the variety collection.

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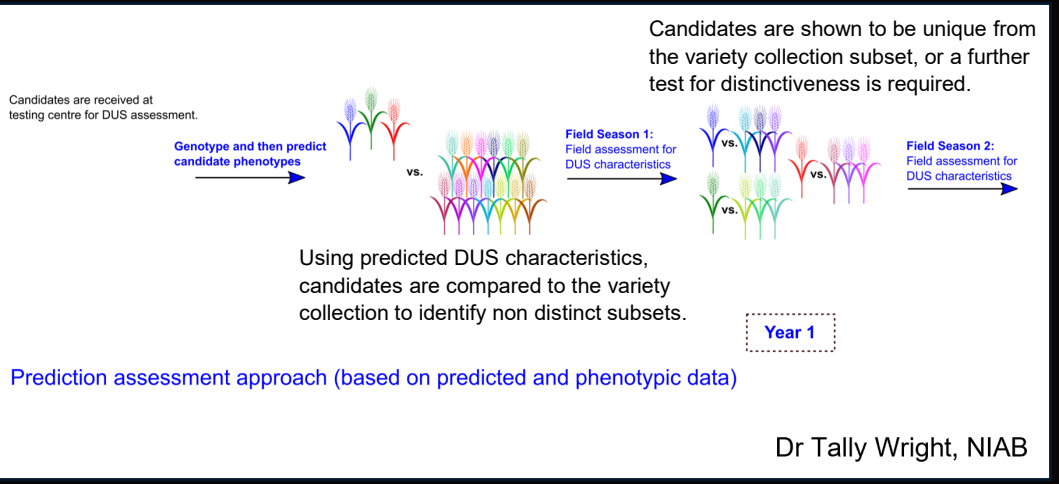
Proof of concept: Identification of variety collection subsets in the absence of prior phenotypic data.

Ambition: to genotype and predict the candidate phenotype before 1st growing trial.



Potential to reduce spring barley DUS testing from the current 2-3 years, to just 2 years.

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Combining molecular markers and Random Forest machine learning

- Previous work has shown that the Random Forest machine learning-based prediction can successfully identify markers in regions of the genome of biological importance for DUS characteristics. Particularly, where there is a high heritability, controlled by one or a small number of genetic loci of strong effect.

- Depending on the trait, setting the algorithm to attribute more weight to these markers can result in improvements to prediction accuracy.

NIAB, 2025
Publication being prepared

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From proof of concept to implementation

Defra has committed further funding to:

1. Genotyping the remaining barley variety collection (~30%) and future candidates.

2. Further optimisation of trait prediction using Random Forest.

3. Validate predicted subset selection of varieties via side-by-side comparisons with live DUS field trials.

4. Develop a user-friendly tool for uptake at testing centres.

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Implementation of Machine Learning genomic prediction approaches, to optimise molecular marker-informed selection of similar varieties

Future considerations

How best to make this machine learning model accessible to UPOV members.

Develop a system where molecular data does not need to be stored in a central database.

Ensure future capability to expand the technology to support DUS testing of other species.