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NEXT GENERATION VARIETY TESTING FOR IMPROVED CROPPING ON EUROPEAN FARMLAND (INNOVAR)

Document prepared by an expert from the United Kingdom

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1. InnoVar ('Next generation variety testing for improved cropping on European farmland') is a Horizon 2020 'Research and Innovation Action' addressing the topic SFS-29-2018 'Innovations in plant variety testing'. InnoVar is coordinated by the Agri-Food and Biosciences Institute (United Kingdom) with funding of almost €8M shared between 21 partners in 10 countries (see Annex). Beginning in October 2019, the project will continue for 4½ years.

2. Variety evaluation systems have evolved in response to changing economic and environmental influences on farming and to drivers and advances in science and technology. Since 1995, the Community Plant Variety Office of the European Union (CPVO) has implemented and applied the system for the protection of plant variety rights established by European Commission legislation, according to the 1991 Act of the International Convention for the Protection of New Varieties of Plants (UPOV Convention). Currently, rapid developments in genomics, phenomics, molecular biology and digital technologies are opening up a multitude of opportunities for a 'next generation' and ongoing evolution of DUS processes. In parallel, there is a requirement to measure the response of plant varieties (VCU) to environmental challenges including climate change and the associated variability in both biotic and abiotic stresses which are increasingly affecting crops, grassland and horticulture.

3. Using wheat as a test crop, InnoVar will devise and demonstrate improved, efficient methods of:

(1) integrating new science into DUS and VCU testing processes,

(2) combining DUS and VCU characters, and

(3) incorporating variety information into decision-making on-farm.

4. Ultimately the tools and models developed will enable assessors to allocate varieties into High Performance Low Risk (HPLR) categories based on their field performance under variable input regimes and their target market environmental conditions. This HPLR categorisation is a novel branding that will be developed by InnoVar to promote understanding of 'fit-for purpose' varieties and their performance by farmers and growers.

5. InnoVar will draw together expertise and knowledge from across crop science, bioinformatics, soil science, meteorology, and computer science to develop and deliver methods and tools to achieve greater efficiency in the DUS and VCU testing processes and in the use of resources on-farm, enabling the EU and its farmers to maximise the potential of their land, in terms of both yield and environmental sustainability (including adaptation to climate change and environmental resilience). Planned dialogue between DUS and VCU specialists and stakeholders on the one hand and invited experts from across the EU and internationally on the other, will ensure appropriate and targeted focus of the work for maximum impact and transfer of research outcomes to growers, breeders, end-users and other stakeholders.

6. The objectives are to:

(1) Identify crop characteristics and sustainability criteria which indicate the capacity of varieties to maintain yield under more variable conditions and more sustainable crop management practices.

(2) Develop precise, rapid and automated methods for DUS testing in compliance with European/international requirements and the granting of PVR for new varieties.

(3) Revise and develop VCU trialling processes to provide data on characters that contribute to the capacity of new varieties to maintain yield under more variable conditions and sustainable crop management practices.

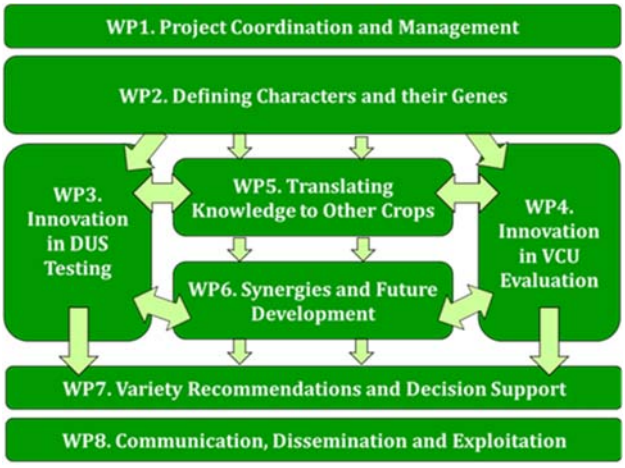
(4) Exploit synergies between DUS and VCU testing using genomics, phenomics, weather and soil data, and machine learning to set up databases and reference collections.

(5) Apply the methods and techniques developed for wheat to other cereals and other crop types, including grasses, legumes and maize.

(6) Develop new tools for the evaluation and detection of variety characteristics, using genomic, phenomic and digital technologies.

(7) Analyse and review existing systems for providing and delivering information about varieties and facilitate variety specialists in adopting and developing new effective methods and tools for dissemination.

7. These objectives will be addressed in eight work packages using technologies which include:



Phenotyping and Phenomics

InnoVar will develop a database based on historic phenotyping data as the foundation. This will form the basis of a greatly expanded database that will capture standardized phenotyping data from standardized DUS and VCU trials across the EU. The database will also include phenomic data collected from selected trials using drone-based technologies to systemically assess the development and resilience of varieties. Environmental data will also be collected for field sites including soil and weather information.

Genomics

8. Existing and *de novo* genetic (SNP) data for selected DUS and VCU varieties will be added to the InnoVar database. These data, combined with the phenotypic and phenomic data, will be used in genome-wide association studies to identify genomic loci and markers associated with DUS and VCU traits of interest.

Machine learning

9. Machine learning and deep learning will be applied to the created standardized environmental, phenotypic, phenomic and genomic data sets to determine the potential of more refined models and algorithms to contribute to DUS and VCU testing.

10. InnoVar will apply the lessons learned from wheat to provide road-maps for other crop groups with more detailed work on grass, maize and legumes.
The InnoVar App will provide a decision support system to empower growers to select crops that are best suited for their agro-climatic region, end-use and growing scenarios.

11. These new approaches – combined with conventional plant evaluation techniques - will deliver Next Generation Variety Testing – NGVT. The ultimate aim is to deliver harmonised variety testing across Europe so that average yields can approach potential yields through the use of 'fit-for-purpose' regional varieties.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 848144 **InnoVar** Factsheet

[Annex follows]

ANNEX

PARTICIPANTS IN INNOVAR

Participant No.	Participant organization name	Type	Country
1 (Coord)	AgriFood and Biosciences Institute (AFBI)	RES	United Kingdom
2	University College Dublin, National University of Ireland, Dublin (UCD)	UNIV	Ireland
3	Agencia Estatal Consejo Superior de Investigaciones Cientificas (CSIC)	RES	Spain
4	RSK ADAS Limited (ADAS)	IND	United Kingdom
5	Debreceni Egytem (UNIDEB)	UNIV	Hungary
6	Universita degli studi della Tuscia (UNITUS)	UNIV	Italy
7	Tystoftefonden (TYST)	OTH	Denmark
8	IP Pragmatics Limited (IPPL)	SME	United Kingdom
9	International Center for Agricultural Research in the dry areas (ICARDA)	INTL ORG	Lebanon
10	Alma Mater Studiorum – Universita di Bologna (UNIBO)	UNIV	Italy
11	Department of Agriculture, Food and the Marine (DAFM)	OTH	Ireland
12	The Secretary of State for Environment, Food and Rural Affairs (DEFRA)	OTH	United Kingdom
13	The Agriculture and Horticulture Development Board (AHDB)	RES	United Kingdom
14	Consiglio per la Ricerca in Agricoltura e l'Analisi dell'Economia Agraria (CREA)	RES	Italy
15	Origin Enterprises PLC (ORIGIN)	IND	Ireland
16	Universidad Politecnica de Madrid (UPM)	UNIV	Spain
17	Stichting International Soil reference and information Centre (ISRIC)	RES	Netherlands
18	Horta S.r.l. (HORTA)	SME	Italy
19	CONSULAI – Consultoria Agro-Industrial, Lda. (CONSULAI)	SME	Portugal
20	National University of Ireland, Maynooth (NUIM)	UNIV	Ireland
21	Lesprojekt – sluzby s.r.o. (LESP)	SME	Czech Republic

RES: Research
UNIV: University
IND: Industry
OTH: Other
SME: Small-Medium sized enterprise
INTL ORG: International Organization

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