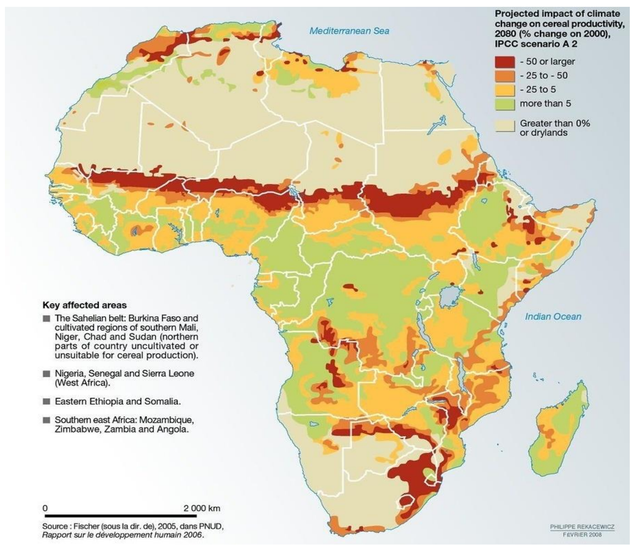
Unveiling Drought-Resilient Pathways: Integrating High Throughput Phenotyping and Multivariate Modeling to Enhance Barley Adaptation Climate Change

S. Ouahid[1] , A. Backhaus [1], J-A Jimenez Berni [2], A. Visioni[1] and M. Sanchez-Garcia.[1]

[1] *Genetic innovation, International Center for Agricultural Research in the Dry Areas (ICARDA).*

[2] *Spanish National Research Council (CSIC).*

Importance of drought-resilient crops



- The increasing threat of climate change makes developing drought-resilient crops more important.
- **Barley *(Hordeum vulgare L.)***, is a highly drought-tolerant cereal and a key player in the future of farming.

Fig. 1 Cereal productivity in Africa under a projected Intergovernmental Panel on Climate Change (IPCC) scenario. Source: https://www.grida.no/

Aim of this project

Investigating Barley-Plant Interactions During Drought

Providing a deeper understanding of the complex relationship between barley and its environment, particularly during drought stress.

Innovative Methodology using Multi-Data Integration and Machine Learning

We are pioneering an innovative research approach that leverages the potential of multi-data integration and machine learning techniques.

High-throughput phenotyping using Phenobuggy, and Physiotron

- We are employing automated ground-based platforms, such as the **Phenobuggy** equipped with ***multi-spectral, RGB camera and a LiDAR*** .
- **Physiotron** – a lysimeter with a multi-sensor bridge – equipped with ***two RGB Cameras, LiDAR*** providing controlled environmental conditions for in-depth study of growing dynamics under different water regimes, for monitoring responses to stress with unmatched precision. It also allows root phenotyping using different techniques.

Fig. 2 Physiotron at Sidi El Aidi (Settat) source : https://www.icarda.org/

Fig. 3 Phenobuggy at Marchouch (Rabat) source: https://www.hiphen-plant.com

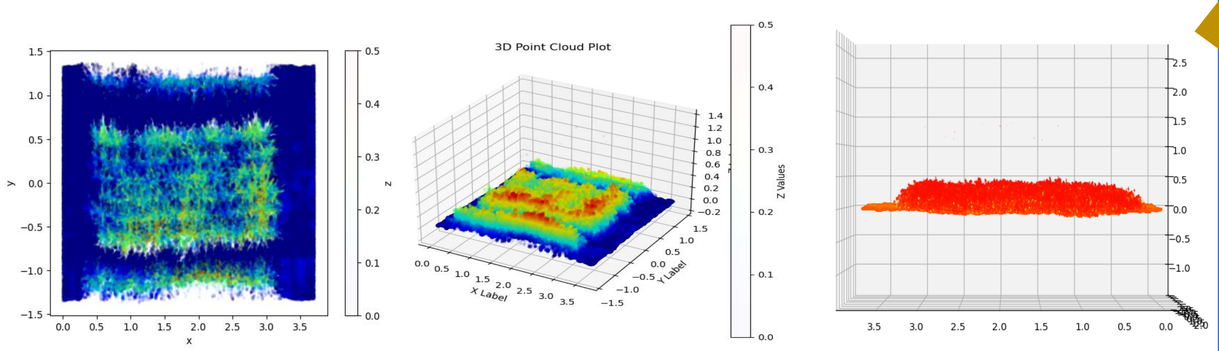


Fig. 4 3D & 2D point cloud generated from LiDAR

Machine learning to decipher complex trait relationships

- This large dataset is subjected to multivariate modeling to discover complex relationships between ***multiple traits, genomic variation*** and ***environmental factors***.
- Leveraging the power of machine learning with phenotypic and genotypic data to unravel the complex relationships between genetic makeup and observable traits.

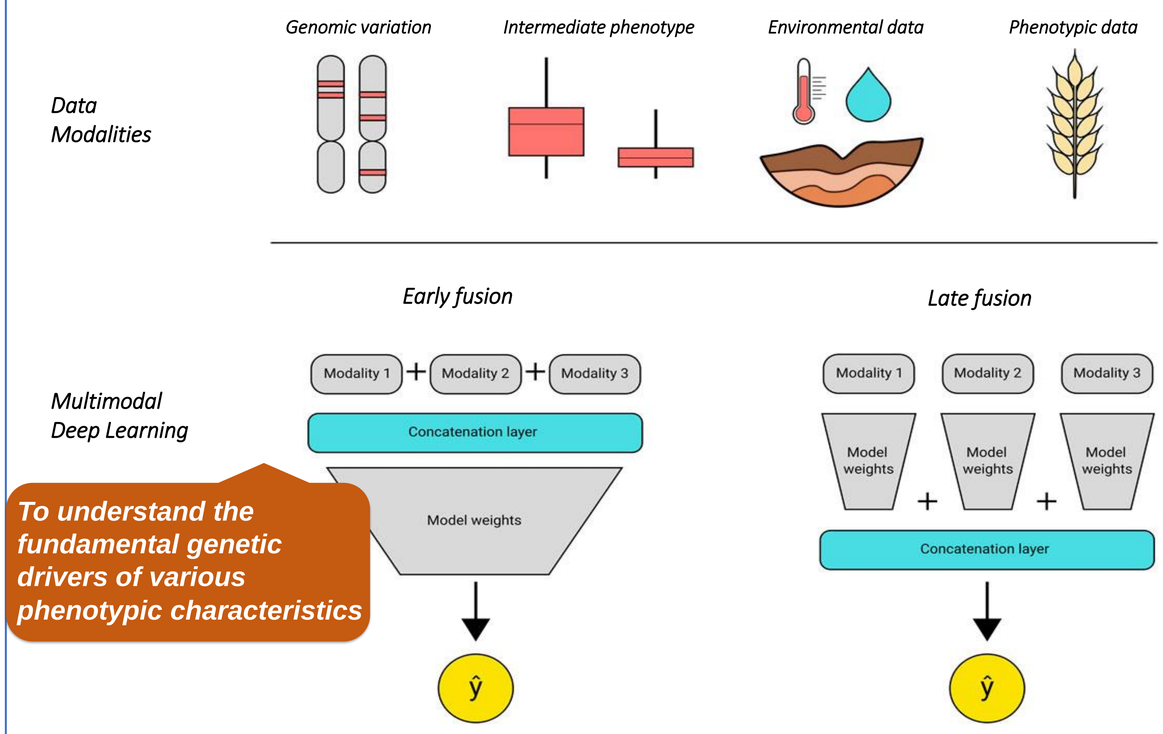
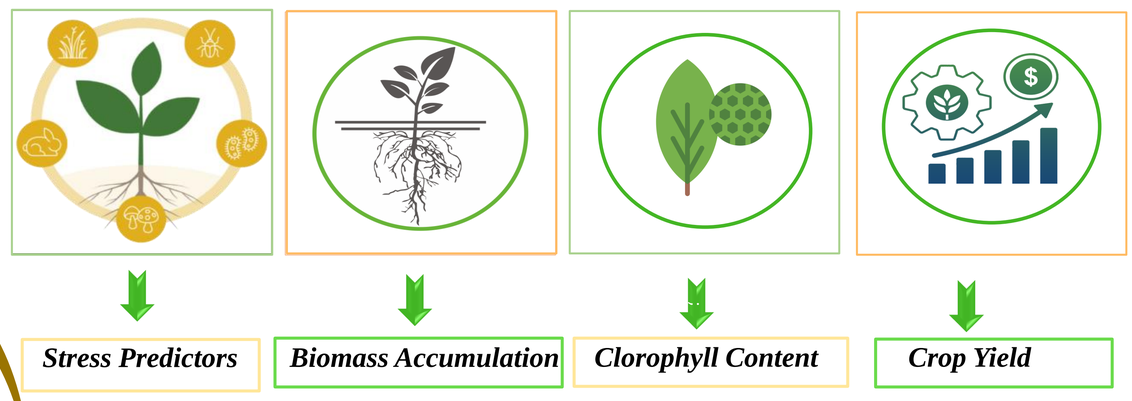


Fig. 7 Multimodal DL models can use a variety of inputs as training data, as shown in "data modalities" at the top.

Complex trait predictions (root traits, biomass, yield, stress responses)

- We concentrate on predicting complex traits such as ***biomass accumulation patterns under controlled water regimes, novel stress predictors, chlorophyl and other compounds concentrations*** that are fundamental to breeding programs to future-proof barley.



Potential for improved crop breeding programs

- By identifying hidden correlations and interdependencies, our models will enable the prediction of phenotypic traits of interest under different stress conditions.
- Offering invaluable insights into barley's drought resistance potential.
- Our work will highlight the importance of data integration and machine learning to unlock the potential of agricultural research .

Acknowledgments and donors

Contact

[1] *S.Ouahid@cgiar.org*
[1] *A.Backhaus@cgiar.org*
[1] *A.Visioni@cgiar.org*
[1] *M.Sanchez- Garcia@cgiar.org*
[2] *Berni@ias.csic.es*