



Marchouch, Morocco



Genotype vs Environment: the ICARDA durum wheat breeding program for African dryland cultivation

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Principal Scientist Genetic Innovations



icarda.org

International Center for Agricultural Research in the Dry Areas

cgiar.org

A CGIAR Research Center



The crop: Durum wheat

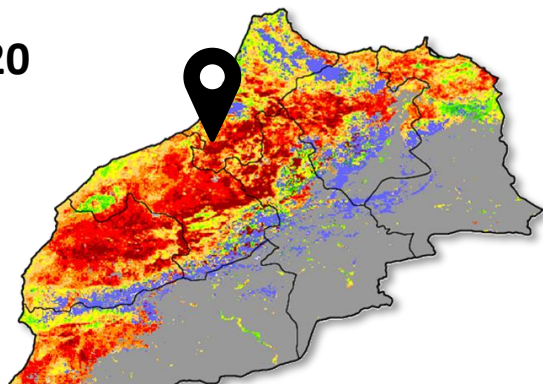
- It is the **10th most important crop** in the World
 - **16** million hectares (70% *rainfed*)
 - **40** million tons
- The program targets **8.5 M ha** of cultivation
 - **150** varieties across 23 countries
 - It is a ***staple and a cash crop***

Pipeline	Area	Production	Rural population
	Ha	MT	N
West/Central Asia drylands - rainfed	4,360,000	8,544,000	109,439,692
North Africa drylands - rainfed	2,500,000	5,000,00	26,763,737
High-cold drylands - rainfed	700,000	2,200,00	27,711,223
South Asia drylands - limited irrigation	600,000	2,100,000	1,020,455,478
East Africa drylands - rainfed	220,000	550,000	96,670,257
West Africa savannas - irrigated	110,000	1,500,000	40,369,022
Total	8,490,000	19,894,000	1,321,409,409

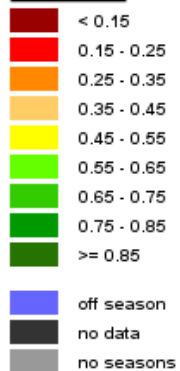


Mediterranean seasonal variation is the **norm**

February 2020



Mean VHI



February 2018



Mediterranean seasonal variation is the norm

April 2020



April 2018



Simulate it with across environment testing MET



Marchouch (Morocco)



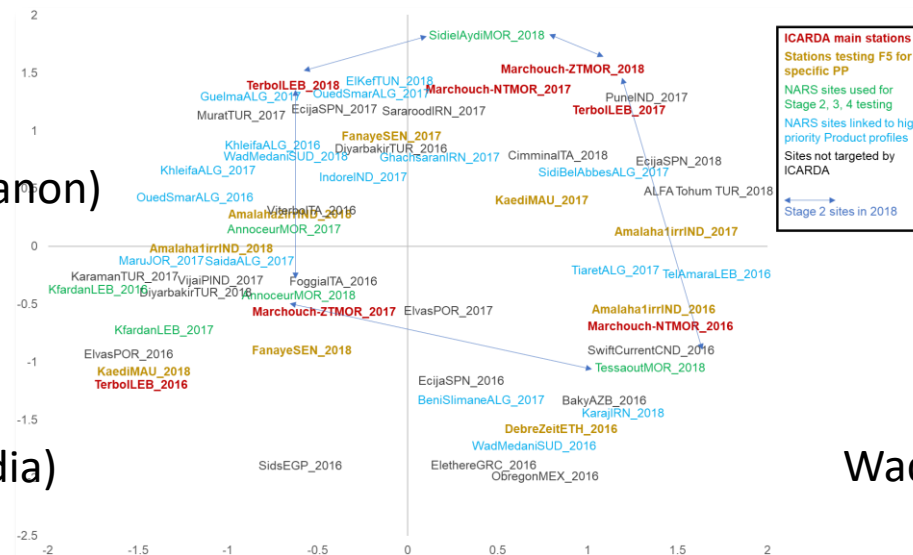
Terbol (Lebanon)



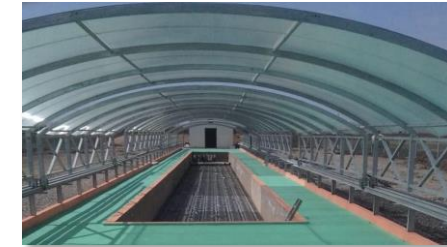
Amlaha (India)



Tel Hadya (Syria)



Sidi el Aydi (Morocco)



Izmir (Turkey)



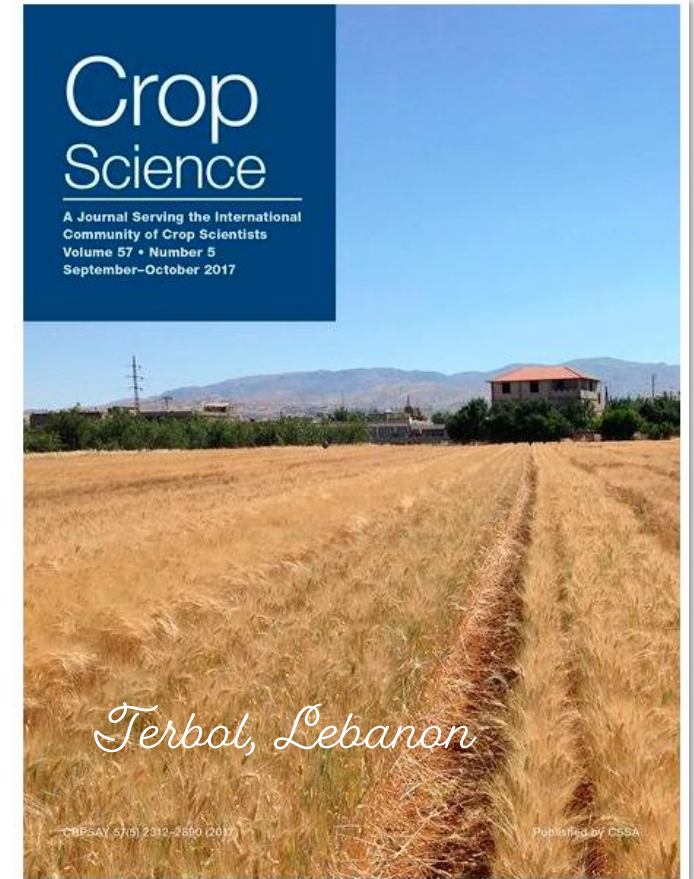
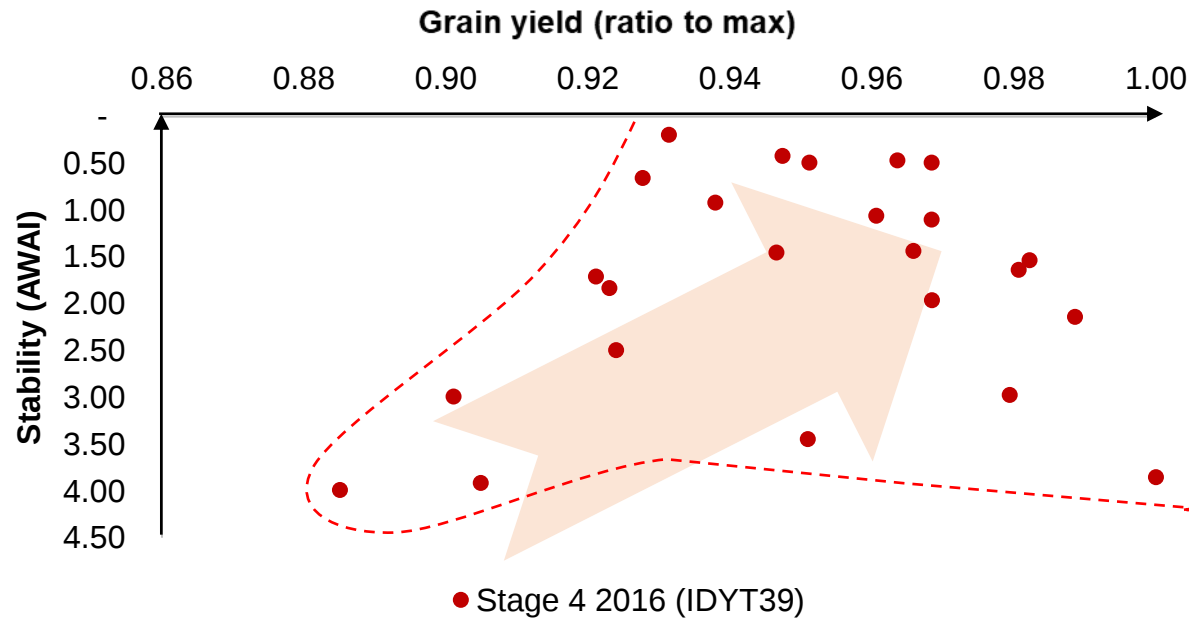
Wad Medani (Sudan)



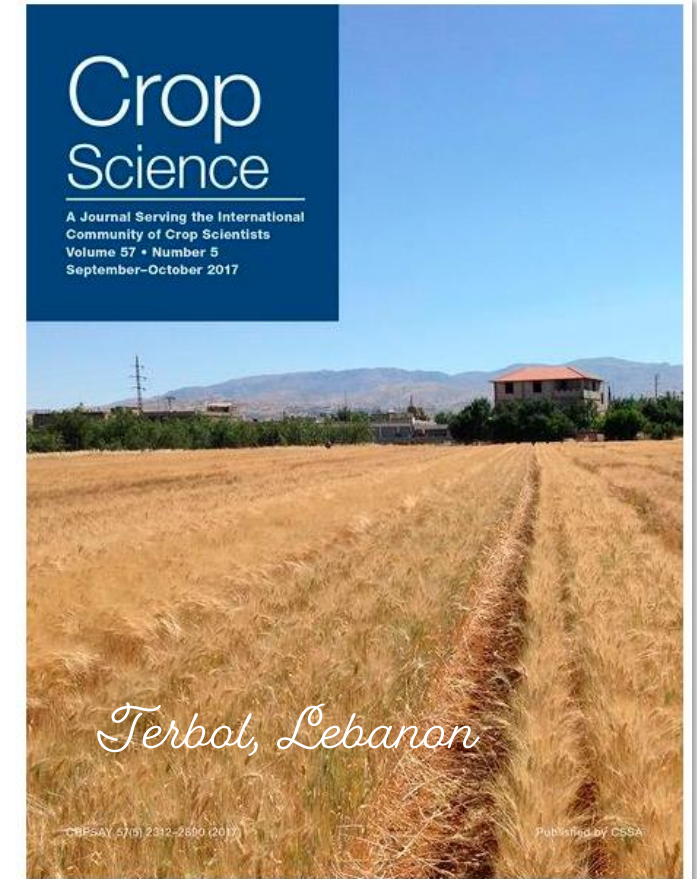
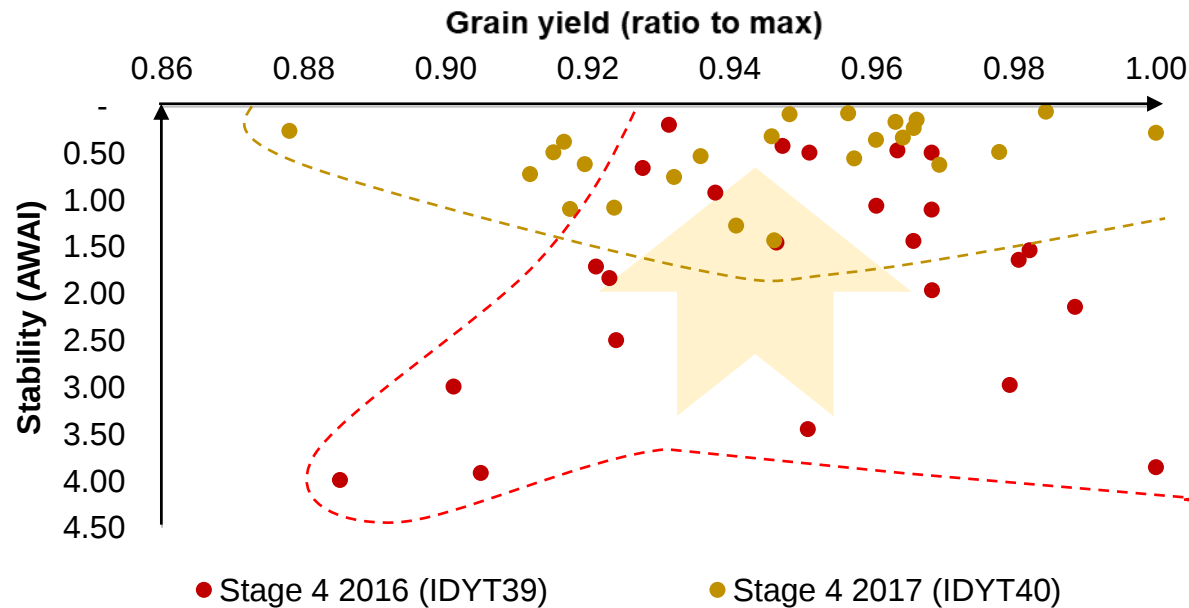
Fanaye (Senegal)



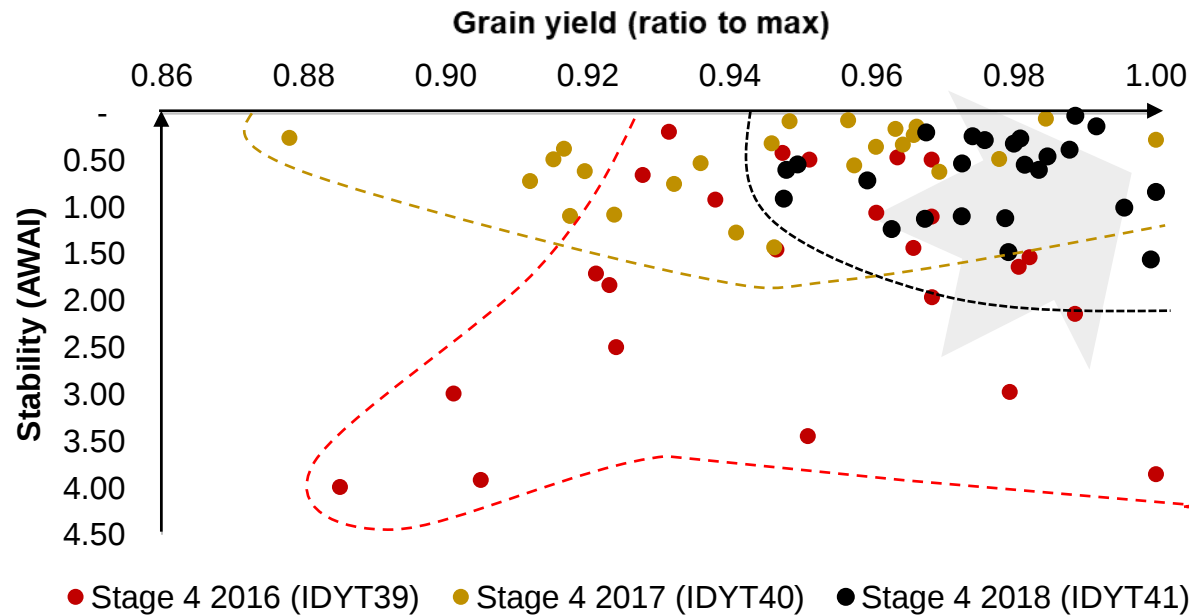
Managing GxY with GxE: Stability



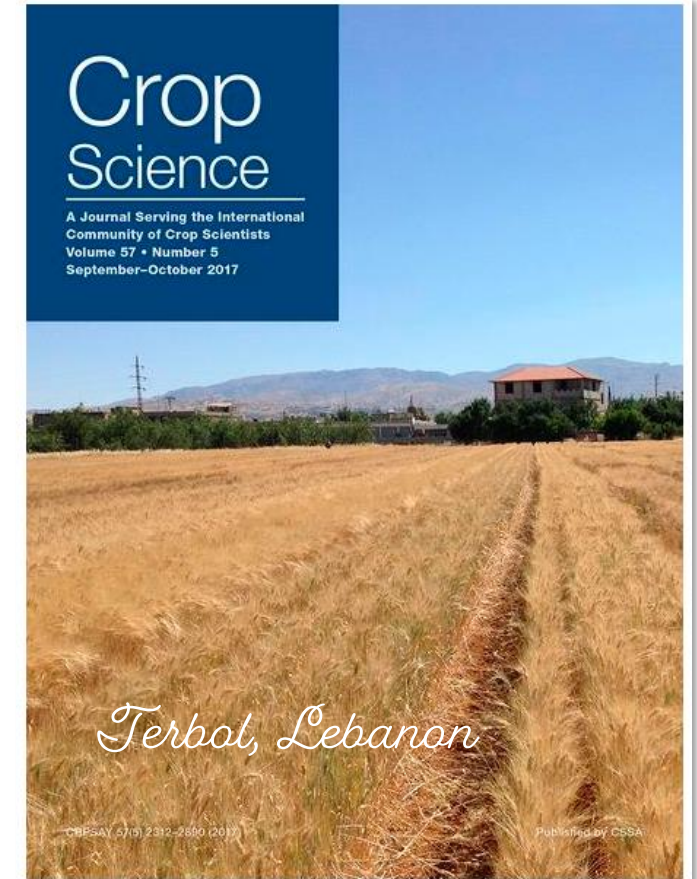
Managing GxY with GxE: Stability



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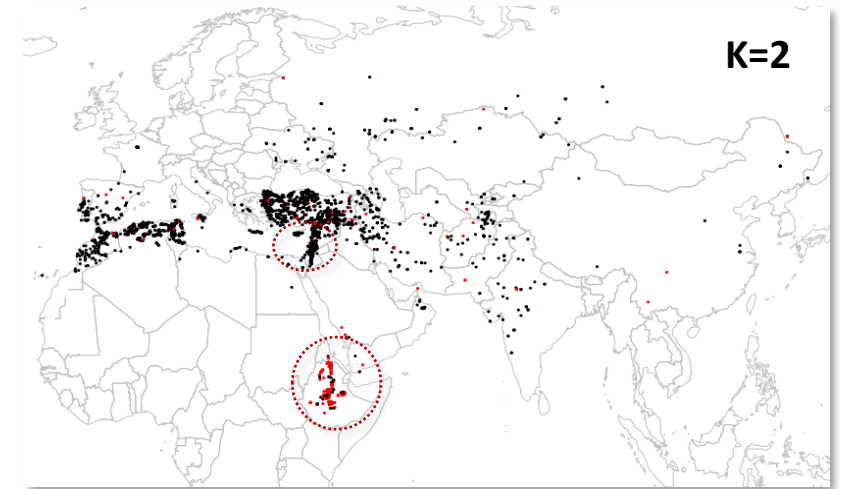
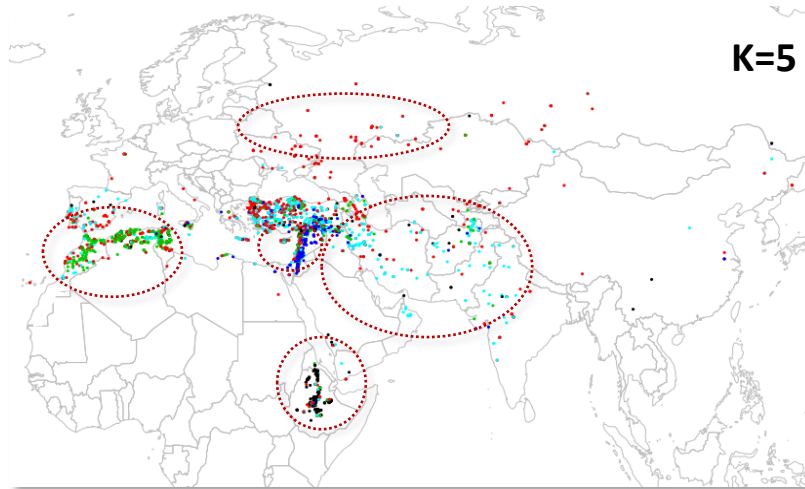


- **Genetic gain** for stability is possible!

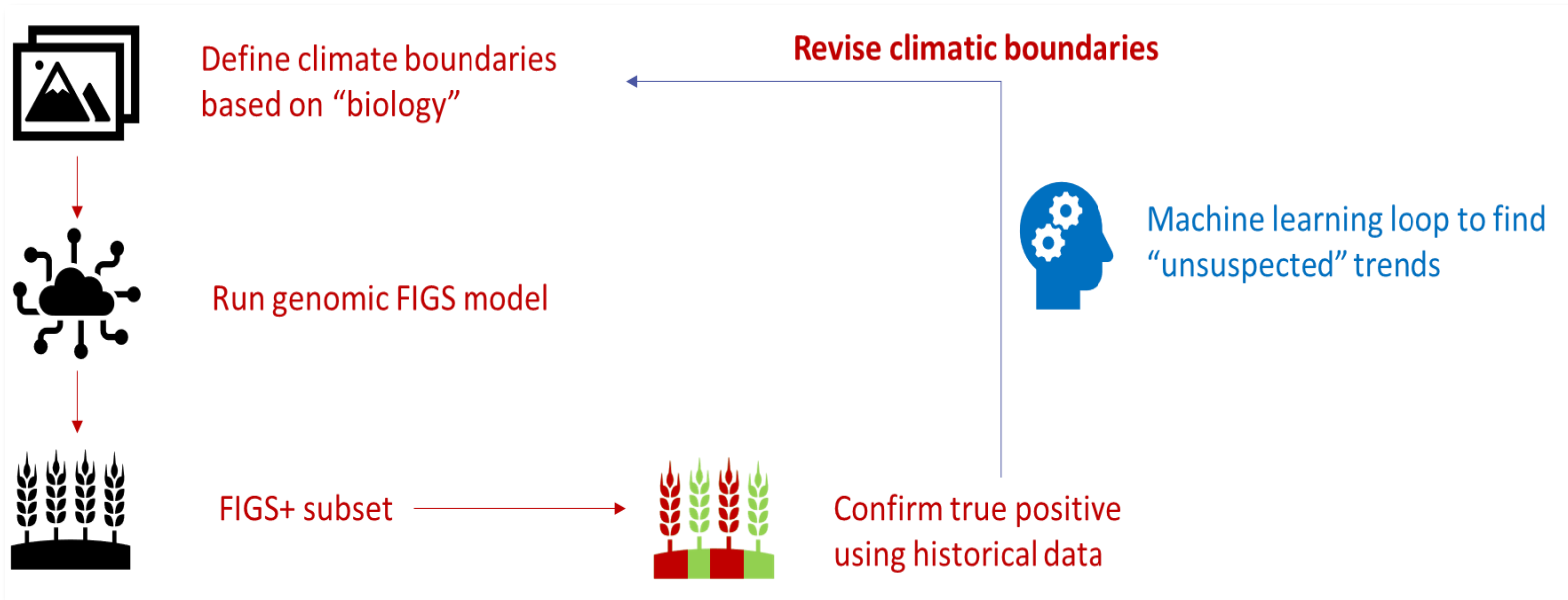


Where to find adaptation: **genebank**

- It is a “biblical” crop
- *Emmer* was domesticated over **10,000** years ago
- Probably **2 times**: Levantine and Ethiopia



Improving the GB usage: AI



Wheat TKW

Approach	Accuracy
FIGS	0.51
FIGS+ (GS)	0.78

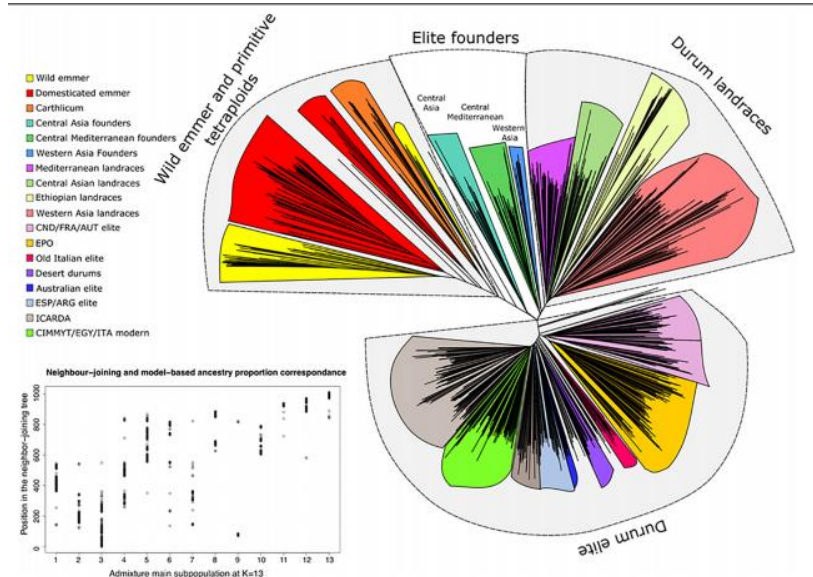
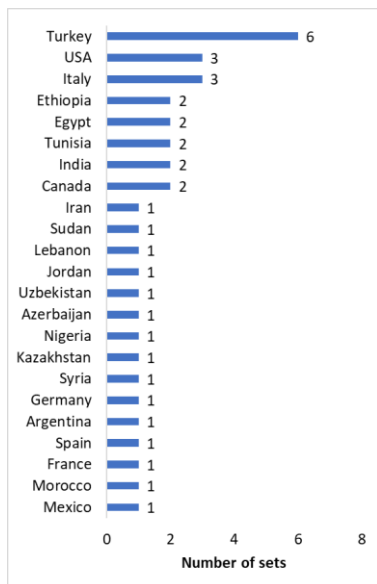
- **Machine learning**: use genomic predictions to "re-train" the model

The Global Durum Wheat Panel (GDP): An International Platform to Identify and Exchange Beneficial Alleles

Elisabetta Mazzucotelli^{1†}, Giuseppe Sciara^{2†}, Anna M. Mastrangelo^{3,4}, Francesca Desiderio¹, Steven S. Xu⁵, Justin Faris⁵, Matthew J. Hayden^{6,7}, Penny J. Tricker⁸, Hakan Ozkan⁹, Viviana Echenique¹⁰, Brian J. Steffenson¹¹, Ron Knox¹², Abdoul A. Niane¹³, Sripada M. Udupa¹³, Friedrich C. H. Longin¹⁴, Daniela Marone³, Giuseppe Petruzzino³, Simona Corneti², Danara Ormanbekova², Curtis Pozniak¹⁵, Pablo F. Roncallo¹⁰, Diane Mather⁸, Jason A. Able⁸, Ahmed Amri¹³, Hans Braun¹⁵, Karim Ammar¹⁶, Michael Baum¹³, Luigi Cattivelli¹, Marco Maccaferri², Roberto Tuberosa² and Filippo M. Bassi^{13*}

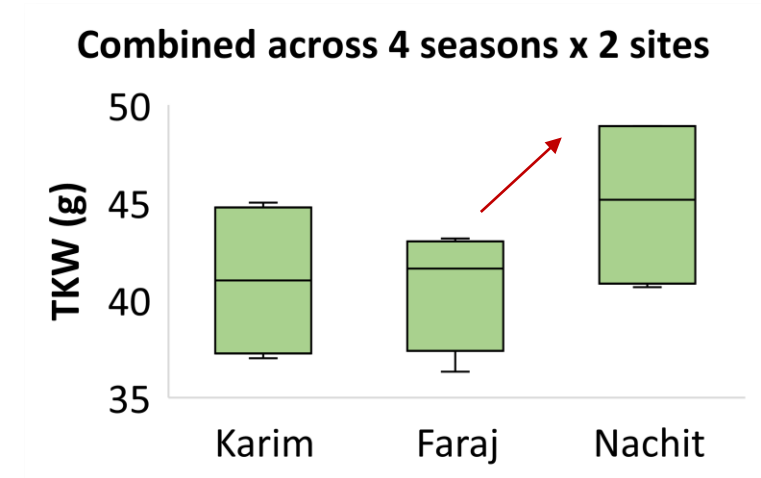
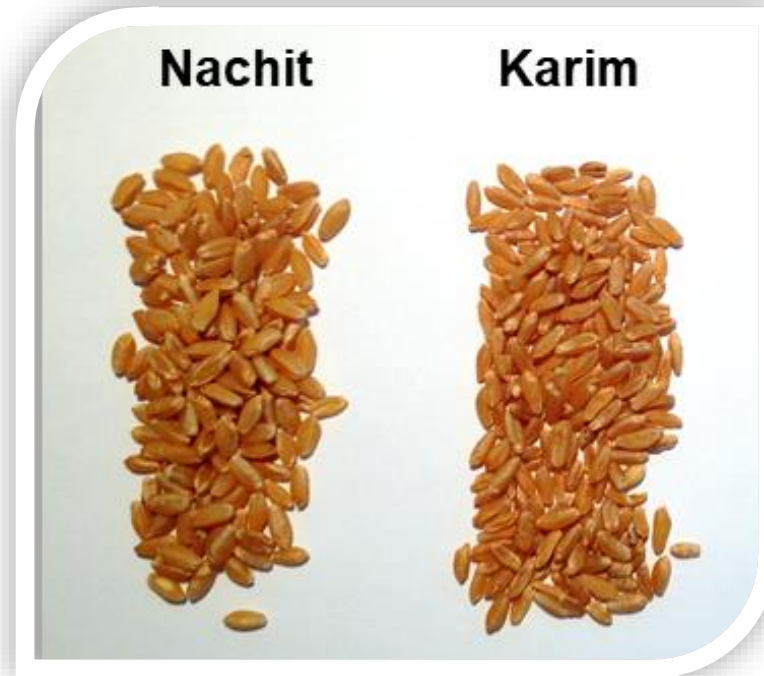
Global Durum Panel: tackling climate change together

- **23 countries** together to discover new useful alleles



“Nachit”: wild emmer for grain size

- Amedakul/T. dicoccoides Syr//Loukus
 - Released for its large grains (+3-4 gr TKW) and *high protein +2%*



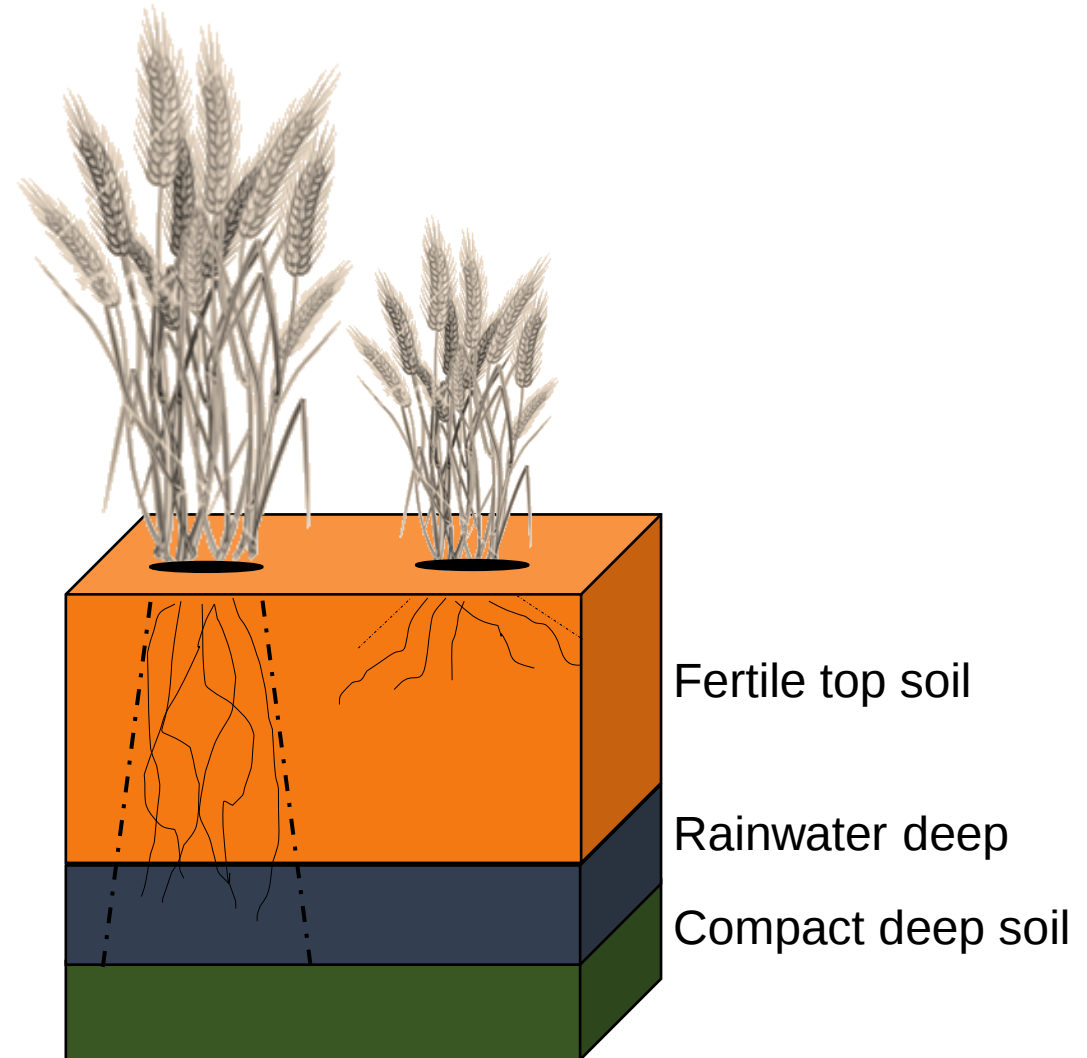
Wild Speltoides roots for drought tolerance

Jabal

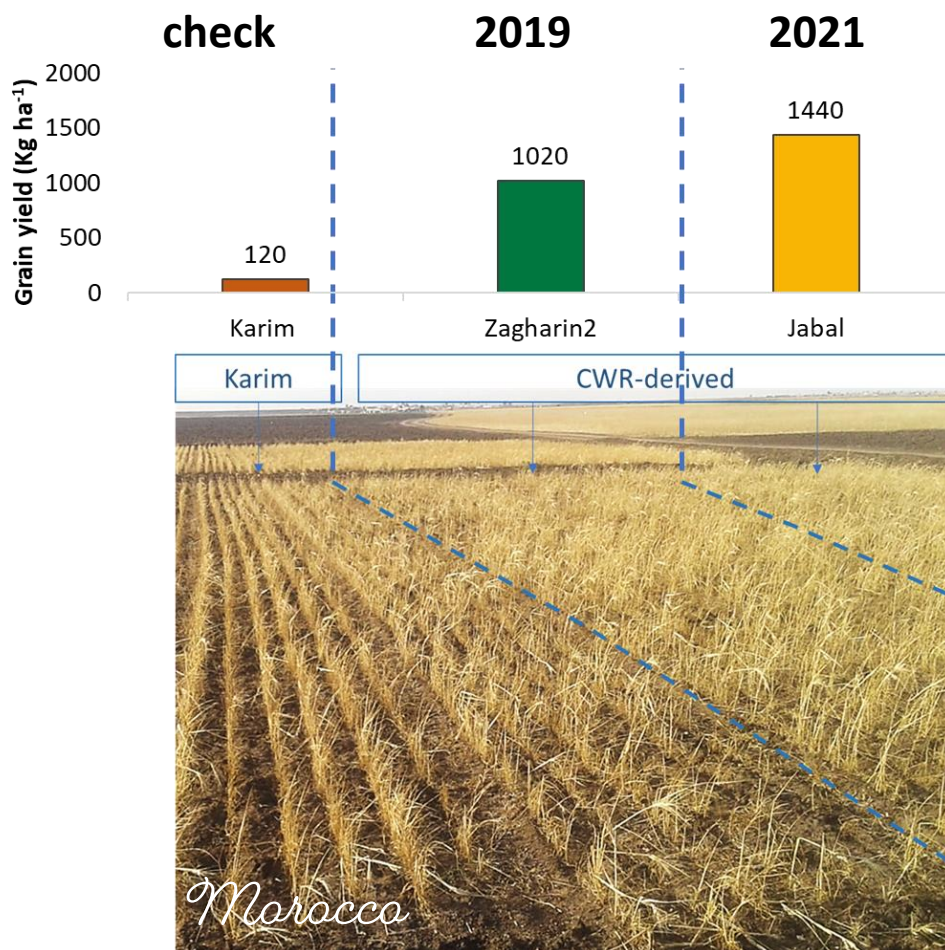
Karim



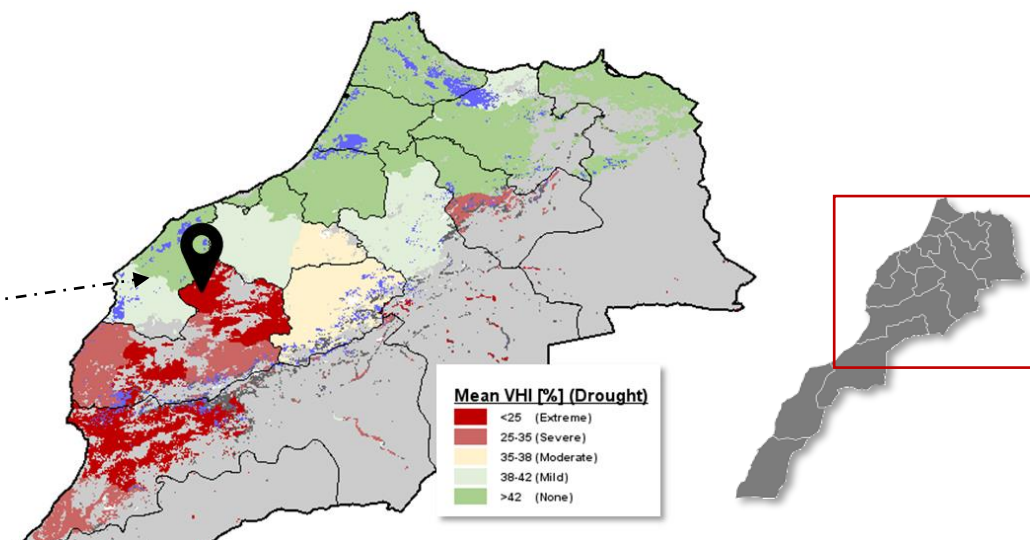
Korifla/**AegSpeltoidesSyr**//Mrb5



Value of roots in Moroccan drylands



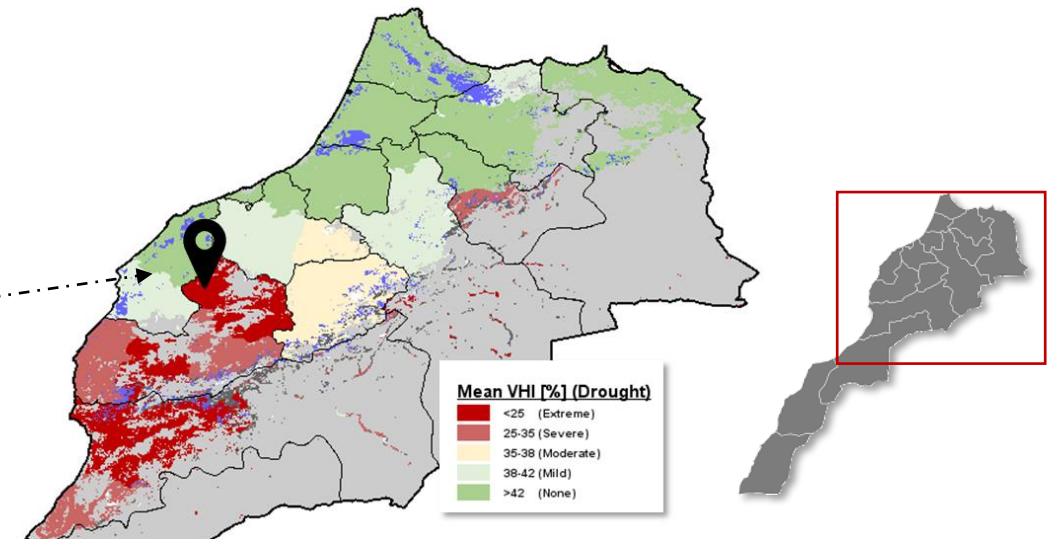
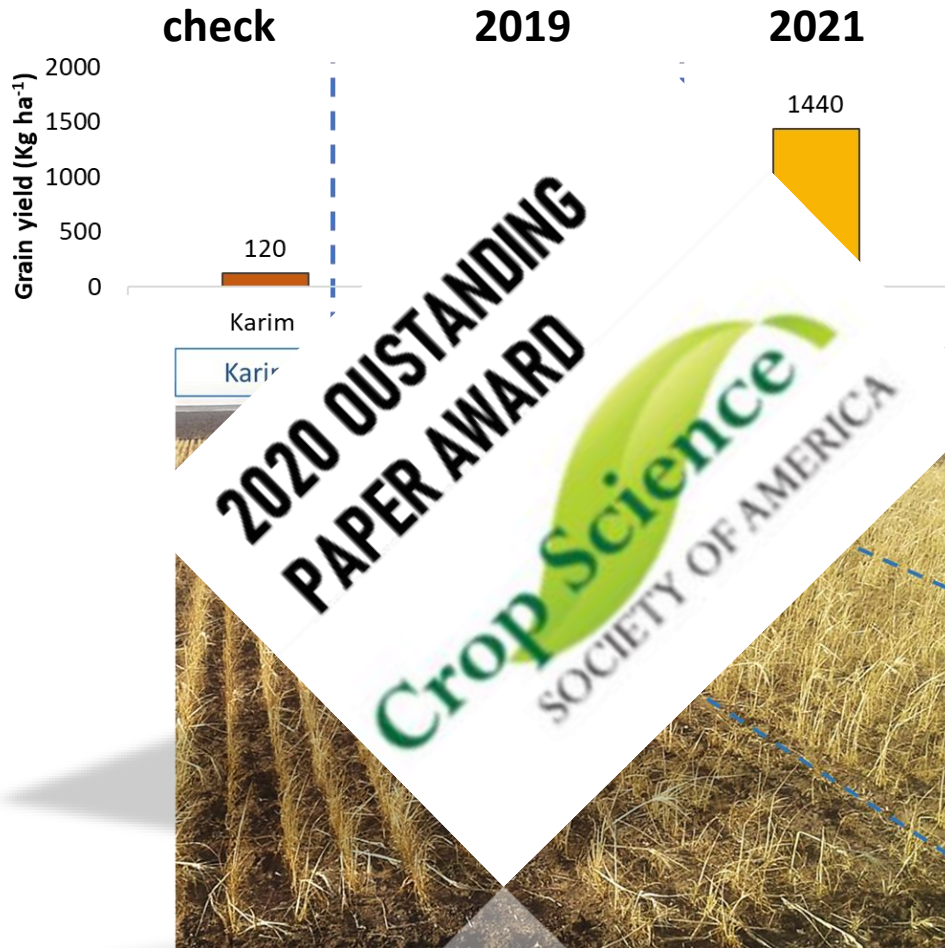
- On farm : **152 mm** total rainfall in Safi region (Morocco)
- Jabal* (Korifla/**AegSpeltoidesSyr**//Mrb5) produced 12-times the commercial check (Karim)



El Hassouni et al. 2018. **Crop Science**,
Doi:10.2135/cropsci2018.01.0076

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Heat tolerance project

Kaedi, Mauritanie



Fanaye, Senegal



Phenotypic evaluation in the Heat of the Senegal River

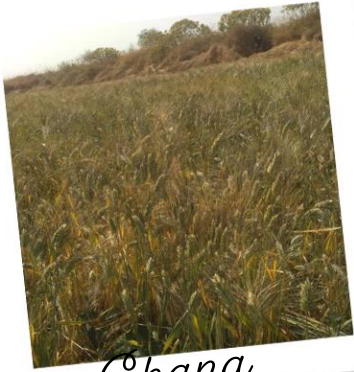
- GY >3,500 Kg ha⁻¹
- Maturity < 95 days
 - **Amina, Haby and Dioufissa**



Sub-Saharan durum wheat



Mali



Ghana



Benin



Senegal



Cote d'Ivoire



Zimbabwe



Olam

PRIZE FOR INNOVATION
IN FOOD SECURITY

Sall et al. 2019 Doi: 10.3390/agronomy9050263

From 1% to 1.8%: a revised program

Cross



F1 > F4

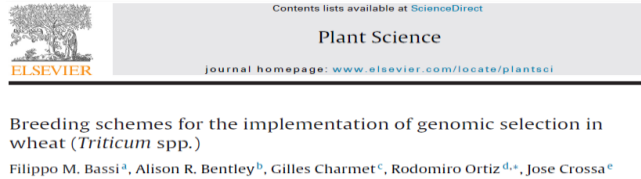


Stage 1



Stage 2

14 countries



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Speed Breeding, Morocco



Pheno Buggy, Morocco



From 1% to 1.8%: a revised program

Packed with **DIVERSITY**

Advancing very **FAST**

Very high **ACCURACY**

Ensure **STABILITY**

Cross

Speed breeding


F1 > F4

Genomic selection


Stage 1

Phenobuggy


Stage 2
14 countries

Speed Breeding, Morocco



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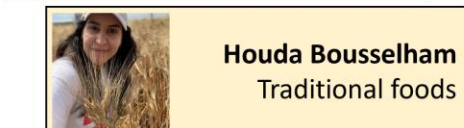
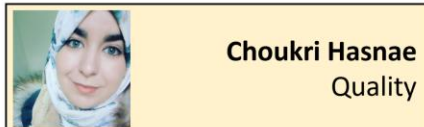
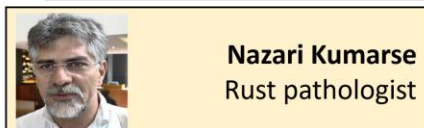
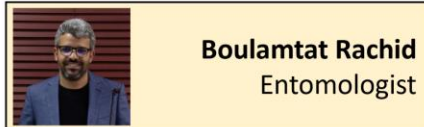
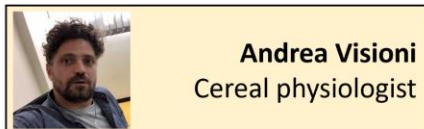
Conclusion and future trends

- **The environment is changing**, but breeders can use it to their advantage
- **GS and Speed breeding** are tools, if well used can deliver gain, but they can also **reduce it**

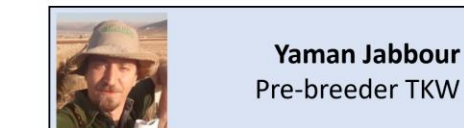
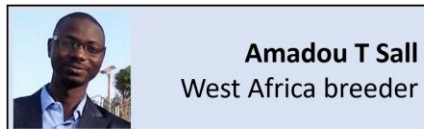


Thank you

Trait assessment team



Breeding team



Data support team

