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Yield Potential and Yield Stability in Durum Wheat using Crop Wild Relative Crosses, and Participatory Assessment of Moroccan Farmers Preferences

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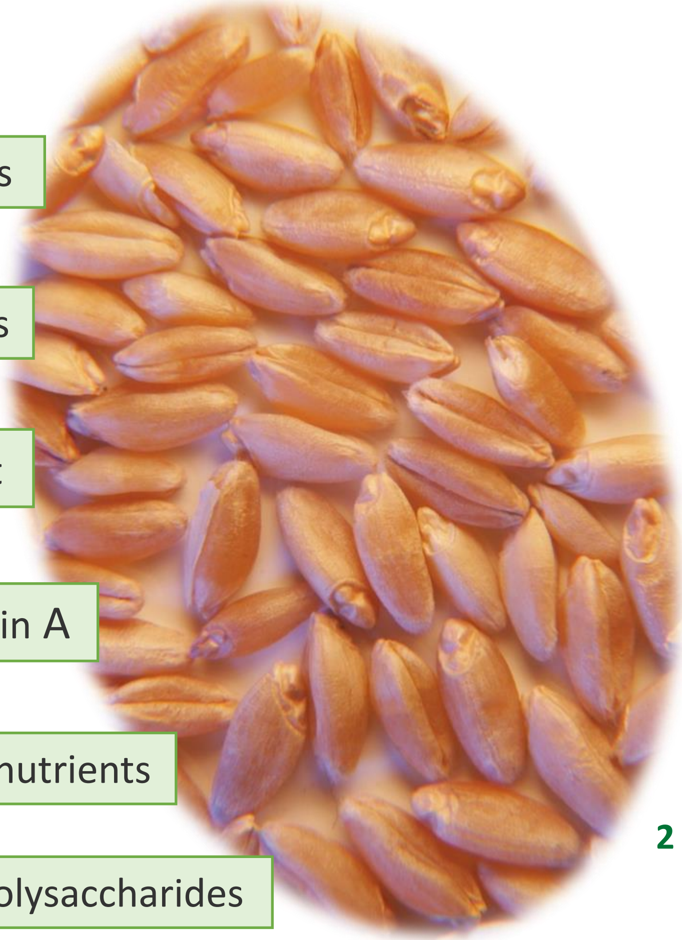
ICARDA
Science for resilient livelihoods in dry areas

Durum wheat: Major Crop in the Mediterranean Basin

- Triticum turgidum L. is a tetraploid species (2n = 28)

- Represents a staple food in the human diet owing to its nutritional and technological features.
    - Macaroni
    - Pasta
    - Spaghetti
    - Semolina
    - Couscous
    - Bread



Carbohydrates

Antioxidants

Protein content

Pro-vitamin A

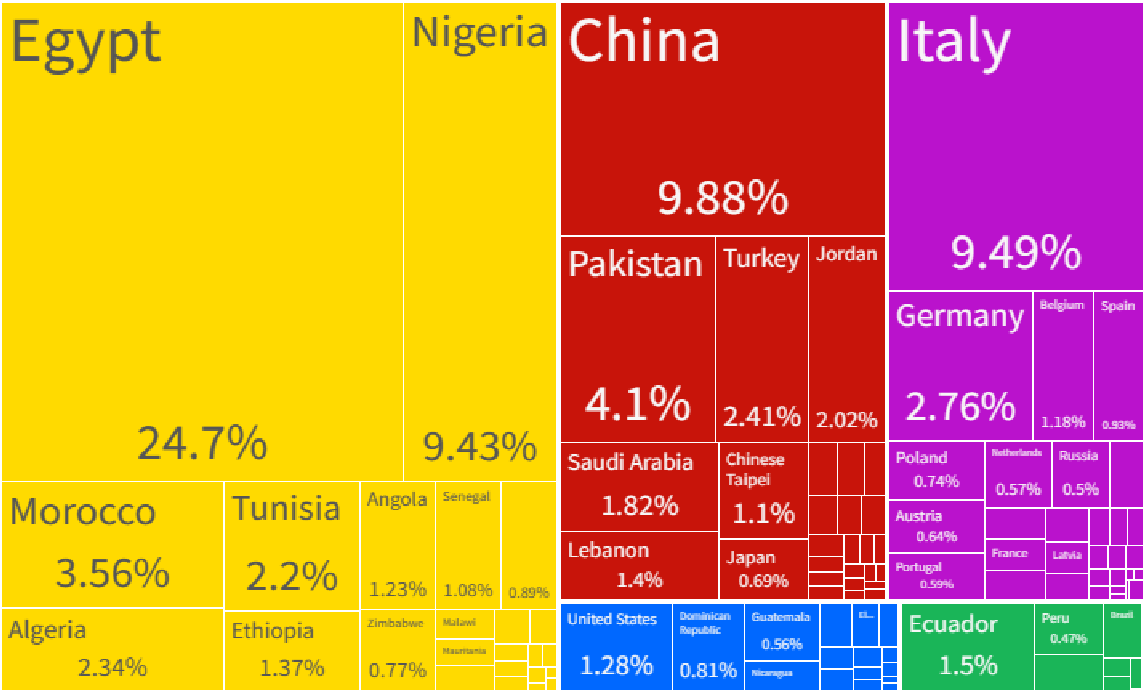
Micronutrients

Polysaccharides

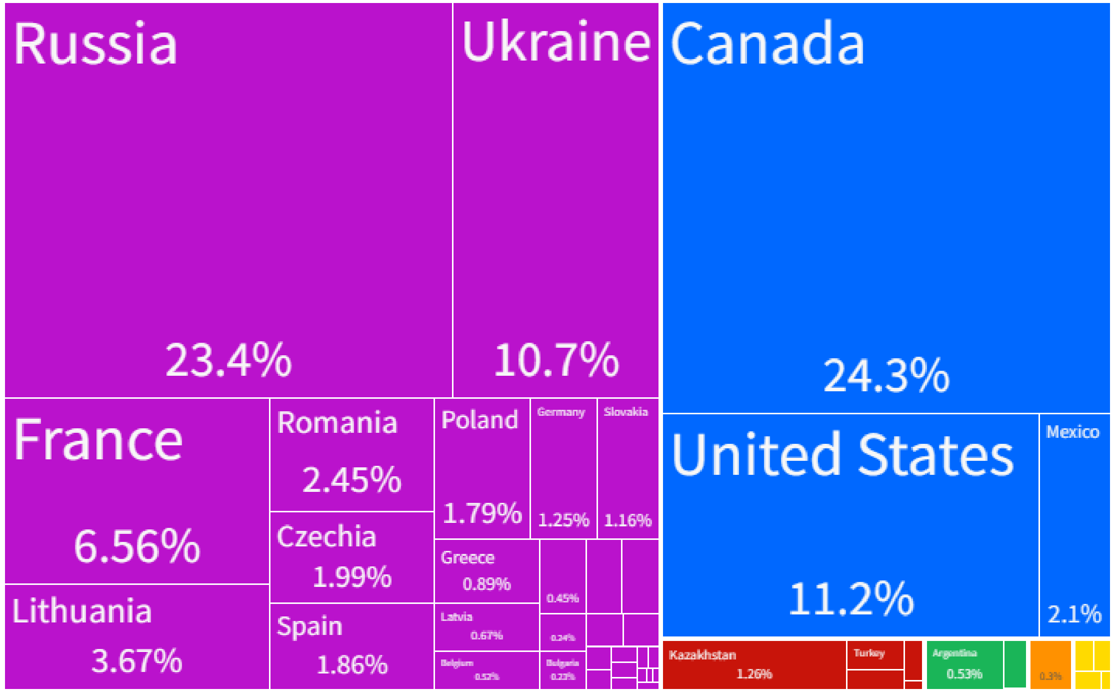
Durum wheat: global market

- **Top exporters:** Canada ($1.78B), Russia ($1.7B), Ukraine ($1.15B), and United States ($772M)
- **Top importers:** Nigeria ($1.58B), Egypt ($1.35B), Italy ($898M), Saudi Arabia ($608M), and Ethiopia ($528M).
- **The global pasta market size: USD 25.67 billion** in 2023**,** by 2032 **USD 31.14 billion.**

Importers of durum wheat
Total: $9.37B

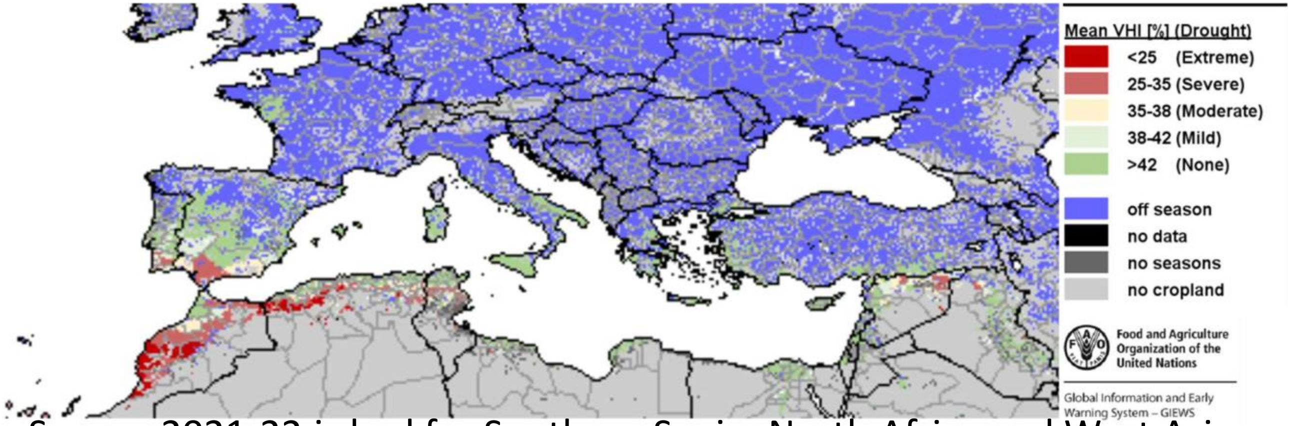


Exporters of durum wheat



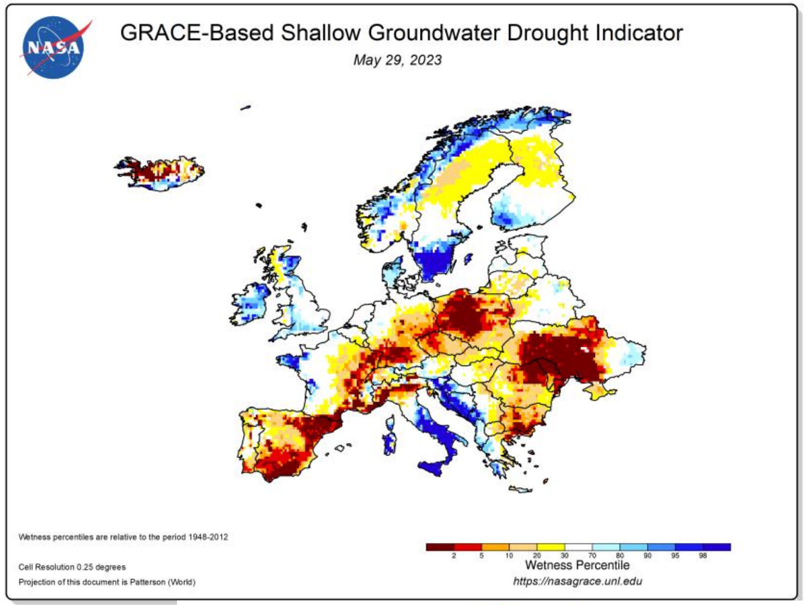
Status: 90% of our Durum wheat is currently under drought conditions

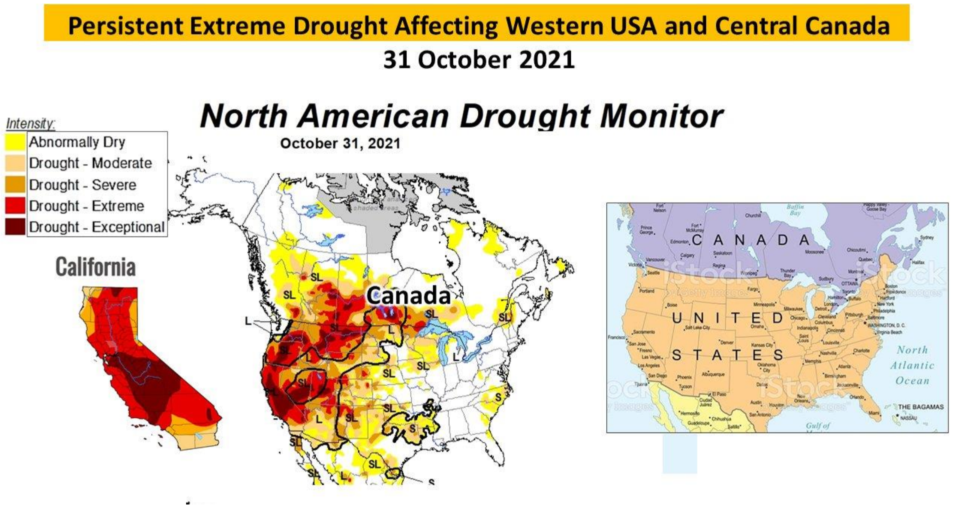
Mediterranean basin

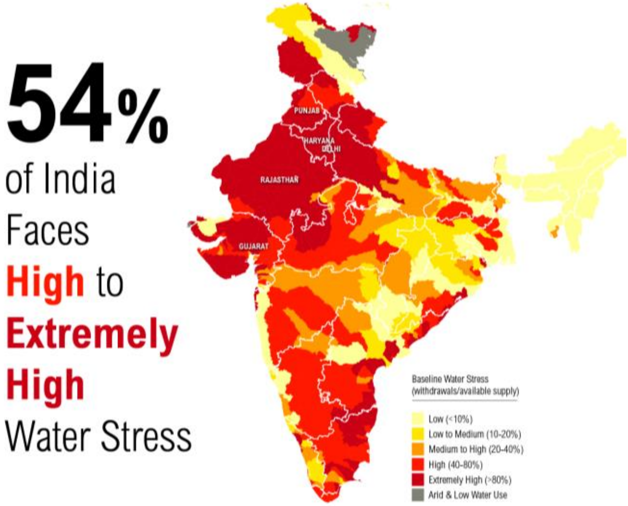


- Season 2021-22 is bad for Southern Spain, North Africa and West Asia

Russia's wheat acres are under growing **drought stress**







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Crop wild relatives : Treasures from the past

- Crop wild relatives (CWR) are undomesticated species related to the cultivated crops, considered to be a rich source of untapped genetic diversity.

- It is estimated that 30–50% of the favorable alleles in modern breeding lines were contributed by wild relatives.

- ICARDA genebank-Rabat Morocco holds more than 44,450 accessions of wheat and more 5,841 wild species accessions.

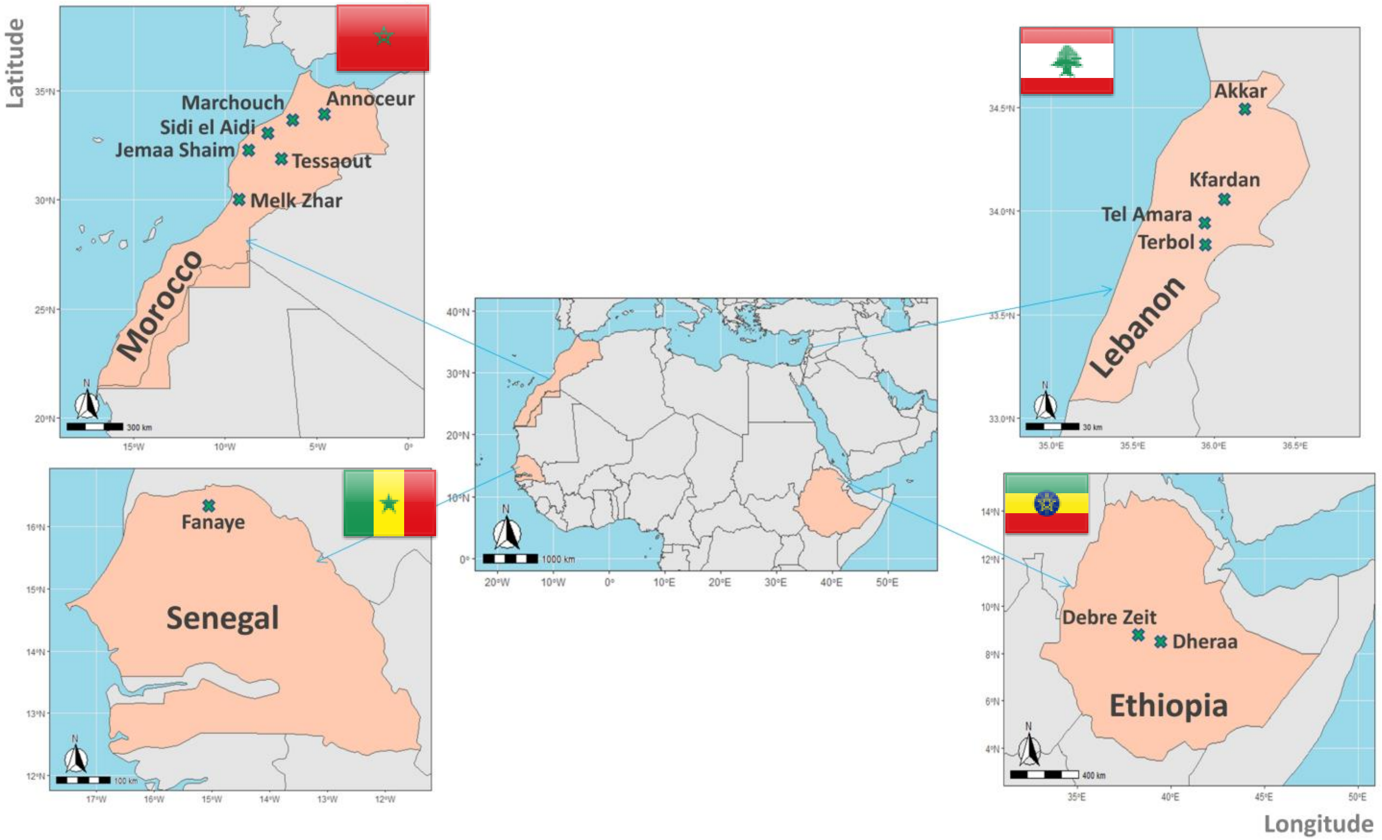
ICARDA genebank in Rabat, Morocco

Assessment of CWR across a range of environments

19 CWR-derived lines were assessed against the best checks.

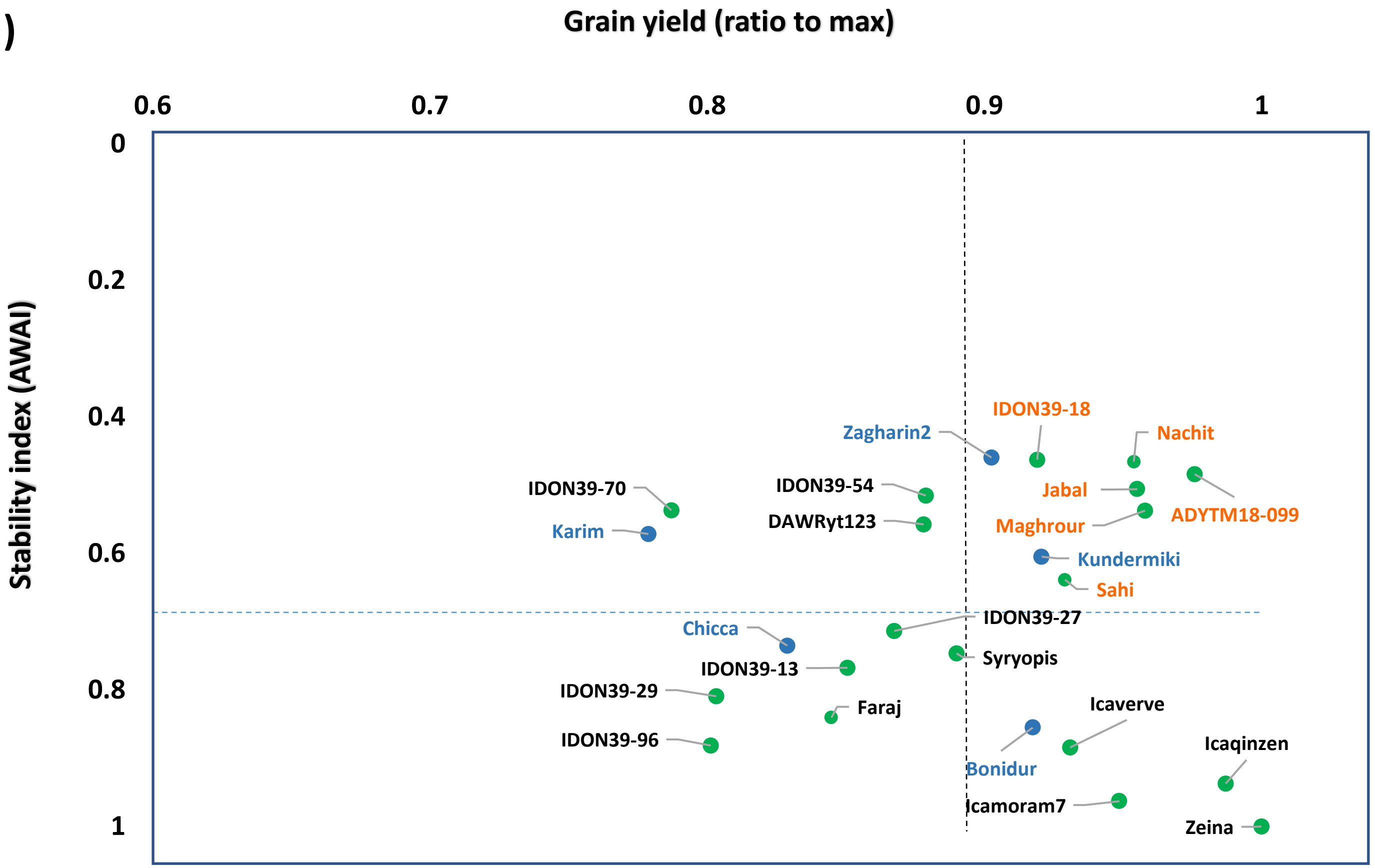
Two cropping seasons evaluation across 13 locations.

A total of 19 environments were used over two seasons (2018-19 and 2019-20)



Yield potential and stability (GxE) across environments

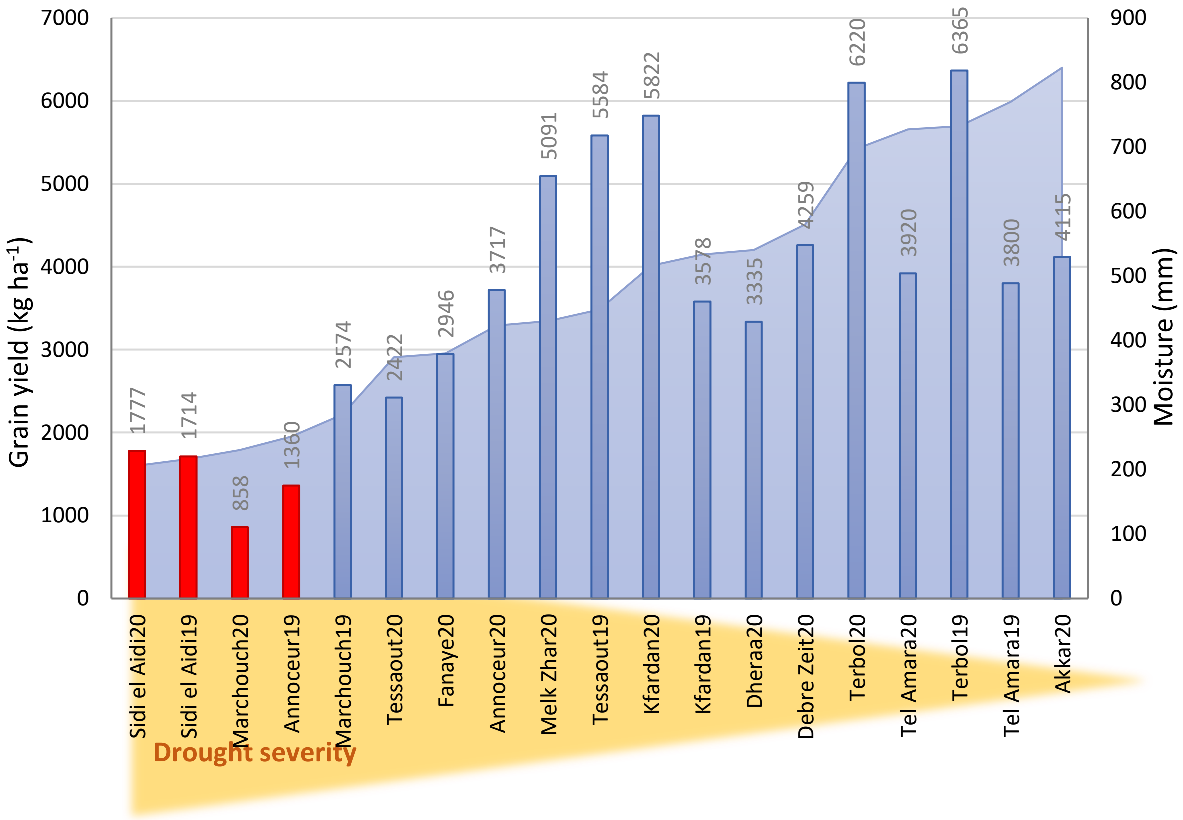
AMMI wide adaptation index (AWAI)

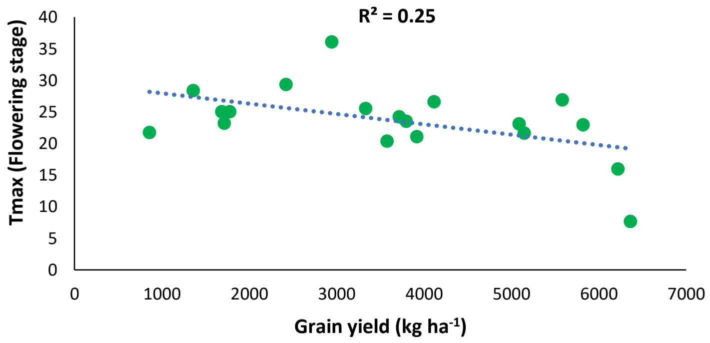


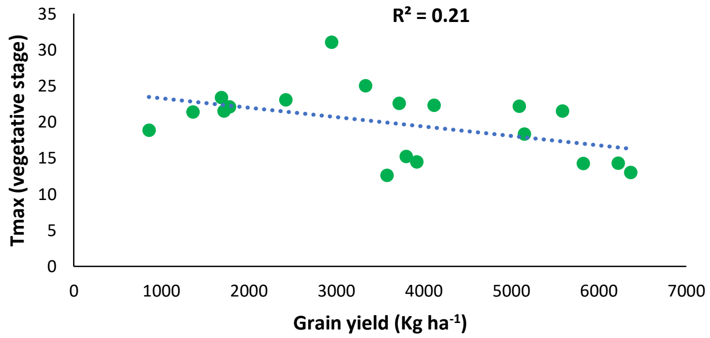
ADYTM18-099 : Amedakul1/**Tdico**SyrCol//Cham1/3/Korifla/**AegSpeltoide**sSyr//Amedakul
Nachit: Icamor**T. araraticum**0471//Icamor**T. araraticum**0459/Ammar8/4/Stj3//Dra2/Bcr/3/Ter3
Jabal: Korifla/**AegSpeltoides**Syr//Mrb5

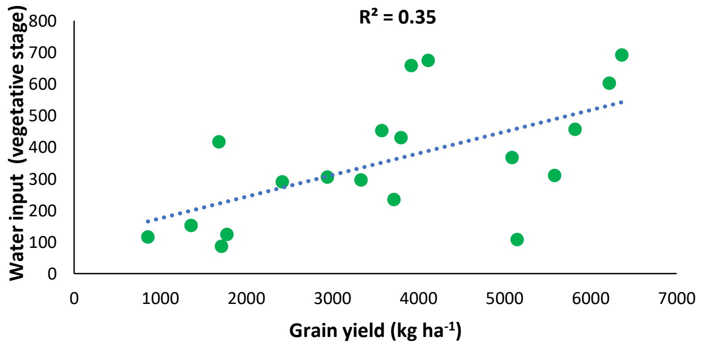
Adaptation and stability analysis of ICARDA durum wheat elites across 18 countries
F. M. Bass &,M. Sanchez-Garcia. Crop Science 57.5 (2017): 2419-2430.

Traits Influencing GY across Mega-Environments

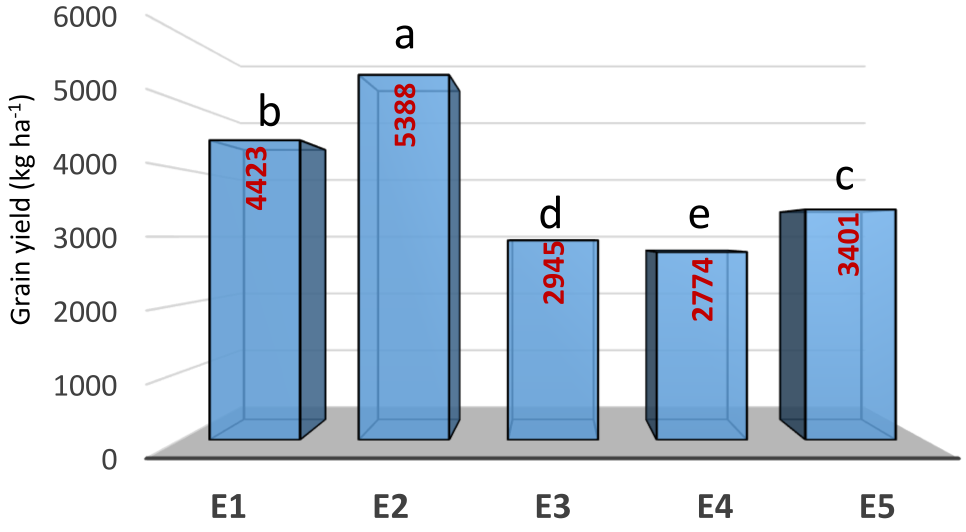


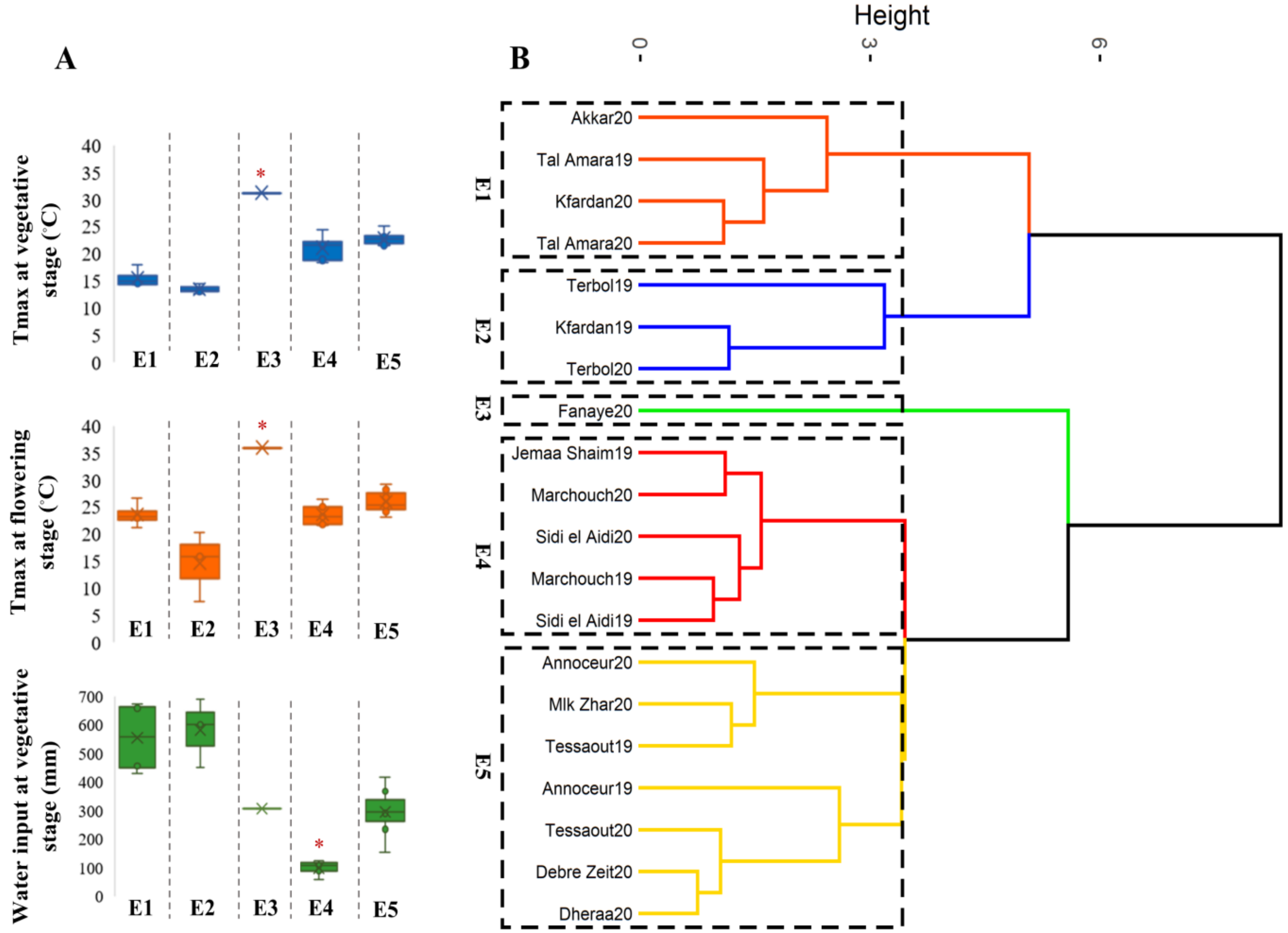




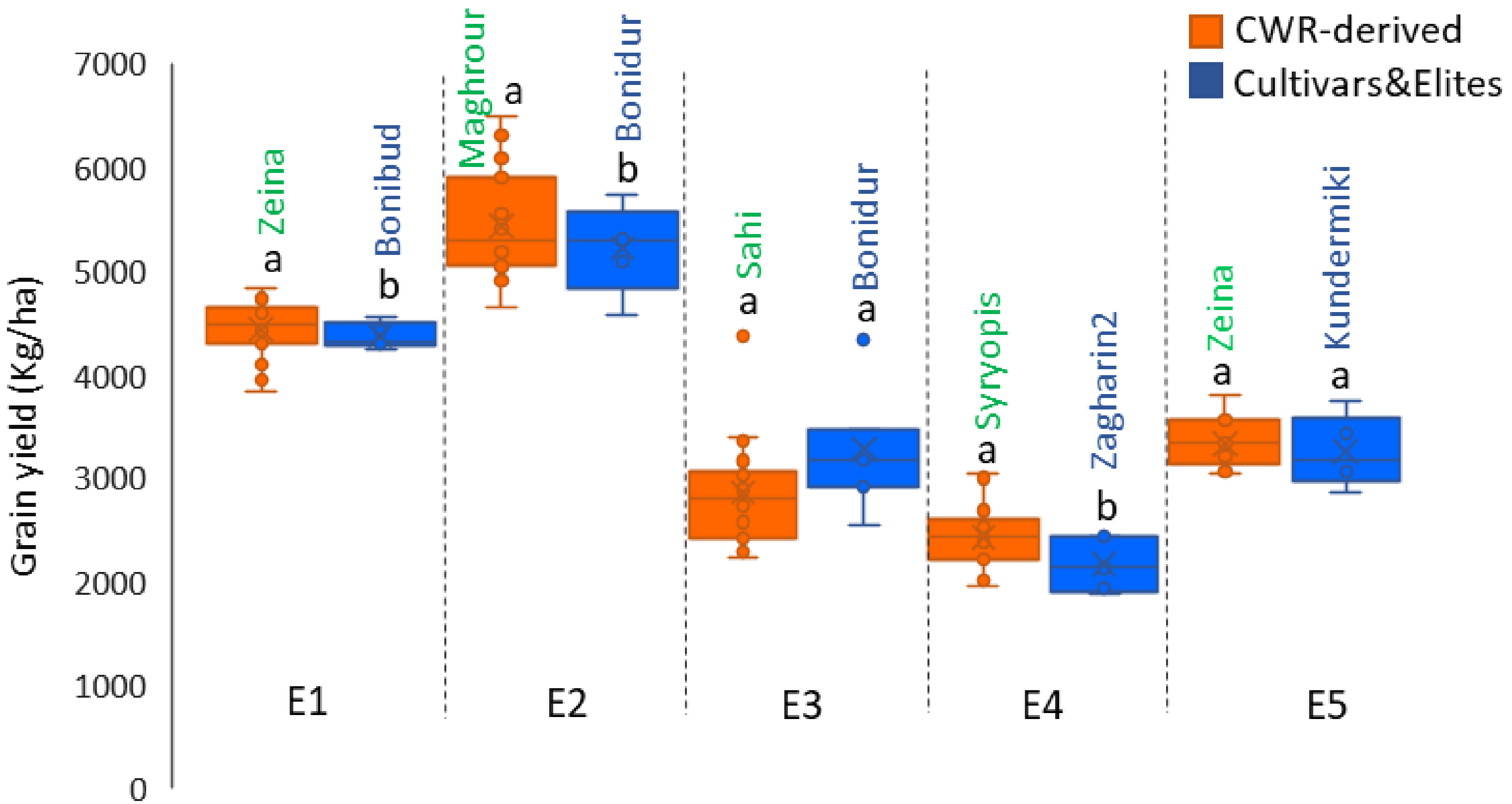


Traits Influencing GY across Mega-Environments





Yield Performances across Clusters of Environments



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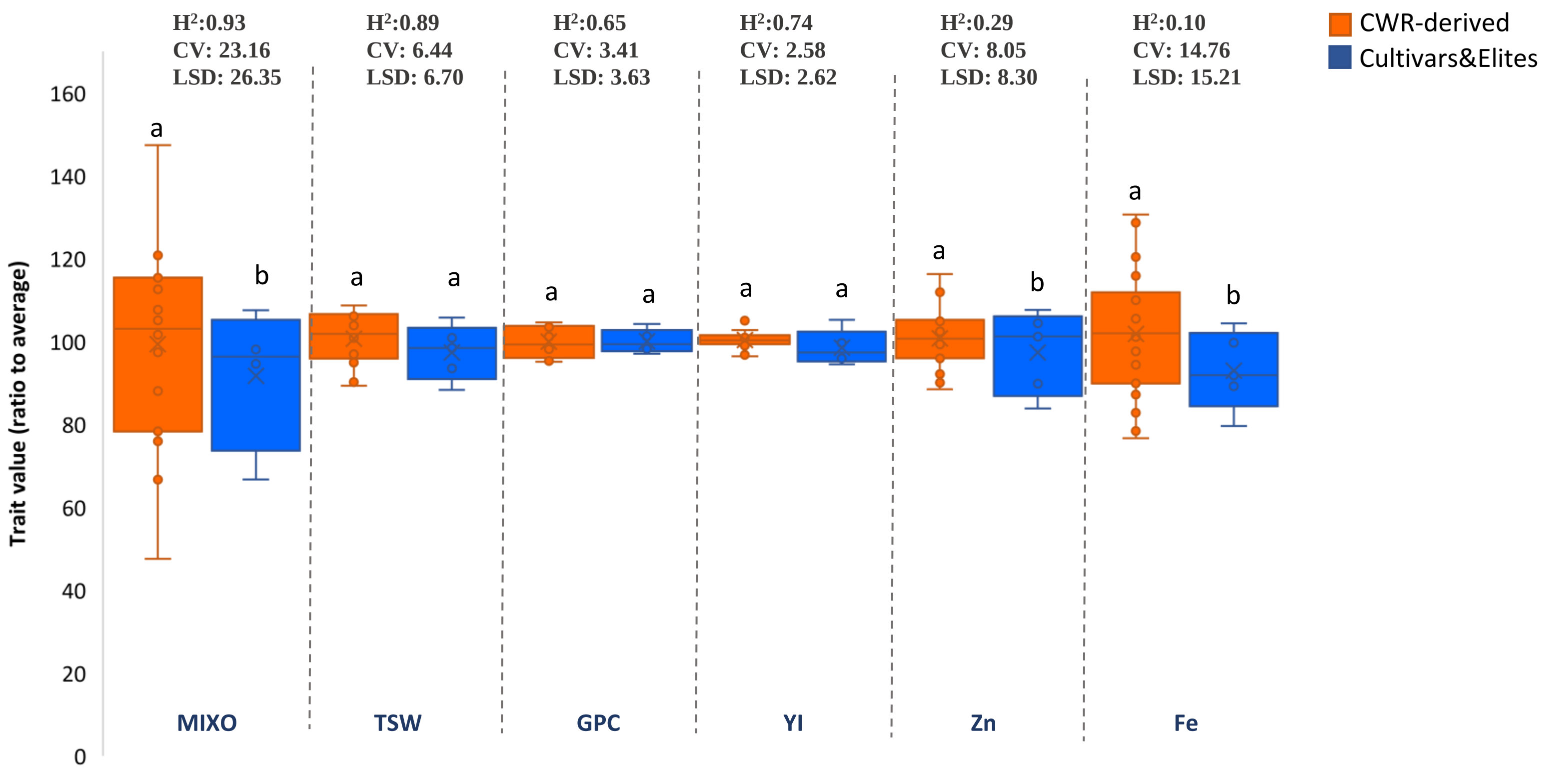
Food transformation characteristics

- ✓ CWR- elites are important source to enhance Zn and Fe content, MIXO score and grain dimensions
- ✓ CWR provided highest MIXO score, indicative of outstanding pasta and bread making quality.



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Participatory varietal selection

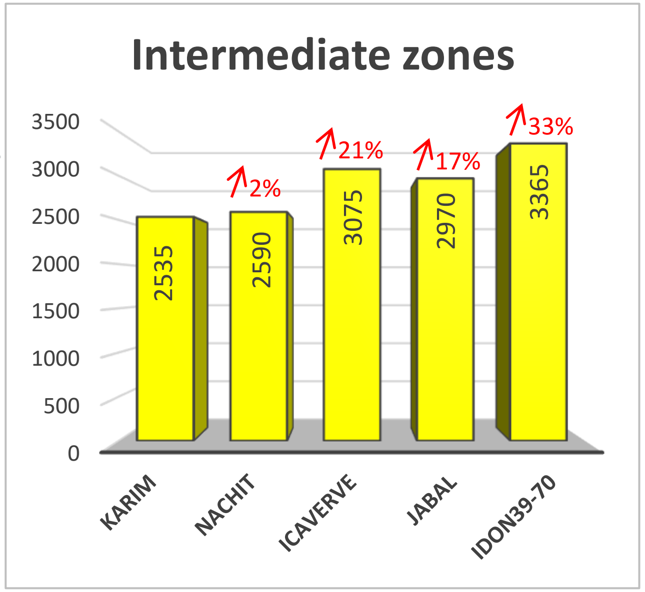

In Marchouch, Ahmed El Amri checking the *Aegilops speltoides*-derived *candidate variety "Jabal", Photo courtesy of Michael Major/Crop Trust.*

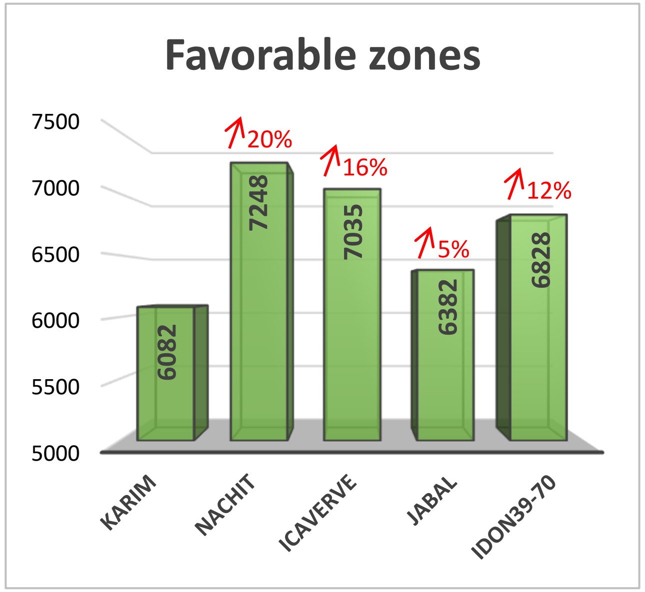
Farmers' Opinions Matter

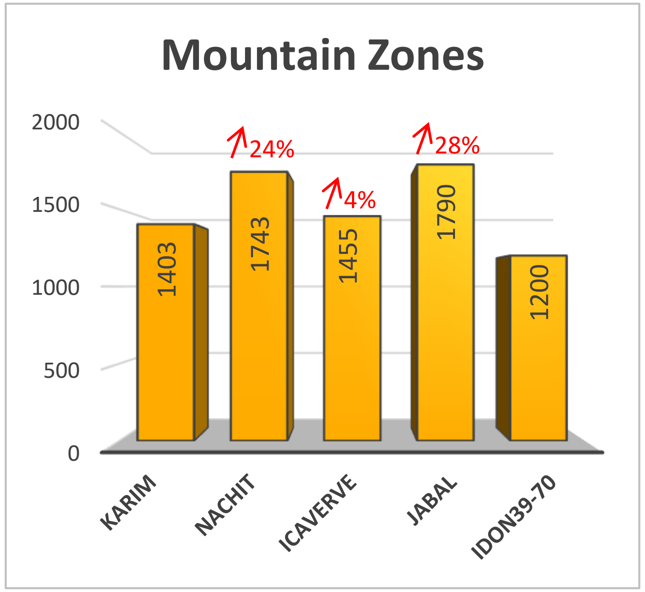
CWR- elites increasing farmers return

Aaziz Haddou has improved his grain productivity in Guigou by utilizing the CWR-derived lines. *Photo courtesy of Michael Major/Crop Trust.*

1st season of evaluation: 2018-2019



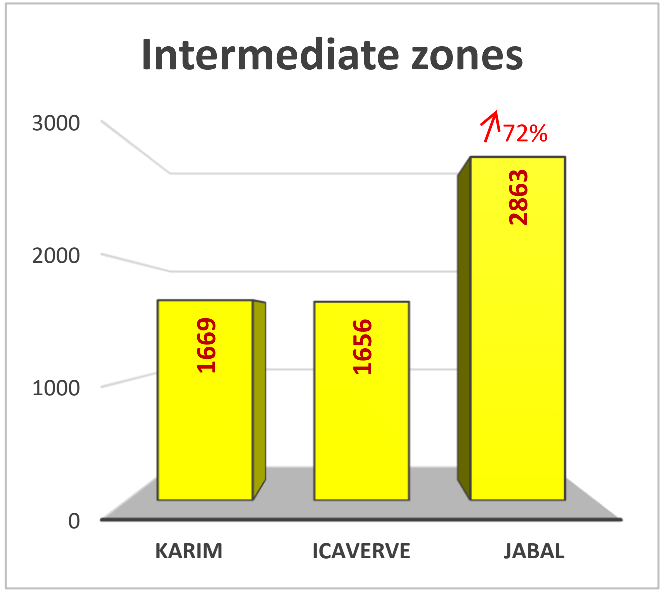


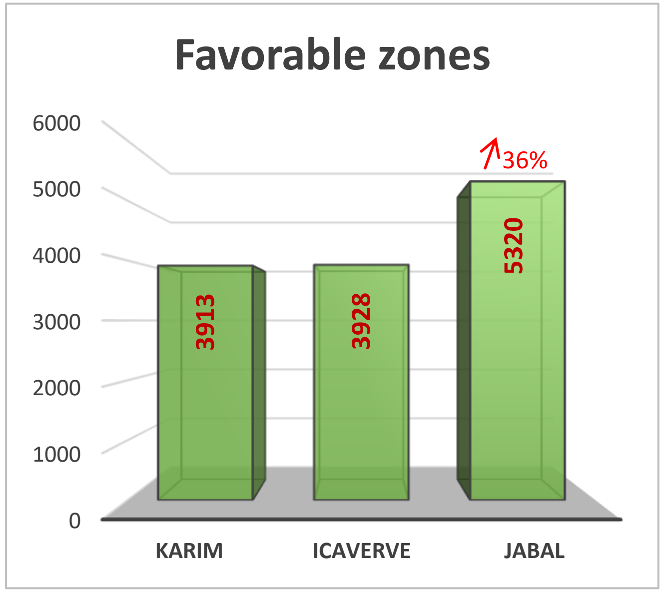


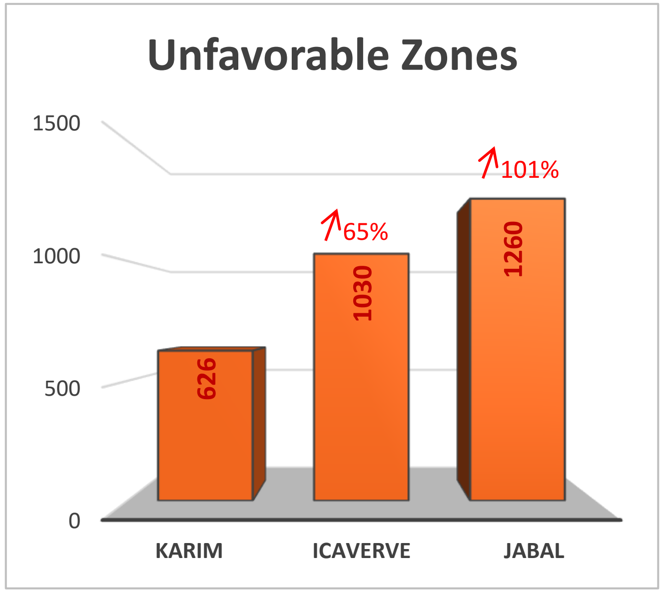
CWR- elites increasing farmers return

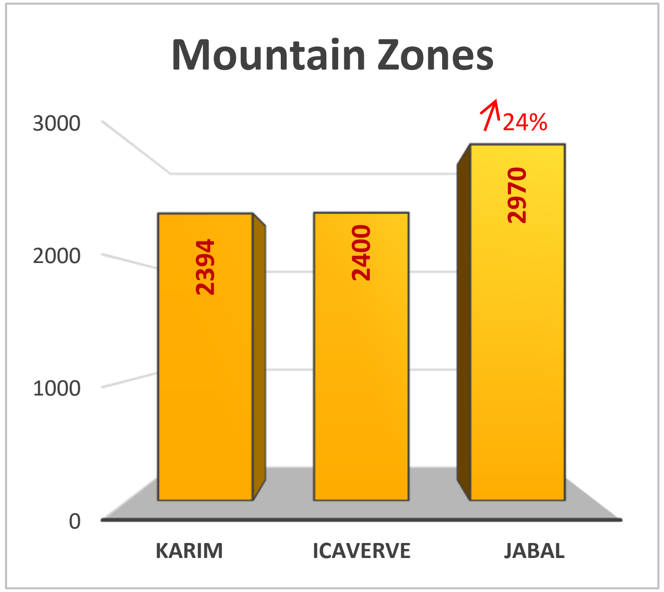
In Tedla, El Kbir Safraouithe looking at his field that is covered by CWR-derived lines.
Photo courtesy of Michael Major/Crop Trust.

2sd season of evaluation: 2019-2020

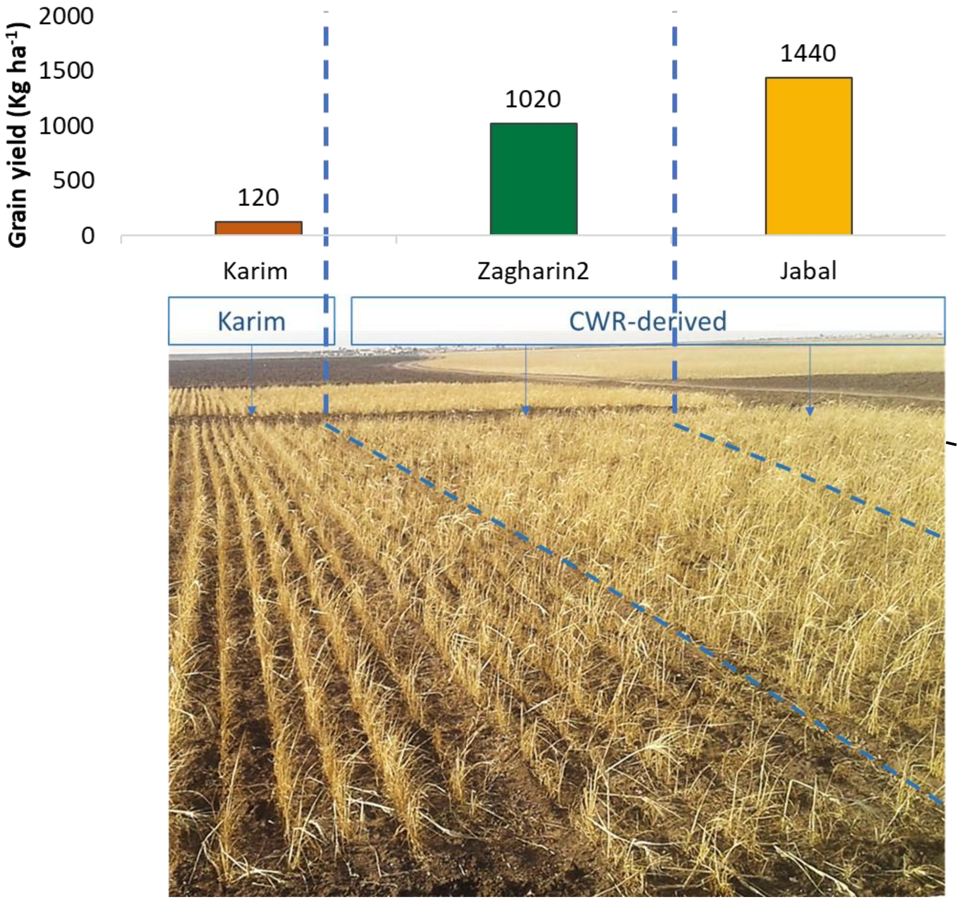






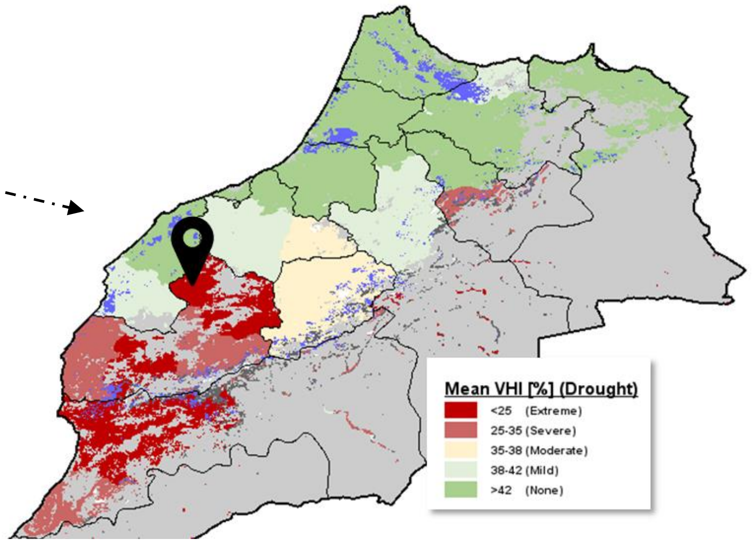


Surviving extreme droughts

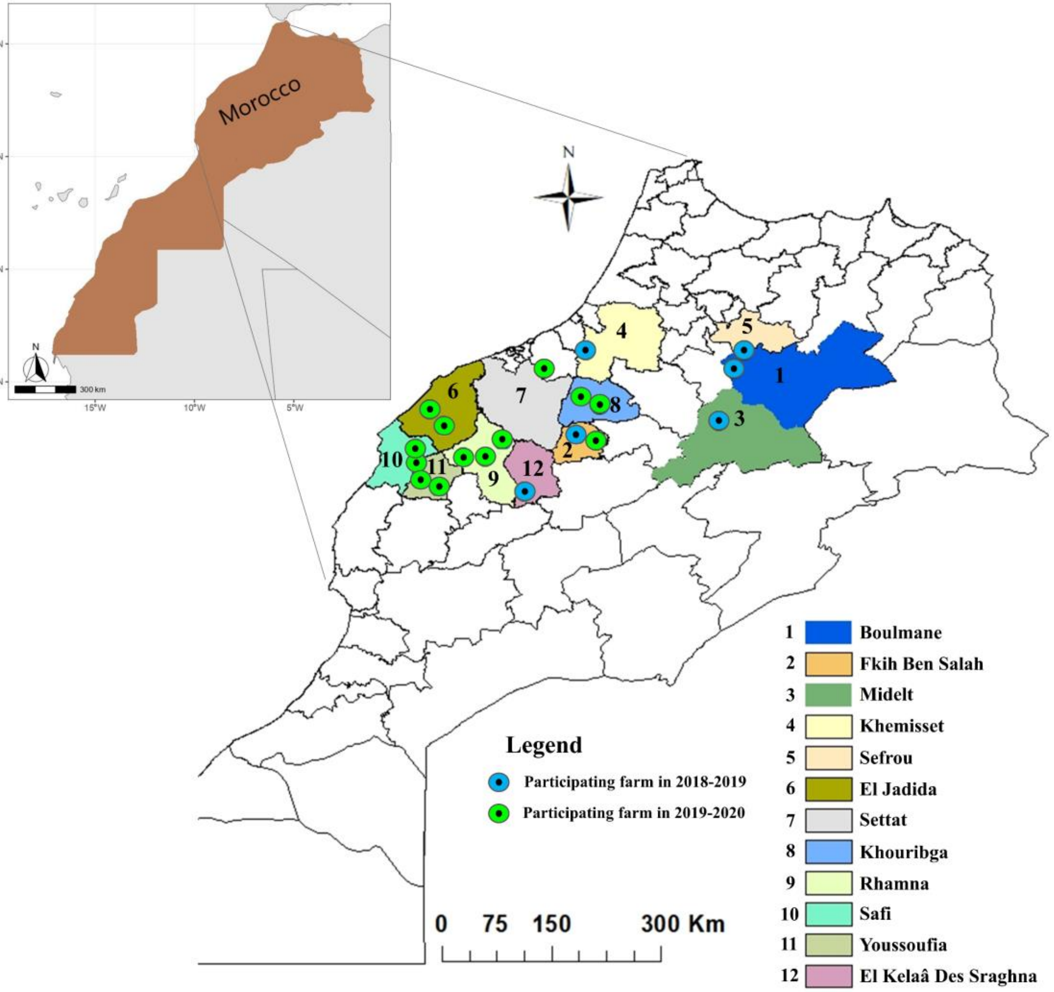


Season 2019-2020, Safi region

*CWR-derived lines of durum wheat tested on farm achieved acceptable productions compared to the commercial check (Karim) under **152 mm total rainfall** in Safi region (Morocco)*



Participatory weighted selection indexes



- A total of 19 Moroccan farmers were involved.
- How much does this trait influence your preference to cultivate a variety?

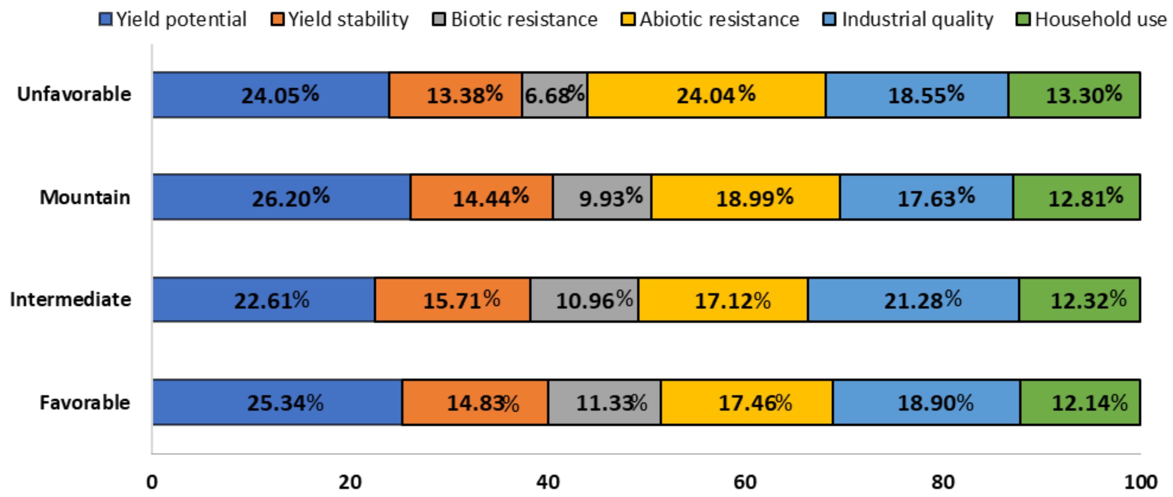
Broad criteria	Field measurement used to score
Yield potential	BLUEs calculated across all environments
Yield stability	AWAI index
Biotic resistance	Leaf rust
Abiotic resistance	Yield at a heat affected station, yield at a drought affected station, TSW at a worst yielding site
Industrial quality	Gluten strength and Colorimeter score for b* across all sites
Household use	Biomass yield, plant height and TSW across all sites

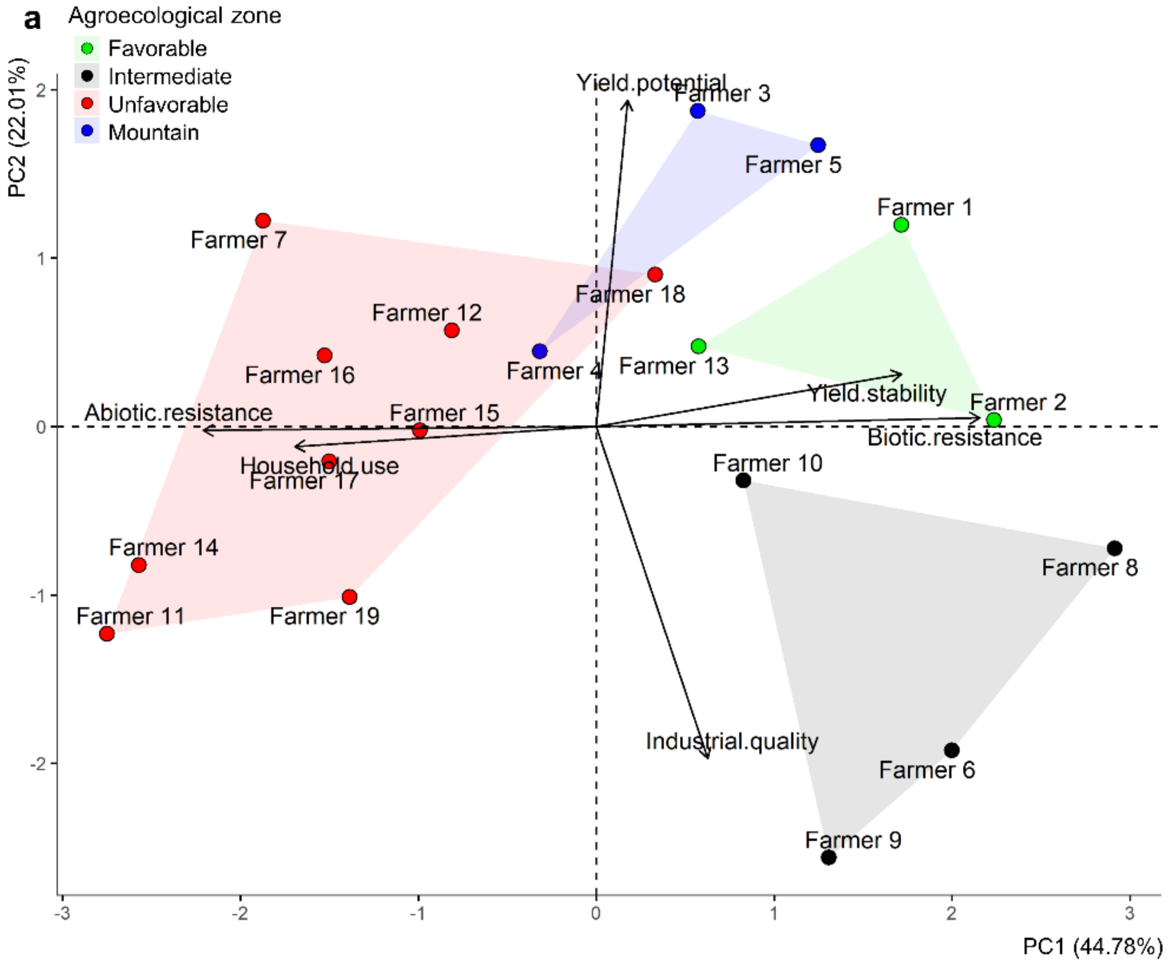
BLUEs; Best linear unbiased estimates, AWAI; AMMI wide adaptation index, TSW; 1000-seed weight; b* is the yellow color channel expressed by Konica Colorimeter.

Bassi, F., 2019. Selection by Stone. URL https//foodtank. com/news/2019/08/selection-by-stone.

Participatory weighted selection indexes

✓ Yield potential, abiotic stress and industrial quality were the most important traits for Moroccan farmers.

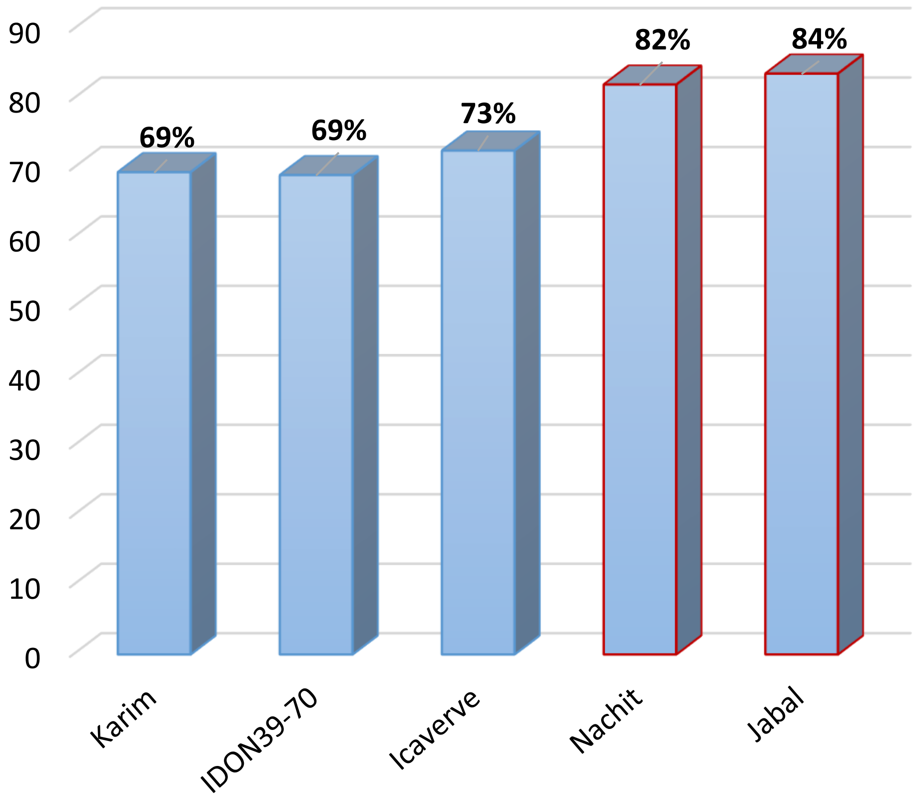




Participatory weighted selection indexes

Tab. The actual performances of the tested entries (El Haddad et al., 2021)

Entry	Yield potential	Yield stability	Biotic resistance	Abiotic resistance	Industrial quality	Household use
Karim	77%	43%	50%	59%	82%	92%
Nachit	**94%**	**56%**	**80%**	**85%**	**85%**	**98%**
Icaverve	**93%**	43%	50%	71%	84%	93%
Jabal	**94%**	**72%**	**80%**	**76%**	**85%**	**99%**
IDON39-70	77%	53%	80%	50%	82%	93%



- The CWR-derived lines Jabal was found as the most suitable entry for Moroccan farmers with up to 84% of the preferences, followed by Nachit.
- This is good agreement with field data.

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Six new drought-tolerant durum wheat and barley have been released in Morocco


Hessian fly (Mayetiola destructor, HF)

Six new drought-tolerant barley and durum wheat have been released in Morocco

- Food and fodder
- Easy thresh-ability (naked)
- Protéine = 13.9%
- Bêta glucane = 8%
- excellent resistance to net blotch disease

- Food and fodder
- Easy thresh-ability
- Protéine = 13.4%
- Bêta glucane = 4.4%
- excellent resistance to net blotch disease

- Feed
- Early
- Protéine = 14.4%
- Bêta glucane = 3.5%

MOUNTAINHER - Empowering women associations as drivers for agro-ecological transformation to generate income for Mountain farming communities.

MOUNTAIN HER
Empowering women in mountain farming communities


Seeding on farm by the farmer

- The focus is on barley and durum wheat, traditional foods
- Revive agriculture, diversify incomes, and promote social inclusion
- Inspire farmers to adopt eco-friendly agro-ecological practices
- The living lab fields assess barley and durum wheat cultivars, driving circular economies and empowering rural women to secure higher prices for local harvests

Conclusion

- The use of CWR in the pedigree did not negatively affect yield performance, climate adaptation, or end-use quality, with any evident linkage drag compared to the check.
- Several CWR-derived elites were superior to the checks for yield potential (G) and yield-stability (GxE) combined across environments.
- The participatory approach seems very promising to provide a scaling opportunity and favoring adoption of the new cultivars and providing a feedback to breeders.
- In Morocco, Lebanon, Ethiopia and Senegal, the best adapted CWR-derived lines were released or submitted for release.

Thank you

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crop wild relatives

Norad

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