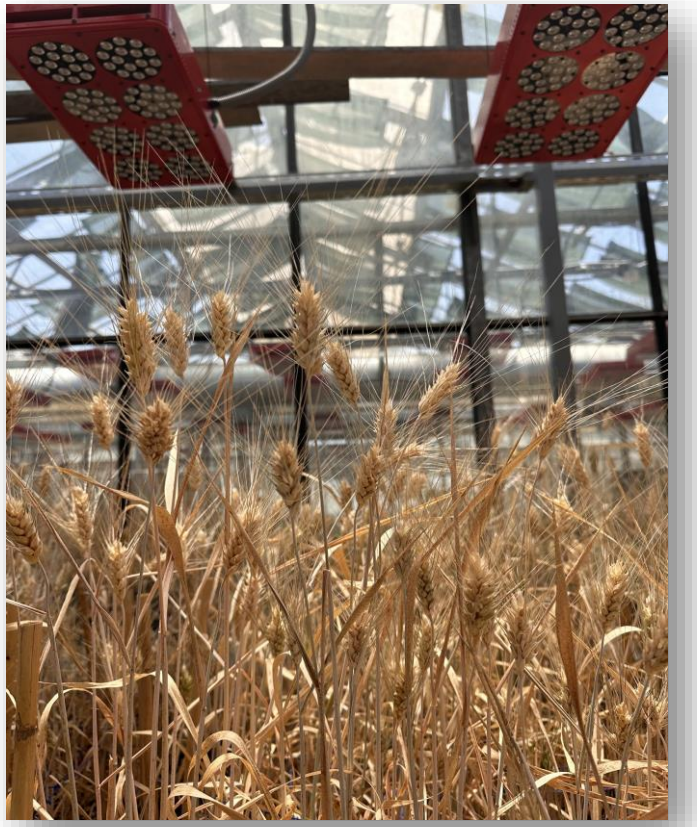

Implementation of an Accelerated Genomic Selection Scheme As The Key Strategy To Enhance Genetic Gain In The ICARDA Durum Wheat Breeding Program.

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Durum wheat : the 10th Important cereal

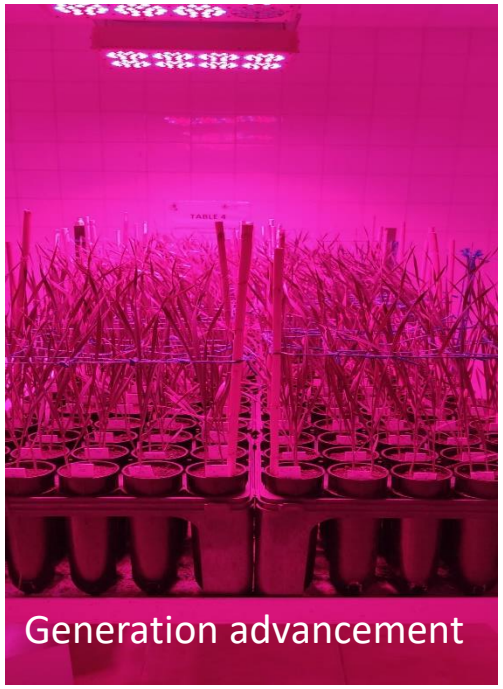
- ✓ Durum wheat is an important crop for the human diet and its consumption is gaining popularity.
- ✓ it is necessary to raise productivity by approximately 1.5% per year.
- ✓ Molecular strategies are the key solution

→ Combining Genomic selection with Speed breeding

$$\text{Genetic gain} = \frac{\text{Accuracy x variance x intensity}}{\text{Cycling time}}$$

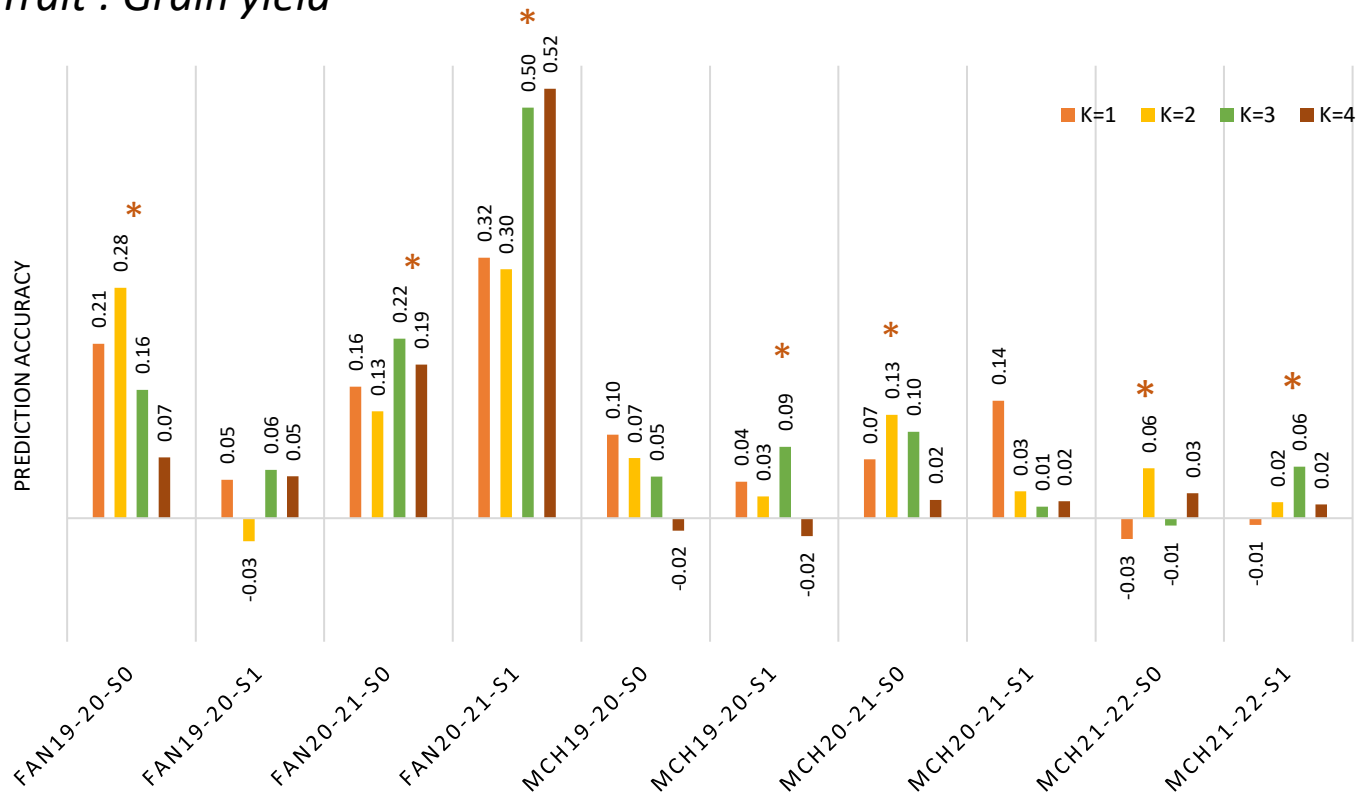
Pilot study : Genomic selection to deliver heat tolerant durum wheat to the Senegal river

Growth chamber , Rabat , Morocco



Improving the predictions: kinship

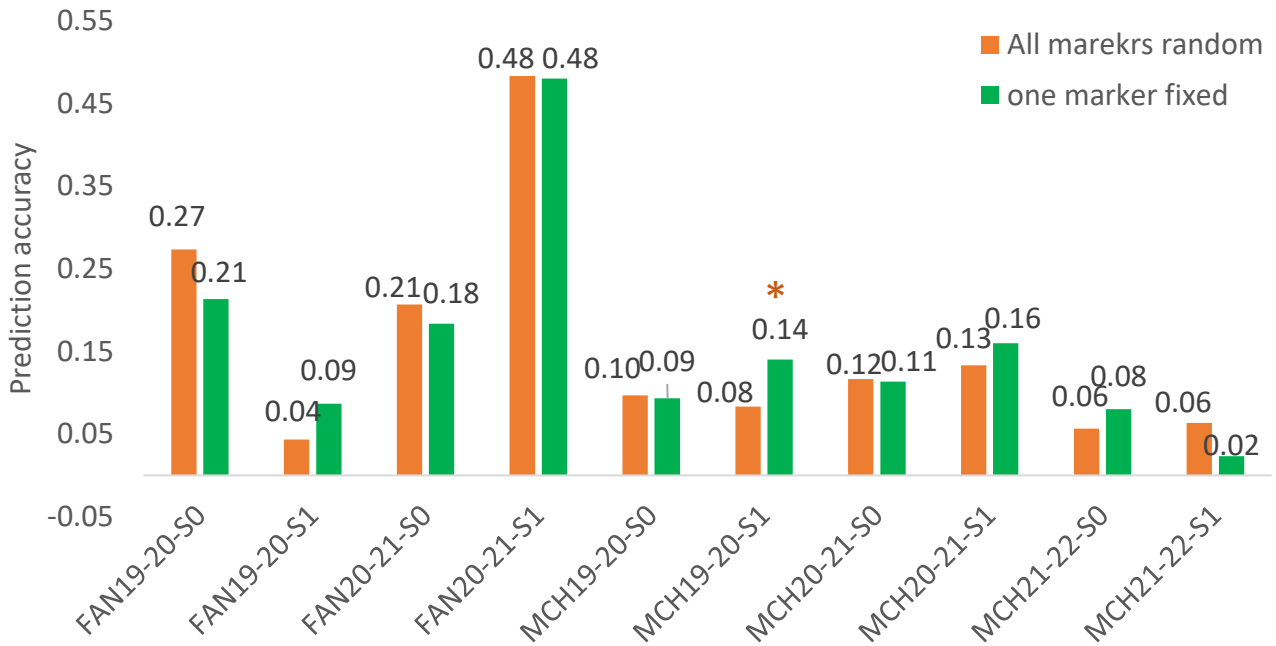
- G BLUP model: 50 random cross validation (80% TP vs 20% VP)
- DAPC to define sub-groups of genetic similarity: K1= No clustering. K2 to k4 = clustering
- *Tested 10 sets of advanced breeding lines*
- *Trait : Grain yield*



➢ DAPC for sub-groups increases significantly the accuracy: **+ 0.06-0.20 points in 70% of tested sets**

Improving the predictions: Fixing markers

- G BLUP model: 5 K fold cross validation (80% TP vs 20% VP)
- *Tested 10 sets of advanced breeding lines at best K*



- Only in 1 trial (*) fixing major marker for GY results in higher prediction accuracy.
- Non-significant numeral increase in accuracy: **+ 0.05-0.1 points**

Improving the predictions : relatedness

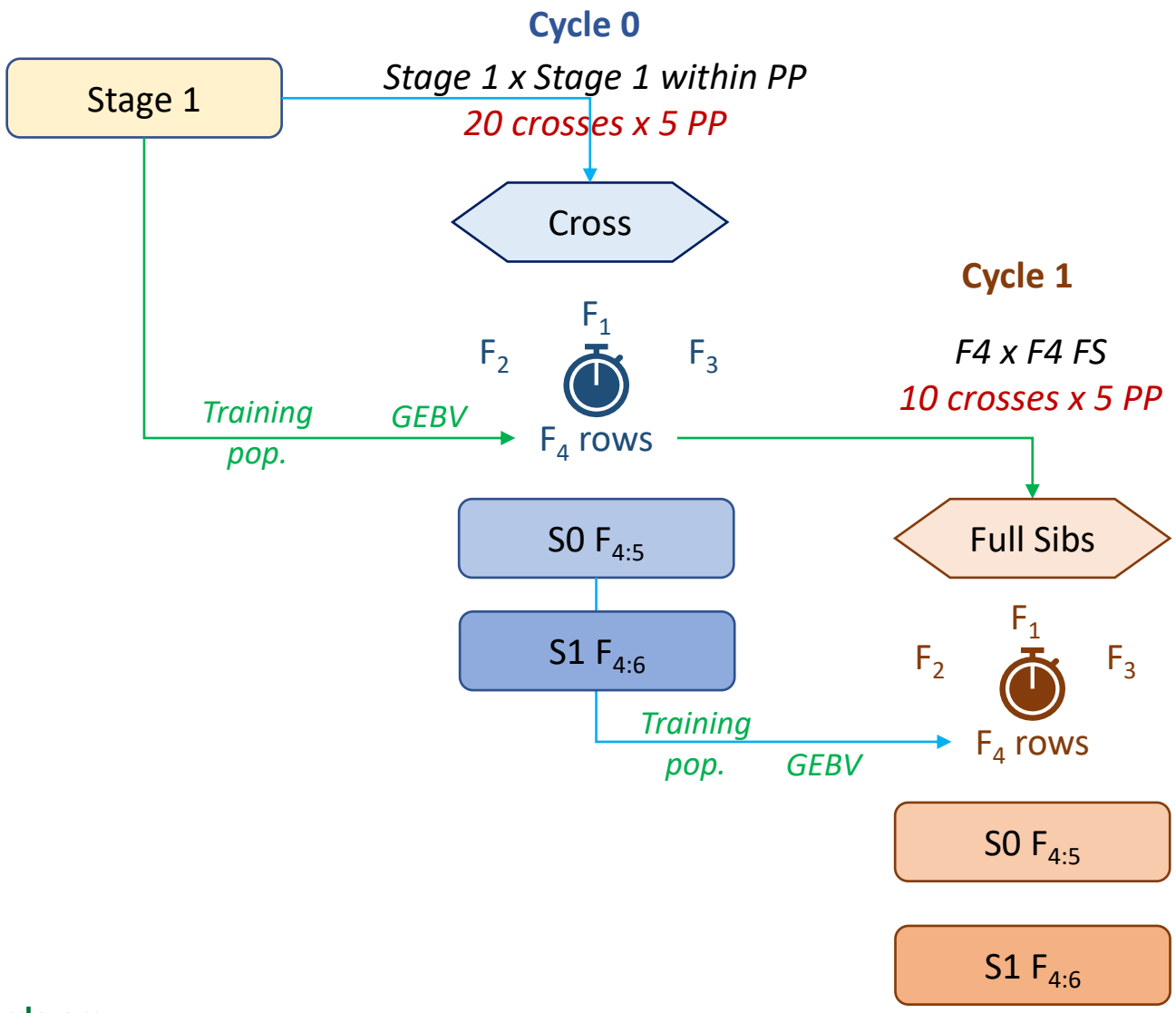
- G BLUP model: 20 random cross validation (50% TP vs 50% VP)
- *Tested 4 populations in half-sibs relationships across 4 environments*

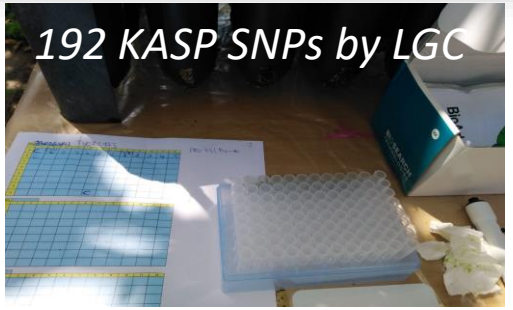
	DRO	IG	YG	SW
	Grain yield			
DRO	0.47	−0.08	−0.11	0.07
IG	−0.09	0.41	0	0.08
YG	−0.07	−0.02	0.35	−0.08
SW	0.06	0.29	−0.13	0.37

➢ Full-sibs relatedness is needed: **+ 0.3-0.4 points**

ZAÏM, Meryem, KABBAJ, Hafssa, KEHEL, Zakaria, *et al.* Combining QTL analysis and genomic predictions for four durum wheat populations under drought conditions. ***Frontiers in genetics*, 2020**, vol. 11, p. 316.

Building the genomic selection pipeline : New facilities, more targeted environments





The recurrent genomic selection scheme by full sib mating

Building the genomic selection pipeline : New facilities, more targeted environments

Selection index vs Mega Product profiles

Target	TPE of Stage 1	Flw	PLH	Frost	HF res	YR res	SR res	LR res	Heat tol	Drought tol	Gluten str.	Yellow Pig	Yield stability	TKW	Yield pot
		BLUP		GY KFD	GH	Izmir	GH	GH	MAS		Mixo	b* sem	AWAI	BLUP	
MPP1 - West Asia drylands	Tel Amara (Lebanon)	M	M	0%	0%	5%	10%	0%	0%	15%	10%	10%	15%	15%	20%
MPP2 - North African Drylands	Marchouch (Morocco)	E	M	0%	14%	5%	0%	10%	0%	11%	5%	10%	10%	15%	20%
MPP3 - East African Drylands	Sidi el Aydi (Morocco)	E	M	0%	0%	5%	15%	0%	0%	15%	5%	10%	15%	15%	20%
MPP4 - South Asia Drylands	Amlaha (India)	M	M	0%	0%	0%	10%	5%	10%	10%	10%	10%	10%	15%	20%
MPP5 - West African Savanhas	Fanaye (Senegal)	E	M	0%	0%	0%	0%	0%	20%	0%	15%	15%	15%	15%	20%

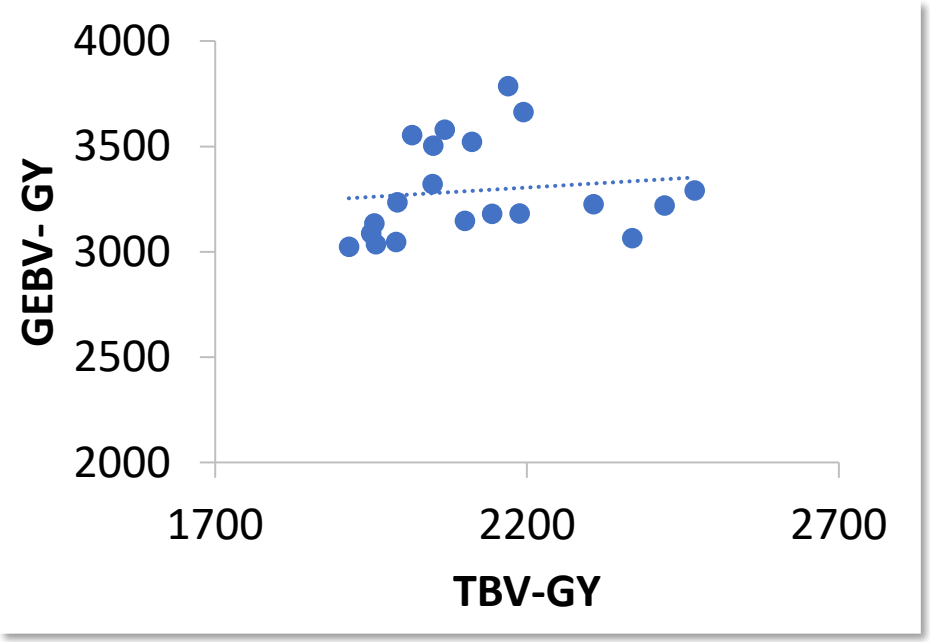
FIVE Targeted population environments (TPEs)

Actual outcomes of the pipeline: ICARDA's elites

Cycle 0

Cross validation Accuracy : 0.15

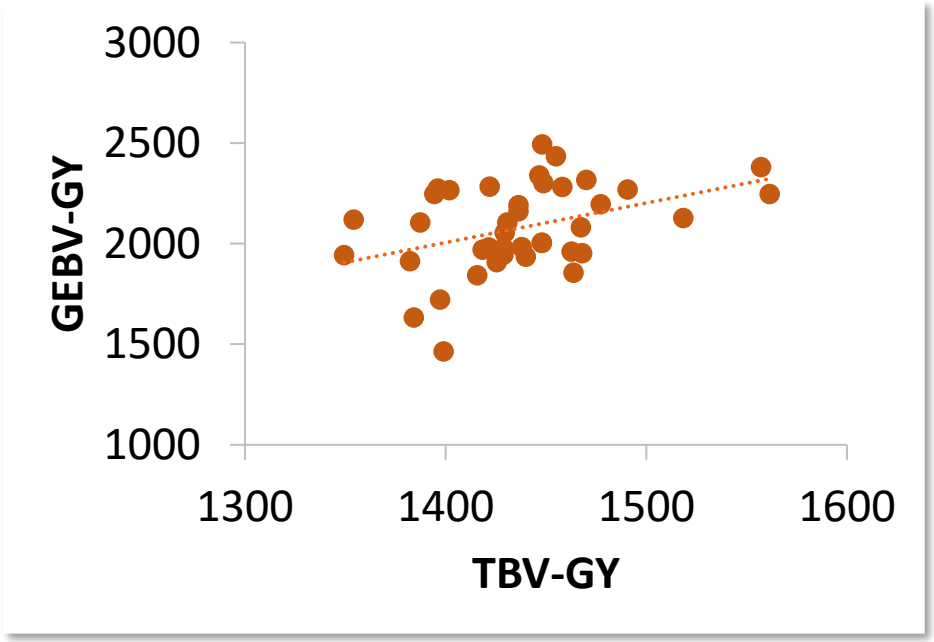
Actual Accuracy: **0.13**



Cycle 1

Cross validation Accuracy : 0.22

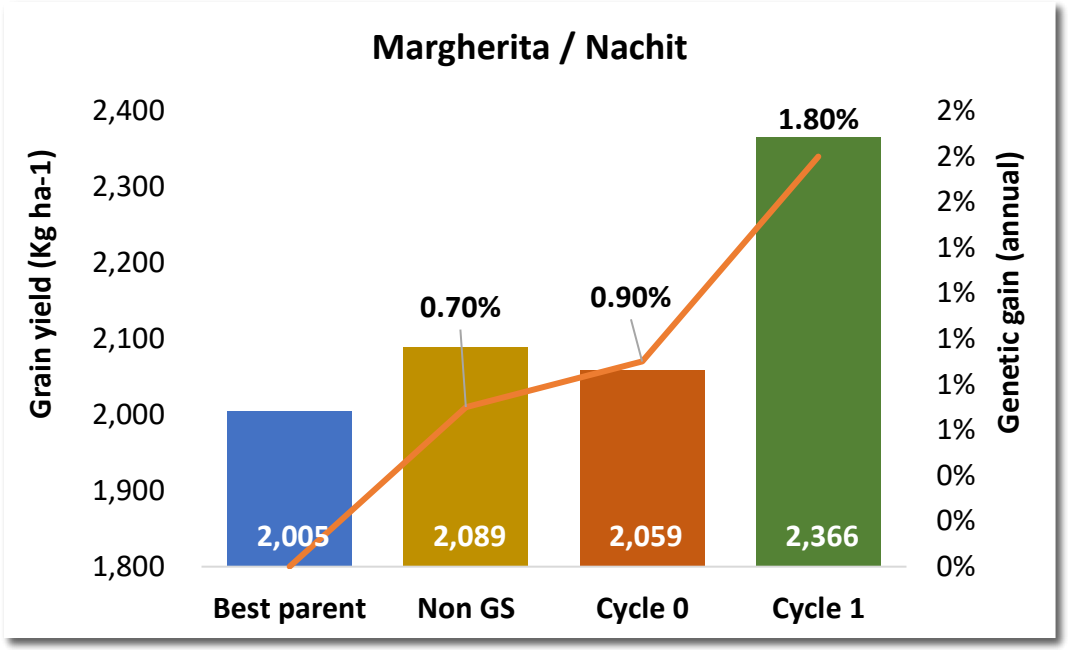
Actual Accuracy: **0.39**



Realized: Genetic Gain

$$\text{Genetic gain} = \frac{\text{Accuracy x variance x intensity}}{\text{Cycling time}}$$

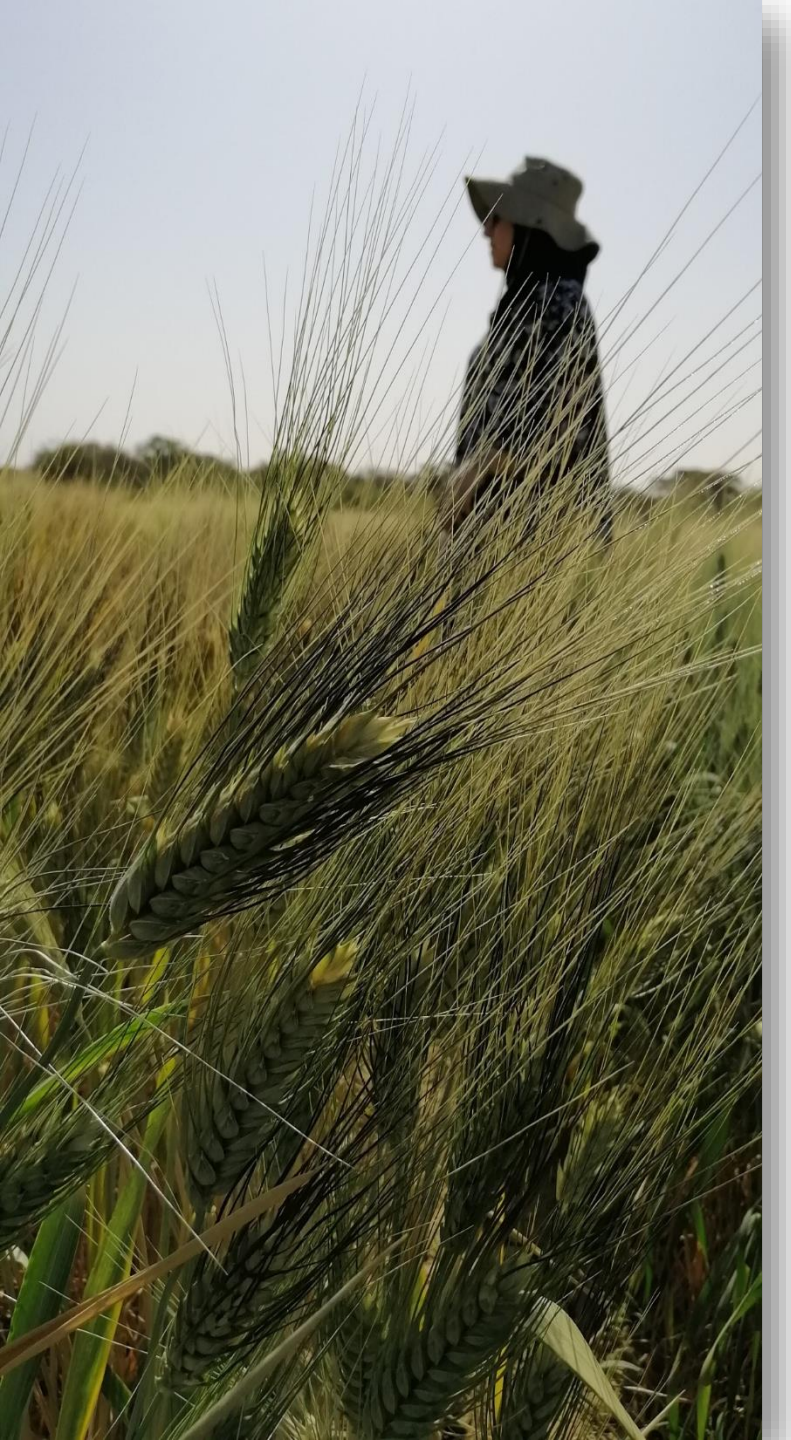
Element	Non GS	GS C0	GS C1
Accuracy	0.05	0.13	0.39
Variance	0.3	0.3	0.3
Intensity	1.0	0.5	1
Cycling time	6.0	3.0	6.0
GG HP %	0.3	0.7	2.0
GG Actual %	**0.7**	**0.9**	**1.8**



- Testing of all three methods together against the parents at 2 environments in Senegal River
- *Cycle 1 FS mating almost **tripled** GG*

Conclusions

- ❑ The use of **Full Sibs mating** increases exponentially GG
- ❑ In every cycle/year:
  - The statistical models need to be **retrained**
  - The list of markers used need to be **revised**
- ❑ The GS pipeline status:
  - **1200** F5 C0-22 + **129** F5 C1-22 as Stage 0.
  - **4800** F2 C0-23+ **300** F2 C1-23 under speed breeding.
  - New C0 & C1 for 2024.



ICARDA

Science for resilient livelihoods in dry areas

ISRA

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INRAA

SLU

Vetenskapsrådet

Thank you