Africa Rice: Number of Parents, Optimal Number of Crosses

EIB-Roslin Collaboration
June 1st 2020

1. Introduction to the problem

Crop by Region

Africa Rice (Irrigated Lowland)

Problem Specification

1. Crossing pool with 80 parents, only 10-20 new parents each year.
2. Optimal combination (range) of crosses/year and individuals per cross.

Breeding strategy component tackled

Crossing

Breeders' equation terms tackled

i (& L)

Hypothesis

Using only/mainly new crossing parents will give higher rates of genetic gain.
An optimized ratio of crosses/year and individuals/cross will give higher rates of genetic gain.

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2. Materials and Methods

Treat	Description
T1 (Baseline)	Current breeding program. Select 10 – 20 new parents each year. Use 80, 40 or 20 parents in total (= 3 different scenarios)
T2 (Grid)	A grid of different combinations of #parents (20-80, 5), #crosses (50-400, 25), #progeny (100-800, 10) under 1500-5000 genotype restriction

- Simulation: 20-year burn-in based on the current scheme (Baseline), and followed by 30 years of breeding for each treatment
- varGxY = 2*varG
- Genetic gain tracked at F2

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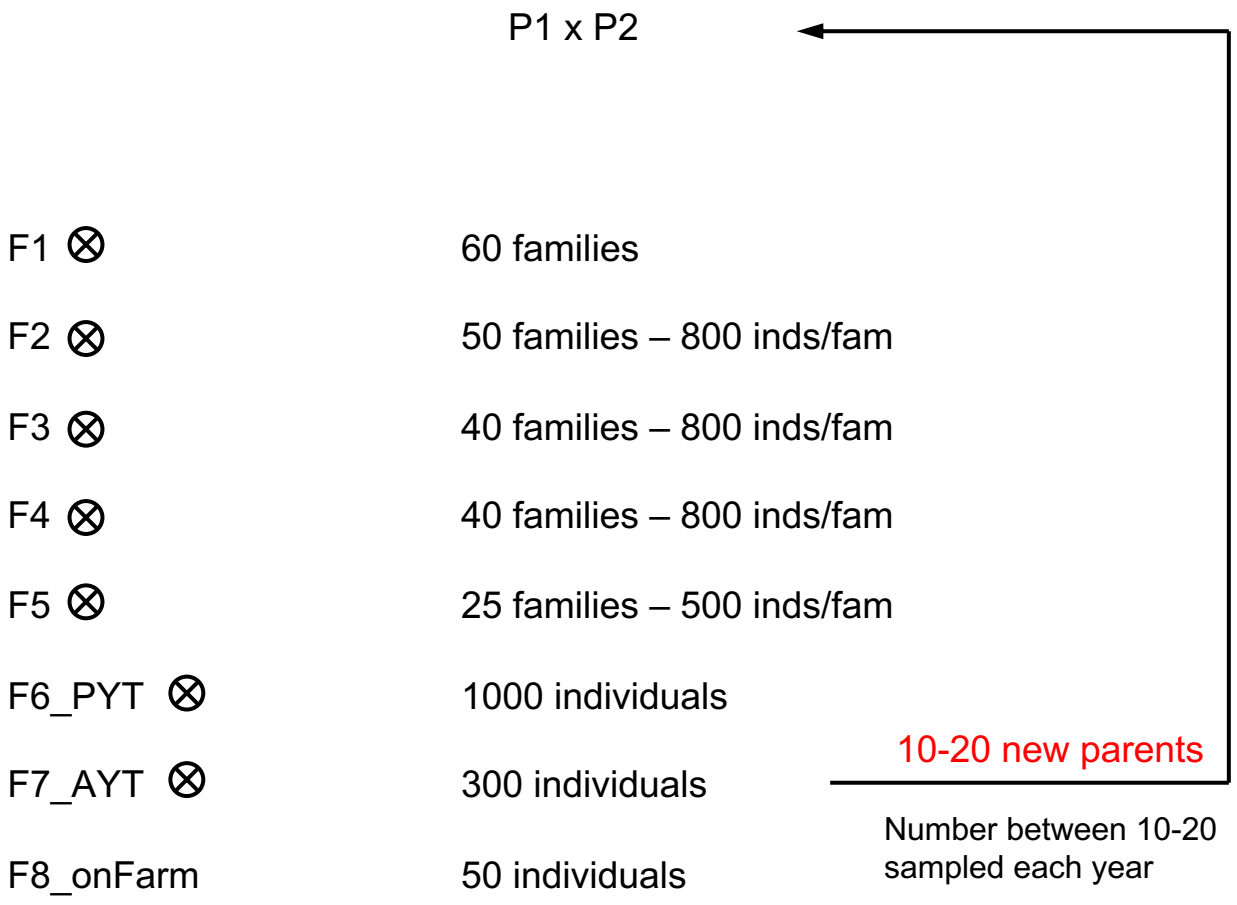
Baseline (T1) – Number of Parents



80 parents → 60 crosses

SCENARIOS

- 20 parents
- 40 parents
- 80 parents

1 env	1 rep	1x1m	(plant bulk)
4 env	2 rep	2x2m	(family bulk)
4 env	3 rep	2x6m	(seed bulk)
10 env	2 rep	3x5m	(seed bulk)

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Baseline (T1) – Number of Parents

2 different simulated approaches of keeping old parents in the crossing pool

SCENARIOS

- 20 parents
- 40 parents
- 80 parents

(1) **New Parents**
Old Parents

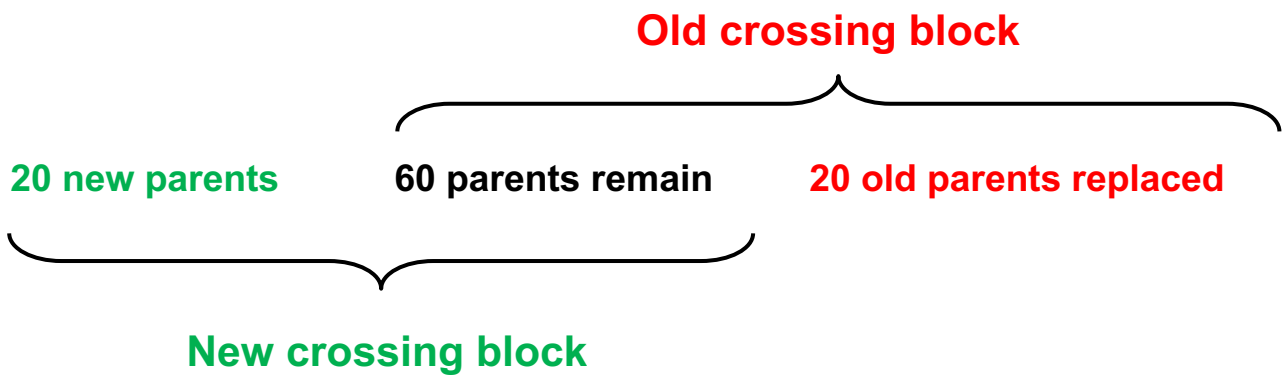
10-20 best inds in F7
retain best inds from crossing pool

E.g. 17 best F7 + 23 best from old crossing pool = 40

(2) **New Parents**

10-20 best inds in F7 used to replace oldest parents in crossing pool (sliding window)

E.g. crossing block of 80 parents



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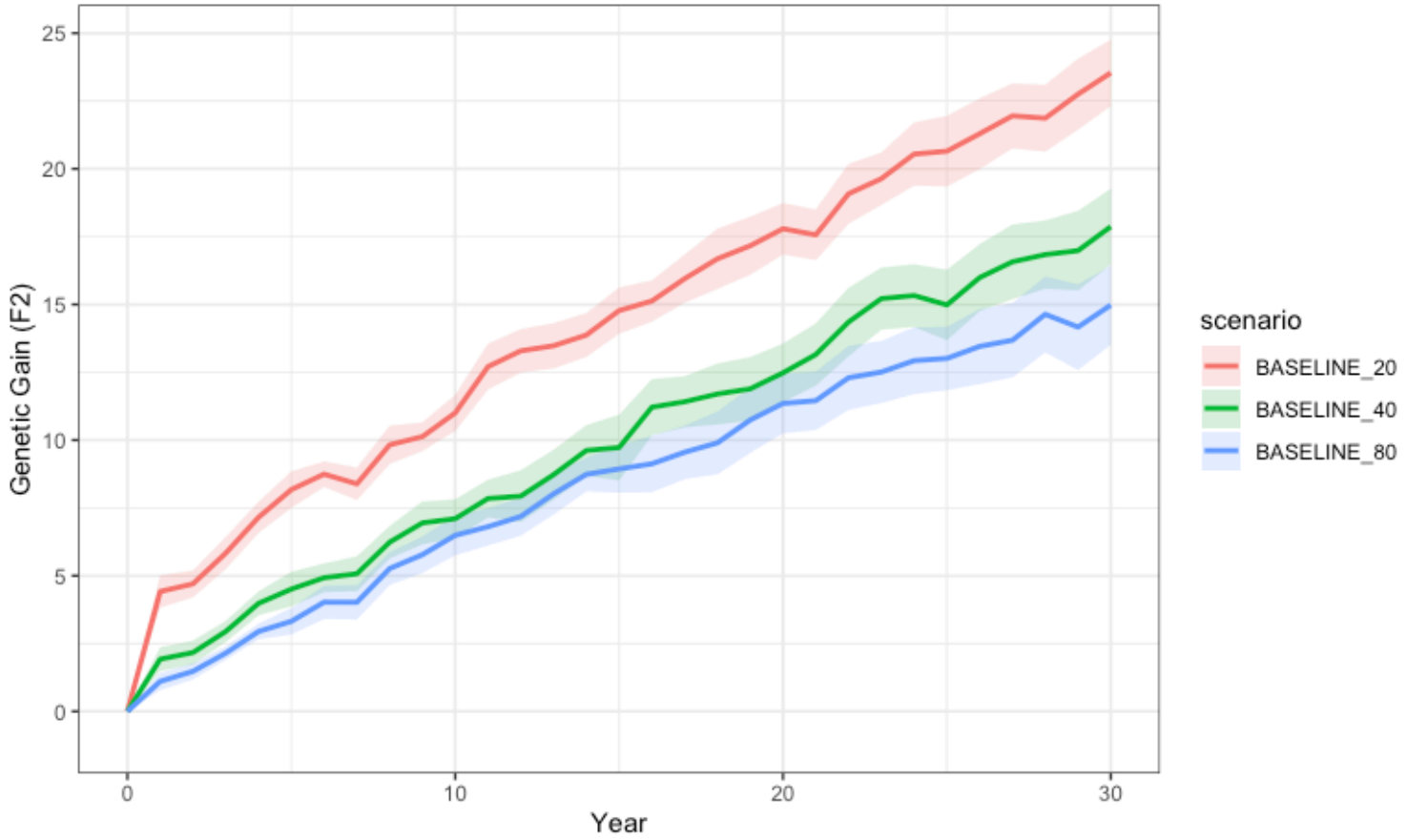
3. Results – T1 (1)



- Initial increase in gain when switching from 80 to 20 parents
  → reduce number of old parents
- Highest rate of genetic gain with 20 parents

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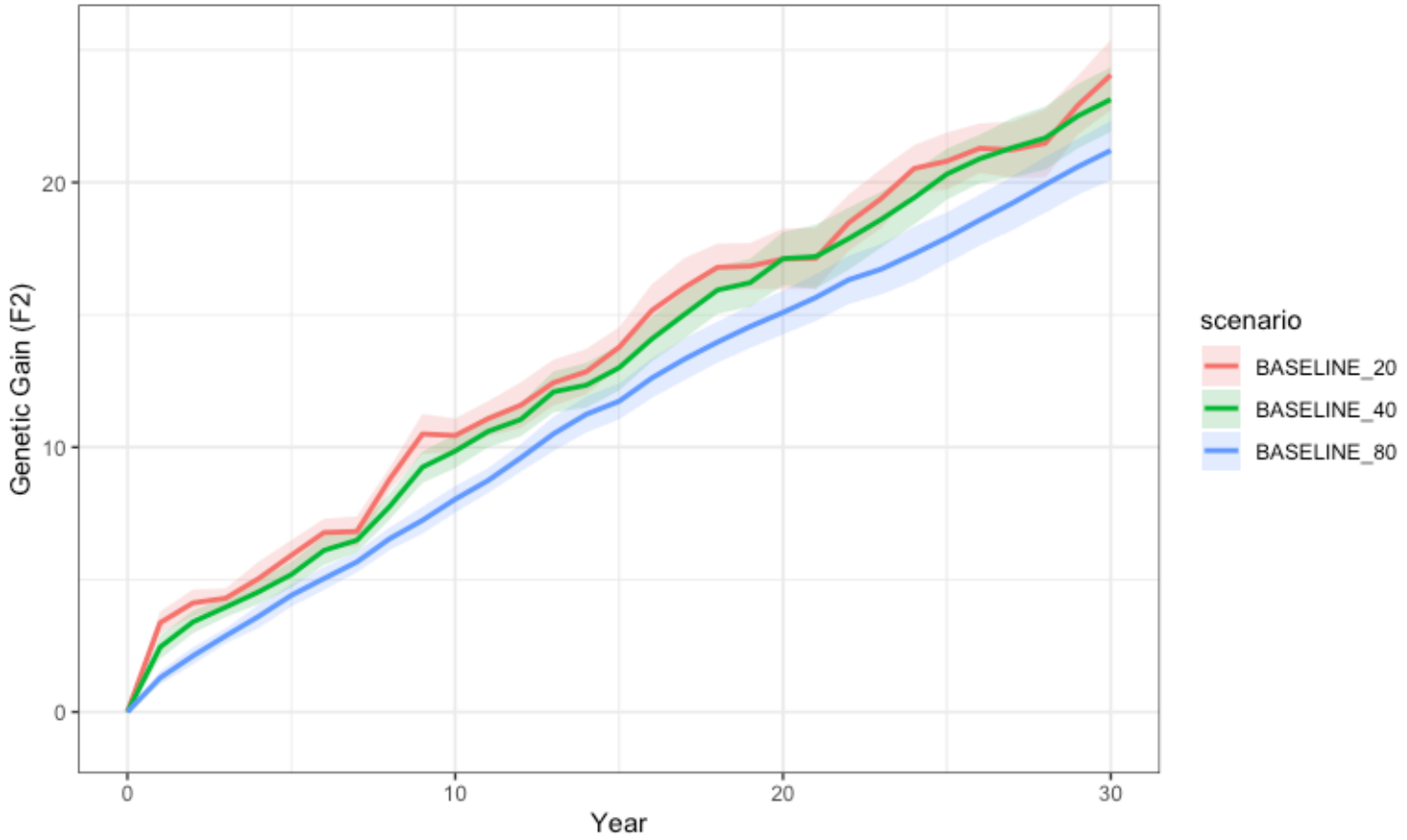
3. Results – T1 (2)



- Less extreme, but same trends as observed for (1)
  → reduce number of old parents

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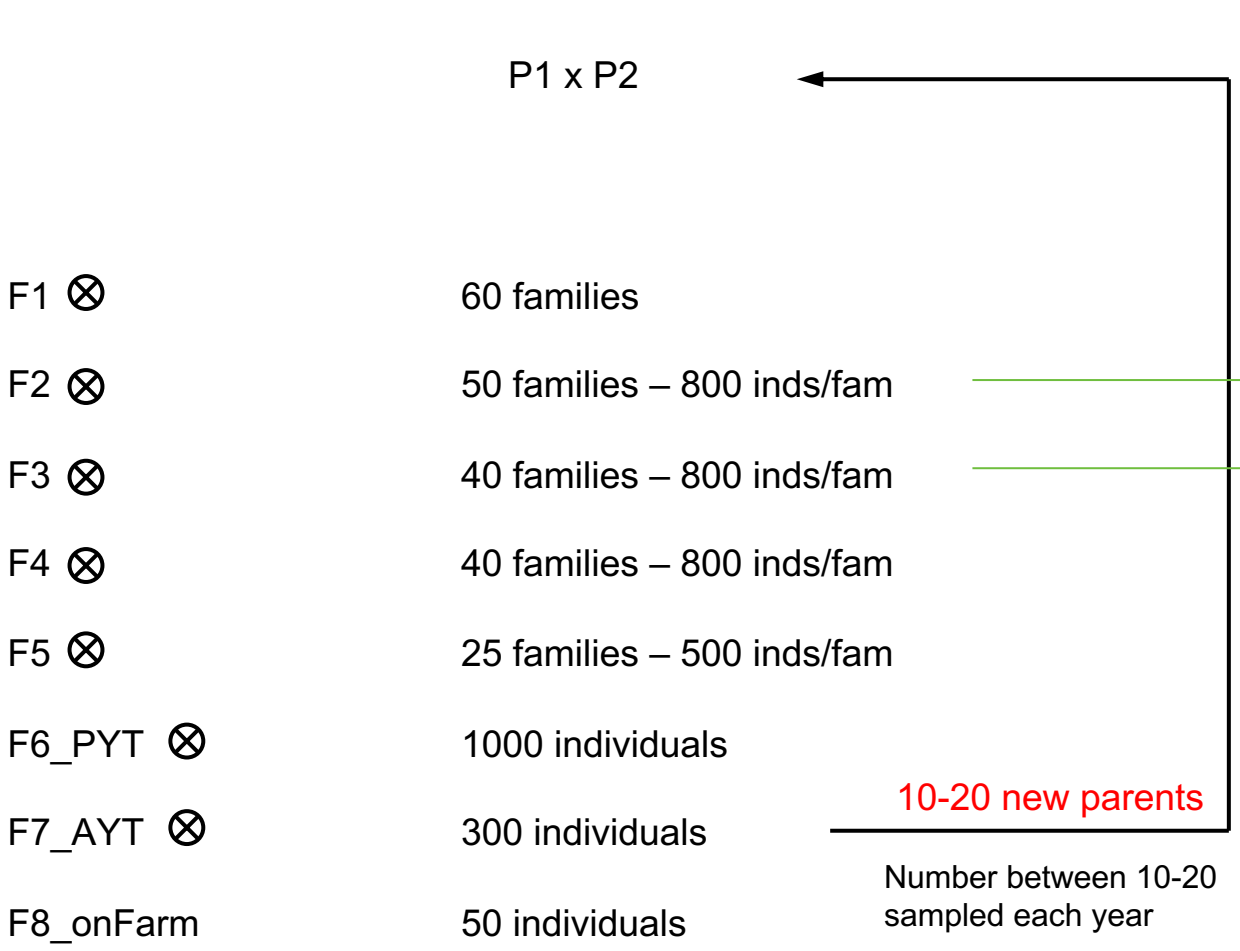
Grid (T2) – Optimal resource allocation



Parents:	20, 25, 30, …, 75, 80	~5,600 combs
Crosses:	50, 75, 100, …, 375, 400	
Inds/cross:	100, 125, 200, …, 775, 800	

RESTRICTIONS

Range	36,000 – 40,000 Inds	215 combs
Max.	32,000 Inds	

E.g. 300 families x 125 inds/fam = 37,500

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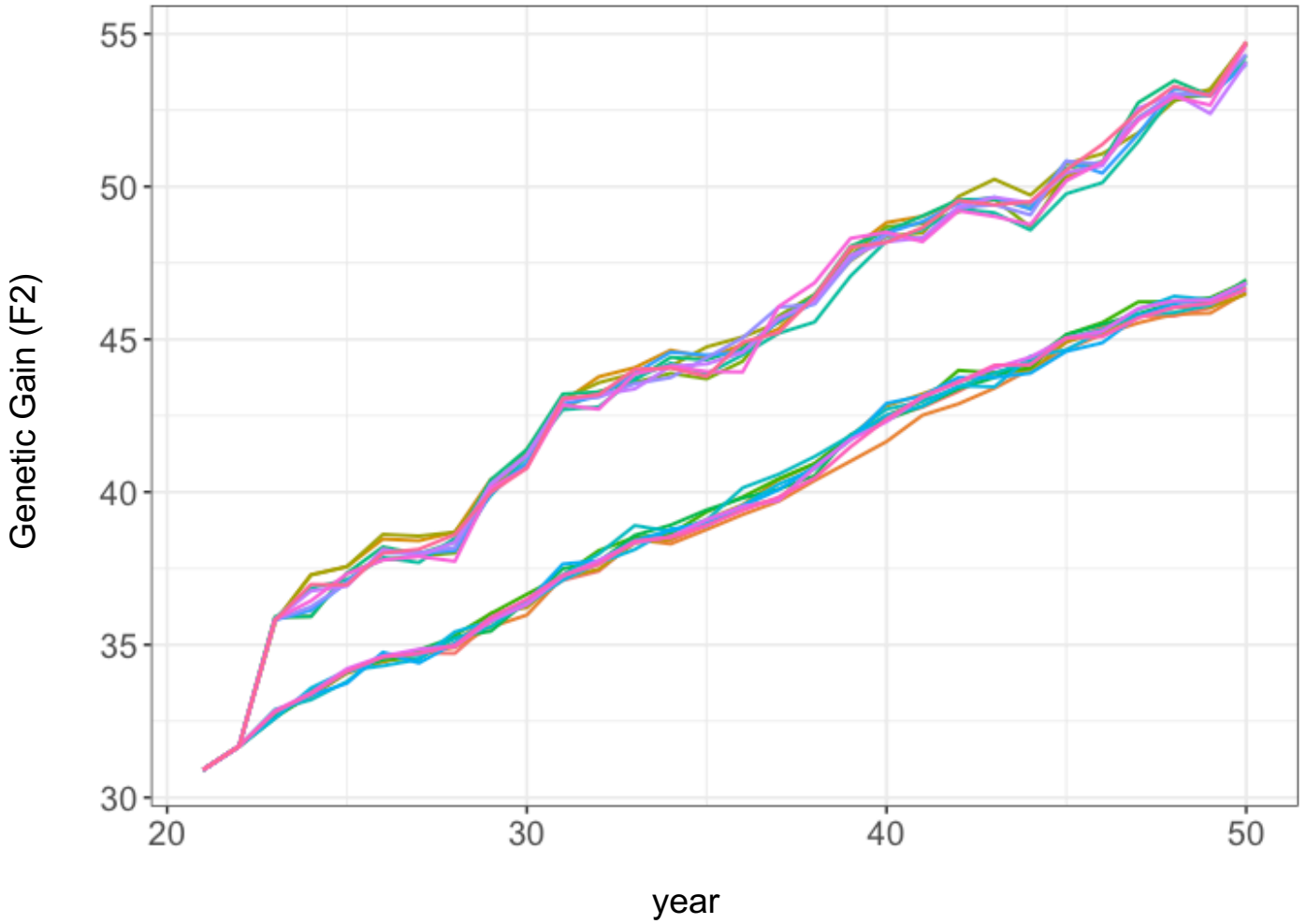
3. Results – T2

Genetic gain at F2: 10 best-performing vs. 10 worst-performing Grid combinations



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3. Results – T2

Genetic gain at F2: best-performing vs. worst-performing Grid combinations

Best-performing Grid combinations

Scenario	gainF2	nParents	nCrosses	nInd	nFamSelF3	nIndTotal
Scn99	54.74811	20	125	300	106	37500
Scn138	54.72041	20	75	500	64	37500
Scn125	54.70774	20	100	400	80	40000
Scn86	54.66407	20	150	250	128	37500
Scn112	54.64443	20	100	375	85	37500
Scn60	54.32868	20	200	200	160	40000
Scn151	54.29179	20	75	525	60	39375
Scn164	54.10404	20	50	725	44	36250
Scn73	54.06558	20	175	225	142	39375
Scn47	54.00171	20	225	175	182	39375
Scn177	53.95097	20	50	750	42	37500
Scn203	53.90649	20	50	800	40	40000

Worst-performing Grid combinations

Scenario	gainF2	nParents	nCrosses	nInd	nFamSelF3	nIndTotal
Scn122	46.48201	70	100	375	85	37500
Scn111	46.54047	80	125	300	106	37500
Scn175	46.61830	75	50	725	44	36250
Scn98	46.63992	80	150	250	128	37500
Scn110	46.70132	75	125	300	106	37500
Scn173	46.82771	65	50	725	44	36250
Scn85	46.83870	80	175	225	142	39375
Scn174	46.84175	70	50	725	44	36250
Scn148	46.88998	70	75	500	64	37500
Scn150	46.95179	80	75	500	64	37500
Scn213	46.98476	70	50	800	40	40000
Scn97	46.99248	75	150	250	128	37500

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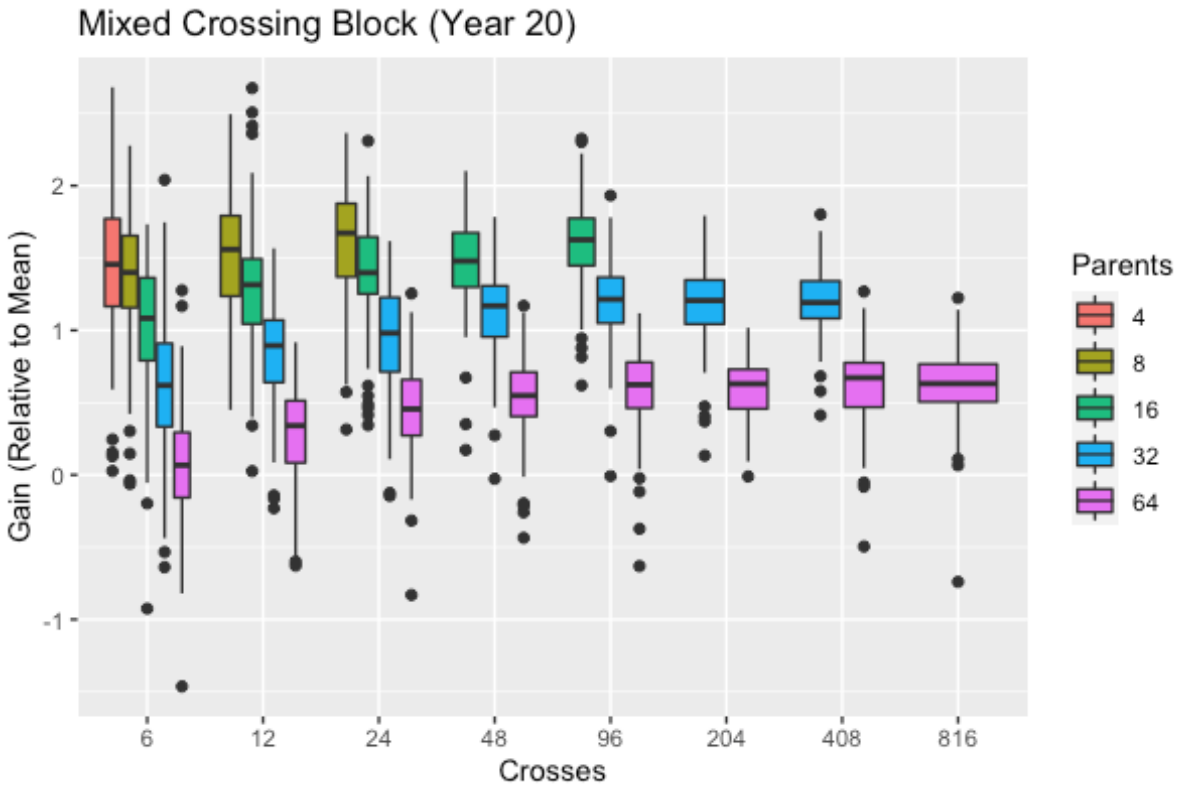
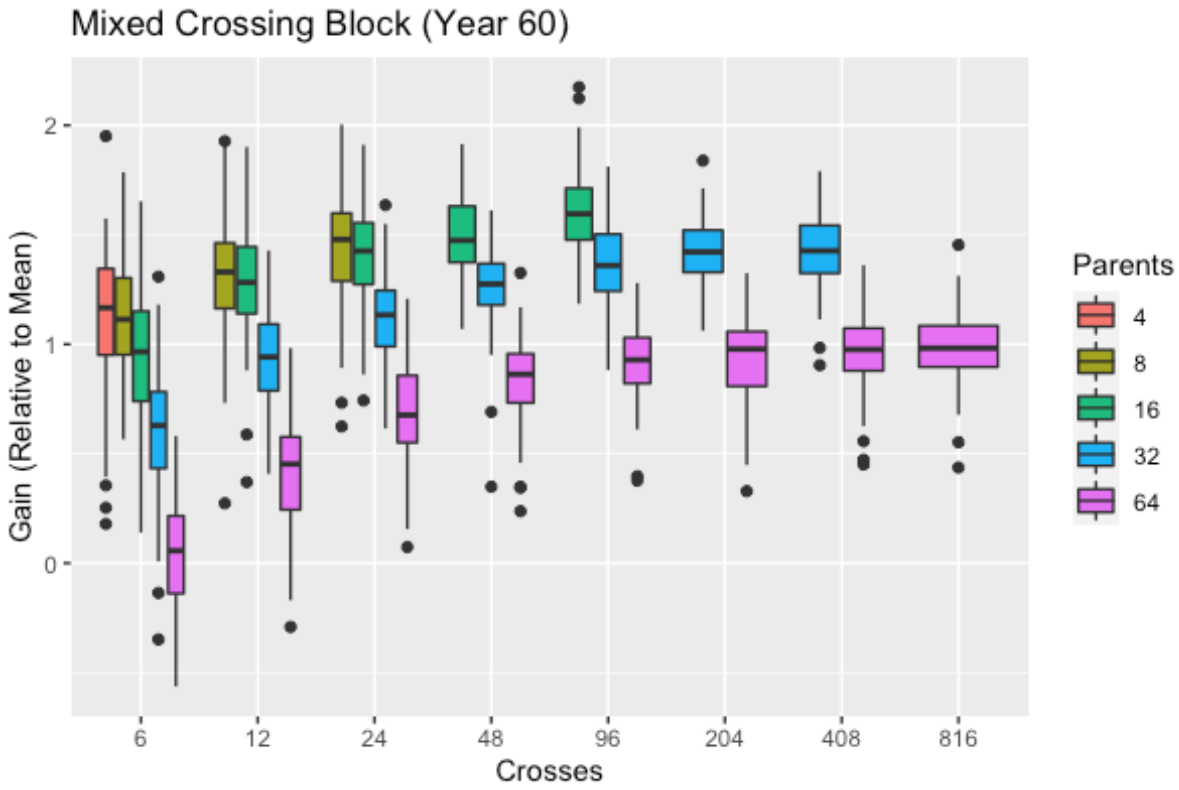
3. Results from EA-Cassava (Dorcus & Chris)





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4. Conclusion

1. Don’t recycle old parents (or, if absolutely necessary, restrict the number to a very few, not too old individuals…)

2. 20 (-30) parents each year is a good number for a breeding program

→ with 16 parents, all (16*15)/2 = 120 pairwise crosses could be made with more than 300 progeny per cross

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Thank you for your interest!

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