Bringing a selection index into the CIMMYT-Maize programs

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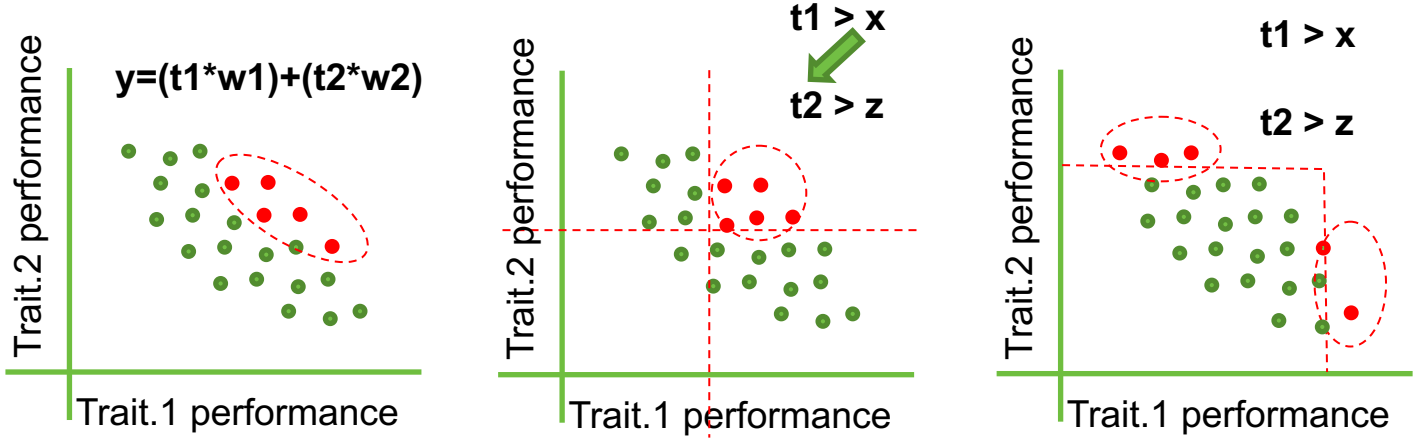
Breeding scheme optimization lead

Approach

1. What we know about the selection method in genetic gain
2. Understand the selection procedure in an algorithm fashion.
3. Identify which parts of the selection procedure can be replaced with an index.
4. Build an index.
5. Compare to current approach using selection differentials and total gain.
6. Refine an index.

What we know about the effect of the selection method in the genetic gain?

- Do simulations show that picking transgressive individuals is a good method to increase genetic gains?
  - T1: use an index to pick the best for total merit (10%)
  - T2: pick the best for yield and then best for zinc (31% > 31% = 10%)
  - T3: pick the best individuals for each trait (top 5% in each = 10%)



Selection index

Independent culling

Tandem-type selection

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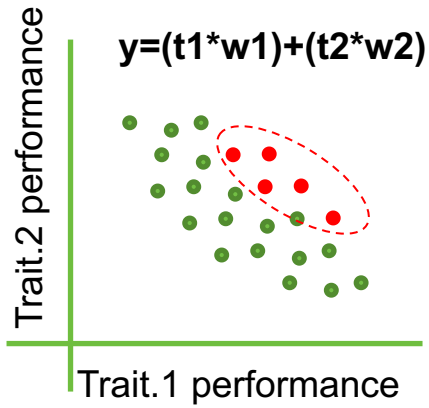
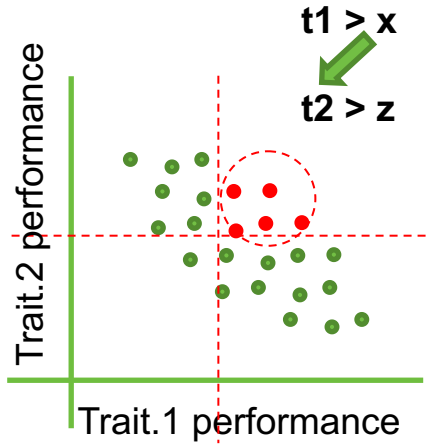
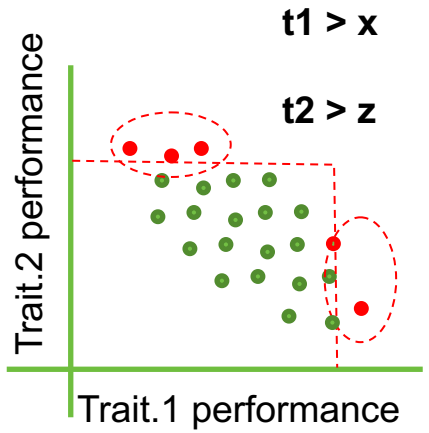


Selection index

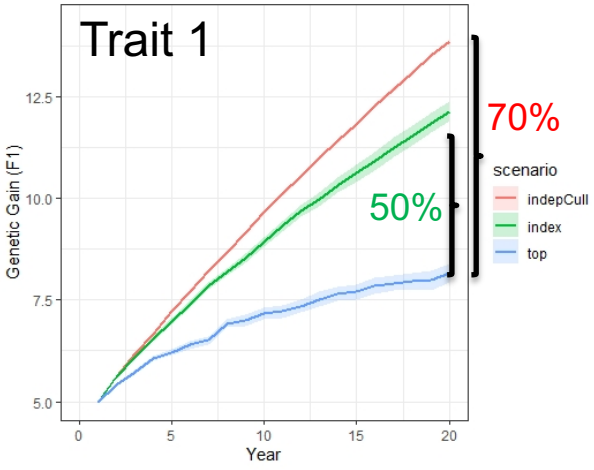


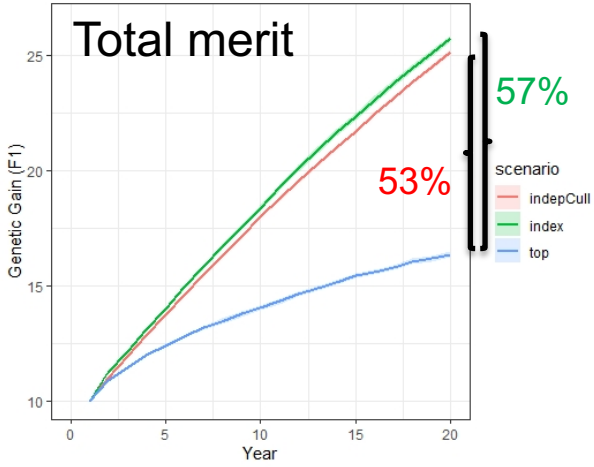
Independent culling



Tandem-type selection

The best parents are not the extreme value individuals with lack of performance in other traits





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Selection step S3 to S4 using an index vs current method

1. Understand the selection procedure in an algorithm fashion S3 to S4

- We identified that the process can be mapped back to a set of reduction and selection steps, each consisting in trait conditions (value and directionality):

As many traits as needed involved in each step

step	selectionUnit	stepType	trait	value	directiona	trait	value	directiona	trait	value	directiona	trait	value	directiona	valueUsed
1	line	select	OPTY	bestCheck	>	MDY	bestCheck	>	LNY	bestCheck	>	MLNY	bestCheck	>	culling
2	line	select	anthesis	2 LSD	.+/-	moisture	17-20 check+LSD								culling
3	line	reduce	PTY-MDY-LI	bestCheck	>=	moisture	17-20 check+LSD	=							culling
Striga ignored															
MLN ignored															

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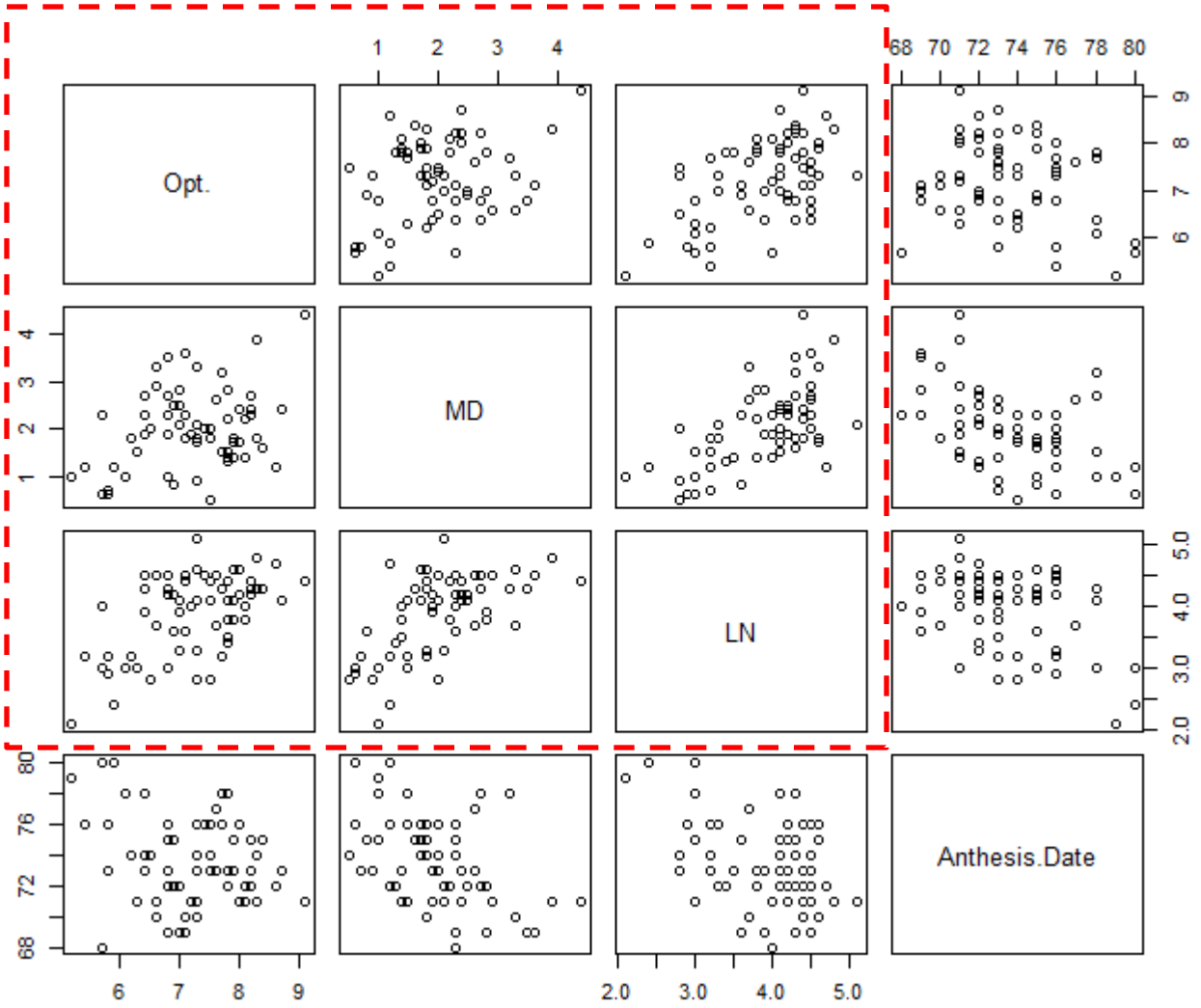
Looking at the relation of some of the important traits



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3. Build and refine an index: retrospective weights $b = P^{-}s$

- If the selection differentials represent the breeder's goal, then the weights determines the merit of individuals selected.
- Weights can be back calculated

$$\begin{array}{l} \\ \text{Opt.} \\ \text{MD} \\ \text{LN} \\ \text{Anthesis.Date} \end{array} \begin{pmatrix} \text{weight(b)} \\ 1.4254 \\ 0.0717 \\ 0.1703 \\ 0.1205 \end{pmatrix} = \begin{pmatrix} & [,1] & [,2] & [,3] & [,4] \\ [1,] & 0.74 & 0.23 & 0.30 & -0.52 \\ [2,] & 0.23 & 0.69 & 0.33 & -1.13 \\ [3,] & 0.30 & 0.33 & 0.42 & -0.71 \\ [4,] & -0.52 & -1.13 & -0.71 & 7.87 \end{pmatrix}^{-} \begin{pmatrix} & [,1] \\ [1,] & 1.09 \\ [2,] & 0.35 \\ [3,] & 0.48 \\ [4,] & -0.39 \end{pmatrix}$$

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Current selection differentials with Yoseph's patented approach vs index

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A comparison of selections shows some differences

	Var1	Freq.Yo	Freq.Inc
1	(CML322/CML543)//CKLMARS1C3S50113	1	1
2	(CML322/CML543)//CKLTI0368	1	1
3	(CML444/CML536)//CKDHL0186	1	1
4	(CML444/CML536)//CKDHL150512	1	1
5	(CML444/CML536)//CKLMARS1C3S50113	1	NA
6	(CML543/CML566)//CKLMARS1C3S50140	1	1
7	(CML543/CML566)//CKLTI0344	1	1
8	(CML566/CKDHL0333)//CKDHL120423	1	1
9	(CML566/CKDHL0333)//CKLTI0344	1	1
10	(CML566/CML395)//CKLMARS1C3S50113	1	NA
11	(CML566/CML569)//CKDHL120423	2	1
12	(CML566/CML569)//CKLMARS1C3S50113	1	1
13	(CML543/CML566)//CML567	NA	1
14	(CML566/CML569)//CML567	NA	1

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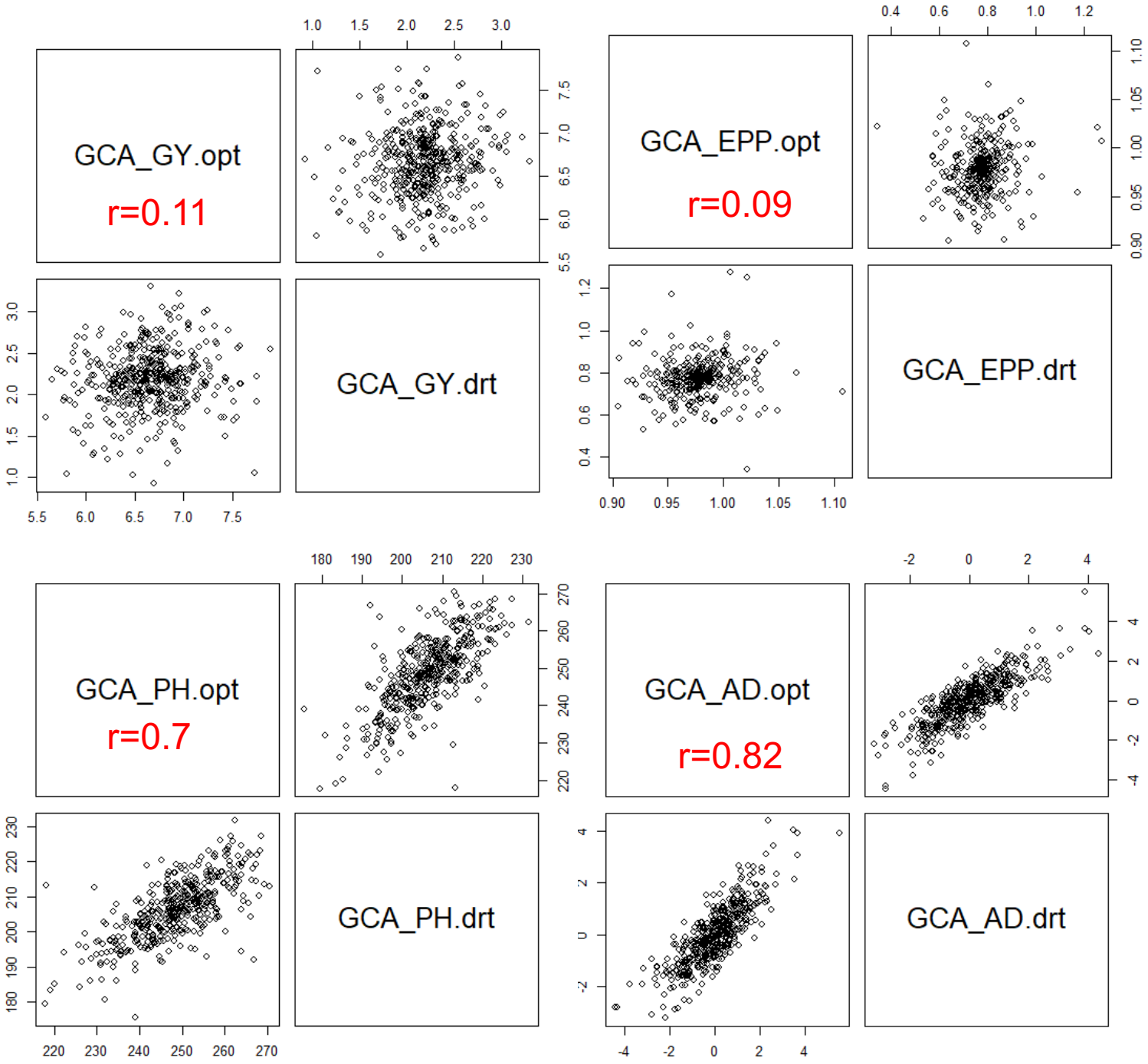
Recycling step using an index vs current method



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3. Build and refine an index: retrospective weights $b = P^{-}s$

- If the selection differentials represent the breeder's goal, then the weights determines the merit of individuals selected.
- Weights can be back calculated
- The index is calculated among family and then within family

	weight (b)
GCA_GY.opt	**3.158**
GCA_AD.opt	-0.099
GCA_ASI.opt	-0.360
GCA_EAR.ASP.opt	-0.533
GCA_BHC.opt	0.017
GCA_ER.opt	0.044
GCA_EPP.opt	**-2.467**
GCA_MOI.opt	0.215
GCA_GY.drt	**2.902**
GCA_AD.drt	0.122
GCA_ASI.drt	-0.084

$=$

	[,1]	[,2]	[,3]	[,4]	[,5]	[,6]	[,7]	[,8]	[,9]	[,10]	[,11]
[1,]	0.15	0.08	-0.02	-0.02	-0.15	-0.06	0.00	0.02	0.02	0.07	-0.01
[2,]	0.08	1.47	0.02	-0.06	-1.71	-0.05	0.00	0.26	-0.09	1.16	0.21
[3,]	-0.02	0.02	0.19	0.00	-0.45	-0.01	0.00	0.06	-0.04	0.01	0.21
[4,]	-0.02	-0.06	0.00	0.04	0.28	0.03	0.00	-0.02	0.00	-0.04	-0.01
[5,]	-0.15	-1.71	-0.45	0.28	36.28	0.43	0.01	-0.58	-0.07	-1.22	-0.81
[6,]	-0.06	-0.05	-0.01	0.03	0.43	0.72	0.00	-0.06	-0.02	-0.05	0.01
[7,]	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
[8,]	0.02	0.26	0.06	-0.02	-0.58	-0.06	0.00	0.31	0.00	0.19	0.09
[9,]	0.02	-0.09	-0.04	0.00	-0.07	-0.02	0.00	0.00	0.13	-0.11	-0.10
[10,]	0.07	1.16	0.01	-0.04	-1.22	-0.05	0.00	0.19	-0.11	1.34	0.11
[11,]	-0.01	0.21	0.21	-0.01	-0.81	0.01	0.00	0.09	-0.10	0.11	0.60

$-$

	[,1]
[1,]	0.53
[2,]	0.04
[3,]	-0.27
[4,]	-0.10
[5,]	-0.10
[6,]	-0.21
[7,]	0.01
[8,]	0.11
[9,]	0.44
[10,]	0.00
[11,]	-0.44

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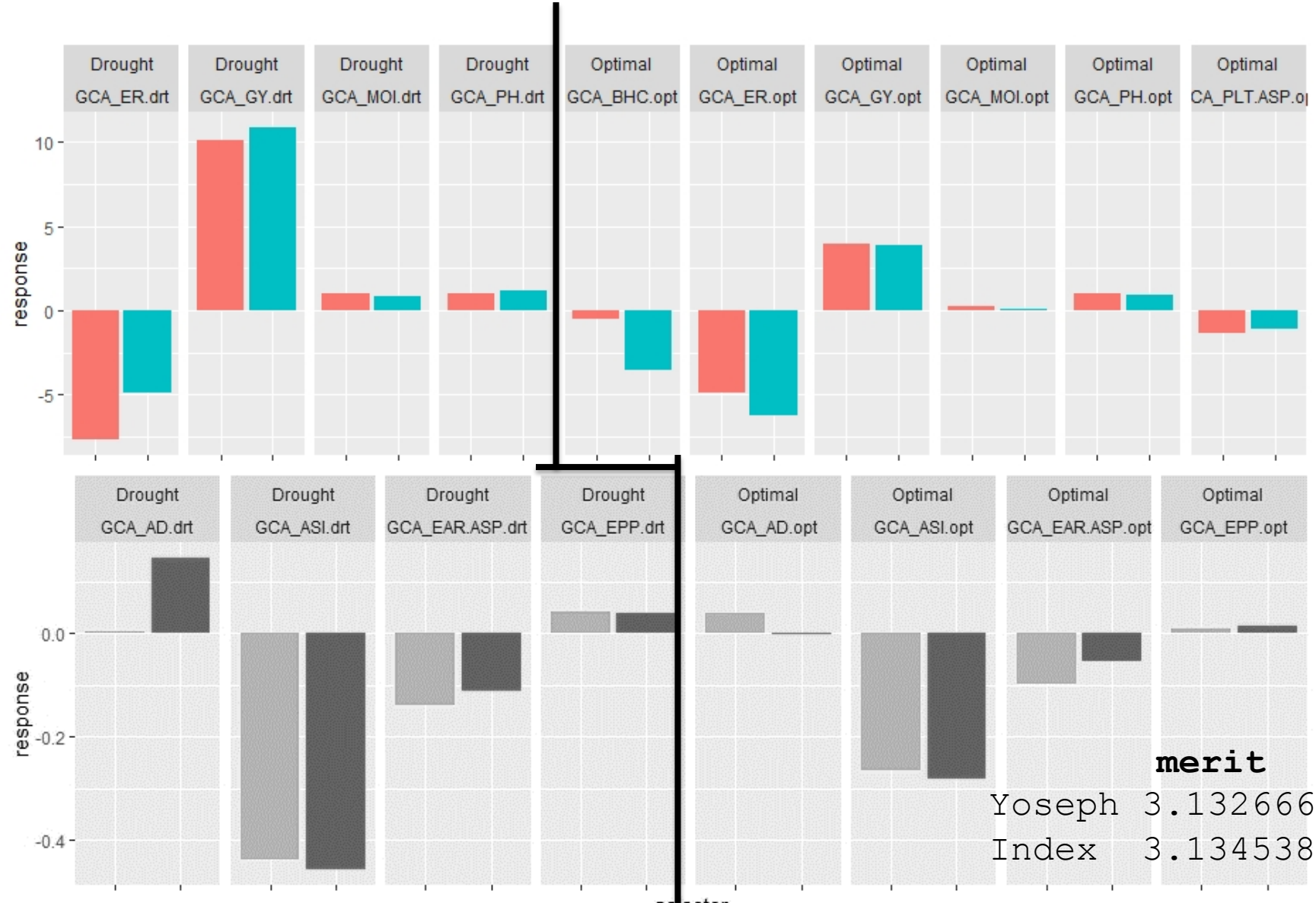
Current selection differentials with Yoseph's patented approach vs index



A comparison of selections shows some differences

	Material	Yoseph	Index		Material	Yoseph	Index
1	((CKDHL0221/CKDHL120312).%DHH3D030045)-B	1	1	26	(PB80/CML536/CML539.%DHH2D02.0177)-B	1	1
2	((CKDHL0228/CKDHL120312).%DHH3D030028)-B	1	1	27	(PHG39/CML539/CML539.%DHH2D02.0025)-B	1	NA
3	((CKDHL0228/CKDHL120312).%DHH3D030089)-B	1	1	28	(PHW52/[MSRXG9]C1F2-205-1(OSU23i)-5-3-X-X-1-BBB-1-B*7/CML5	1	1
4	((CKDHL0228/CKDHL120312).%DHH3D030139)-B	1	1	29	(PHW52/[MSRXG9]C1F2-205-1(OSU23i)-5-3-X-X-1-BBB-1-B*7/CML5	1	1
5	((CKDHL120143/CKDHL120312).%DHH3D030045)-B	1	1	30	(RS_CML395/CKSBL10002:@.%DHH3D030012)-B	1	1
6	((CKDHL120184/CKDHL120312).%DHH3D030034)-B	1	NA	31	(RS_CML444/CKSPL10073:@.%DHH3D030011)-B	1	1
7	((CKDHL120312/CKDHL0214).%DHH3D030015)-B	1	1	32	(TZMI711/CML539.%DHH2D02.0677)-B	1	1
8	((CKDHL121167/CML464).%DHH3D030110)-B	1	NA	33	(TZMI711/CML539.%DHH2D02.0726)-B	1	NA
9	((CML202/CKL05003).%DHH3D030095)-B	1	1	34	(ZEWAc2F2-152-1-BBB-B-B-B-B/CML540.%DHH2D02.0100)-B	1	1
10	((CML463/CML536).%DHH3D030051)-B	1	NA	35	(ZEWAc2F2-152-1-BBB-B-B-B-B/CML540.%DHH2D02.0196)-B	1	NA
11	((CML536/CKDHL120312).%DHH3D030081)-B	1	1	36	(ZEWAc2F2-152-1-BBB-B-B-B-B/CML540.%DHH2D02.0315)-B	1	1
12	((CML536/CKDHL120312).%DHH3D030094)-B	1	1	37	(ZEWAc2F2-183-2-BBB-B-B/00SADVEA-#-28-1-2-1-1-1-2-3-B.%DHH2	1	1
13	((CML536/CKDHL120312).%DHH3D030131)-B	1	1	38	((CKDHL120143/CKDHL120312).%DHH3D030049)-B	NA	1
14	((CML536/CKDHL120312).%DHH3D030229)-B	1	1	39	((CKDHL120312/CML464).%DHH3D030050)-B	NA	1
15	((CML536/CKDHL120312).%DHH3D030272)-B	1	1	40	((CML536/CKDHL120312).%DHH3D030127)-B	NA	1
16	([(CML395/CML444)-B-4-1-3-1-B/CML395//DTPWC8F	1	NA	41	((CML536/CKDHL120312).%DHH3D030262)-B	NA	1
17	([(CML395/CML444)-B-4-1-3-1-B/CML395//DTPWC8F	1	NA	42	(PB80/CML536/CML539.%DHH2D02.0091)-B	NA	1
18	([SC/CML204//FR812]-X-30-2-3-2-1-B*6/[CML445/ZM	1	NA	43	(PB80/CML536/CML539.%DHH2D02.0151)-B	NA	1
19	(2369/CML536/CML539.%DHH2D02.0121)-B	1	NA	44	(PHW52/[MSRXG9]C1F2-205-1(OSU23i)-5-3-X-X-1-BBB-1-B*7/CML5	NA	1
20	(2369/CML536/CML539.%DHH2D02.0224)-B	1	NA	45	(PHW52/[MSRXG9]C1F2-205-1(OSU23i)-5-3-X-X-1-BBB-1-B*7/CML5	NA	1
21	(CML511/CML546.%DHH2D02.0097)-B	1	1	46	(RS_CML395/CKSBL10002:@.%DHH3D030009)-B	NA	1
22	(CML511/CML546.%DHH2D02.0155)-B	1	NA	47	(RS_CML444/CKSPL10073:@.%DHH3D030020)-B	NA	1
23	(La Posta Seq C7-F71-1-2-1-2-B-B-B/CML312SR = MAS	1	1	48	(RS_CML444/CKSPL10073:@.%DHH3D030022)-B	NA	1
24	(PB80/CML536/CML539.%DHH2D02.0047)-B	1	1	49	(ZEWAc2F2-152-1-BBB-B-B-B-B/CML540.%DHH2D02.0044)-B	NA	1
25	(PB80/CML536/CML539.%DHH2D02.0088)-B	1	1				

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Conclusions and recommendations

- A traditional selection method can be translated in an index.
- An index gives the advantage of keeping selection consistent.
- Move to use an index and later refine it.

How to define indices moving forward?

- Program => Stage => Product profile

- Programs: LATAM, EA, SA
- Stage: Stage 1 and Stage 2 (focus on recycling)
- Product profiles: Based on programs

- **Action item: Share data from this stages and programs.**

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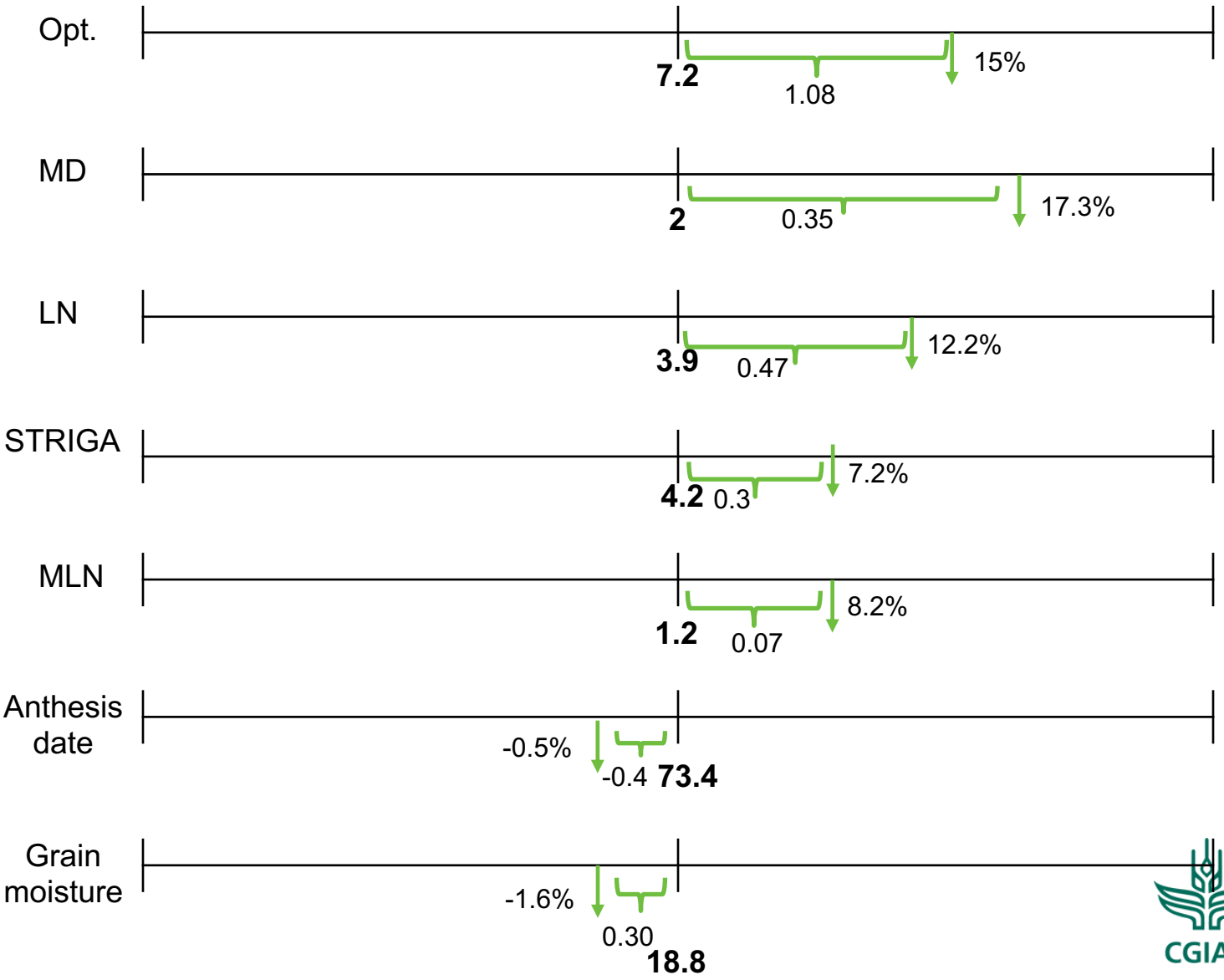
Current selection differentials with Yoseph's patented approach



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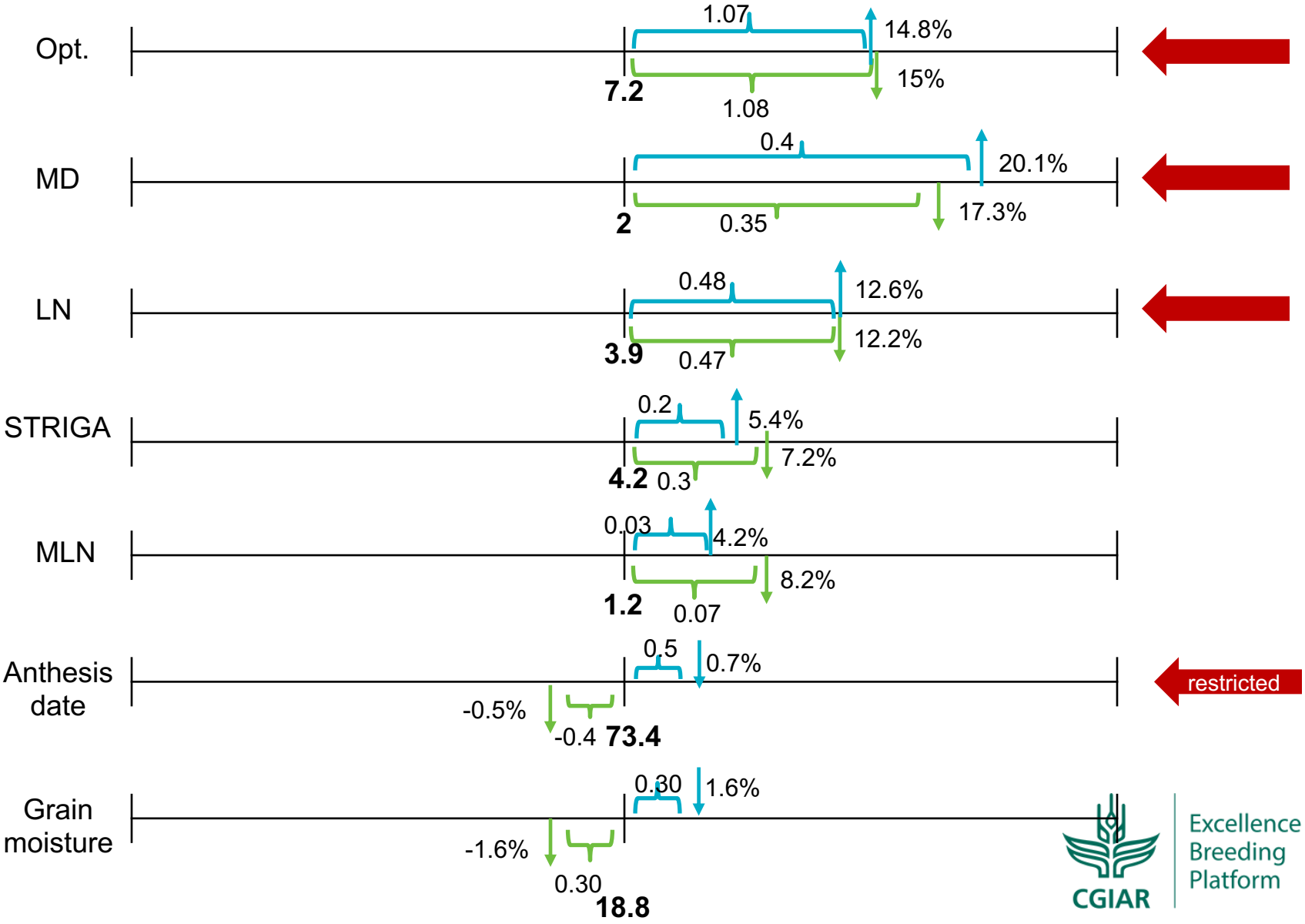
Current selection differentials with Yoseph's patented approach



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4. Compare to current approach using selection differentials

	Opt.	MD	LN	AD	MLN	STRIG	GM	Merit
Yoseph	1.09	0.35	0.48	-0.39	0.07	0.30	-0.31	1.61
Index	1.07	0.41	0.49	0.53	0.04	0.23	0.29	1.70

Selection differentials

	weight
Opt.	1.4254
MD	0.0718
LN	0.1703
AD	0.1206
MLN	0
STRIGA	0
GM	0

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