# Bringing a selection index into the IRRI programs

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Excellence in Breeding Platform

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# Approach

1. Understand the targeted pipeline
    1. Breeding pipeline 1: market segments Hard White- Optimum Environment (HW-OE) and Hard White- Heat Tolerant Early Maturity (HW-HTEM).
    2. Breeding pipeline 2: market segments Hard White- Drought Tolerant Normal Maturity (HW-DTNM), Hard White- Drought Tolerant Early Maturity (HW-DTEM); Hard White- High Rainfall (HW-HR) & Hard Red
    3. Breeding Pipeline 3- Zn mainstreaming
2. Understand the targeted stage
    1. Stage 1
    2. Stage 2
    3. Stage n
3. Agree on the selection purpose
    1. Selection of parents
    2. Advancement of products
4. Understand the traits and selection procedure in an algorithm fashion.
5. Calculate retrospective weights
    1. b = P-S
6. Finetune weights.

# 1. Understand the selection procedure in an algorithm fashion

- 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 | directionality | trait | value | directionality | valuesUsedAs | useTraitCovariance | TotalSelected |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | DESIGNAT | reduce | YLD_rel | 0.4 | > | ZNC_rel | 0.3 | > | culling | - | 891 |
| 2 | DESIGNAT | select | Xa21 | R | = | YLD_BV | 6.8 | > | culling | - | 20 |
| 3 | DESIGNAT | select | Xa21 | R | = | ZNC_BV | 14 | > | culling | - | 20 |
| 4 | DESIGNAT | select | Xa5 | R | = | YLD_BV | 5 | top | culling | - | 8 |
| 5 | DESIGNAT | select | Xa5 | R | = | ZNC_BV | 5 | top | culling | - | 8 |
| 6 | DESIGNAT | select | Pi54 | R | = | YLD_BV | 5 | top | culling | - | 8 |
| 7 | DESIGNAT | select | Pi54 | R | = | ZNC_BV | 5 | top | culling | - | 8 |
| 8 | DESIGNAT | select | Pita | R | = | YLD_BV | 5 | top | culling | - | 6 |
| 9 | DESIGNAT | select | Pita | R | = | ZNC_BV | 5 | top | culling | - | 6 |
| 10 | DESIGNAT | select | YLD_BV | 10 | top | | | | culling | - | 6 |
| 11 | DESIGNAT | select | ZNC_BV | 10 | top | | | | culling | - | 6 |
| 12 | DESIGNAT | select&re | PHT_BV | 115 | < | FLW_BV | 90 | < | culling | - | 40 |
| 13 | PARENTA( | select | COUNT | 3 | random | | | | culling | - | 18 |

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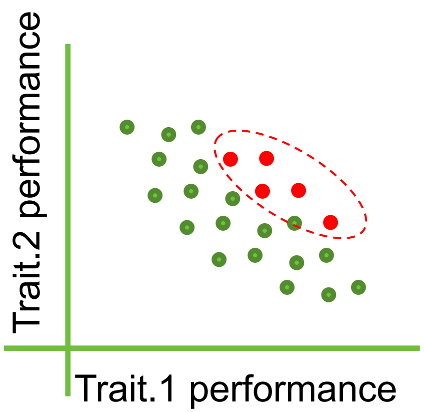
# Can we recreate or improve Josh's selections?

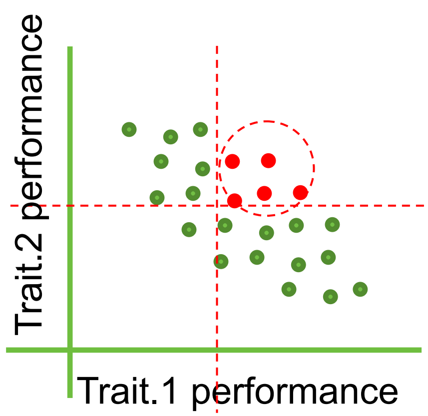
- We compared the selections made by Josh vs the algorithm and a selection index.
- Current method gives a strong weight to single-trait transgressive individuals.

# Current method gives a strong weight to extreme value individuals NOT total merit

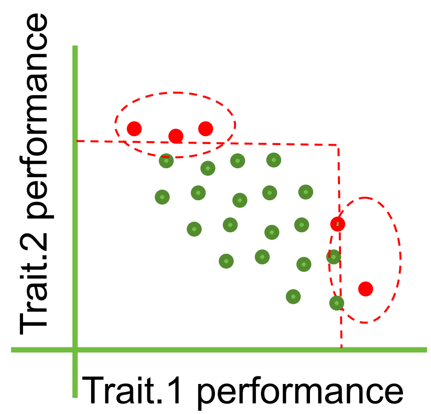
- Do simulations show that picking transgressive individuals is a good method to increase genetic gains?
  - T1: use an index to pick the best for total merit (10%)
  - T2: pick the best for yield and then best for zinc (31% > 31% = 10%)
  - T3: pick the best individuals for each trait (top 5% in each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



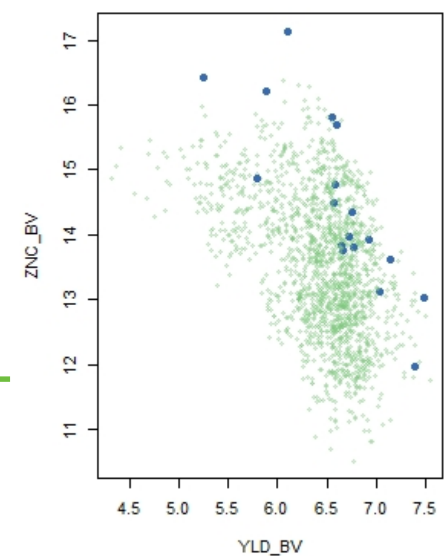

**Selection index**




**Independent culling**




**Tandem-type selection**

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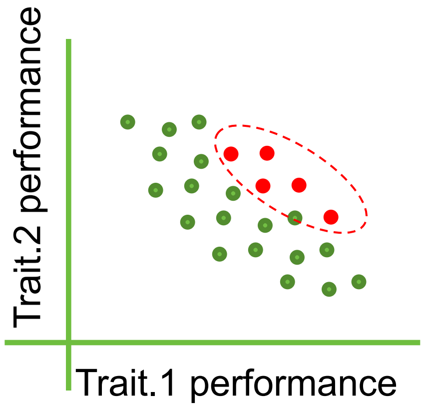
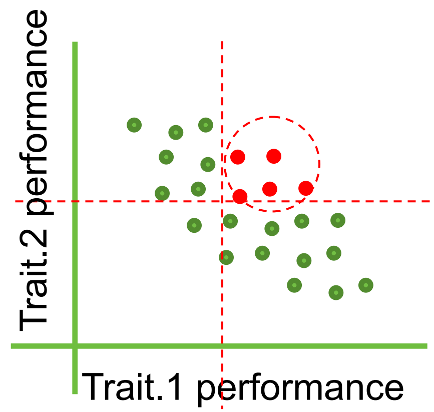
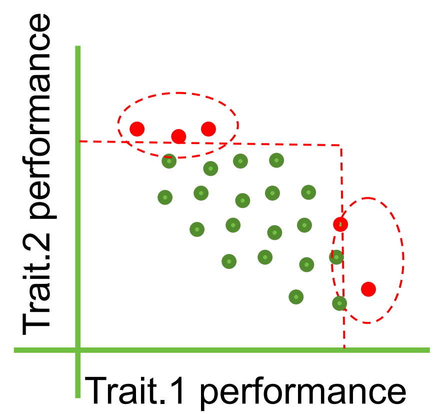
# The best parents are not the extreme value individuals with lack of performance in other traits



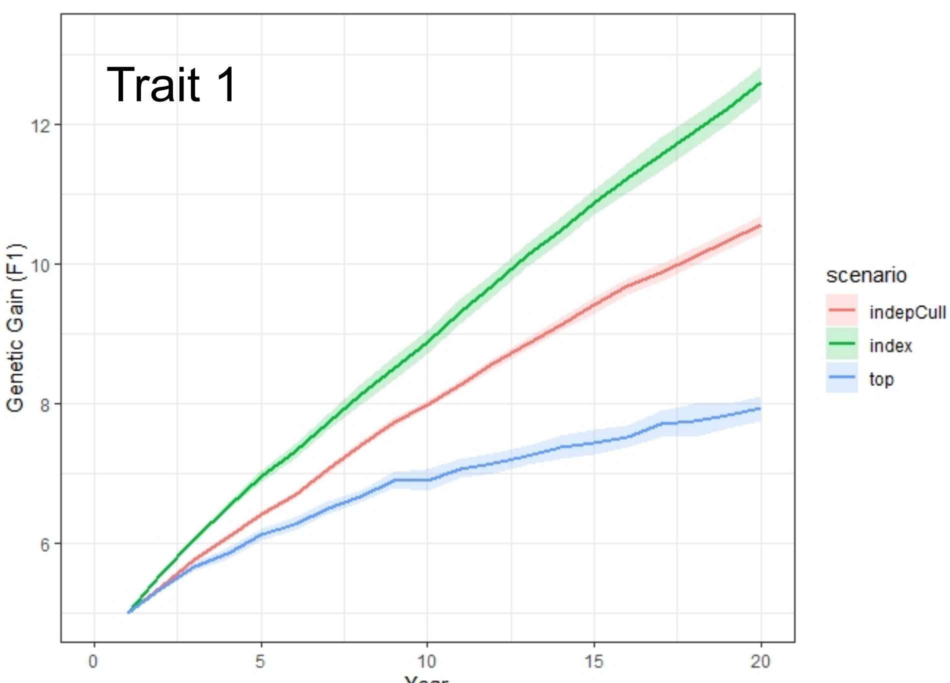

**Selection index**

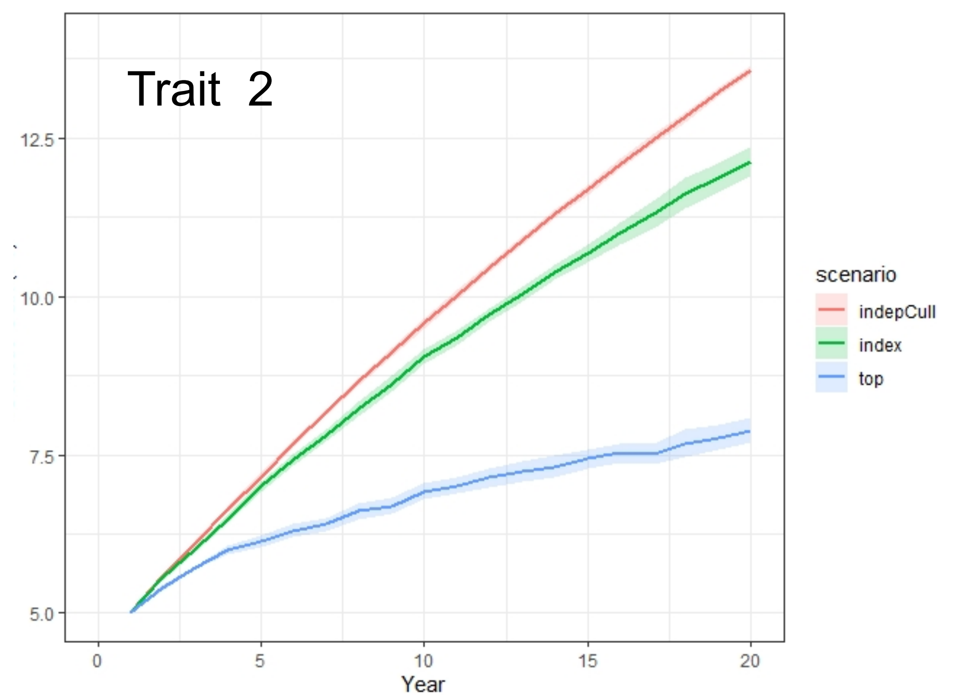



**Independent culling**




**Tandem-type selection**



# 2. Identify which parts of the selection procedure can be replaced with an index

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

As many traits as needed involved in each step

| step | selectionUnit | stepType | trait | value | directionality | trait | value | directionality | valuesUsedAs | useTraitCovariance | TotalSelected |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | DESIGNAT | reduce | YLD_rel | 0.4 | > | ZNC_rel | 0.3 | > | culling | - | 891 |
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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.

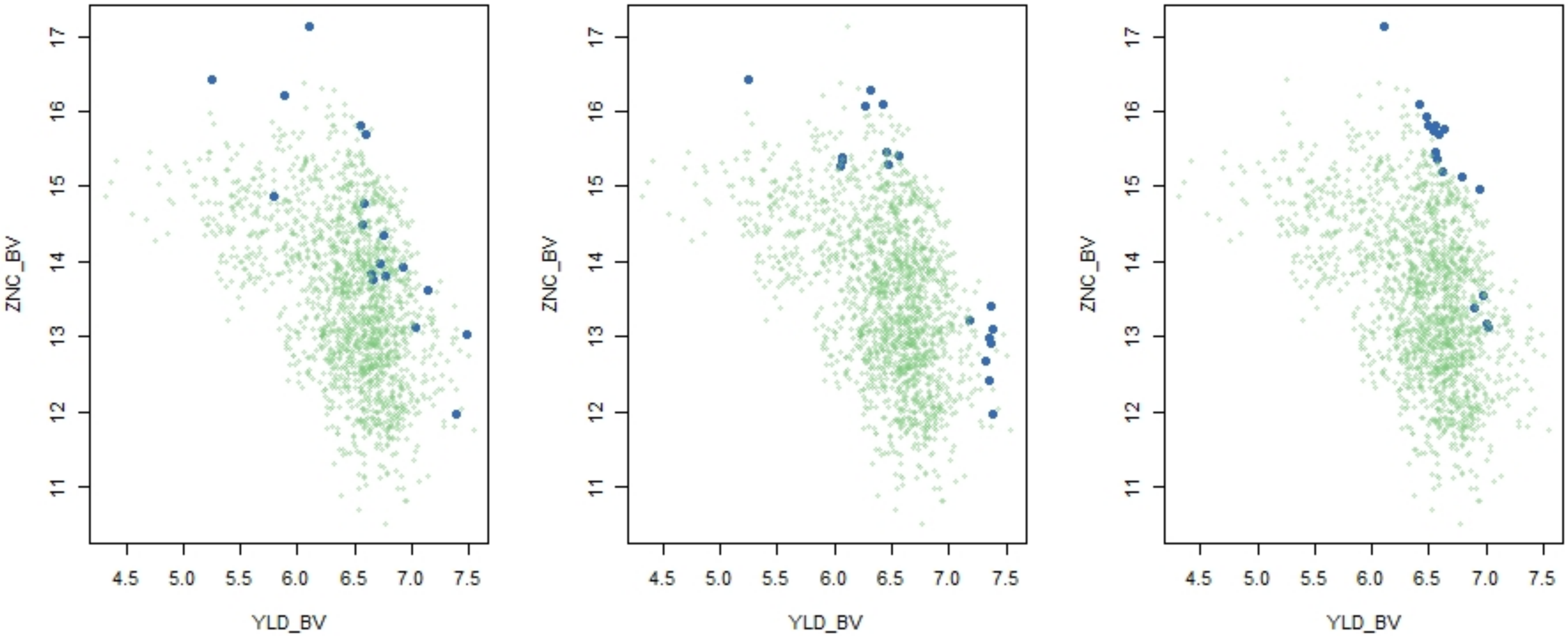
**Retrospective weights obtained using Josh's files**

| | Bangladesh | ESA | India | Philippines |
|---|---|---|---|---|
| **YLD_BV** | 2.905 | 4.764 | 3.371 | 2.015 |
| **ZNC_BV** | 0.457 | 0.629 | 0.460 | 1.199 |
| **Xa21n** | -3.148 | 1.003 | -3.533 | -0.844 |
| **Xa5n** | 0.751 | -0.436 | 0.915 | -0.492 |
| **Pitan** | -0.496 | -1.075 | -1.153 | -1.358 |
| **Pi54n** | -1.051 | -5.222 | -2.889 | -1.348 |

# 4. Compare to current approach using selection differentials

| | Philippines |
|---|---|
| YLD_BV | 2.015 |
| ZNC_BV | 1.199 |
| Xa21n | -0.844 |
| Xa5n | -0.492 |
| Pitan | -1.358 |
| Pi54n | -1.348 |

Josh selections | Algorithm selections | Index selections




| | YLD_BV | ZNC_BV | Xa21n | Xa5n | Pitan | Pi54n | Final gain |
|---|---|---|---|---|---|---|---|
| Philippines.Josh | 0.155 | 0.965 | -0.078 | -0.194 | -0.174 | -0.040 | 1.919 |
| Philippines.Algorithm | 0.255 | 0.906 | -0.365 | 0.015 | 0.104 | 0.027 | 1.722 |
| Philippines.Index | 0.093 | 1.951 | -0.564 | -0.319 | -0.174 | 0.027 | 3.361 |

# Selection differential and total gain is higher for selection indices across all regions

| | YLD_BV | ZNC_BV | Xa21n | Xa5n | Pitan | Pi54n | Final gain |
|---|---|---|---|---|---|---|---|
| Bangladesh.Josh | 0.620 | 0.372 | -0.188 | -0.119 | 0.061 | -0.032 | 2.477 |
| Bangladesh.Index | 0.671 | 1.447 | -0.953 | -0.208 | -0.063 | 0.027 | 5.457 |
| ESA.Josh | 0.530 | 0.110 | 0.047 | -0.165 | -0.097 | -0.127 | 3.481 |
| ESA.Index | 0.392 | -0.484 | 0.047 | -0.319 | -0.174 | -0.973 | 7.018 |
| India.Josh | 0.651 | 0.402 | -0.188 | -0.056 | 0.037 | -0.078 | 3.178 |
| India.Index | 0.487 | 1.537 | -0.953 | -0.108 | -0.069 | 0.027 | 5.617 |
| Philippines.Josh | 0.155 | 0.965 | -0.078 | -0.194 | -0.174 | -0.040 | 1.919 |
| Philippines.Algorithm | 0.255 | 0.906 | -0.365 | 0.015 | 0.104 | 0.027 | 1.722 |
| Philippines.Index | 0.093 | 1.951 | -0.564 | -0.319 | -0.174 | 0.027 | 3.361 |

# You can consider that your weights were not the optimal and propose new ones

- You can finetune the weights to reflect better what you want.
- For example, we double the weight for yield:

| | Bangladesh | ESA | India | Philippines | |
|---|---|---|---|---|---|
| YLD_BV | 2.905 | 4.764 | 3.371 | 2.015 | * 2 = 4.030 |
| ZNC_BV | 0.457 | 0.629 | 0.460 | 1.199 | |
| Xa21n | -3.148 | 1.003 | -3.533 | -0.844 | |
| Xa5n | 0.751 | -0.436 | 0.915 | -0.492 | |
| Pitan | -0.496 | -1.075 | -1.153 | -1.358 | |
| Pi54n | -1.051 | -5.222 | -2.889 | -1.348 | |

| | YLD_BV | ZNC_BV | Xa21n | Xa5n | Pitan | Pi54n | Final gain |
|---|---|---|---|---|---|---|---|
| Philippines.Josh | 0.155 | 0.965 | -0.078 | -0.194 | -0.174 | -0.040 | 2.230 |
| Philippines.Index | 0.425 | 1.078 | -0.397 | -0.319 | -0.174 | -0.029 | 3.772 |

Comparison of crosses selected by Josh vs the index

| Cross | Freq.Josh | Freq.Index |
|---|---|---|
| BR 28/IR 50::C1 | 1 | 1 |
| FEDEARROZ 50/IR 77298-14-1-2-10//IRRI 123/IR 45427-2B-2-2B-1-1///SANHUANGZHAN NO 2/... | 1 | NA |
| IR 55182-3B-3-2-2-2/IR 10198-66-2 | 1 | NA |
| IR 98418-B-B-15/IR09A224 | 1 | 2 |
| IR03A262/IR 50::C1 | 1 | 2 |
| IR05N412/BRRI DHAN 55 | 1 | 1 |
| IR09A116/IRRI 156 | 1 | 1 |
| IR09N190/BRRI DHAN 55 | 1 | 1 |
| IR09N190/IR09F436 | 1 | 1 |
| IR09N190/IRRI 156 | 1 | 1 |
| IR10N237/BRRI DHAN 55 | 1 | 1 |
| IRRI 156/IR04A115 | 1 | NA |
| IRRI 156/IR11A293 | 1 | 1 |
| IRRI 174/IR11A293 | 1 | NA |
| IRRI 174/IR12A330 | 1 | 1 |
| MANAW THUKHA/IRRI 154 | 1 | 1 |
| TAKANARI/IRRI 154 | 2 | NA |
| IR09A116/MANAW THUKHA | NA | 1 |
| IR10N225/BRRI DHAN 55 | NA | 1 |
| IRRI 154/MOROBEREKAN | NA | 1 |
| IRRI 174/IR04A428 | NA | 1 |
| PR 36921-B-6-1-3-4/IRRI 154//IR09A228 | NA | 1 |

# Keeping selection of individuals per family balanced in the Philippines still favors the index

Selection differentials using index for across and within family selection

| | YLD_BV | ZNC_BV | Xa21n | Xa5n | Pitan | Pi54n | FinalGain |
|---|---|---|---|---|---|---|---|
| Bangladesh.Josh | 0.620 | 0.372 | -0.188 | -0.119 | 0.061 | -0.032 | 2.477 |
| Bangladesh.Index | 0.649 | 0.478 | -0.153 | 0.181 | -0.074 | -0.073 | 2.833 |
| ESA.Josh | 0.530 | 0.110 | 0.047 | -0.165 | -0.097 | -0.127 | 3.481 |
| ESA.Index | 0.613 | 0.158 | 0.047 | -0.052 | -0.041 | -0.173 | 4.038 |
| India.Josh | 0.651 | 0.402 | -0.188 | -0.056 | 0.037 | -0.078 | 3.178 |
| India.Index | 0.706 | 0.211 | -0.153 | 0.231 | -0.024 | -0.073 | 3.468 |
| Philippines.Josh | 0.155 | 0.965 | -0.078 | -0.194 | -0.174 | -0.040 | 1.997 |
| Philippines.Index | 0.252 | 0.989 | -0.111 | -0.056 | -0.069 | -0.026 | 2.069 |

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