UNIVERSIDADE DE SÃO PAULO
ESCOLA SUPERIOR DE AGRICULTURA
"LUIZ DE QUEIROZ"
DEPARTAMENTO DE GENÉTICA
LGN5825 Genética e Melhoramento de Espécies Alógamas

Reciprocal Recurrent Selection

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Definition and scheme

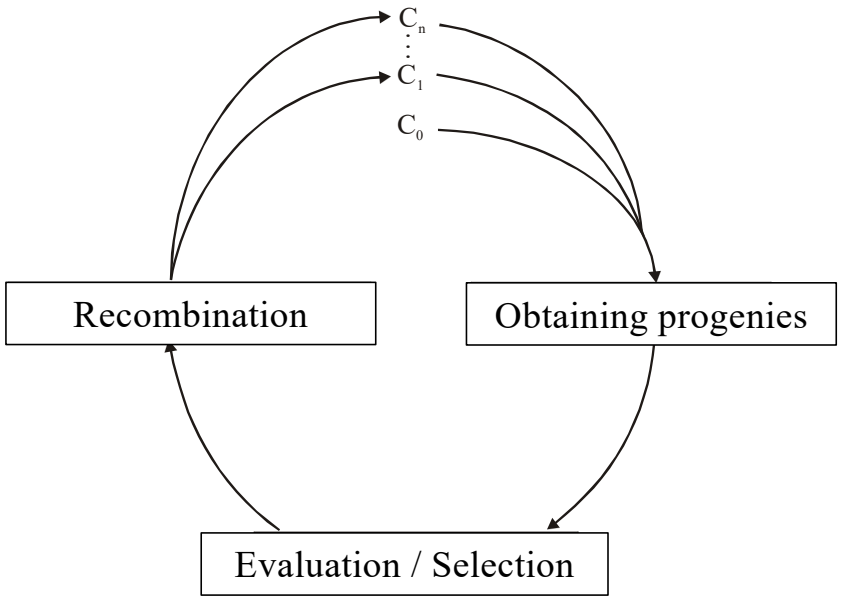
- Continuous process which aims the increasing of the allele frequencies but without miss substantial genetic variability.
- Dynamic process – every cycle is possible to release na improved material and add more genetic variability

- <u>Three stages</u>

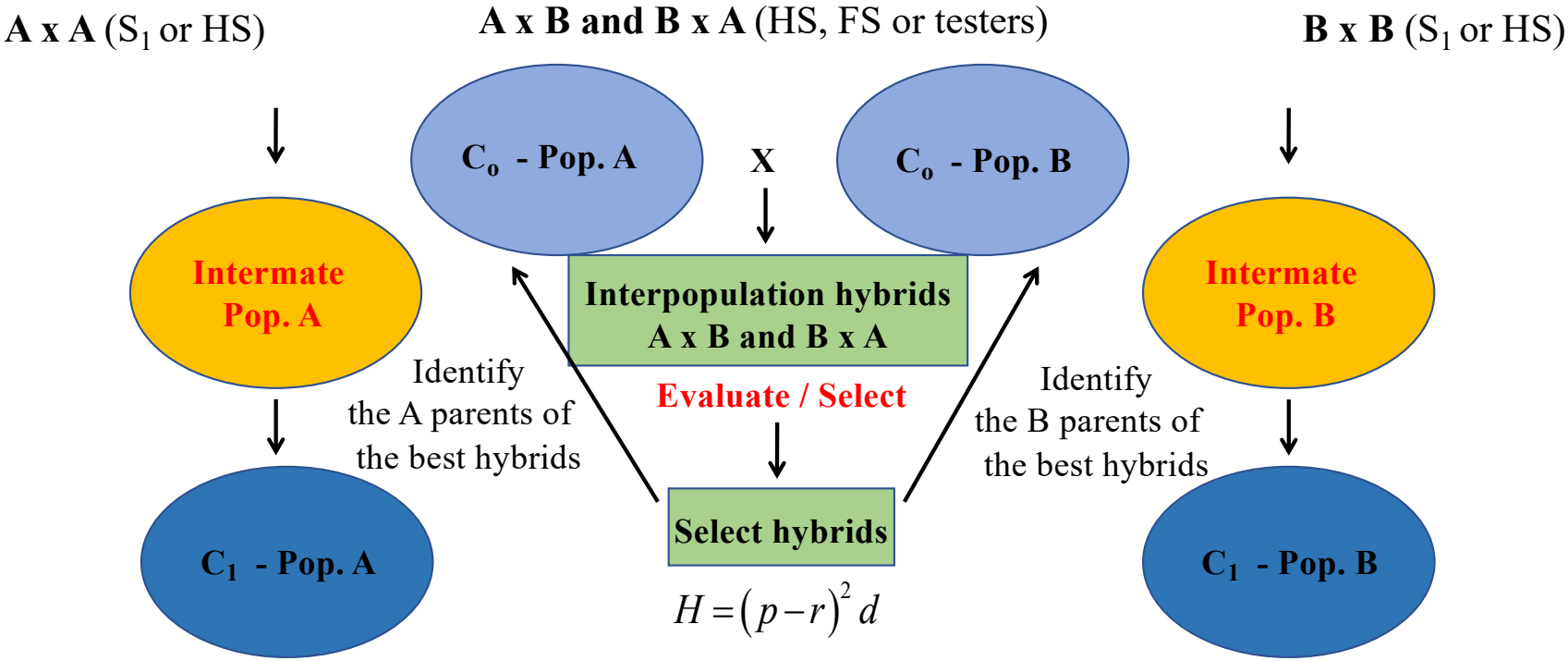
i) Obtaining progenies

ii)Evaluation and selection – identify the best parents

iii) Intermate the selected progenies (next cycle of selection)



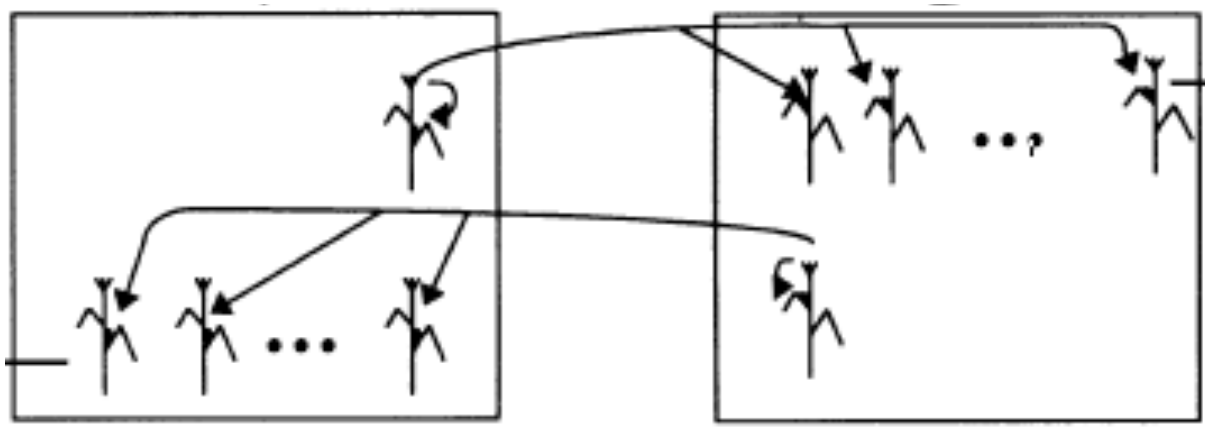
General scheme of RRS



Increase the heterosis between populations

Stages of RRS

- **Stage 1:** ***obtaining progenies***



Testers, HS, or FS – Which one is the best to evaluate?
HS or S_1 – Which one is the best to intermate?

Stages of RRS

- **Stage 2:** ***evaluation and selection***
- Breeding objectives

$$RS = \frac{i}{\sigma_P} c \sigma_A^2$$

$$RS = i_1 . c . \frac{\sigma_{A1:2}^2}{\sigma_{P1:2}} + i_2 . c . \frac{\sigma_{A2:1}^2}{\sigma_{P2:1}}$$

Avaliação	Recombinação	c	Ne	Ne (10% de 200)
MI	MI	¼	4	80
MI	S_1	½	1	20
IC	IC	½	2	40
IC	S_1	½	1	20

%	20	10	1	0.1
i	1.40	1.76	2.67	3.37

$$Ne = \frac{1}{2F}$$

- c = Parental control and additive covariance between the units of selection and recombination
- Effective population size - *evaluation* (200) *and intermate* (10 to 20)
- Avoid to miss the genetic variability and boost the genetic drift

Scheme - interpopulation HS / S_1

$$RS = i_1 . \frac{1}{4} . \frac{\sigma^2_{A1:2}}{\sigma_{P1:2}} + i_2 . \frac{1}{4} . \frac{\sigma^2_{A2:1}}{\sigma_{P2:1}}$$

$$RS = i . \frac{1}{2} . \frac{\sigma^2_A}{\sigma_P}$$

Male A

?

Female B

1/2

1

US=HS

UR=S_1

$c = \frac{1}{2} . 1 \frac{1}{2} . \frac{1}{2} = \frac{1}{8}$

1/2

Female A

1

1/2

?

Male B

UR=S_1

US=HS

$c = \frac{1}{2} . 1 \frac{1}{2} . \frac{1}{2} = \frac{1}{8}$

1/2

Pop $_B$ improved

Pop $_A$ improved

1/2

1/2

1/2

1/2

$c = \frac{1}{2} . 1 \frac{1}{2} . \frac{1}{2} = \frac{1}{8}$

US=HS

UR=S_1

Male A

?

1/2

Female B

1

Y_M Hybrids

UR=S_1

$c = \frac{1}{2} . 1 \frac{1}{2} . \frac{1}{2} = \frac{1}{8}$

US=HS

Male B

?

1

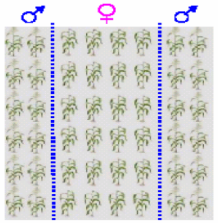
1/2

Female A

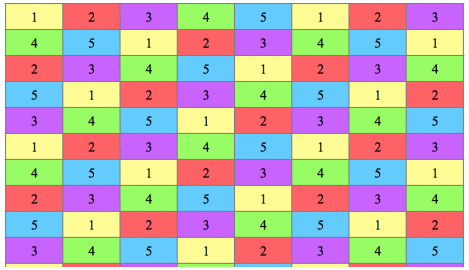
Stages of recurrent selection

- **Stage 3**: ***intermate – each group separately***
- Produce genetic variability for the next cycle
- Combine the superior allele/genes selected from different individuals in the newest genotypes

Ireland Method



Macho mistura das sementes das progênies selecionadas
Fêmea: progênies selecionadas

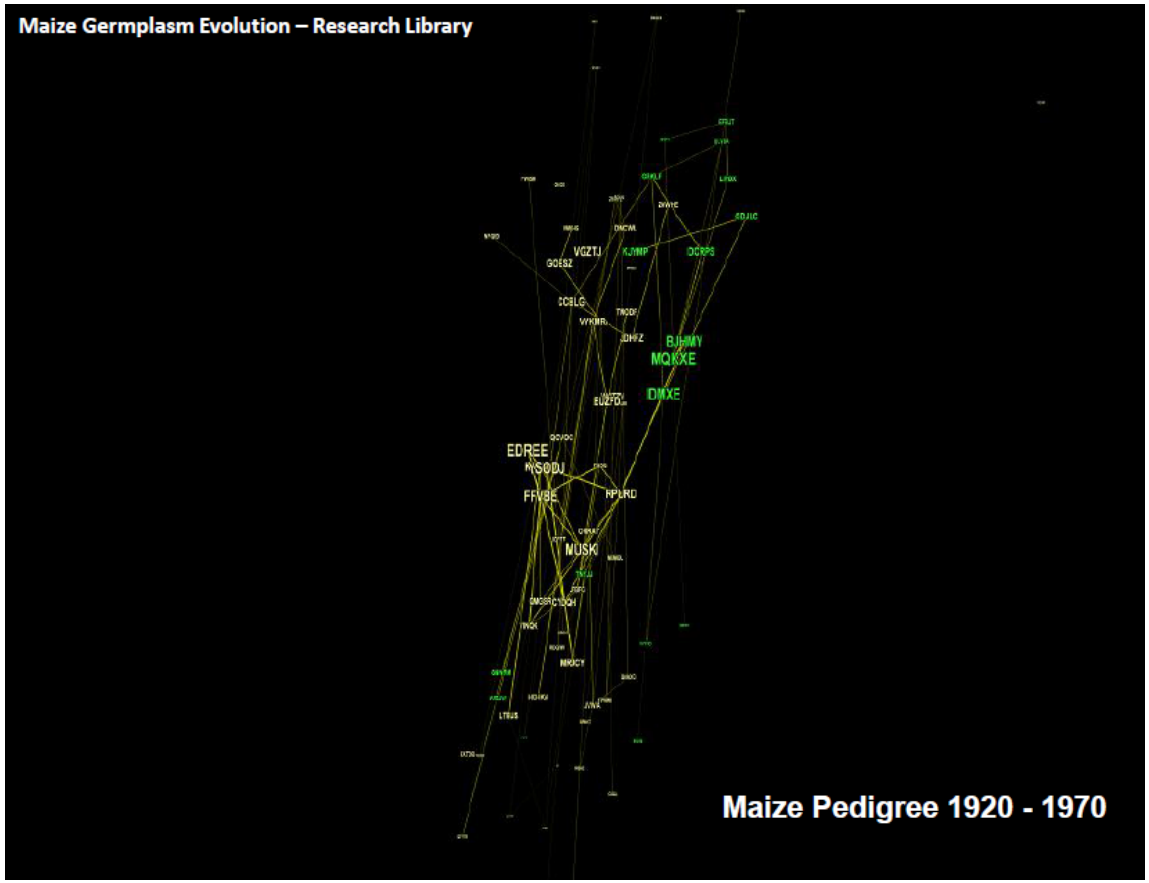


$$Ne \cong \frac{2N}{\frac{\sigma_o^2}{\mu_0} + 1}$$

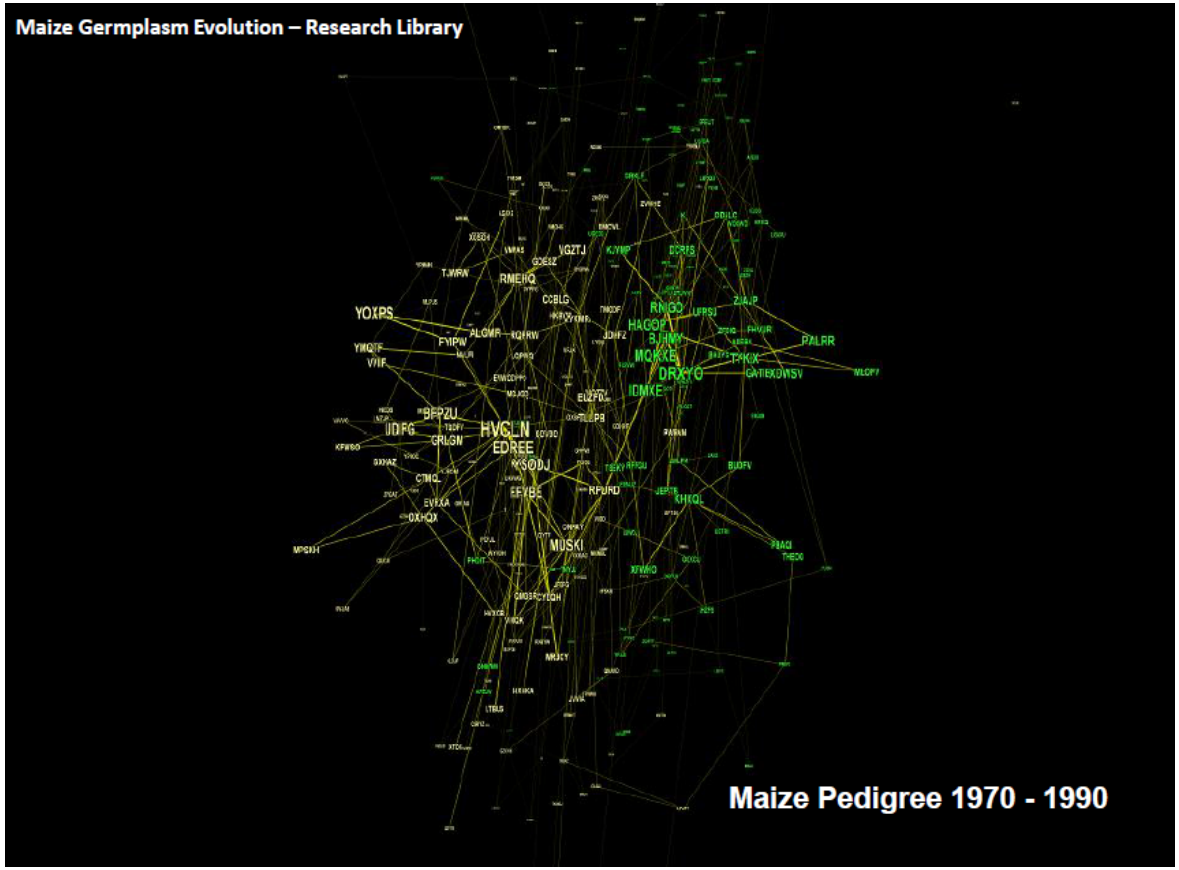
- 50 plants at least in the female rows
- Just one cycle of random intermate is enough to achieve the HWE
- Use the same number of seeds to hybridize and to compose the post-harvest sample

2N = number of gametes used
u_0 = mean of gametes per parent
σ = variance for number of gametes

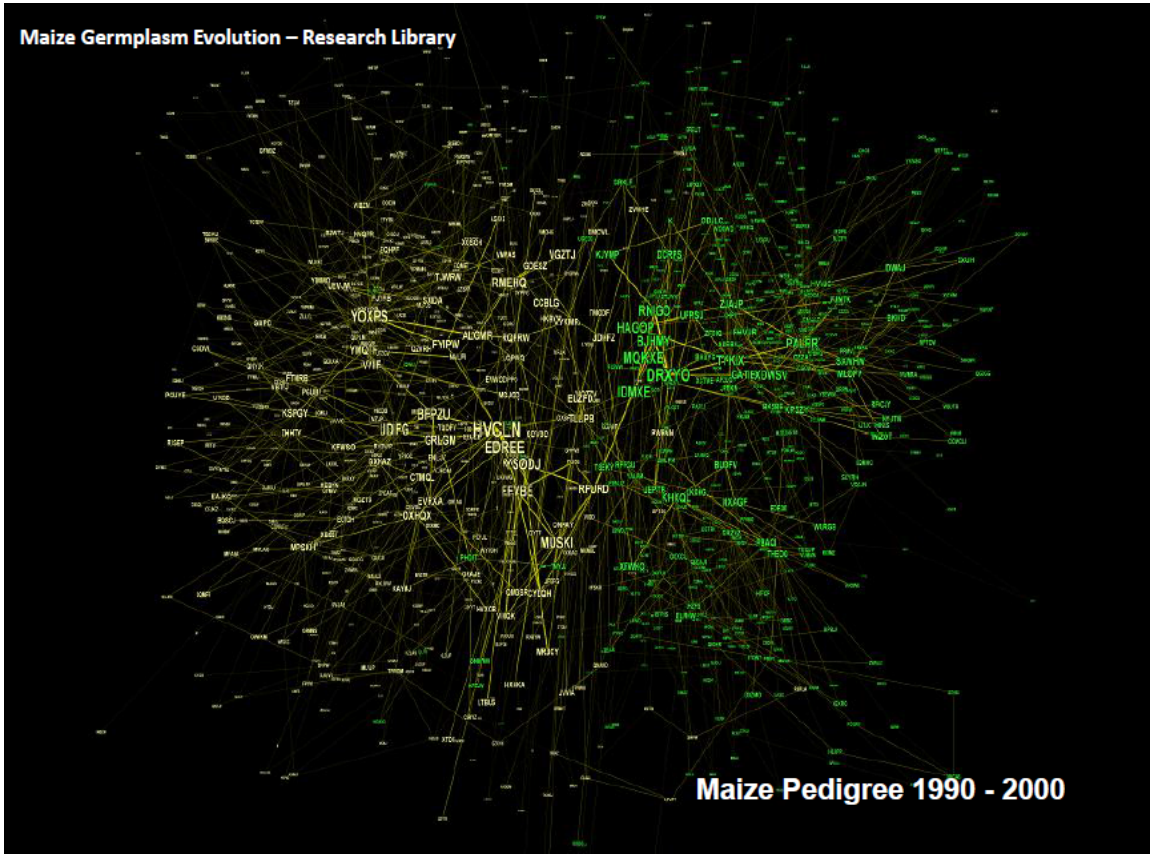
Germplasm of DuPont - Pioneer



Germplasm of DuPont - Pioneer

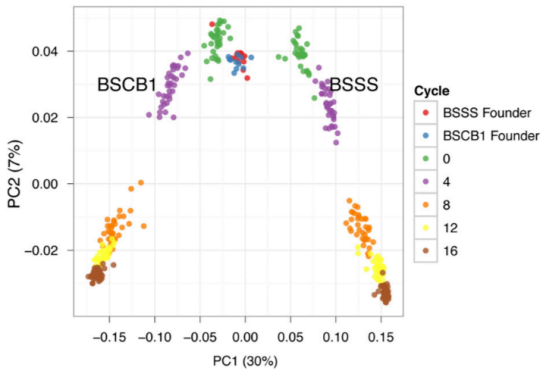


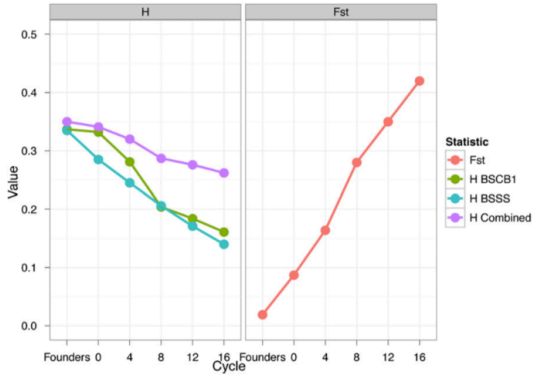
Germplasm of DuPont - Pioneer

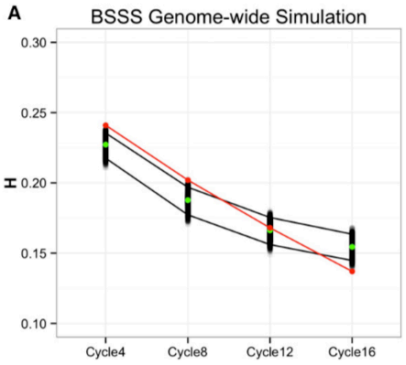


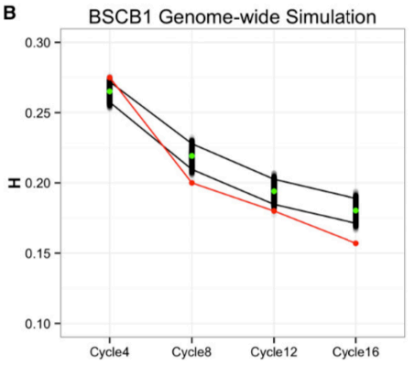
Drift and selection in RSS

- **Gerke et al (2015)**
- **Iowa RRS program** – started in 1949 – 16 cycles
- **Founders:** BSSS population 16 and BSCB1 12 inbred lines
- **100 progenies - HS/S1** (Ne = 1 each one)
- **Between cycle 4 and 8, 2 self generations**
- **Using empirical and simulated data they evaluated Fst, Ht, diversity, and distance**

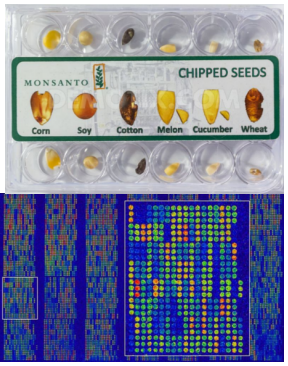








Genomic Reciprocal Recurrent Selection

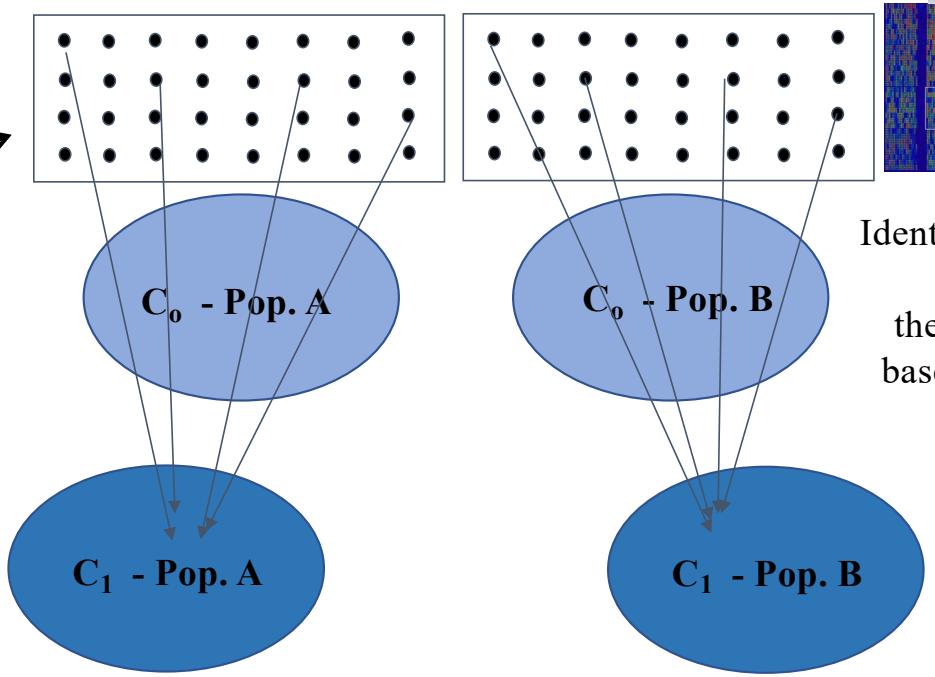


Many cycles of
Genomic selection

Training / Validation Set

Genotyping the lines
Phenotyping the hybrids (NCII)
Adjust the models and identify the marker effects per group

Improved lines
(hybrids or the newest TS)



Identify the A and B parents of the best hybrids based on markers

Doubled haploids

Long-term selection gains in GS

- **Gorjanc et al (2018)**
- **Coanscestry = *C* = IBD**
- *where, X = M - 1 (0, 1, 2)*
- **Expected inbreeding**
- *where, n vector of number contributions (0, 1,2 3, or 4)*
- *and n_c number of crosses*

$$C = \frac{1}{2}(1 + \frac{1}{n_m} XX^T)$$

$$c = xTCx \qquad x = \frac{1}{2nc} n$$

$$RS = xTa$$