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

Recurrent selection

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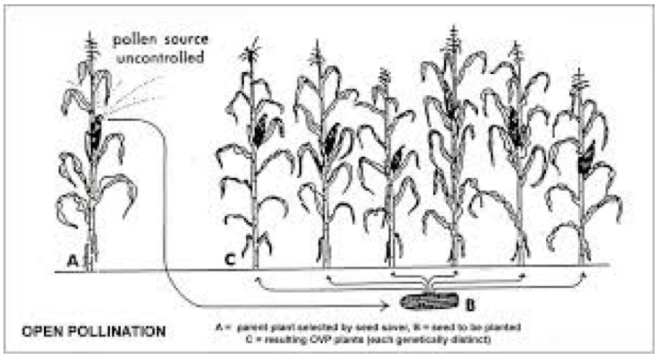
Applications

- Heterogeneous populations
- *Advantages*
- *Disadvantages*
- There is a limit of heterosis exploited
- It is difficult to identify the best balance between genetic variability, heterozygosity, and number of cycles

- **Types of population**
- Synthetics
- Pre-breeding
- Heterotic groups
- Open-pollinated varieties (OPV)



Definition and scheme

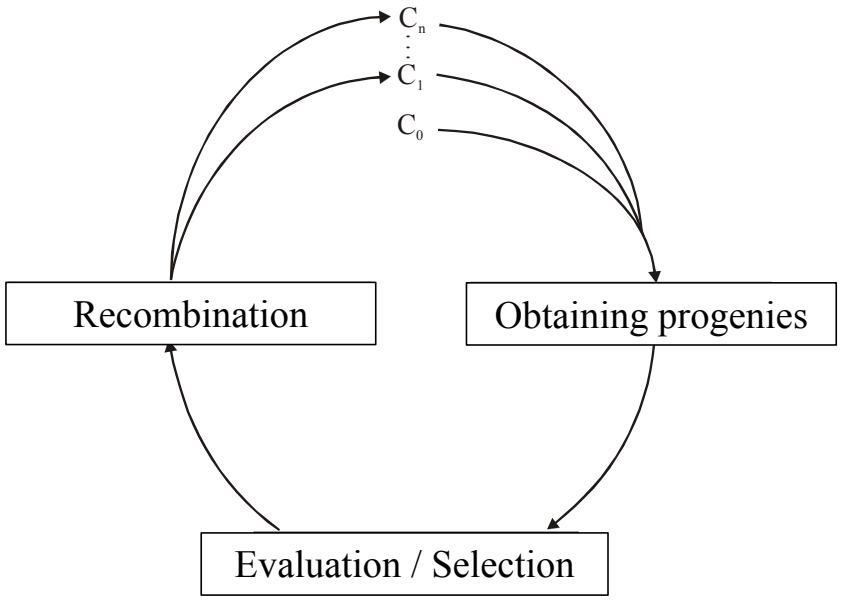
- Continuous process which aims the increasing of the allele frequencies but without miss substantial genetic variability.
- Dynamic process – every cycle is possible to release na improved material and add more genetic variability

- Three stages

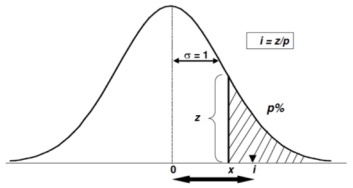
i) Obtaining progenies

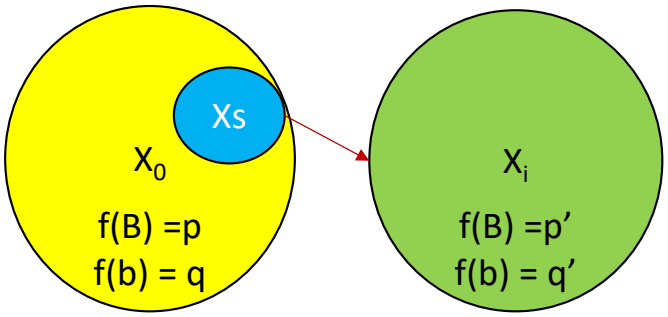
ii)Evaluation and selection – identify the best parents

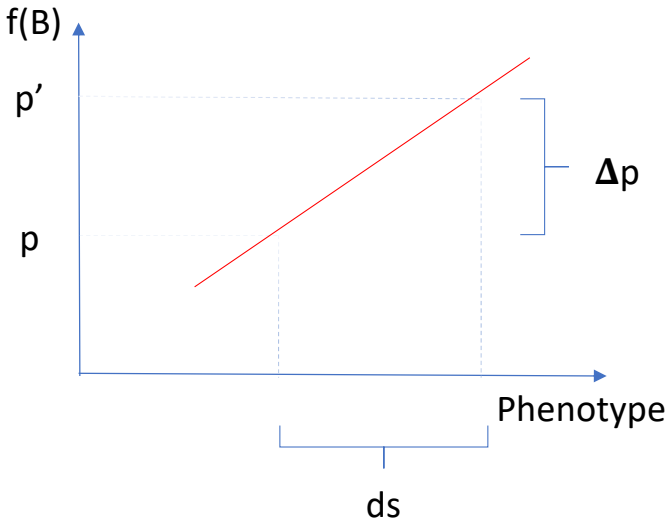
iii) Intermate the selected progenies (next cycle of selection)

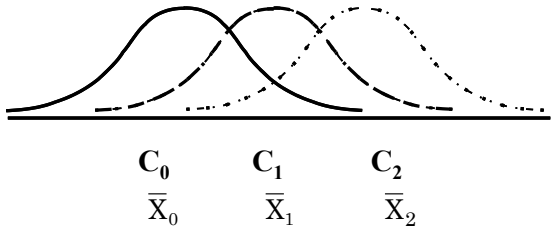


Main features







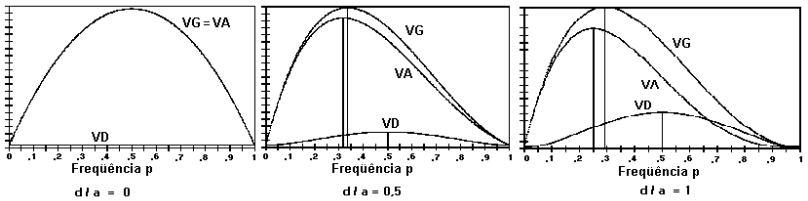


$$\sigma_A^2 = 2pq\alpha^2$$

$$\alpha = a + (q - p)d$$

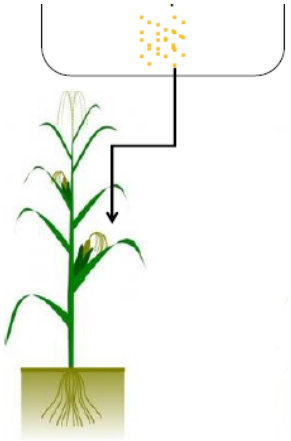
$$\sigma_D^2 = (2pqd)^2$$

- Long-term objectives (by the standard method)
- Time-consuming per cycle
- 2 or 3 cycles to achieve the first results
- Quantitative traits



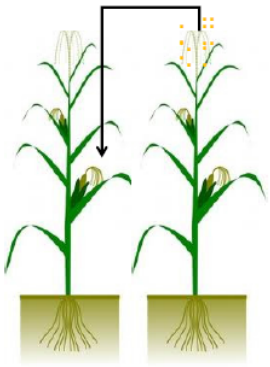
Stages of recurrent selection

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



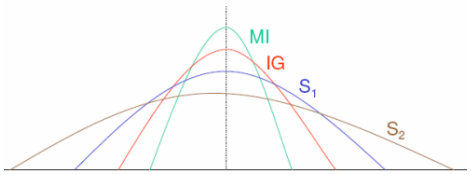
Half-sibs (HS)
Open-pollinated

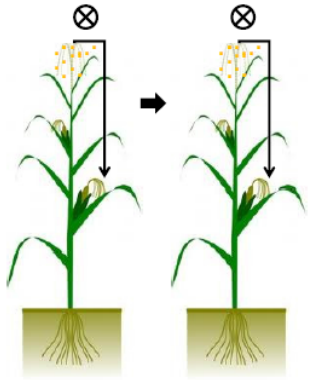
$$\sigma_g^2 = \frac{1}{4}\sigma_A^2$$



Full-sibs (FS)
Controlled pollination

$$\sigma_g^2 = \frac{1}{2}\sigma_A^2 + \frac{1}{4}\sigma_D^2$$





Self-pollinated (Sn)
Controlled pollination

$$\sigma_g^2 = \frac{1}{2}\sigma_A^2$$

Stages of recurrent selection

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

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

$$RS = \frac{i}{\sigma_P} c\left(\sigma_A^2 + \frac{D1}{2Ne}\right) - \frac{ID}{2Ne}$$

Evaluate	Intermate	c	Ne	Ne (10% of 200)	D_1
HS	HS	¼	4	80	0
HS	S_1	½	1	20	0
FS	FS	½	2	40	0
FS	S_1	½	1	20	0
S_1	S_1	1	1	20	0.5

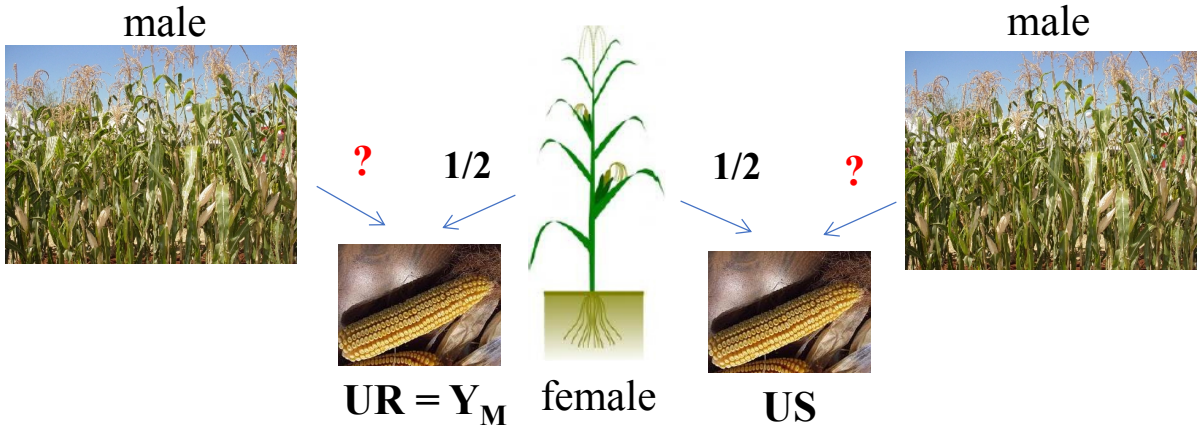
%	20	10	1	0.1
i	1.40	1.76	2.67	3.37

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

- c = Parental control and additive covariance between the units of selection and recombination
- D_1 = covariance between additive and dominance effects in the homozygous genotypes
- DE = inbreeding depression
- Effective population size - *evaluation* (200) *and intermate* (30 to 40)
- Avoid to miss the genetic variability and boost the genetic drift

Scheme based on one type of progenies

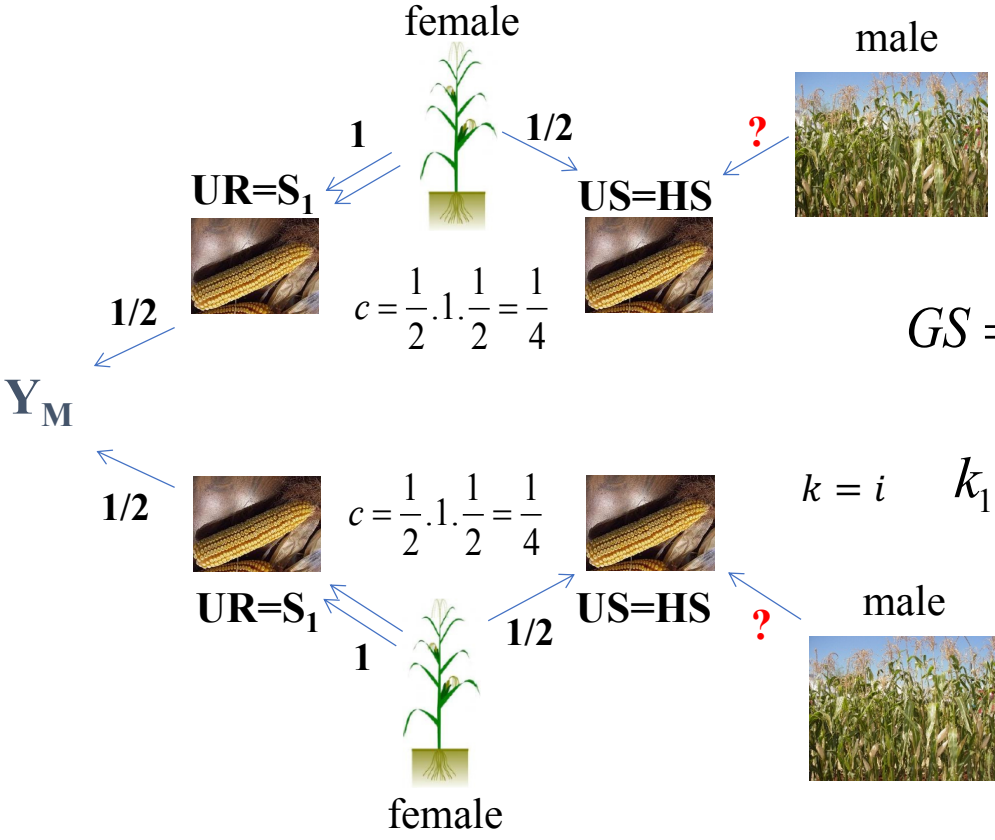
- Among half-sibs (only one sex)



$$c = \frac{1}{2}.\frac{1}{2} = \frac{1}{4} \qquad GS = k.\frac{1}{4}.\frac{\sigma_A^2}{\sigma_F}$$

$$k = i$$

Scheme based on two types of progenies – HS / S_1



$$GS = k_1 . \frac{1}{4} . \frac{\sigma_A^2}{\sigma_F} + k_2 . \frac{1}{4} . \frac{\sigma_A^2}{\sigma_F}$$

$$GS = k \frac{1}{2} \frac{\sigma_A^2}{\sigma_F}$$

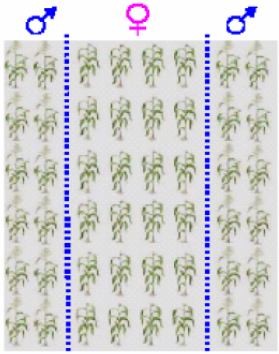
Stages of recurrent selection

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

Ireland Method

$$Vq = \frac{pq}{2N}$$

1	2	3	4	5	1	2	3
4	5	1	2	3	4	5	1
2	3	4	5	1	2	3	4
5	1	2	3	4	5	1	2
3	4	5	1	2	3	4	5
1	2	3	4	5	1	2	3
4	5	1	2	3	4	5	1
2	3	4	5	1	2	3	4
5	1	2	3	4	5	1	2
3	4	5	1	2	3	4	5



Macho mistura das sementes das progênies selecionadas
Fêmea: progênies selecionadas

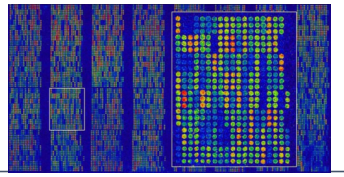
- 50 plants at least in the female rows
- Just one cycle of random intermate is enough to achieve the HWE
- Use the same number of seeds to hybridize and to compose the post-harvest sample

Genomic Recurrent Selection

Training / Validation Set

Genotyping the lines **OTS**
Phenotyping the hybrids **HTP**
Adjust the models and identify the marker effects

Many cycles of
Genomic selection
(by the markers set that maximize the accuracy)



C_n
C_1
C_0

Improved lines
(hybrids or the newest TS)

Doubled haploids

Recombination

Obtaining progenies

Synthetics or OPV

Evaluation / Selection

Is this an worthy effort?

TABELA 6. Número de indíviduos a serem avaliados em um ciclo seletivo para se obter uma linhagem com o mesmo número de alelos favoráveis de dois ciclos seletivos, considerando 40 locos segregantes e diferentes números de famílias (Q) sendo avaliadas.

Número desejado de alelos favoráveis	Número de famílias a serem avaliadas		
	Dois ciclos seletivos	Um ciclo seletivo	
	Q=Q'	Q_1	$Q_1/2Q$
31,3	50	3500	35
32,6	100	18800	94
33,8	200	116400	291
34,8	400	543200	679

[1]Q=Q' indica que o mesmo número de famílias foi considerado nos dois ciclos.