Pedigree versus mass selection

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Outline

- Logistical constraints
- Breeding scheme
- Mass selection versus pedigree selection
- Shall the population size of promising crosses be increased?

Logistic and economic assumptions

- **Logistic assumptions**
  - **10 DH lines can be produced from a single S1 (250 kern.)**
  - **1 multiplication of DH lines needed to have sufficient seed for *perse* test, isolation with tester, and further multiplication**
  - **Two row trials on testcross performance with 33 plants per row (sowing of 55 kernels per row)**

- **Economic assumptions**
  - **Costs for producing one DH line = 8 Euro**
  - **Costs for one testcross plot with two rows = 15 Euro**
  - **Costs for one isolation row with 20 plants = 10 Euro**
  - **Costs per hand selfing / crossing = 0.6 Euro**
  - **Costs for one observation row (not harvested) = 6 Euro**
  - **Equal costs in summer and winter season**

Economic frame and quantitative-genetic parameters

- **Standard scenario:** (Longin et al. 2006)
  - Budget: B = 1000 field plots for one population
  - Ratio of variance components with

    VC = 1 : 0.5 : 0.5 : 1 : 2 (Gordillo and Geiger 2004)

    $$\sigma_g^2 : \sigma_{gy}^2 : \sigma_{gl}^2 : \sigma_{gly}^2 : \sigma_e^2$$

- **Abbreviations**:
  - L : number of test locations
  - N : number of DH lines
  - C : extra costs for producing doubled haploid (DH) lines defined in field plot equivalents

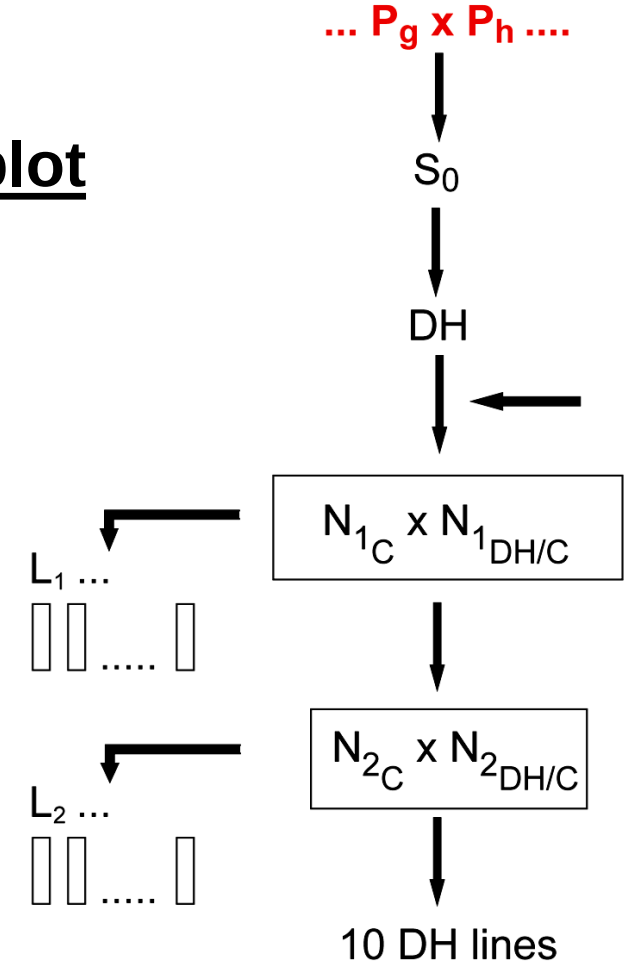
Hybrid maize breeding scheme with parental selection

Costs in field plot equivalents:

N_{1_C} $N_{1_{DH/C}}$ C

N_{1_C} $N_{1_{DH/C}}$ L_1

N_{2_C} $N_{2_{DH/C}}$ L_2

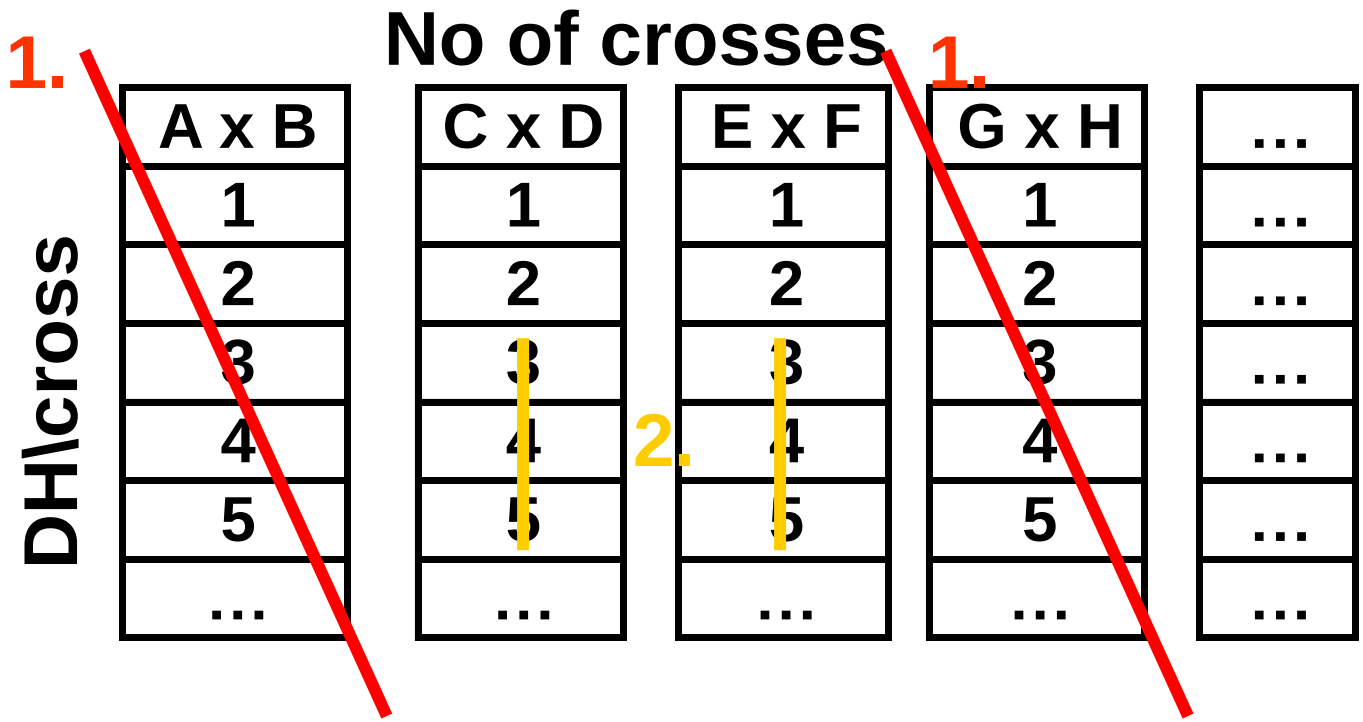


1. Selection stage: testcandidates = no. of **crosses x DH lines within crosses**

2. Selection stage: testcandidates = no. of **crosses x DH lines within crosses**

$$B = N_{1_C} N_{1_{DH/C}} C + N_{1_C} N_{1_{DH/C}} L_1 + N_{2_C} N_{2_{DH/C}} L_2$$

Alternative selection strategies – „pedigree selection“

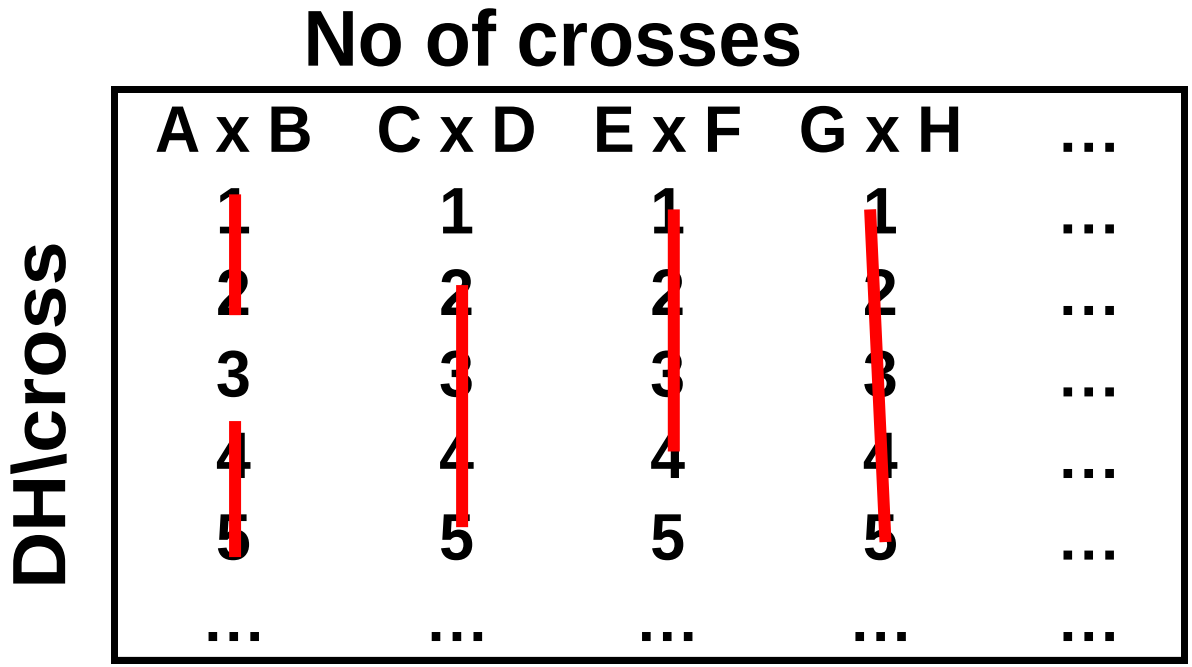


1. Selection among crosses: mean value of cross

2. Selection within crosses: mean value of DH

$$N_f = N_{f_{cross}} \times N_{f_{DH\backslash cross}}$$

Alternative selection strategies – „mass selection“



Selection among all DH lines regardless their origin

$$N_f = N_{f_{DH}}$$

Alternative selection strategies – „pedigree vs. mass selection“

Selection gain (ΔG) and its standard deviation (SD) for a breeding strategy using pedigree or mass selection.

Breeding scheme	Selection gain	Standard deviation
Pedigree	100%	100%
Mass	102%	84%

Mass selection reduces SD and increases gain from selection and is logistically much easier than pedigree selection.

Source: Wegenast et al. 2009

Variable size of crosses and families

- **Informations on parental lines available from TCs, EXs,… → concentration on „hot“ crosses**
- **Second cycle breeding in maize: $\rho_P \geq 0.5$**
  (Wegenast et al. 2008, Bernardo 2003)

No of crosses

DH\cross	A x B	C x D	E x F	G x H	…
1	1	1	1	1	…
2	2	2	2		
3	3	3			
4	4	4			
5					
6					

Constant vs. variable size of crosses and families

Selection gain (ΔG) and its standard deviation (SD) for a breeding strategy using constant populations sizes versus variable pop. sizes, where promising crosses have increased number of progenies in favor of normal crosses with reduced number of progenies.

Size of cross	Selection gain	Standard deviation
constant	100%	100%
variable	99%	101%

Enlarging promising crosses has only a limited potential to increase the gain of selection.

Source: Wegenast et al. 2009

Summary

- **Mass selection is superior to pedigree selection in hybrid maize breeding schemes with DH**

- **Enlarging promising crosses at the expense of smaller number of DHs within normal crosses has only a limited potential to improve success of selection.**