Parameters influencing the optimum allocation of resources

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Outline

- Technology costs – e.g. doubled haploids with high cost for their production
- Budget available for a breeding program
- Number of finally selected lines
- Number of selection stages

Logistic and economic assumptions

- <u>**Logistic assumptions**</u>
  - **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)**

- <u>**Economic assumptions**</u>
  - **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

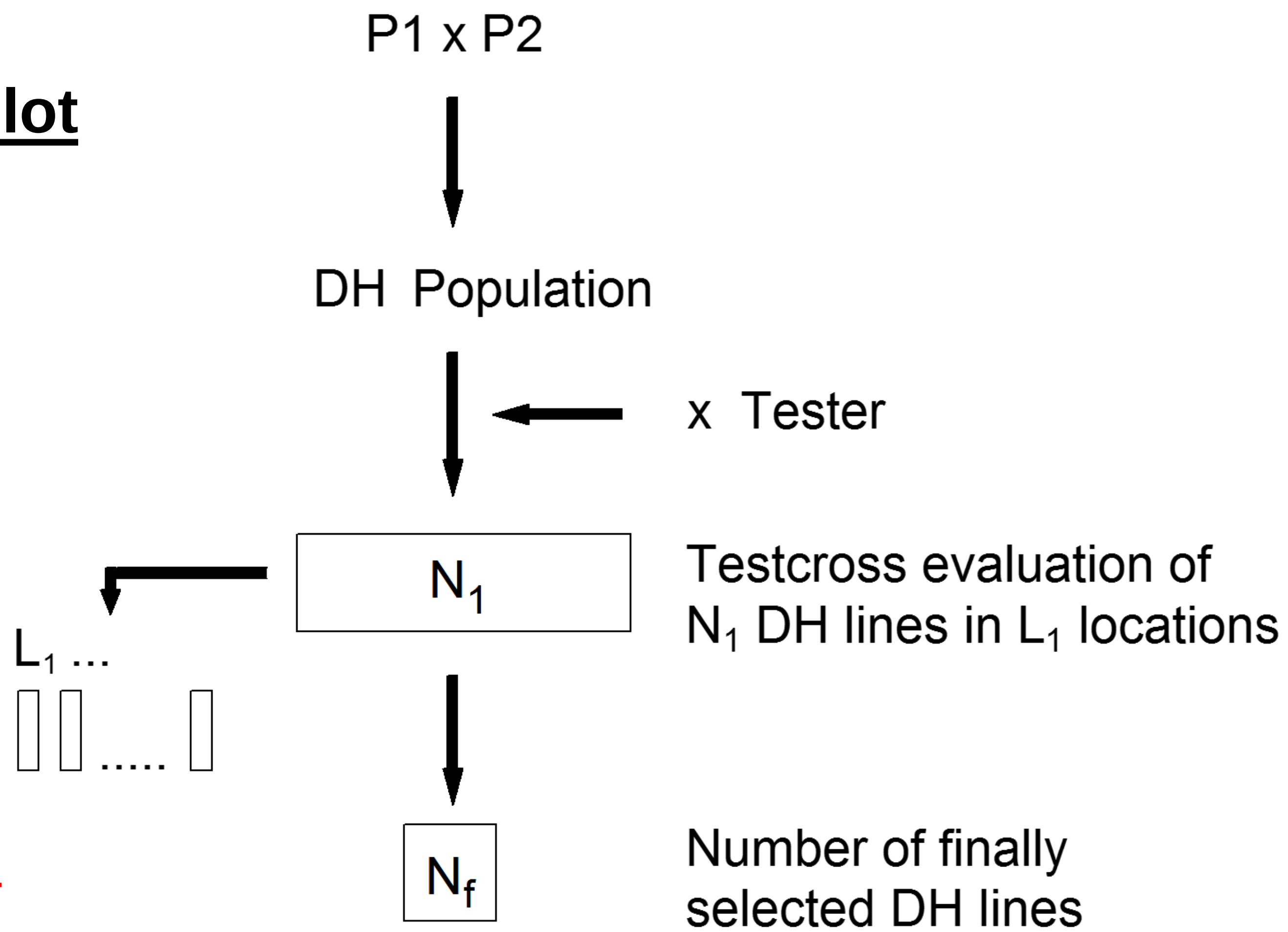
Hybrid maize breeding scheme – one-stage selection

Costs in field plot equivalents:

N_1C

$N_1 L_1$

$B = N_1C + N_1 L_1$



Impact of DH costs on the optimum allocation and opt. criteria

Optimum allocation of test resources, selection gain (ΔG), and its standard deviation (SD) for different assumptions of DH production costs (C).

C	Optimum allocation		ΔG	SD
	N_1	L_1		
0	142	7	1.86	0.76
0.5	133	7	1.85	0.76
1	125	7	1.83	0.77

DHs can be integrated in existing breeding schemes simply by compensating the larger production costs with a smaller number of initial DH lines

Source: Longin et al. 2006a; TAG 112:903-912

Parameters influencing the optimum allocation and opt. criteria

Optimum allocation of test resources for the selection gain (ΔG) or the probability to identify the x% best lines (Px%) regarding different numbers of selection stages (k), budgets (B), and number of finally selected lines (N_f).

k	B	N_f	N_1	N_2	L_1	L_2	ΔG	P(5%)	P(1%)	P(0.1%)
1	1000	1	133	-	7	-	1.85	0.60	0.27	0.05
1	5000	1	588	-	8	-	120.0%	130%	163%	240%
1	1000	5	222	-	4	-	82.2%	72%	59%	60%
2	1000	1	298	17	2	15	118.9%	132%	156%	200%

In standard one-stage selection with a budget of 1000 plots and the aim to select the best line, we recommend to screen 133 DH lines in 7 field locations

Source: Longin et al. 2006a; TAG 112:903-912

Parameters influencing the optimum allocation and opt. criteria

Optimum allocation of test resources for both optimization criteria regarding different numbers of selection stages (k), budgets (B), and number of finally selected lines (N_f).

k	B	N_f	N_1	N_2	L_1	L_2	ΔG	P(5%)	P(1%)	P(0.1%)
1	1000	1	133	-	7	-	1.85	0.60	0.27	0.05
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An fivefold increase of the budget increased the selection gain only by 20%; this is realized mainly with an increased selection intensity

Source: Longin et al. 2006a; TAG 112:903-912

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1	1000	5	222	-	4	-	82.2%	72%	59%	60%
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The larger the number of finally selected lines, the lower the selection gain and the higher the optimum number of DH lines to be tested.

Source: Longin et al. 2006a; TAG 112:903-912

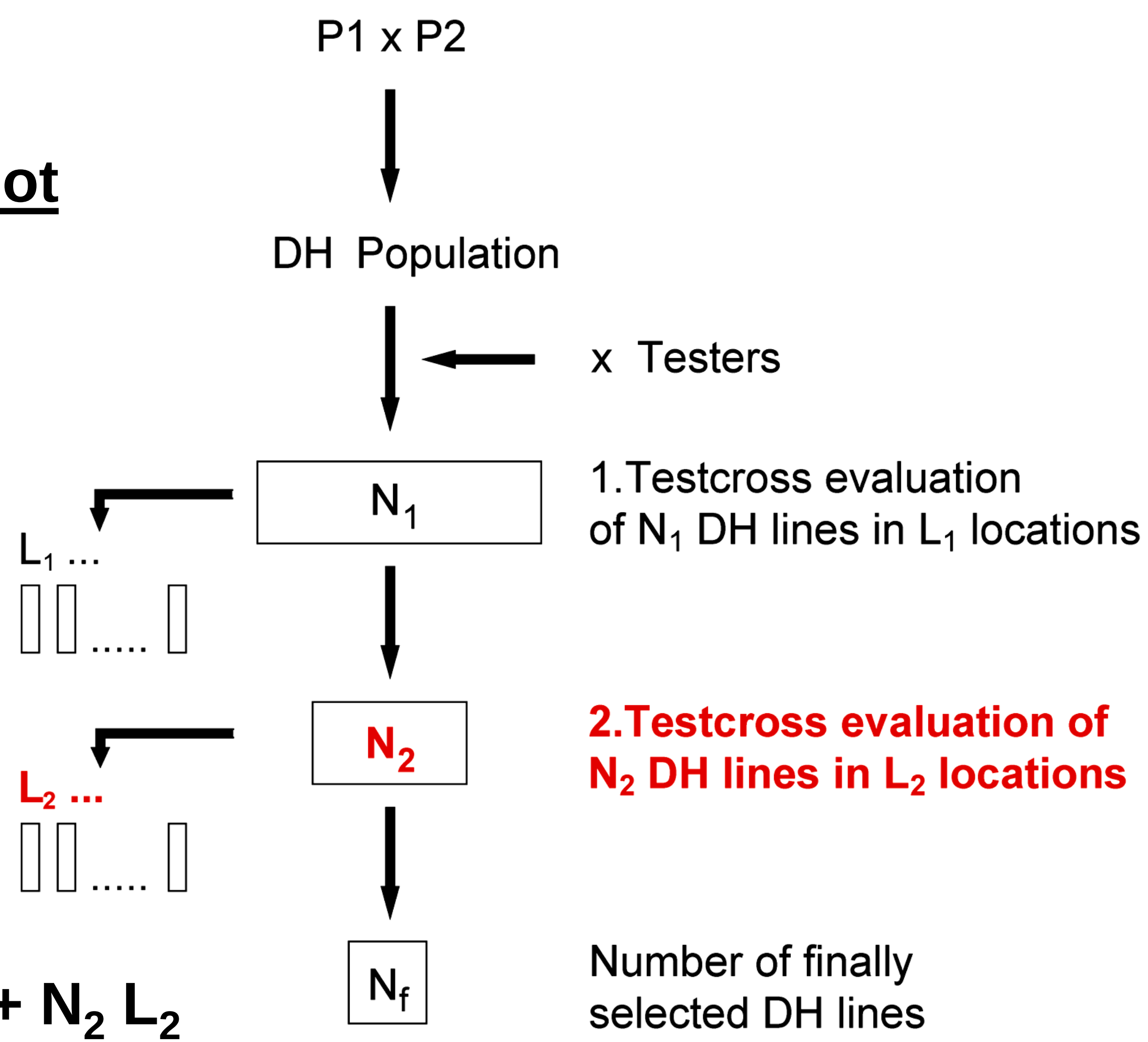
Hybrid maize breeding scheme – two-stage selection

<u>Costs in field plot equivalents:</u>

$N_1 C$

$N_1 L_1$

$N_2 L_2$



$$B = N_1 C + N_1 L_1 + N_2 L_2$$

Parameters influencing the optimum allocation and opt. criteria

Optimum allocation of test resources for both optimization criteria regarding different numbers of selection stages (k), budgets (B), and number of finally selected lines (N_f).

k	B	N_f	N_1	N_2	L_1	L_2	ΔG	P(5%)	P(1%)	P(0.1%)
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Increasing the number of selection stages for yield from 1 to 2 increased the selection gain like a fivefold increase of the budget.

Source: Longin et al. 2006a; TAG 112:903-912

Summary

- DH costs are only of limited importance for the optimum allocation of test resources as long they are not higher than 30€ per line
- An increase of the budget increases the selection gain, but the return from investment is rather low
- Increasing the number of selection stages bears the potential to increase the selection gain, but should be considered in the whole framework of the breeding company