Optimum choice of tester

Dr. Friedrich Longin
State Plant Breeding Institute
University of Hohenheim, Germany
Friedrich.longin@uni-hohenheim.de

Outline

- Assumptions on economic frame
- Use of broad versus narrow tester
- Optimum number of testers in two-stage sleection
- Evalute progenies of each tester at each location? Or alternatively evaluate each tester only in a single location?

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)

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

  - Ratio of GCA to SCA variance: (Schrag et al. 2006)

    $$\sigma_{SCA}^2 = 0.5\sigma_{GCA}^2$$

- **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
  - T : number of testers

Two-stage testcross selection

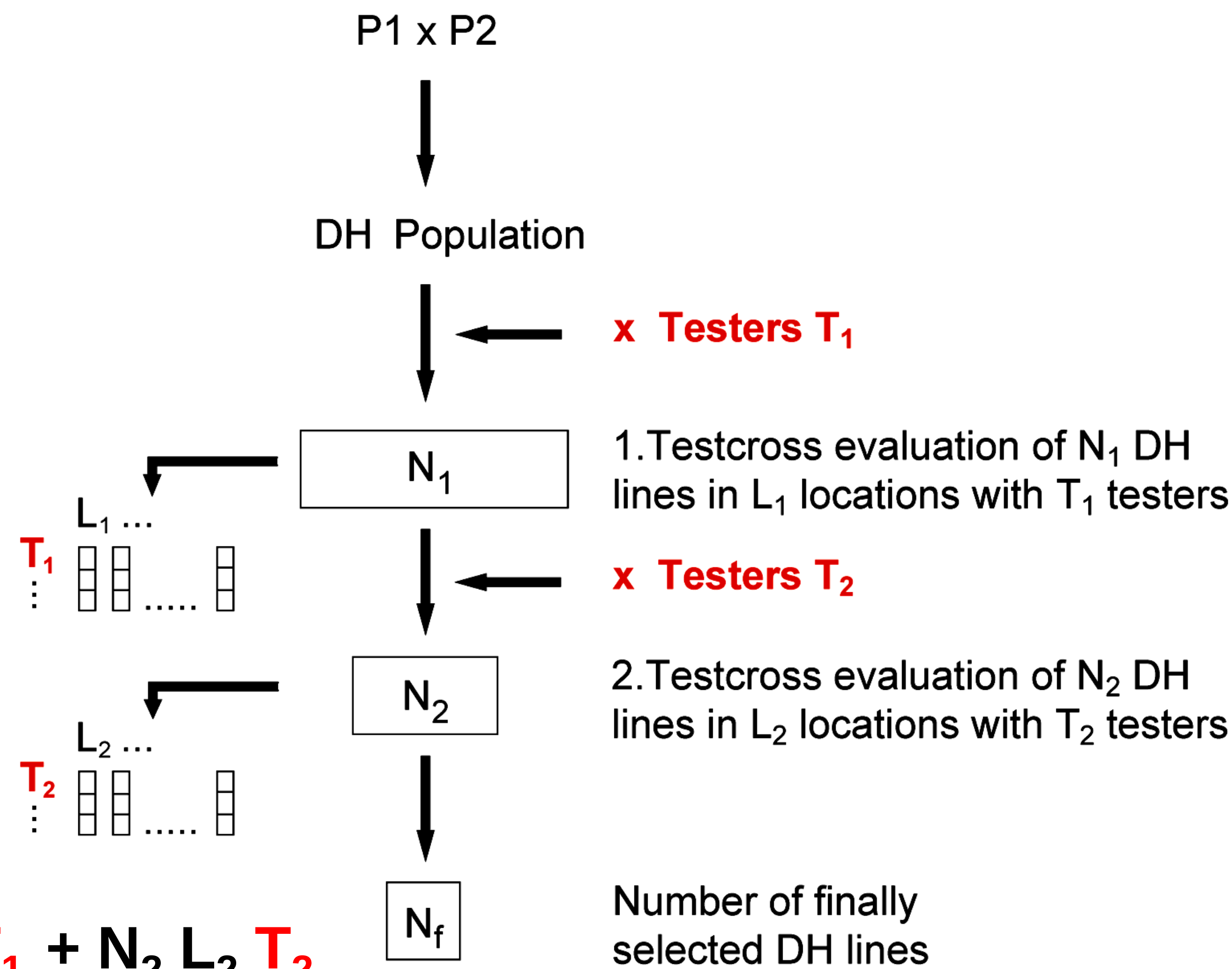
Target variable: Selection gain for GCA

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

N_1C

$N_1\ L_1\ T_1$

$N_2\ L_2\ T_2$



$$B = N_1C + N_1\ L_1\ T_1 + N_2\ L_2\ T_2$$

The optimum type of testers

Optimum allocation of test resources and selection gain (ΔG) for varying tester type (2W = single-cross, 8W = double-double cross) assuming $V_{SCA} = 0.5\ V_{GCA}$.

Tester type		Optimum allocation						
Stage 1	Stage 2	T_1	T_2	L_1	L_2	N_1	N_2	ΔG
Inbred	Inbred	1	3	2	5	238	27	100%
8W	8W	1	1	2	12	253	31	109.5%
2W	Inbred	1	3	2	5	246	26	101.7%
2W	Inbred	3[a]	14	3	14	191	24	108.7%
2W	Inbred	3[a]	2	3	7	200	21	103.4%

[a] Each tester evaluated only in a single location

The broader the genetic base of a tester, the higher is the selection gain for GCA.

Source: Longin et al. 2007; TAG 114:393-403

The optimum type of testers

Optimum allocation of test resources and selection gain (ΔG) for varying tester type (2W = single-cross, 8W = double-double cross) assuming $V_{SCA} = 0.5\ V_{GCA}$.

Tester type		Optimum allocation						
Stage 1	Stage 2	T_1	T_2	L_1	L_2	N_1	N_2	ΔG
Inbred	Inbred	1	3	2	5	238	27	100%
8W	8W	1	1	2	12	253	31	109.5%
2W	Inbred	1	3	2	5	246	26	101.7%
2W	Inbred	3[a]	14	3	14	191	24	108.7%
2W	Inbred	3[a]	2	3	7	200	21	103.4%

[a] Each tester evaluated only in a single location

Practical concerns might limit the use of broad testers to stage one, but still about 2 % advantage in selection gain

Source: Longin et al. 2007; TAG 114:393-403

Modified two-stage testcross selection

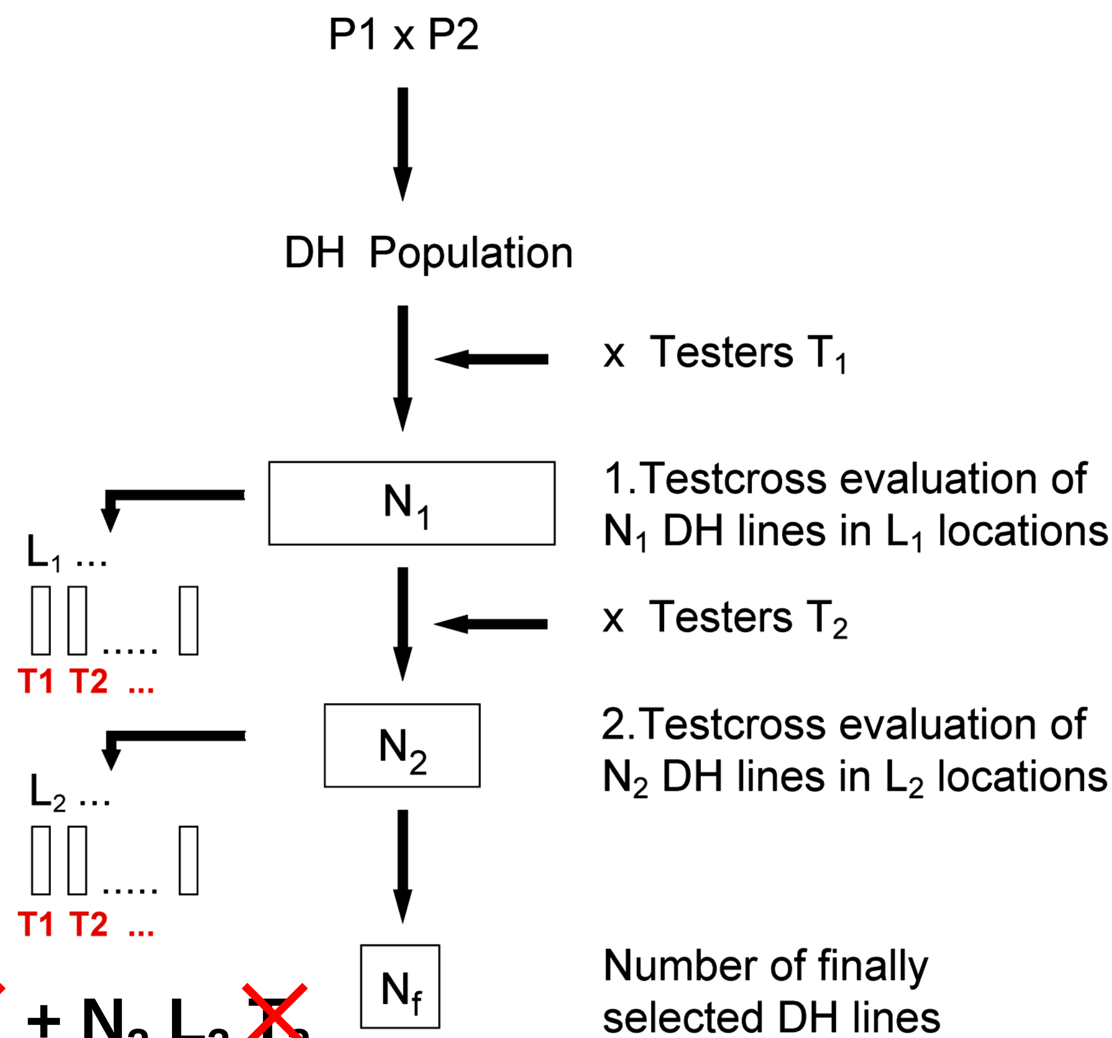
Idea: Test progenies for each tester only at a single location

Costs in field plot equivalents:

N_1C

$N_1 L_1$

$N_2 L_2$



$$B = N_1C + N_1 L_1 \cancel{T_1} + N_2 L_2 \cancel{T_2}$$

The optimum type and number of testers

Optimum allocation of test resources and selection gain (∆G) for varying tester type (2W = single-cross, 8W = double-double cross) assuming $V_{SCA} = 0.5\ V_{GCA}$.

Tester type		Optimum allocation						
Stage 1	Stage 2	T_1	T_2	L_1	L_2	N_1	N_2	∆G
Inbred	Inbred	1	3	2	5	238	27	100%
8W	8W	1	1	2	12	253	31	109.5%
2W	Inbred	1	3	2	5	246	26	101.7%
2W	Inbred	3[a]	14	3	14	191	24	108.7%
2W	Inbred	3[a]	2	3	7	200	21	103.4%

[a] Each tester evaluated only in a single location

The evaluation of progenies of each tester only at a single location increases selection gain for GCA.

Source: Longin et al. 2007; TAG 114:393-403

The optimum type and number of testers

Optimum allocation of test resources and selection gain (ΔG) for varying tester type (2W = single-cross, 8W = double-double cross) assuming $V_{SCA} = 0.5\ V_{GCA}$.

Tester type		Optimum allocation						
Stage 1	Stage 2	T_1	T_2	L_1	L_2	N_1	N_2	ΔG
Inbred	Inbred	1	3	2	5	238	27	100%
8W	8W	1	1	2	12	253	31	109.5%
2W	Inbred	1	3	2	5	246	26	101.7%
2W	Inbred	3[a]	14	3	14	191	24	108.7%
2W	Inbred	3[a]	2	3	7	200	21	103.4%

[a] Each tester evaluated only in a single location

Practical concerns might limit the use of broad testers to stage one, but still about 2 % advantage in selection gain

Source: Longin et al. 2007; TAG 114:393-403

Summary – type and number of tester

- **Testers with broad genetic base increase selection gain on GCA**

- **Applied breeding requires compromises**
  - First stage: use single- or double-cross testers and evaluate their progenies only in a single location
  - Second stage: use inbred testers and evaluate their progenies in all locations