Specific purity of hybrid larch FRM: How much does it matter?

G. Philippe, S. Matz, C. Buret, L.E. Pâques

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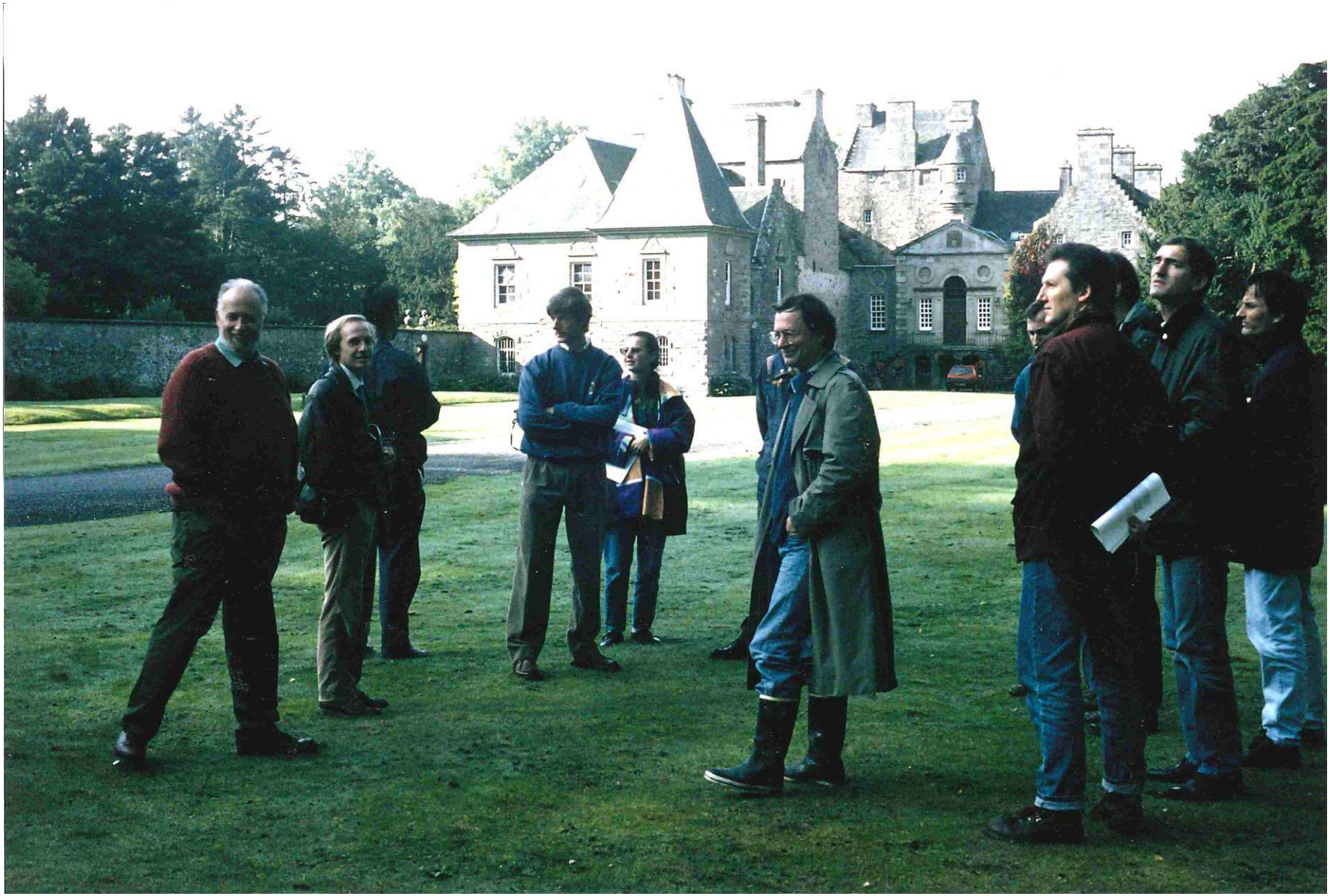
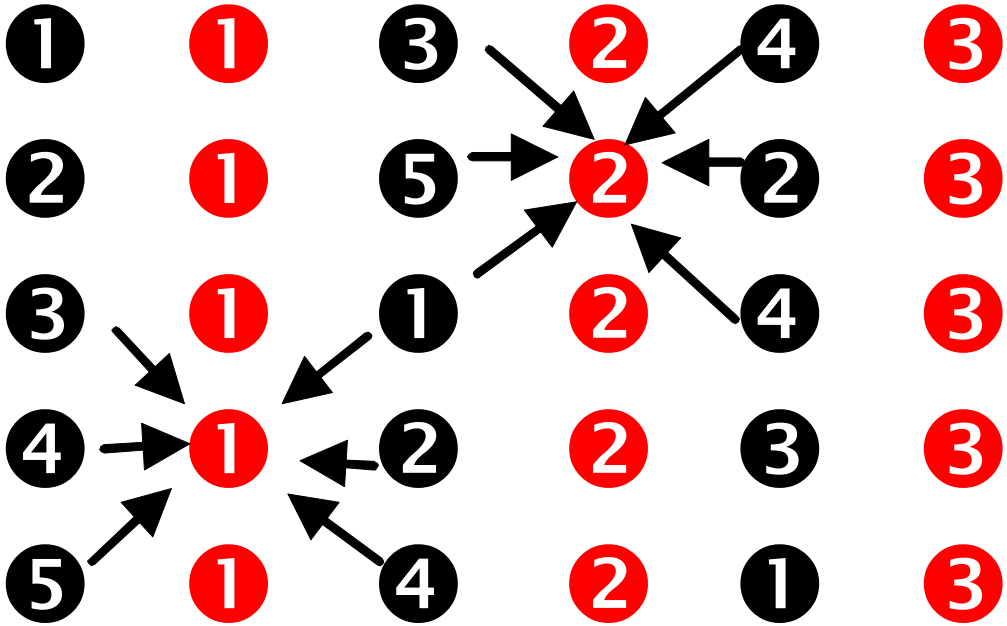
Dunkeld estate (Scotland): a place of pilgrimage



Different kinds of orchards

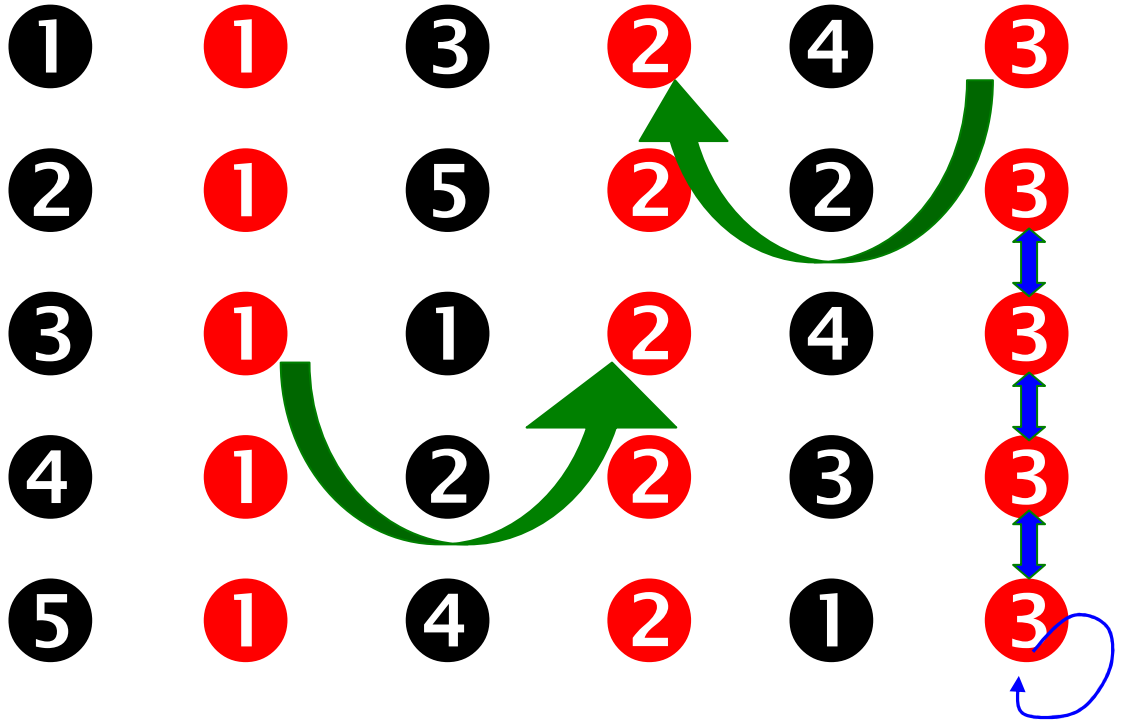
Nb of genotypes		Female species	Planting design	Pollination
♀	♂			
few → dozens	few → dozens	EL or JL or both	EL & JL intimately mixed or alternating rows	open
1	1 → dozens	EL or JL		
			separate orchards	SMP

Inter-specific crossings …



maternal / paternal species

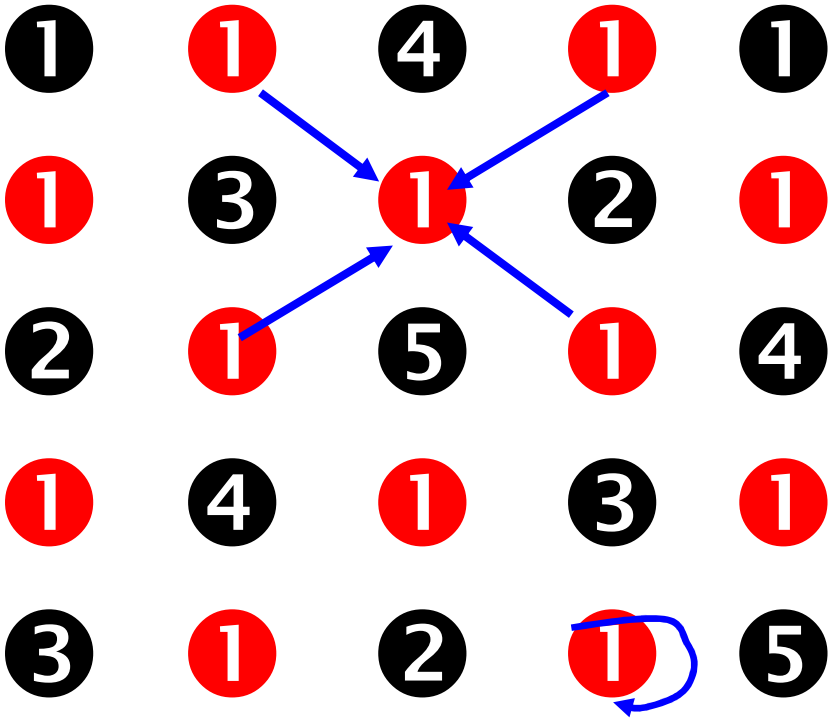
… but also intra-specific crossings



Several maternal clones:

Crossings among clones + self-pollination

Case of s.o. with a single maternal clone



Self-pollination only …
assuming the s.o. is well isolated from external pollen

The crops of hybridisation orchards composed of a mixture of seeds

- hybrid seeds

- pure species
    * crossings among different clones
    * selfing

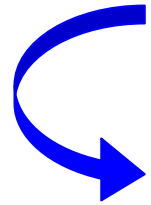
(+ hybrids or pure species due to pollen contamination)

Hybrid rate varies according to genetic, climatic and anthropic factors

- the number of genitors of the mother species

- contribution of EL and JL clones to pollen cloud

- flowering overlap between EL & JL



- clonal phenology, « selfing ability »
- Winter T°C
- SMP

- flowering ability
- climate during flower initiation
- flower induction treatments

→ **Hybrid purity will fluctuate from one orchard to another but also from year to year**

Species purity can now be quantified in any s.o.

Distinguishing hybrids to the naked eye impossible (seeds) or long (seedlings)

Pâques et al. (2006)

1990's: isozymes but restrictions

Bergmann, Ruetz (1987), Häcker, Bergmann (1991), Ennos, Tang Quian (1994)

2000's: molecular markers based on cytoplasmic DNA

Acheré et al. (2004)

→ Highly variable HL% in orchard crops (10-90%)

Objectives of the study

1- Effect of HL purity on **stand productivity and quality**

* To what extent are hybrids superior to pure species?
* Is there a threshold below which HL% should not fall to ensure convenient stand production?
* Is the importance of HL% the same for any kind of orchard?

2- Consequences of fluctuating FRM species purity in **seed orchard testing**

Material and Methods

Principle:

- Determination of taxonomic status of trees present in two s.o. testing trials

- Comparison of hybrid and pure species populations within each variety

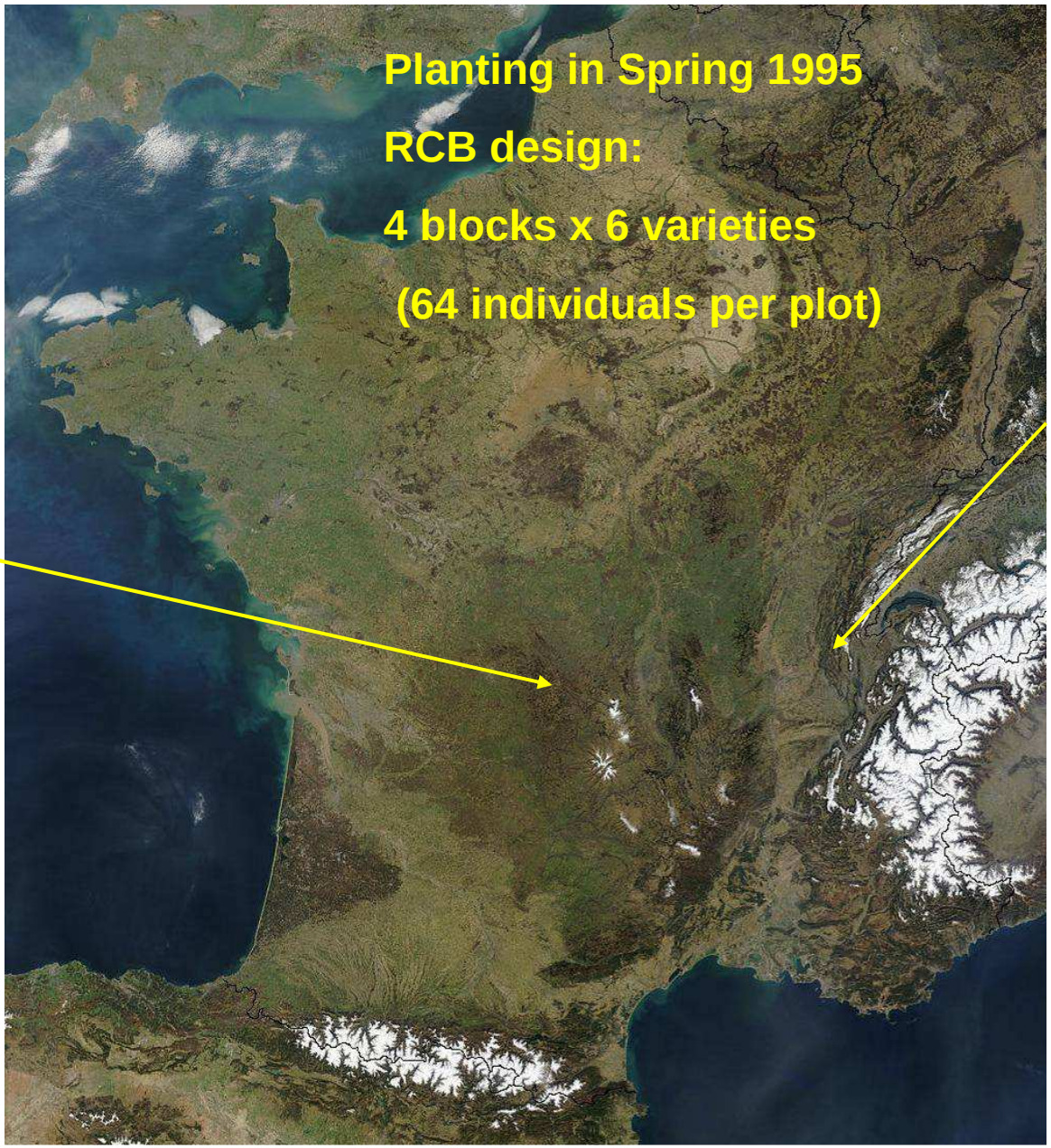
- Estimation of thinning effect on HL%

M&M: studied varieties

Variety	orchard	Planting year	Country	Mother species	Number clones (EL/JL)
Halle	Halle	1959	B	JL & EL	15/15
FP 237	Grund	1978	DK	EL	1/17
FH 201	Les Barres	1976	F	EL	1/FS
Vaals	Vaals-01	1969	NL	EL	1/26
Esbeek	Esbeek-01	1971	NL	EL	1/4
Maglehem	51 Maglehem	1956	S	JL	8/1

open pollination in all the orchards except FH 201 (SMP)

M&M: Variety testing trials



Site 1

800 m elevation

deep soil

granite

8℃, 1100 mm

JL

Site 2

1000 m elevation

shallow soil

limestone

6℃, 1500 mm

EL


Site 1


Site 2

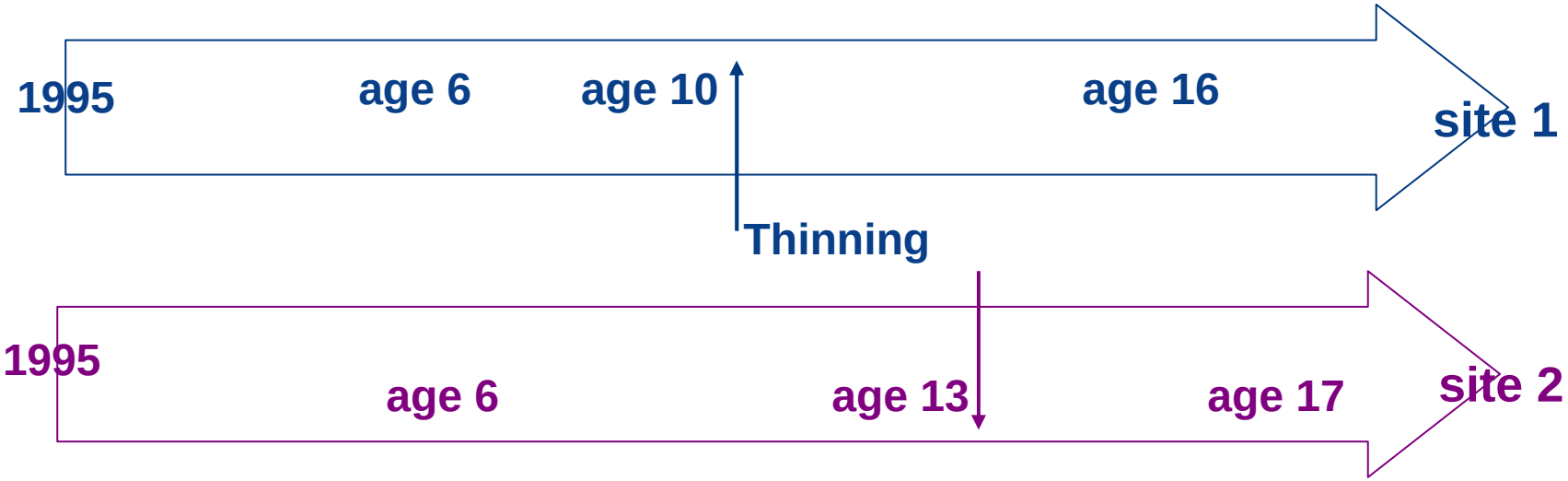
M&M: Taxa identification

- Bud collection at age 10 or 14

- Taxa identification (INRA) using markers based on cytoplasmic DNA (LL and F-13)

- Were determined:
  * Site 1: Halle, FH 201, Esbeek, Maglehem (2 blocks)
  * Site 2: id + Vaals and FP 237 (2 blocks)

M&M: Performance assessment



Adaptation – Growth – Stem form


Growth: circumference + height at age 6

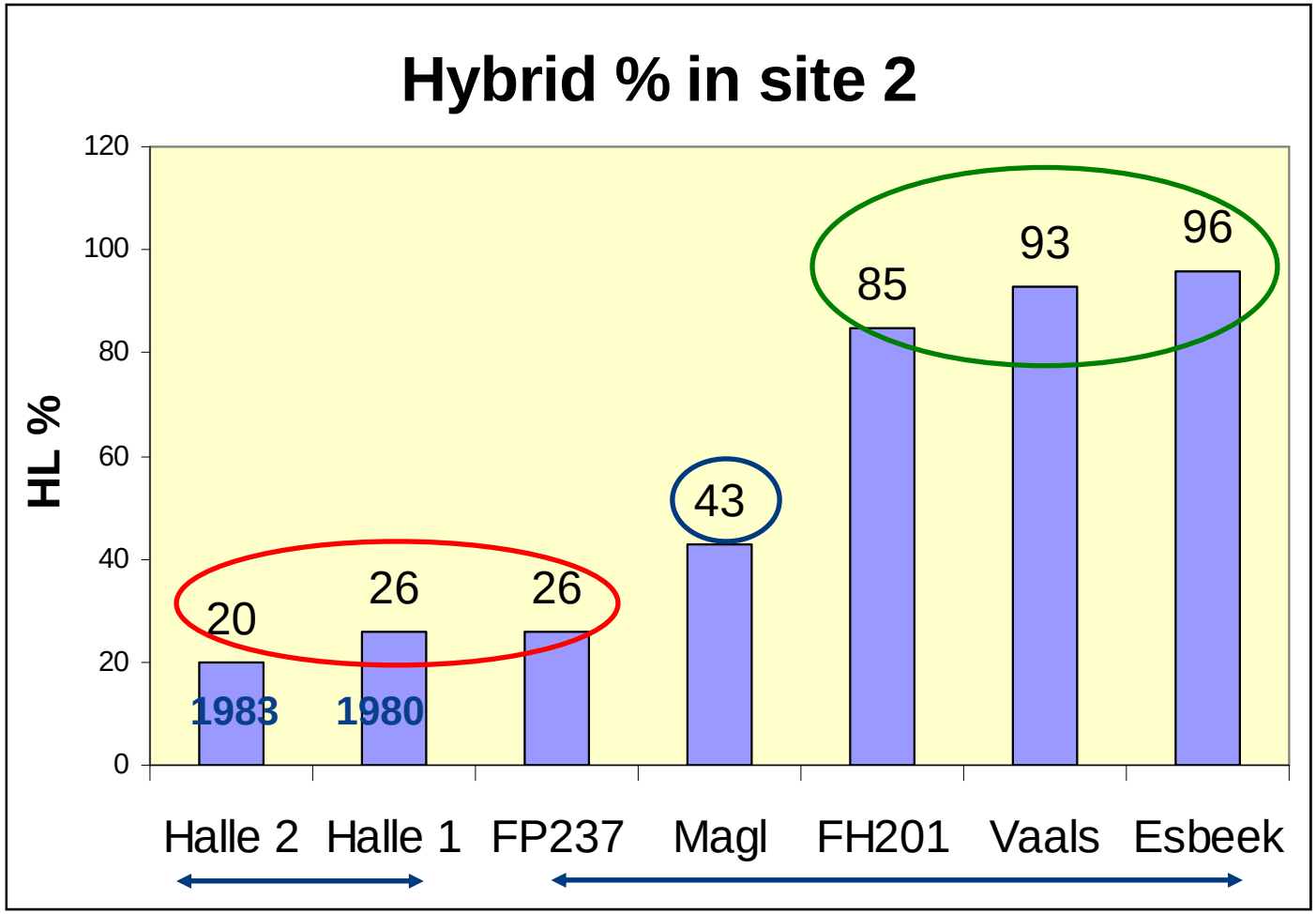
Stem straightness

Score 1

Score 5


Basal sweep (age 13 - site 2)

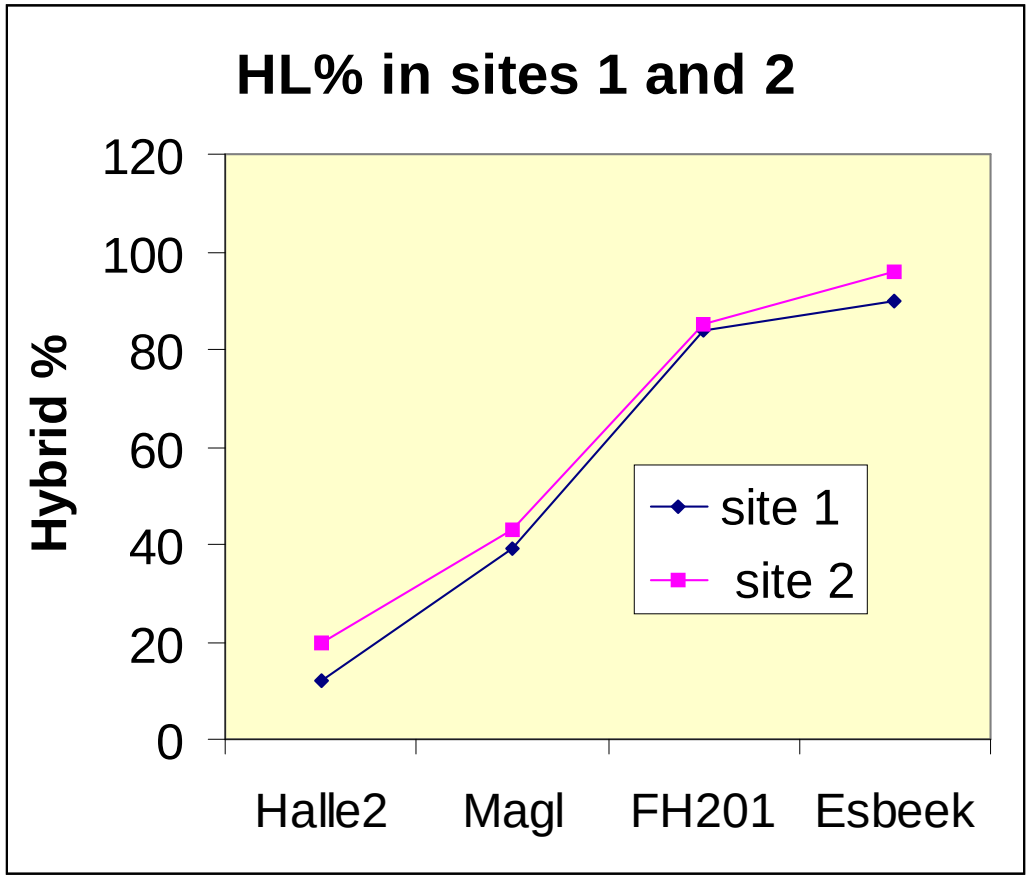
Results: Proportion of hybrids



Results: hybrids *vs* pure species - Adaptation traits

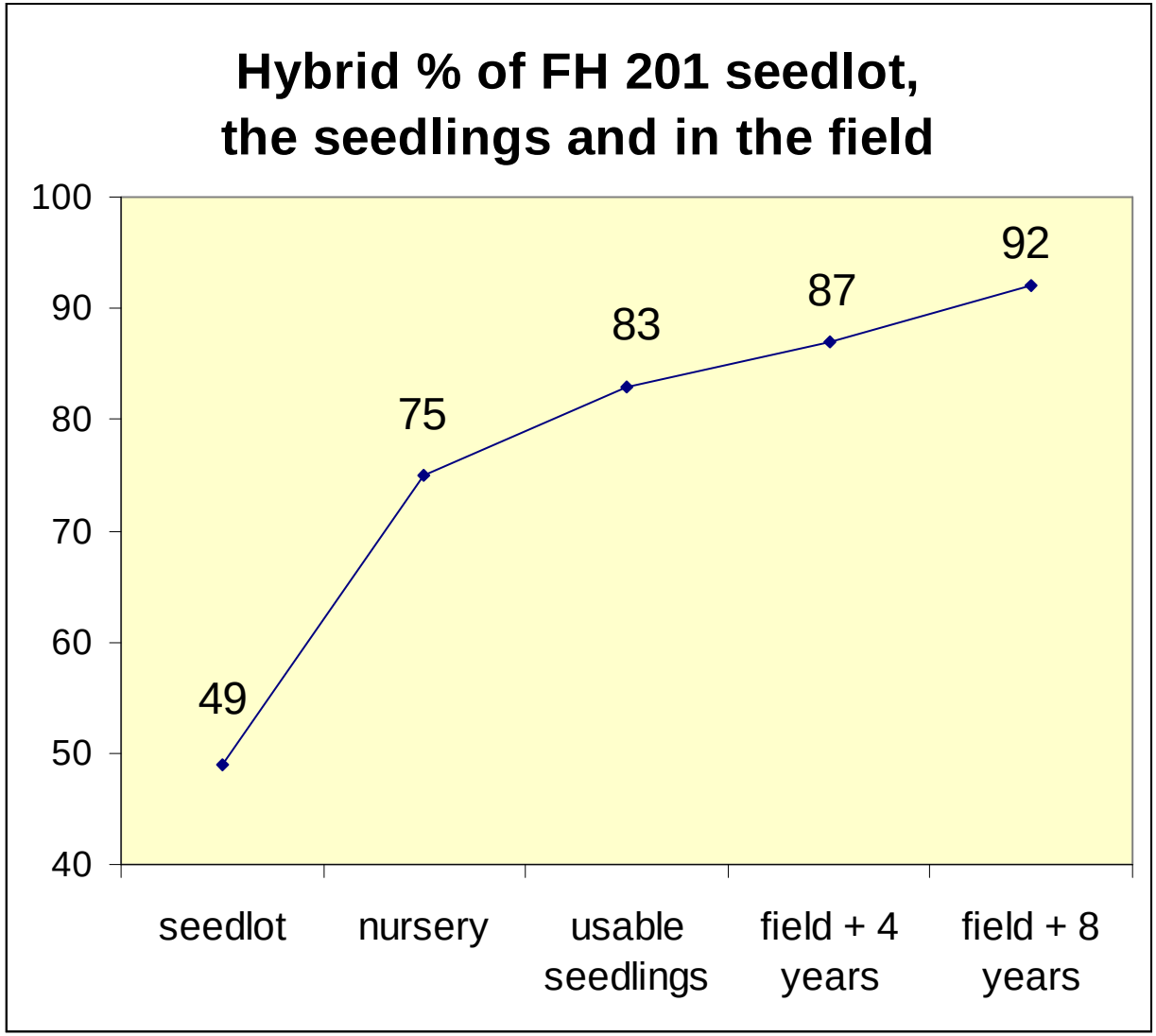
No difference between taxa for adaptation traits

But hybrid % higher in site 2 (15% mortality) than in site 1 (4% mortality)

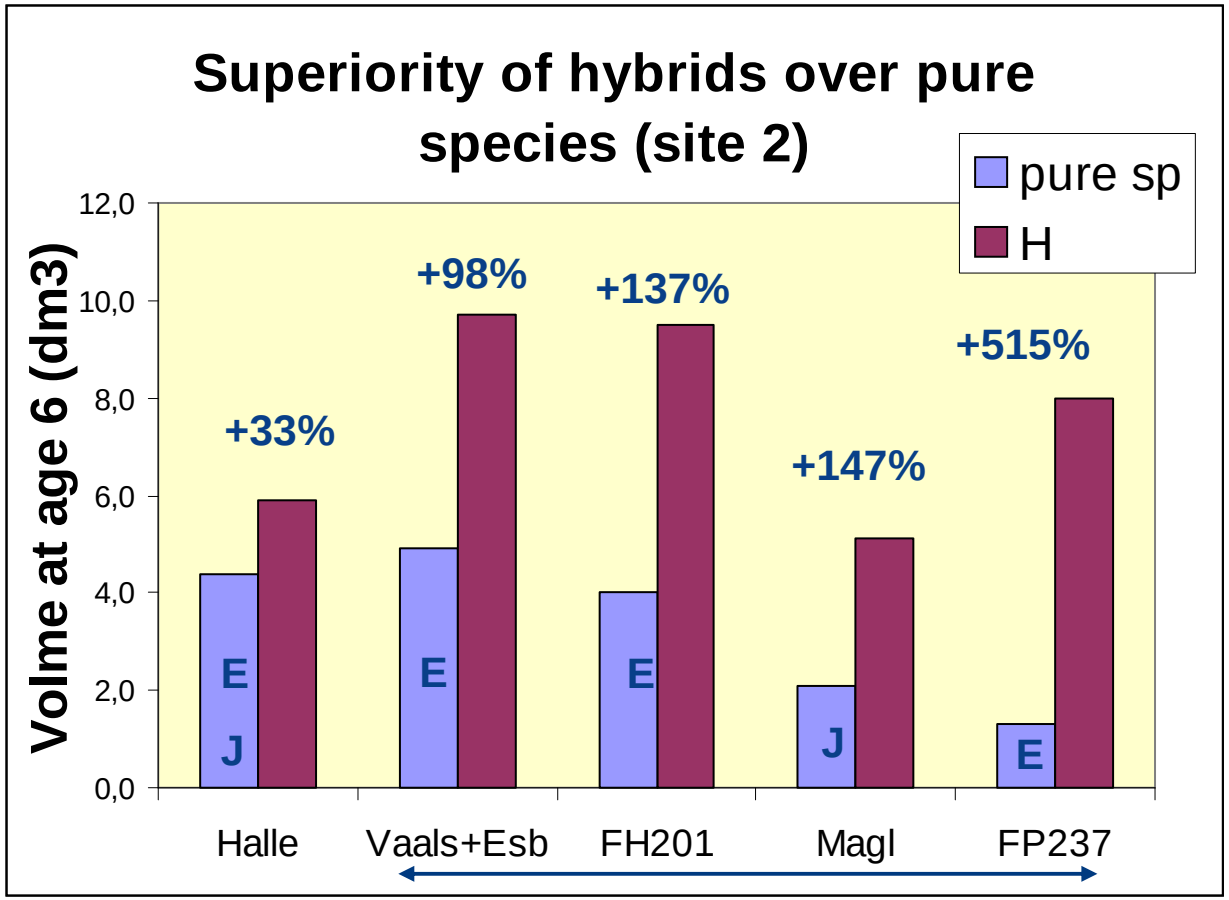


Results: hybrids *vs* pure species - Mortality

	Survival
EL	38%
HL	86%**

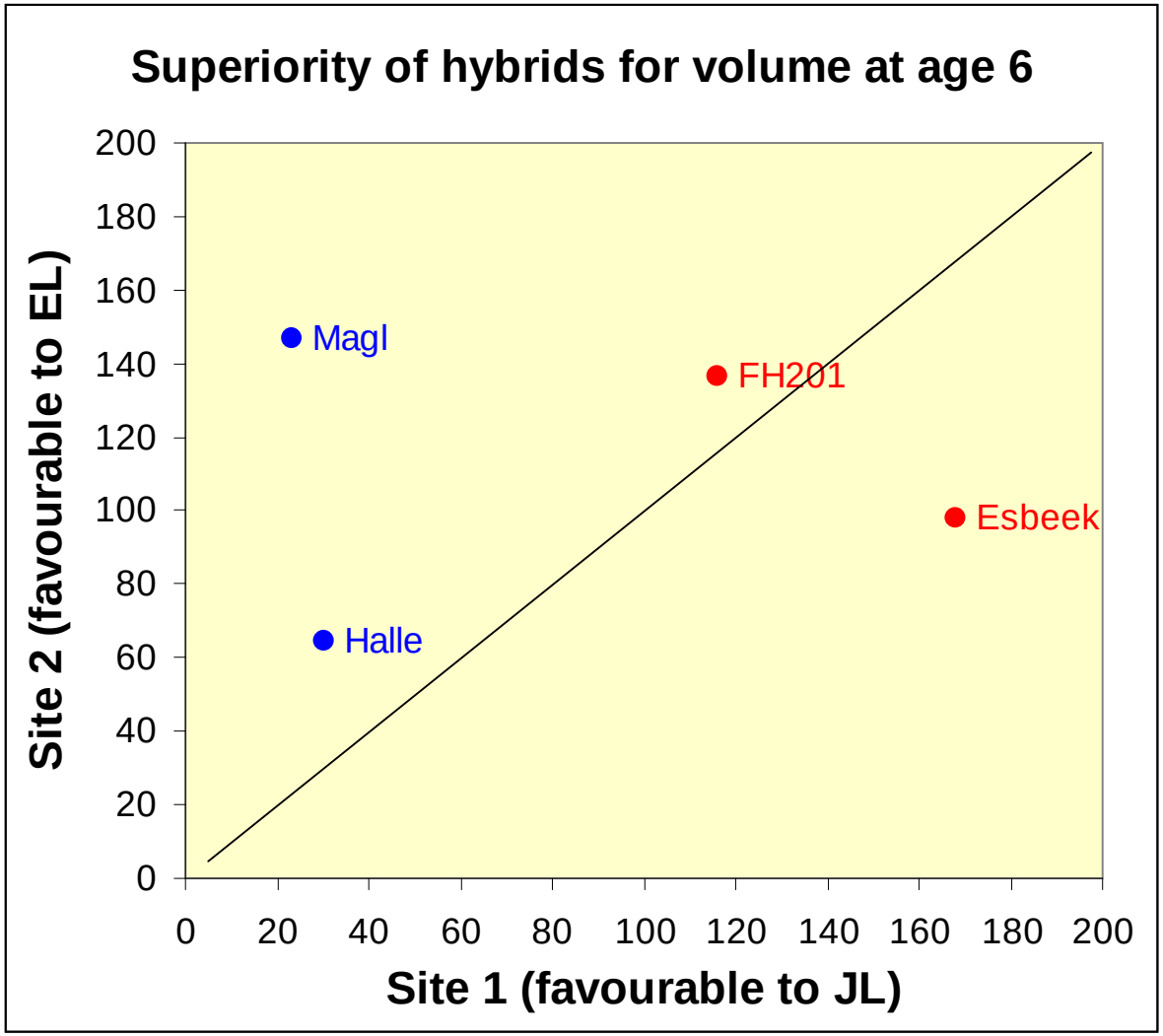


Results: hybrids *vs* pure species - Growth



Volume = $C^2H^2 / 8\pi (H-1.30)$ *(Pardé 1961)*

Results: hybrids *vs* pure species - Growth



Maternal species

blue: JL

red: EL

Results: hybrids *vs* pure species – Growth

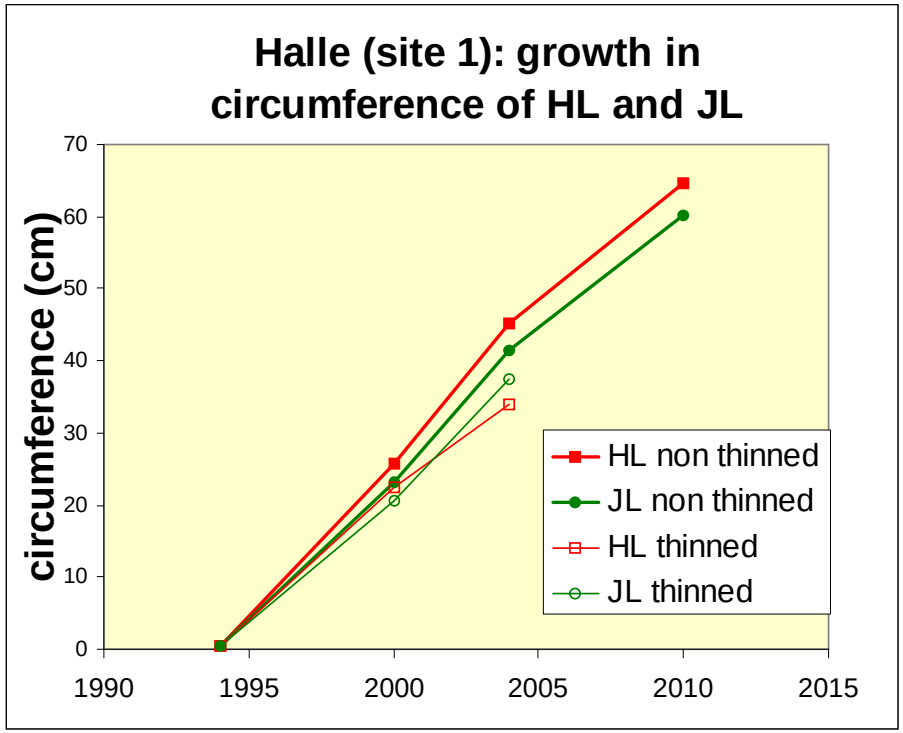
Hybrids are always more vigorous than pure species but their superiority varies according to the variety and the site

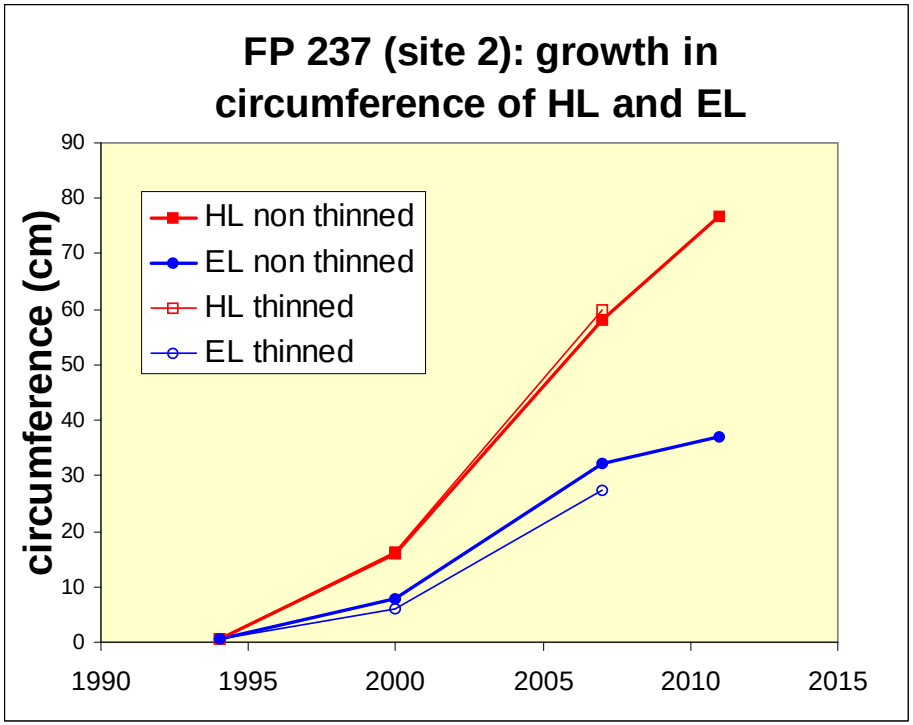
Two explanatory factors :

→ the number of maternal clones

→ the adaptation of mother species to the planting site

Results: hybrids *vs* pure species – Further growth





ability to grow + competition

Results: hybrids versus pure species – Stem form

- H/circumference

Hybrids are less slender than pure species in most of the varieties

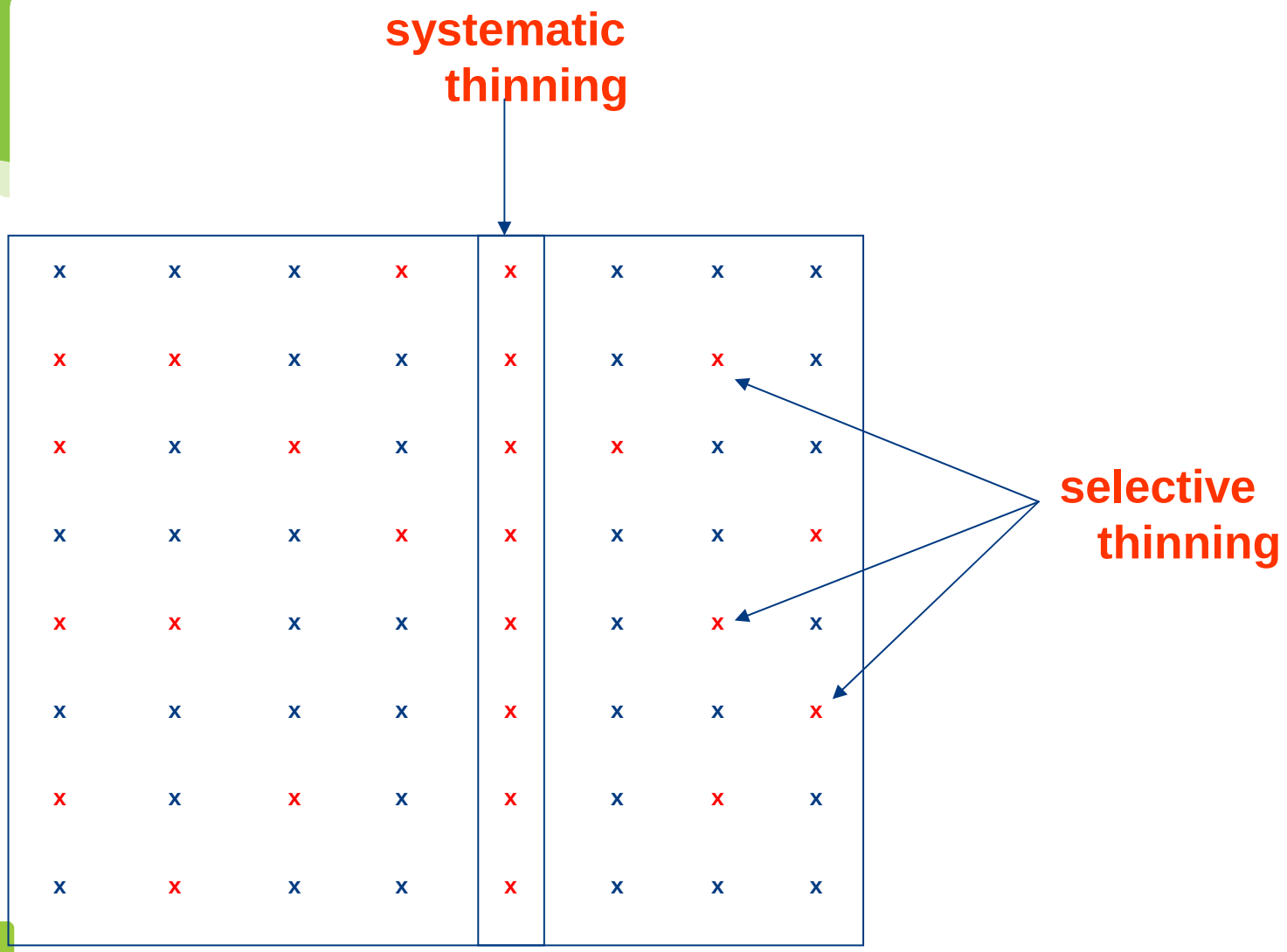
- Stem straightness and basal sweep

Hybrids are somewhat less straight but differences rarely significant

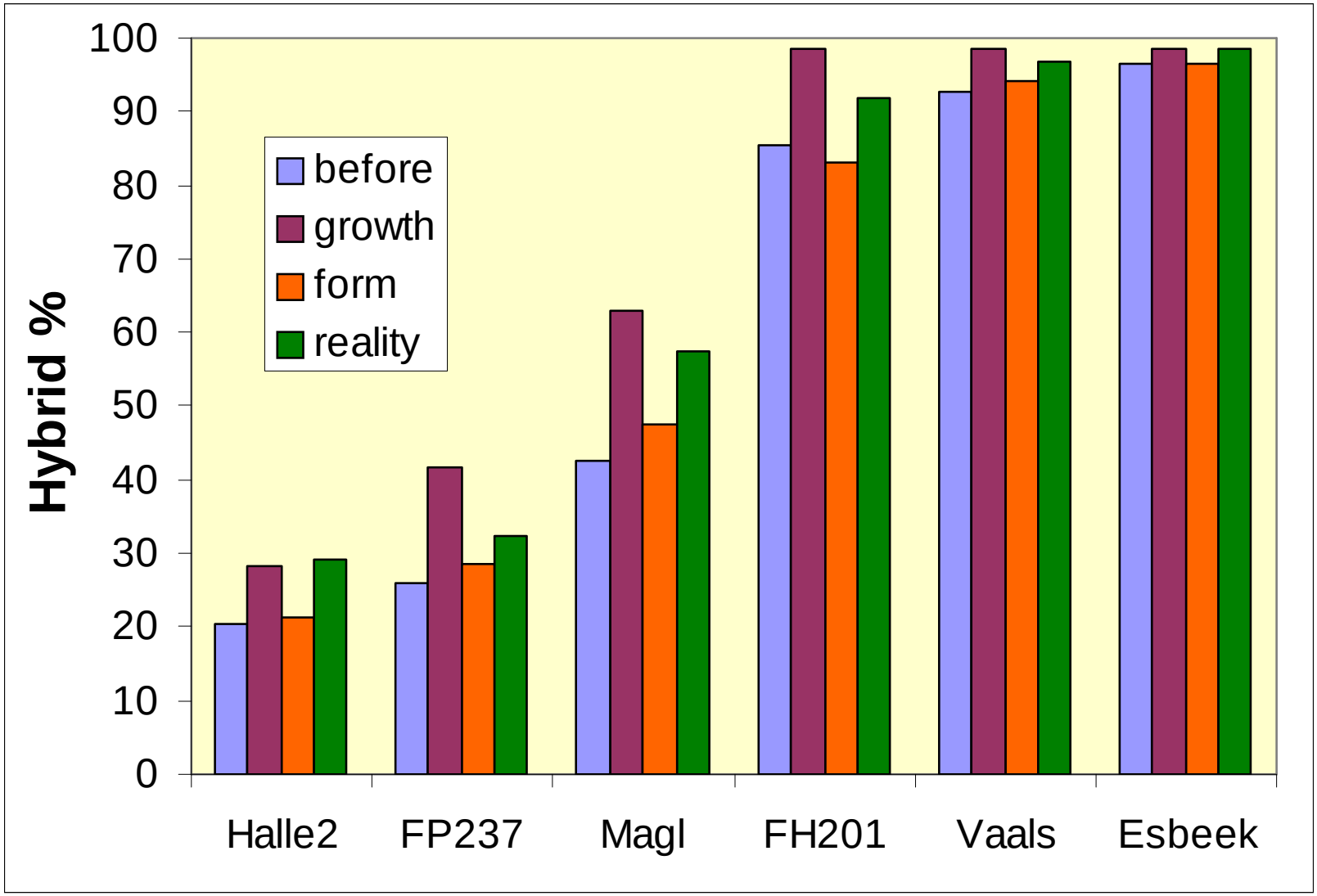
Results: effect of 1st thinning on species purity

Thinning at age 10 (site 1) and 14 (site 2)

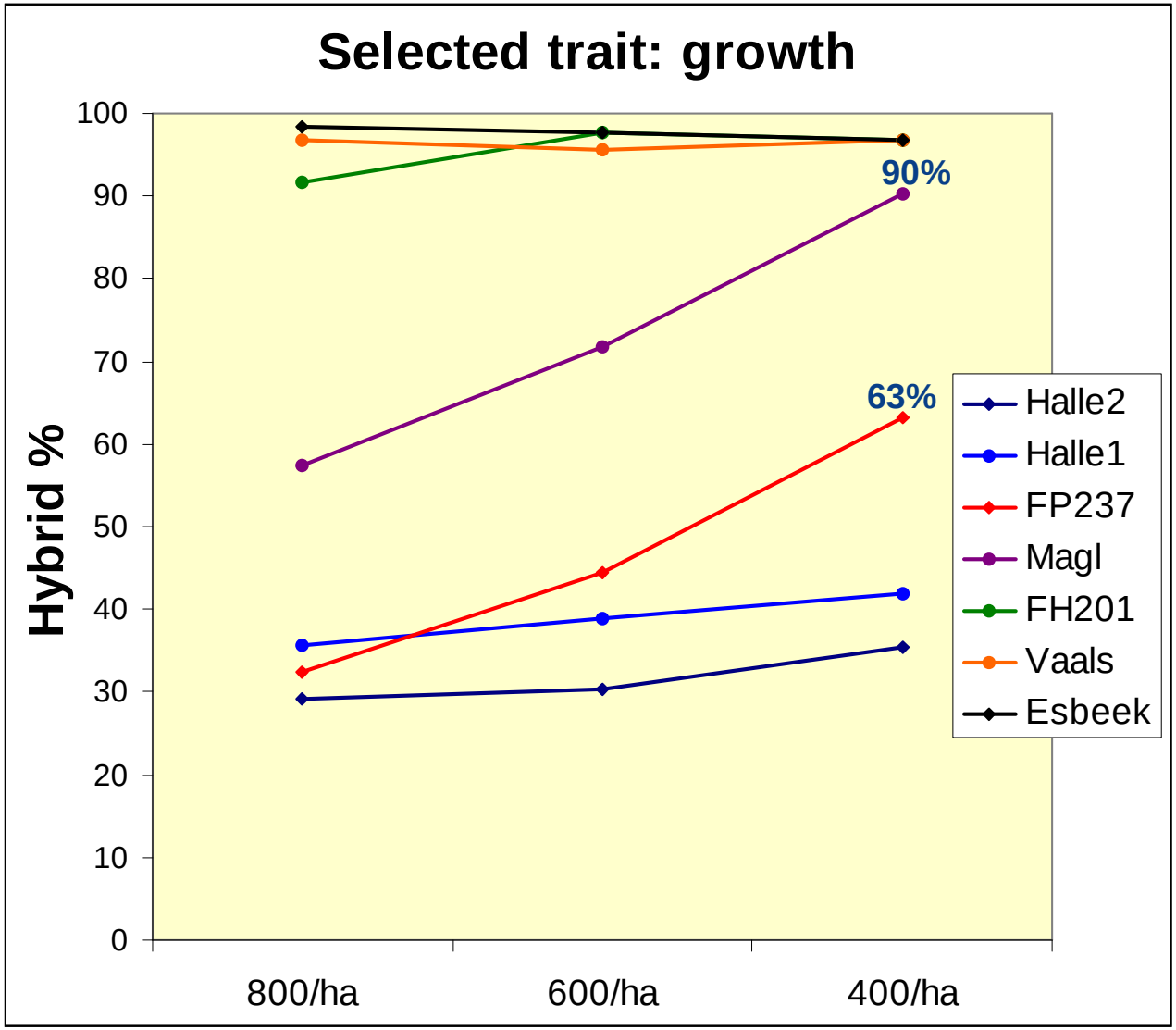
	Density (number of trees per ha)		
	at planting	before thinning	after thinning
Site 1	1667	1610	940
Site 2	1667	1440	790


systematic thinning
selective thinning

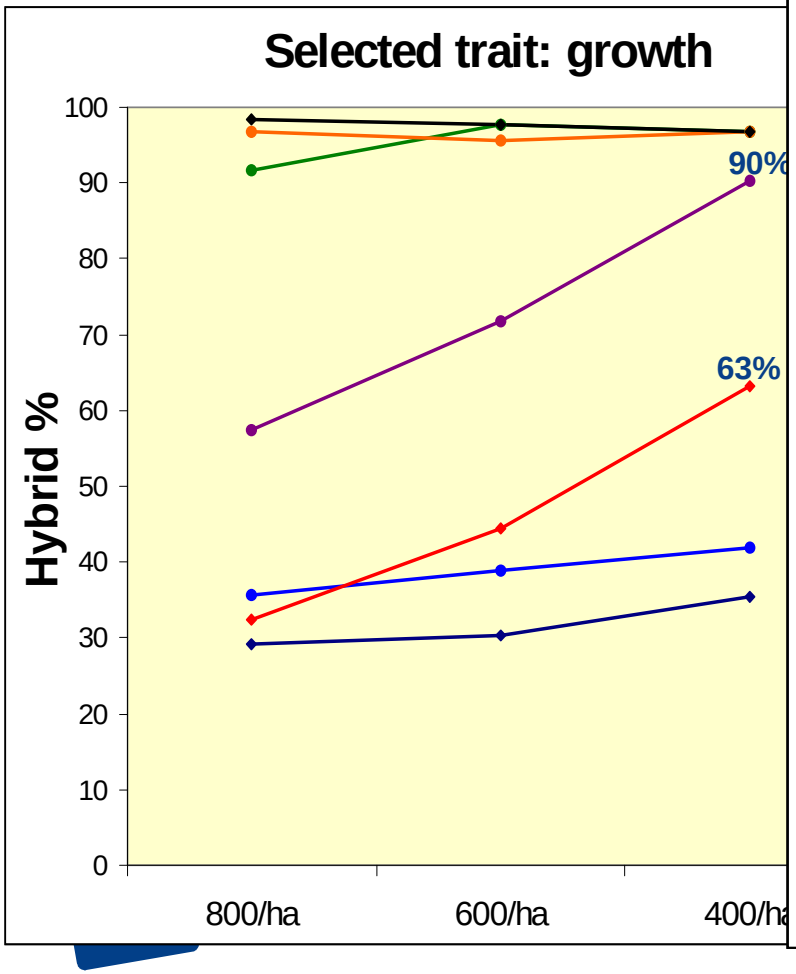
Effect of 1st thinning on specific purity

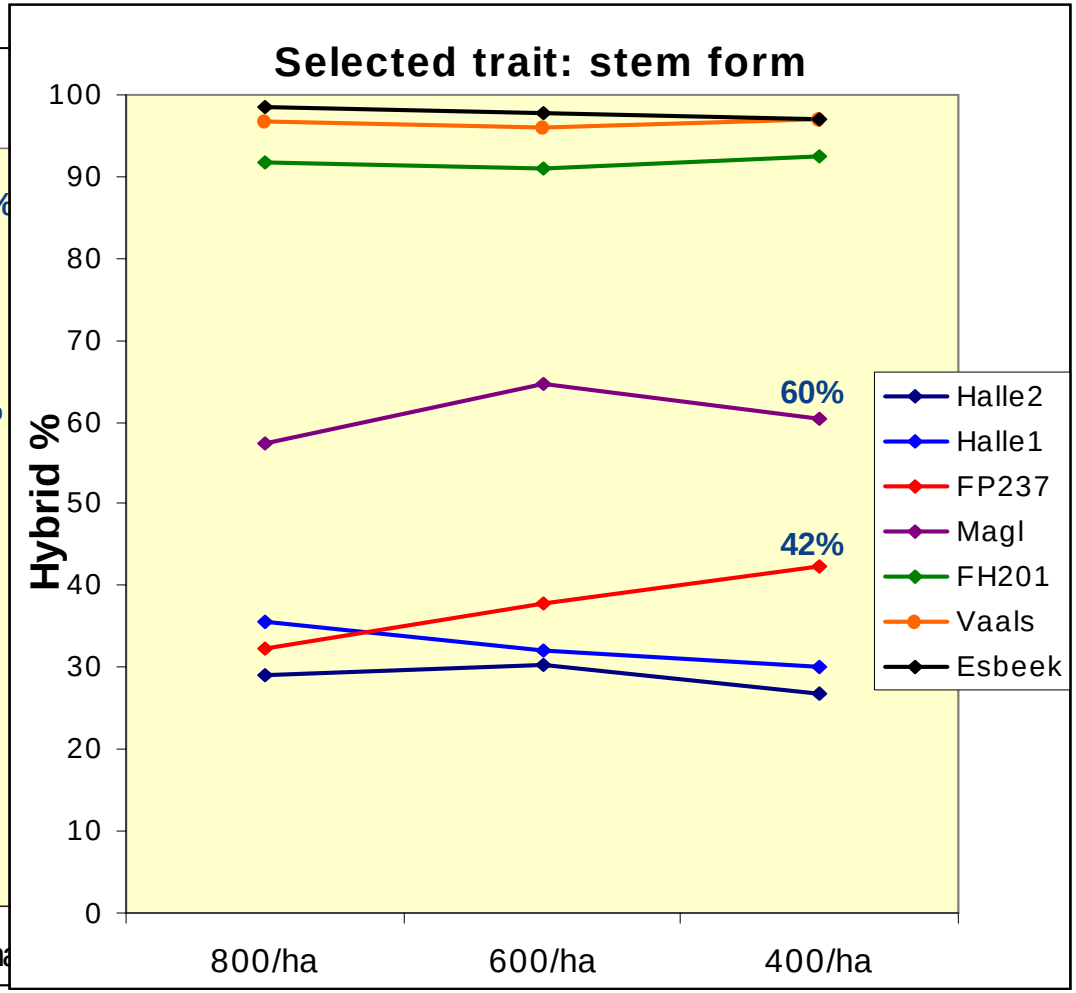


Simulation of 2nd and 3rd thinning



Simulation of 2nd and 3rd thinnings





Consequences for the forest owner

They depend on **forest owner strategy** and the **variety**:

Stem form objective: hybrid richness does not matter much
but nonsense to target only form with hybrid varieties

Timber production
HL ~ pure species → moderate loss of productivity
HL >> pure species → potentially high risk
but limited consequences if hybrid% > 60-70%

Biomass production requires 100% hybrids

Conclusion

1- Some so-called HL varieties have a low hybrid rate

→ abstain from collecting the cones in high risk years

→ set a minimal threshold of purity for commercialisation

2- Hybrid superiority varies with the variety

number of maternal clones + adaptation of mother species

3- Hybrid rate increases after thinnings based on vigour

But HL% < 100% if low initial species purity → loss of income

FRM species purity should be > 60-70% in high risk varieties

Conclusion

NO SEED LOT SHOULD BE COMMERCIALISED OR SHARED FOR TESTING WITHOUT MENTIONING HYBRID PURITY

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Thank you for your attention !