# Specific purity of hybrid larch Forest Reproductive Materials: how much does it matter?

Gwenaël Philippe, Stéphane Matz, Corinne Buret, Luc Pâques

LARIX 2012

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

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

Pour mieux affirmer ses missions, le Cemagref devient Irstea

irstea

www.irstea.fr

INRA Institut National de la Recherche Agronomique

**LARIX 2012: Larch in a warm climate**

8th international symposium of IUFRO Working Group S2.02.07 – Larch Breeding and Genetic Resources

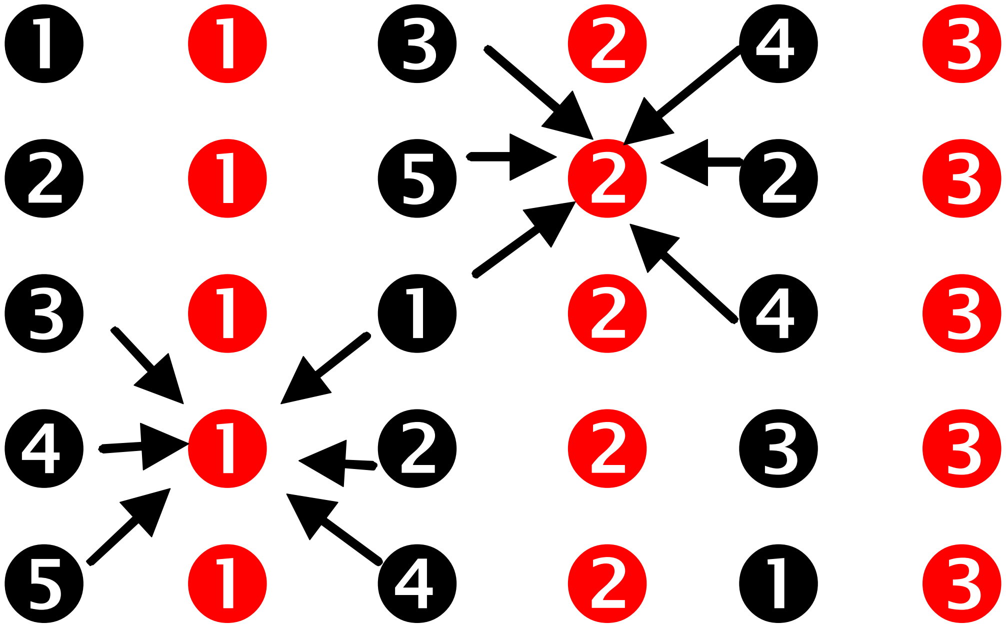
Hallormsstaðaskógur National Forest, Iceland, 11 - 13 September 2012

# Dunkeld estate (Scotland): a place of pilgrimage

# Different kinds of orchards

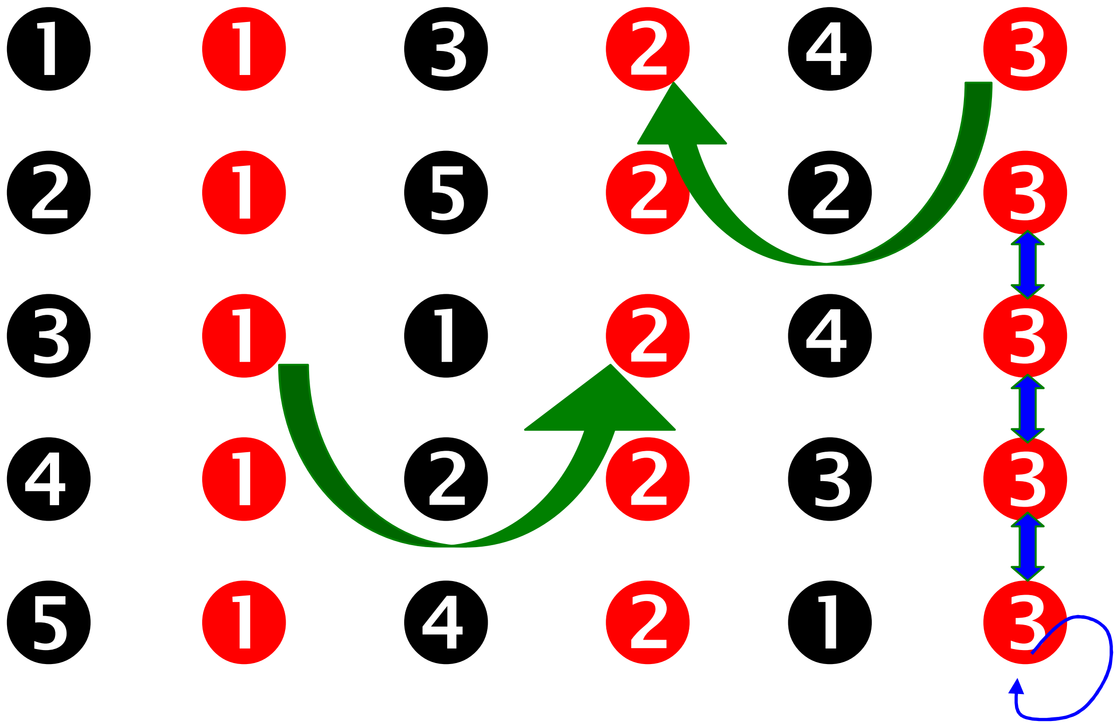
<table>
<tr><th colspan="2">Nb of genotypes</th><th rowspan="2">Female species</th><th rowspan="2">Planting design</th><th rowspan="2">Pollination</th></tr>
<tr><th>♀</th><th>♂</th></tr>
<tr><td>few → dozens</td><td>few → dozens</td><td>EL or JL or both</td><td rowspan="2">EL & JL intimately mixed or alternating rows</td><td rowspan="2">open</td></tr>
<tr><td rowspan="2">1</td><td rowspan="2">1 → dozens</td><td rowspan="2">EL or JL</td></tr>
<tr><td>separate orchards</td><td>SMP</td></tr>
</table>

# Inter-specific crossings …




**maternal / paternal species**

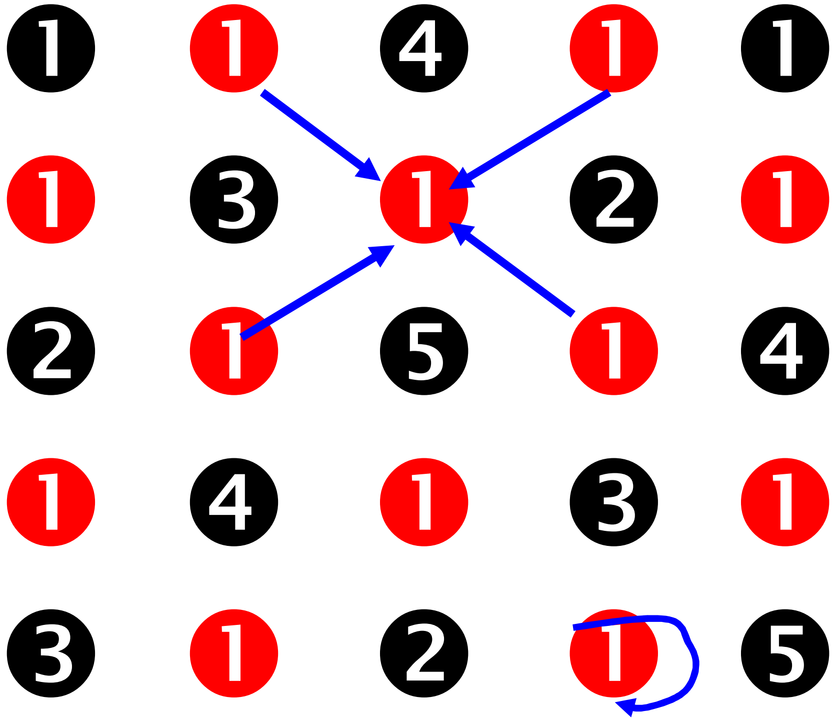
# … but also intra-specific crossings




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

- flowering overlap between EL & JL
  - clonal phenology, « selfing ability »
  - Winter T℃
  - SMP

→ **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**

irstea

# 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%

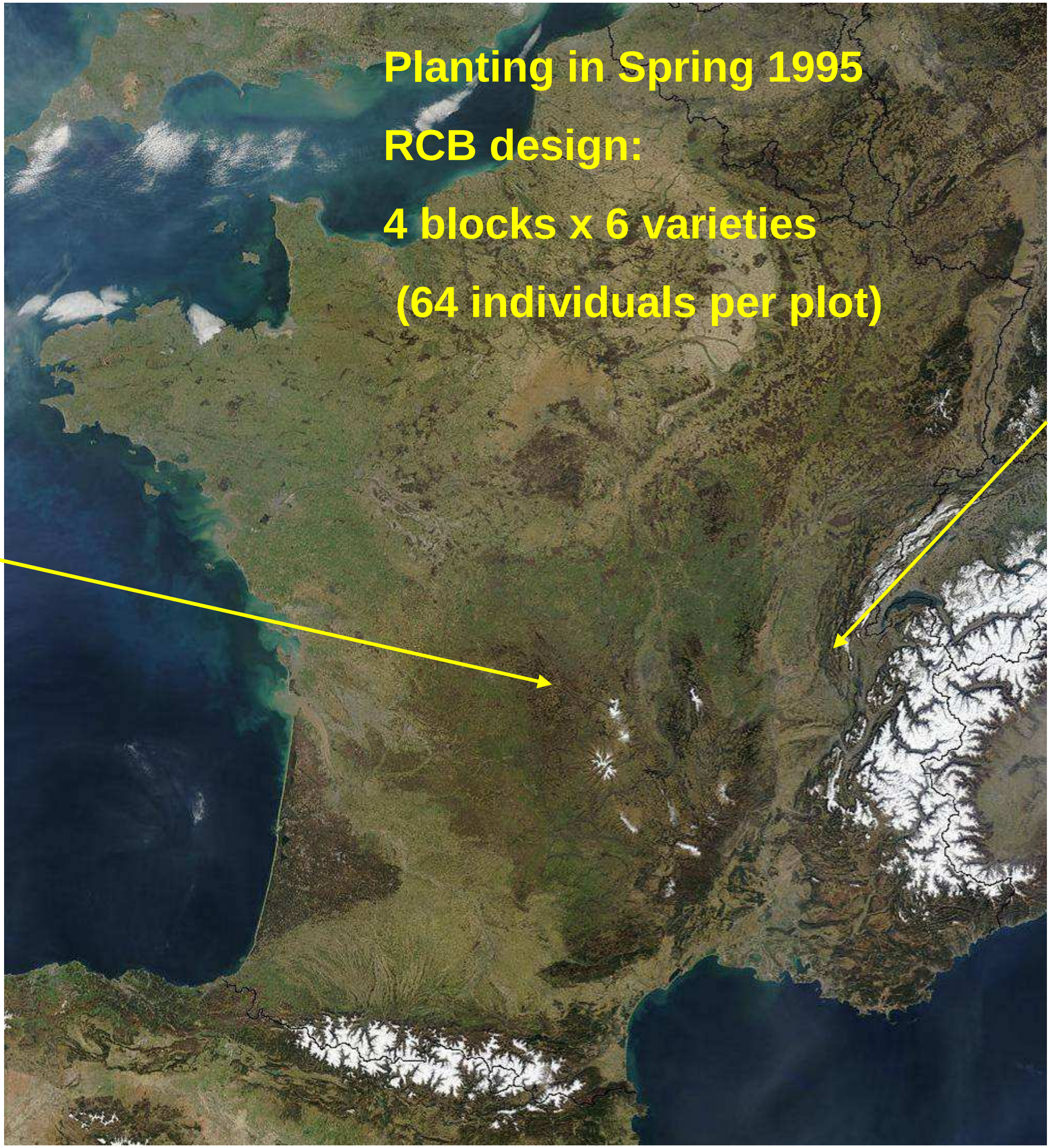
# M&M: studied varieties

| 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

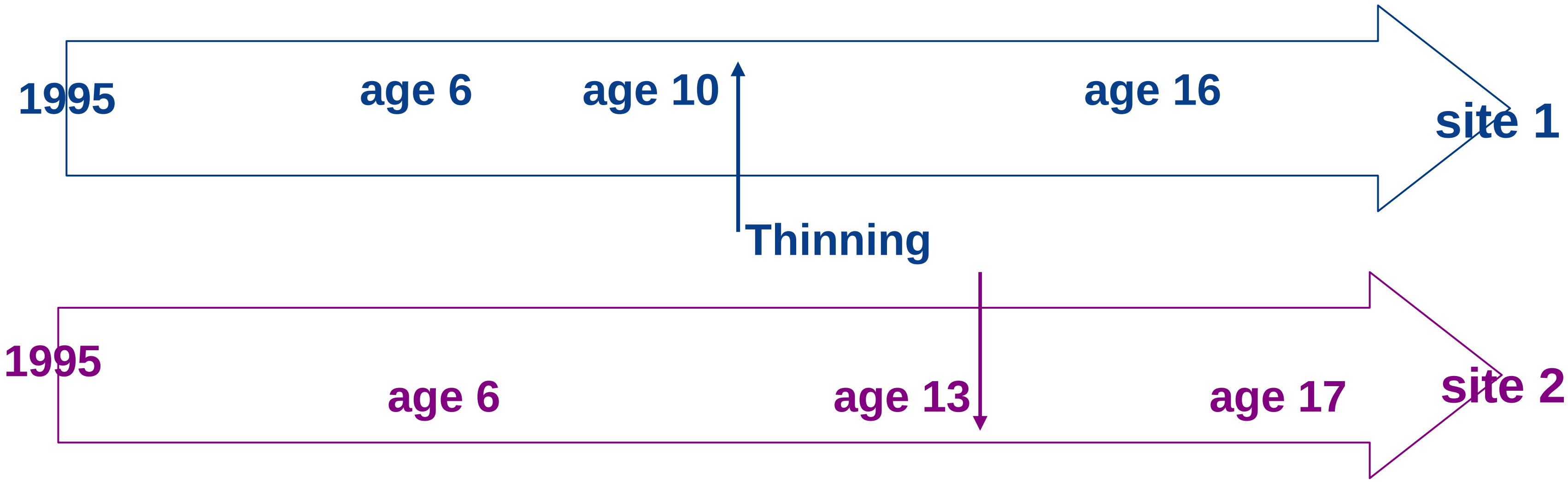
# M&M: Taxa identification

- 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

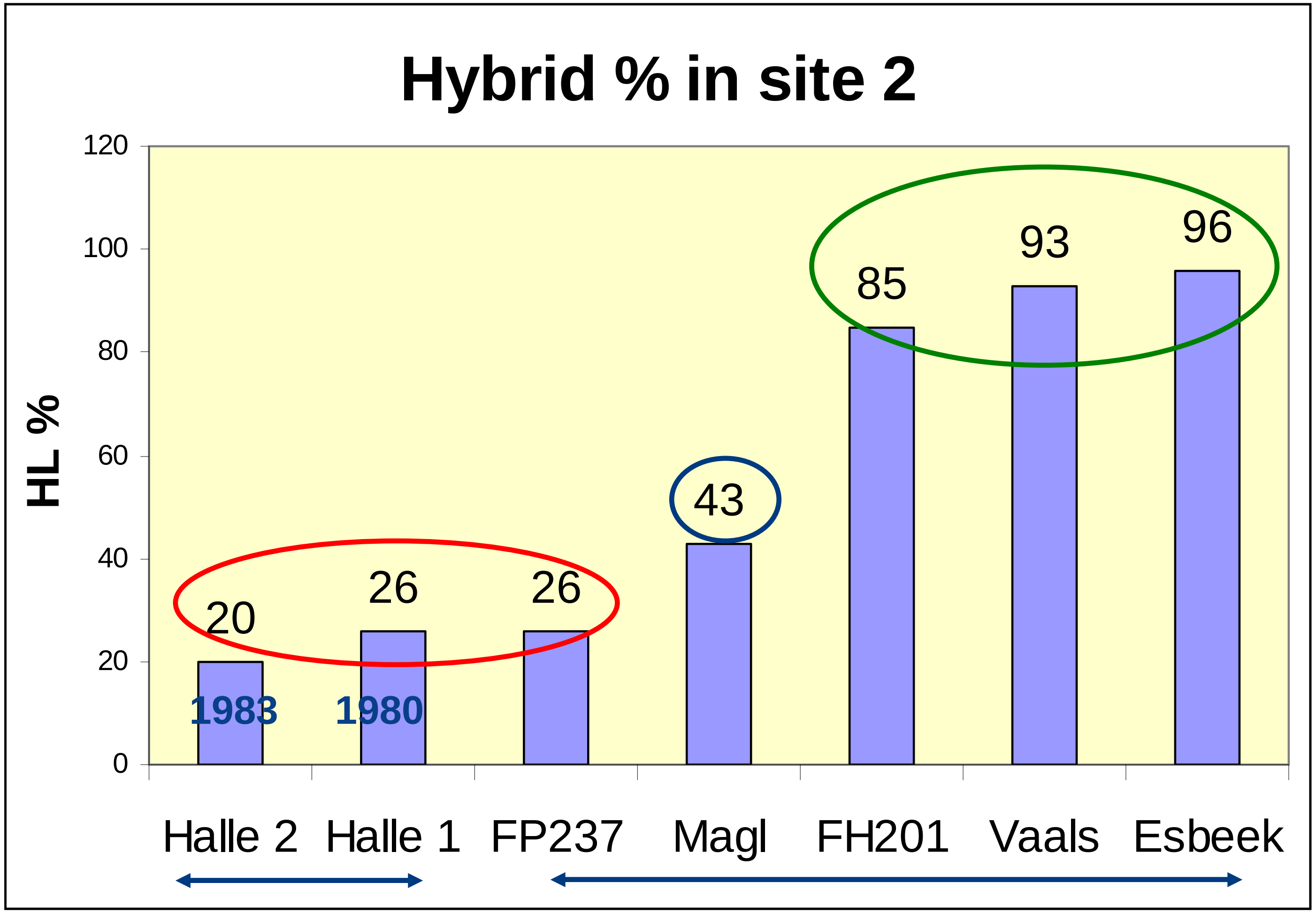
# Stem straightness

Score 1

Score 5


Basal sweep (age 13 - site 2)

# Results: Proportion of hybrids

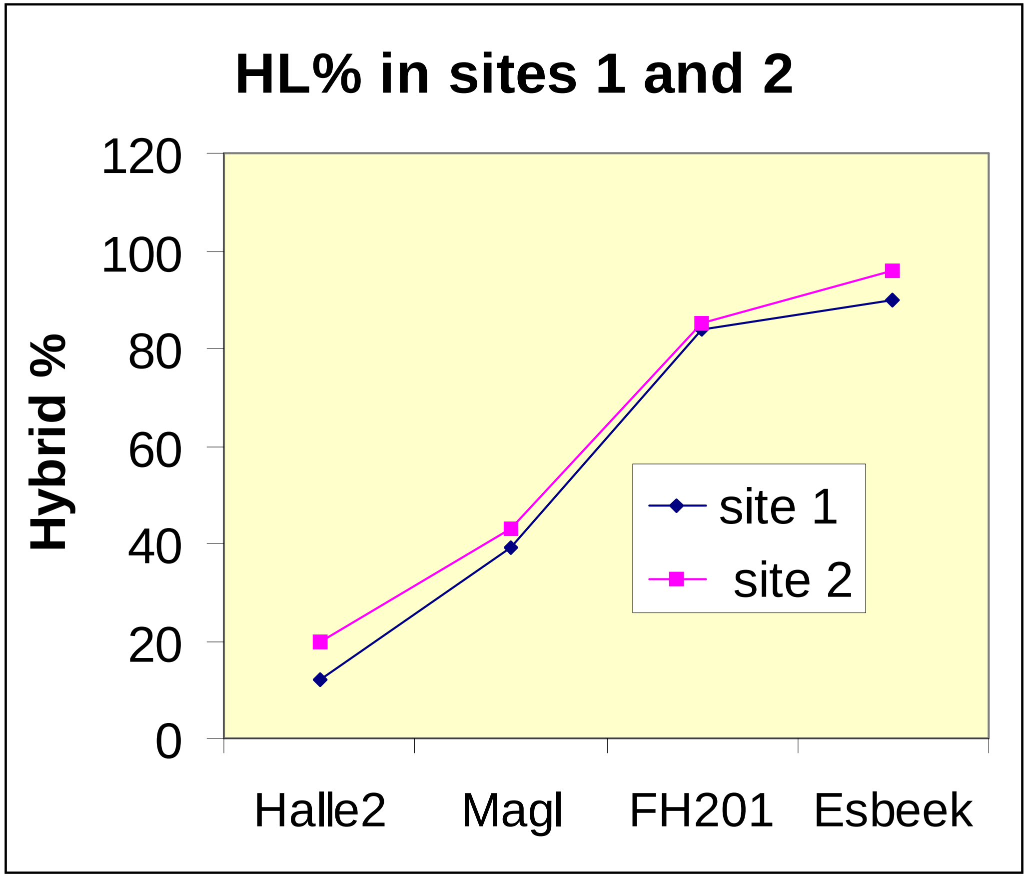



**several clones** **single mother clone**

# Results: hybrids *vs* pure species - Adaptation traits

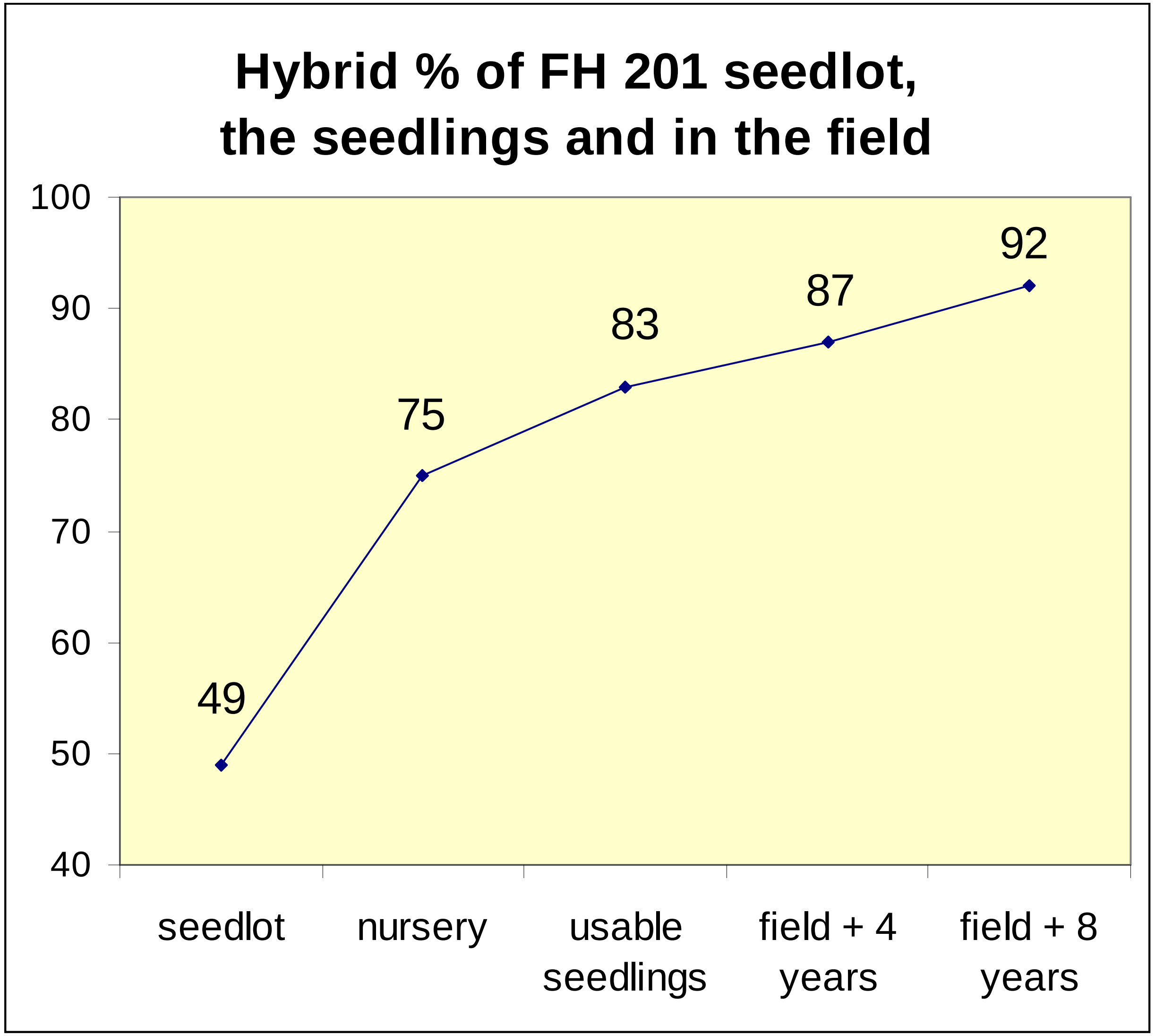
No difference between taxa for adaptation traits

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

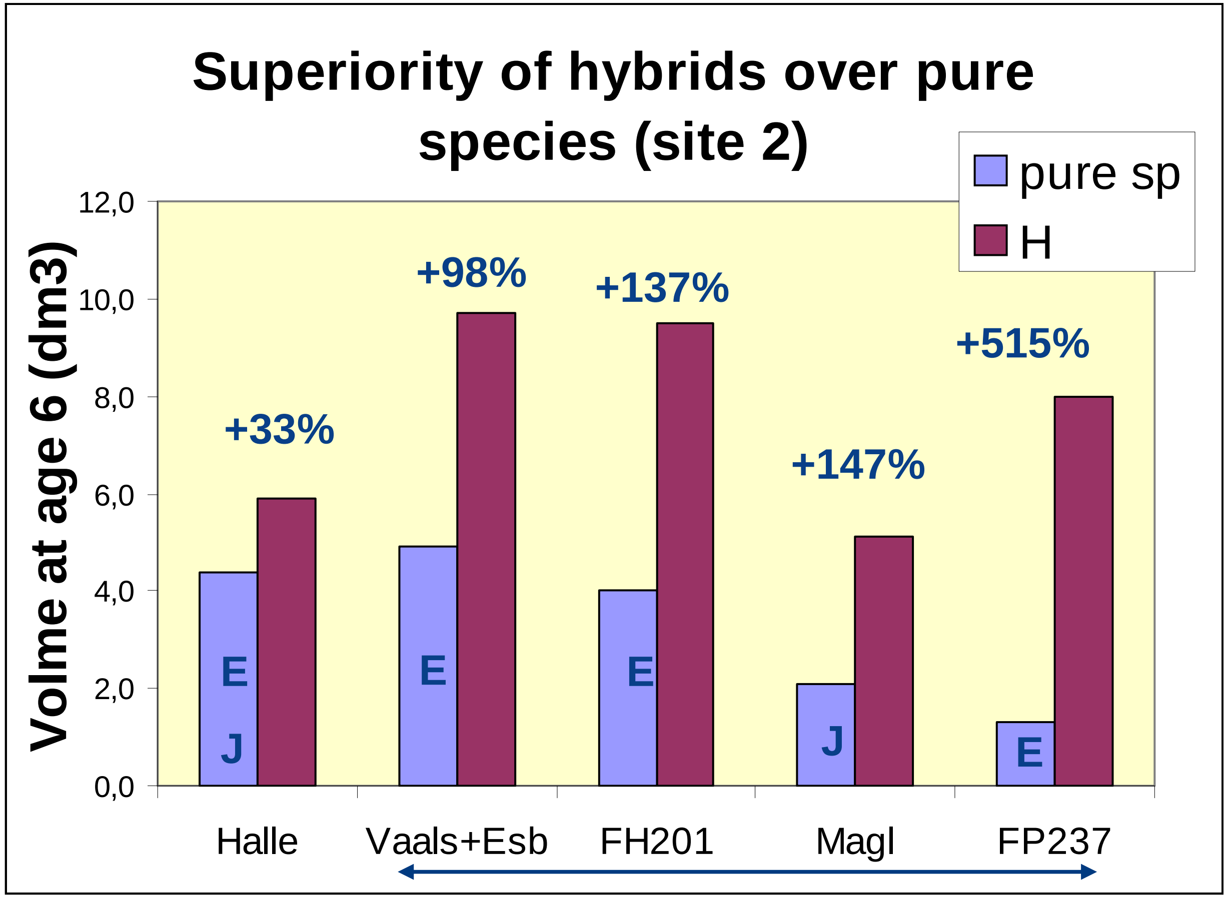


# Results: hybrids *vs* pure species - Mortality

| | Survival |
|---|---|
| EL | 38% |
| HL | 86%** |



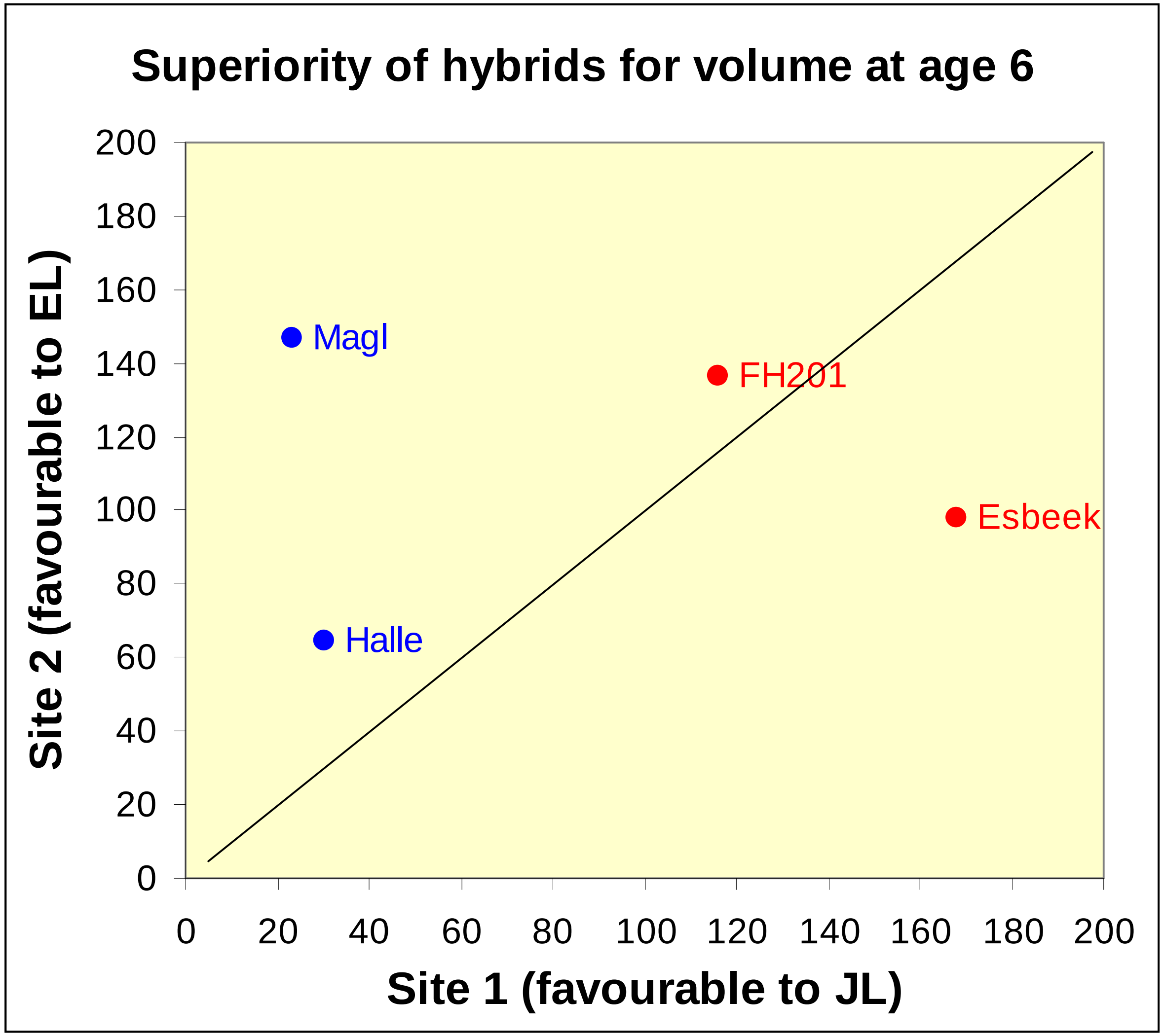
# Results: hybrids *vs* pure species - Growth




**single mother clone**

*Volume = C²H² / 8 π (H-1.30)* *(Pardé 1961)*

# Results: hybrids *vs* pure species - Growth




**Maternal species**

**blue: JL**

**red: EL**

# Results: hybrids *vs* pure species – Growth

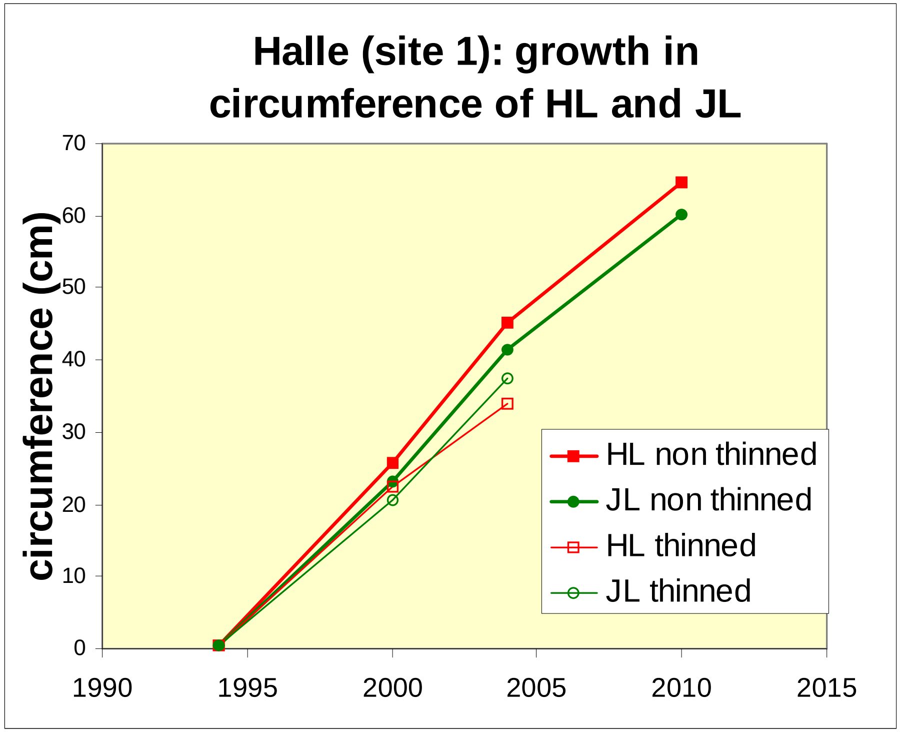
Hybrids are always more vigorous than pure species but their superiority varies according to the variety and the site

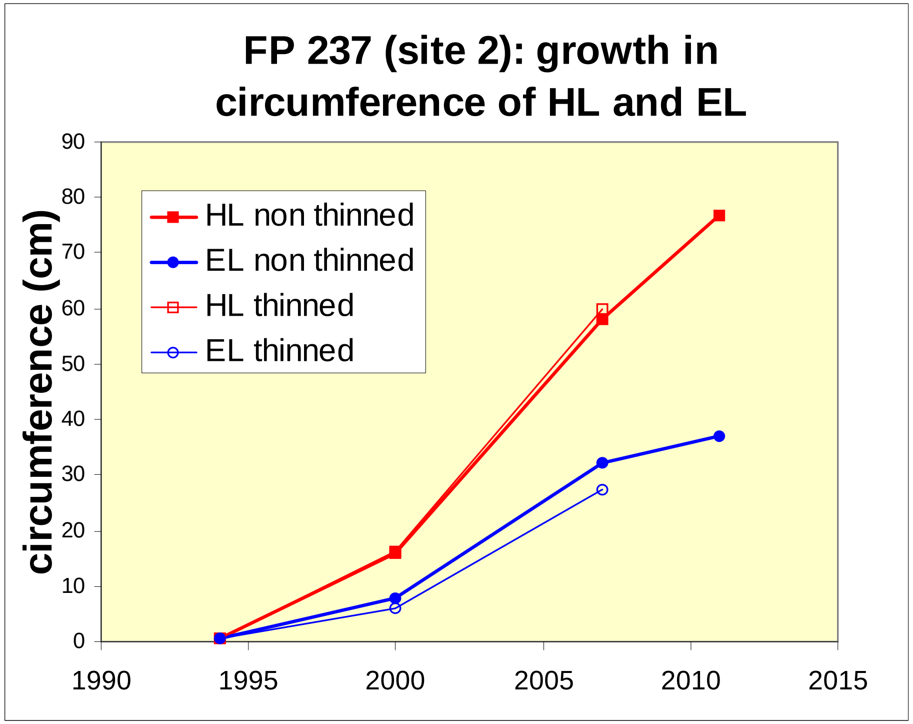
Two explanatory factors :

→ 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

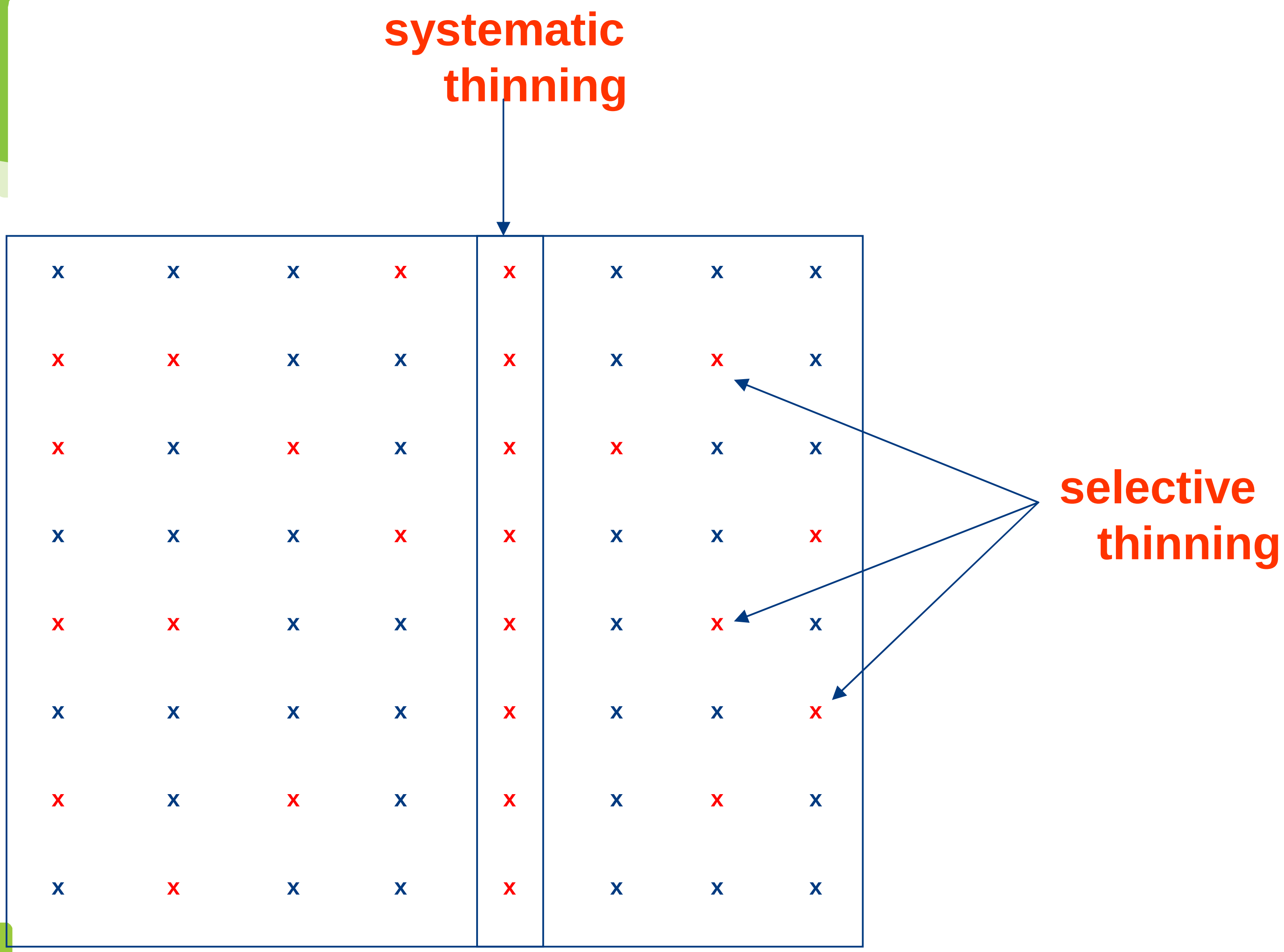
- Stem straightness and basal sweep

Hybrids are somewhat less straight but differences rarely significant

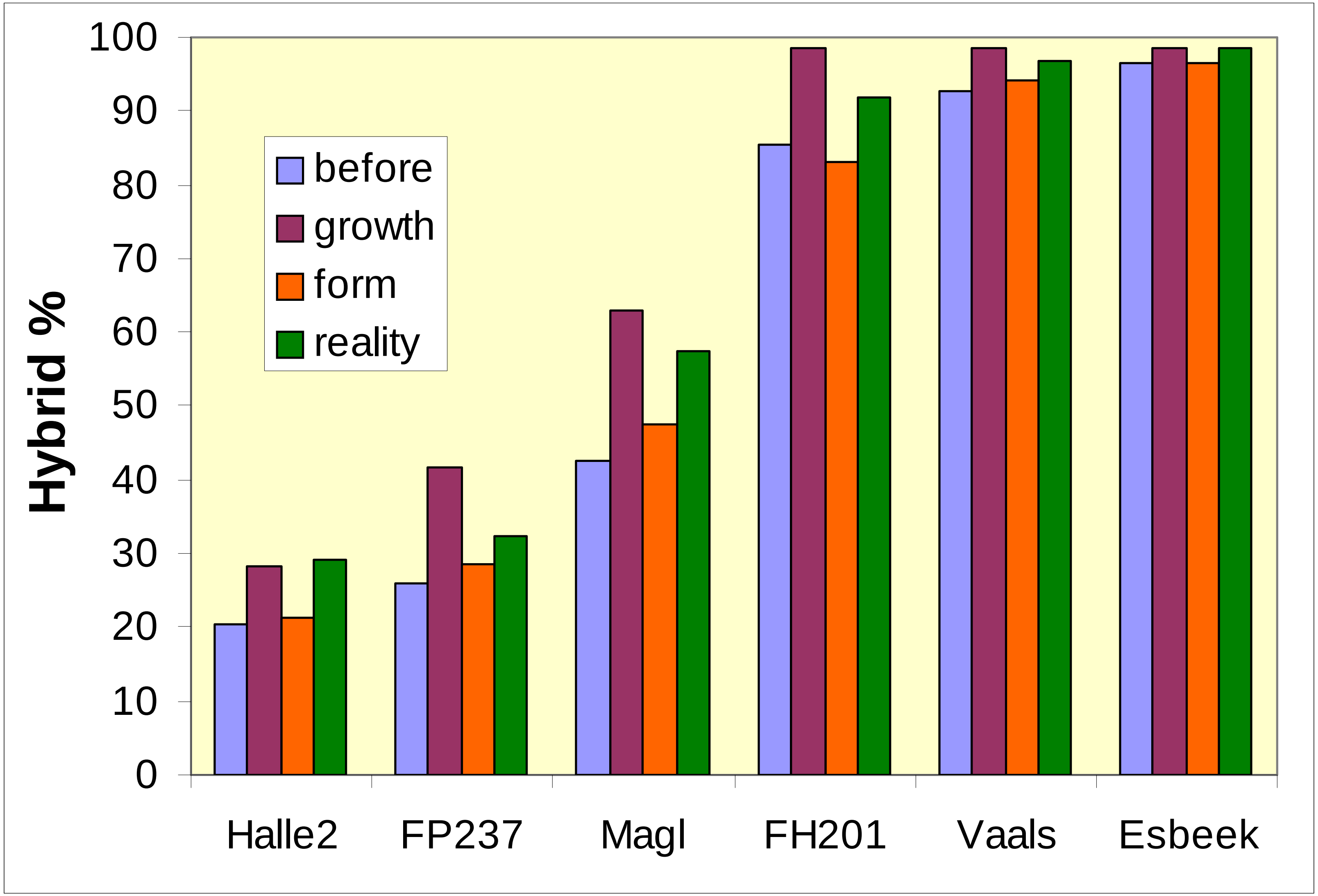
# Results: effect of 1st thinning on species purity

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

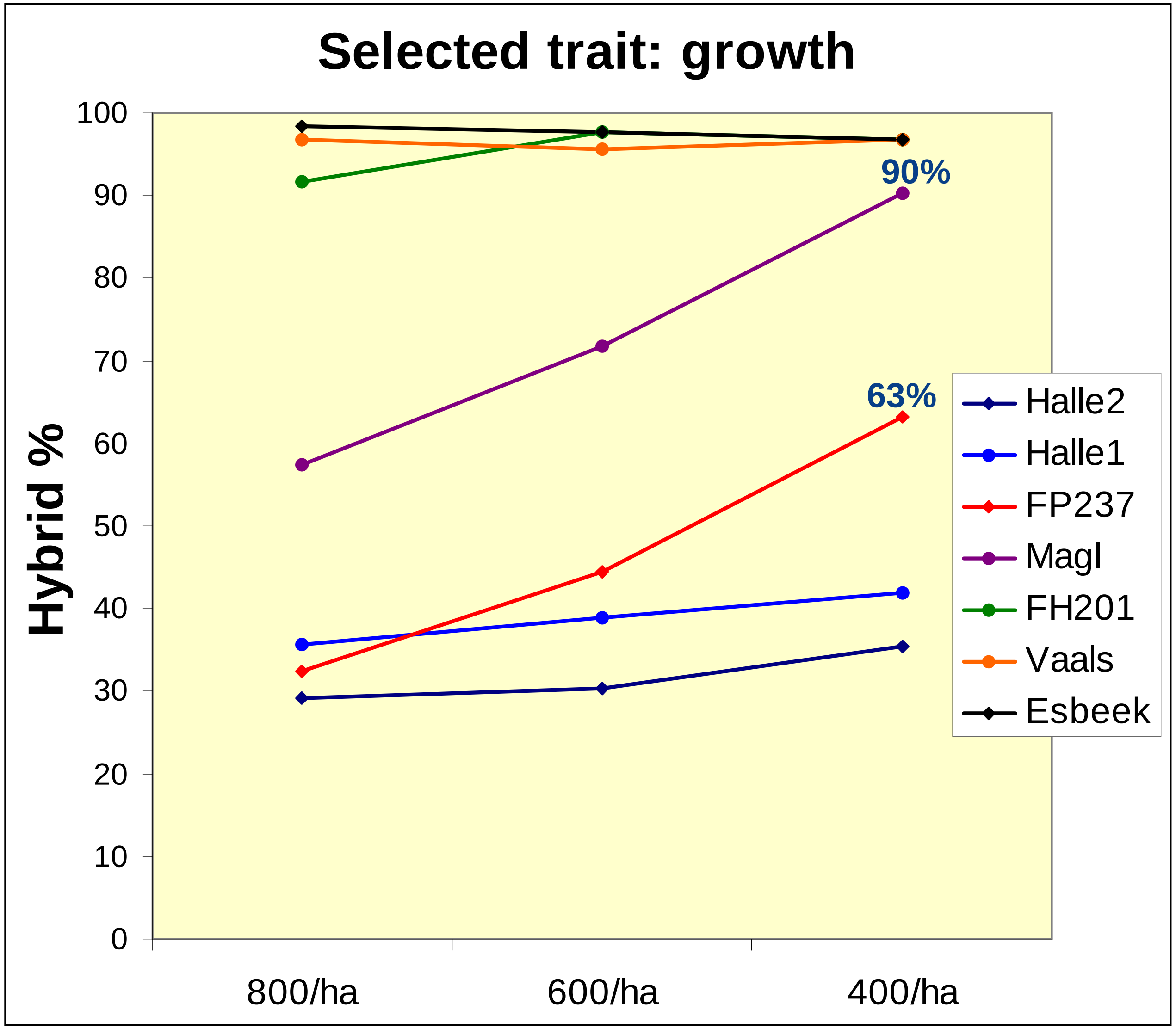
| | Density (number of trees per ha) | | |
|---|---|---|---|
| | at planting | before thinning | after thinning |
| Site 1 | 1667 | 1610 | 940 |
| Site 2 | 1667 | 1440 | 790 |


systematic thinning
selective thinning

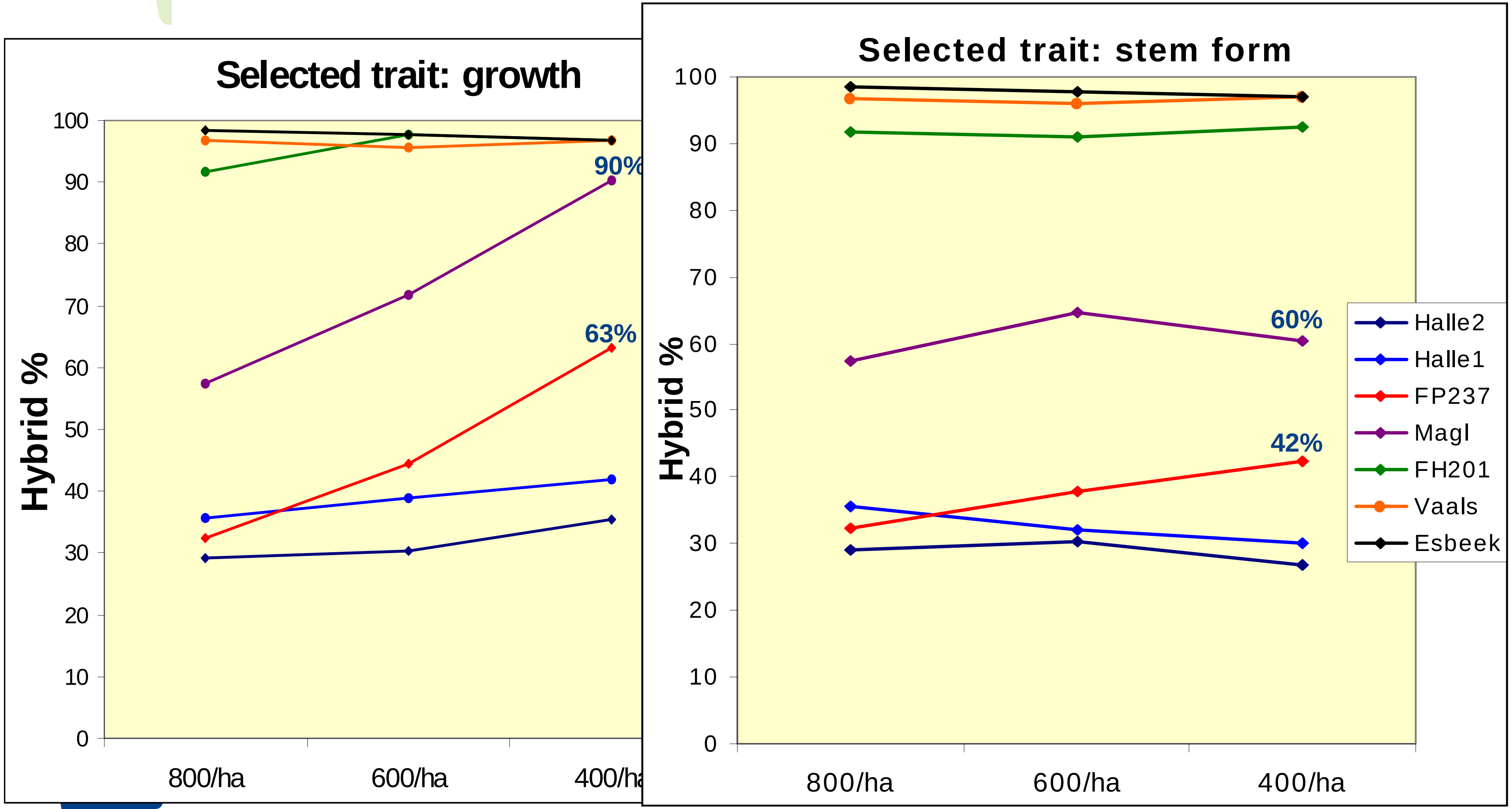
# Effect of 1st thinning on specific purity



# 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

irstea

# 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**

.

# Thank you for your attention !


**Study funded by the French Ministry in charge of forests**