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

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# 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



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**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

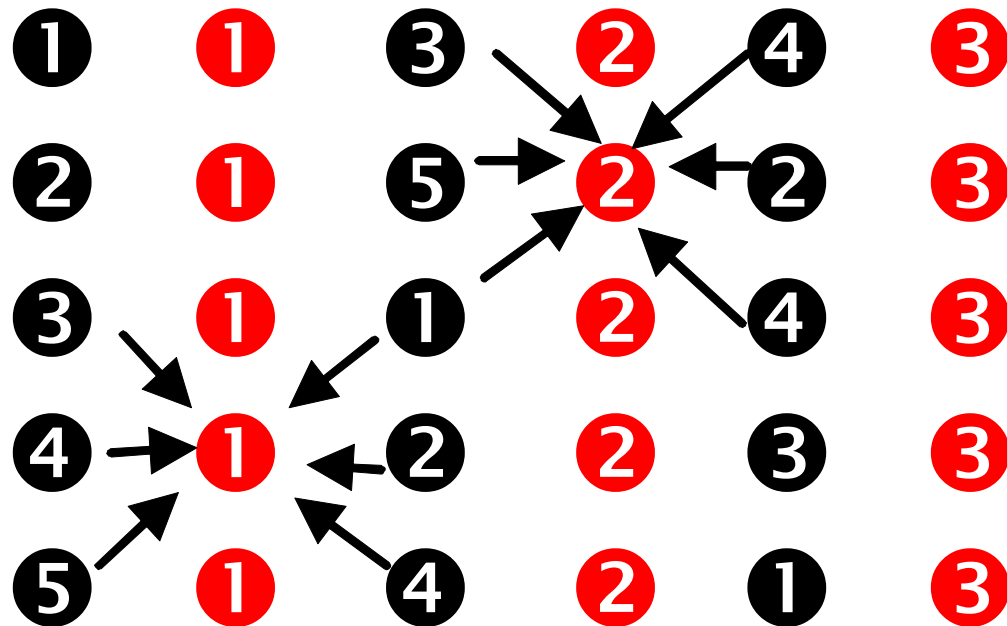
## Dunkeld estate (Scotland): a place of pilgrimage



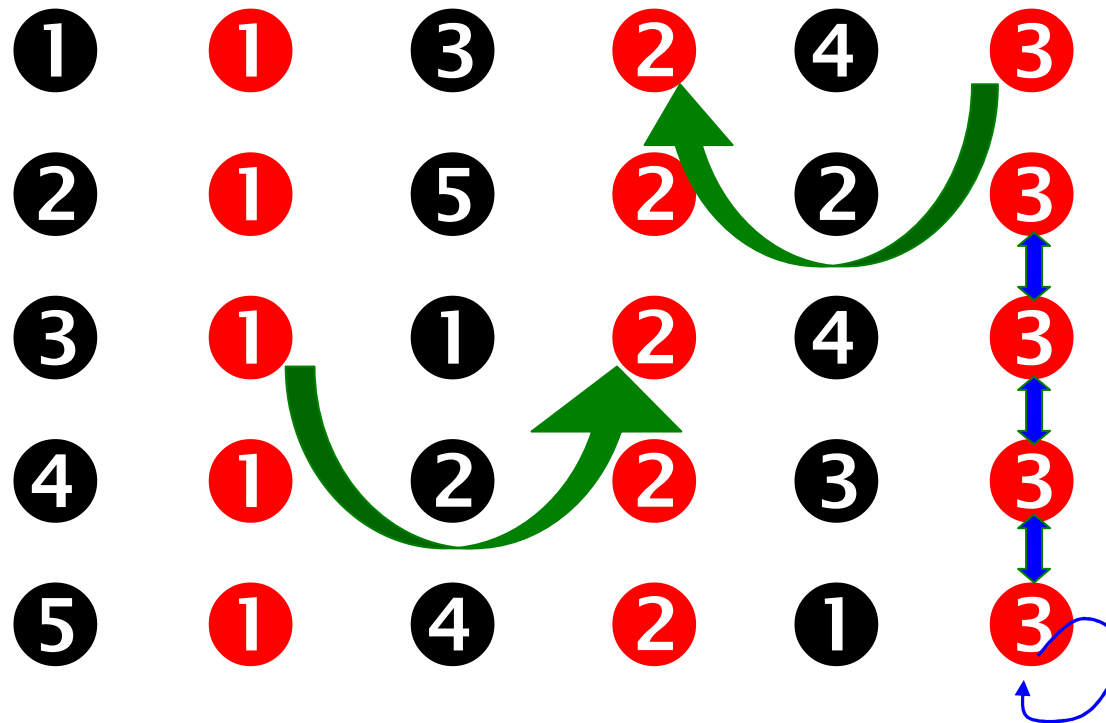
## Different kinds of orchards

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		

## Inter-specific crossings ...



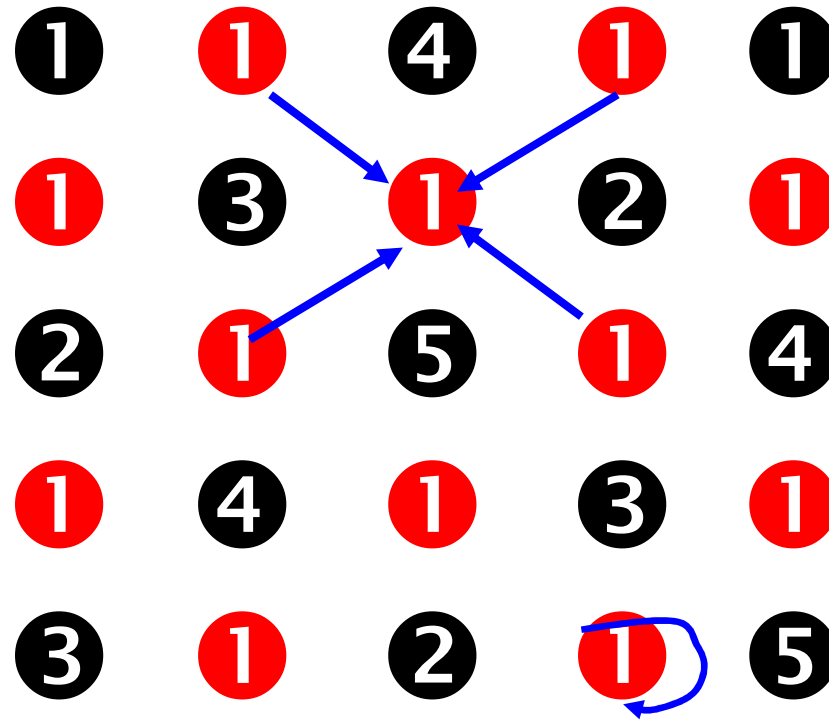
... but also intra-specific crossings



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


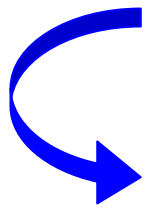
  - \* crossings among different clones

  - \* 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
  - flowering ability
  - climate during flower initiation
  - flower induction treatments
- clonal phenology, « selfing ability » 
  - Winter T°C
  - 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**



## 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%



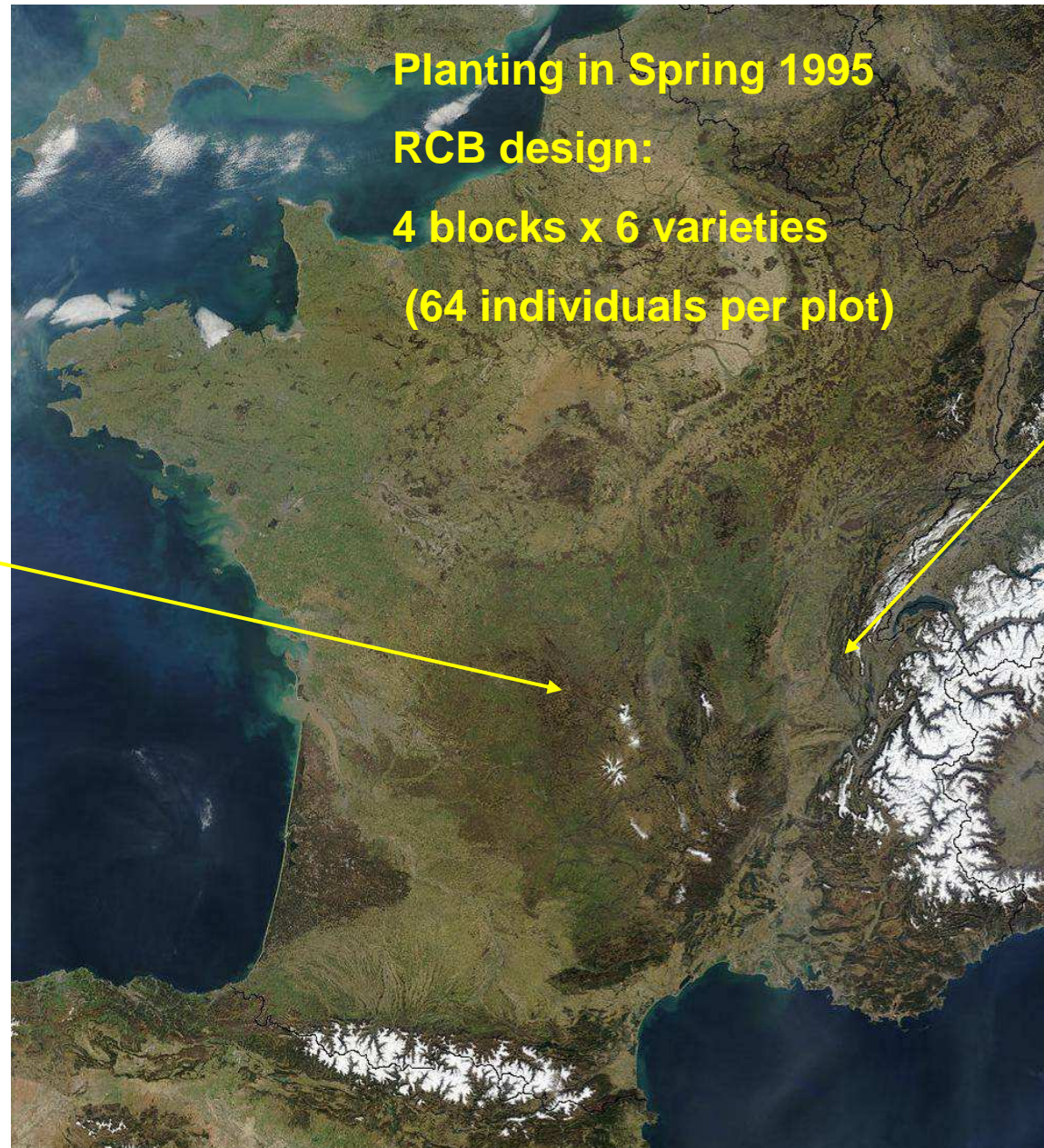
## M&M: studied varieties

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



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

# M&M: Variety testing trials



## Site 1

800 m elevation  
deep soil  
granite  
8°C, 1100 mm  
JL

## Site 2

1000 m elevation  
shallow soil  
limestone  
6°C, 1500 mm  
EL





**Site 1**

Site 2



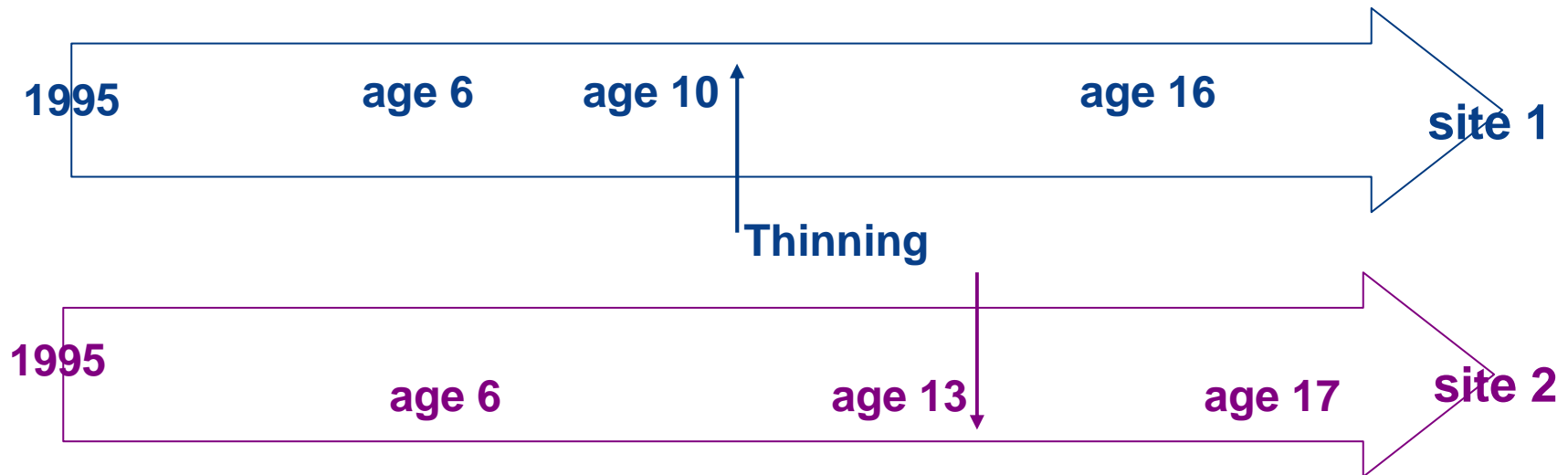




## M&M: Taxa identification

- 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

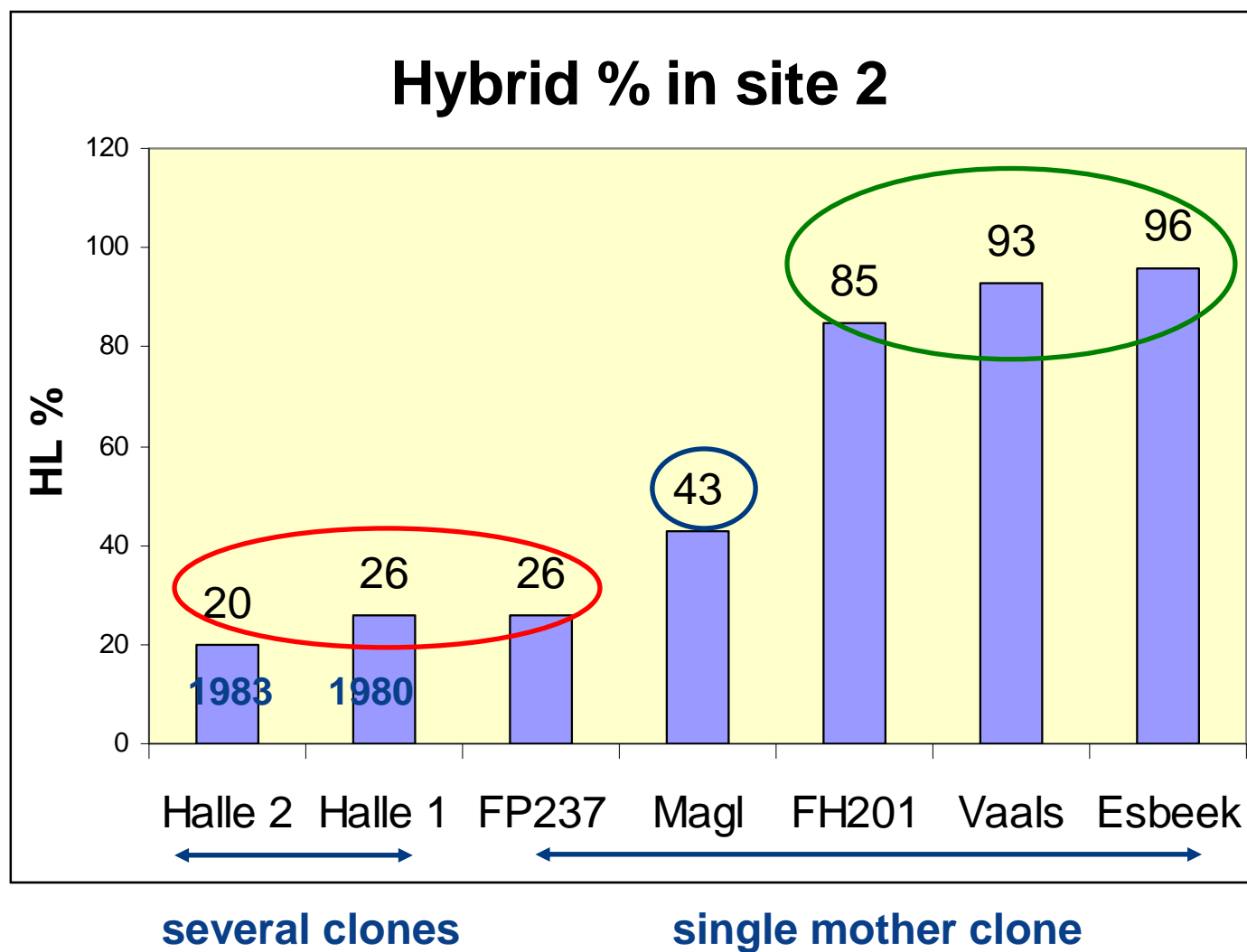


Score 5



**Basal sweep (age 13 - site 2)**

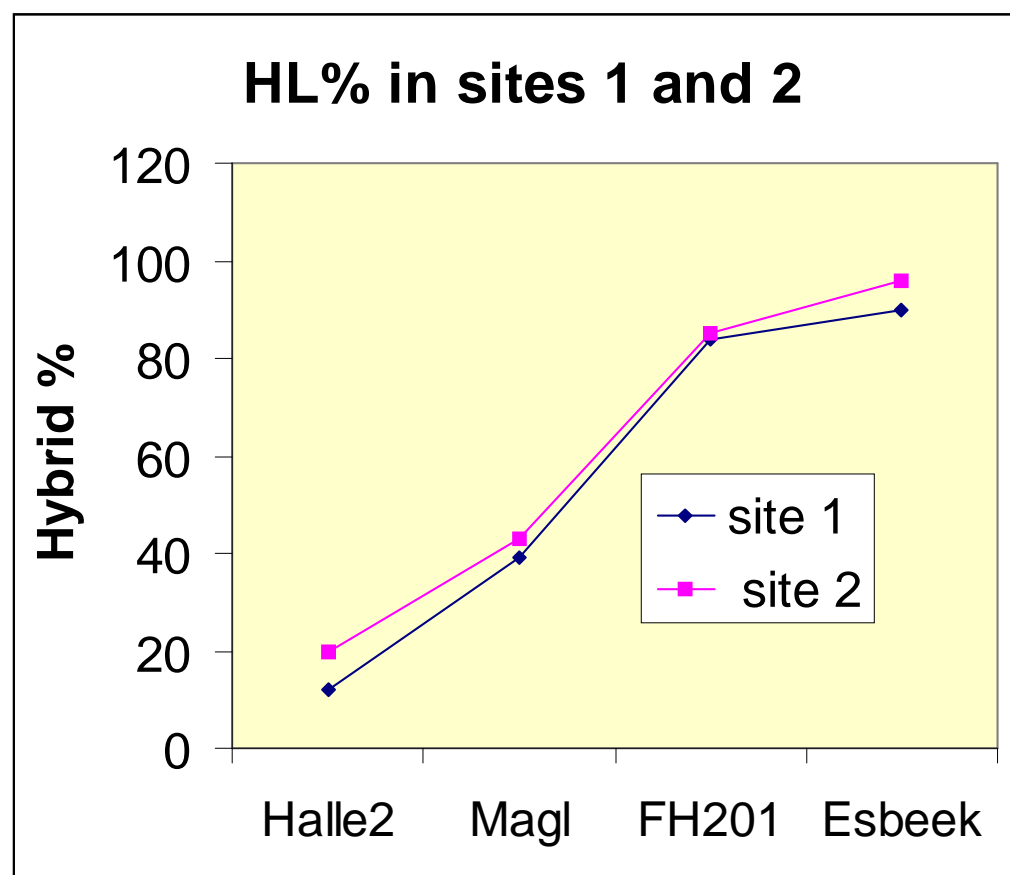
## Results: Proportion of hybrids



## Results: hybrids vs pure species - Adaptation traits

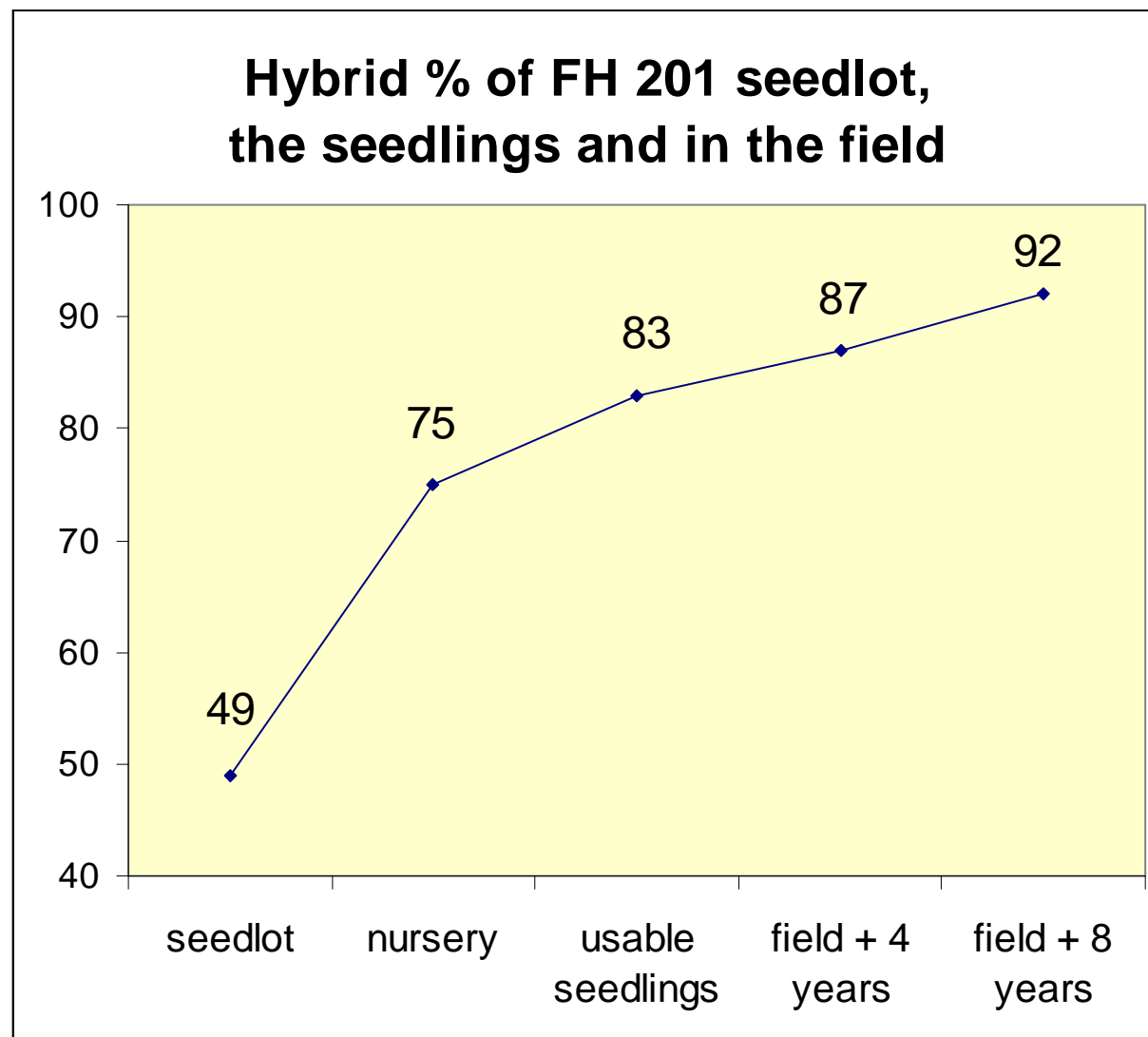
No difference between taxa for adaptation traits

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



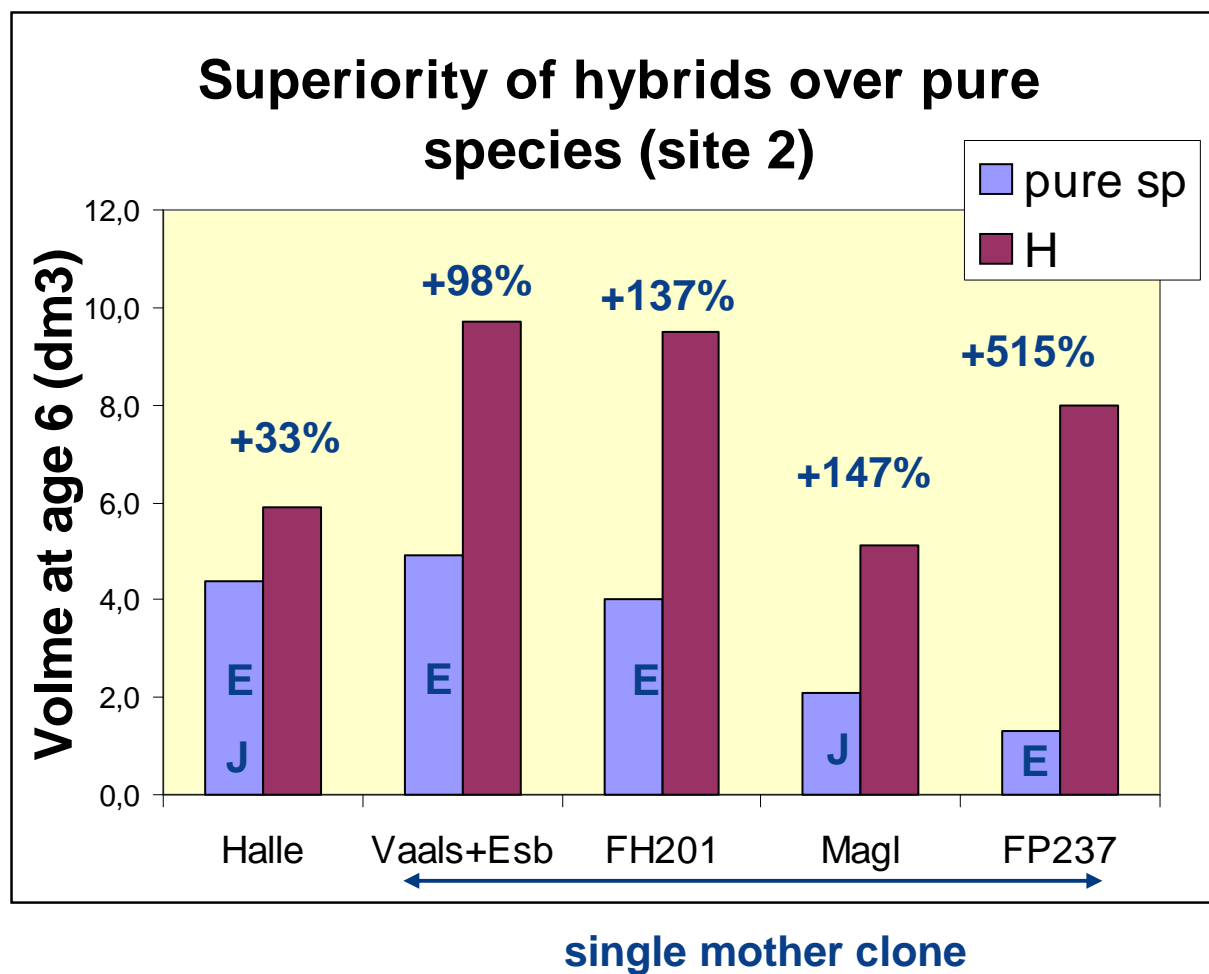
## Results: hybrids vs pure species - Mortality

	Survival
EL	38%
HL	86%**



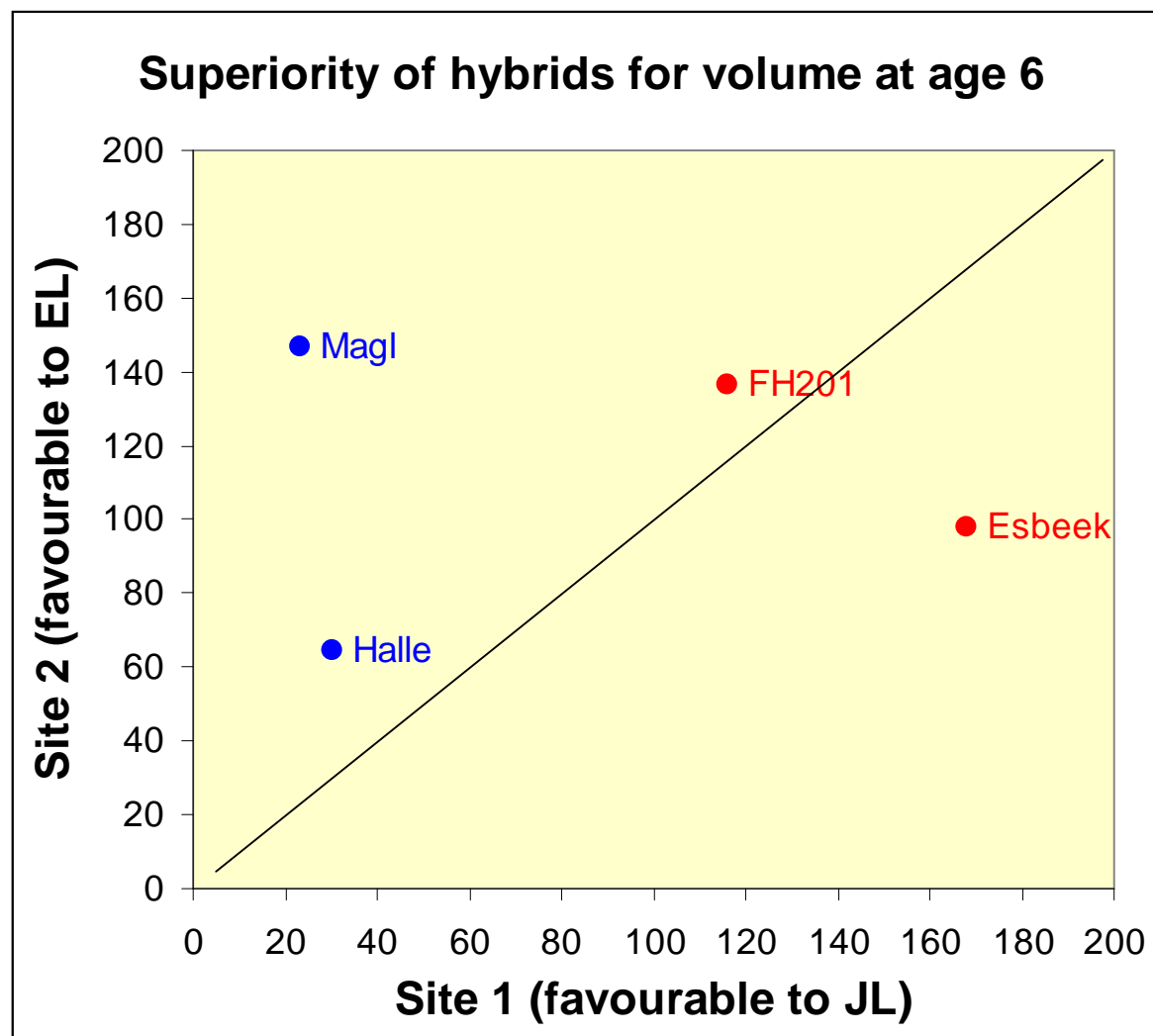


## Results: hybrids vs pure species - Growth



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

## Results: hybrids vs pure species - Growth



Maternal species

blue: JL

red: EL



## Results: hybrids vs pure species – Growth

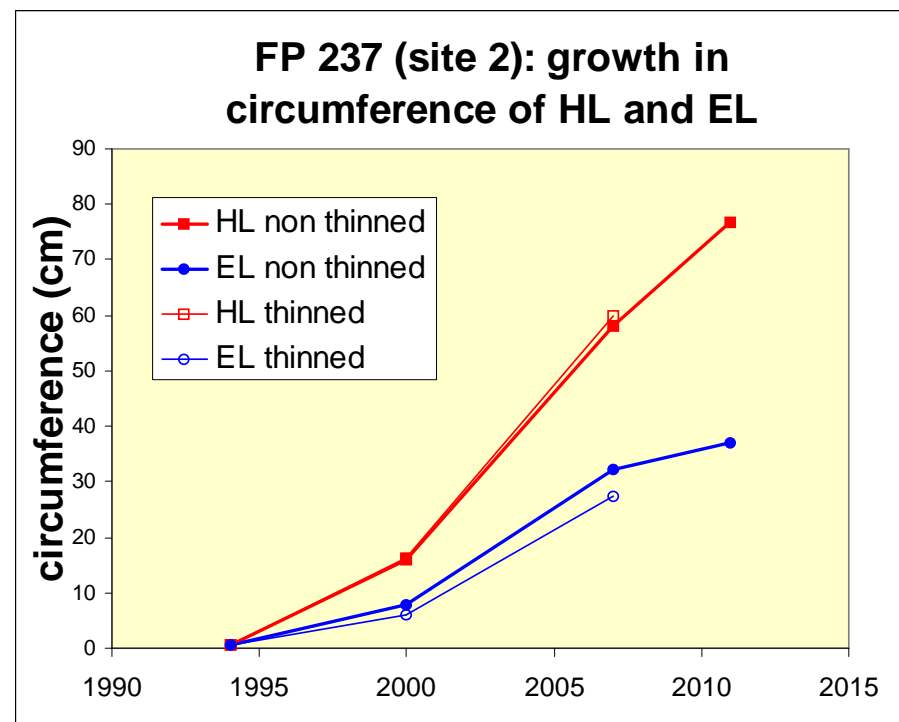
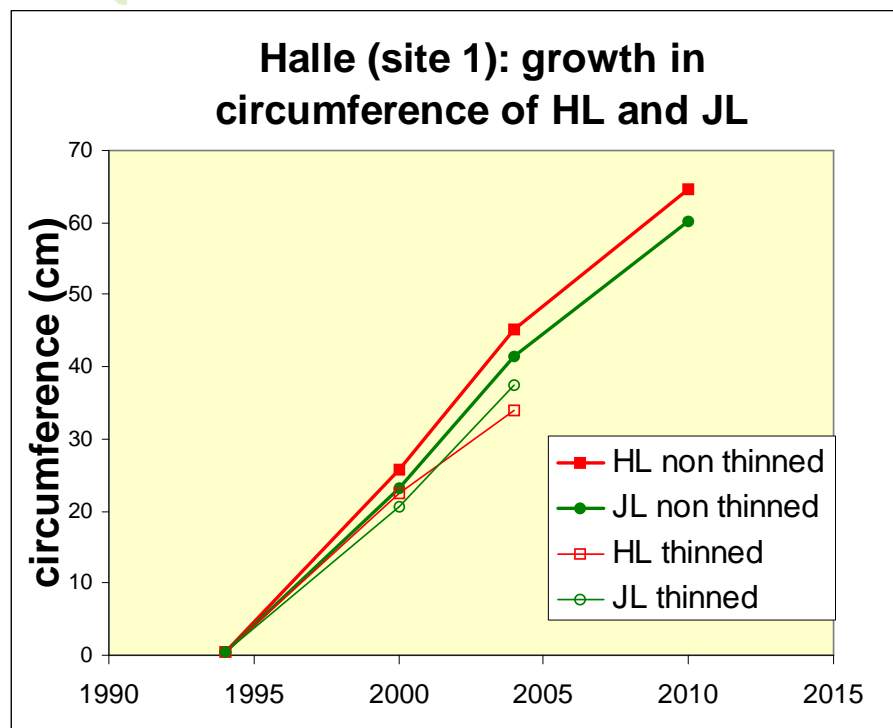
Hybrids are always more vigorous than pure species but their superiority varies according to the variety and the site

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



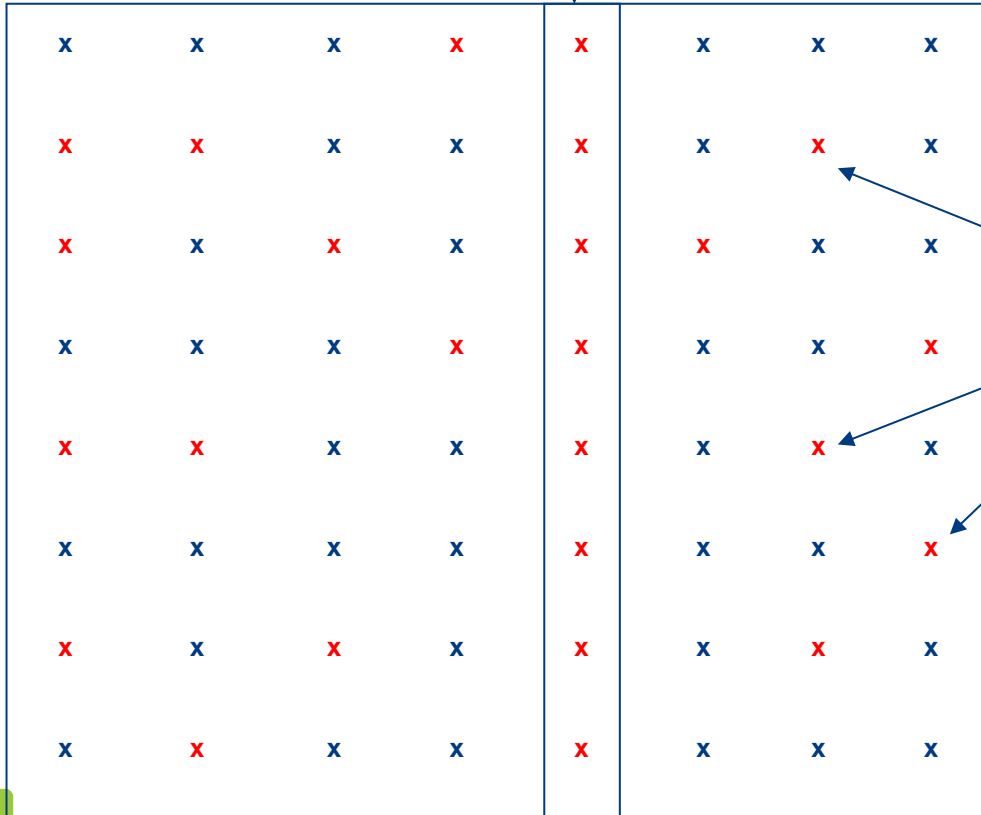
## Results: effect of 1st thinning on species purity

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

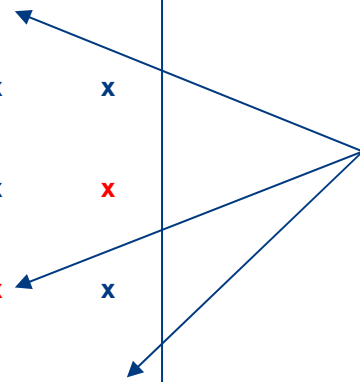
	Density (number of trees per ha)		
	at planting	before thinning	after thinning
<b>Site 1</b>	<b>1667</b>	<b>1610</b>	<b>940</b>
<b>Site 2</b>	<b>1667</b>	<b>1440</b>	<b>790</b>



**systematic  
thinning**

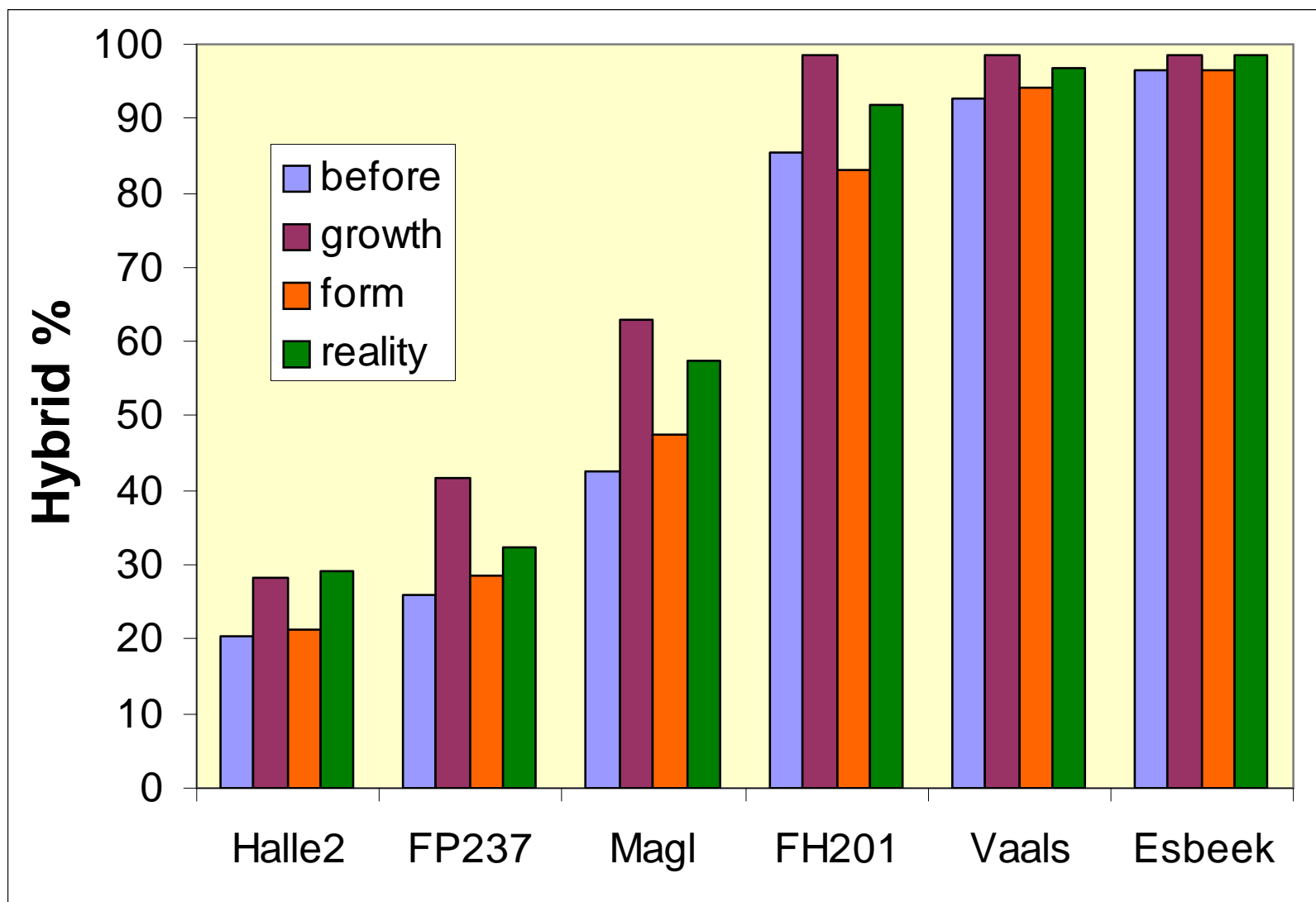


**selective  
thinning**



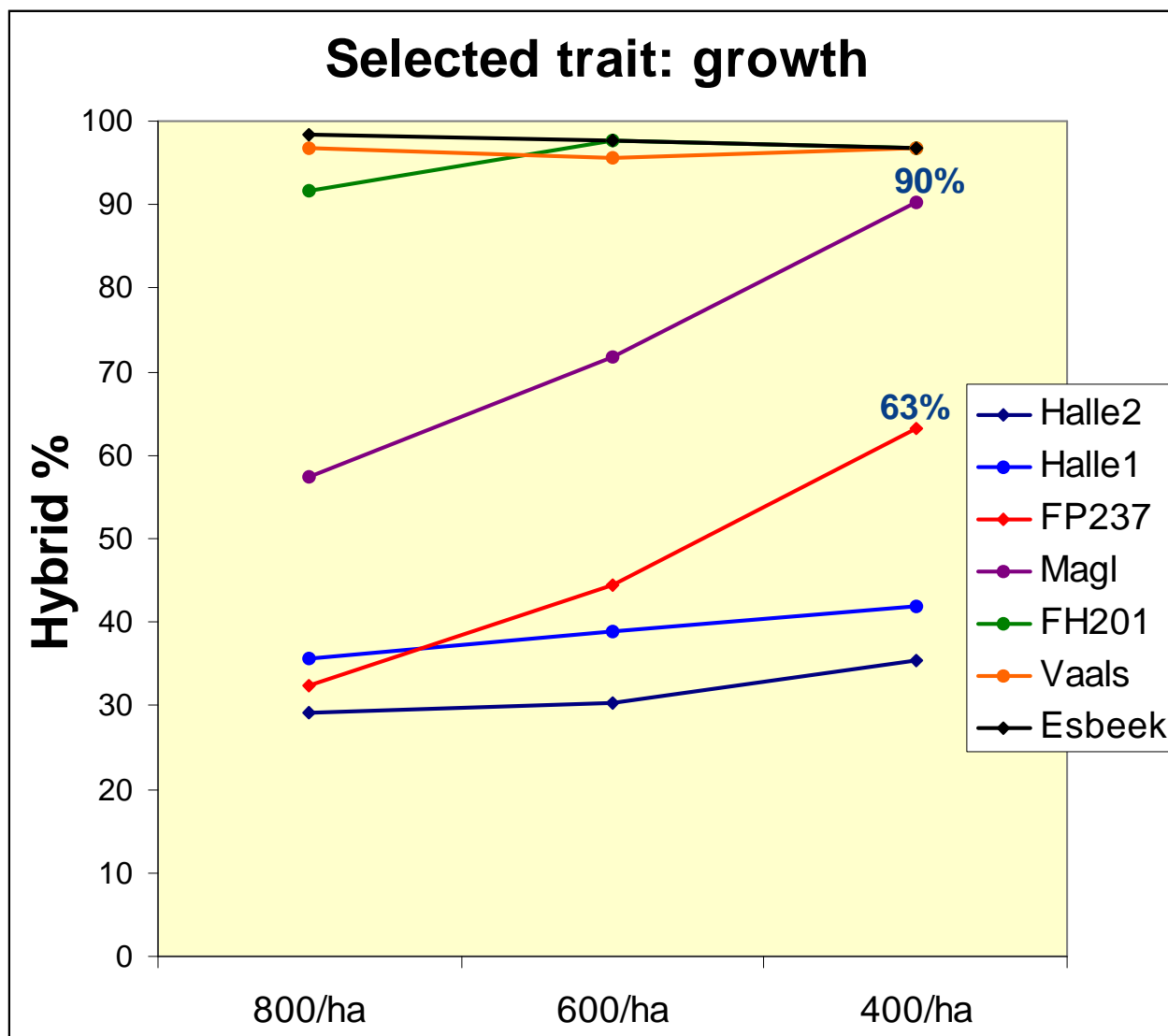
irstea

## Effect of 1st thinning on specific purity

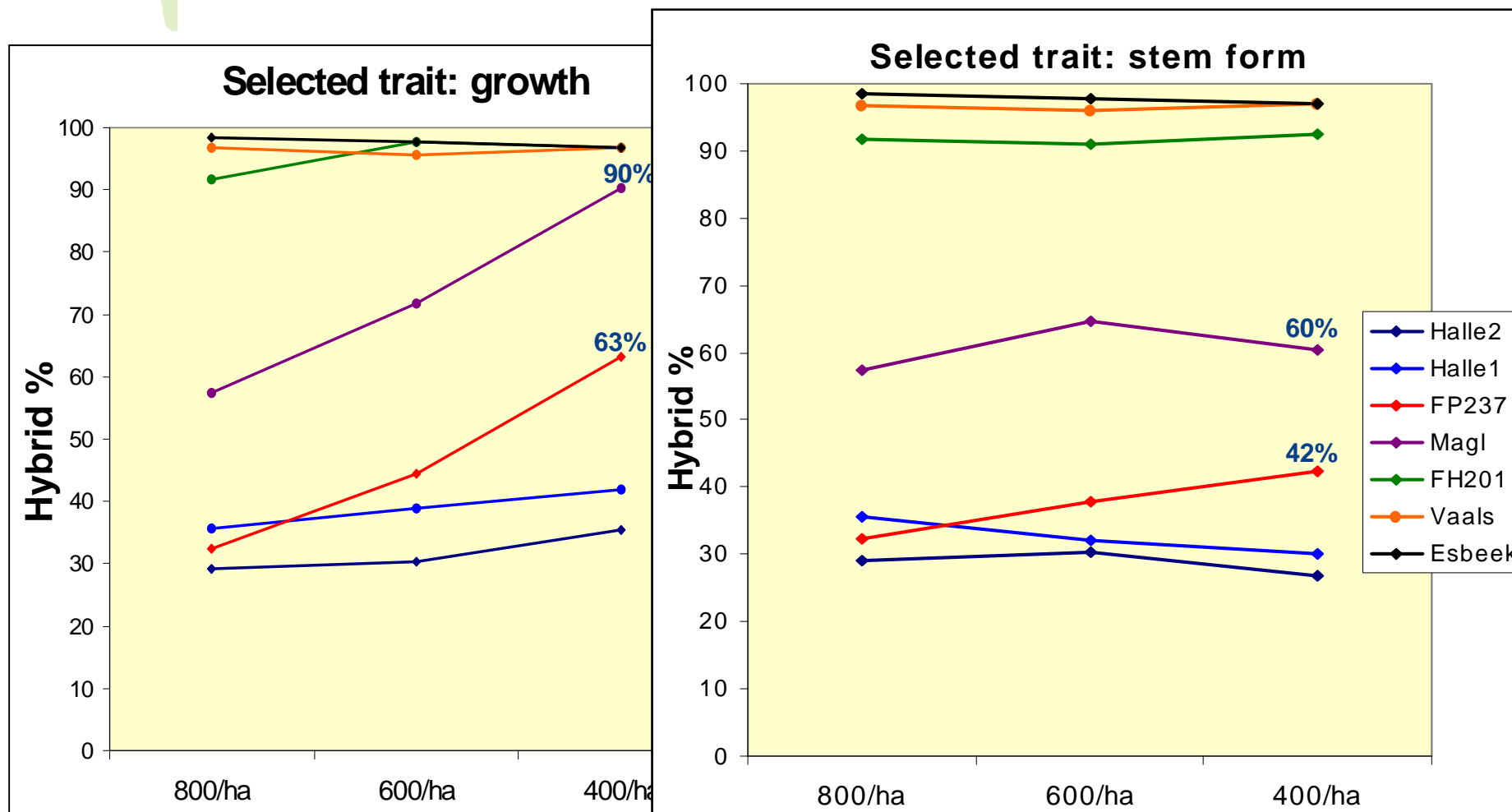




## Simulation of 2<sup>nd</sup> and 3<sup>rd</sup> thinning



## Simulation of 2<sup>nd</sup> and 3<sup>rd</sup> 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 !**

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

ONF Vay P301