

High quality seed for better wood quality

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...more background

- > Concerns about the quality of the juvenile wood
 - > Low wood density
 - > High spiral grain
 - > High microfibril angle
 - > Low strength and stiffness
 - > Poor stability against distortion during drying
- > Concerns about structural wood quality due low input forest management
 - > Low cost planting: Fewer plants per unit area
 - > No thinning
 - > Increased branch diameters
 - > Reduced possibilities of removing poor quality trees in thinnings
- > What is the effect of breeding for faster growth when this is combined with the "modern" silviculture?

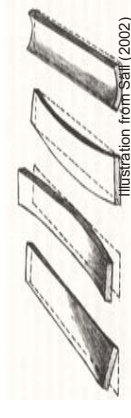
Implementing wood quality traits in the Norwegian spruce breeding

Outline

- > Wood quality studies (genetic) in Norway [2000 – present]
- > Implementation in breeding
 - > SO's: From untested "clonal archives" towards tested
 - > User input in the strategic planning
 - > Short term breeding goals
- > New issues and ongoing projects

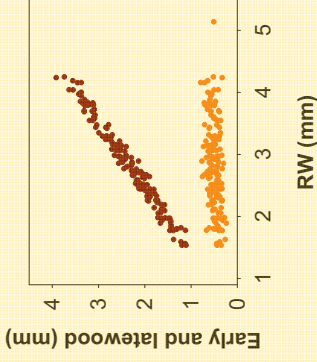
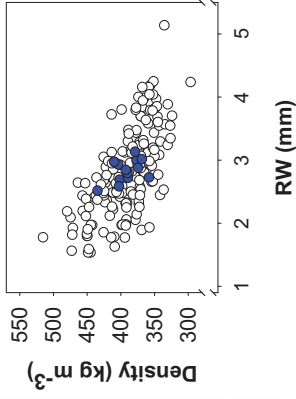
Recent studies [2000 – present >

- > Focus on structural wood: Strength and dimensional stability
- > Traits
 - > Study the "new" trait: Microfibril angle
 - > A follow-up of earlier studies made on wood density , spiral grain, stem form and branches
- > **How is the potential of improving wood quality traits by breeding?**
- > **Which correlations with growth must we be aware of?**
- > Making up our own experience
 - > Variation
 - > Methods
 - > Analysis

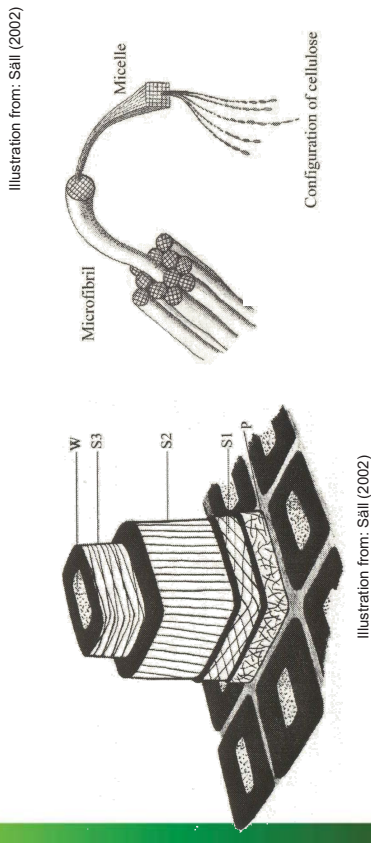


Wood density

- > Negative correlation between density and RW
- > Genetic correlation c. -0.5 is well documented in literature



Microfibril angle (MfA)



Microfibril angle (MfA)

- > Stiffness of ... cell wall \neq cellulose
- > In structural wood
 - > Stiffness
 - > Stability against distortion
- > In pulp
 - > Flexibility and strength of "fibers"
- > Uncorrelated with growth?

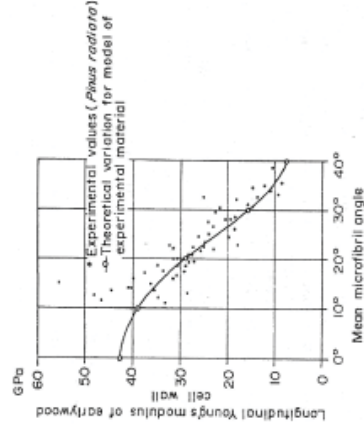
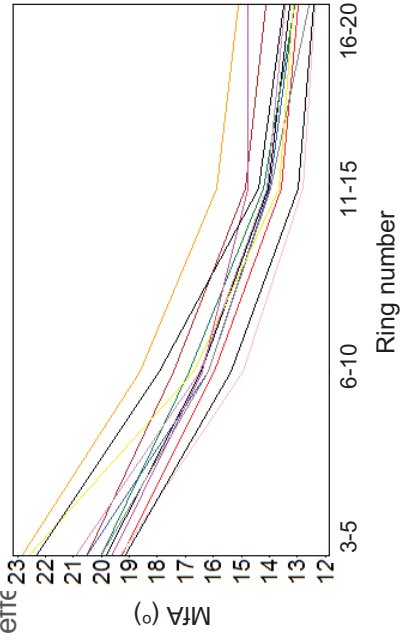


Figure from: Cave 1994

MfA

- > $h^2 \approx 0.40$
- > > 40 % of the total (phenotypic) variation is due to genetic effects



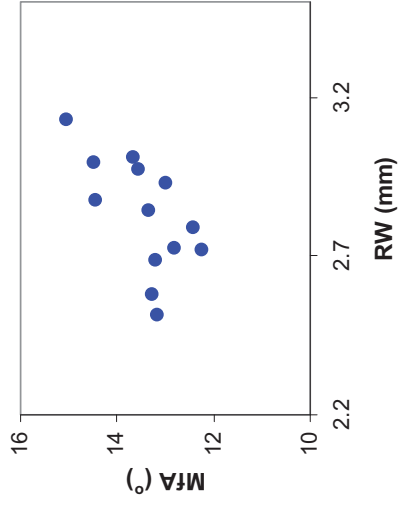
Phenotypic and genetic correlations



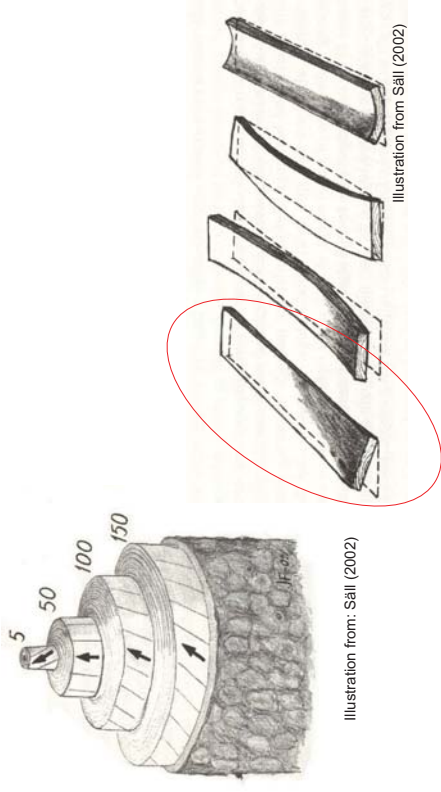
Ring no 13-16

$$r_p = 0.39$$

$$r_g = 0.64$$



Spiral grain



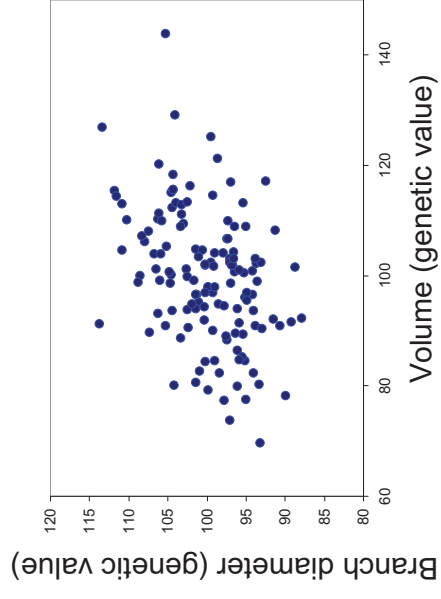
Spiral grain 30-year-old trial, Gjøvik Norway

Unpublished data

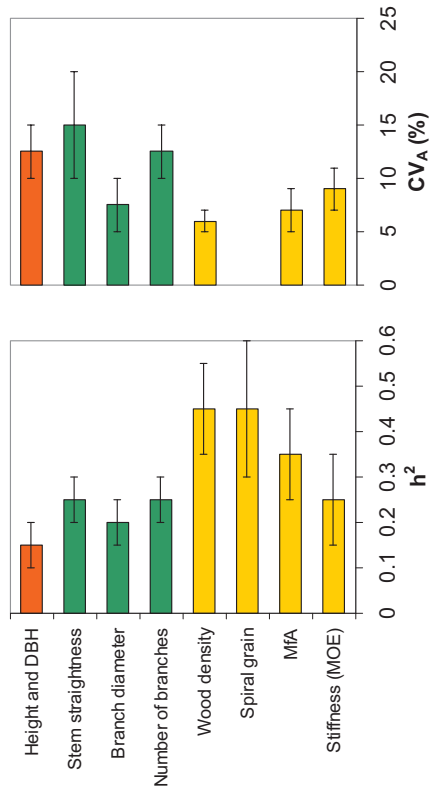
	Female parent										
	1	2	3	4	5	6	7	8	9	10	Mean
1	.	-0.8	-0.8	-1.2	-2.6	-2.4	-1.5	-1.6	-1.6	-1.0	-1.5
2	.	.	-1.5	-1.7	-3.7	-2.3	-2.2	-3.2	-1.9	-1.3	-2.1
3	.	.	.	-1.0	-2.7	-2.2	-0.7	-1.0	-2.0	-1.3	-1.5
4	-3.4	-2.7	-1.2	-1.7	-2.1	-2.0	-1.9
5	-4.7	-2.8	-3.4	-4.3	-2.7	-3.4
6	-2.3	-3.1	-3.9	-3.0	-3.0
7	-1.0	-1.6	-1.1	-1.6
8	-2.0	-1.8	-2.1
9	-1.3	-2.3
10	-1.7

MOE: -10 %

Genetic correlation between volume and branch diameter



Summary: heritability and variation



Grafting of breeding materials into seed orchards



Foto: Hans Christian Brede, Skogselskapet i Trøndelag

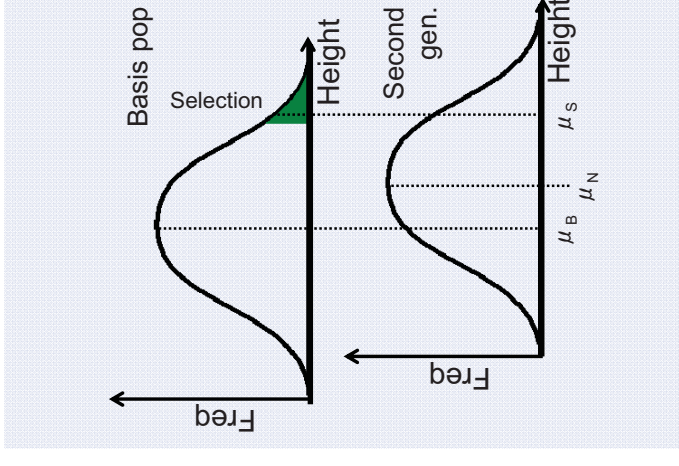
Tree breeding

Aim: Provide forestry with superior regeneration materials

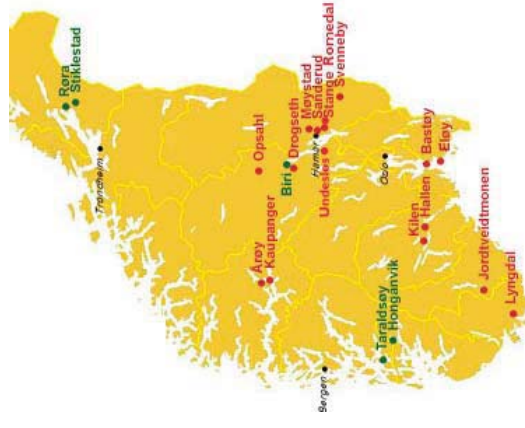
Climatic adaptation

Growth

Quality



Seed orchards in Norway



Strategic planning:

End-use in 50-100 years?

- > Use of wood changes
 - > Buildings in massive wood
 - > Less emphasis on strength?
 - > More emphasis on volume?
- > Microfibril plastic and paper
- > Bio-fuel
- > Carbon sink



Acknowledge the group

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Strategic planning: Users in the decision making

Target a: Volume

Target b: Volume - keep relative quality unchanged

- > "Relative" density and branch diameter
- > Stem form, branchiness and spiral grain
- > Silviculture controls diameter and branch growth

Target c: Volume - keep quality unchanged

- > Control that actual wood quality values do not change
- > Less emphasis on the silviculture

Target d: Quality - keep growth unchanged

- > Straighter stems, higher density lower branch diameter, lower spiral grain
- > Areas with more a specific quality breeding

Publications

Steffenrem, A., Särnpää, P., Lundqvist, S.O., and Skrøppa, T. 2007. Variation in wood properties among five full-sib families of Norway spruce (*Picea abies*). *Annals of Forest Science* 64(8): 799-806.

Steffenrem, A., Lindland, F., and Skrøppa, T. 2008. Genetic and environmental variation of intermodal and whorl branch formation in a progeny trial of *Picea abies* *Scandinavian Journal of Forest Research* 23(4): 290-298.

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Steffenrem, A., Kvaalen, H., Høibø, O.A., Edvardsen, Ø.M., and Skrøppa, T. 2009. Genetic variation of wood quality traits and relationships with growth in *Picea abies*. *Scandinavian Journal of Forest Research* 24(1): 15-27.