

# High-throughput methodologies – the highway for an efficient phenotyping of trees

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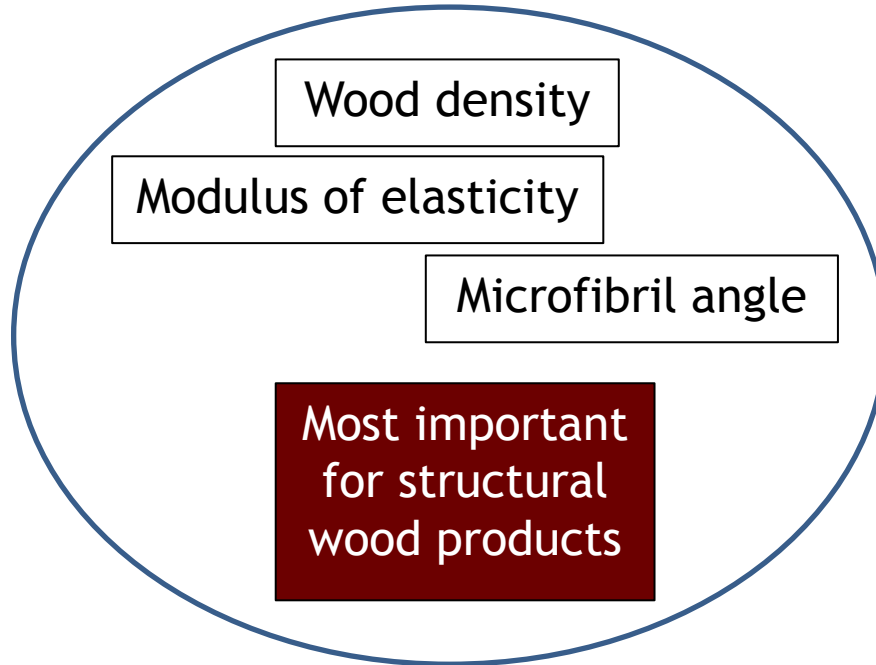
# The need for high-throughput methodologies

- Breeding in the past
  - Traits of interest: Survival, yield, stem quality, resistance to specific factors
  - Old school capacities and old fashioned infrastructures
- Breeding in the present and in the future
  - More traits of interest and more complex traits: E. g. tree-water-relationships, due to changing environments; wood qualities due to development in wood processing industries
  - Improved infrastructures and lean capacities

# The need for high-throughput methodologies

- Genotyping (genetic structure) and phenotyping (expression of traits)
- Preconditions for efficient phenotyping
  - Evaluation of many trees in a simple way and to low cost
  - Collection of many information as possible per tree
  - Production of dense time-series data
- Challenges for the data produced
  - Real
  - Reliable
  - Reproducible

## Example: Wood quality and breeding objectives

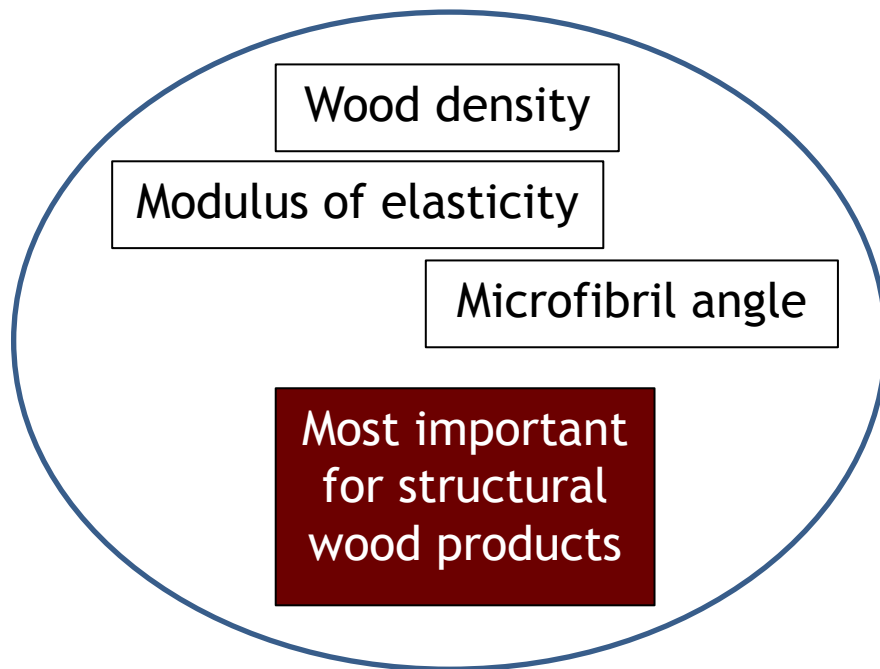


Wood density:  
Measurement relatively  
easy, not very expensive

Modulus of elasticity/  
Microfibril angle:  
Measurement expensive,  
destructive

Chen *et al.* 2014, 2015

## Example: Wood quality and breeding objectives



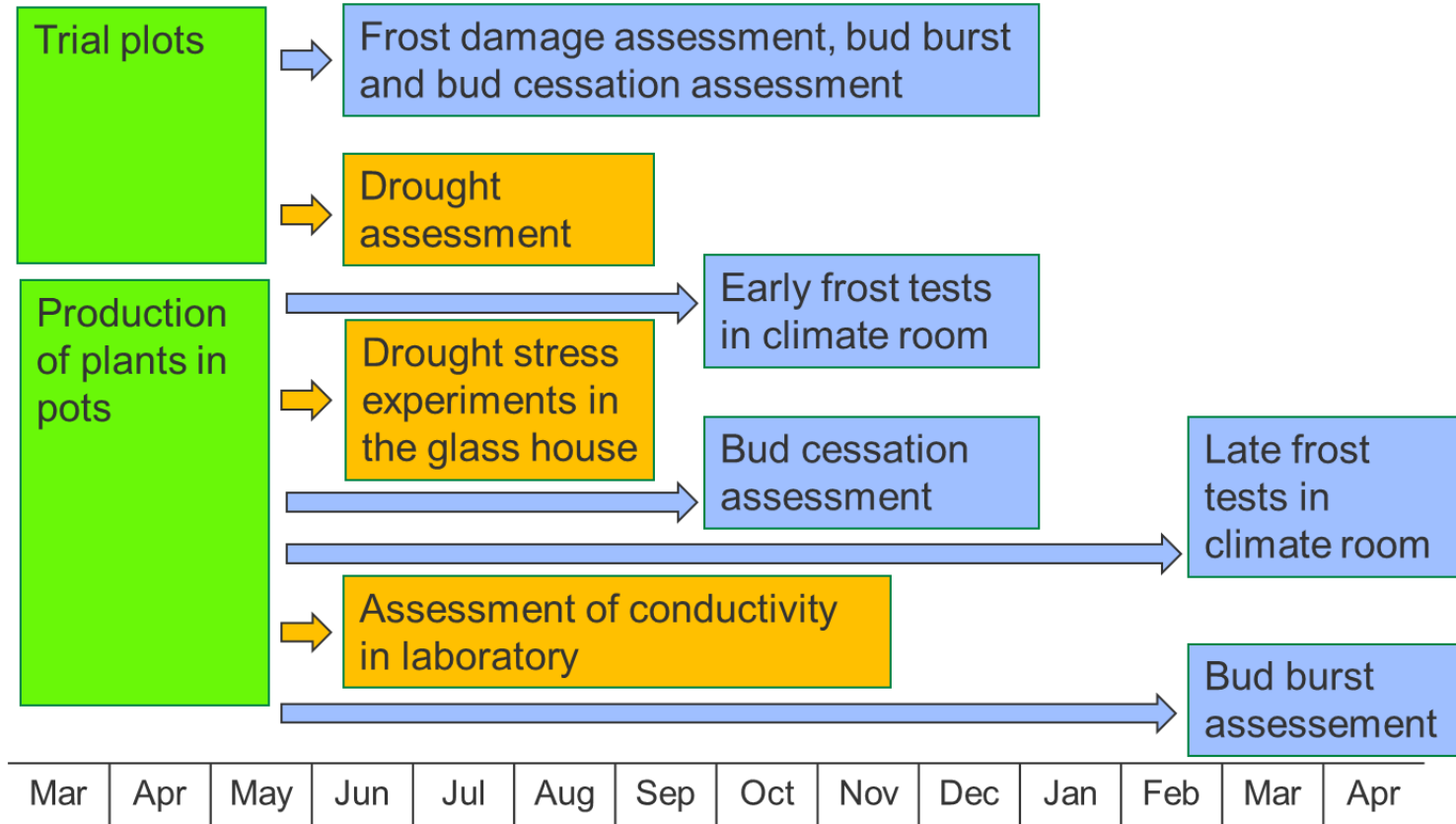
Norway spruce -  
Breeding objective DBH

Genetic gains:

DBH	+ 19 %
Density	- 5 %
MOE	- 9 %
MFA	+ 8 %

Chen *et al.* 2014, 2015

# Example: Assessment of drought and frost resistance



## Example: Assessment of drought and frost resistance
















Methods	Advantages	Disadvantages
Assessment in the field	<ul style="list-style-type: none"> <li>+ Near to reality</li> <li>+ Examples for demonstration</li> </ul>	<ul style="list-style-type: none"> <li>- Occurrence accidentally</li> <li>- Planning difficult</li> <li>- Activities on very short notice</li> </ul>
Experiments under controlled conditions	<ul style="list-style-type: none"> <li>+ Application of stress</li> <li>+ Additional traits</li> </ul>	<ul style="list-style-type: none"> <li>- Verification and calibration</li> <li>- Murphy´s law</li> <li>- Cost (time, labour)</li> </ul>
Assessment of conductivity	<ul style="list-style-type: none"> <li>+ Middle-throughput (5 to 25 clones per week)</li> </ul>	<ul style="list-style-type: none"> <li>- Verification and calibration</li> <li>- Delicacy</li> <li>- Cost (time, labour)</li> </ul>

# The potential for high-throughput methodologies

Traits	Limits	Proxies	Participants involved
Phenology	Subjectivity, planification, meaning	Captors, ex situ assesst Secondary meristem act	CRA, IBL, INRA
Hydraulic properties (conductivity, cavitation)	Destructive, cost	Anatomy, NIRS	BOKU, INRA, SBS, Un.Gent
Chemicals Lignin/cellulose Extractives	Cost, time-consuming	NIRS Raman spectr., NIRS	IICT, INRA, INNVENTIA, LUKE
Natural durability	Reproducibility, cost, time-consuming, destructive	Increment core test, Extractives NIRS	IVALSA, INRA
Spiral grain	Destructive, time- consuming	Diffraction	INNVENTIA, INRA
MOE	Destructive, time- consuming	Acoustic, NIRS	INRA, GAIN
Collapse and tension wood	Destructive, time- consuming	NIRS (cell + MOE)	GAIN, IICT






# For what *finally* (may be replaced), we are doing that?

Trait	Expression	Max 1	7-177 T	7-183 A
Drought	Establishment			
	Increment			
	Loss of increment			
Frost	Early frost			
	Late frost			

*Finally*, we have:

Administrations, clients,  
companies, consumers,  
customers, experts,  
farmers, foresters,  
industries, tree planters,  
.....

	Unsuitable
	Average
	Suitable