Wood Quality Improvement of Teak (*Tectona grandis*)

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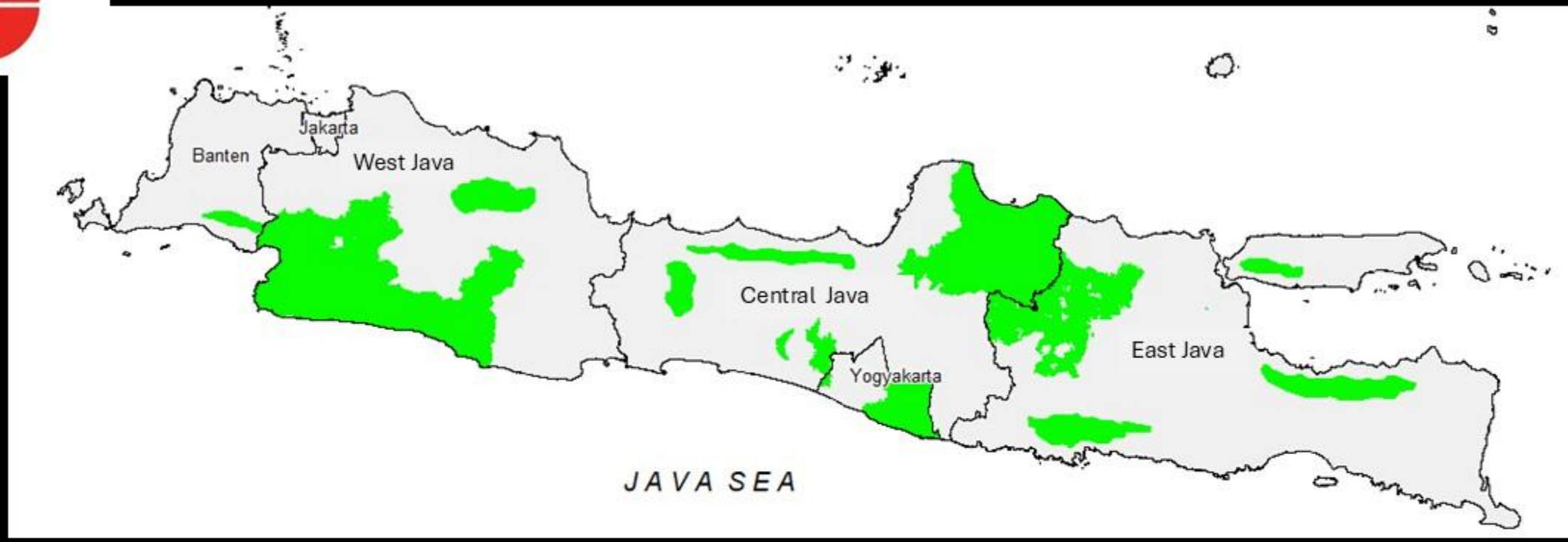
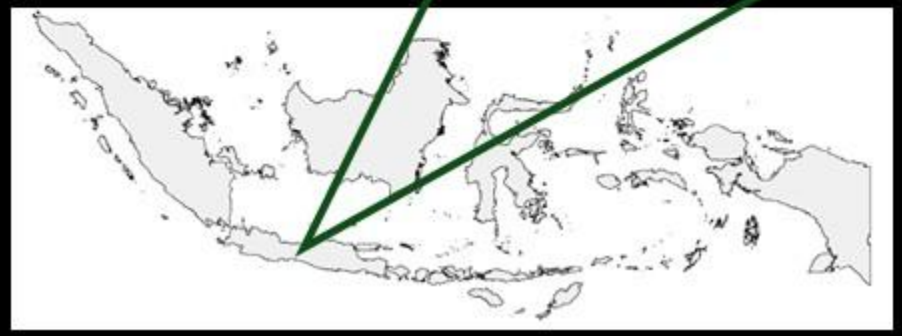
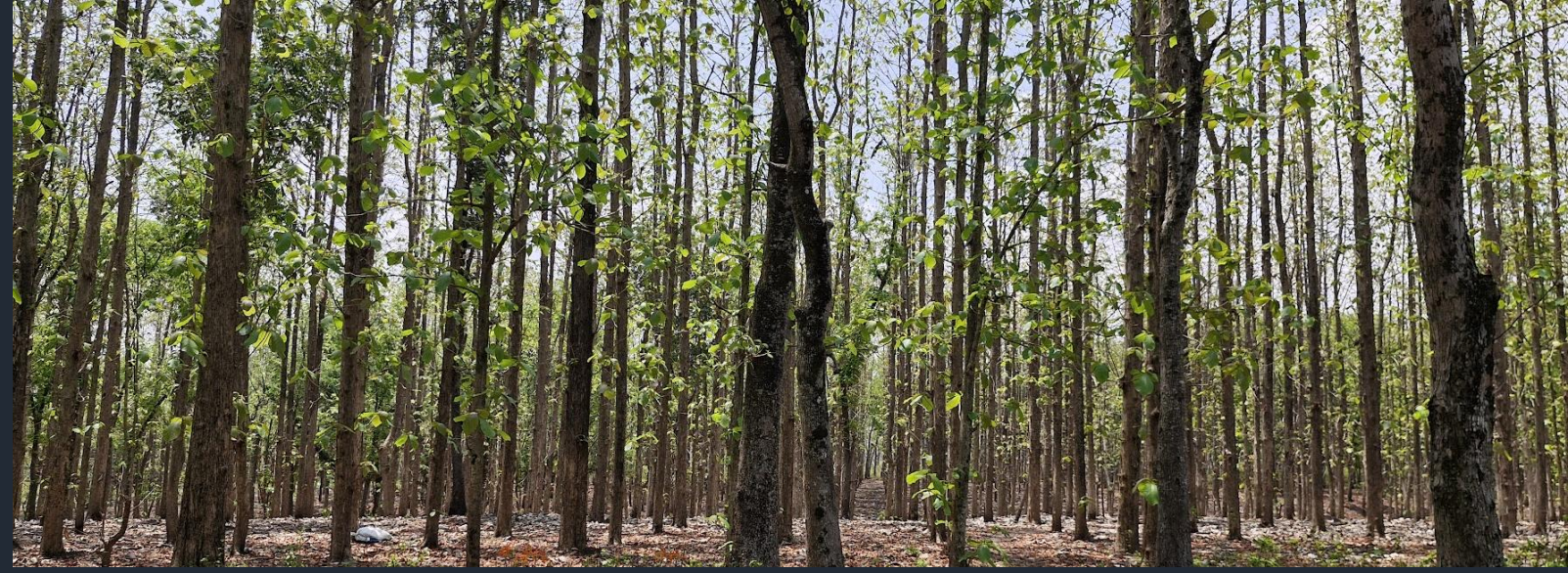
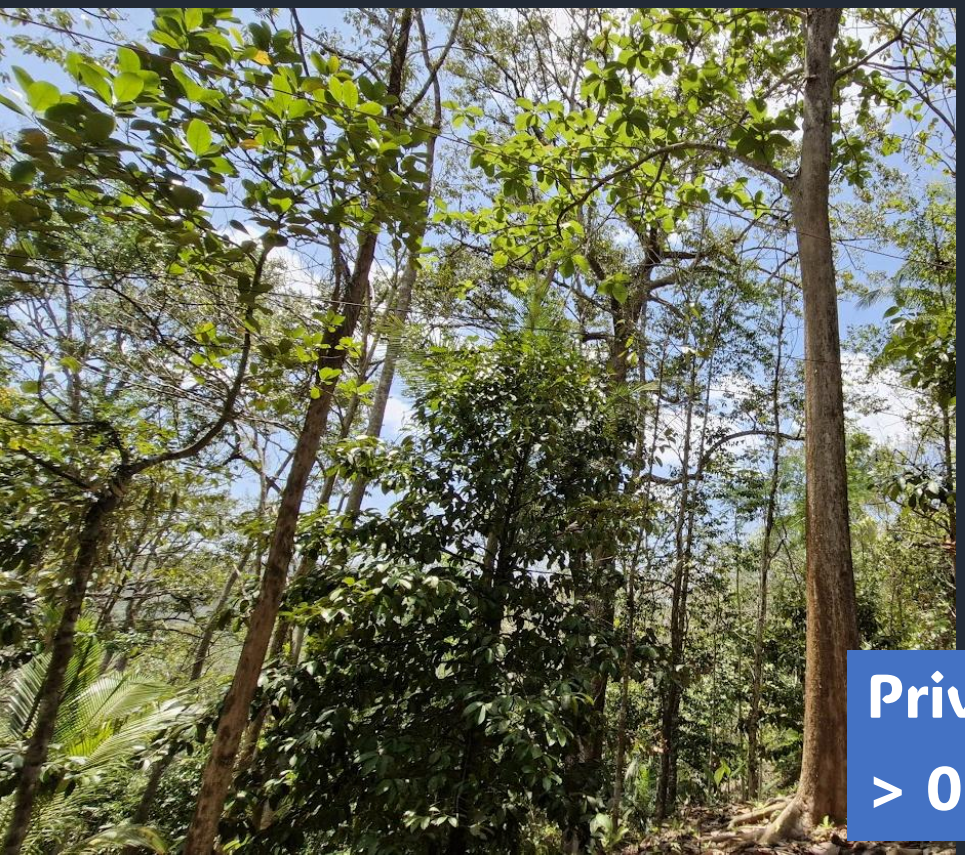




Teak forests distribution in Java

Teak Forest Area in Java





PERUM PERHUTANI
1,38 million hectares

In the world
4.85 million hectares

Privately owned forest in Java
> 0.5 million hectares

Teak Improvement in Indonesia

Before 1990

1932 : 4 Provenance Trials (Ngawi , Randublatung, Bojonegoro and Blitar)- Busbouw Proefstation

1988 : Teak Improvement Program - Perum Perhutani and Faculty of Forestry, Gadjah Mada University

Teak Forest in KPH Jatinegara , KPH Pemalang, DIVRE of CENTRAL JAVA, PERUM PERHUTANI

Mean Annual Increment (MAI) : 10-15 m3/ha/year

Tree Improvement for Industry and Privately owned forest

Centre for Forest Biotechnology and Tree Improvement, Ministry of Forestry

1992/1993

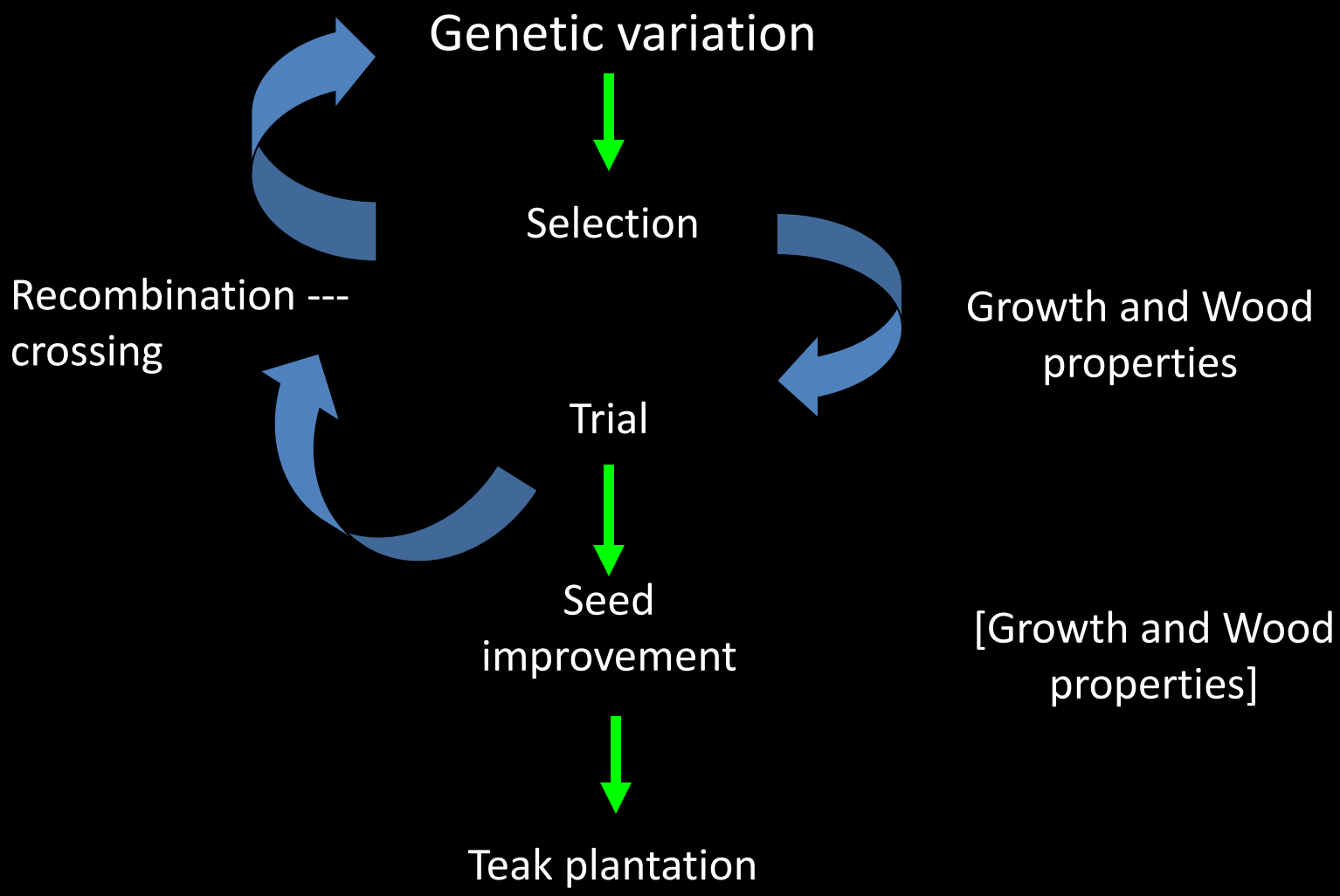
Forest Tree Improvement for fast/slow Growing SpeciesTree

2020

Established 40 Trials

(*Tectona grandis, Acacia sp, Eucalyptus sp, Shorea sp, Tectona grandis, Swietenia macrophyiia, Hibiscus macrophyllus, Gmeiina arborea, Manglietia glauca, Falcataria moluccana, Araucaria sp, Alstonia scholaris)*

Forest tress improvement cycle for teak



Plus Tree
(Low wood quality)

Donor Tree
(High wood quality)

Cycles of backcross

Cross breeding

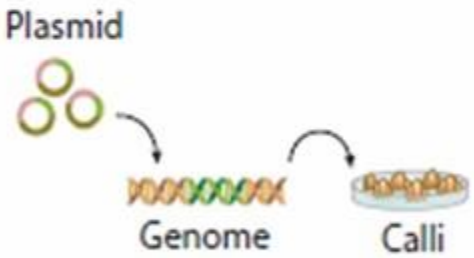
Mutant

Plus Tree
(Low wood quality)

Selection

Mutation Breeding

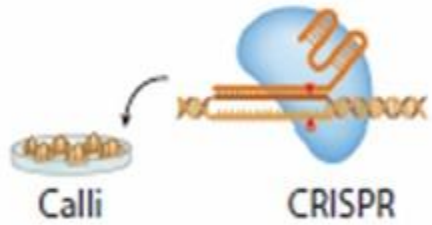
Plus Tree
(Low wood quality)



Foreign gene integration

Transgenic breeding

Plus Tree with high wood quality



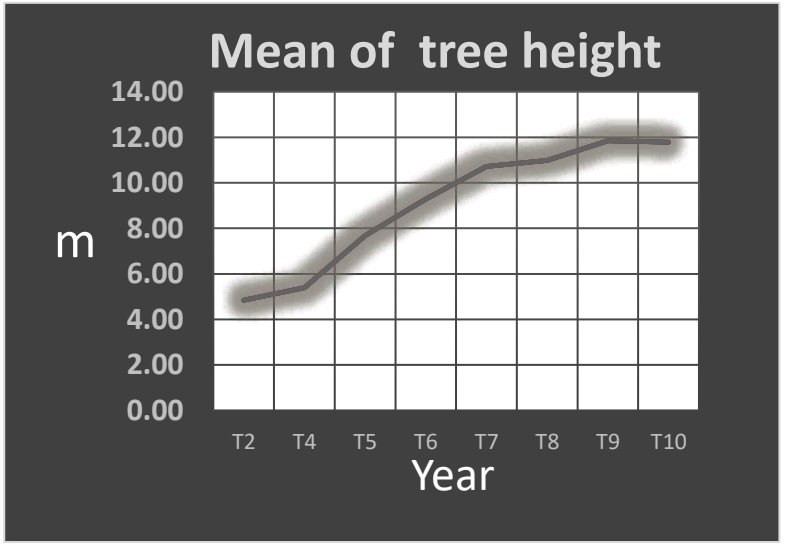
Endogenous gene modification

Plus Tree
(Low wood quality)

Genome editing

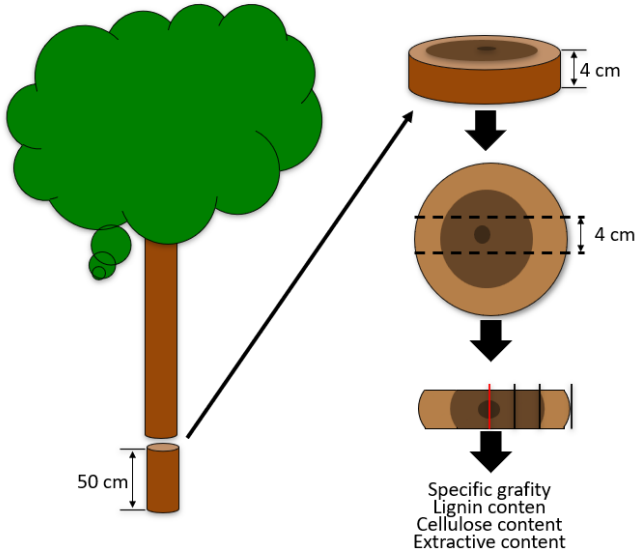
Tree illustrations from https://id.pngtree.com/so/pohon-jati

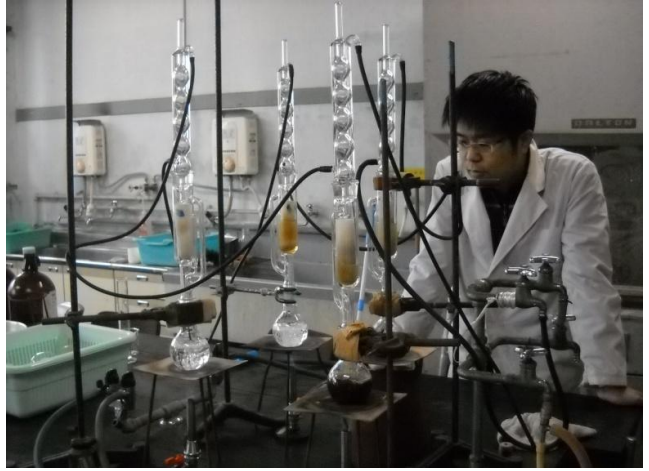
Clonal and progeny test of Teak



Wood quality Improvement Step

- Wood properties study
- Genetic wood properties variation
- Tree selection base on genetic value





Wood properties

Carbon storage -120 t/ha (Kraenzel et al, 2003**)**

- **Specific gravity (0,62-0,72)**
- **20-30 % Lignin ($C_9H_{7.95}O_{2,4}$ $(CH_3)_{0,93}$ - 61–65 % Carbon (C)**
- **40-50 % Cellulose $(C_6H_{10}O_5)n$**
- **20-30% Hemicellulose (C5H8O4)n**
- **Extractive Content : Carbamic Acid (NH_2COOH), Ammonium carbamate ($NH_4(NH_2COO)$, Acetic Acid (CH_3COOH)**

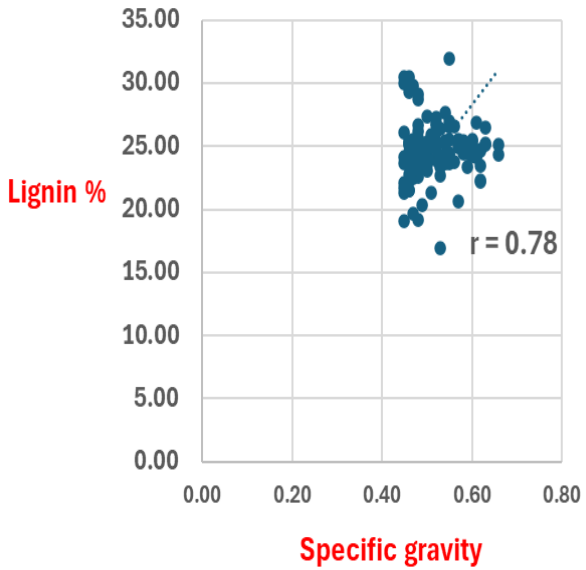
Wood Durability there was a positive correlation of termite resistance with age of tree and extractive content (Dacosta et al. 1958; Lukmandaru and Takahashi, 2008**).**

Mechanical wood properties

a) Compressive strength
b) Bending strength
c) Shear strength
d) Stiffness
e) Hardness
f) Toughness
g) Cleavability
h) Resilience

Genetic correlation between wood properties

Example



	PP	SG	Ext	HC	Lig	AC	FL	LD	CW	MC
PP		-0.67	-0.98	-0.22	0.58	-0.96	0.00	-0.48	0.55	0.46
SG	-0.68		0.16	0.03	-0.24	0.53	-0.32	0.00	0.00	0.61
Ext	0.01	0.06		0.34	0.60	-0.57	-0.43	0.00	0.00	0.00
HC	0.16	0.25	0.08		-0.92	-0.08	-0.43	0.72	-0.54	0.00
Lig	-0.13	0.17	0.23	-0.90		-0.11	0.45	-0.65	0.37	0.00
AC	-0.12	0.25	-0.04	0.06	0.01		-0.01	0.00	0.44	0.00
FL	0.32	0.12	-0.02	0.10	-0.10	-0.03		0.00	0.00	-0.50
LD	0.13	0.08	0.06	-0.04	-0.06	0.04	0.00		-0.82	0.00
CW	0.11	0.06	-0.02	-0.05	0.04	-0.13	0.14	-0.03		0.00
MC	0.35	-0.49	0.00	0.00	0.00	0.00	0.19	0.00	0.00	

Notes: PP = Pilodyn penetration; SG = Specific gravity; Ext = Extractive content;
HC = Holocellulose content; Lig = Lignin content; AC = Alpha cellulose;
FL = Fiber length; LD = Lumen diameter; CW= Cell wall thickness; MC = moisture content

Genetic gain estimation in Trees selection

Example

Traits	$\sigma^2 p$	i	h^2_i	ΔG %
Pilodyn penetration (mm)	1.32	1.75	0.30	6.16
Moisture content (%)	5.74	1.75	0.15	1.51
Specific gravity	0.07	1.75	0.37	9.72
Fiber length (mm)	0.06	1.75	0.35	3.57
Cell wall thickness (μ)	0.41	1.75	0.09	1.78
Lumen diameter (μ)	2.13	1.75	0.13	4.01
Extractive content (%)	0.71	1.75	0.24	6.95
Lignin content (%)	2.85	1.75	0.21	4.22
Holocellulose content (%)	2.64	1.75	0.27	1.77
Alpha cellulose content (%)	6.80	1.75	0.37	6.53

Thank You