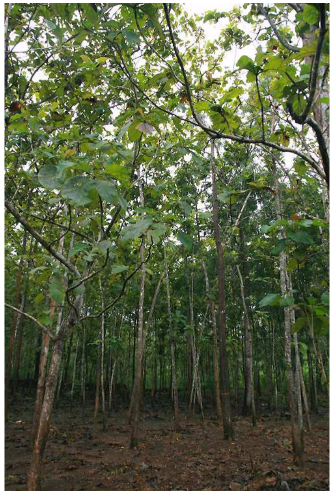
Trade-off analysis and economic valuation of intercropping teak – maize under different silvicultural management



Ni’matul Khasanah

Aulia Perdana, Arif Rahmanullah, Gerhard Manurung,
James M. Roshetko, Meine van Noordwijk, Betha Lusiana

“Tropentag 2013: Agricultural development within the rural-urban continuum”

Stuttgart-Hohenheim, September 17 - 19, 2013

Research Location

- Upland limestone in Wonosari, Gunung Kidul, Yogyakarta, Indonesia
- Annual rainfall 1750 mm
- Teak is the dominant crop

Teak Cultivation and Issues

- Smallholder systems
- Lack of good tree management
- Low quality timber and hence low revenues for farmers
- Teak production in Indonesia increasingly comes from this smallholder systems

Challenges

- Can multiple combination of management practices (spacing, pruning and thinning) increase timber quality and revenues for smallholder systems?
- What are the trade-offs amongst different management practices?

Objectives

- To explore the effect of different management practices (spacing, thinning, pruning) on growth and production of teak and maize when they are intercropped,
- To identify the best and the most profitable management practices for smallholder teak.

Ex-ante analysis using the tree-crop interactions model WaNuLCAS

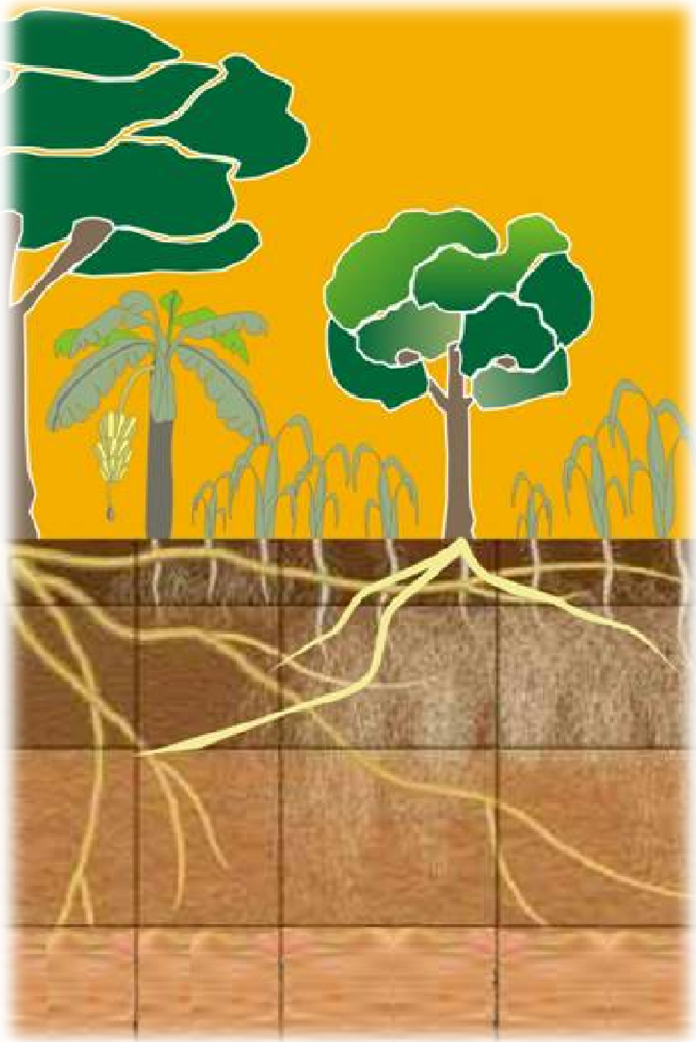
Profitability Analysis

World Agroforestry Centre

Ex-ante analysis using the tree-crop interactions model WaNuLCAS



WaNuLCAS model

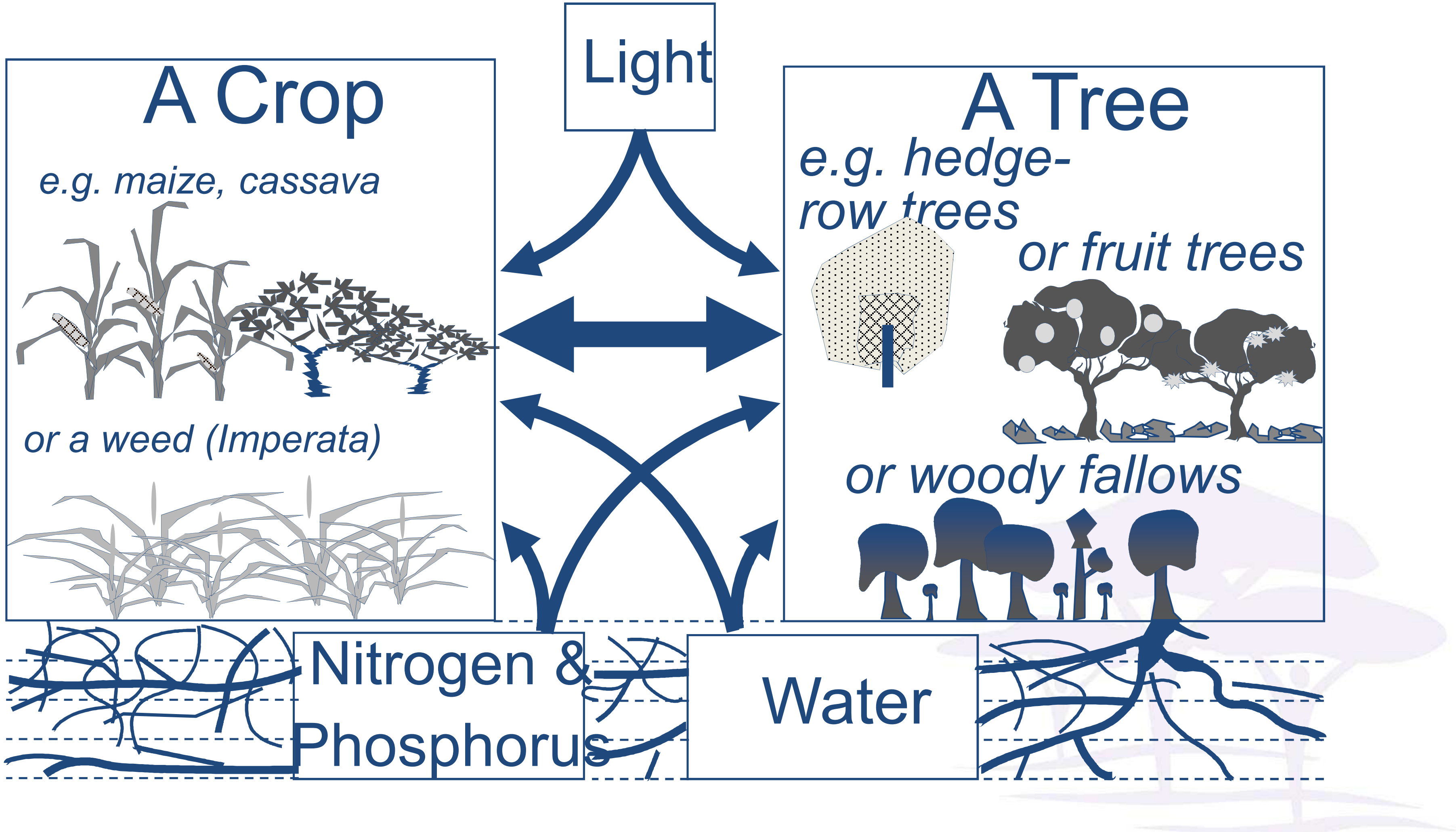


Was developed to represent tree-crop interactions in a wide range of agroforestry systems where trees and crops overlap in space and/or time (simultaneous and sequential agroforestry).

Spatial scale: plot (represents a four-layer soil profile, with four spatial zones.

Time scale: daily

Principle Component



Modules

Core Module

- Climate
- Tree
- Crop
- Planting Schedule
- Soil : Water & Nutrient

Additional Module

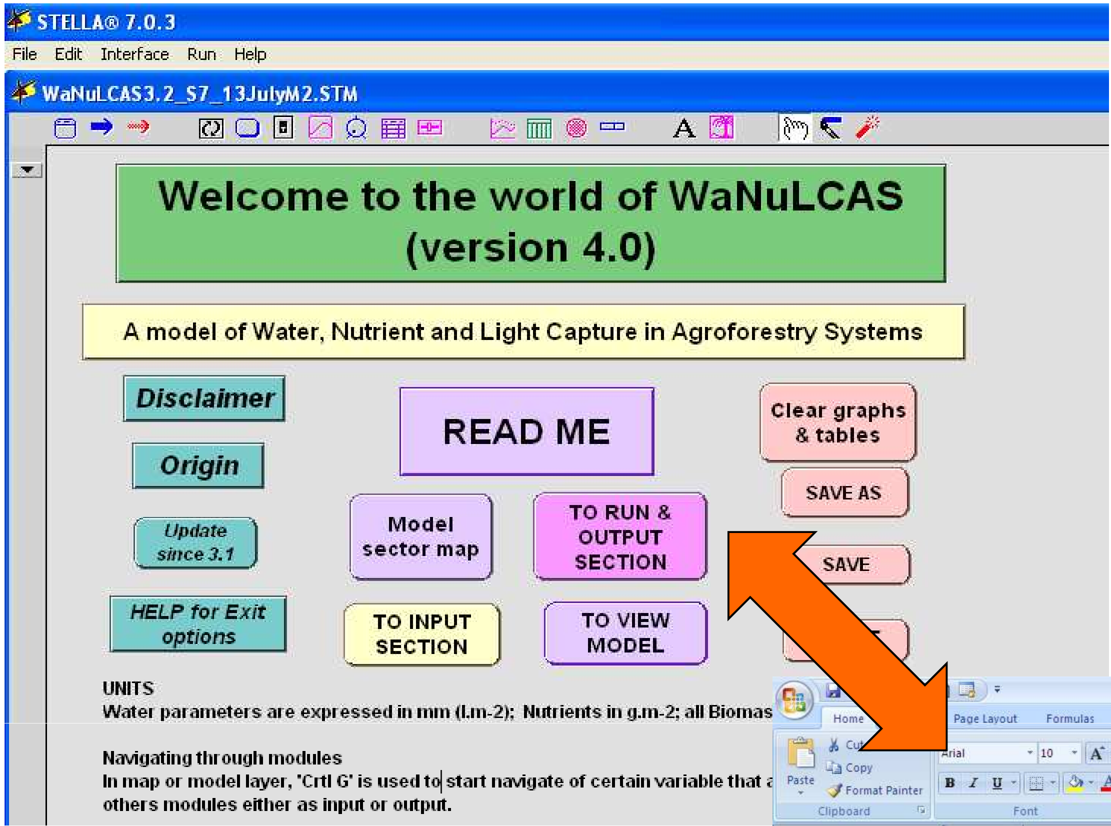
- Labour use and Profitability
- Slash and Burn
- Tree Product:
  - Oil Palm
  - Rubber/Latex
- Parasitism
  - Semi-parasitic (cendana)
  - Loranthus

Additional Module

- Management:
  - Soil Tillage
  - Pruning
  - Fruit Harvesting
  - Timber Harvesting
  - Killing Trees
  - Mulching
  - Weed Growth
- Grazing

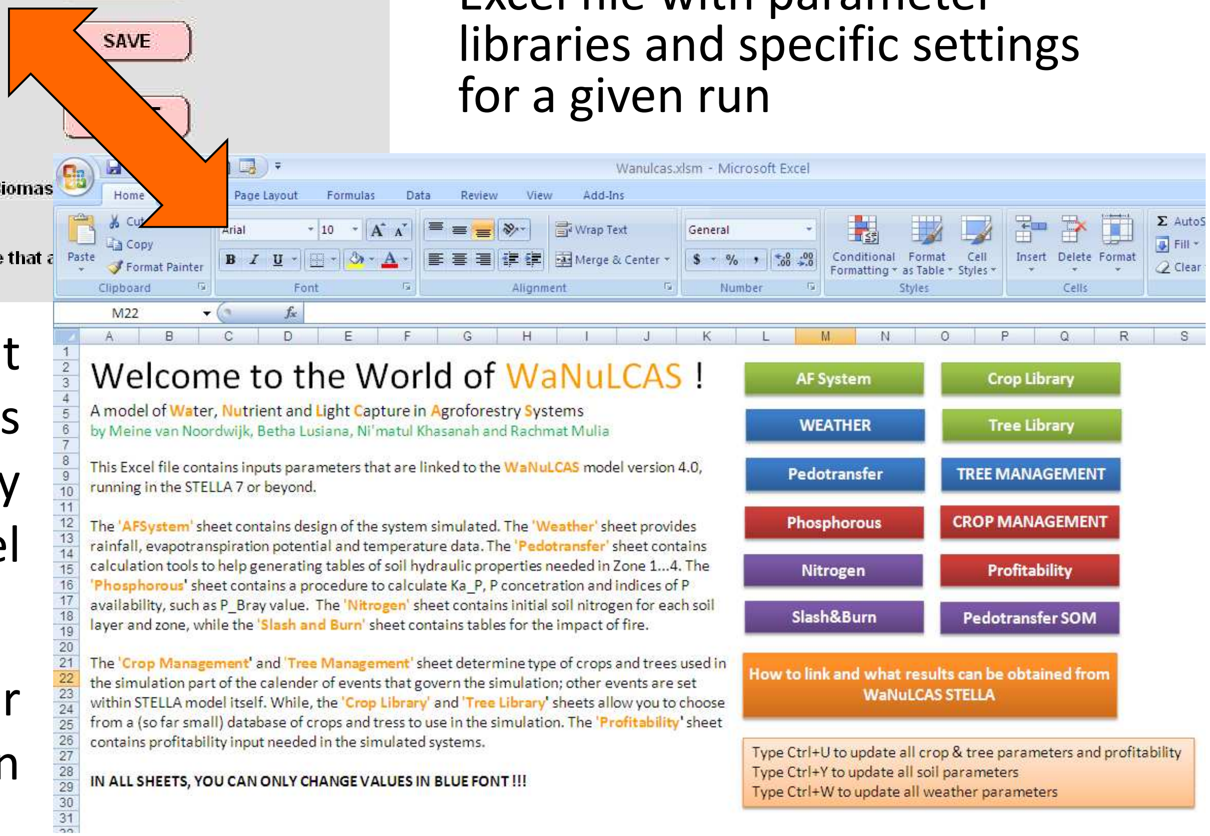
- Pest and Diseases
- Soil Structure Dynamic
- Soil Erosion and Sedimentation

Platform and Interface



STELLA as model development platform: allows non-modellers to easily run, diagramatically trace and modify the model

Excel file with parameter libraries and specific settings for a given run



Dynamic linkage to Excel for input & output manipulation

Outputs and Inputs

Outputs:

- Water, carbon, nutrient (nitrogen and phosphorous), financial and soil balance
- Tree and crop growth and production

Inputs:

Climate, soil characteristic, tree and crop characteristic, and managements

Modeling Steps

- Parameterization (climate, soil, management, tree: *T. grandis* and crop: maize)
- Calibration and validation (tree growth: height and diameter, crop: maize yield)
- Model performance evaluation
- Scenario simulation of management practices

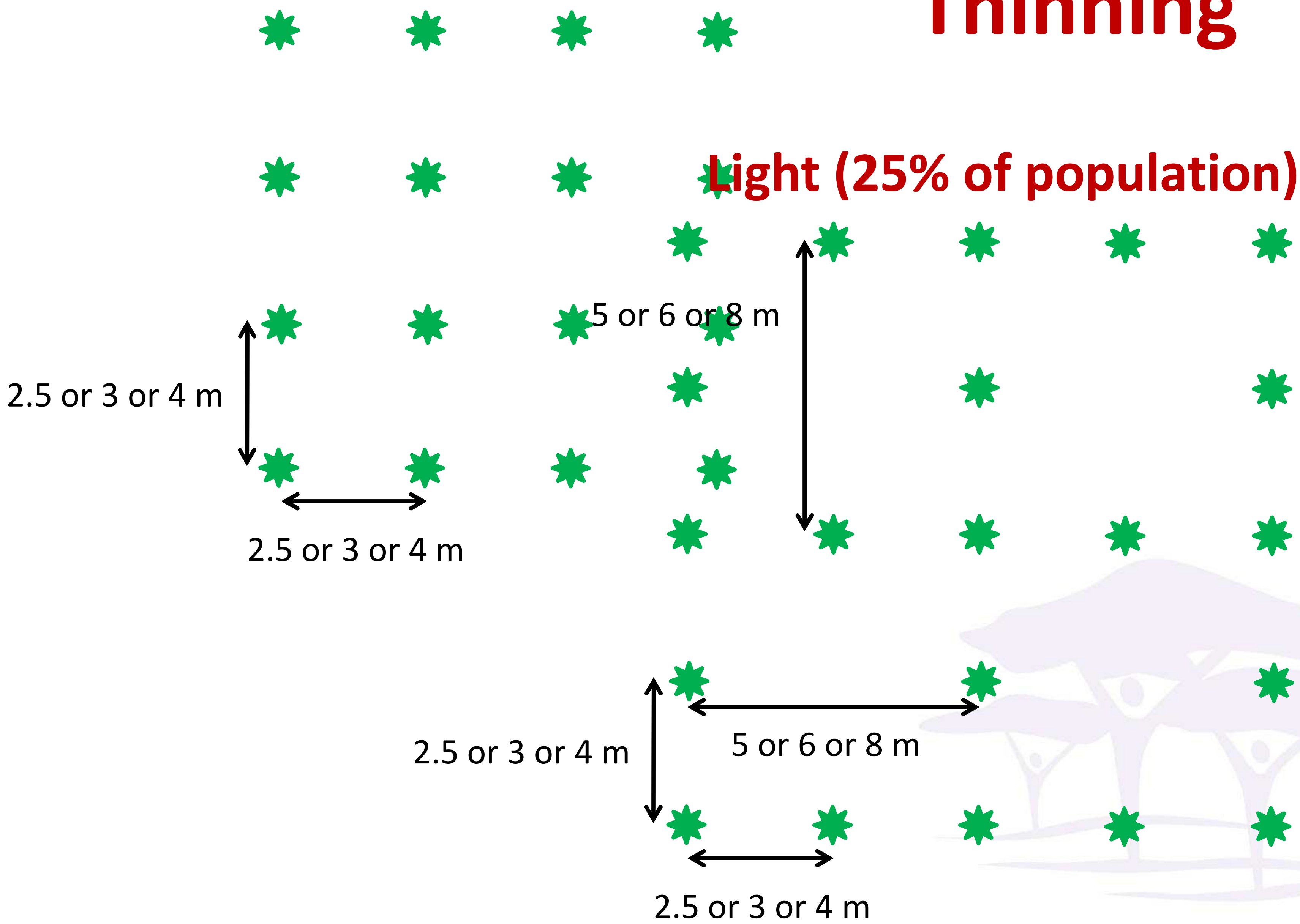
Scenarios

- Teak + maize (two cropping season per year)
  - Initial teak density, trees ha^{-1} (tree spacing, m):
    - 1600 (2.5 x 2.5)
    - 1111 (3 x 3)
    - 625 (4 x 3)
  - Thinning:
    - Light :25% thinned at year 10
    - Medium: 50%, 25% thinned at year 5 and 25% thinned at year 15 or 20
    - Heavy: 75%, 50% thinned at year 5 and 25% thinned at year 15 or 20
  - Pruning: 40% or 60% of canopy, pruned at year 4, 10 and 15
- Maize monoculture: two cropping season per year
- Teak monoculture: without pruning and thinning; allowing weeds to grow; with initial tree density 1200, 800, 400, 833, 556, 278, 469, 313, and 156 trees ha^{-1}

Initial spacing

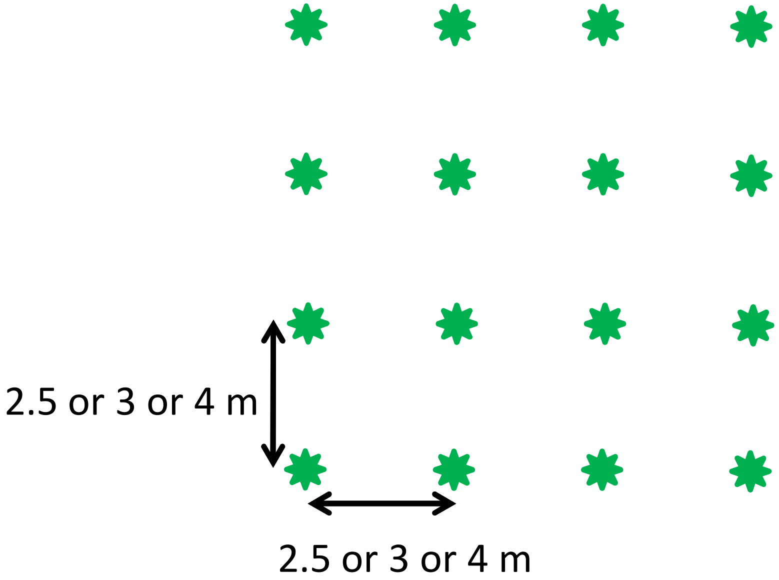
Thinning

Light (25% of population)

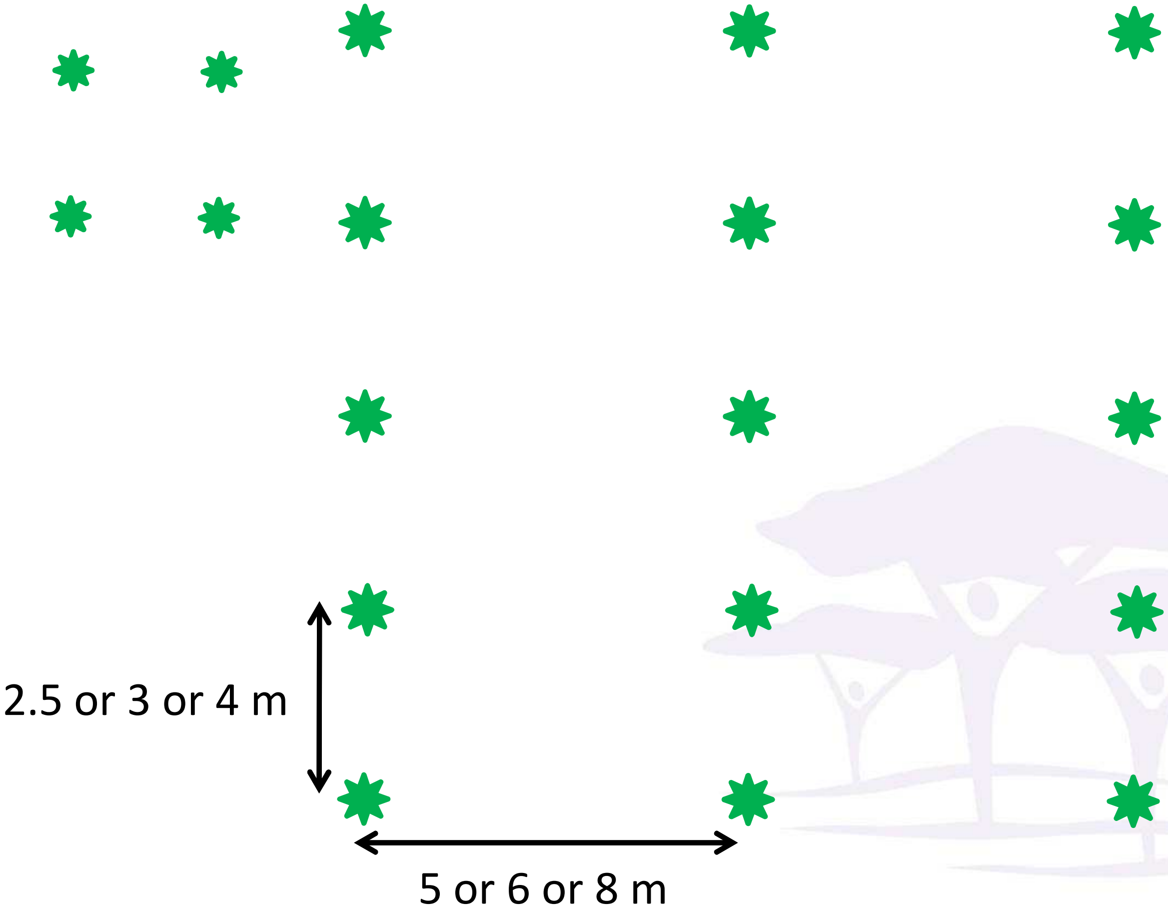


Initial spacing

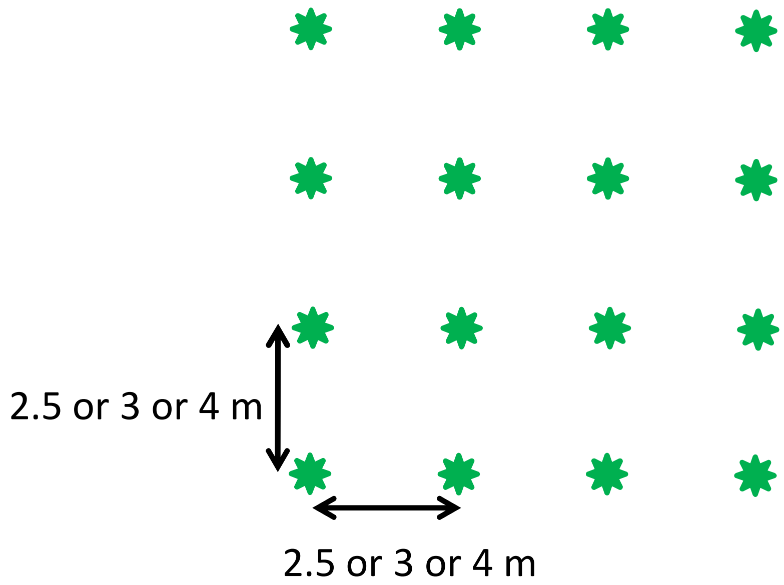
Thinning



Medium (50% of population)

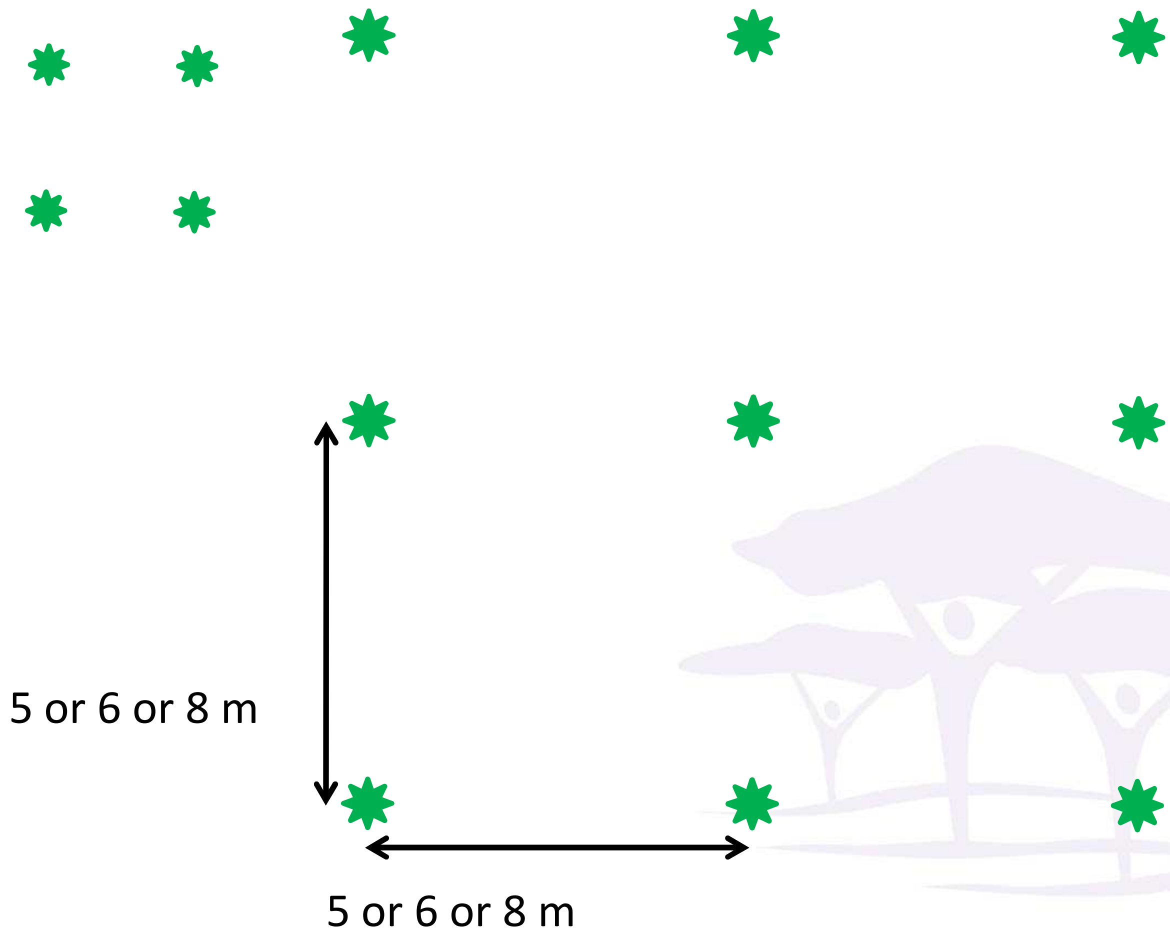


Initial spacing



Thinning

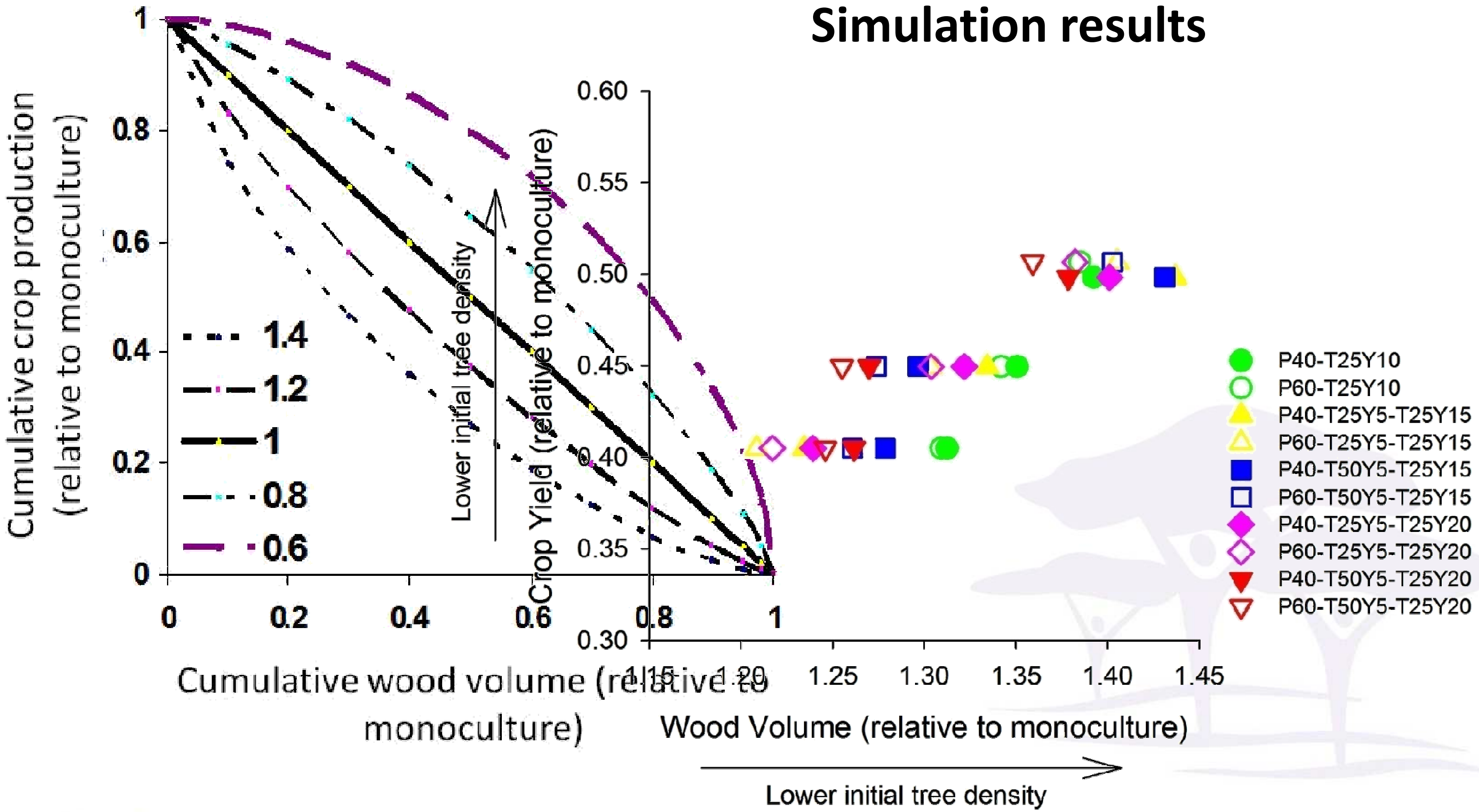
Heavy (75% of population)



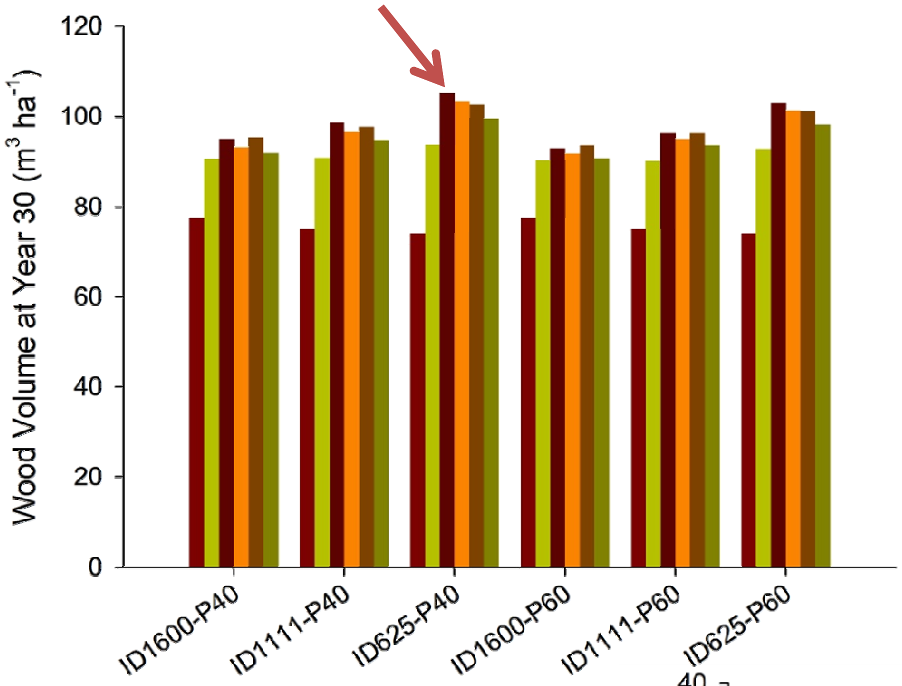
Trade-offs

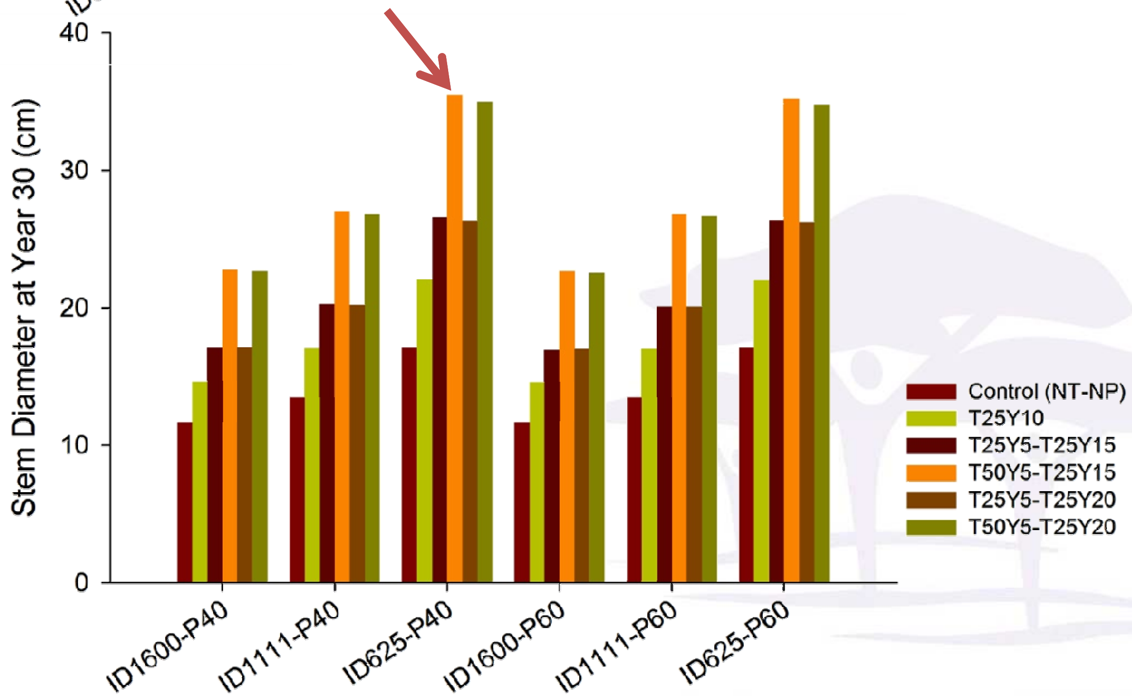
Hypothesis

Simulation results



Wood Volume and Stem Diameter





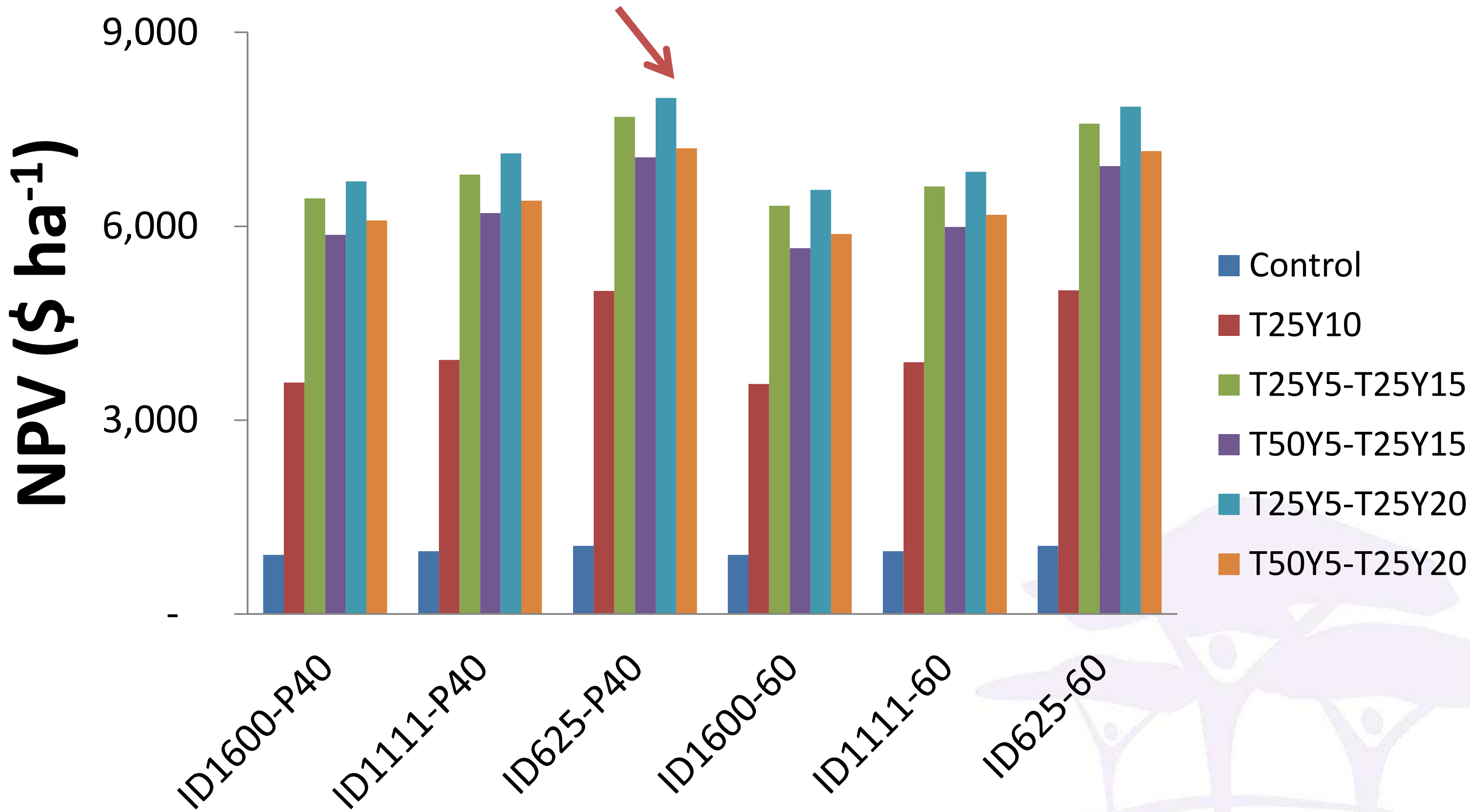
Profitability Analysis



Assumptions

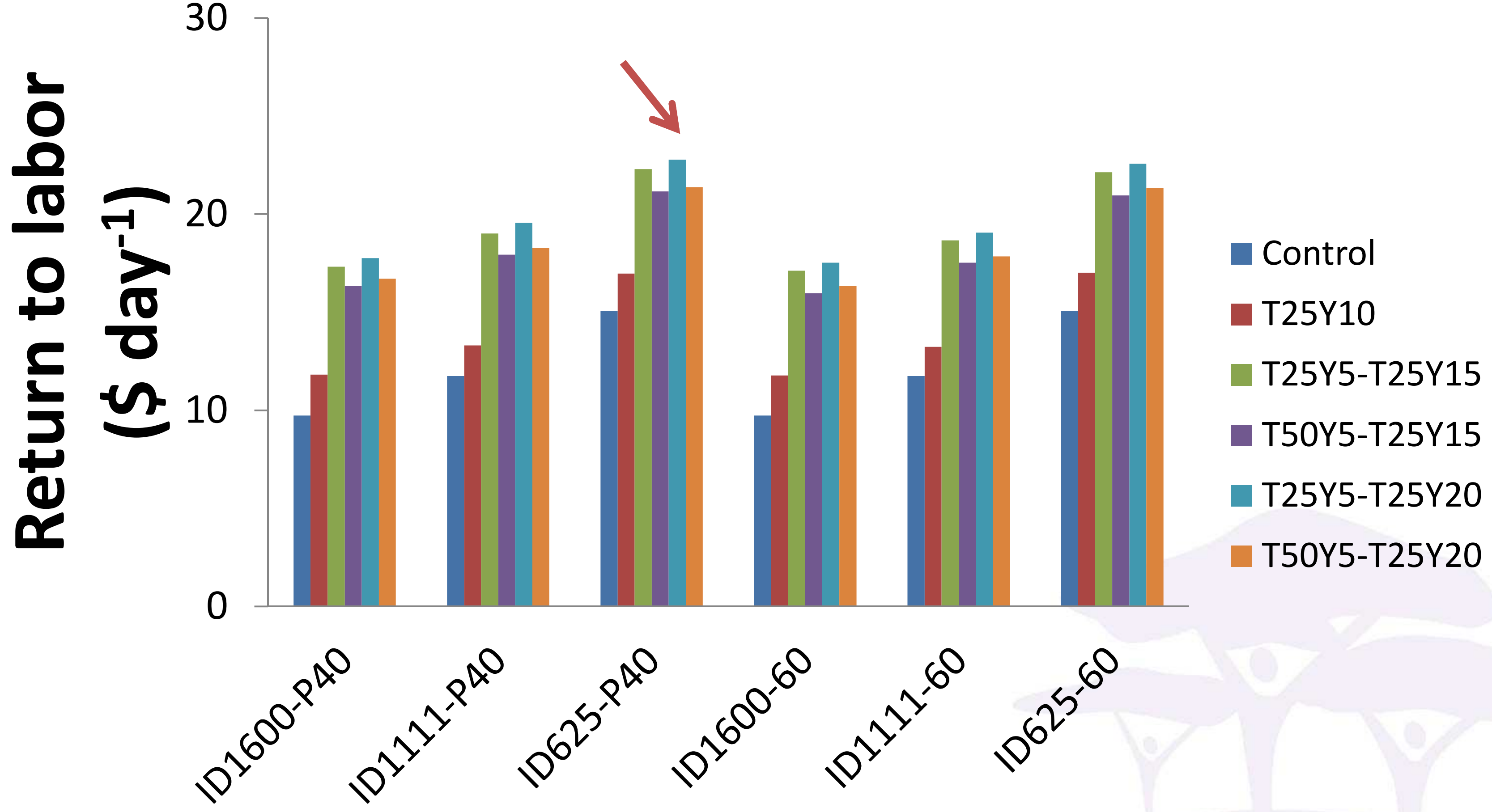
- Interest rate: 8%
- Wage rate: USD 2.75/day
- Teak price: USD 202 per m^3 (2009 prices of Yogyakarta)

NPV ($ ha^{-1})



All scenarios under monoculture system and mixed tree + crop are profitable (NPV> 0)

Return to labor ($ day^{-1})



All scenarios are above daily wage rate (more attractive for farmer to engage)

Conclusion

- Maize intercropping at the early stage of teak growth is clearly advantageous either at low or high teak population density
- Max. wood volume (m^3 ha^{-1}) was provided by the system with initial tree density 625 trees ha^{-1}, 25% of it was thinned at year 5 and another 25% of it was thinned at year 15 and 40% of crown pruned at year 4, 10 and 15
- The highest NPV and return to labour was provided by the system with the second 25% thinning done in year 20 instead of year 15
- Lower costs at initial period is the key components for higher profitability

Thank You

WaNuLCAS model and manual
http://www.worldagroforestrycentre.org/af2/node/193

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