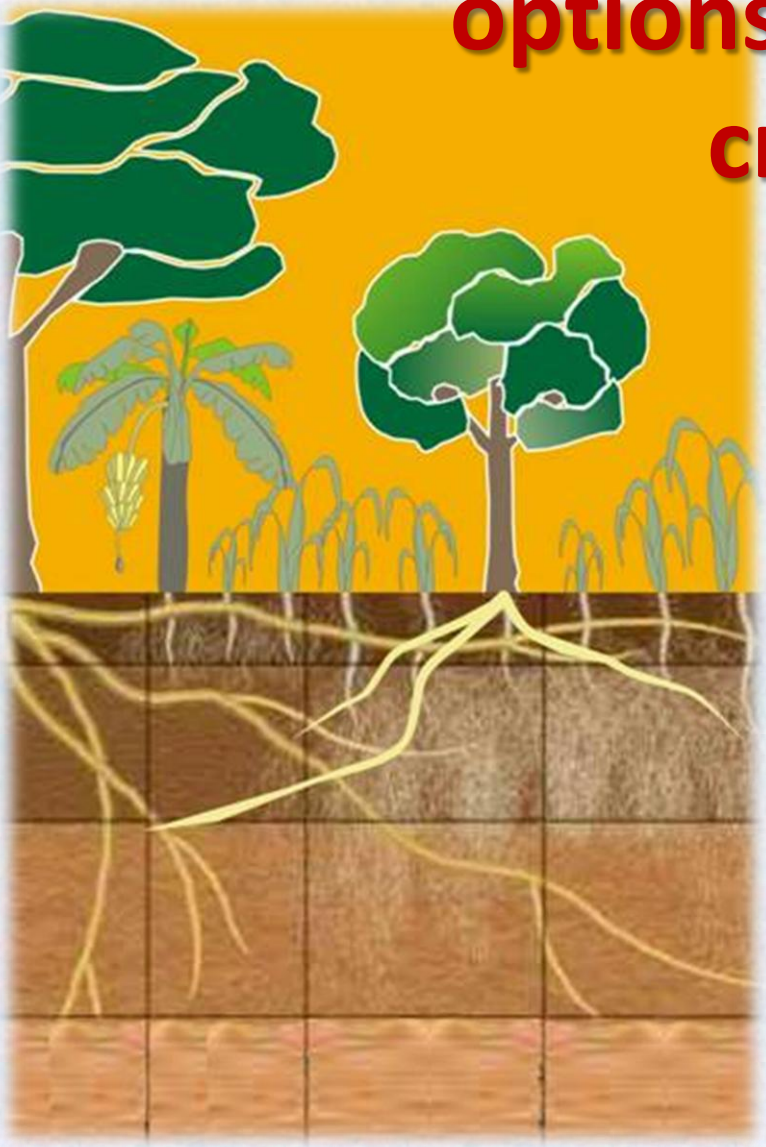
Exploration of tree management options to manipulate tree and crop interaction trade-off



N Khasanah and R Mulia
ICRAF-SEA, Bogor, Indonesia

WaNuLCAS Model Training,
Hanoi - Vietnam
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Agroforestry Systems and Management Options

The complexity of understanding the impact of various farmers' decision on tree-crop systems performance arise from:

1. the vast number of choices,
2. the complex interactions between various choices,
3. time lag between the time decision was taken and its effect on final output and
4. the final outputs are also strongly influenced by site characteristics, weather/climate variability and fluctuating prices of input and outputs.

modelling approach → WaNuLCAS

WaNuLCAS (Water, Nutrient and Light Capture in Agroforestry Systems)

Site characteristics, climate & weather

Strategic Choices: tree species & planting pattern (multi-year)

WaNuLCAS

Tree growth in interaction with crops, weeds soil and climate

Light capture	Water capture	Nutrient capture
Reduce light intensify at crop level	+ Reduce water runoff - Compete for soil water content +/- Hydraulic equilibration	+ Reduce nutrient loss - Compete for soil nutrient
Observations Tree biomass, canopy width & height	*Observations* ▪ Rainfall, runoff, interception ▪ Soil water content ▪ Root distribution	*Observations* ▪ Litter input, ▪ Available N & P stock ▪ Deficiency symptoms

Tactical choices:

(yearly/monthly basis):

- Crop choice & management
- Tree canopy pruning
- Tree root pruning

Options

WaNuLCAS

Tradeoffs

Crop yields
Tree products
Input requirements
Environmental services

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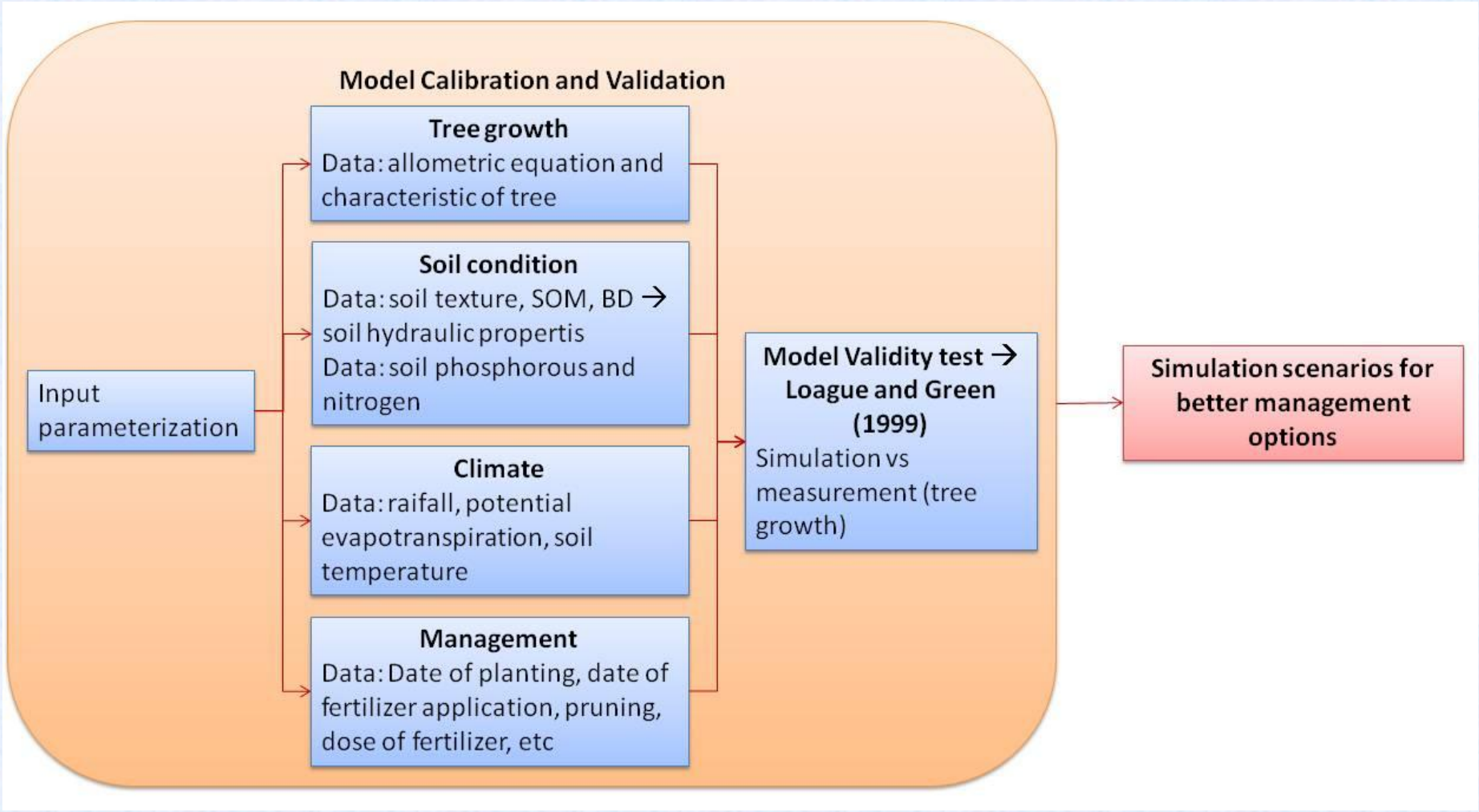
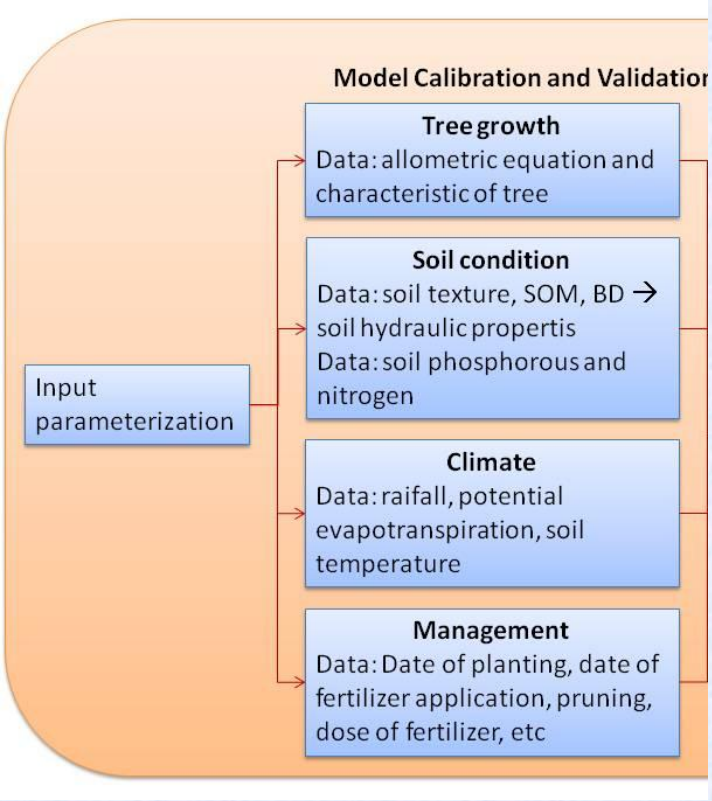
Objectives

- To explore the tactical and strategic decisions of farmers using a tree-crop interactions model WaNuLCAS.
- To find the domains where tradeoffs of the benefit from tree and crop, with some benefits from 'complementarity' of tree – crop interactions.

Work Flow

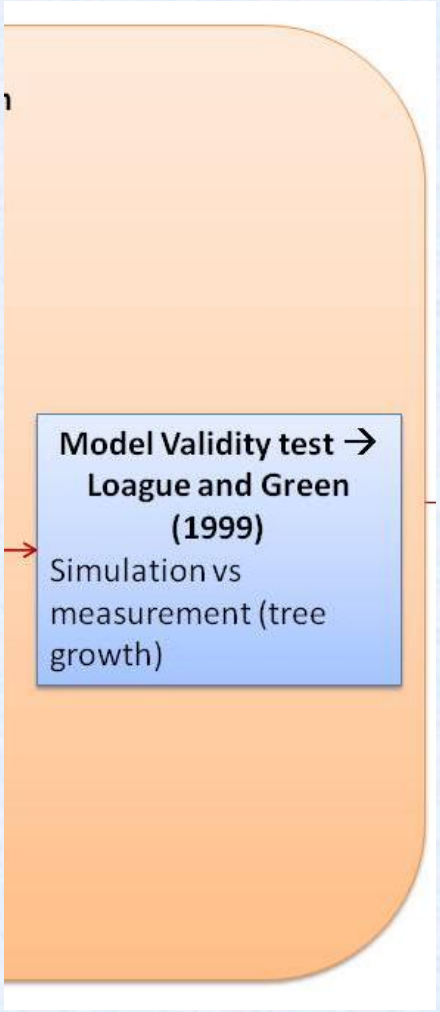

Model Calibration and Validation
Tree growth
Data: allometric equation and characteristic of tree
Soil condition
Data: soil texture, SOM, BD → soil hydraulic propertis
Data: soil phosphorous and nitrogen
Climate
Data: raifall, potential evapotranspiration, soil temperature
Management
Data: Date of planting, date of fertilizer application, pruning, dose of fertilizer, etc
Input parameterization
Model Validity test → Loague and Green (1999)
Simulation vs measurement (tree growth)
Simulation scenarios for better management options

Work Flow



Simulation	Fertilizer (kg ha^{-1})	Tree	Spacing (m)/Tree density (tree ha^{-1})
Cassava monoculture (weed-free)	100 N 60 P	-	0.25 X 0.25
Tree + Cassava (weed-free)	100 N 60 P	Paraserianthes falcataria, Acacia mangium, Swietenia macrophylla	4 x 2 / 1250
		Hevea brasiliensis	6 x 3 / 556

Work Flow

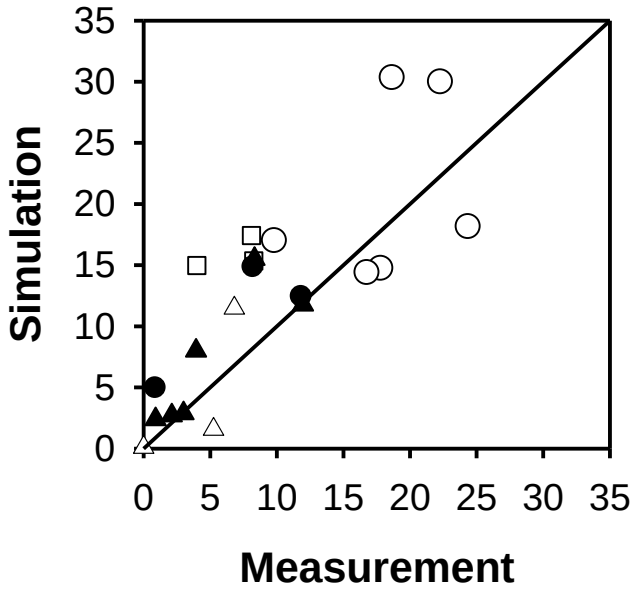


1. Comparison between measurement and simulation:
   - Tree growth: tree height, tree diameter, canopy width, canopy height, tree biomass
   - Cassava yield
2. Model validity test: Loague and Green (1999)

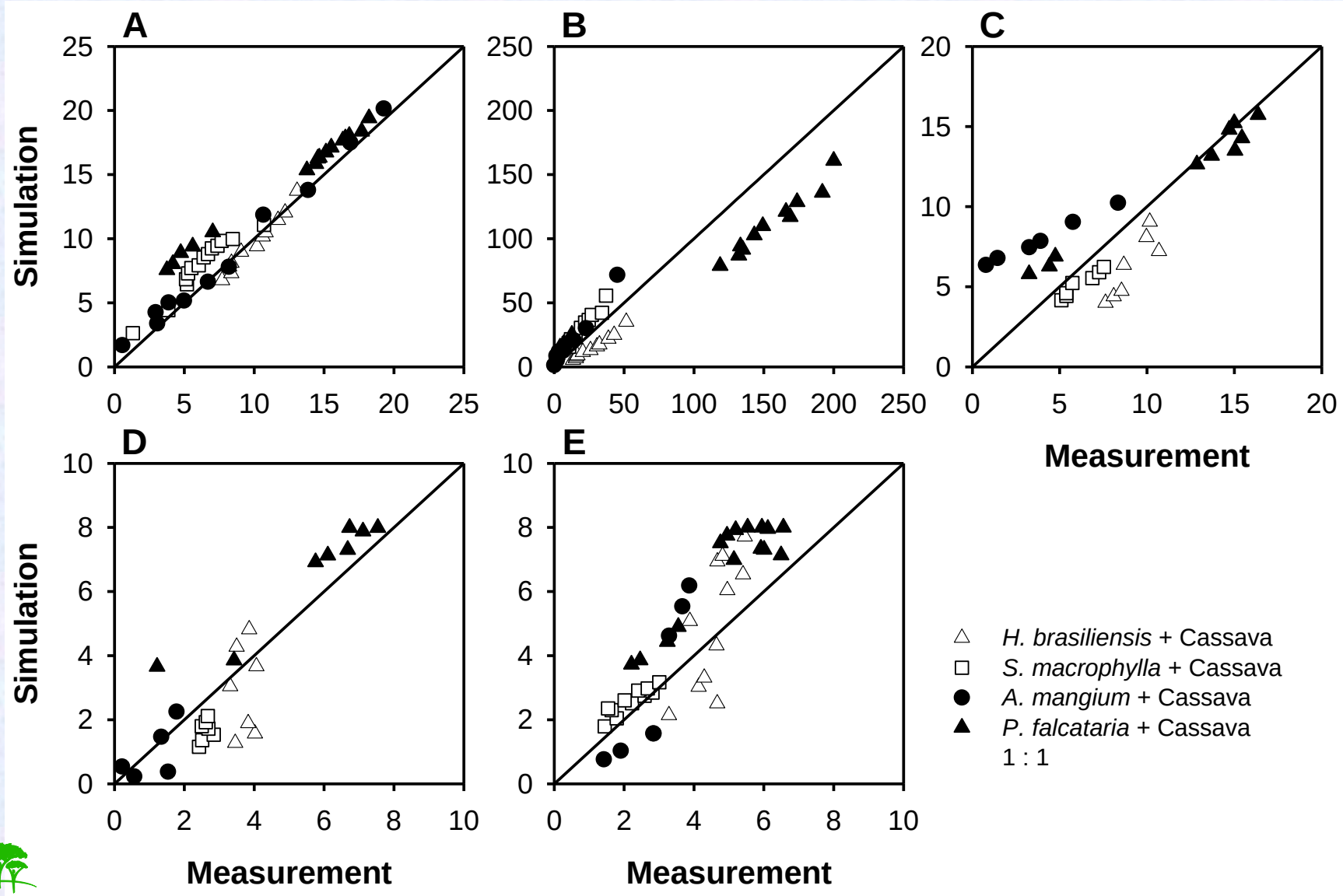
Work Flow

Simulation group	Fertilizer (kg ha^{-1})	Tree	Spacing (m)	Tree density (tree ha^{-1}
Crop monoculture (weed-free)	100 N 60 P	-	0.25 x 0.25	-
Tree monoculture (weed-free)	-	P. falcataria, A. mangium, S. macrophylla	4 x 2, 8 x 2, 10 x 2, 12 x 2, 16 x 2, 3 x 3, 4 x 4, 8 x 4, 8 x 8	1250, 625, 500, 417, 313, 1111, 625, 313, 156
		H. brasiliensis	6 x 3, 9 x 3, 12 x 3, 15 x 3, 6 x 3, 5 x 3, 4 x 4, 6 x 6, 12 x 6	667, 370, 278, 222, 556, 667, 625, 278, 139
Tree +cassava : effect of widening tree row spacing on crop yield	100 N 60 P	P. falcataria, A. mangium, S. macrophylla	4 x 2, 8 x 2, 10 x 2, 12 x 2, 16 x 2	1250, 625, 500, 417, 313
		H. brasiliensis	6 x 3, 9 x 3, 12 x 3, 15 x 3	667, 370, 278, 222
Tree + cassava: alternative spacing designs on tree – crop yield		P. falcataria, A. mangium, S. macrophylla	Narrow 4 x 2 3 x 3, 4 x 4 Wide 8 x 4, 8 x 8	1250, 1111, 625, 313, 156
		H. brasiliensis	Narrow 6 x 3, 5 x 3, 4 x 4 Wide 6 x 6, 12 x 6	556, 667, 625, 278, 139

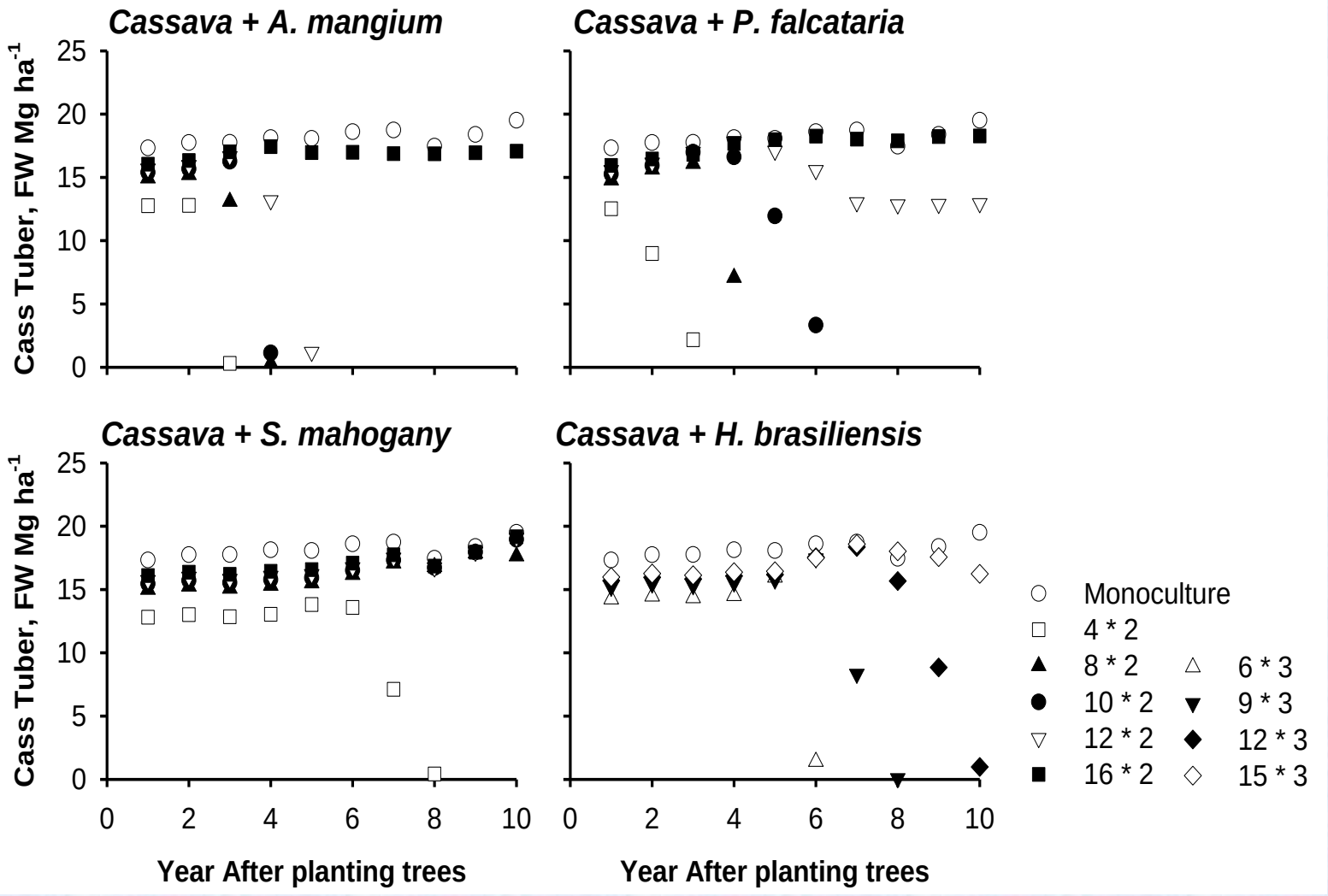
Calibration and Validation



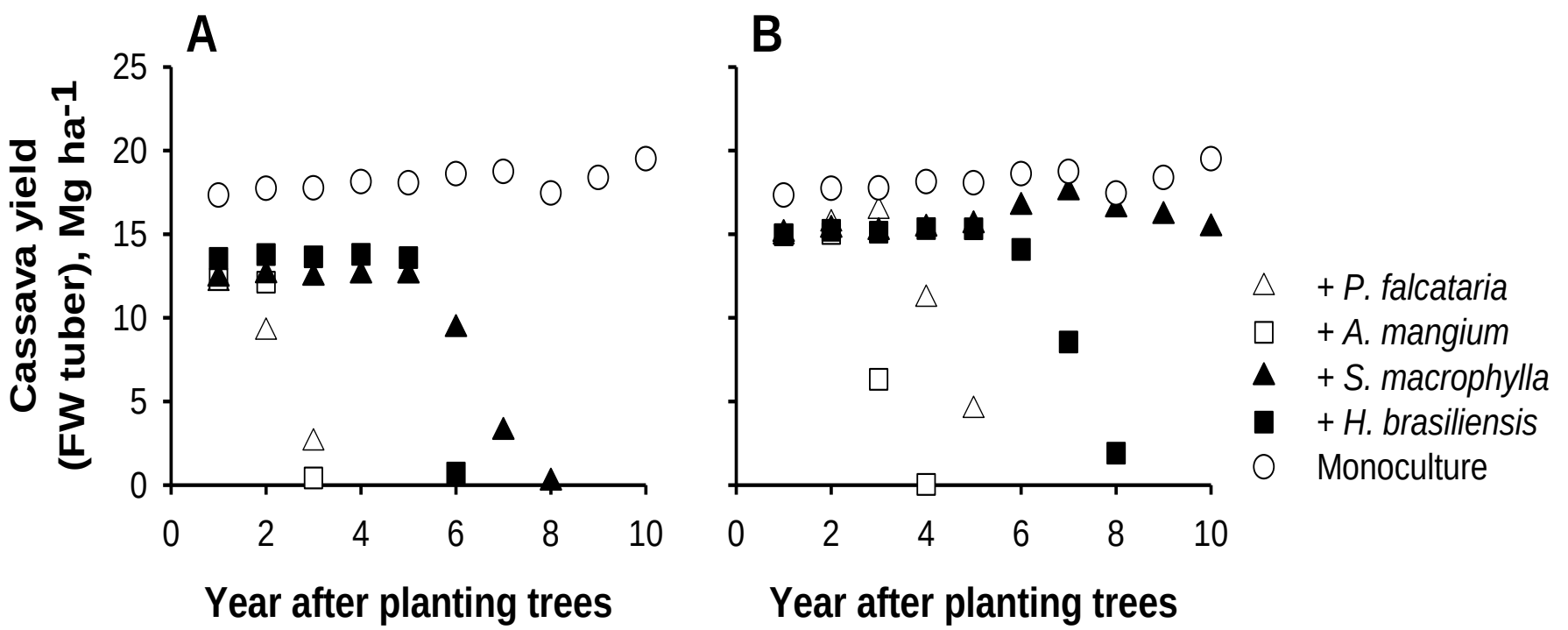
Calibration and Validation



Strategic Decision: Length of Cropping Period

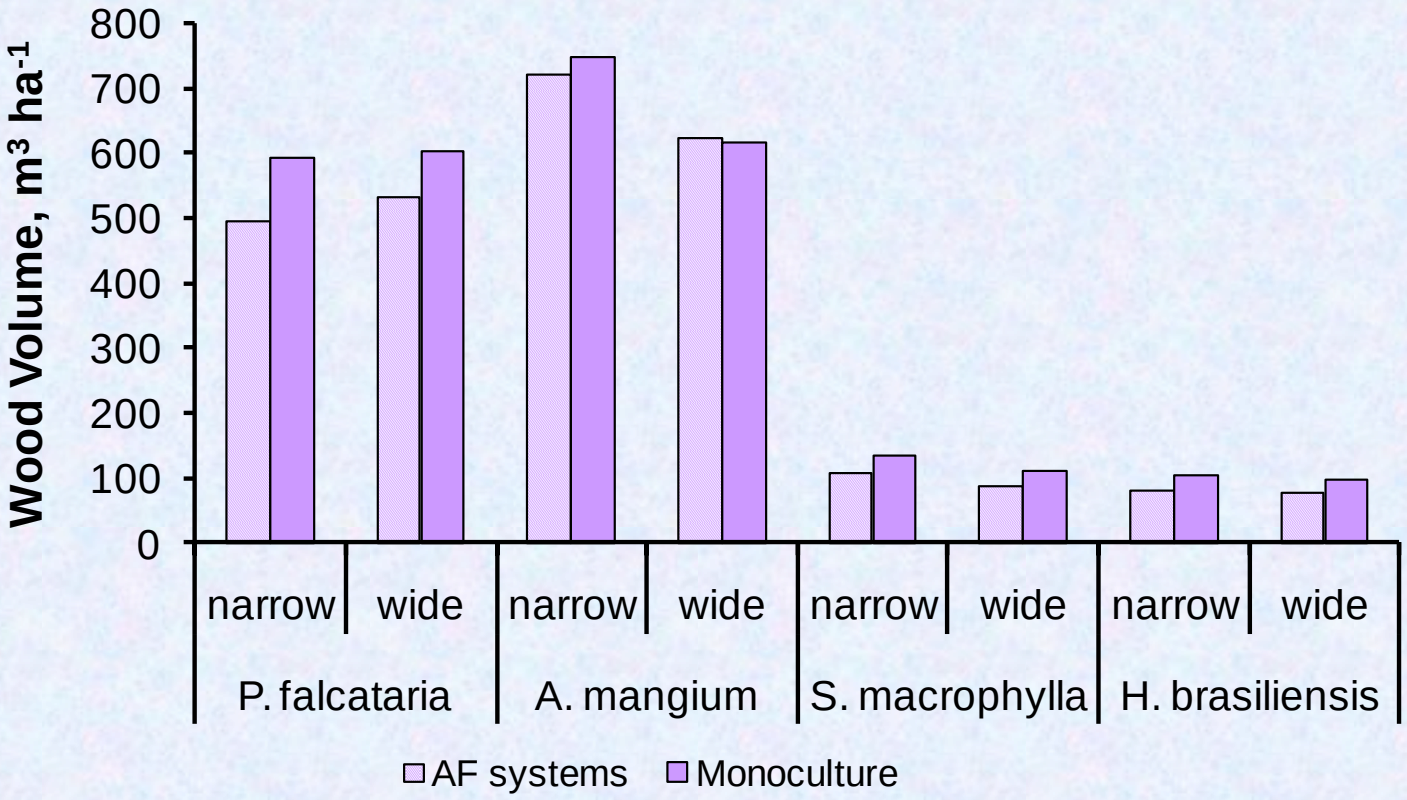


Strategic decision: alternative spacing designs

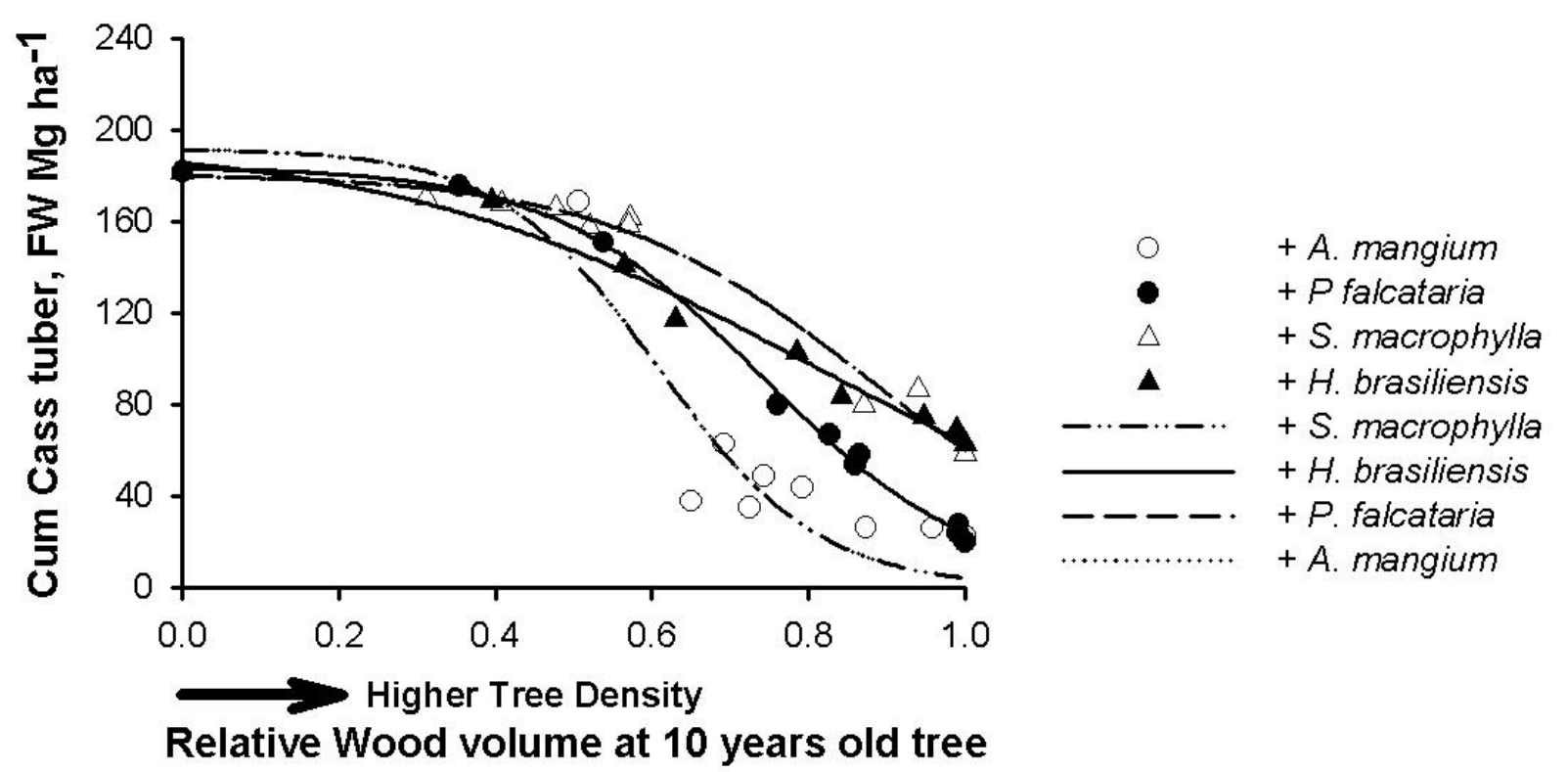


A. Narrow spacing, B. wide spacing

Strategic decision: alternative spacing designs



Trade-off between tree and crop yields



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