

The legacy of three-consecutive rotations of *Acacia mangium* on the productivity of the first rotation of *Eucalyptus pellita* in South Sumatra, Indonesia: Impact of inter-rotation management

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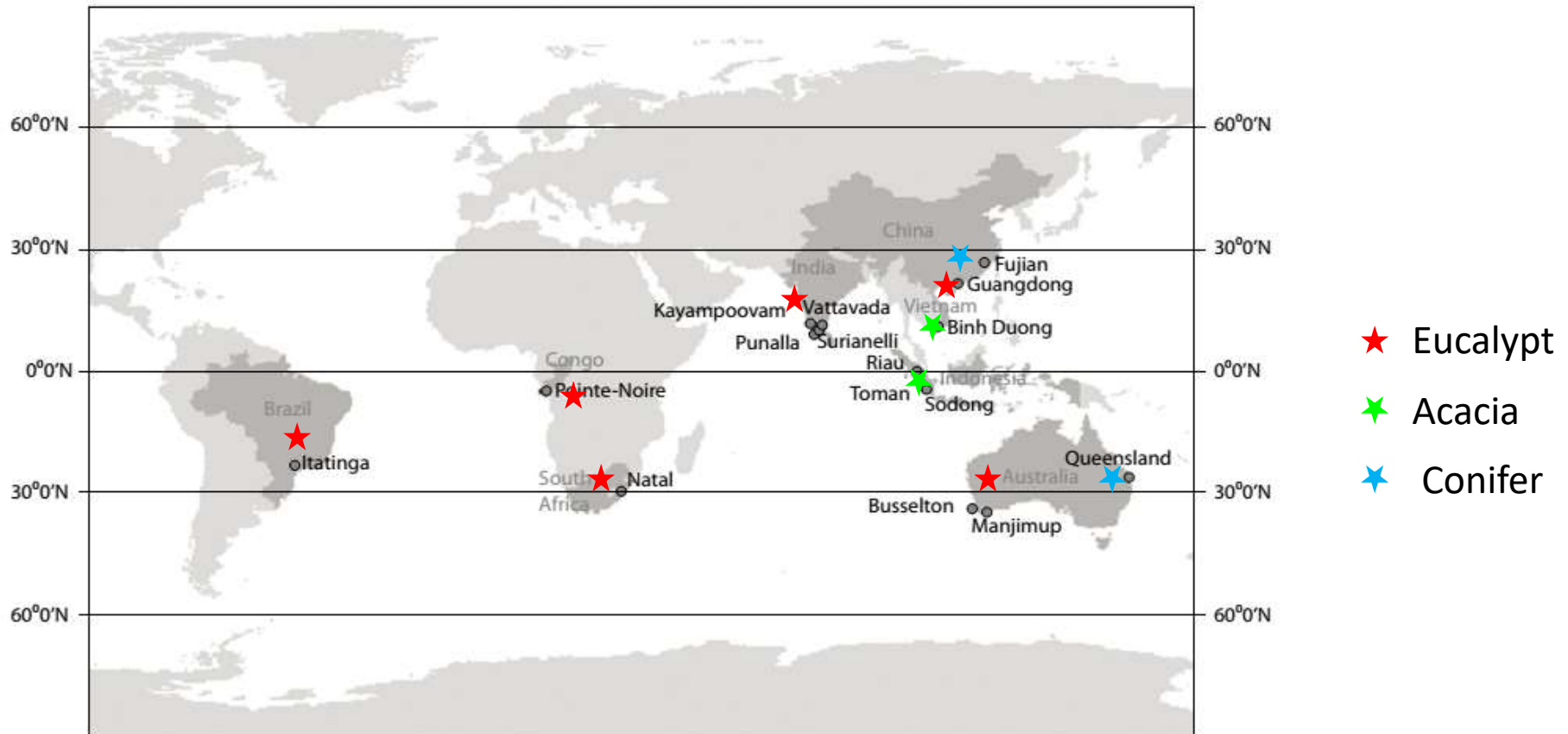


First Rotation of *Acacia mangium*



- Established in early 1990s mostly on grassland dominated by *Imperata* grass which invaded logged-secondary forests
- The previous land units were influenced by shifting cultivation and repeated fires

Network of Site Management Study



- **Started in late 1990s**
- **Coordinated by the Center for International Forestry Research (CIFOR) involving 8 countries in 4 continents (Australia, Indonesia, Vietnam, China, India, S. Africa, Congo and Brazil)**
- **Established at 16 experimental sites: 10 eucalypt, 4 acacia and 2 conifer**
- **At few sites the experiments are continually being managed**

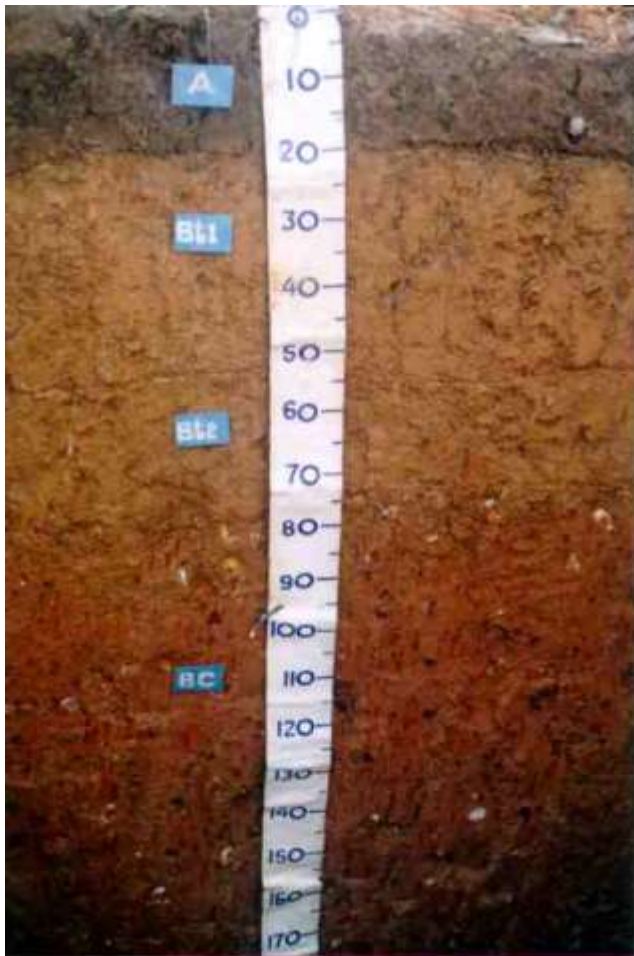
Site Management Study in South Sumatra



Properties	Soil depth (cm)		
	0 - 10	10 - 20	20 - 40
Bulk density (g cm ⁻³)	1.12	1.25	1.33
Sand (%)	9.75	9.75	7.75
Silt (%)	16.75	15.0	25.5
Clay (%)	73.5	75.25	66.75
pH (H ₂ O)	4.08	4.12	4.24
Organic C (%)	3.10	2.61	1.65
N total (%)	0.24	0.211	0.15
Extr. P (mg kg⁻¹)	5.35	3.21	1.39
Exch. K (Cmol kg ⁻¹)	0.08	0.06	0.02
Exch. Ca (Cmol kg ⁻¹)	1.14	0.81	0.63
Exch. Mg (Cmol kg ⁻¹)	0.62	0.51	0.44

Established in 1999 at the end of 1st rotation of *Acacia mangium*

Objectives:



- Evaluate the impacts of site management practices on the productivity of successive rotations of plantations
- Develop management options for maintaining or increasing plantation productivity

Slash and litter treatment

- BL0 = litter and slash removed
- BL1 = whole tree harvest
- BL2 = only stem of commercial size removed
- BL3 = double slash
- BL2+P = BL2 + P fertiliser (40 kg P ha⁻¹) in 3rd and 4th rotation



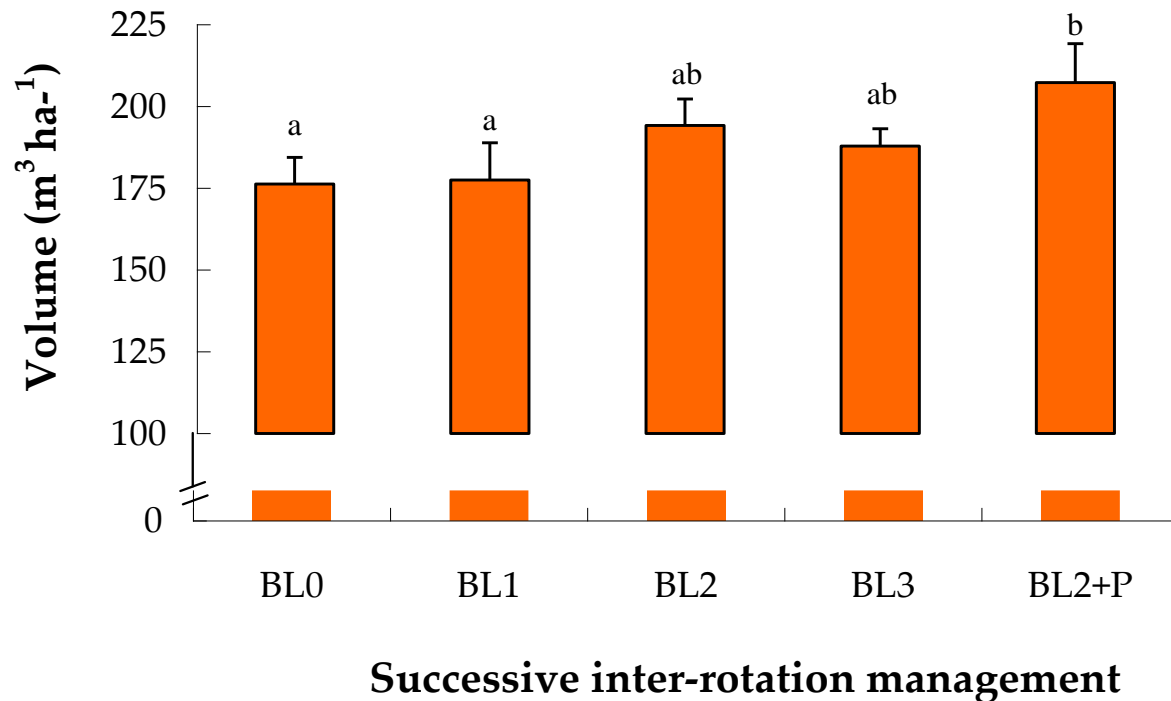
Slash and litter treatment

- The same treatment was repeated in 3rd rotation of *A. mangium*; the experiment was terminated at age 3 years due to severe damage by wilt disease caused by *Ceratocystis* fungi aggravated by monkey attack
- In 4th rotation *A. mangium* was replaced with *Eucalyptus pellita*, the same treatments were repeated as in 3rd rotation

Nutrient content in slash and litter, and soil (0-20 cm) at the end of 3rd rotation of *A. mangium*

Treatment	Biomass (ton ha ⁻¹)	Nutrient (kg ha ⁻¹)				
		N	P	K	Ca	Mg
BL ₀ -Soil	-	4873	3.3	88.9	43.5	23.9
BL ₁ -Slash and litter	2.12	2.2	0.8	26.9	5.5	4.6
-Soil		4830	3.5	96.5	52.3	26.0
BL ₂ -Slash and litter	53.9	13.0	2.0	55.5	26.9	8.6
-Soil		5467	4.2	96.7	61.6	26.7
BL ₃ -Slash and litter	98.8	27.3	2.9	56.0	26.6	8.8
-Soil		5771	4.8	100.8	72.3	27.8
BL _{2+P} -Slash and litter	55.4	13.1	2.5	56.4	27.2	9.3
-Soil		5162	5.7	120.4	78.4	33.5

Legacy effect of three consecutive rotations of *A. mangium* on wood production of 1st rotation of *E. pellita* at age 6 years



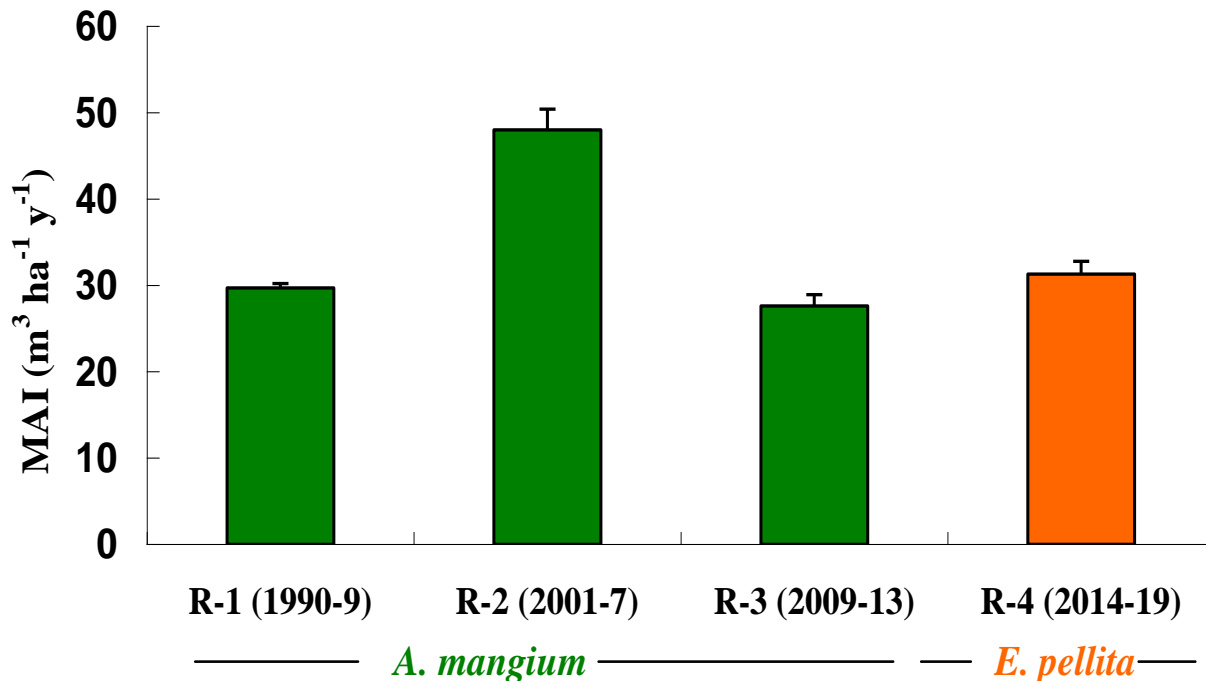
- Slash and litter retention of three successive rotations of *A. mangium* enhanced growth of *E. pellita* even though its effect was modest
- Added P (40 kg P ha⁻¹) had strong response on growth despite a long history of organic matter retention and P fertilisation

Growth parameters of 2nd rotation of *A. mangium* and 1st rotation of *E. pellita* at a common age of 6 yr at the same site

Parameter	<i>Acacia mangium</i>	<i>Eucalyptus pellita</i>
Stocking: Planting/harvest (tree ha ⁻¹)	1111/869	1666/1005
Height (m)	26.4 (0.2)	18.4 (0.3)
Diameter (Dbh, cm)	20.3 (0.9)	13.0 (0.1)
MAI (m ³ ha ⁻¹ y ⁻¹)	50.0 (1.5)	34.9 (0.7)
Commercial wood, diameter >5 cm (m ³ ha ⁻¹)	288.3 (8.8)	178.3 (3.3)
Standing biomass (Mg ha ⁻¹)	171.6 (4.9)	131.9 (3.0)
Mean litterfall (Mg ha ⁻¹ y ⁻¹)	10.0 (0.4)	8.7 (0.4)
Rain during the rotation (mm y ⁻¹)	2570	2848

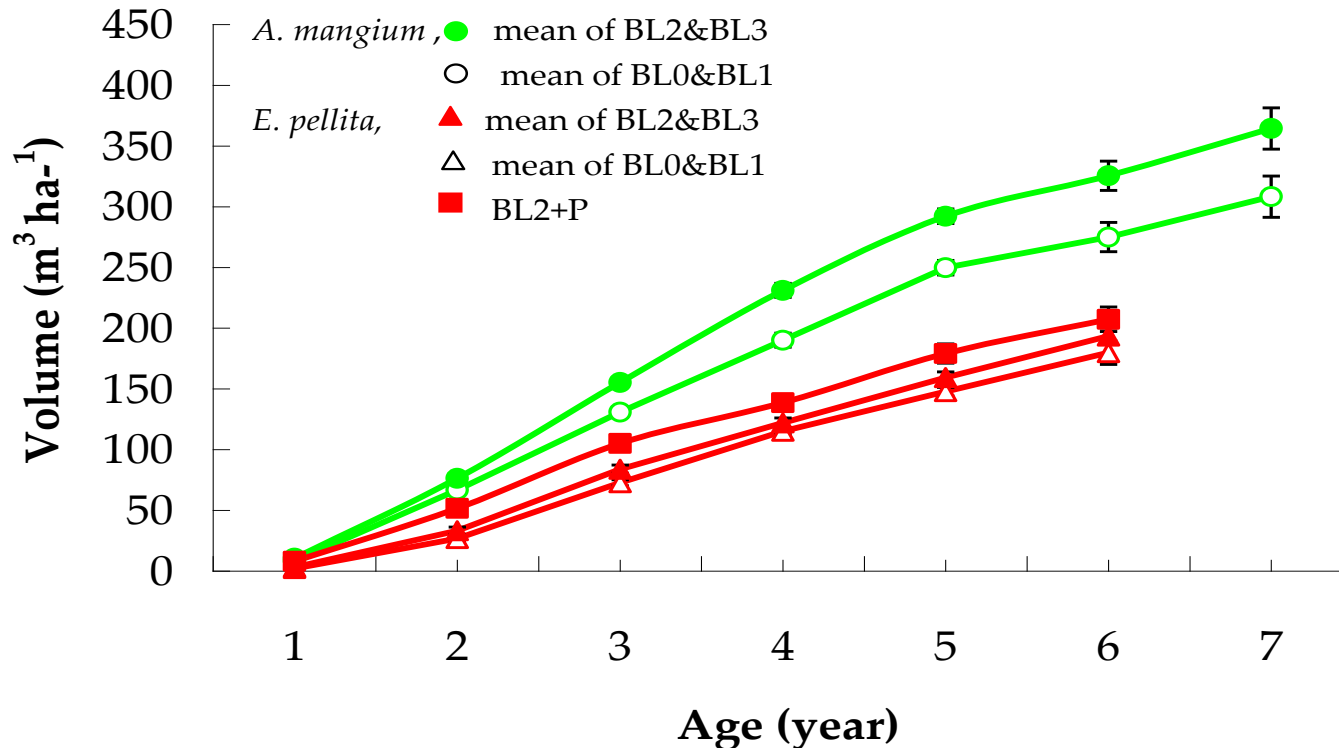
Numbers in parenthesis are SE

Wood production in three successive rotations of *A. mangium* and one rotation of *E. pellita* at the same site



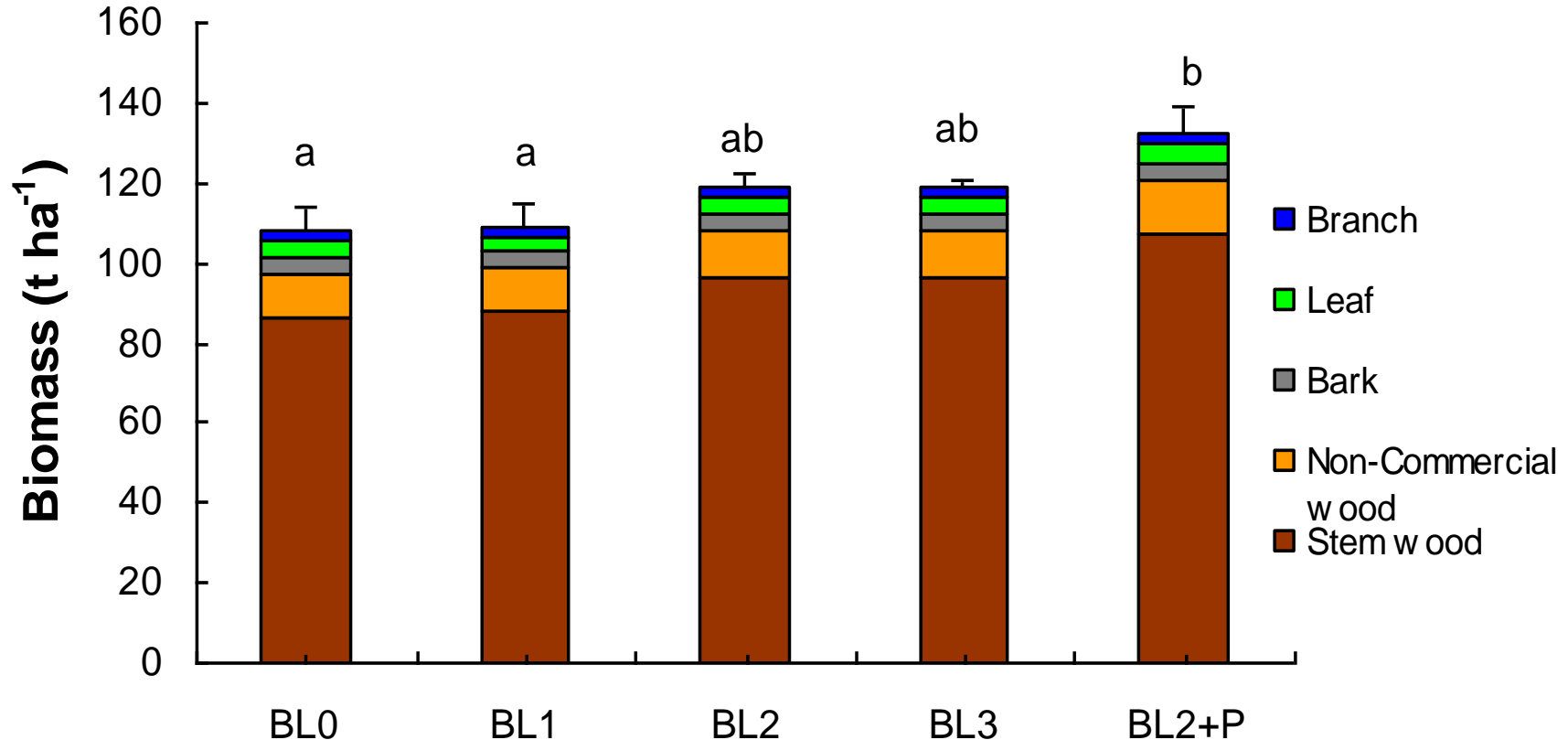
- *A. mangium* had higher productivity than *E. pellita*
- Productivity of 3rd rotation (R3) of *A. mangium* was low ($\sim 29 \text{ m}^3 \text{ha}^{-1} \text{y}^{-1}$), damaged by wilt disease and terminated at age 3 yr, but comparable with that of 2nd rotation at a common age of 3 yr ($\sim 27 \text{ m}^3 \text{ha}^{-1} \text{y}^{-1}$)

Growth response of *A. mangium* and *E. pellita* to inter-rotation site management at the same site



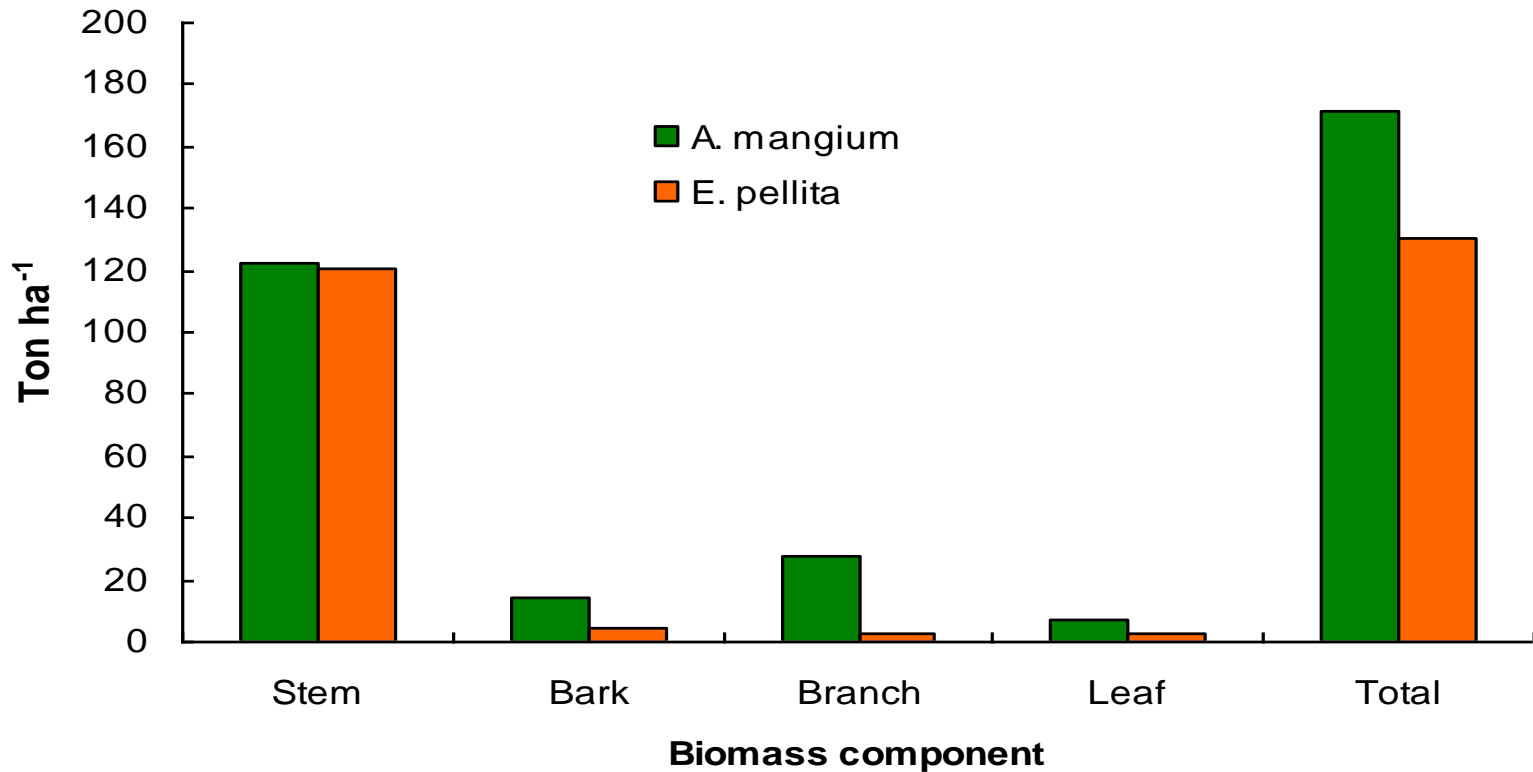
- High slash and litter retention (BL2&BL3) improved productivity of *A. mangium* and *E. pellita*
- Productivity of *E. pellita* was higher if P fertiliser was applied besides conserving slash and litter

Biomass production of 1st rotation of *E. pellita* at age 6 years established at ex-site of three consecutive rotations of *A. mangium*



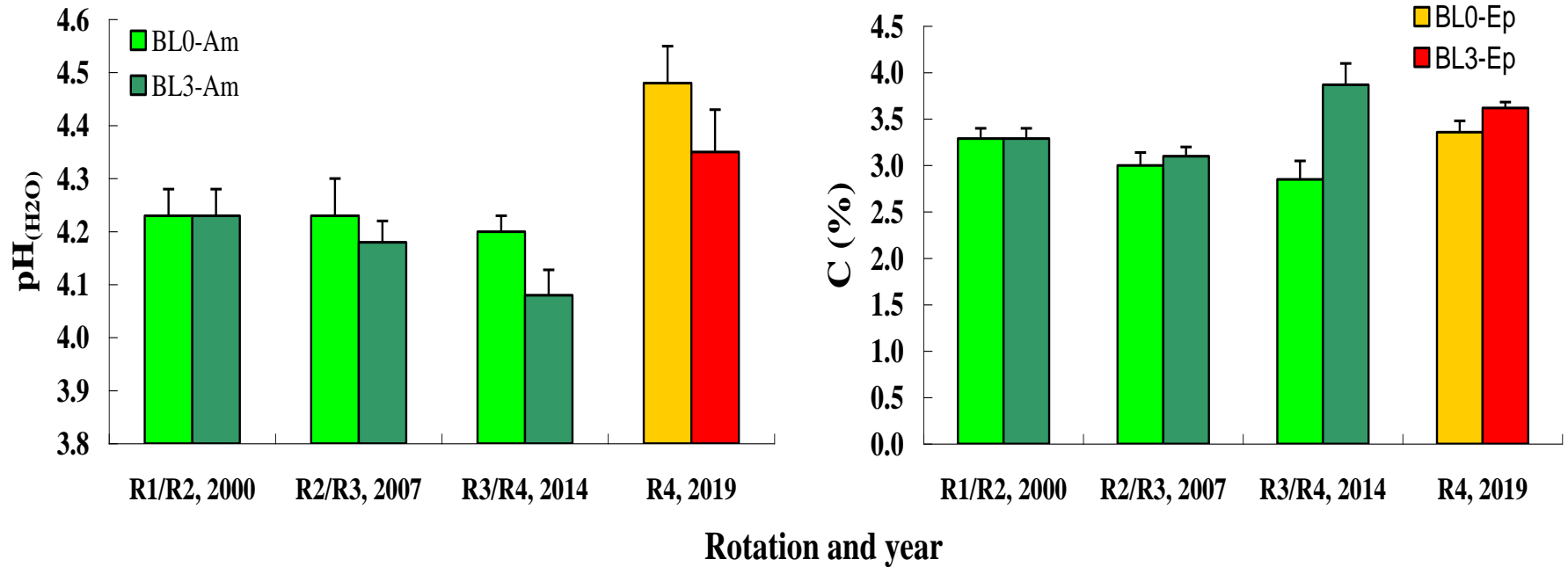
- Retaining slash and litter and added P fertiliser enhanced biomass production

Biomass production of 2nd rotation of *A. mangium* and 1st rotation of *E. pellita* at a common age of 6 yr at the same site



- Total biomass of *E. pellita* was lower than *A. mangium*, but wood biomass of two species was about the same (*E. pellita* had higher wood density than *A. mangium*)

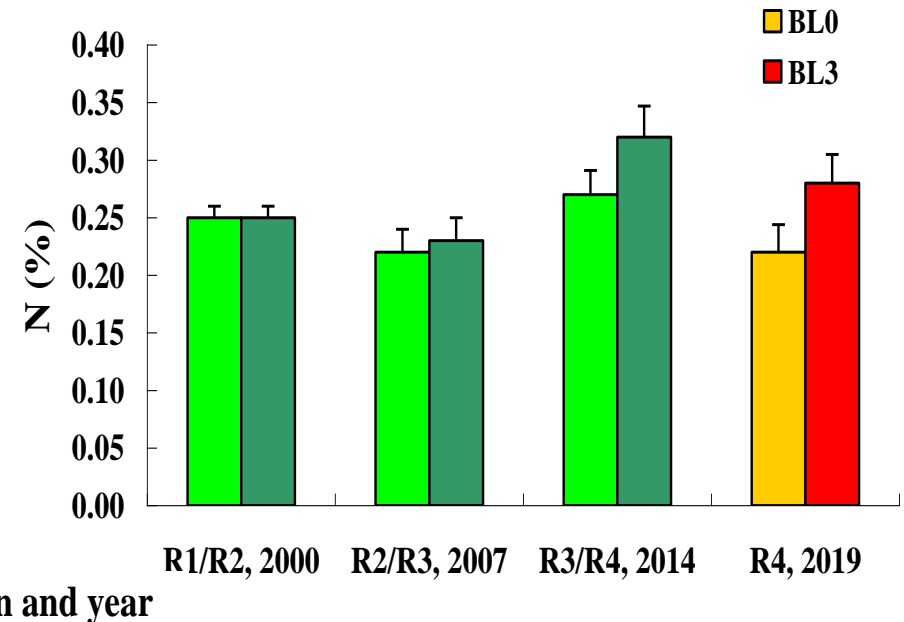
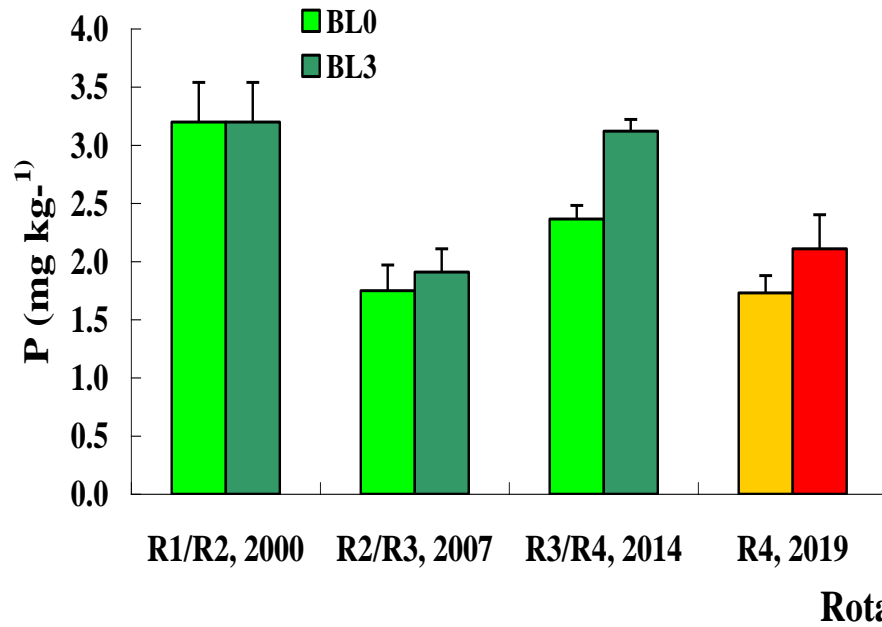
Changes in soil pH and SOC (0-10 cm) across four rotations (~ 20 years)



Am = *Acacia mangium*, Ep = *Eucalyptus pellita*

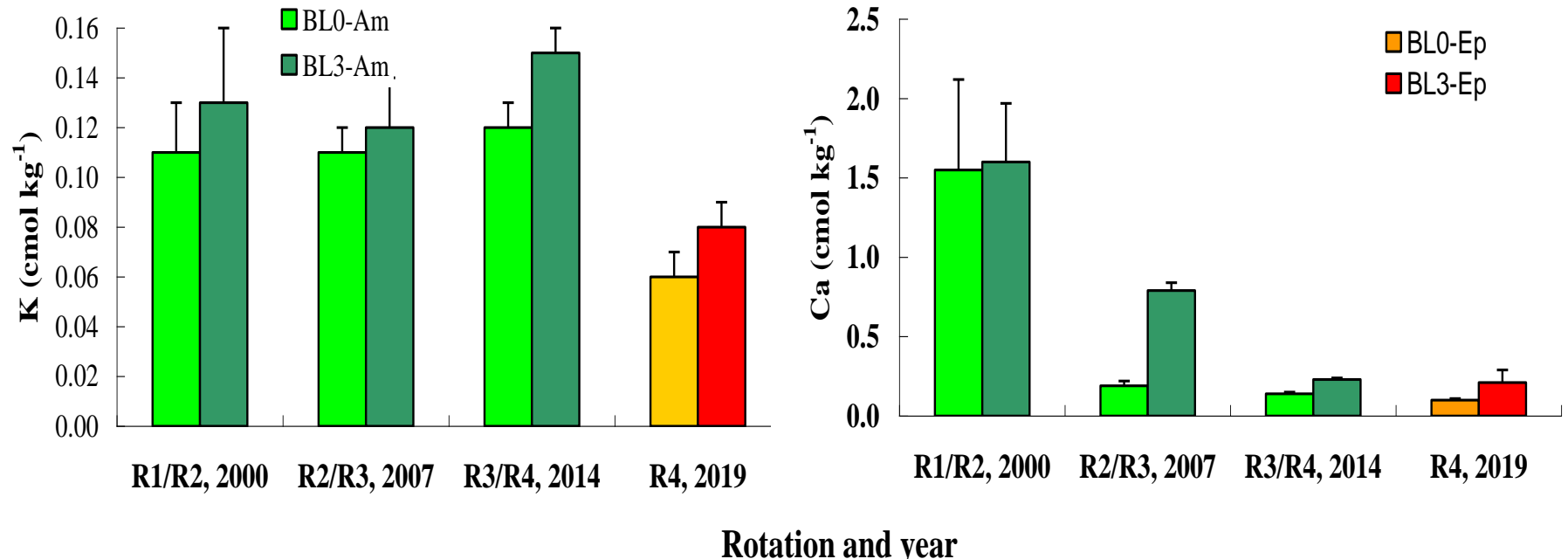
- Soil pH tended to decline slightly from R1 (1st rotation) to R3 (3rd rotation) and then increased (0.12-0.25 units) in R4 (4th rotation)
- Soil organic carbon (C) changed little

Changes in soil N and extractable P (0-10 cm) across four rotations (~ 20 years)



- Extractable P tended to decline, added P fertiliser had strong response on growth of *A. mangium* (R2&R3) and *E. pellita* (R4)
- Total N changed little, added N fertiliser (up to 120 kg N ha⁻¹) had little response on growth of *E. pellita* (R4)

Changes in soil cations (0-10 cm) across four rotations (~ 20 years)



- Exchangeable K and Ca (with large sampling error) declined over time
- K (up to 70 kg ha⁻¹) and Ca (2.5 t ha⁻¹ lime) fertiliser application had little impact on growth of *A. mangium* (R2&R3) and *E. pellita* (R4)

Long Term Sustainability

- Except for extractable P, chemical soil properties are not of immediate concern, local soil has a capacity to support productivity over successive rotations
- Application of P fertiliser at planting time is required to achieve high plantation productivity
- Pest and disease are the chief threat to plantation sustainability
- Changing species from *A. mangium* to *E. pellita* (more resistant to wilt disease) is the best available tool to manage the threat

Long Term Sustainability



- Retention of slash and litter (BL2) have become a common inter-rotation practice in the establishment of *A. mangium* plantation since mid 2000 in the region, it remains relevant for growing *E. pellita*



Acknowledgements



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