



Introduction

Soil erosion is a major problem limiting availability of nitrogen and other nutrients for crops on sloping lands in Southeast Asia. The Integration of timber trees with annual crops in contour hedgerow systems reduces erosion, increases farmers' income and improves environmental services such as water quality and carbon sequestration. This integration is considered a viable option for smallholder farmers in the humid tropics of SE Asia.



Gmelina arborea



Acacia mangium

Objective

Using deep 15N placement to determine from which soil profiles hedgerow trees take up N in relation to the maize crop, and to assess their N contribution to the system.

Materials and Methods

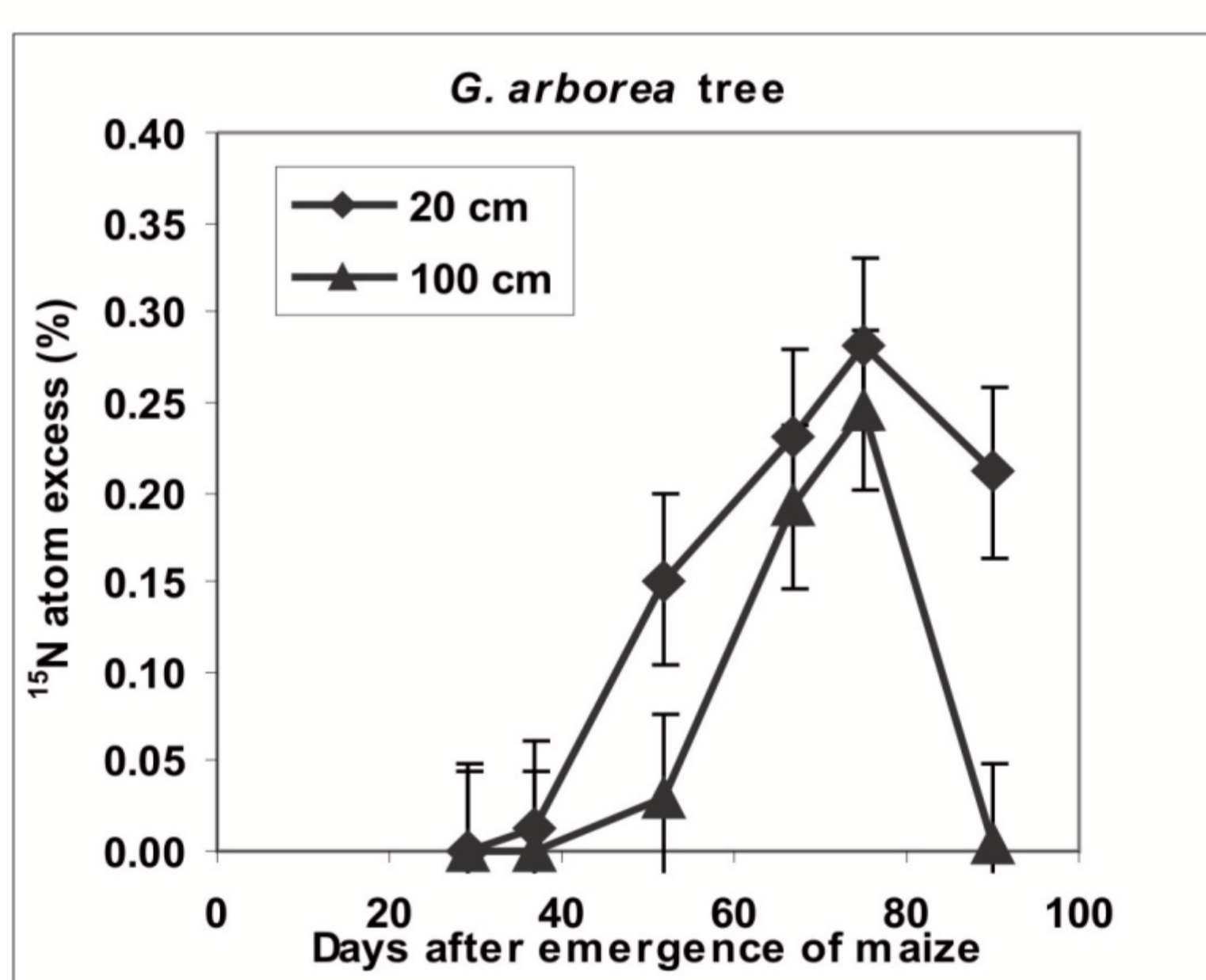
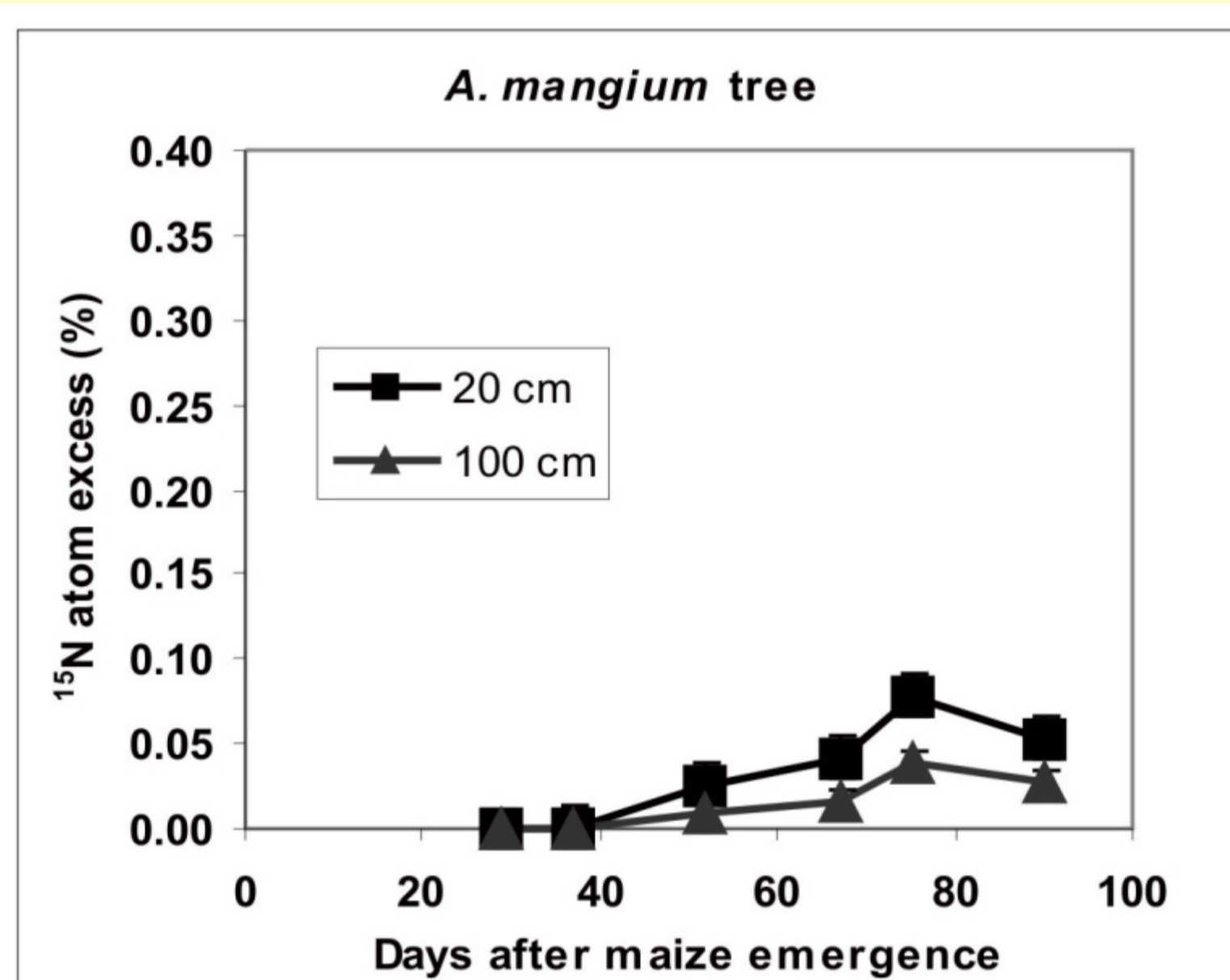
Hedgerow systems of *Acacia mangium* (N₂-fixing) and *Gmelina arborea* (non-N₂-fixing) in association with maize were set up in Claveria, Misamis Oriental, Philippines (8°38' N 124°55' E).

Hedges were 6 m apart and trees spaced at 1 m and 16 months old. The maize crop received 30 kg PK ha⁻¹ and 80 N kg ha⁻¹ (split).

A small quantity of (¹⁵NH₄)₂SO₄ (40 atom %) was injected (split in 3 portions) at 20 and 100 cm soil depth using a pre-installed ceramic porous cup 60-120 cm from hedgerows.

N₂ fixation of *Acacia* was determined using the ¹⁵N natural abundance method.

Results



High temporal ¹⁵N uptake activity in young leaves derived from top and sub-soil in *G. arborea* indicating strong competition for N with associated maize

Higher total ¹⁵N recovery in *A. mangium* from topsoil and safety-net zone (>100 cm) but less N competition for associated maize.

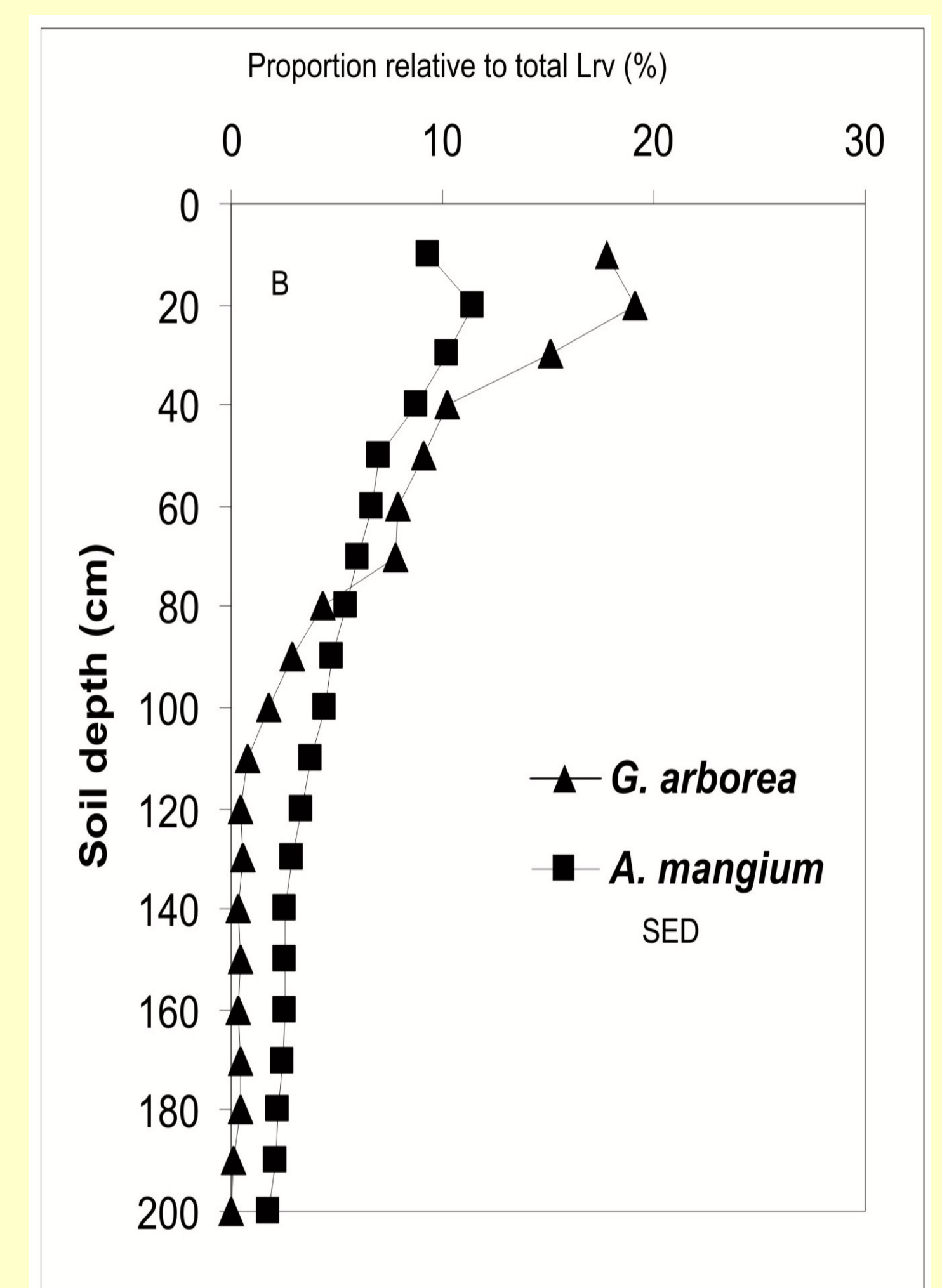
Depth	20 cm		100 cm	
	Acacia	Gmelina	Acacia	Gmelina
¹⁵N recovery (% applied)				
Tree	9.6	5.3	10.4	4.2
Maize	32.0	27.0	0.3	0.9
Total	41.5	32.3	10.8	5.1

Higher amounts of N were recycled in tree based systems through:

- Pruning of lateral branches: *A. mangium* system provided 2x more pruning N compared to the equally fast growing *G. arborea*.
- N uptake from safety-net zone. *A. mangium* derived 58% of its soil N from the safety-net zone (> 100 cm depth).
- Inputs from N₂ fixation: 213 kg N by *A. mangium*
- These inputs counterbalanced the mineral N uptake by *A. mangium* from the upper soil depths, leading to higher

Systems	Plant above-ground	Roots	Pruning	Total	N ₂ fixation	Uptake from soil ^a	Uptake from safety ^b net zone	Offtake (wood or grains)	Net N balance
A. mangium system					N kg ha ⁻¹				
Tree	227	69	46	342	144	198	115	136	111
Maize	239	10	-	249	69	179	2	108	-35
Total	466	79	46	591	213	377	117	244	76
G. arborea system									
Tree	134	27	26	187	-	187	74	78	-4
Maize	175	8	-	183	-	183	6	92	-87
Total	309	35	26	370	0	370	80	170	-91
Monoculture maize	202	12	-	214	0	214	nd	118	-118

a - Uptake including from applied 80 kg N ha⁻¹
b - Safety net zone defined as depth greater than 100 cm



A. mangium had more fine roots (root length density, Lrv) even at lower depths, which provided good opportunities for safety-net and nutrient pumping functions compared to *G. arborea*.

Conclusions

A. mangium was less competitive with maize than *G. arborea*, and was thus more appropriate as a hedgerow species.

Timber hedgerow system is a more sustainable farming option than the conventional maize monocrop system due to the substantial N uptake by trees from lower soil depths regardless of species being used.

The maize in *A. mangium* system benefited with 28% of its N uptake through transfer of fixed N₂, e.g., through the application of lateral branches prunings and root turnover

Plant	d ¹⁵ N	SE	%N derived from N ₂ fixation
Maize			
- Associated with <i>G. arborea</i>	5.0	1.2	
- Associated with <i>A. mangium</i>	3.6	1.8	28
<i>G. arborea</i>	5.3	0.3	
<i>A. mangium</i>	2.7	0.5	42

Acknowledgement and Contact

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