NITROGEN-FIXING TREE HEDGES TO FERTILIZE CROPS ON ACID TROPICAL SOIL

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Agroforestry in Malaysia – disregarded technology in need for re-visiting and re-practicing, more relevant now with 3D (dangerous, dirty, difficult) job sectors re-emphasized. Three decades ago it was practiced extensively by farmers and planters in young plantations particularly immature rubber..

Common practiced by plantation industries

Not seriously practiced

Few failures in forest plantation relates to unexpected maintenance costs, low quality seedlings, error in site-species selection and disease outbreak.

Agroforestry approach may be able to address part of these issues particularly interim income to subset part of the maintenance costs. Of the many agroforestry approaches: we select hedgerow planting with tree having ability to fix nitrogen.

For the present event, we presented research output on the performance of the six nitrogen fixing trees intended to use as hedge as well as green fertilizer.

Six hedgerow species screened:

- *Gliricidia sepium*
- *Parkia speciose*
- *Azadirachta excels*
- *Paraserianthers falcataria*
- *Acacia mangium*
- *Leucaena leucocephala*

STUDY SITE & RESEARCH APPROACH

Site parameters:

- Humidity (avg.): 88.3% – 93.4%
- Mean max temperature: 34.7°C – 35.8°C
- Mean min temperature: 20.1°C – 20.4°C
- Rainfall (avg.): 2100 mm
- Soil: Bungor series (Typic paleudult)
- Chemical properties: pH 4.65; OC 1.48%; Bray-1 P 4.39 mg/kg; total N 0.6 g/kg; CEC 8.3 $cmol_c$/kg; exch. K 0.17 $cmol_c$/kg.

Experiment 1:

- Screening for hedgerow woody trees.
- Plot size: 10m x 10m; Trench: inner 6m x 6m, ^{15}N applied on seedling within trench.
- Trench lining: Plastic sheet till 1m depth
- Reference trees for BNF measurement: *Hopea odorata & Khaya ivorensis*
- Seedling planting: Random within plots
- Data: Growth at 4, 6, 12 & 30 MAP
- Biomass: Destructive sampling of each species at 30 months after planting

Experiment 2:

Using *G. sepium* as hedgerow tree and sweet corn as cash crop. Treatments:

T1 - Control without hedgerows
T2 - Control with hedgerows
T3 - Leaf pruning with hedgerows
T4 - Leaf pruning without hedgerows
T5 - Roots without hedgerows
T6 - Roots with hedgerows
T7 - Leaf pruning + roots without hedgerows
T8 - Leaf pruning + roots with hedgerows

RESULTS & DISCUSSION

Table 1. Biomass fraction, nitrogen yield and biological nitrogen fixation of potential hedgerow trees at 30 m-old

Species	Tree Biomass (g/tree)		Nitrogen Yield (g/tree)		N from fixation (g/tree)	
	Leaves	Stem	Leaves	Stem	Leaves	Stem
P. falcataria	4,073 a	61,043 a	138.6 a	423.1 a	122.3 a	196.0 a
L. leucocephala	175 c	2,554 c	7.2 d	26.3 c	4.7 c	6.9 c
G. sepium	200 c	3,281 c	8.4 d	34.2 c	1.6 c	0.0 d
A. mangium	2,389 b	18.247 b	75.7 b	118.8 b	62.1 b	59.1 b
A. excelsa	832 c	2,168 c	25.6 c	13.9 c	7.2 c	1.7 d
P. speciosa	Not harvested due to very low biomass				-	-

From the six N fixing tree species evaluated, *P. falcataria* was the fastest growing and also the highest N fixer (Table 1). *Acacia mangium* gave the second best performance for the growth and N fixation. The least performed species is *P. speciosa*, generating very low biomass particularly leaves that we decided not to sampled it. Perhaps macro-environment at the study site was not favourable for this species.

The nitrogen fixing ability over intervals of 30 months for the six species is tabulated in Table 2. *Paraserianthes falcataria* is a champion species at 4 and 6 month-old but upon reaching 30 month-old, *A. mangium* became equal being at par with *P. falcataria*. *Leucaena leucocephala* showed equal performance to *G. sepium* until 6 month-old but at 30 month-old fixed significantly higher N than the latter species. It was clear that P. *speciosa* thrived at the beginning and able to fix 10% atmospheric N but later seems to halt growing.

Table 2. Percentage of N_2 fixed at different ages

Tree species	4 month-old	6 month-old	30 month-old
P. falcataria	43.39 a	86.04 a	87.92 a
L. leucocephala	20.04 b	64.64 b	59.38 b
G. sepium	25.21 b	71.03 b	20.05 c
A. mangium	27.89 b	63.24 b	82.26 a
A. excelsa	22.31 b	22.59 c	26.48 c
P. speciosa	10.12 c	0.00 d	0.00 d

The use of N fixing tree hedges as green fertilizer for crop (corn) growth resulted in variable performance depending on the combination of biomass applied (Table 3). For the first crop, root biomass in combination of leaf pruning and hedgerow of N fixing tree (T8) give the highest corn biomass yield. Whilst for the second crop, combination of roots with hedgerow of N fixing trees produced the highest yield. Interestingly, more N uptake from N fixing tree hedge was recorded for second crop indicating significant residual effect of green fertilizing with N fixing tree biomass.

G. sepium planted as hedgerow tree and sweet corn as cash crop.

- Hedgerows – *G. sepium* planted on the edge of the plots.
- $^{15}(NH_4)_2SO_4$ of 10% a.e. at 40kg applied to 7 plants in the center row.
- Plots with root biomass – *G. sepium* planted all over giving 20 plants/plot, later the above-ground biomass was removed & stumps smeared with weedicide mixture prior to planting of corn.
- Hedgerow trees were cut to 1m for pruning application
- Nutrient content (pruned biomass): 4.21% N, 0.16% P, 2.65% K, 2.3% polyphenol, 12.1% lignin. Basal P and K fertilizers applied.

Table 3. Nitrogen uptake by sweet corn with variable green hedgerow pruning input

Treatment	Dry weight (kg/ha)	N conc. (%)	N yield (kg/ha)	^{15}N a.e. (%)	Ndf_GS (%)
Crop 1: T1	2412 c	1.49 ab	36.0 c	1.982 abc	0.00 c
T2	2745 abc	1.45 ab	39.7 bc	1.662 cd	16.99 b
T3	2574 bc	1.64 a	42.2 abc	1.834 bcd	7.47 b
T4	3716 ab	1.48 ab	55.1 ab	2.610 a	0.00 c
T5	2629 abc	1.30 b	34.2 c	1.261 d	36.38 a
T6	2795 abc	1.54 a	43.1 abc	2.576 a	0.00 c
T7	2070 c	1.39 b	28.8 c	2.463 ab	0.00 c
T8	3867 a	1.54 a	59.5 a	1.778 cd	10.29 b
Crop 2: T1	1039 b	1.57 b	17.0 b	4.008 ab	0.00 c
T2	1251 ab	1.85 a	23.6 ab	2.565 c	36.02 a
T3	2148 a	1.73 ab	32.4 ab	4.416 a	2.38 c
T4	1381 ab	1.66 ab	23.3 ab	3.627 abc	9.56 bc
T5	1623 ab	1.76 ab	29.1 ab	2.694 c	32.02 a
T6	1973 ab	1.80 ab	35.3 a	4.142 ab	5.36 c
T7	1721 ab	1.91 a	32.0 ab	3.107 bc	22.48 ab
T8	1814 ab	1.81 ab	32.8 ab	3.175 bc	20.79 ab

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