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Spacing Trial of *Leucaena* in Correlation with Fuelwood Production

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ထင်းစိုက်ခင်းတည်ထောင်ရန်အတွက် ဘောစကိုင်း သစ်မျိုး၏ ပန္နက်အကွာအဝေးကို စူးစမ်းလေ့လာခြင်း။

ဦးမင်းကိုကိုကြီး၊ ဦးအောင်ခင်
သစ်တောသုတေသနဌာန၊ရေဆင်း။

စာတမ်းအကျဉ်းချုပ်

ထင်းများကို များများမြန်မြန်ထုတ်လုပ်ပေးနိုင်ပါက လောင်စာစွမ်းအင် ပြဿနာကို တဖက်တလမ်းမှ ဖြေရှင်းရာ ရောက်ပေမည်။ ထို့ကြောင့် ထင်းများများ၊ မြန်မြန် ထုတ်လုပ်ရောင်းချနိုင်မည့် သစ်မျိုးများ အနက် အလားအလာ ရှိသောဘောစကိုင်းသစ်မျိုး၏ ထုထည်အများဆုံးထွက်နိုင်မည့် ပန္နက်အကွာအဝေးကို စူးစမ်းလေ့လာခြင်းဖြစ်သည်။

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Abstract

Demand for fuelwood production in the country is high and establishment of a short rotation fuelwood plantation is greatly needed. *Leucaena*, which is one of the very fast growing legumes of the tropic, has great potential. Thus, correct spacing at which the highest fuelwood yield is expected was studied and the results discussed.

Introduction

Wood as a source of energy may not be very important in the developed part of the world, but it plays a very important role in the developing countries. Ratio of consumption of fuelwood in the developed to that of developing countries in 1974 was estimated to be 1:9 (Arnold, 1978). Over one and a half billion people in the developing countries derive at least 90% of their energy needs from wood and charcoal while another billion people meet at least 50% of their energy requirements this way (Anon, 1980, Arnold, 1978). The need for wood fuel is greatest especially for the people in the rural areas. The requirement is mainly for cooking their daily food and for warmth.

With the increase in population and the price of fossil fuel, the destructive pressure on the forests for fuel in the developing countries also increased. Thus, the question arises as to how long the forests in these regions support the need of the people. The answer can be rather frightening. According to the discussions in the first Asian Forestry Congress held in Manila in 1983, the present rate of deforestation in the Asian countries can deplete most of their forests within a decade. The high rate of deforestation in these regions can greatly be attributed to the need for fuelwood. It has been estimated that ½ the timber cut in the world serves as fuel for cooking and heating (Anon, 1980). It is therefore quite evident that the fuelwood problem in the developing countries needed to be attended to urgently and effectively.

Although Burma is endowed with 57% of its total area with valuable forests, it also has its own fuelwood problem.

During the war and the unsettled conditions prevailing in its aftermath, most of the local supply reserves had been completely cut and destroyed. With the increased in population (31.37 million in 1978) at the rate of 2.24% and the destruction of the local supply reserves, the domestic wood supply has reached a critical stage. Consequently, the rural people, out of necessary, began encroaching upon the commercial supply reserves for their domestic need. If this is not checked, it could result in serious depletion of the country's forestry wealth within short period of time.

With a total forest cover area of 95.699 million acres and the present estimated population of 35.06 million, the average per capita forest land is calculated to be 2.73 acres. However, due to the uneven distribution of the population, the per capita forest areas in some part of the country are very low (see Appendix I). Based on the figures reported in the Forest Department (1979) " Country report on Forestry", the per capita forest areas in the domestic wood deficit areas are reestimated for 1983 in Appendix I.

From Appendix I, it can be seen that the per capita forest area has dropped approximately 10.5% with the increase in population within a period of 5 years. Thus, with the increase in population with time, the per capita forest area will keep on decreasing. In order to compensate for this, it become necessary to make full use of our forest land by establishing plantation with fast growing species and using the most suitable spacing so as to get the maximum yield possible for domestic use particularly fuelwood.

Since very short rotation (5-10 yrs) is aimed at in most fuelwood plantation, initials spacing also plays a significant role in determining the yield per unit area. Normally, closer spacing, having more number of trees produces more wood than wider spacing (Evan, 1982). Although wider spacing do stimulate radial growth, height growth is however generally independent of stand density. (Low and Tol, 1974) Thus, influence of spacing on growth is related only on individual tree.

Initial spacing as close as 1m x 1m and as wide as 6m x 6m has been tried and used in different parts of the world. This however primarily depended upon the object of management, species used and the site condition. Closer spacing will be preferred for fuelwood production where a fast growing species with short rotation will be used for maximum production per unit area.

List of fast growing species suitable for fuelwood has been published by the Advisory Committee in Technology Innovation, Board on Science and Technology for International Development and *Leucaena leucocephala* was included as one of the prospective species (Anon. 1980). The species has been tried with success in many tropical countries and K_8 and K_{28} strains were found to be in the top list. (Kaul and Gurumurti, 1981. Anon 1977). Leucaena has also been planted in different parts of Burma and they have also been found to be doing quite well.

The need for the establishment of fuelwood plantations in Burma is quite evident. It therefore become necessary to find the right species and spacing for such plantations. Species trial for fuelwood production is at present in progress. While awaiting for the results of the trial *Leucaena leucocephala* was considered to be the best and was therefore used in this spacing trial which was included in the first set of field trials after the formation of the Forest Research Institute at Yezin.

Materials and Method

The experiment was conducted in Compartment (72), Ngalaik Reserve in Pyinmana Township. The area was selected, clearfelled and burned.

Randomised complete block design was used. Six blocks containing 3 block were laid out (see Appendix IV). The plots were randomly assigned to the following 3 spacing treatment (A) 4' x 4' (B) 6' x 6' (C) 8' x 8'. Staking was then carried out in the respective pots and 54 seedlings of *Leucaena leucocephala* K_8 strain were sown in each plot on 17th of June 1979.

Due to drought with only 24 inches of rainfall during the year heavy casuality was encountered and the surviving plants were in a rather poor shape. Patching was done on 9th of July same year. As usual, 3 weedings were carried out in the first year, twice in the second and third year and once in the fourth and the fifth year.

The area was fire protected. However, in March 1981, the plot was maliciously burned from inside. Although majority of the trees were only scorched, the whole plots was coppiced so as to maintain homogeneity for all the treatments applied. Measurements of fuelwood yield in stacked cubit feet was taken and recorded.

In November 1983, the whole plots was again felled and coppiced. All the branches having (0.5") diameter and about were cut into 28" length and stacked, and stacked volume for twenty trees for each plots was measured.

The measurements obtained were converted into fuelwood yield per acre. Statistical analysis was carried out and the results were interpreted.

Total production cost and cost per cubic foot of the total production to date was also calculated and compared.

Results

Fuelwood yield of twenty trees for different treatments.

The yield of twenty tree for different spacing treatments were as given in Table 1. Although the yield of 20 trees for each treatment has a tendency to increase with the increase in spacing, the differences were statistically not significant. (See Appendix II A).

Table 1. Fuelwood Yield of Twenty Trees for Different Treatments.

Block	Treatment			Block Total
	A (4' x 4')	B (6' x 6')	C (8' x 8')	
I	29.4	14.6	35.9	79.9
II	19.6	27.2	48.5	95.3
III	15.8	27.1	18.3	61.2
IV	40.0	29.8	54.4	124.2
V	32.3	57.3	53.1	142.7
VI	37.7	21.8	46.6	106.1
Total	174.8	177.8	256.8	609.4
Mean	29.1	29.6	42.8	101.6

Fuelwood yield per acre for different treatments.

The yield per acre for different spacing treatments were as given in table 2. The yield per acre has strong tendency to increase with the decreased in spacing from 8' x 8' to 4' x 4' Treatment 'A' with 4' x 4' spacing gave significantly much higher yield than other two treatments, however, the difference between treatment ' B' with 6 'x 6 ' spacing treatment 'C' with 8' x 8', spacing was statistically not significant (see Figure 2 and Appendix II B). For simplicity rankings are given below with lines linking treatment which did not differ significantly .

A [4' x 4']
B [6' x 6']
C [8' x 8']

Table 2. Fuelwood Yield per Acre for Different Treatment. (stacked cuft)

Block	Treatment			Block Total
	A (4' x 4')	B (6' x 6')	C (8' x 8')	
I	3397	882	1220	5499
II	2672	1647	1649	5968
III	2156	1671	621	4418
IV	5445	1805	1853	9103
V	4398	3469	1807	9674
VI	5133	1318	1587	8038
Total	23201	10762	8737	42700
Mean	3867	1794	1456	2372

L.S.D 1467 at 1 %

Comparison of the yield per acre obtained in the first and the second rotations.

The yield per acre obtained in 1981 and 1983 for each treatment was compared in table 3. It will be noticed that the yield obtained in the second rotation was more than that obtained in the first rotation for each treatment (See Figure 1). Statistical analysis for the comparison was not carried out.

Table 3. Comparison of the yield per Acre obtained in the First and the Second Rotations.

Treatment	1 st Rotation (1981)	2 nd Rotation (1983)	Total
A [4' x 4']	522	3867	4389
B [6' x 6']	153	1794	1947
C [8' x 8']	64	1456	1520

Costs of establishment and production

Cost of establishment per acre and production cost on the 5th year were as given in Table 4.

Table 4. Establishment and Production Costs.

Treatment	Cost of establishment per acre (Kyats)	Production cost per stacked cuft (Kyats)
A [4' x 4']	930.60	0.21
B [6' x 6']	677.00	0.35
C [8' x 8']	587.40	0.39

Establishment cost per acre increased with the decrease in spacing while production cost per stacked cuft decreases with the decrease in spacing (see Appendix II for details).

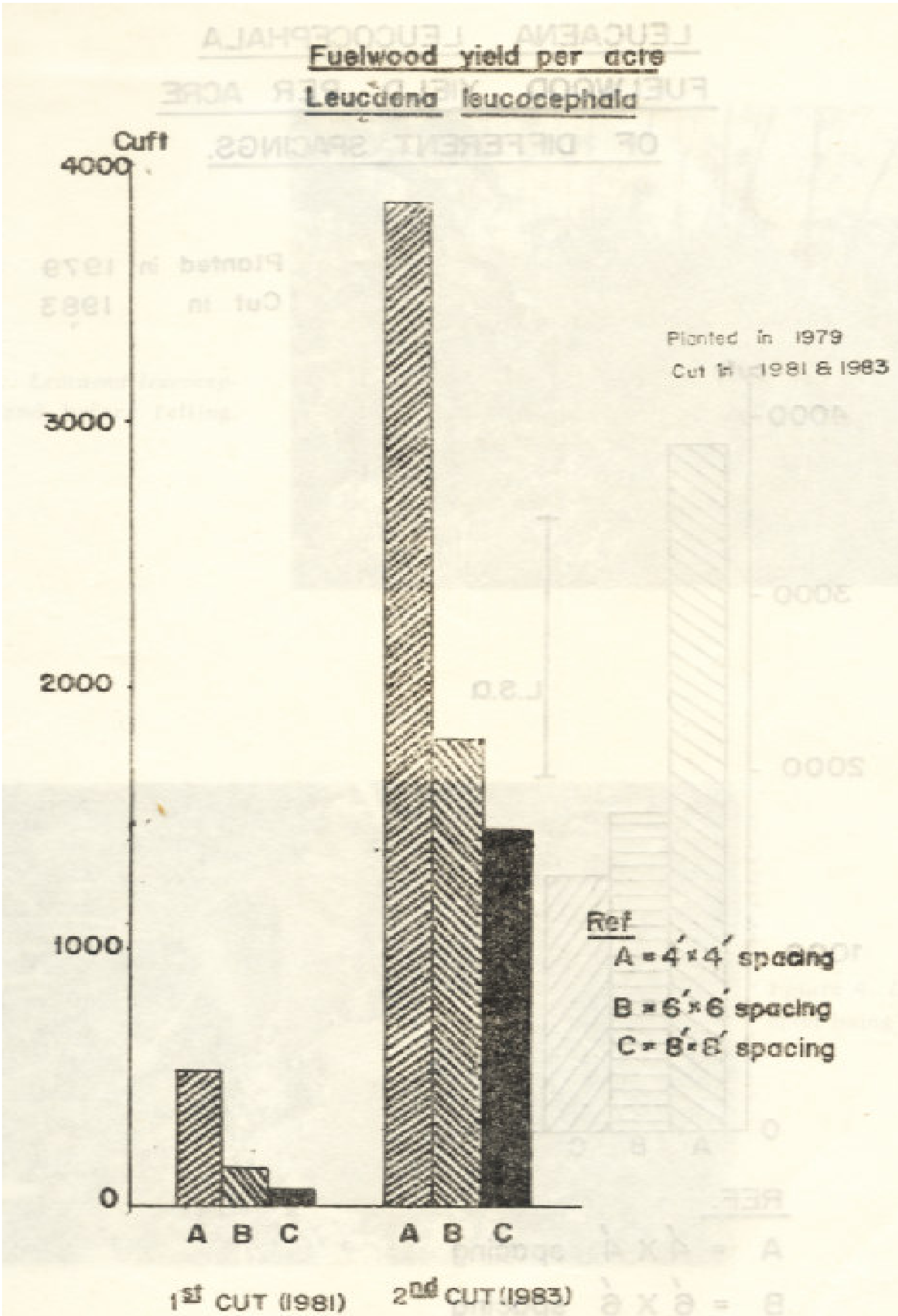

Fuelwood yield per acre
Leucaena leucocephala
Cuft
4000
3000
2000
1000
0
Planted in 1979
Cut in 1981 & 1983
Ref
A = 4′×4′ spacing
B = 6′×6′ spacing
C = 8′×8′ spacing
A B C
A B C
1st CUT (1981)
2nd CUT (1983)

Figure . 1 .

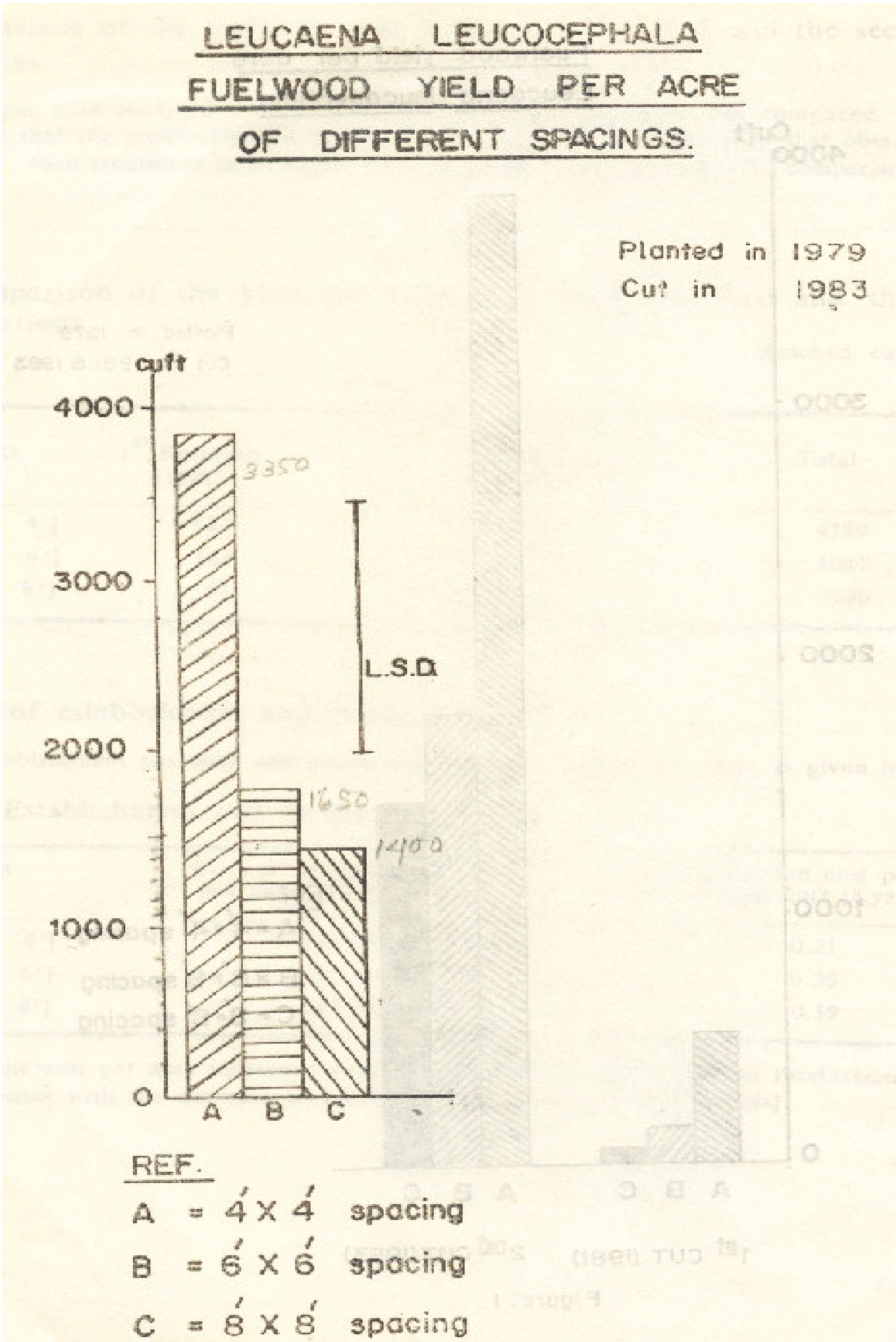

LEUCAENA LEUCOCEPHALA
FUELWOOD YIELD PER ACRE
OF DIFFERENT SPACINGS.
Planted in 1979
Cut in 1983
cuft
4000
3000
2000
1000
0
3350
1650
1400
L.S.D.
A
B
C
REF.
A = 4′ X 4′ spacing
B = 6′ X 6′ spacing
C = 8′ X 8′ spacing

Figure. 2.

Figure 3. *Leucaena leucocephala* stand before felling.

Figure 4. *Leucaena leucocephala* after being felled and coppiced.

Discussion

As was mentioned is the introduction the impact of spacing on growth is related only to individual tree. Thus if fixed number of tree in each treatment were, it would appear that wider spacing is more desirable than closer spacing as the yield will be higher. Although statistically not significant, the trend of the result for yield of twenty trees are in agreement with this statement.

The season that individual trees in wider spacing produce more wood is that diameters increase with spacing (low and van Tol, 1974). Moreover, wider spacing produces more branches and coppice shoots. This was also supported by the observation done in this experiment as the number of coppice shoots for twenty trees were observed to be 45,54 and 60 for treatments A (4 ' x 4 '), B (6 ' x 6 ') and C (8 ' x 8 ') respectively.

Although the growth of individual trees is smaller in closer spacing, the increase number of stems per area than more than compensate for the loss in growth. Consequently, a much higher yield per unite area was observed in the closer spacing than in the wider spacing. For fuelwood production the present trend is to plant fast growing species with close spacing coupled with short time harvesting (Gurumuti, 1981; Kaul and Gurumurti 1981; and Srivastava 1981).

An interesting point observed in this study was that the yield in the second rotation was much higher than that in the first rotation. The growth period in both rotations was the same i.e. 2 years. This is probably due to the production of more than one coppice shoot (See Figure 3 & 4) after the area was cut in 1981, thus, resulting in more number of stems per acre.

The cost of establishment was more for closer spacing than wider spacing as more seedlings had to be used for planting and patching. Moreover, it also means that more stakes are needed for staking. The cost for weeding was shown to be the same all treatments as equal treatment had to be given for experiment purpose. However, in practice, less weeding should be required in closer spacing. However, even with this conservation calculation, the cost of production per stacked cu. ft was cheaper in the closer spacing than in the wider spacing.

Conclusion

From this study, it is evident that by using closer spacing in fuelwood production a higher yield per acre at a lesser cost per cu. ft production can be benefited. Thus, in establishing a fuelwood plantation with *Leucaene leucocephala.*

(a) a spacing of not wider than 4 ' x 4 ' should be used, and
(b) a coppice system is recommend

Appendix I

Population and Per-capita Forest Area in Domestic wood Deficit Areas

No.	Civil Division	Forest Division	Population		Forest Area (Acres)	Per capita Forest Area (acres)	
			1978	1983		1978	1983
1.	Rangoon	Hmawbi	3562289	3979077	487443	0.14	0.12
2.	Mandalay	Mandalay / Maymyo	1110646	1240927	1158350	1.04	0.93
		Dry Zone	1126031	1257777	155932	0.14	0.12
		Meiktila	1000484	1117541	671067	0.67	0.60
		Yamethin	595616	665303	647449	1.09	0.97
3.	Pegu	South Pegu	684984	765127	666817	0.97	0.87
		North Pegu	522043	583122	912374	1.75	1.57
		Prome	710351	793462	1094680	1.55	1.38
		Zigon	499634	558091	333305	0.67	0.60
		Tharrawaddy	419747	468857	296933	0.71	0.63
4.	Irrawaddy	Delta	2242846	2505259	977400	0.44	0.39
		Henzada/Bassein	2402463	2683551	1648526	0.69	0.61
5.	Sagaing	Lower chindwin	1317887	1472080	1211265	0.92	0.82
		Shwebo	1263261	1411063	2496940	1.97	1.77
6.	Magwe	Magwe	1087030	1214213	1014558	0.94	0.84
		Yaw	989494	1105265	1472208	1.49	1.33
7.	Mon	Thaton/Ataran / Kadoe	1460850	1631770	1418502	0.97	0.87

Note . Population for 1983 was obtained projecting the figure for 1978 with the population growth rate of 2.24 %

Appendix II

A

Analysis of Variance for Fuelwood Yield of Twenty trees

Source of Variation	df	Sum of Squares	Mean Squares	F
Block	5	1454.3		
Treatment	2	720.8	360.4	3.54 N.S
Error	10	1016.5	101.65	
Total	17	3191.6		

B

Analysis of Variance for Fuelwood Yield of per acre

Source of Variation	df	Sum of Squares	Mean Squares	F
Block	5	7517805		
Treatment	2	20446481	10223240	15.89**
Error	10	6430666	643066	
Total	17	34394952		

Appendix III

Cost of Establishment and Production.

	A (4 ' x 4 ')	B (6 ' x 6 ')	C (8 ' x 8 ')
Site preparation			
(a) Felling	120	120	120
(b) Kyunkwe	60	60	60
(c) Staking (10 K/540)	50.40	22.40	12.60
Cost of seedling (0.10 K/ seedling)			
(plus 20% for patching & other causes)	326.60	145.20	81.60
Cost of planting (15 K/ 540)			
(plus 10% for patching)	81.10	36.90	20.70
Cost of weeding 1st Year (3 times)	97.50	97.50	97.50
2nd Year (2 times)	65.00	65.00	65.00
3rd Year (2 times)	65.00	65.00	65.00
4th & 5th (one time each)	65.00	65.00	65.00
Cost up to 5th Year	930.60	677.00	587.40

Cost production per cu. ft. of fuelwood

A (4 ' x 4 ') = $\frac{930.60\ K}{4389\ cu\ ft}$ = 0.21K/cu ft.

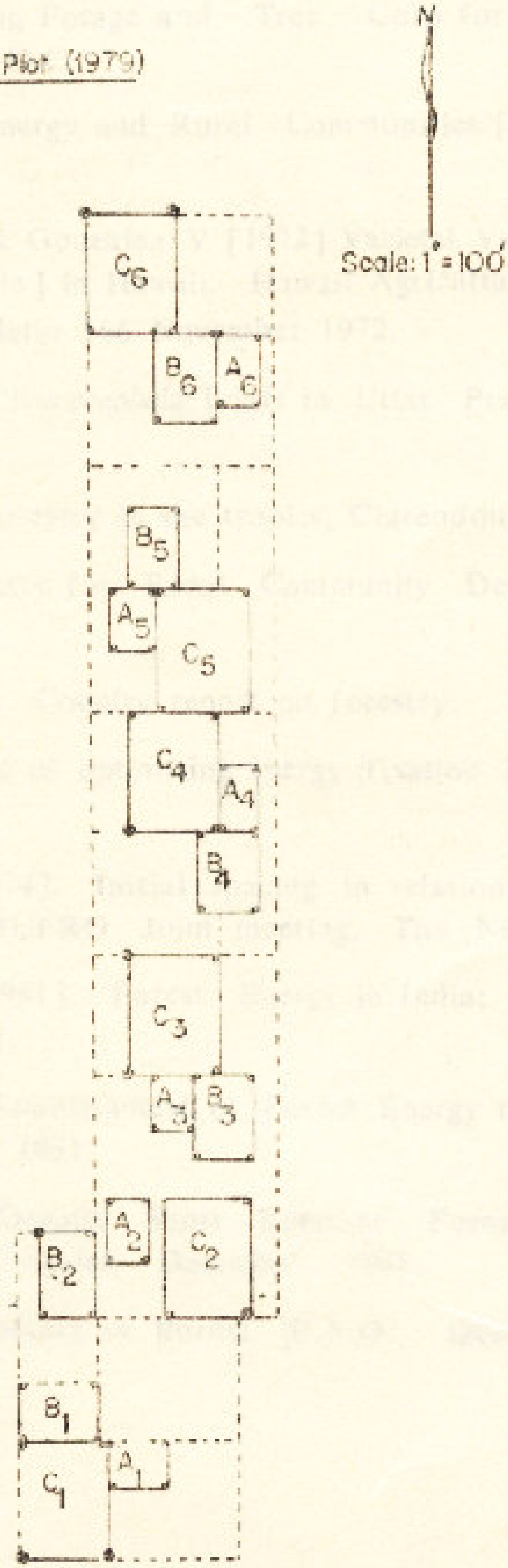
B (6' x 6 ') = $\frac{677.00\ K}{1947\ cu\ ft}$ = 0.35 K/cu ft.

C (8 ' x 8 ') = $\frac{587.40\ K}{1520\ cu\ ft}$ = 0.39K/cu ft.

Appendix IV

Leucaena Spacing Trial Plot (1979)

0·85 Ac.



Ref.

A = 4' x 4' spacing

B = 6' x 6' spacing

C = 8' x 8' spacing

Each plot contains 9 Rows x 6 Rows

Leucaena leucocephala K - 8

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