New *Leucaena* Species and Hybrids for Livestock Production

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ABSTRACT

A study consisting of plot trial, sheep preference test and grazing experiment was conducted with an aim of evaluating the potentials of the less known *Leucaena* species and some of their hybrids for livestock production. A total of 25 accessions were evaluated in terms of psyllid resistance, plant growth and biomass production in 3 locations with diverse agro-ecological conditions. Nineteen of which with good yield potential were subjected to sheep palatability trials. Four promising new species were further evaluated under grazing conditions using 25 heads of cattle as test animals.

All L. leucocephala lines were highly susceptible to psyllid. Nevertheless, a new *L. leucocephala* cv. K636 has exhibited strong tolerance (but not resistance) to psyllid damage. *L. involucrata* exhibited high degree of psyllid susceptibility. The highly resistant groups included the *L. pallida*, *L. diversifolia*, *L. collinsii*, *L. macrophylla nelsonii*, *L. trichandra* and the KX2F1 hybrid of *L. leucocephala* K636 x *L. pallida* K748.

The KX2 hybrid and the *L. macrophylla* 47/85 were fast growers and they were the most productive among the highly psyllid-resistant accessions across sites. No definite trend was obtained in terms of plant growth and yield in all other remaining accessions across sites. Furthermore, none of the less-known *Leucaena* species has exhibited strong tolerance to highly acidic soils (pH < 5.0).

The KX2 hybrid and the *L. collinsii* 52/88 were found to be highly palatable and comparable to *L. leucocephala*. The least acceptable group included the *L. pallida*, *L. diversifolia* K156, *L. esculenta*, *L. salvadorensis* and *L. macrophylla* subsp. nelsonii. There were indications that preference to the less acceptable accessions changed with time suggesting a need for longer exposure of sheep to these species.

Some of the most promising new *Leucaena* maybe successfully introduced in native Imperata pastures for increased livestock production. The highest animal production was obtained in *L. leucocephala* K636 and *L. collinsii* followed by *L. trichandra*. The *L. pallida* produced the lowest LWG that was just statistically comparable to that of the native pastures (control).

INTRODUCTION

Leucaena leucocephala (Lam.) de Wit commonly known as leucaena , is one of the most productive and versatile tree legumes available to tropical agriculture. It is native to Mexico and has spread pantropically due to its value not only for forage but also for wood, green manure, shade and soil conservation. Its multiple uses, ease of propagation and management and exceptional fodder quality have been key factors promoting its widespread use in the tropical and subtropical countries. With extended use, however, a number of limitations of *L. leucocephala* become apparent, including the narrow genetic base of the early introductions (*Hughes 1998; Brewbaker and Sorensson 1990*). Foremost among the limitations is its susceptibility to the psyllids, *Heteropsylla cubana*, which spread across Asia between 1984 to 1989 and into Africa in 1992 resulting to widespread destruction of *Leucaena* plantations. Other limitations include its lack of acid soil tolerance (*Ahmad and Ng 1981; Ruaysoongnern 1990*) and poor rate of seedling growth (*Maasdorp and Gutteridge 1986*) hindering establishment .

In the Philippines, leucaena has long been a vital and integral part of smallholder agriculture where it is used mainly as source of fodder and fuelwoods. The arrival of psyllids in late 1985 devastated many of the *Leucaena* plantings prompting the search for other multi-purpose trees (MPT). However, almost all of the promising MPT species failed to surpass the versatility and fodder quality (intake, digestibility) of leucaena. Hence, there are strong reasons to re-examine the *Leucaena* genus and to develop some of the lesser-known species for the benefit of the farming systems and rural communities of the country.

This study aimed to determine the agronomic performance and psyllid resistance of other *Leucaena* species under different agro-ecological conditions of the country. Other objectives were to identify highly palatable provenances which have other desirable agronomic characteristics and determine their livestock production potentials under grazing conditions.

MATERIALS AND METHODS

The germplasm evaluation was conducted in three different locations namely: 1) Lipa, Batangas, 2) Tanay, Rizal and 3) Palayan, Nueva Ecija. While the grazing experiment was done at Milagros, Masbate. The description of each site is summarized in **Table 1**.

Dry Matter Yield and Psyllid Damage

The experiment was laid-out in a randomized complete block design (RCBD) with 3 replications except the Tanay site with only 2 replicates due to seed limitation. Treatments were the *Leucaena spp*. and hybrids (**Table 2**). Two rates of lime application (0 lime and 3 tons/ha) were imposed as additional treatments in Tanay. Each accession was planted in 5m plot in single row 3 m apart. There were 10 trees per plot planted 50 cm apart.

Seedlings were grown in polyethylene bags for about 2-3 months depending on sites before transplanting. The newly planted seedlings were provided with water 3 times/week during the dry season at the rate of 1 L/plant/application. Manual weeding was conducted regularly.

Four representative plants within row were marked for proper identification and designated as sample plants.

Measurements of plant height (from the ground level to the terminal meristem) and stem diameter (10 cm above the ground level) were done at monthly interval until the first biomass harvest. Initial measurements were conducted 2 months after transplanting (MAT).

A total of 8, 3 and 7 destructive harvests were conducted, respectively, at Lipa, Tanay and

Table 1. Description of the different sites used in the experiment.

Item	Site			
	Lipa Batangas	Tanay Rizal	Palayan Nueva Ecija	Milagros Masbate
Latitude	13O 9'N	14O 36'N	15 ON	12O 22'N
Longitude	121O 25'E	121O 21'E	121 OE	123O 37'E
MAR (mm)	1,898	2,790	1,866	1,920
Climate	Long wet (8 mo) and short dry (4 mo) seasons	Long wet (7 mo) and long dry (5 mo) seasons	Long wet (7 mo) and long dry (5 mo) seasons	Long wet (8 mo) and short dry (4 mo) seasons
MMin/Max TO	23/32 OC	20/28 OC	22/33 OC	23/33 OC
Mean RH (%)	78	81	78	84
Soil type	Vertisol	Ultisol	Vertisol	Vertisol
Soil texture	Silty loam	Clay	Heavy clay	Clay
pH (1:5 water)	5.9	4.4	6.3	6.1
Soil fertility	good	very poor	good	medium/good
Elevation (m)	312	550	50	200
Major limitations	(nil)	Infertile and acid soil; long dry season	long dry season	soil of low in N and P

Table 2. Accession number and code of 25 Leucaena lines and hybrids grown in each evaluation site.

Acc. No.	Species/Hybrids	Origin	Acc. Code	Evaluation Site1		
				Lip	Tan	Pal
1	*L. leucocephala* cv. Tarramba	Univ. of Queensland, Australia	K636	t	t	t
2	*L. leucocephala* cv. Cunningham	Univ. of Queensland, Australia	UQ8	t	t	t
3	*L. leucocephala* cv. Peru	(Control) Alabang, Philippines	Alabang	t	t	t
4	*L. pallida* (unknown hybrid)	Univ. of Queensland, Australia	52/87	t	t	t
5	*L. pallida*	Univ. of Queensland, Australia	CQ 3439	t	t	t
6	*L. pallida*	Univ. of Queensland, Australia	79/92	t	t	t
7	*L. diversifolia* subsp. diversifolia	Univ. of Queensland, Australia	82/92	t	t	t
8	*L. diversifolia*	Univ. of Queensland, Australia	4/91	t	t	t
9	*L. diversifolia* subsp. diversifolia	Univ. of Queensland, Australia	83/92	t	t	t
10	L. diversifolia	Univ. of Queensland, Australia	K156 UQ1	t	t	t
11	*L. collinsii*	Univ. of Queensland, Australia	52/88	t	t	t
12	*L. collinsii* subsp. zacapana	Univ. of Queensland, Australia	56/88	t	t	n.a.
13	*L. esculenta* subsp. esculenta	Univ. of Queensland, Australia	47/87	t	t	t
14	*L. involucrata*	Univ. of Queensland, Australia	87/92	t	t	t
15	*L. lanceolata* subsp. lanceolata	Univ. of Queensland, Australia	43/85	t	t	t
16	*L. macrophylla* subsp. nelsonii	Univ. of Queensland, Australia	47/85	t	t	t
17	*L. lempirana*	Univ. of Queensland, Australia	6/91	n.a.	n.a.	t
18	*L. pulverulenta*	Univ. of Queensland, Australia	83/87	t	t	t
19	*L. salvadorensis*	Univ. of Queensland, Australia	36/88	t	t	n.a.
20	*L. shannonii* subsp. magnifica	Univ. of Queensland, Australia	19/84	t	t	t
21	*L. trichodes*	Univ. of Queensland, Australia	61/88	t	t	t
22	*L. trichandra*	Univ. of Queensland, Australia	53/88	t	t	n.a.
23	*L. leuc* K636 x *L. pal* 748	Univ. of Queensland, Australia	KX2F1	t	t	n.a.
24	*L. leuc* K636 x *L. pal* K376	Univ. of Queensland, Australia	KX2F5	t	t	n.a.
25	*L. leuc* K8 x *L. div* K156	Univ. of Queensland, Australia	KX3F2	t	t	t

[1] Lip= Lipa, Batangas; Tan= Tanay, Rizal, Pal= Palayan, Nueva Ecija; t = tested; n.a.= not available

Palayan during the duration of the trial. Initial harvest was done when the trees were approximately 1 year of age. Subsequent harvests were carried-out periodically depending on coppice vigor to prevent mortality. The last harvest at all sites was conducted in November 1997. Trees from each plot were cut to 50 cm height. Plant materials from the designated sample plants were weighed fresh and immediately separated into edible (leaf + stem < 5 mm diameter) and non-edible (stems and branches > 5 mm diameter) fractions and weighed. Sub-samples (c. 300 g) were oven-dried at 70 0C for 5 and 7 days respectively for the leaf and stem fractions.

Psyllid ratings were taken on a monthly basis using an empirical score of 1 to 9 developed by the Nitrogen Fixing Tree Association (*Wheeler, 1988*). The results were averaged and only those months where mean damage score across accessions was > 2 were analyzed.

Data on each site were subjected to analysis of variance in randomized complete block design using the MicroQUASP statistical program.

Palatability Test

The palatability of 19 accessions of Leucaena species for sheep was conducted at the Bureau of Plant Industry (BPI) Compound, Lipa, Batangas during the months of March, May and November 1997.

A circular pen with an area of about 50 m2 was constructed and all vegetation within was removed. Three sheep with an average weight of 16 kg were used as test animals. They were trained to become familiar with the circular arrangement of the troughs by giving concentrate (100 g/trough) for two consecutive days. Three days prior to the trial, the sheep were exposed to a small amount of each accession in randomly arranged troughs around the perimeter of the pen with an observer recording the time each sheep spent eating the forage.

After which, the sheep were offered 500 g of freshly cut edible forage (leaf + fine stem < 6 mm up to the 5th fully expanded leaf) in clearly labeled troughs placed randomly and equally distant around the inside perimeter of the pen for four consecutive days. The sheep were allowed inside the pen for 40 minutes, rested in a side pen with no feed for 40 minutes and then placed back into the main pen for another 40 minutes. During the exposure, accessions being eaten by each sheep, if any, were recorded every 20 seconds. Dry matter intakes (DMI) were calculated by measuring the difference between the dry matter on offer at the start of the exposure and the dry matter left after the exposure ended. Dry matters before and after feeding were estimated using 100 g sub-sample.

Water for the animals was made available at the center of the pen throughout the measurement period.

Data on DMI and feeding frequency were subjected to analysis of variance using MicroQUASP statistical package to determine the least significant differences between accessions.

Grazing Experiment

Ten hectares of Imperata-dominated pasture in Masbate Livestock Production Center (MLPC), Milagros, Masbate were utilized as experimental area. It was equally divided into ten 1-ha paddocks and randomly allotted to 5 different pasture types as treatments namely:

T1- Native Pasture (NP)
T2- NP + L. leucocephala (K636)
T3- NP + L. pallida (CQ 3439)
T4- NP + L. collinsii (OFI 52/88)
T5- NP + L. trichandra (OFI 53/88)

The site was considered for its accessibility to livestock raisers and its proximity to the provincial road adjoining the other villages.

The area designated for planting of tree legumes were strip-plowed to come-up with strips 1-m in width 3-4 m apart. Weedicide (RoundUp) was sprayed on strips a week prior to field planting. The 2.5 mo old seedlings were transplanted in June 1996 at a distance of 1 m between plants or a planting density of 2,500 trees/ha. Solophos fertilizer (0-18-0) was applied at the rate of 60 g/plant immediately after handweeding.

The whole area was protected from stray animals and bush fire until the commencement of experimental grazing.

A total of 25 heads of American Brahman steers with mean initial weights ranging from 152-163 kg were selected from the main herd, classified based on weight and allotted at random in each treatment. All animals were rope-tamed and treated for external and internal parasites prior to the formal conduct of the experiment. They were also subjected to urine test as described by Jones and Megarrity (1986) to determine if all the animals have the DHP-degrading bacteria to overcome mimosine toxicity.

The 2-paddock rotational grazing was adopted. Newly grazed paddocks were rested until adequate regrowth had occurred. No mineral supplement except for table salt (NaCl at the rate 50 g/head/day) was provided to grazing animals. Water for drinking was available at all times. Experimental grazing commenced 1 year after transplanting when the trees were considered to be well established .

Understorey yields were measured periodically using the dry-weight estimate method as advocated by Haydock and Shaw (1975). The regression between the actual yield and the visually estimated yield was computed using the simple linear regression model. A regression curve was plotted and understorey yield was estimated by converting the visual scores into actual yield. The same protocol was applied in estimating the edible yield of tree legumes in each paddock. A total of 120 trees/paddock were picked at random and designated as sample plants.

Individual weighings of animals were conducted periodically after 15 hr of overnight fasting.

RESULTS AND DICUSSSIONS

Germplasm Evaluation

Weather conditions during the early establishment period at all sites were favorable for plant growth. Seedling mortality was nil at Lipa and Palayan but poor seedling growth was observed in Tanay particularly on the unlimed plots.

Dry Matter Yield and Psyllid Damage

Psyllid Damage. Psyllid damage was consistently low at Tanay and Palayan during the duration of the trial. Whereas, in Lipa, high psyllid pressure was observed on several occasions.

In Lipa, psyllid damage was high during the months of October to February, a period when rainfall and temperature were very suitable for the growth of the accessions. No attempt however was made to measure the correlation of the climatic factors with psyllid damage. Nevertheless, it is clear as has been pointed out by Bray (1994) that climatic conditions favorable for the growth of leucaena also favor the multiplication of the psyllid insect.

The mean psyllid damage ratings of the different accessions are shown **Figure 1**. Eleven of the 24 accessions were highly resistant (rating: 1-2) while 4 entries were either moderately susceptible (rating: 4-5) or highly susceptible (rating: 5-9) to psyllids. Included in the highly resistant group were the *L. pallida, L. diversifolia, L. collinsii, L. macrophylla, L. trichandra* and the hybrid between the *L. leucocephala x L. pallida* (KX2

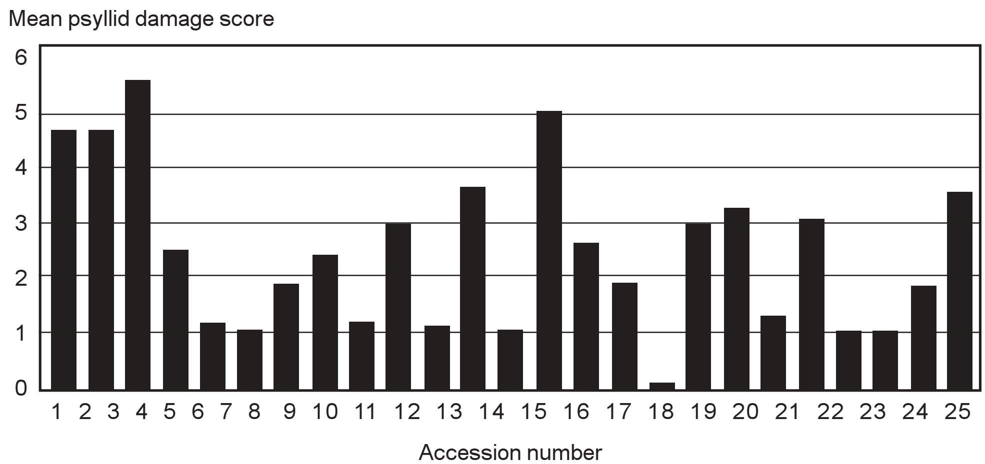

Figure 1. Mean psyllid damage score.

hybrid). The two KX2 hybrids and the *L. macrophylla* were the most productive among the highly resistant accessions. All *L. leucocephala* lines were susceptible. The new leucaena cultivar Tarramba (K636) exhibited tolerance rather than resistance to psyllids. It produced many axial branches when growing tips are damaged. *L. involucrata* species exhibited high degree of susceptibility to the psyllid insect.

There are strong indications that psyllid resistance may also vary within species as has been reported by Bray (1994) and Castillo et al. (1997a). This is evidenced by the considerable variation in leaf damage scores within *L. collinsii* and *L. diversifolia*. Likewise, the KX2 hybrid seems to be more resistant to the psyllid than that of the KX3 hybrid, *L. leucocephala* x *L. diversifolia* (*Castillo et al. 1997a*).

Plant Growth. Growth performance was expressed as incremental increase in height and stem diameter per month. In general, plant growth at Lipa and Palayan was higher than those grown at Tanay where majority of the plants remained stunted over the 8 mo. period (**Table 3**). This is attributed to the highly acidic and infertile soil conditions of Tanay. Lime application at 3 tons/ha had some positive effects on growth but not comparable to the fast growth rate obtained in the good soils of Lipa and Palayan.

The KX2F1 hybrid had the highest growth rate in all the sites indicating its wider range of adaptation. No definite trend was obtained on all other remaining accessions across sites indicating the importance of matching the accessions with the environments. Growth of *L. macrophylla* 47/85 for example, was comparable to KX2F1 at Tanay with lime application but relatively moderate at Lipa and Palayan. The same is true for the *L. leucocephala* K636 whose growth was outstanding at Palayan but only moderate at Lipa and Tanay. Growth also varied significantly within species and within hybrids grown at Lipa and Palayan. The K636 was the best in terms of growth among the 3 lines of *L. leucocephala*

Table 3. Increase in plant height (cm/mo) and stem diameter mm/mo) of the different *Leucaena* accessions at each site during the 1st year of establishment.

Acc.No.	Plant Height[1]				Stem Diameter[1]			
	Lipa	Tanay		Palayan	Lipa	Tanay		Palayan
		+Lime	-Lime			+Lime	-Lime	
1	18.0	1.8	0.8	40.6	2.6	0.6	0.4	2.9
2	9.1	1.4	0.9	27.8	1.3	0.3	0.3	2.2
3	8.4	3.4	0.3	25.2	1.2	0.6	0.4	2.1
4	17.2	5.4	2.4	17.7	2.1	0.7	0.4	0.9
5	15.6	9.9	n.a.	29.0	2.2	0.8	n.a.	1.9
6	15.5	3.1	0.4	21.8	1.8	0.5	0.2	1.6
7	19.4	5.2	0.3	20.4	1.9	0.6	0.4	1.0
8	14.6	3.3	3.6	21.0	1.6	0.3	0.3	1.2
9	30.0	8.8	1.4	19.3	2.8	0.7	0.3	1.3
10	19.0	11.0	n.a.	18.0	1.9	0.8	n.a.	1.2
11	20.0	6.2	1.3	25.5	3.4	0.5	0.3	1.6
12	10.0	6.6	1.2	n.a.	1.1	0.6	0.2	n.a.
13	9.0	0.6	0.4	14.8	2.0	0.3	0.2	1.7
14	4.9	0.2	0.5	20.7	0.4	0.1	0.1	1.1
15	19.0	1.3	1.0	29.1	2.4	0.4	0.1	2.1
16	26.3	10.8	1.3	28.9	3.1	0.9	0.2	1.8
17	n.a.	n.a.	n.a.	29.4	n.a.	n.a.	n.a.	2.2
18	7.6	2.3	0.7	22.7	0.7	0.4	0.1	1.5
19	22.1	3.0	0.5	n.a.	1.8	0.3	0.2	n.a.
20	20.4	6.1	1.5	25.7	2.2	0.7	0.2	1.4
21	10.6	2.6	1.9	18.7	1.1	0.3	0.3	0.9
22	8.1	6.0	2.0	n.a.	2.9	0.6	0.3	n.a.
23	49.9	10.6	0.1	n.a.	5.6	1.1	0.3	n.a.
24	28.3	2.7	0.2	n.a.	4.0	0.5	0.3	n.a.
25	13.0	2.9	1.9	25.0	1.7	0.5	0.5	1.7
LSD(.05)	6.8	6.9	3.1	5.5	0.8	0.4	0.3	0.4

[1] Measurement period: Lipa (October 1995 to March 1996); Tanay (October 1995 to July 1996) and Palayan (December 1995 to July 1996). Please refer to Table 1 for the names of *Leucaena* accessions.

at both sites and the KX2F1 among the hybrid lines at Lipa.

Improvement of soil pH from 4.4 to 4.9 (1:5 in H20) and reduction in aluminum saturation from 67% to 49% were attained at Tanay with lime application. The attained values however were still far from the critical pH level of < 5.5 and aluminum saturation of > 20% for the *Leucaena*. Hence, almost all of the accessions had stunted growth despite of lime application. Exceptions to this were the relatively higher growth rates of 10-11 cm/mo exhibited by the *L. pallida* CQ3439, *L. diversifolia* K156, *L. macrophylla* 47/85 and the KX2F1 hybrid. This indicates their higher potential to establish on infertile and highly acidic soils as compared to the other accessions. The poor growth performance of the KX3 hybrid with lime (2.92 cm/mo) or without lime (1.88 cm/mo) does not conform with the findings of Lungu and Solberg (1988) on the superior growth and biomass yield of this particular hybrid on the highly acidic soils (pH 4.5 in H2O) of Northern Zambia. This may be due to site differences particularly the aluminum or manganese contents of the soil.

Dry Matter (DM) Production. DM data were expressed as grams per meter row per month of growth to allow comparison between sites. At Tanay, only the limed treatment was assessed due to high mortality rates of the unlimed plants ranging from 70-90% depending on species. The survival rates of the different accessions at Tanay has already been reported by Castillo et al. (1997b) hence would not anymore be covered in this paper.

Edible Dry Matter (EDM). **Table 4** shows the initial and the seasonal EDM production of accessions planted at each site. Significant (P<0.05) variations were obtained among accessions planted at each site during the initial as well as the succeeding harvests. The two KX2 hybrids were consistently the highest yielding accessions across site. This was followed closely by the *L. macrophylla* 47/85 whose yields were almost comparable to the KX2F5 hybrid.

Majority of the new leucaena species and hybrids were able to establish well on the good environments of Lipa and Palayan. Reasonable amount of EDM were obtained although significant (P<0.05) differences were observed among accessions in each period of harvest. EDM yields of the KX2F1 hybrid were outstanding in Lipa in all measurement periods. But in its absence at Palayan, none of the new species was able to surpass the yield performance of the *L. leucocephala* lines probably due to nil psyllid pressure in the area. This is important in view of the higher feeding value of leucaena relative to other less known species as has been reported elsewhere. The top yielding group also include the *L. macrophylla* 47/85, *L. lanceolata* 43/85, KX2F5 and the 3 *L. pallida* lines. All of the most productive species were able to tolerate the cutting interval of 60-75 days and remained productive during the study period.

A longer cutting frequency (minimum of 6 months) was imposed at Tanay due to the poor regrowth of the plants. Under this cutting regime, the local control (*L. leucocephala* cv. Peru) and 4 of the test entries (*L. diversifolia* K156, KX2F1, KX2F5 and *L. macrophylla* 47/85) had exhibited ability to adapt to highly acidic soils as evidenced by the reasonable amount (> 80 g/m row/mo) of EDM obtained during the last harvest. The yields of *L. diversifolia* K156 and *L. leucocephala* cv. Peru in particular were even higher as compared to the same accessions grown in the other sites.

Total Dry Matter (TDM). The trend obtained among accessions in TDM production in general were similar to those recorded for EDM (**Table 5**). The KX2F1 was the most productive and has exhibited excellent seedling growth and resistance to the psyllids. However, a considerable decline in biomass production was noted in its F5 progenies indicating the need of mass propagating the hybrid by asexual means. Leucaena in developing countries such as the Philippines is mainly used as source of fodder and fuelwood. The KX2F1 hybrid is probably the best bet under this situation. Its wide adoption and utilization in the region, however, would depend on the development of simple and low cost methods of vegetative propagation.

L. macrophylla 47/85 is also one of the highly productive and psyllid resistant species identi-

Table 4. Edible dry matter yields (g/m row/mo) of *Leucaena* lines and hybrids grown in each evaluation site.

Acc.No.	Initial Cut[1]			(Year 1)					(Year 2)		
				WetSeason[2]		Dry Season[3]			Wet Season[4]		
	Lip	Tan	Pal	Lip	Pal	Lip	Tan	Pal	Lip	Tan	Pal
1	35.9	1.7	33.3	77.1	102	54.5	3.4	50.9	98.1	66.8	109
2	16.2	0.6	29.0	50.0	105	31.6	0.6	41.3	84.8	0.03	128
3	16.1	2.9	26.7	58.4	103	39.0	3.5	40.1	92.6	194	165
4	17.4	4.3	14.8	56.8	106	19.2	0.03	8.6	92.4	63.4	121
5	21.5	2.5	16.7	69.3	94.7	57.6	4.0	5.9	104	37.7	98
6	20.7	1.8	16.3	86.9	83.1	42.4	1.5	6.0	103	30.0	85
7	11.9	3.2	4.3	22.8	8.8	17.5	1.8	1.5	41.9	66.1	5.8
8	16.8	1.7	7.5	12.4	25.6	18.0	4.2	10.7	23.4	71.9	44
9	21.4	2.3	6.2	44.3	10.9	40.3	1.2	1.0	70.3	0.03	12
10	21.1	4.4	6.1	41.1	23.6	25.0	2.5	5.4	52.5	155	38
11	41.7	2.4	11.6	75.0	16.6	67.5	0.8	4.2	98.9	0.03	39
12	25.0	1.4	n.a.	20.1	n.a.	9.1	0.6	n.a.	49.0	0.03	n.a.
13	10.6	0.3	22.3	58.2	64.2	32.2	0.03	5.7	82.3	11.4	92
14	1.8	0.03	9.4	8.3	21.6	5.2	0.03	2.4	12.5	0.03	30
15	31.4	0.7	27.7	79.3	66.2	71.1	1.1	34.6	112	8.1	116
16	63.4	4.1	18.4	146	96.6	112	2.6	22.1	160	81.4	133
17	n.a.	n.a.	22.6	n.a.	69.5	n.a.	n.a.	21.9	n.a.	n.a.	94
18	9.3	1.4	11.6	15.3	39.2	16.7	0.6	18.7	38.4	12.5	37
19	29.8	0.8	n.a.	34.5	n.a.	29.5	0.5	n.a.	83.2	6.2	n.a.
20	35.7	0.9	7.5	48.2	39.5	40.7	0.2	4.1	65.5	0.03	32
21	13.4	0.4	5.4	17.3	12.8	14.0	0.03	3.5	19.8	0.03	10
22	64.2	3.0	n.a.	78.9	n.a.	54.8	1.2	n.a.	104	19.1	n.a.
23	187	9.8	n.a.	255	n.a.	253	4.5	n.a.	324	178	n.a.
24	69.8	2.8	n.a.	129	n.a.	75.5	3.4	n.a.	206	98.5	n.a.
25	15.6	0.6	17.4	45.9	49.6	34.3	0.1	16.4	69.4	0.03	75
LSD (.05)	32.0	3.5	8.7	33.5	33.4	29.6	4.0	17.9	40.7	151	63

[1] Lipa: June 25, 1996; Tanay: October 4, 1996 and Palayan: July 16, 1996.
[2] Average of 2 consecutive harvests conducted for each site during the season.
[3] Average of 2 consecutive harvests conducted at Lipa during the season; only 1 harvest each for the other 2 sites.
[4] Values were the average of 3 consecutive harvests conducted each for Lipa and Palayan during the season; only one harvest at Tanay.

fied in this study. It exhibited broader adaptation relative to other new species as evidenced by its high rate of seedling growth and biomass production in the high psyllid environment of Lipa, in highly acidic soil of Tanay and under moisture stress condition at Palayan. Further studies, however, are required on the management and feeding value of this large-leaflet species for the present results to become more conclusive.

Sheep Preference

Dry Matter Intake (DMI). **Table 6** shows the sheep DMI and feeding frequency of the different Leucaena accessions. The results re-affirmed the superior palatability of all *L. leucocephala* cultivars for ruminants. These include the cv. Tarramba (K636), Cunningham and Peru (Alabang). The KX2F1 and KX2F5 hybrids were found to be equally palatable. Another species readily eaten by sheep was the *L. collinsii*.

Table 5. Total dry matter yields (g/m row/mo) of *Leucaena* lines and hybrids grown in each site.

Acc.No.	Initial Cut[1]			(Year 1)					(Year 2)		
				WetSeason[2]		Dry Season[3]			Wet Season[4]		
	Lip	Tan	Pal	Lip	Pal	Lip	Tan	Pal	Lip	Tan	Pal
1	103	2.30	71.4	167	192	87.7	6.4	96.7	172	83.0	229
2	34.0	0.6	63.5	78.4	172	39.6	0.7	58.6	140	0.01	259
3	34.8	4.0	43.9	112	177	50.0	4.5	36.7	153	210	318
4	81.5	10.3	36.7	130	196	31.2	0.8	10.3	162	99.7	222
5	51.2	5.9	34.6	137	160	98.3	0.7	10.7	175	52.4	184
6	67.9	3.1	31.8	160	134	72.3	2.4	7.8	165	38.7	147
7	34.7	7.3	6.6	43.0	10.3	24.2	3.5	1.8	66.8	109	7.9
8	34.5	4.4	14.6	24.6	34.8	23.1	8.0	15.0	33.3	95.0	63
9	73.6	6.8	10.6	102	14.8	58.0	2.6	1.3	111	0.01	18
10	78.4	10.0	11.4	84.7	36.9	33.5	7.1	9.8	80.6	181	58
11	153	7.0	25.2	161	24.8	104	5.6	5.5	178	0.01	63
12	63.8	3.5	n.a.	38.2	n.a.	11.5	2.9	n.a.	81.6	0.01	n.a.
13	23.2	0.4	34.4	88.2	81.5	39.7	0.03	7.0	108	20.0	139
14	3.42	0.03	15.6	12.3	28.5	5.8	0.03	2.5	17.6	0.01	45
15	97.6	1.2	63.2	161	108	102	2.1	74.0	186	14.4	219
16	216	8.9	35.0	295	167	192	4.8	45.3	289	111	244
17	n.a.	n.a.	41.2	n.a.	94.3	n.a	n.a.	27.5	n.a.	n.a.	180
18	14.3	1.6	18.4	21.7	46.4	17.9	0.6	27.4	47.0	13.2	49
19	123	1.4	n.a.	65.3	n.a.	45.7	0.7	n.a.	142	7.5	n.a.
20	118	2.9	17.5	115	50.6	68.5	0.4	8.7	118	0.01	53
21	38.4	0.7	9.8	38.9	17.2	18.8	0.06	5.0	30.9	0.01	14
22	195	6.6	n.a.	143	n.a.	86.1	2.6	n.a.	150	28.3	n.a.
23	680	23.7	n.a.	651	n.a.	429	8.8	n.a.	659	215	n.a.
24	229	4.6	n.a.	280	n.a.	137	5.9	n.a.	341	113	n.a.
25	52.1	0.8	35.0	93.4	79.7	45.6	0.2	30.5	117	0.01	126
LSD (.05)	108	8.8	19.8	81.2	58.6	46.4	7.6	29.5	78.8	185	106

[1,2,3,4] (Refer to footnotes in Table 4)

The less palatable accessions included the *L. pallida, L. esculenta, L. macrophylla, L. salvadorensis* and *L. diversifolia.* There were indications that preference to these accessions changed with time with palatability decreasing as the trials progressed (data not shown). Sheep preference to the remaining Leucaena species was ranked as moderate. High degree of positive relationship (r2 = 0.70) was obtained between the DMI and feeding frequency.

Sheep in general are more selective than cattle. Hence, it is possible that most of the other *Leucaena* species would be readily accepted by cattle as have been reported in Florida, USA (*Austin et al 1991*) and in Queensland, Australia (*Faint et al., 1998*)

Palatability and Plant Composition. In this particular experiment, no attempt was made to determine the chemical composition of the plant samples and relate it with sheep preference. Nevertheless, the most recent report of Faint et al (1998) found no significant correlation between sheep DMI and condensed tannin (CT), total tannin (TT), CP, DMD, OMD, NDF, ADF or DOMD. Hence, background information on the chemical composition of

Table 6. **Short term dry matter intakes, feeding observations and rankings for freshly cut *Leucaena* species assessed with sheep in Lipa, Batangas.**

Accession	Mean DMI (g/hd/80min)	Mean feeding frequency[1]	Rank (based on DMI)
*L. leucocephal*a cv Tarramba (K636)	27.20	14.89	1
L. leucocephal cv Cunningham	19.10	11.75	4
L. leucocephal cv Peru (Alabang)	16.16	10.08	5
L. pallida 52/87 (unknown hybrid)	12.9	10.78	9
L. pallida CQ3439	4.66	1.39	19
L. pallida 79/92	6.72	1.76	16
L. diversifolia 82/92	5.34	3.28	18
L. diversifolia 83/92	10.56	6.89	11
L. diversifolia K156	9.26	0.78	14
L. collinsii 52/88	20.66	11.64	3
L. esculenta 47/87	6.25	2.45	15
L. lanceolata 43/85	9.27	8.45	13
L. macrophylla 47/85	8.42	2.45	15
L. salvadorensis 36/89	9.38	7.86	12
L. shanonnii 19/84	13.81	5.22	7
L. trichandra 53/88	13.38	1.22	8
L. leuc K636 x *L. pal* K748 (KX2F1)	21.22	16.95	2
L. leuc K636 x *L. pal* 748 (KX2F5)	15.94	8.08	6
L. leuc K8 x *L. div* K156 (KX3F2)	10.86	4.75	10
LSD (P<0.05)	13.93	9.42	-

[1] Number of times sheep were observed on a particular accession/80 minutes.

Leucaena accessions could give little insight into why some were readily eaten than others. Several species that were found to have poor palatability may have inherent palatability problems. In *L. macrophylla* for example, a pungent odor was noted which may have prevented the animals from feeding as has been commonly reported in *G. sepium.* The KX2 hybrid has shown enormous promise agronomically with broad environmental adaptation, high edible DM yields and psyllid resistance (see section on gemplasm evaluation). Combined with high palatability as shown in this trial and a high nutritive value (*Castillo et al 1997a*), the KX2 hybrid has great potential as forage tree legume. Another new species showing good potential as a fodder tree legume is the *L. collinsii*. This species was highly palatable and has the added advantages of being resistant to psyllid and containing minimal amount of condensed tannin (*Dalzell and Kerven 1998*). The KX2 hybrid and *L. collinsii* deserve large-scale evaluations of their feeding value for livestock.

Grazing Experiment

Pasture Yields. The mean pre-grazing yields in each measurement period for both tree legume and undestorey pasture are presented in **Table 7**. Edible yields of *L. pallida* and *L. trichandra* were consistently higher than that of the *L. leucocephala* and the *L. collinsii* except during the initial measurement period (*June 1997*). Moreover, considerable decline in yield with time was obtained in the latter two species in contrast to that of the two former species.

Unfortunately, the high yielding species, *L. pallida* and *L. trichandra*, were not readily eaten out by the steers as compared to *L. leucocephala* and *L. collinsii*. These marked differences in acceptability were consistently observed during the duration of the trial. Approximately 70-80% of the leaves within the reach of the animals remained intact in *L. pallida* and *L. trichandra* at the end of each grazing cycle. On the other hand, leaves (and other edible portion) of *L. leucocephala* and *L. collinsii* were highly (90-95%) grazed by cattle. These marked differences in the acceptibility of tree legumes had an influence on their regrowths. The relatively low palatability of *L. pallida* and *L. trichandra* had resulted to their high leaf retention and improvement in regrowth. By contrast, leaf retained on the two palatable tree legumes was almost nil, thus, negatively affecting their ability to regrow. Mean yields of tree legumes were generally low (< 450 kg/ha). Nevertheless, understorey yield were considerably high (> 5,000 kg/ha) hence overgrazing was not observed in all treatments.

Animal Liveweights. The experiment was divided into 2 grazing periods (GP) with 3 months gap in between when all animals were withdrawn from their respective paddocks. This strategy of resting the pastures was adopted to arrest the continuous decline in yields of the *L. leucocephala* and *L. collinsii*.

Steers' gain in the 1st 144 days of grazing (GP1) was highest in the *L. leucocephala* followed by the *L. collinsii* and *L. trichandra* (**Table 8**). *L. pallida* had the lowest steer gain among tree legumes but the value was still twice that of the native pasture (control). Similar trend was obtained in the succeeding period (GP2) except in the *L. trichandra* where a very big improvement in

Table 7. Mean DM yields (kg/ha) of tree legumes and understorey species at MLPC, Milagros, Masbate.

Pasture Treatment	Measurement Period*						Mean
	1	2	3	4	5	6	
NP (Control)	6500	6440	5440	4960	7020	7000	6227
L. leucocephala							
edible	350	384	121	83	200	200	223
understorey	7000	7080	4561	4640	6740	6500	6087
L. pallida							
edible	300	241	139	345	400	436	310
understorey	6400	5180	4659	3520	6510	6730	5500
L. collinsii							
edible	150	88	82	36	110	107	96
understorey	7500	7720	4282	5640	5420	5400	5994
L. trichandra							
edible	430	452	315	396	461	447	417
understorey	6300	6080	5795	3520	7620	7500	6136

*1= June 1997 (rep 1); 2= July 1997 (rep 2); 3= Sept. 1997 (rep 1)
4= Oct. 1997 (rep 2); 5= Feb. 1998 (rep 1); 6= March 1998 (rep 2)

Note: Experimental area was given a rest during the period November 1997 to January 1998.

Table 8. Mean LWG (kg) of steers grazing various grass/tree legume pastures at MLPC, Milagros, Masbate.

Item	Liveweight Gain (kg)		
	Per head	Per hectare	ADG
GP 1 (144 days)*			
NP (Control)	20.00 d	50.00 e	0.14 d
L. leococephala	59.80 a	149.50 a	0.42 a
L. pallida	36.40 bcd	91.00 bcd	0.25 bcd
L. collinsii	50.80 ab	127.00 ab	0.35 ab
L. trichandra	47.20 abc	118.00 abc	0.33 abc
GP 2 (45 days)*			
NP (Control)	5.50 d	13.75 d	0.12 d
L. leucocephala	20.40 ab	51.00 ab	0.45 ab
L. pallida	6.60 d	16.50 d	0.15 d
L. collinsii	14.00 bc	35.00 bc	0.31 bc
L. trichandra	27.40 a	68.50 a	0.61 a

Means within row with a common letter are not significantly different (P>0.05).
* Grazing period (GP) 1 = July 1 to November 22, 1997
Grazing period (GP) 2 = February 10 to March 27, 1998

LWG was obtained. It is interesting to note that the species with higher steer gains where those that were readily eaten by the animals. These species were also reported to have higher IVDMD and lower condensed tannin levels as compared to *L. pallida* and *L. trichandra* (*Castillo et al., 1997a*). There are also indications that forage quality is a factor that cannot easily be compensated for by additional yield. DM contributions of the *L. leucocephala* and *L. collinsii* to the total pasture yield were lower relative to the remaining species. Inspite of this they still gave the higher steer gain. Dr. R. Gutteridge (personal communication) of the University of Queensland also reported that the *L. leucocephala* cv. K636 despite of its lower yield, gave higher steer gain than Tipuana tipu and *Albizzia chinensis*. Reasons for the poor preference of steers for *L. pallida* and *L. trichandra* are still not known as discussed in the previous section (see section on sheep preference).

The cumulative LWG of steers on the different pasture types are shown in **Figure 2**. There was a continuous increase in steer weight in all pastures with time except during the period when all animals were placed in native pastures. The overall trend showed that the pastures containing the tree legumes continuously gave much higher LWG as compared to the control treatment.

CONCLUSIONS

The results confirm the big potentials of some less known *Leucaena* accessions for livestock production. The F1 hybrid between *L. leucocephala* K636 x *L. pallida* K748 (KX2 hybrid) in particular has demonstrated outstanding characteristics as forage plant. It is highly resistant to psyllid and an excellent wood and forage producer and therefore the best bet in smallholder farms where

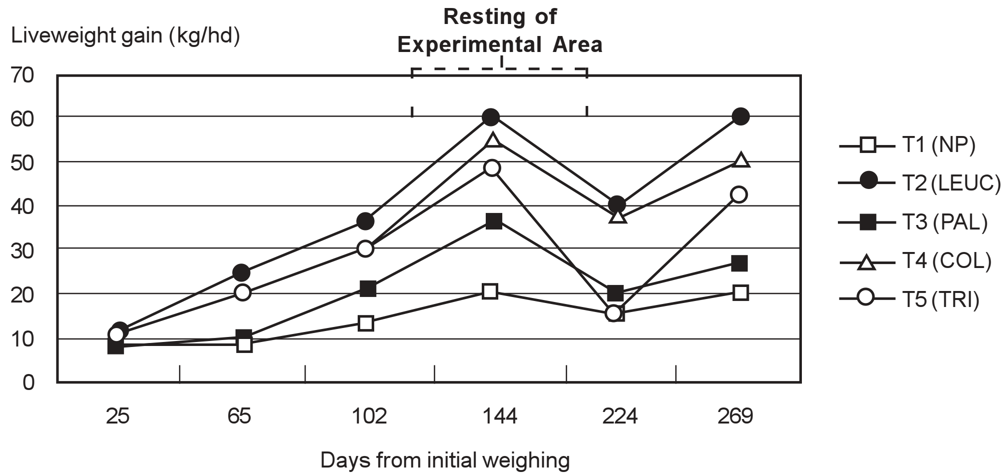

Figure 2. Cummulative liveweight gain (kg/hd) of Brahman steers on various pasture types, MLPC, Milagros, Masbate.

psyllid infestation is a major constraint. However, low cost methods of vegetative propagation have to be developed before undertaking wide-scale promotion to meet the potential demands of planting materials. Such methods are currently under study.

Another new accession that deserves further attention is the *L. leucocephala* cv. K636. This accession unlike the KX2 hybrid is less woody , has superior forage quality and may easily be propagated by seed. Hence, it is the best bet for wide scale planting in commercial ranches where soil pH is above 5.0.

Further studies on other promising accessions particularly the *L. collinsii* and the *L. macrophylla* and other interspecific *Leucaena* hybrids in wider environments and involving animals are still necessary.

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