EVALUATION OF LEGUMINOUS FODDER TREES AS DRY SEASON FEEDS FOR LIVESTOCK IN THE GAMBIA

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INTRODUCTION

Inadequate feeding has been identified as one of the limiting factors to livestock production systems in The Gambia. Improved animal performance is dependent on the supply of good quality feeds throughout the year; but forage availabilty fluctuates due to seasonality of rainfall which also influences the quality and the pattern in which livestock utilize these resources.

At present livestock are managed under traditional methods. In the wet season cattle herds and small ruminant flocks are herded away from crop fields to graze natural pastures surrounding the village; but some producers individually tether sheep and goats on edges of crop fields or along road sides.

Significant amounts of crop residues are produced by farmers who are also livestock owners. In the early dry season the animals utilize crop residues and weeds in addition to range forage. Farmers collect the residue of the groundnut crop, but there is no quantitative data to show the extent of cereal crop residue storage and feeding.

The peak of the dry season is characterised by a reduction in available range forage. The herbaceous biomass, if not devastated by bush fires, decline in quality to the extent that it can no longer meet the nutrient needs of the ruminant livestock population. As a consequence small ruminants in particular are forced to scavenged around the village or other areas where feed can be found.

Sheep however receive nutritional supplementation in the dry season in the form of household scraps and cereal brans, but groundnut hay is the most commonly given supplement throughout the year (Greenwood and Mullineaux, 1985). Groundnut hay is superior nutritionally to the cereal crop residues. Immediately after the harvest groundnut hay leaves contain about 18% crude protein (CP) while the stems contain about 11% on a dry matter (DM) basis compared to 6 and 3% CP found in maize leaves and stems (Njie, 1993). The retention of the CP content of the feed depends on how it is stored. Groundnut hay stored in covered buildings retains its feeding value better than when it is exposed.

Groundnut is the most important crop in The Gambia, but the processing of this crop for oil is centralised as a result very little of the cake produced is available to farmers. On the other hand sesame seed cake is produced in small oil extraction plants in 16 villages throughout The Gambia (Njie, 1993). The cake is used for soap making in addition to livestock and poultry feeding.

Browse tree leaves and fruits are also important components of livestock diets in the dry season. *Pterocarpus erinaceous* with a CP content of over 12% (on a dry matter basis) appears to be the most important local browse tree species in The Gambia. The leaves are widely used to supplement free ranging livestock and draught animals during the late dry and early rainy season.

Improving livestock nutrition requires, among other things, the cultivation of forages to meet the maintenance and growth requirements of large and small ruminants. At present Gambian farmers do not grow forages because of the land tenure system, lack of planting material and technical knowledge. The current land tenure and extensive grazing systems are not favourable for the establishment of pastures because, under these systems, producers do not have exclusive access rights to the grazing resources.

Back yard gardens have been identified as a suitable entry point for the cultivation of forages because farmers have exclusive access rights to the resources. Feed gardens (fodder trees, cultivated and managed intensively) could be established in the back yard gardens of small ruminant producers at low cost in terms of labour, land and management inputs. The back yards have stock proof fences which will prevent livestock from damaging the trees. The close proximity of the fodder gardens to the animal holding areas and homestead will facilitate the watering of the trees during the dry season and the use of the cut-and-carry system.

Leucaena leucocephela (Lam) de wit - Variety: 'Hawaii" (K26) and *Gliricidia sepium* (Jacq) - Variety: 'Fajara Local' are two fodder tree species which are adapted to Gambian conditions and could be easily established in the back yards. The fodder trees produce protein rich leaves all year round which could be used as supplementary feed throughout the year.

OBJECTIVES

The major objectives of this study were to investigate methods of establishment and management of fodder trees in small holder farming systems.

The specific objectives were to

1 determine the most appropriate establishment method;

2) measure leaf yield of *L. leucocephela* and *G. sepium* and

3) evaluate the persistence of the 2 species.

METHODS

The *L. leucocephela* seeds were scarified by immersing them in hot water for about 2 minutes followed by sun drying; but *G. sepium* seeds were not scarified. the seeds were drilled at a depth of 2 cm in black polythene pots containing a mixture of 25% cattle dung and 75% soil in April, 1992. The pots were kept under shade, watered once daily prior to plant emergence, and twice daily thereafter until the seedlings were transplanted in July.

The fields were cleared with a hoe after the first rains in July, 1992 and soil samples obtained for chemical analyses; no soil amendments were applied prior to planting.

Two establishment methods were compared to determine the most appropriate:

1) Transplanting: About 90 day old *G. sepium* and *L. leucocephela* seedlings were transplanted in pure stands of 150 trees each with 2 replicates at two sites in July, 1992. Inter and intra row spacing is 25 and 100 cm, respectively (30 trees per row).

2) Direct seeding: scarified *L. leucocephela* and unscarified *G. sepium* seeds were direct seeded in pure stands with 2 replicates at the two sites in July, 1992. Plant population is the same as the transplanted plots.

In August, 1993 5 trees in each of the 5 rows were cut back to either 25, 50 or 100 cm above ground level to measure leaf yield; i.e. 3 treatments (cutting height 25, 50 and 100 cm) with 50 trees per treatment. The same trees were again cut back to their original heights of 25, 50 and 100 cm in January, 1994.

The green weight of the leaves from each tree were obtained and bulked sub-samples oven dried to 50 C for three days to obtain the DM. The CP (N * 6.25), ash, Neutral Detergent Fibre (NDF) and Acid Detergent Fibre (ADF) were obtained using standard methods.

RESULTS AND DISCUSSIONS

SITES

The characteristics of the 2 sites are summarized in Table 1. In Keneba *Macroptilium atropurpureum* (siratro) was on the site prior to tree establishment while the Sololo field was in maize the previous rainy season.

TABLE 1. SITE CHARACTERISTICS

	Keneba	Sololo
Soils:	Sandy Clay	Sandy Loam
Soil Ph	5.6	5.2
Organic Matter:	1.2%	0.8%
Available P:	1.5 ppm	9.0 ppm
Exchangeable K:	49.7 ppm	56.3 ppm
Exchangeable Ca:	361.0 ppm	190.4 ppm
Exchangeable Na:	62.7 ppm	59.7 ppm
Rainfall May to October, 1992:	750.4 mm	778.8 mm
Min. and Max. Temperatures:	19.5 - 40.5^{0}C	14.0 - 45.0^{0}C

Organic matter and available nutrients are generally low at both sites but soil Ph is within the range that could be tolerated by *L. leucocephela*. *L. leucocephela* requires a Ph range of 5 to 8 (Skerman et al, 1986) while ***G. sepium*** tolerates a wide range of acid soils (Chadhokar, 1982).

EMERGENCE AND ESTABLISHMENT RATES AND TREE HEIGHTS

Emergence rates were determined 30 days after pot sowing (DAS) by counting the number of pots with seedlings and expressed as a percentage of the original number of pots sowed. *G. sepium* had the highest emergence rate (Table 2). Poor seed viability might have been responsible for the none emergence of the *L. leucocephela* seeds.

TABLE 2. EMERGENCE AND ESTABLISHMENT RATES AND TREE HEIGHTS

SITE	SPECIES	EMER. RATE (%)	ESTAB. RATE (%)	MEAN HGT. PLANTING (cm)	MEAN HGT IN NOV. (cm)	SD
KENEBA	Lele	73	90	14	135	15
SOLOLO	Lele	70	90	16	124	20
KENEBA	Glse	92	93	21	111	13
SOLOLO	Glse	97	95	22	134	19

The emergence rates of the directly seeded plots were generally poor. At 30 DAS emergence rates of 34 and 29% were recorded for *L. leucocephela* and *G. sepium*, respectively. In Keneba seeding was followed by a two day dry spell while in Sololo seeding was immediately followed by rainfall which should have resulted in high germination rates but this did not occur. The emergence rates observed in this trial compare to the 33% recorded elsewhere in The Gambia (DAR, 1987).

Initial seedling heights at the time of transplanting, establishment rates and average heights attained at the end of the first rainy season are shown in Table 2. *G. sepium* had higher initial seedling heights than *L. leucocephela* but establishment rates (determined by counting the number of trees growing and expressed as a percentage of the original number transplanted) of both species were 90% and above at both sites. The establishment percentages recorded for *G. sepium* are higher than those reported in Sri Lanka where the trees were established by stem cuttings (Chadhokar, 1982).

The transplanted trees attained average heights of 111 cm and above after 112 days of growth. These heights are below those achieved in the more humid coastal region of Kenya (Getahun and Jama, 1986).

LEAF DRY MATTER YIELD AND TREE PERSISTENCE

All the trees which were established at the end of the 1992 rainy season survived the hot and dry weather of 1992/93. Total rainfall for the whole rainy season (July to October) of 1993 in Keneba and Sololo was 621 and 693 mm, respectively.

Leucaena leucocephela

Overall mean tree heights attained after 13 months of growth were 190 cm in Keneba and 180 cm in Sololo; in January tree heights averaged 185 cm in Keneba.

Leaf (DM) yields of *L. leucocephela* cut at three different heights in August, 1993 and January, 1994 are presented in Table 3. In August, differences in fodder yield at the two sites were not significant, but there were significant yield differences between treatments. In Keneba the trees cut at 50 cm during the rainy season gave the highest yield, but in January the lowest cutting height resulted in the highest yield.

The leaf DM yields obtained are below the range of 9 to 10t/h (Skerman *et al*, 1988) for the small and bushy Hawaiin *L. leucocephela* but is within the range of 2 to 20 t/h that has been reported elsewhere (Lulandala and Hall, 1986).

Individual tree leaf yields were variable due to differences in tree heights (60-300 cm in Keneba and 50-380 cm in Sololo), number of branches per tree and degree of leaf shedding by individual trees. The taller trees appeared to bear more harvestable branches and yielded more leaf biomass. These factors account for the high coefficient of variation (CV%) (Table 3).

TABLE 3. LEAF DRY MATTER YIELDS OF LEUCAENA LEUCOCEPHELA CUT AT 25, 50 AND 100 CM FROM GROUND LEVEL AT 2 SITES.

		Keneba			Sololo		
	Cutting Height	DM g/tree	SD	CV%	DM g/tree	SD	CV%
Aug. '93	25 cm	79.3 a,b	55.8	70.4	73.3 a,b	72.6	99
	t/h	3.0			2.9		
Jan. '94		49.6 d	42.8	86.3	Nil		
		2.0					
Aug. '93	50 cm	83.3 a,b	77.0	92.4	60.5 a,b	47.0	77.7
	t/h	3.3			2.4		
Jan. '94		35.7 e	27.8	77.9	Nil		
		1.4					
Aug. '93	100 cm	45.7 a,c	34.4	75.3	37.9 a,c	36.4	96.0
	t/h	1.8			1.5		
Jan. '94		28.4 f	24.4	85.9	Nil		
	t/h	1.1					

NB: a: Values on the same row marked with the same letter are not significantly different at the 0.05 level.

b,c,d,e,f: Values on the same column not marked with the same letter are significantly different at the 0.05 level.

The Hawaiian *L. leucocephela* is a prolific seeder which flowers throughout the year and sheds a great deal of leaves. Leaf shedding was observed throughout the year but was most pronounced during the dry season. In fact the trees in Sololo could not be harvested in January because they were defoliated.

Leucaena leucocephela withstands defoliation and is persistent once established (Skerman *et al*, 1988). In Keneba all the trees harvested in the rainy season of 1993 persisted, but there was a post harvest mortality rate of 15% in Sololo. The death of the trees could be attributed to site specific factors like soil type, moisture regime and partly to management. The Keneba soil has a higher water holding capacity because of its clay content; it is therefore likely that the trees obtained water during the dry season and continued their growth while growth ceased completely in Sololo.

Leucaena leucocephela is a poor weed competitor when young (Skerman *et al*, 1988). The plots in Keneba were kept weed free during the year while those in Sololo were infested with weeds. weeding reduced competition for water and nutrients which led to the good establishment of the trees.

Leucaena leucocephela has been successfully used for small ruminant production systems in Nigeria either in alley farming or in feed gardens (Ademosum, 1986). The tree foliage can be cut-and-carried to supplement tethered sheep or goats during the wet season. Given a DM yield of 79 g/tree (Table 3;

cutting height=25 cm; Keneba), and assuming a 200 g DM/day supplementation level, 151 trees will be required to supplement one tethered small ruminant for 60 days during the cropping season.

The DM and CP content of *L. leucocephela* is presented in Table 4. Leaf CP content is higher in the rainy season. The 14% CP content in the dry season is less than the 18% CP in groundnut hay leaves reported by Njie (1993). However, it has been demonstrated, through on station feeding trials, that L. leucocephela leaves could replace groundnut hay as a protein supplement during the dry season. When fed at sufficient levels to provide 50 g CP/day the supplements produced comparable daily weight gains.

TABLE 4. DRY MATTER AND CRUDE PROTEIN CONTENT OF LEUCAENA LEUCOCEPHELA HARVESTED IN AUGUST AND JANUARY

Site	Sampling Date	% DM	
		DM	CP
Keneba	August	27	24
Keneba	January	39	14
Sololo	August	33	20

A feed garden consisting of 150 trees and harvested at 25 cm from ground level during the dry season will provide 20 days of supplemental feed (50 g CP/day) for one ram. However, since all the trees will not be harvested at the same time feed supply will be available for more than the calculated number of days.

Gliricidia sepium

After 13 months of growth tree heights averaged 170 cm (40-330) and 190 cm (80-300) in Keneba and Sololo, respectively; but January mean heights were equal to 210 cm. The tree heights achieved are more than those reported in the western part of The Gambia (less than 1 metre) where the trees were established from seed (DAR annual Report, 1987).

Significant leaf yield differences were found across sites but not between treatments in Sololo (Table 5). The lowest cutting height yielded more fodder than those cut at 50 and 100 cm in Keneba but the differences between treatments were not significant. Dry season yields were however found to be significantly different. These yield fiqures are below those reported in Sri Lanka (Chadhokar, 1982).

Dry matter yield is influenced by age and size of plants, agro-climatic conditions and frequency of cutting (Chadhokar, 1982). *G. sepium* should be harvested only once or twice during the first two or three years of establishment. The low yields obtained could be a result of harvesting after just 12 months of growth.

TABLE 5. LEAF DRY MATTER YIELDS OF GLIRICIDIA SEPIUM CUT AT 25, 50 AND 100 CM FROM GROUND LEVEL AT 2 SITE.

	Cutting Height	Keneba DM g/tree	SD	CV%	Sololo DM g/tree	SD	CV%
93	25	136.9 a,c	113.9	83.2	46.8 b,d	34.0	72.6
	t/h	5.5			1.9		
94		37.6 e	34.8	92.6	Nil		
	t/h	1.5					
93	50	103.2 a,c	58.2	56.4	49.9 b,d	28.1	56.3
	t/h	4.1			2.0		
Jan. '94		22.5 f	25.0	111.1	Nil		
	t/h	0.9					
Aug. '93	100	100.2 a,c	79.8	79.6	43.2 b,d	31.3	72.5
	t/h	4.0			1.7		
Jan. 94		27.0 g	26.1	96.7	Nil		
	t/h	1.1					

a,b: Values on the same row marked with different letters are significantly different at the .05 level

c,d,e,f,g: Values on the same column marked with the same letter are not significantly different at the .05 level

Post harvest tree survival was poor in Sololo. All the trees in one of the replications died during the 1993 dry season and a 5% mortality rate was observed in the other replication. This high mortality rate could be attributed to agro-climatic conditions, management factors and poor tree establishment.

Gliricidia sepium flowers in December and the pods mature in March/April during which time the trees shed their leaves. In Sololo the trees were completely defoliated by January. In order to avoid leaf shedding and maximise DM yield the interval between each harvest should be shortened. It is recommended that *G. sepium* be harvested every 3 months (Chadhokar, 1982).

Gliricidia sepium is often compared to *L.leucocephela* in terms of feeding value but it takes longer for animals to get accustomed to eating *G. sepium* leaves. Leaf CP content of the two species harvested in August were found to be similar (Tables 4 and 6). The 15% level in the dry season is above the 11% CP found in groundnut hay stems (Njie, 1993).

TABLE 6. DRY MATTER AND CRUDE PROTEIN CONTENT OF GLIRICIDIA SEPIUM HARVESTED IN AUGUST AND JANUARY.

Site	Sampling Date	% DM DM	CP
Keneba	August	26	14
Keneba	January	35	15
Sololo	August	23	21

CONCLUSIONS

The results show that transplanting about 90 day old *L. leucocephela* and *G. sepium* seedlings had a higher success rate than direct seeding. Farmers who wish to plant fodder trees would have to start raising the seedlings in April so that they are ready for planting in July. The plants should be watered daily at a time when farmers are busy clearing their fields in readiness for the cropping season. This would appear to be labour intensive, but the high success rate that would be achieved will compensate their efforts.

Management practices like weeding seem to have affected tree establishment and persistence. The trees in Keneba persisted better than those in Sololo mainly because the plots in Keneba were kept weed free during the first two years of establishment. Labour availability is critical during the cropping season, but the weeding of the fodder gardens could be carried out at the same time as when farmers are weeding other crops in the back yard..

The optimum time to harvest was not an issue in this trial but time of cutting appears to have an influence on *G. sepium* dry season leaf growth and retention. This tree is completely defoliated during the flowering and fruiting period; therefore, it should be harvested before it flowers in December to avoid the loss of biomass.

These preliminary results show that significantly more leaf biomass is produced if *L. leucocephela* is cut at 25 cm above ground level, but it is too early to draw any conclusions on the effects of cutting height on yield and persistence since the effects will only become apparent in the long term.

The high CP content found in the foliage of the fodder trees demonstrates their desirable qualities as supplementary feeds for small ruminants. These qualities, coupled with their ability to adapt to the weather and poor soils should be exploited to meet the needs of small scale small ruminant producers throughout the year.

RECOMMENDATIONS

1) Continue to assess the effects of cutting height on yield and persistence.

2) Investigate different intervals and times of cutting.

3) Assess the effects of cutting height on CP levels.

4) Identify and acquire high yielding *L. leucocephela* and *G. sepium* cultivars for evaluation under Gambian conditions

5) Explore the feasibility and acceptability of establishing fodder banks through multi locational on-farm trials.

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