3 Yield and nutritional value of alley crops

3.1 Introduction

Leucaena leucocephala (leucaena) has the potential to increase agricultural production, especially in developing countries where fertilisers are expensive, availability of technology is restricted and productivity low. The adoption of techniques such as alley cropping can result in increased productivity, thereby also improving income and living standards of subsistence farmers (Blair, Catchpoole & Horne, 1990).

Leucaena was found to be compatible with a number of forage- or crop production systems, ranging from fruit trees, vegetables and cash crops, the most common being maize. Hedge trimmings from leucaena can be carried as excellent green manure to row crops like maize and rice. Leucaena leaves mature over a period of 2 – 4 weeks and the leaflets, pinnae and midribs dehisce in 3 – 5 months. The litter is fragile and quickly decomposed, with a N-half life of 7 days if buried (Guevarra *et al.*, 1978; Kang *et al.*, 1984; both cited by Brewbaker, 1987). The continuous removal of pruning biomass reduces soil fertility, while the incorporation of prunings as green manure, or mulch, enriches soils, especially sandy soils that are exposed to leaching of soluble fertilisers in tropical environments (Mwange, Mbaya & Luyindula, 1997). Repeated application of leucaena prunings maintained higher soil organic matter levels and increased the soil moisture retention capacity. The deeper root system of leucaena also appears to extract more soil moisture from lower soil horizons (>50 cm) than the maize crops which taps the surface layers (<50 cm depth), and thereby reduces competition for moisture (Kang, Grimme & Lawson, 1985).

Dommergues (1987) referred to results by Sanginga, Mulungoy & Ayanaba (personal communication), who found that leucaena fixed 98 – 134 kg N_2/ha in 6 months. The high nitrogen-fixing potential of this tree is related to its abundant nodulation under specific soil conditions.

Application of leucaena prunings could supply enough N to maize plants to significantly reduce the degree of N deficiency (Xu, Saffigna, Myers & Chapman, 1993) but cannot provide enough N to be *equivalent* to those recommended when using inorganic fertilisers in order to get maximum yields of maize. However, the significant positive interaction between N fertilizer and leucaena prunings in increasing maize yield, suggested that application of leucaena prunings could improve the efficiency of use of N fertilizer. The application of N fertilizer could also increase the benefits of leucaena prunings for maize production (Xu *et al.*, 1992; Xu, Myers, Saffigna & Chapman, 1993). The addition of leucaena prunings significantly increased N uptake of seedlings, N percentage in ear leaves of maize, and the dry matter yield of maize. With pot experiments, incorporating the prunings appeared to be more effective than applying it as mulch. This can possibly be attributed to NH_3-N volatilization loss during decomposition under high temperature conditions in the field. Field trials, however, failed to show any difference between incorporation as opposed to surface application of leucaena leaves. Although leucaena was not as efficient as inorganic fertiliser, it had a significant residual effect on the succeeding maize crop (Kang, Sipkens, Wilson & Nangju, 1981; Read, Kang & Wilson, 1985).

Although results varied, cropping in association with leucaena invariably resulted in higher total biomass production than compared to monocropping systems and reduced fertiliser requirements (Gill & Patel, 1983 as cited by Singh, 1987; Palada, Kang & Claassen, 1992). In some instances the addition of prunings alone would only maintain crop yield, requiring supplementary fertilisation in order to increase yields (Kang, Wilson & Sipkens, 1981; Kang, *et al.*, 1985; Kang & Fayemilihin, 1995). The contrary has also been reported: that prunings alone could result in increased yields (Brewbaker, 1987; Singh & Singh, 1987, as cited by Singh, 1987). It could generally be accepted that yield may be increased with the addition of prunings, but to obtain optimal yield, additional fertiliser would be required. Kang and Fayemilihin (1995) concluded that when the availability of N was limited by removing hedgerow prunings, and not applying fertiliser N, proximity to leucaena hedgerows improved maize yield, possibly due to litter fall, which overrode the competitive effects such as partial shading. Szott, Pall & Sanchez (1991) observed that crop yields generally increased with distance from the hedges and declined with time, despite crop residue return and hedgerow intercropping.

There is a perception that some of the evidence of the high productivity of legumes in the tropics is indirect and inferential, with a paucity of information from controlled experimentation and research. Much of the information on cutting management of leucaena for forage is conflicting, and there are few reports of the yields of nitrogen that can be obtained when forage is cut from leucaena (Blair *et al.*, 1990). To date, much of the work of alley cropping has been in context of continuous cropping, which is not sustainable on acid, infertile soils. Szott *et al.* (1991) emphasized its use in situations where it is clearly beneficial, for example, in areas where land availability is severely limited, erosion control (aiding terrace formation on slopes) and/or as a "head start" to fallow regrowth in improved shifting agriculture systems.

It has been stressed that leucaena is not a miracle tree. Brewbaker (1987) remarked that with an average tropical maize yield of only 1.2 t/ha, however, any procedure increasing grain yields to 2 t/ha under continuous rather than periodic cropping could have a substantial impact on tropical maize production. It is generally concluded, however, that in view of the escalating costs of inorganic fertilisers, the role of these trees as a supplementary source of N can not be ignored, and could be especially important for smallhold farmers. The principle is just as applicable in areas receiving less rainfall, where available moisture is yet another restrictive factor in agricultural production.

The objective of this paper was to assess yield and quality responses of alley cropped grains and fodder, receiving leucaena mulch, in a semi-arid setting.

3.2 Materials and methods

An alley cropping field experiment was conducted on the Hatfield Experimental Farm of the University of Pretoria (Table 1). The study was laid out in a 2x3x3 factorial randomized complete block design with five replications, involving two alley widths (3m and 6m), three pruning treatments (Table 2), and a split plot for three alley crops (maize, grain sorghum, fodder sorghum). Blocking was done across the length of the plot, on an east-west axis, based on previously observed differences in growth (Lindeque, 1997). Statistical analysis did not compare yields between the two years, as treatments were adapted by experience after the first harvest season. An analysis of variance with the GLM and ANOVA models (Statistical Analysis Systems, 1994) was used to determine the significance between different cutting treatments, rows, blocks and the interaction between treatment and rows and season effects for unbalanced data. Least square means (LSM) and standard errors (SE) were calculated. Significance of difference ($P \leq 0.05$) between LSM was determined with the Bonferroni test (Samuel, 1989).

Table 1 Site description on Hatfield Experimental Farm

Locality	28°16'E, 25°45'S
Altitude	1372 m
Av. Annual rainfall	709 mm
Av. Max. and min. temp.	30°C (Jan), 2°C (Jun)
Soil type	Sandy clay (37 % clay), Hutton, homogenous to a depth of 0.66 m after which it becomes gravelly (MacVicar, Loxton, Lamprechts, Le Roux, De Villiers, Verster, Merryweather, Van Rooyen & Von M. Harmse, 1977).

Table 2 Pruning treatments applied to *L. leucocephala* in the alley cropping trial

S1	Control - no pruning
S2	Pruning to a single stemmed tree (± every 6 weeks), clearing the undergrowth up to 1 m. In 1998 the interval was changed to 8 weeks. Prunings returned as mulch.
S3	Hedgerow (± every 4 weeks), cut back to 1m height and ±0.75 m width. Prunings returned as mulch.

An existing leucaena stand, planted at a tree density of 3 333 trees per ha, was used. Before the start of the 1996/1997 growing season, the trial was converted to an alley cropping trial by removing selected alternate rows. Pruning of the trees started in November 1996 and was repeated at fixed intervals thereafter, until April 1998. Maize, grain sorghum and fodder sorghum were planted between the leucaena rows at a row espacement of 60 cm. The 6m alley contained 7 rows of crops, and the 3m alley 2 rows of crops respectively. The first crop row was located 1.2 m away from the hedgerow. The crops received no irrigation or fertiliser. Yields of the different pruning treatments were applied as mulch between the alley crops (Fig. 1). Control plots receiving no mulch were planted of each crop, at the same plant density. The control was also not irrigated, but received supplementary fertiliser as follows:

1997: N1 = 21 kg N/ha 3 weeks after plant, 42 kg/ha N as top dressing
1998: N0 = no fertiliser
N1 = 15 kg N/ha at plant, 50kg/ha N as top dressing

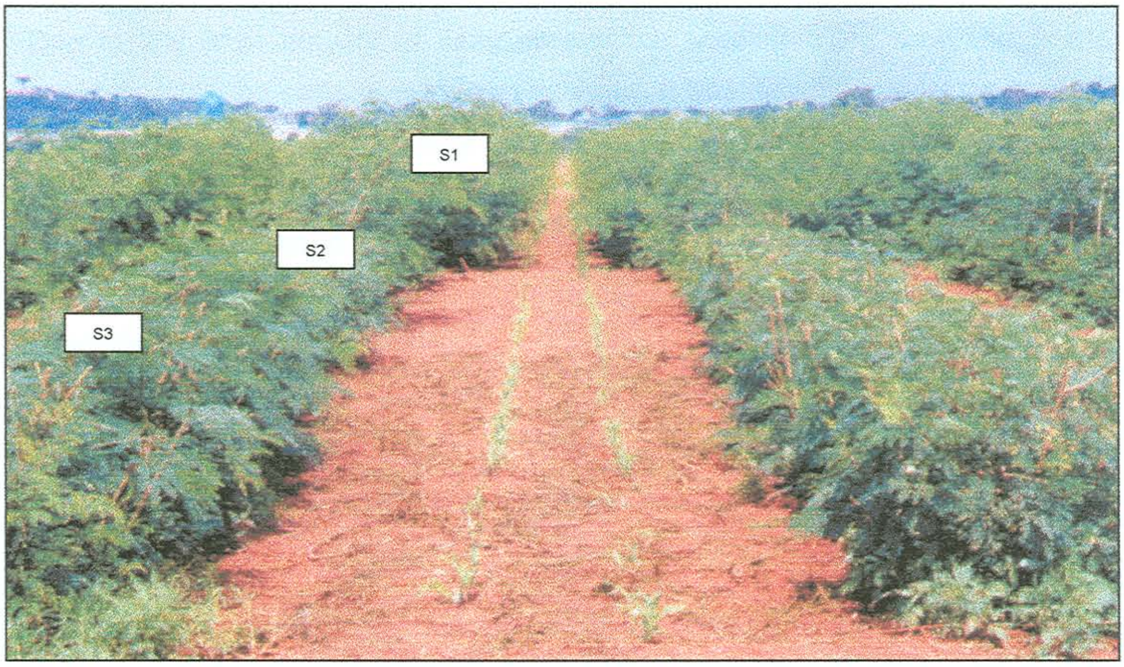

Fig. 1 Layout of plot. Three pruning treatments are visible (front to back: S3, S2, S1) as well as the first mulch application.

Observations envisaged included:

- Maize : Grain yield, stubble yield, stubble quality (CP, NDF, IVOMD)
- Grain sorghum : Grain yield, stubble yield, stubble quality (CP, NDF, IVOMD)
- Fodder sorghum : Plant height before harvest, fodder yield, fodder quality (CP, NDF, IVOMD)

Because of bird damage to both the maize and grain sorghum in 1996/1997, only fodder sorghum was planted in 1997/1998.

Samples for the determination of dry matter yield and dry matter concentration were taken at each harvest and dried at 100° C for 24 hours, before being weighed again. Samples for the determination of nutritive value were taken at each harvest and dried at 60° C for 24 hours, before being weighed again. The following analyses were conducted:

- N content as determined by the micro-kjeldahl method (% CP = %Nx6.25) (AOAC, 1984).
- Neutral Detergent Fibre (NDF) (Van Soest & Wine, 1967)
- *In vitro* digestible organic mattter (IVDOM) (Tilley & Terrey, 1963, as adapted by Engels & Van der Merwe, 1967).

Due to the large amount of samples and the accompanying time and financial implications of the costs of nutritional analyses, it was decided to pool the harvested material of some rows of the alley *after* the dry mass yields were determined. Rows 1,2, 6 & 7 were pooled and are hereafter referred to as group 1 (Fig. 2). Rows 3 and 5 were pooled as group 2 and row 4 remained as group 3. Samples for the analysis of nutritional value were taken from the pool, therefore no statistical analysis were conducted on the nutritional values.

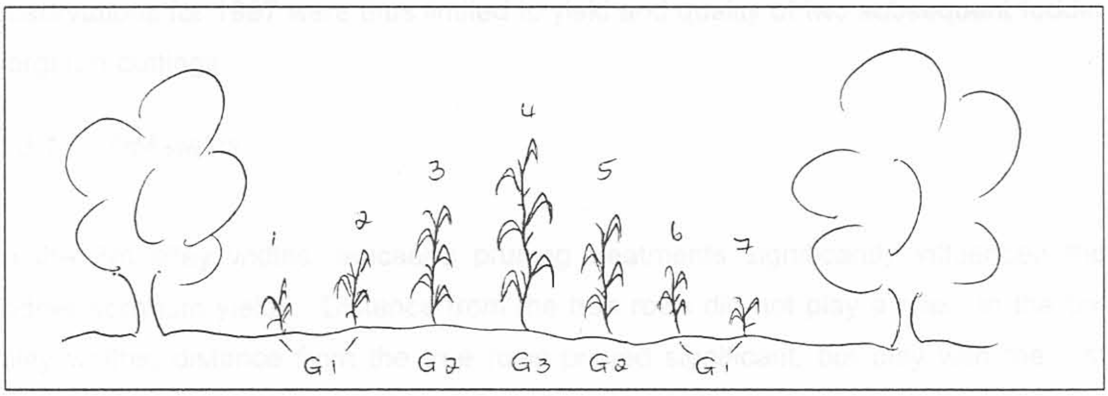

Fig. 2 Schematic representation of alley crop layout and combination of rows for analytical purposes

3.3 Results and discussion

After being weighed, the leucaena prunings were placed in the alleys as a mulch in the respective treatments where it was harvested. Crude protein content was determined at each harvest (Table 3). The results of the yield determination and chemical analyses are presented in Fig. 3 to 21 and Tables 4 to 12.

Table 3 Total biomass yield (t/ha) and nitrogen concentration (%) of leucaena prunings applied to alley crops (DM basis)

Treatment	1997		1998	
	3m	6m	3m	6m
S1	-	-	-	-
S2	23.448	17.534	18.235	11.079
S3	18.148	11.172	38.593	20.037
Ave. [N]	3.64		4.69	

3.3.1 1996/1997 season

The 1997 potential harvest was lost to a great extent due to damage to the crops by birds. The maize crop was destroyed by guinea fowl within days of being sown and could thus not be harvested. The grain sorghum crop was severely damaged by birds at the time of grain development, and no grain could be harvested. Although the stubble was harvested, it was decided not to use the results as nutrient allocation to the leaves would not be representative of a post-grain-harvest situation. The observations for 1997 were thus limited to yield and quality of two subsequent fodder sorghum cuttings.

3.3.1.1 DM yields

In the 3m alley widths, leucaena pruning treatments significantly influenced the fodder sorghum yields. Distance from the tree rows did not play a role. In the 6m alley widths, distance from the tree rows proved significant, but only with the first harvest. The pruning treatment was significant throughout.

With both cuttings in the 3m alleys, the lowest yields were obtained in the S1 treatment (no pruning) (Table 4). In S2, the yields seemed to decrease towards the second cut, while the opposite was observed in S3. The trees of S3 were kept pruned to a height of ±1m, thus allowing light to reach the fodder sorghum, whereas the trees of S2 already cast a shade over the alley crops. This may have depressed yields.

In the 6m alleys, yields in S1 also tended to be lower, although not significantly lower than S3 (Table 5). Yields in both S2 and S3 tended to increase towards the second cut. A monocrop stand of fodder sorghum at the same density tended to have higher yields (DM1 = 0.203 kg/m and DM2 = 0.318 kg/m). The lower yields of the monocrop in the first cutting could be attributed to the fact that fertiliser was only applied three weeks after planting, resulting in sub-optimal growth conditions.

Definite effects were observed with regard to row position in the 6 m alleys with the first cutting (Table 6). The rows nearest to the tree rows (r1 and r7) had the lowest yield, followed by the second rows (r2 and r6). It must be noted that yield increases towards the middle of the alley (r3-r5, >2.4m away) could have been induced by the removal of a tree row the previous year, in order to create the 6m alley. Nitrogen could be released by the decomposing plant material, creating a carry-over effect that, together with the application of prunings, could have induced higher yields.

Table 4 Effect of mulching in different pruning treatments on the dry mass yields of fodder sorghum in 3m alleys

Treatment	DM1 (kg/m)	± SE	DM2 (kg/m)	± SE
S1	0.0400	0.0094	0.0020	0.0081
S2	0.1065[a]	0.0094	0.0990	0.0081
S3	0.0775[a]	0.0094	0.1548	0.0081

LSM with the same alphabetical superscript in columns do not differ significantly ($P \leq 0.05$) (Bonferroni)

Table 5 Effect of mulching in different cutting treatments on the dry mass yields of fodder sorghum in 6m alleys, 1997

Treatment	DM1 (kg/m)	± SE	DM2 (kg/m)	± SE
S1	0.2063[a]	0.0087	0.0832[a]	0.0213
S2	0.2542	0.0087	0.1669[b]	0.0213
S3	0.2099[a]	0.0087	0.1449[ab]	0.0213

LSM with the same alphabetical superscript in columns do not differ significantly ($P \leq 0.05$) (Bonferroni)

Table 6 Effect of distance from tree rows on the dry mass yields of fodder sorghum in 6m alleys,1997

Treatment	DM1 (kg/m)	± SE	DM2 (kg/m)	± SE
r1	0.0977[a]	0.0131	0.1204	0.0325
r2	0.2229[b]	0.0131	0.1453	0.0325
r3	0.3237[c]	0.0131	0.1349	0.0325
r4	0.3098[cd]	0.0131	0.1547	0.0325
r5	0.3314[cd]	0.0131	0.1266	0.0325
r6	0.1959[b]	0.0131	0.0862	0.0325
r7	0.0832[a]	0.0131	0.1534	0.0325

LSM with the same alphabetical superscript in columns do not differ significantly ($P \leq 0.05$) (Bonferroni)

Based on the above values, the total yields for the season were calculated and represented graphically. In the 3m alleys, S2 and S3 yielded approximately 80% and 82% more than S1 respectively. In the wide alleys, this perceived advantage was ± 31% and ± 18% respectively. The total yield from the monocrop was ± 20% higher than the highest obtained in either of the two alley widths (Fig. 3).

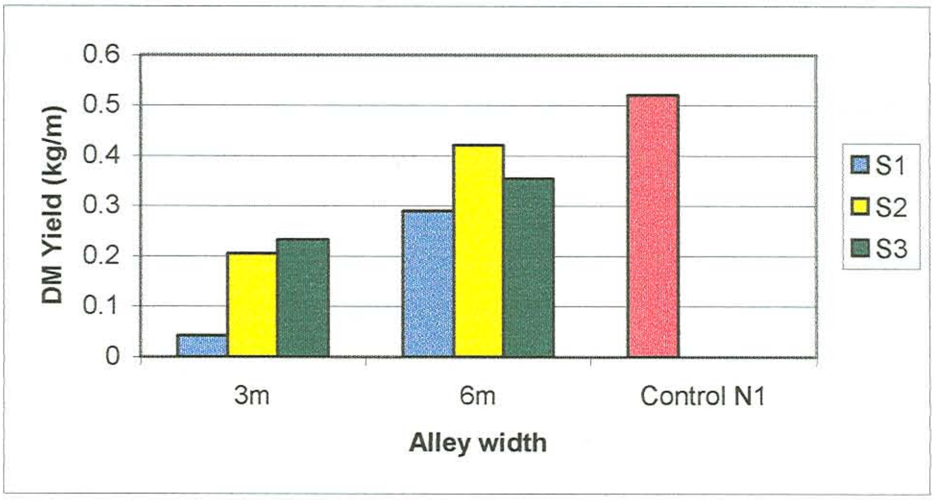

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Fig. 3. Total yields obtained in pruning treatments

When considering the total yields obtained in the different row positions, a clear trend could be observed for lower yields nearer to the tree rows (Fig.4). Rows 3-5 (at least 2.4 m from the trees) tended to have relatively similar yields. Rows to the south of the trees tended to have lower yields than the corresponding rows to the north of the trees.

Fig. 4 Total fodder sorghum yields observed in different row positions in 6m alleys, 1997

3.3.1.2 Nutritional value

- *Crude protein*

The CP concentration appeared to increase from group 1 towards group 3 in the middle of the alley (Fig.5). The relative higher values in the middle of the alley could have been induced by a carry-over effect of N released by decomposing material, the remainder of a tree row that was removed. The CP concentration of the 3m treatment appeared to be the highest. This was possibly induced by the high incidence of leaf drop from the unpruned treas.

The CP concentrations observed at the second harvest were higher, except for the 3m plots in S1, where growth was severely stunted, possibly due to competition from the trees, where canopy closure had occurred by this time (Fig. 6).

- *Neutral detergent fibre*

Neutral detergent fibre (NDF) provides an indication of cell wall material and is negatively correlated with digestibility (Van Soest, 1982, Van der Merwe, 1992). At the first harvest (Fig. 7), NDF content ranged between ±50-60%. The control was relatively higher at almost 65%. The values increased at the second harvest, implying that digestibility decreased slightly, but that of the control was marginally lower (Fig. 8).

- *In vitro digestibility (organic matter)*

The digestibility of the second harvest was lower than the first (Fig. 9 & 10), corresponding with the higher NDF content of the second harvest. This as especially evident in S1, where the few surviving plants tended to adopt a more shoot-like growth habit, attempting to reach the available light. More lignification had evidently taken place by this stage, resulting in lower digestibility, higher NDF and lower N values.

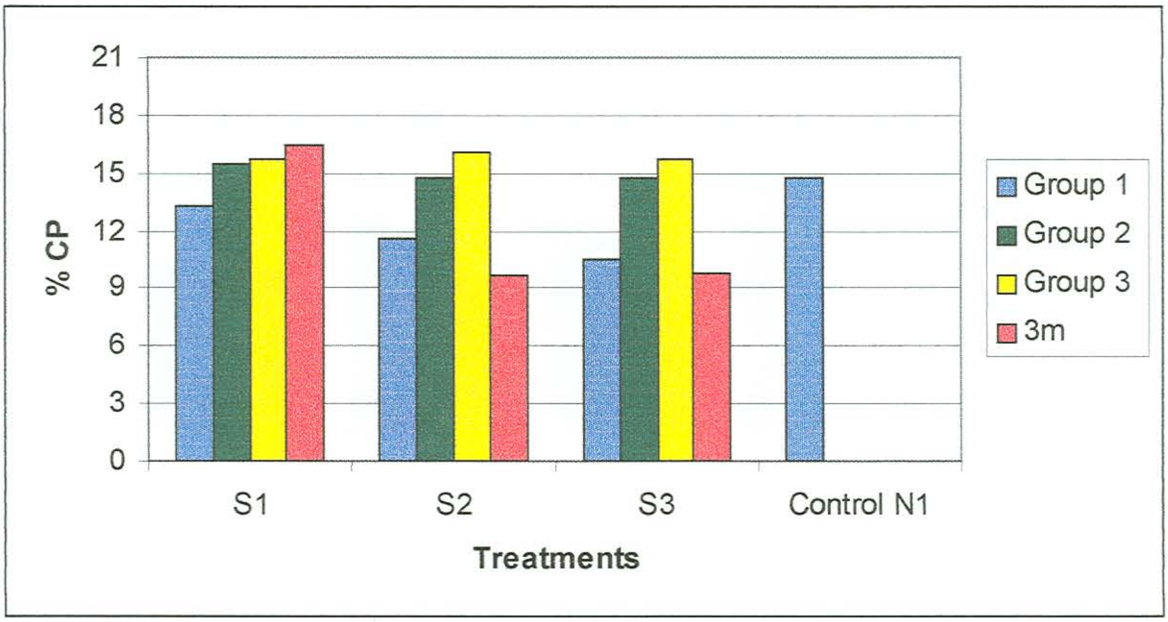

Fig. 5 Crude protein concentration of first fodder sorghum harvest, 1997

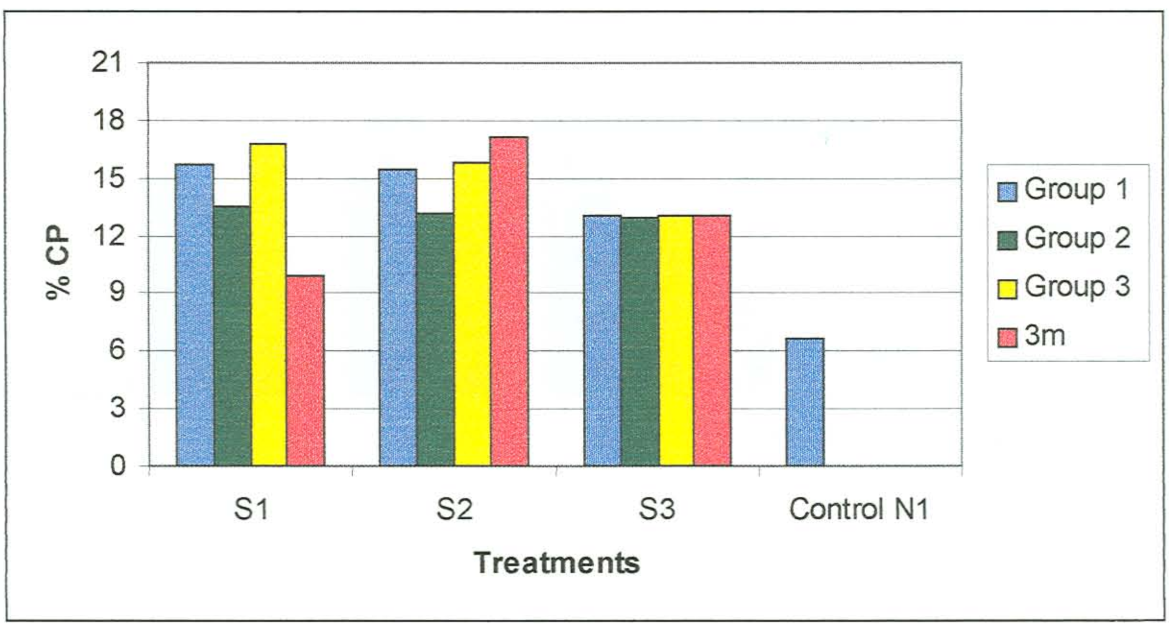

Fig. 6 Crude protein concentration of second fodder sorghum harvest, 1997

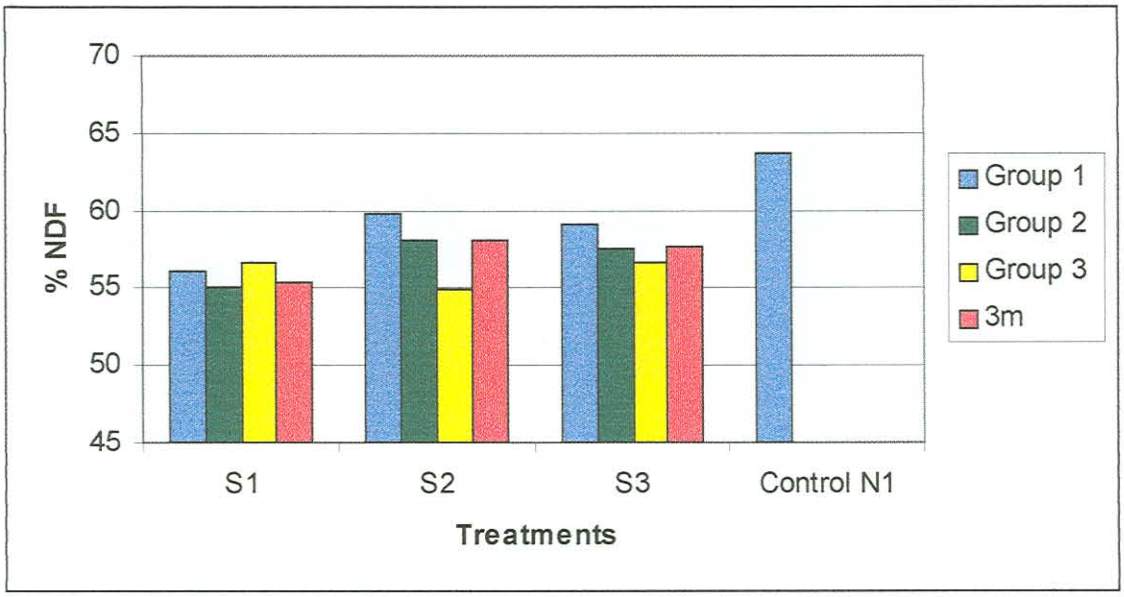

Fig. 7 NDF concentration of first fodder sorghum harvest, 1997

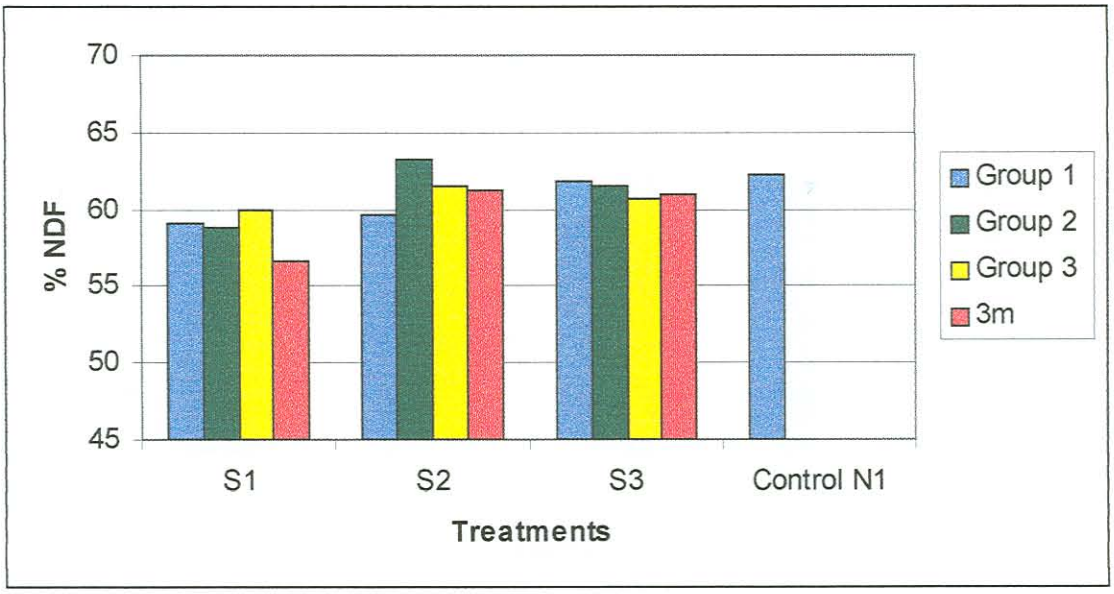

Fig.8 NDF concentration of second fodder sorghum harvest, 1997

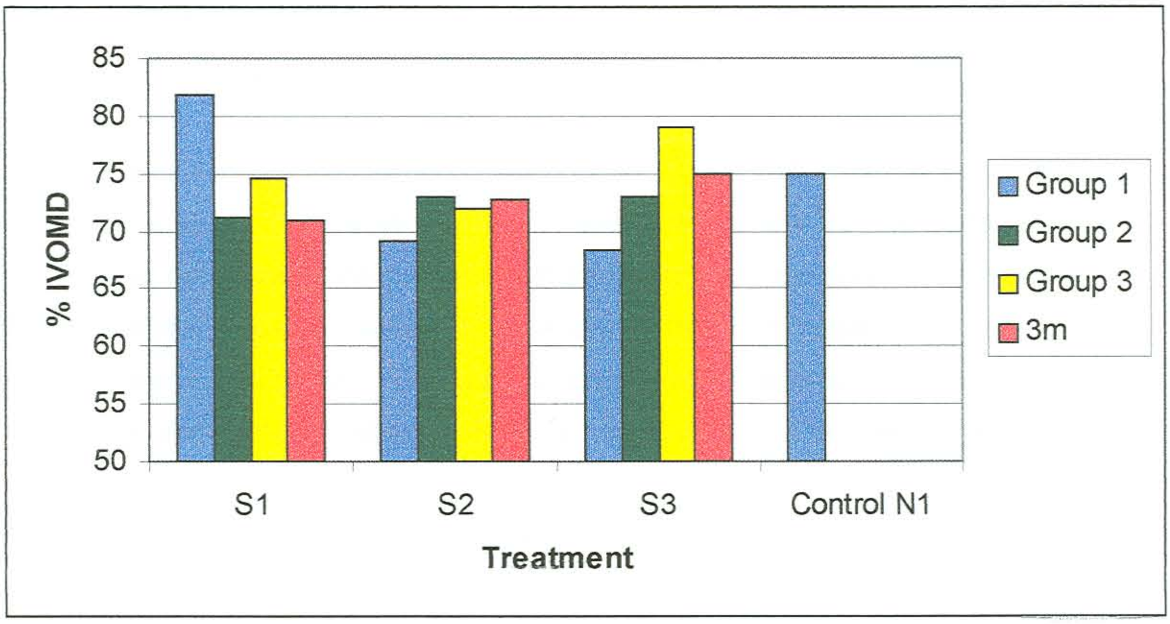

Fig.9 ***In vitro* digestibility (OM) of first fodder sorghum harvest, 1997**

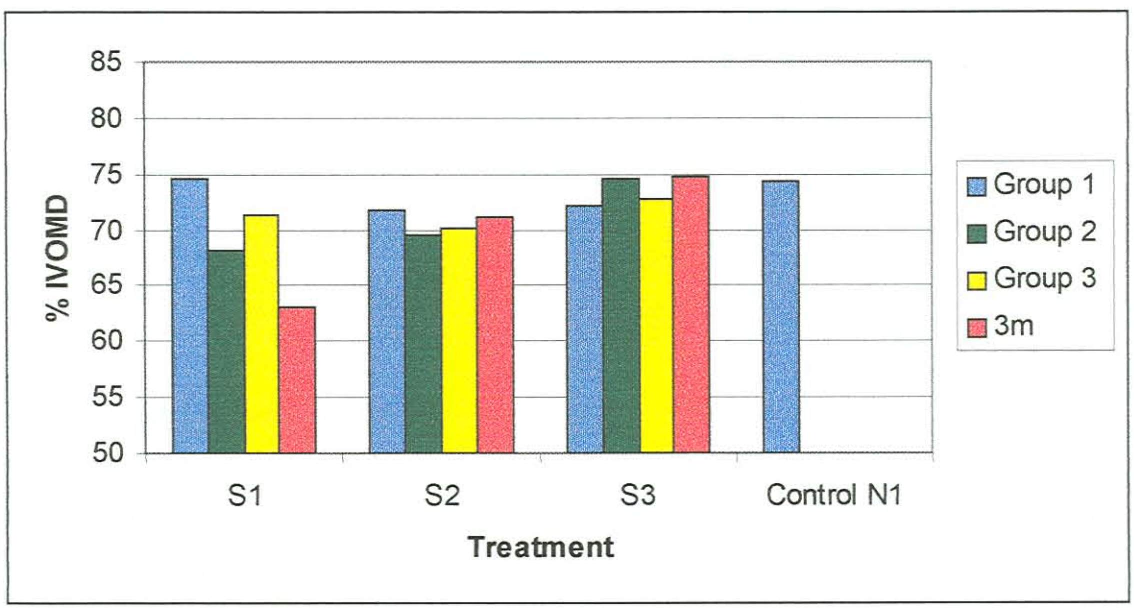

Fig. 10 ***In vitro* digestibility (OM) of second fodder sorghum harvest, 1997**

3.3.2 1997/1998 season

3.3.2.1 Plant heights

Plant heights were measured before each cutting in the 1997/1998 season. In both alley widths, plants in S1 were significantly shorter that in the S2 and S3 treatments. As S1 was not pruned, the fodder sorghum plants were exposed to more shading and therefore limited in received in receiving the light required for successful photosynthesis and growth. This is most possibly also the reason why little regrowth were observed in the 3m alleys of S1 (Fig. 11) (Table 7). The average plant height tended to be higher in the 6m alleys (Table 8), especially at the second cutting, where more light could penetrate the alley crops.

Fig. 11 Single surviving plants of group 1 in the S1 treatments

Only in the wide alleys did distance from the tree row played a significant role in the growth of fodder sorghum (Table 9). The rows nearest to the tree rows were especially stunted in growth, both with the first cutting and the regrowth before the second cutting (Fig. 12 & 13).

Table 7 Effect of mulching in different cutting treatments on the plant height of fodder sorghum in 3m alleys just before cutting, 1998

Treatment	H1 (cm)	± SE	H2 (cm)	± SE
S1	61.67	6.14	No regrowth	-
S2	143.33	6.14	138.33	6.35
S3	102.5	6.14	136.67	6.35
LSM with the same alphabetical superscript in columns do not differ significantly ($P \leq 0.05$) (Bonferroni)				

Table 8 Effect of mulching in different cutting treatments on the plant height of fodder sorghum in 6m alleys just before cutting, 1998

Treatment	H1 (cm)	± SE	H2 (cm)	± SE
S1	129.05	5.37	101.76	5.90
S2	164.76^{a}	5.37	140.47^{a}	5.69
S3	149.05^{a}	5.37	134.76^{a}	5.69
LSM with the same alphabetical superscript in columns do not differ significantly ($P \leq 0.05$) (Bonferroni)				

Table 9 Effect of distance from tree rows on the plant height of fodder sorghum in 6m alleys just before cutting, 1998

Treatment	H1 (cm)	± SE	H2 (cm)	± SE
r1	100.00^{a}	8.21	84.11^{a}	9.42
r2	152.22^{b}	8.21	115.56^{ab}	8.69
r3	176.67^{bc}	8.21	145.56^{bc}	8.69
r4	182.22^{bcd}	8.21	161.11^{cd}	8.69
r5	166.67^{bcde}	8.21	153.33^{bcde}	8.69
r6	143.33^{bce}	8.21	132.22^{bcde}	8.69
r7	112.22^{a}	8.21	87.78^{ab}	8.69
LSM with the same alphabetical superscript in columns do not differ significantly ($P \leq 0.05$) (Bonferroni)				

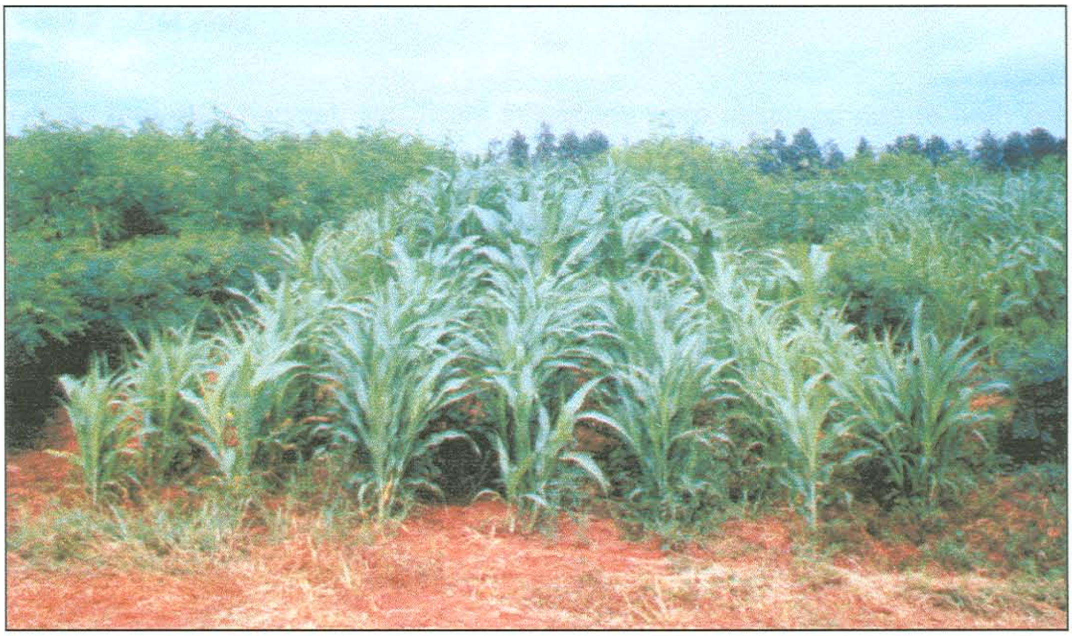

Fig. 12 Differences in plant height across the 6m alley

Fig. 13 Shading of plants nearest to the tree row

3.3.2.2 *DM yield*

During the 1998 harvest, significant influences were observed due to both pruning treatment and row position within the 6m alleys. Only treatment played a role in the 3m alleys.

In the 3m alleys, the highest yield was obtained from S 2 with the first cutting and S3 with the second cutting (Table 10). At this time, S3 was still kept pruned to a 1m high hedgerow and thus allowed more penetration of sunlight. The poor regrowth of S1 was not measurable at this stage. In the 6m alley, the highest yield was obtained in S3 (first and second cutting), although not significantly higher than S2 (Table 11). Stunted growth in S1 could again be attributed to shading.

With regard to the total yields for the season, S2 and S3 yielded respectively ± 96% and ± 95% more than S1 in the 3m alleys. In the wide alleys, this perceived advantage was ± 55% and ± 45% respectively. A higher yielding trend was observed in both the fertilised and unfertilised monocrops over the pruned treatments in both alley widths (Fig. 14). The unfertilised plots yielded 0.252 kg/m and 0.219 kg/m respectively at both cuttings and the fertilised plots yielded 0.226 kg/m and 0.332 kg/m respectively. Comparing these yields with the highest obtained from the alley crops (S3 in 6m), the yield from the unfertilised control was 30% higher and those from the fertilised control 41% higher.

When comparing total yields for the season across the different rows, an interesting trend was observed. Again the two rows nearest to the trees tended to have the lower yields, but especially so for the rows on the southern side of the tree row (Fig. 14 & 15) (Table 12). A clear tendency was observed towards lower yields from the rows to the south of the tree rows.

Table 10 Effect of mulching in different cutting treatments on the dry mass yields of fodder sorghum in 3m alleys, 1998

Treatment	DM1 (kg/m)	± SE	DM2 (kg/m)	± SE
S1	0.0085[a]	0.0121	No regrowth[a]	-
S2	0.1303	0.0137	0.0272[a]	0.0199
S3	0.0358[a]	0.0121	0.1632	0.0199
LSM with the same alphabetical superscript in columns do not differ significantly ($P \leq 0.05$) (Bonferroni).				

Table 11 Effect of mulching in different cutting treatments on the dry mass yields of fodder sorghum in 6m alleys, 1998

Treatment	DM1 (kg/m)	± SE	DM2 (kg/m)	± SE
S1	0.0472[a]	0.0121	0.1022	0.0172
S2	0.1169[ab]	0.0121	0.1523[b]	0.0172
S3	0.1611[b]	0.0121	0.1704[b]	0.0172
LSM with the same alphabetical superscript in columns do not differ significantly ($P \leq 0.05$) (Bonferroni)				

Table 12 Effect of distance from tree rows on dry mass yields of fodder sorghum in 6m alleys just before cutting, 1998

Treatment	DM1 (kg/m)	± SE	DM2 (kg/m)	± SE
r1	0.0883[a]	0.0184	0.1757[a]	0.0253
r2	0.1154[ab]	0.0184	0.1294[ab]	0.0293
r3	0.1517[bc]	0.0184	0.2098[bc]	0.0253
r4	0.1382[abcd]	0.0184	0.1678[abcd]	0.0253
r5	0.1070[bcde]	0.0184	0.1938[bcde]	0.0253
r6	0.0984[abcdef]	0.0184	0.1290[abcdef]	0.0253
r7	0.0597[abdf]	0.0184	0.0859[abdef]	0.0275
LSM with the same alphabetical superscript in columns do not differ significantly ($P \leq 0.05$) (Bonferroni)				

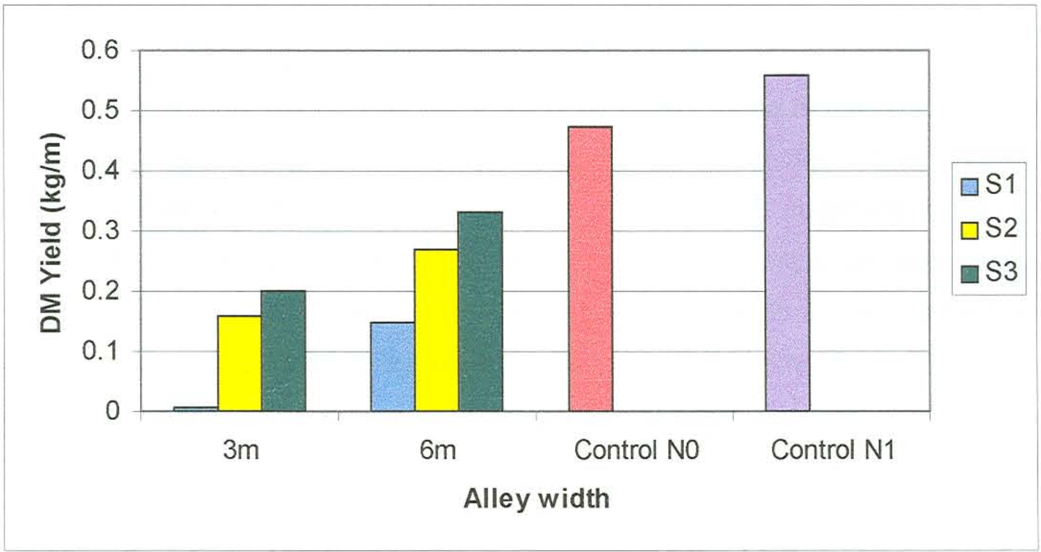

Fig 14 Total fodder sorghum yields observed in different cutting treatments, 1998

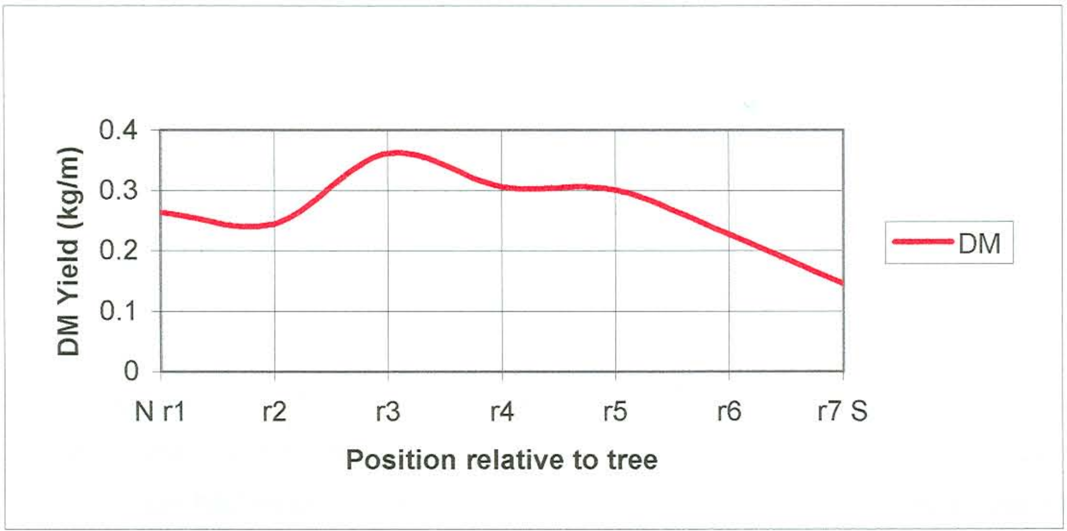

Fig. 15 Total fodder sorghum yields observed in different rows of the 6m alleys, 1998

3.3.2.3 Nutritional value

- *Crude protein*

At the first cutting, the highest CP concentration was found in the S1 treatments (Fig. 16). The three groups of S3 had almost the same CP content. The values were in general lower with the second cutting (Fig. 17). In both treatment S2 and S3, the values for the 3m alley were higher than the 6m alley. Although approximately the same amount of mulch was placed in the two alley widths, the concentration per surface area in the 3m alley was double that of the 6m alley. The crops thus received much more nitrogen from the leucaena mulch. It is interesting to note that the highest protein content was obtained in a treatment not receiving any mulch (S1 3m). This phenomenon could not be explained.

- *Neutral detergent fibre*

The NDF concentration of the first cutting was found to be in a relatively small range, with the fertilised control having the higher value (Fig. 18). The values increased in the second cutting with group 1 generally having the lower values. The plants of group 2 and 3 were generally much taller and more mature by this stage, compared to group 1 (Fig. 19), as they were exposed to better growth conditions (experienced less competition with the adjacent trees for water, nutrients and sunlight).

- *In vitro digestibility (organic matter)*

The digestibility of the first cutting was high for all treatments, but was dramatically lower in the second cutting (Fig. 20 & 21). As observed with the 1997 harvest, more lignification had evidently taken place by this stage, resulting in lower digestibility, higher NDF and lower N values. The plants in S1, experiencing much more shading, did appear to have softer stems (visual observation), indicating less cell wall material, although this is not supported by the NDF data.

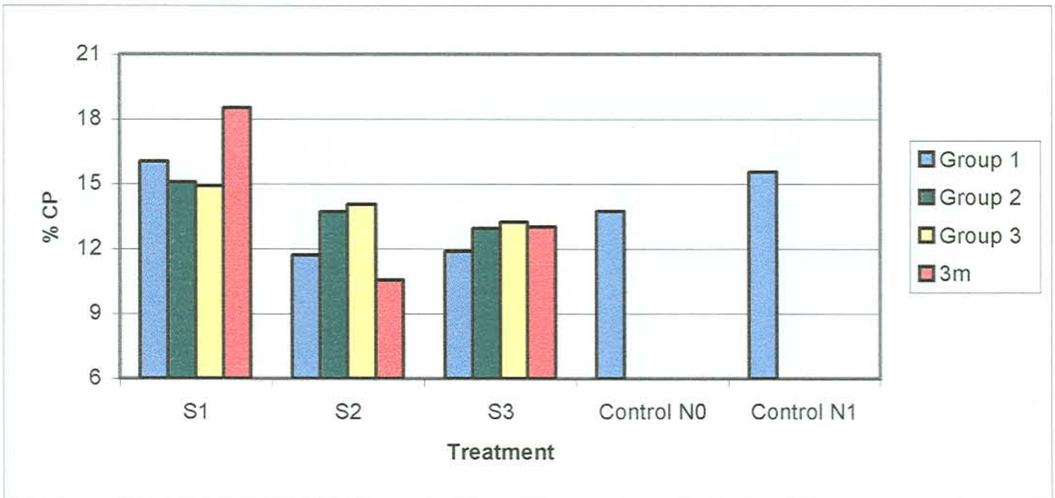

Fig.16 Crude protein concentration of first fodder sorghum harvest, 1998

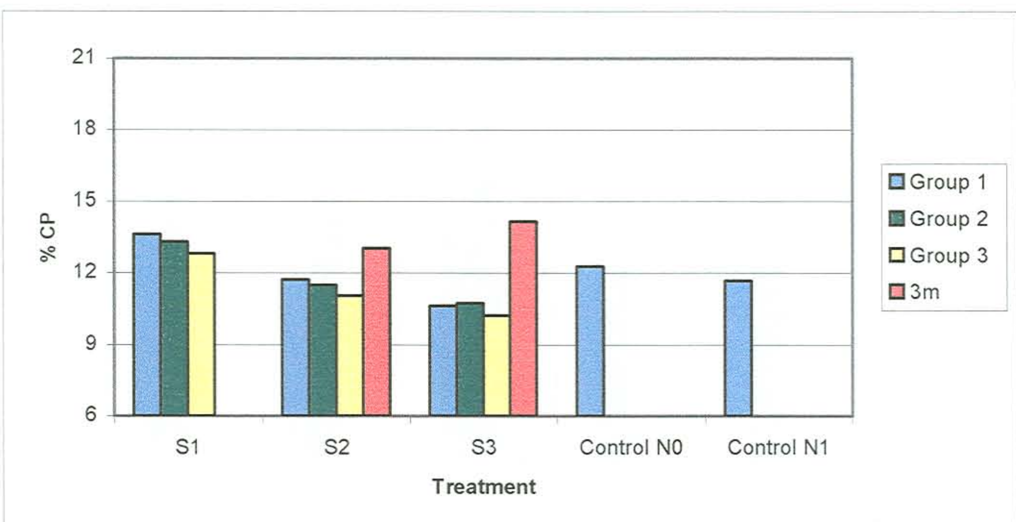

Fig.17 Crude protein concentration of second fodder sorghum harvest, 1998

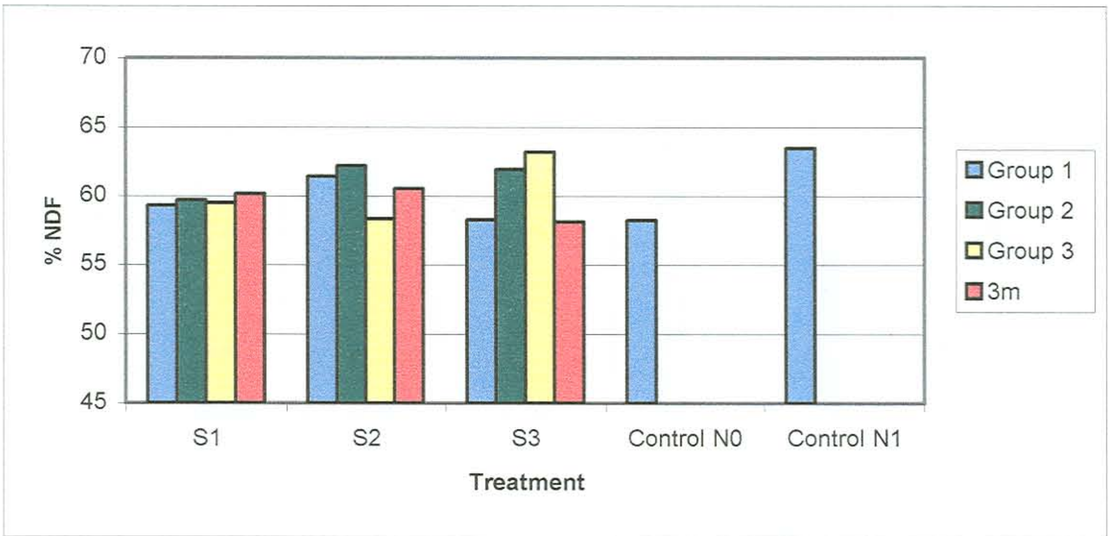

Fig.18 NDF concentration of first fodder sorghum harvest, 1998

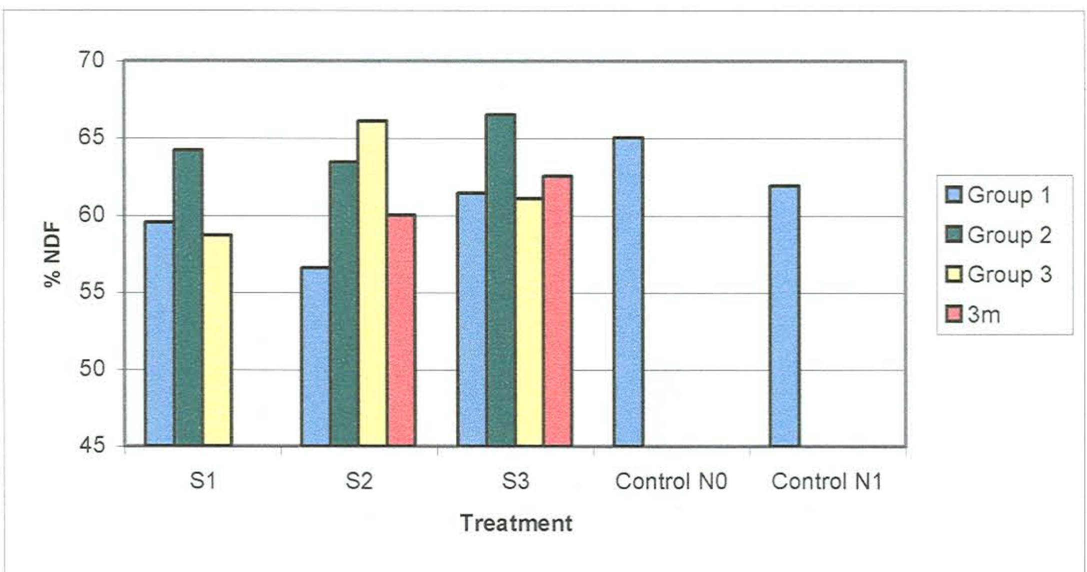

Fig.19 NDF concentration of second fodder sorghum harvest, 1998

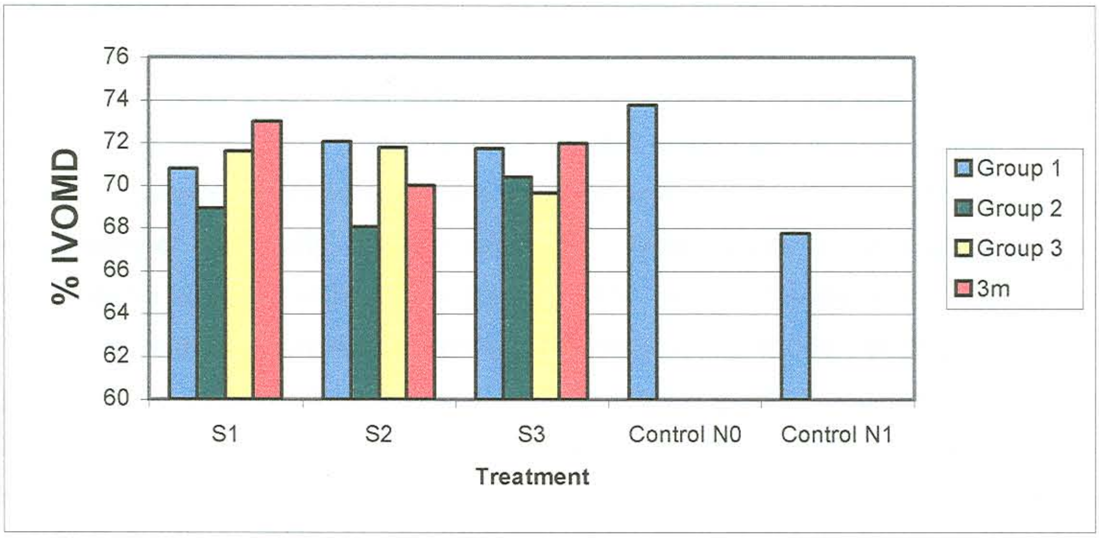

Fig.20 ***In vitro*** **digestibility (OM) of first fodder sorghum harvest, 1998**

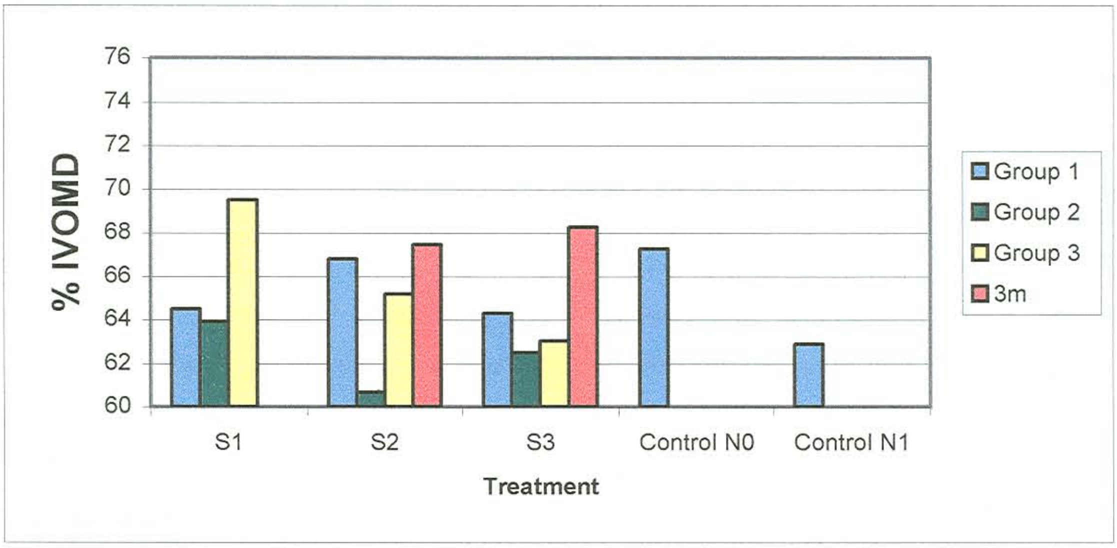

Fig. 21 ***In vitro*** **digestibility (OM) of the second fodder sorghum harvest, 1998**

3.4 Conclusion

The forage value of any feed depends on a combination of the palatability, nutrient content and digestibility. The intake of sufficient energy and nutrients by an animal, however, cannot be predicted from a separate analysis of a plant's nutrient content, digestibility or palatability. These can serve only as a guide to the value of species, but must be regarded with caution (Lefroy, Dann, Wildin, Wesley-Smith & McGowan 1992). Chemical analyses commonly overestimate digestibility, particularly that of protein, as it does not take into account that protein is often bound to tannins and lignin, which can prevent its breakdown in animals. Palatability can vary seasonally and between animals and cannot, therefore, be assessed on the basis of the occasional consumption of browse.

Both yield and quality of fodder sorghum in S2 and S3 compared favourably with each other and the monocrops crops, although an advantage could not be attained over the monocrops. Balasubramanian & Sekayange (1991) also reported only a marginal yield effect with sorghum after mulching with leucana in semi-arid Rwanda. General results reported from the tropics and sub-humid regions indicated to improved yields from alley cropping compared to monocropping (Kang *et al.*, 1981; Brewbaker, 1987; Palada, *et al.* 1992; Mugendi & Nair, 1997).

Improved yields with increased distance from the tree row, as observed in the 6m alleys, were previously confirmed by Szott *et al* (1991), who also reported that yields declined with time. As observed by Kang *et al* (1981) and Read *et al* (1985), a CP advantage was obtained after mulching with leucaena prunings. Lower yields obtained to the south of tree rows was an interesting observation and most possible due to competitive factors with regard to available sunlight and soil moisture. Plant heights also tended to be slightly lower in the southern rows of the alley, indicating a possible lower growth rate.

From the results it became clear that the use of a 3m alley is not really an option under local conditions. Results reported by Rao, Sharma & Ong (1990) in semi-arid India confirmed reduced sorghum yields in alley widths closer than 3m. The yields obtained in this alley were too low to favourably compare with the other treatments. It was also clear that cropping should not be attempted within 2m of tree rows, as especially yields of plant material would not be satisfactorily.

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