PERFORMANCE OF FORAGE SORGHUMS AND MILLETS UNDER REPEATED CUTTING AND FERTILIZATION IN THE MARKHAM VALLEY

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ABSTRACT

In a comparison of four forage sorghums and two millets, the forage sorghums gave higher dry matter yield and persisted longer than millets. Millets disappeared after four (white panicum) and five (MX001) harvests but all the sorghum varieties persisted and yielded well even one year after establishment. All the sorghums responded to nitrogen application but Zulu responded most at lower level of nitrogen. Dry matter yield, nitrogen content and its yield all decreased with increasing maturity. Studies on plant characteristics (e.g. tiller number, tiller size, stem and leaf proportion) and persistence under grazing indicated that Zulu is more suitable than other sorghums under the present climatic conditions and with proper management practices it should be possible to continue harvesting for about one year without replanting. Practical implications of the results are also discussed.

INTRODUCTION

With the steady increase in the cattle population in the Markham Valley, shortages of feed are often experienced, especially during the dry season. The use of forage crops, mainly sorghums, has been increasing recent years. These supplemental forages help to maintain a high level of production during the dry when production and quality of pastures is very low.

Overseas work indicates quite encouraging results from various forage crops. In Queensland, live weight gains of 0.51 to 0.55 kg/head/day were reported from *Sorghum almum* grazed for a year (Yates *et al.* 1964; Coaldrake *et al.* 1969). A very high weight gain of 0.94 kg/head/day from *Sorghum almum* resulting in 270 kg/ha beef production over a short period of 121 grazing days was reported from Texas (Gangstad 1963). Gangstad (1959) also reported high live weight gains of 0.70 to 1.01 kg/head/day with the hybrid forage sorghum Sudax. In contrast, grain sorghum used as green fodder gave low gains of about 0.45 kg/head/day (Quinby and Marion 1960). Blunt and Fisher (1973) from Northern Australia reported that fodder sorghum grazed at 6.4 and 4.0 head/ha for 26 weeks gave a mean liveweight gain of 0.36 and 0.41 kg/head/day respectively, but ratooned grain sorghum grazed at 4.0 head/ha gave 0.35 kg/head/day and was unable to carry 6.4 head/ha. They also reported that green chopped fodder sorghum fed at the preflowering and at soft dough stage gave mean live weight gains of 0.48 and 0.37 kg/ha/day respectively over 26 weeks.

Multiple harvesting or ratooning of forage sorghum has also been reported from overseas (Plucknett and Young 1963; Parberry 1966). In Papua New Guinea, Hill (1969) compared forage sorghums and a millet at Bubia, under high rainfall conditions (2 800 mm), but these were harvested only once at a certain stage of growth, and so this trial did not give information on performance under repeated cuttings or grazing. This paper presents results on the performance of forage sorghums and millets under lower rainfall conditions with repeated cuttings. Response to nitrogenous fertilizer and plant characteristics and persistence were studied.

PROCEDURE

The trial was conducted on a heavy clay soil at Markham Farming under about 1 100 mm annual rainfall conditions. Four forage sorghums commercially known as Zulu, Sudax 11a, *Sorghum almum* (Columbus grass) and NK300F (both grain and forage type) and

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millets, hybrid MX001 and white panicum (*Echinochloa crus-galli*) were planted in November, 1973. Katherine pearl millet was chosen but failed to germinate and was replaced by white panicum. These species were planted at 5 cm spacing in rows one metre apart. Nitrogen, at 16.6 and 33.2 kg/ha as sulphate of ammonia, was applied after each harvest except the first harvest when no nitrogen was applied. Species were laid out in main plots and nitrogen levels in subplots, with four replications in randomized blocks. Nitrogen was applied after cutting the stand to 15 cm height with bush knives. In all, 11 harvests were taken at about one-month intervals.

Dry matter yield was estimated by cutting a one-metre length of row at 15 cm height and drying at 80°C for 48 hours before weighing. These samples were also used for estimating number of tillers, percentage dry matter, proportion of stem and leaves, and size of individual tillers. Samples pooled over replicates were analysed for nitrogen content for four harvests (2, 3, 4 and 5) only.

In order to study the effect of repeated grazing on persistence of the forage sorghums, small plots (10 m x 20 m) were established at Erap and were grazed every month. Observations on regrowth and persistence were taken.

Data on percentage dry matter and proportion of stem and leaf were transformed (angular) for statistical analysis.

RESULTS

Soil and Growing Season

The soil was heavy clay with moderate to high fertility which became hard during the dry weather. This land was previously used for growing grain sorghum. Although the weather was dry during the establishment period, all the species established well but the initial growth was slow. Rainfall data during the growth period are presented in *Figure* 2B.

Percentage Dry Matter

Results are presented in *Figure* 1A and 1B. Dry matter content was higher in the millets than in the sorghums, especially at later harvests as a result of the millets setting grain. On average, day matter percentage remained between 17 and 20 per cent in all the sorghums except at the second harvest when Zulu and Sudax had only 14 per cent dry matter. Dry matter appeared to have slightly increased with time but decreased with nitrogen especially during the last three harvests.

Number of Tillers

Numbers of tillers per metre length of row are given in *Figure* 2A and 2B. Tillering reduced in all the species with advance in age of the stand and appeared to have been slightly influenced by rainfall. Tillers were highest in *Sorghum almum* and lowest in NK300F and they significantly differed from Zulu and Sudax which had intermediate numbers. Of the millets, white panicum had significantly more tillers than MX001.

Application of nitrogen (*Figure* 2b) appeared to have positive effects on tillering in most of the harvests but results did not reach significant level except at the last four harvests.

Tiller Size

Weight of individual tillers was calculated by dividing the dry matter by the number of tillers and is presented in *Figure* 3A and 3B. Amongst the sorghums NK300F had the biggest and *Sorghum almum* the smallest tiller size and these were significantly different from Zulu and Sudax. Zulu had slightly bigger tillers than Sudax but the differences were not significant. Generally tiller size reduced with time, except at the last harvest. In the millets, white panicum had significantly smaller tillers than MX001.

Application of nitrogen had a significant positive effect on tiller size but only in sorghums (*Figure* 3B).

Proportion of Leaf and Stem

Various parts of a forage plant have varying nutrient value and acceptability to cattle. Inflorescence with grain is the most valuable, leaf (green) next most and the stem is the least valuable. Proportion of leaf and stem are presented in *Figure* 4A and 4B. Contribution of inflorescence in sorghum species was very small and is not presented here. In sorghum species, proportion of leaves increased with decrease in stem. Highest leaf proportion was in NK300F in the beginning but *Sorghum almum* dominated at later stages. However amongst the sorghums Zulu had the lowest proportions of leaves. In the millets, inflorescence was a major contribution to yield and white panicum had the lowest proportion of both leaf and stem as compared to MX001.

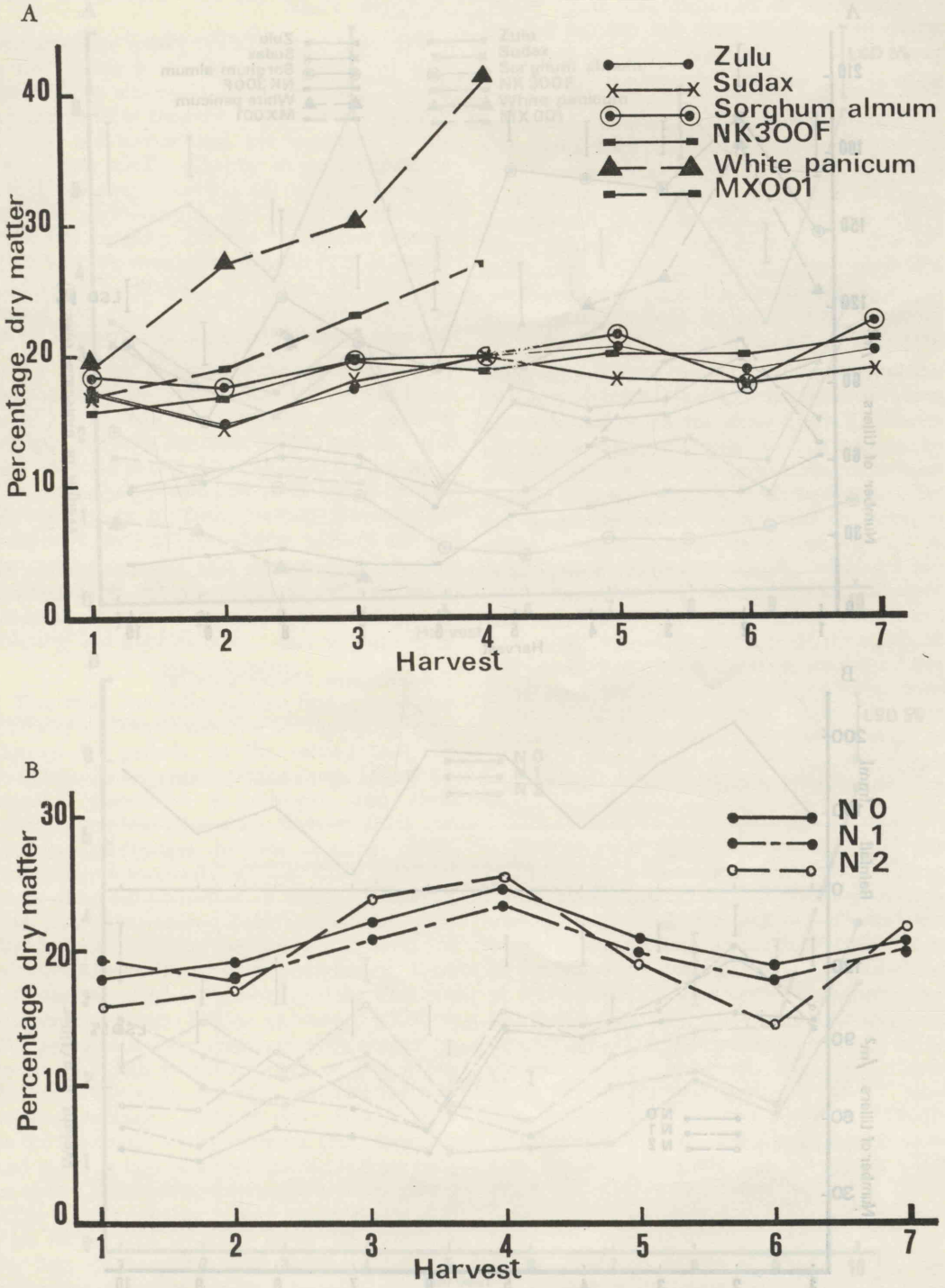

Figure 1.—A. Percentage dry matter in various forage crops (averaged over nitrogen application rates) B. Effect of nitrogen on percentage dry matter (averaged over forage species)

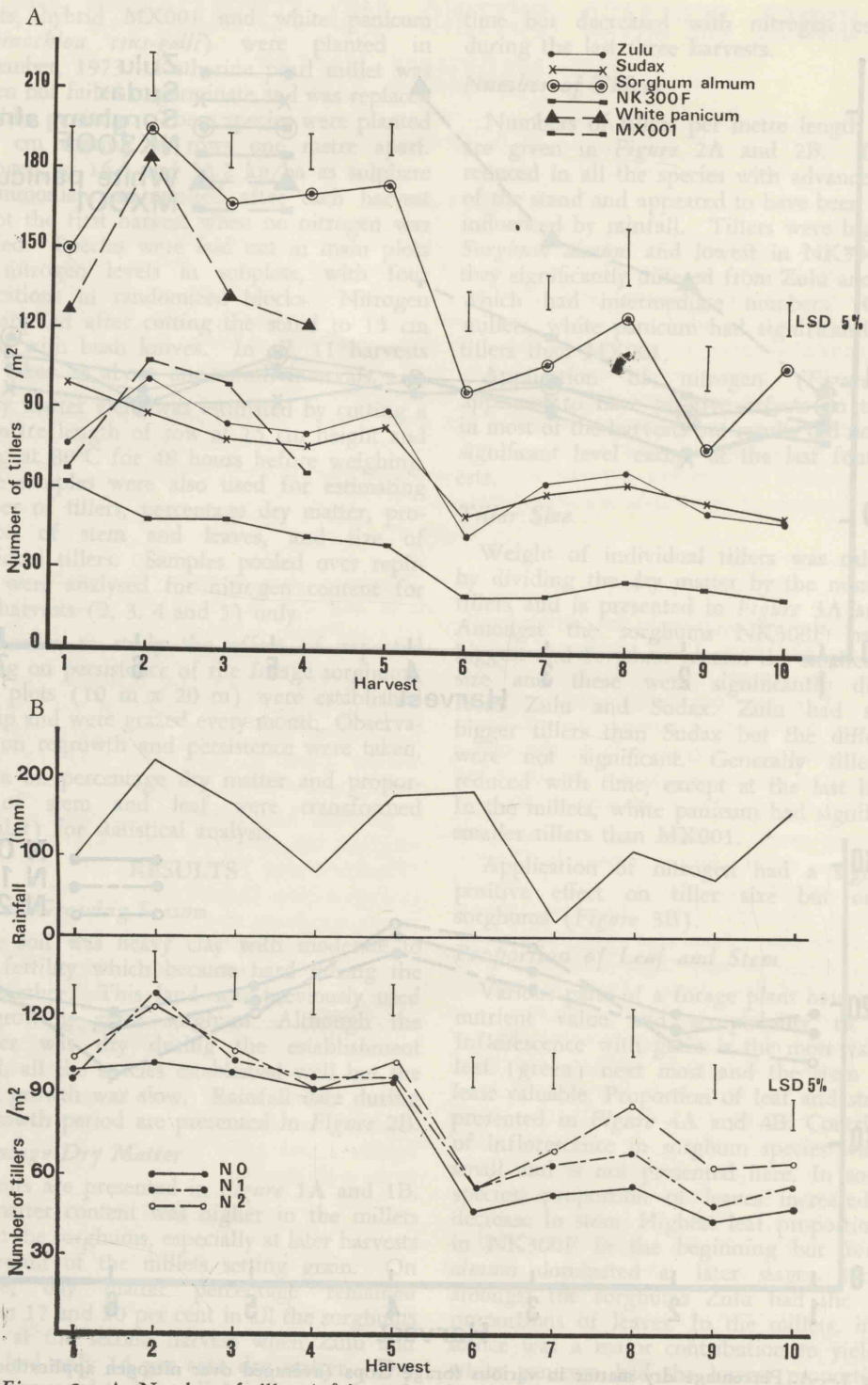

Figure 2.—A. Number of tillers/m² in various species at various harvests. B. Number of tillers/m² as affected by nitrogen application

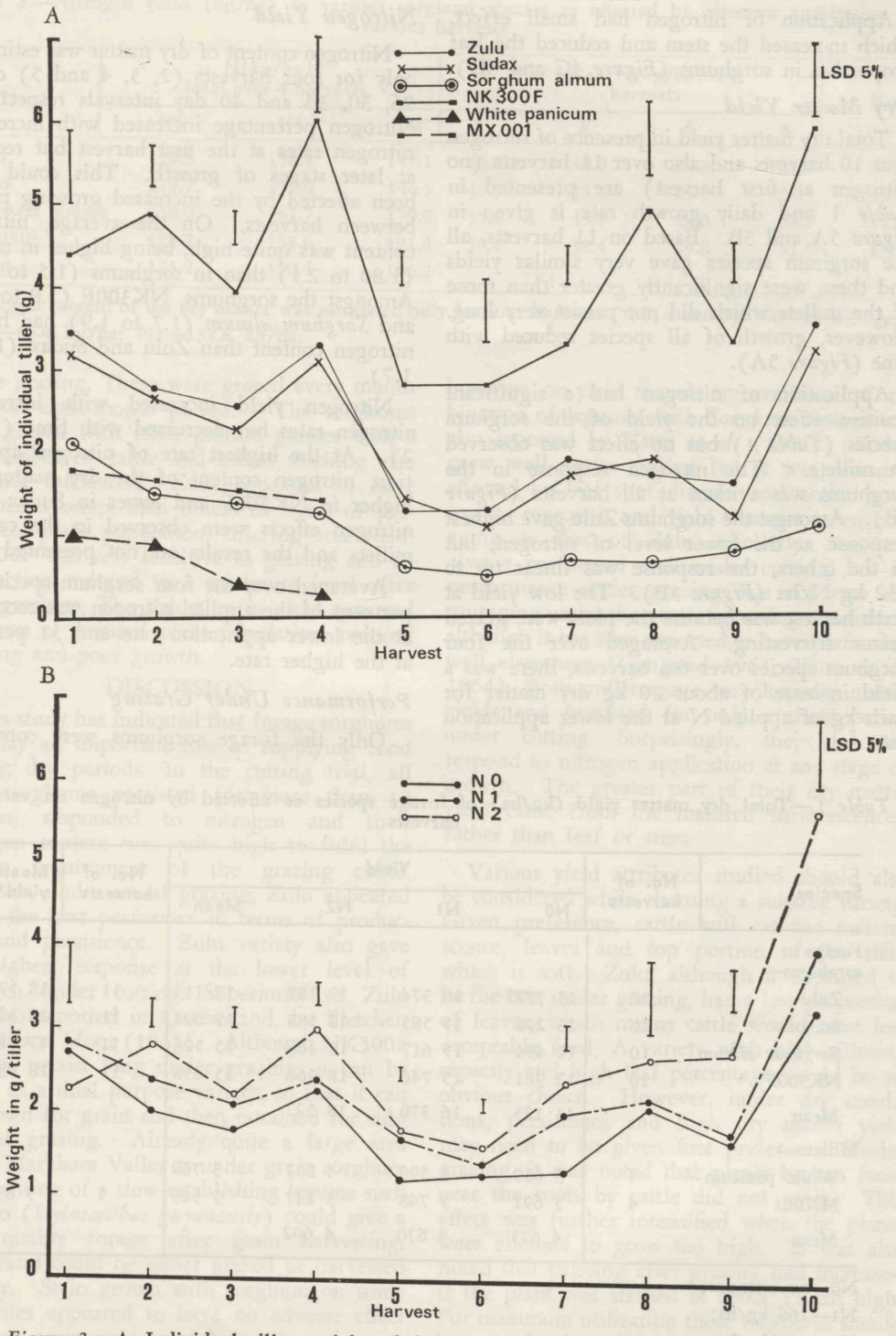

Figure 3.—A. Individual tiller weight of forage species at various harvests. B. Effect of nitrogen application on individual tiller weight at various harvests

Application of nitrogen had small effect, which increased the stem and reduced the leaf proportion in sorghums (*Figure* 4C and 4D).

Dry Matter Yield

Total dry matter yield in presence of nitrogen over 10 harvests and also over 11 harvests (no nitrogen at first harvest) are presented in *Table* 1 and daily growth rate is given in *Figure* 5A and 5B. Based on 11 harvests, all the sorghum species gave very similar yields and these were significantly greater than those of the millets which did not persist very long. However, growth of all species reduced with time (*Figure* 5A).

Application of nitrogen had a significant positive effect on the yield of the sorghum species (*Table* 1) but no effect was observed in millets. The nitrogen response in the sorghums was evident at all harvests (*Figure* 5B). Amongst the sorghums Zulu gave highest response at the lower level of nitrogen, but in the others, the response was linear up to 332 kg N/ha (*Figure* 5B). The low yield at sixth harvest was because the plots were grazed before harvesting. Averaged over the four sorghum species over ten harvests, there was a yield increase of about 20 kg dry matter for each kg of applied N at the lower application rate.

Nitrogen Yield

Nitrogen content of dry matter was estimated only for four harvests (2, 3, 4 and 5) cut at 26, 30, 34 and 40 day intervals respectively. Nitrogen percentage increased with increasing nitrogen rates at the first harvest but reduced at later stages of growth. This could have been affected by the increased growing period between harvests. On the average, nitrogen content was quite high, being higher in millets (1.80 to 2.1) than in sorghums (1.5 to 1.9). Amongst the sorghums, NK300F (1.8 to 2.0) and *Sorghum almum* (1.7 to 1.9) had higher nitrogen content than Zulu and Sudax (1.5 to 1.7).

Nitrogen yield increased with increasing nitrogen rates but decreased with time (*Table* 2). At the highest rate of nitrogen application, nitrogen content of the dry matter was higher in NK300F and lower in Sudax. No nitrogen effects were observed in the case of millets and the results are not presented here.

Averaged over the four sorghum species, 38 per cent of the applied nitrogen was recovered at the lower application rate and 31 per cent at the higher rate.

Performance Under Grazing

Only the forage sorghums were compared

Table 1.—Total dry matter yield (kg/ha) of forage species as affected by nitrogen on various harvests

Species	No. of harvests	Yield				No. of harvests	Mean yield*
		N0	N1	N2	Mean		
Forage sorghums—							
Zulu	10	13 777	18 374	19 187	17 113	11	18 579
Sudax	10	13 298	15 585	18 188	15 691	11	18 320
Sorghum almum	10	12 494	15 617	18 466	15 526	11	17 787
NK300F	10	12 961	15 746	18 266	15 658	11	18 935
Mean		13 123	16 370	18 527			
Millets—							
White panicum	4	3 659	3 590	4 057	3 769		
MX001	4	5 691	5 748	5 147	5 529	5	7 832
Mean		4 675	4 670	4 602			

N0—no nitrogen;
N1—166 kg/ha;
N2—332 kg/ha.
* Nitrogen was not applied at first harvest in the case of 11 harvests.

Table 2.—Nitrogen yield (kg/ha) in various sorghum species as affected by nitrogen application at various harvests

Species	N(kg/ha)* total over 4 harvests			Mean N(kg/ha) at harvests				Total
	N0	N1	N2	2	3	4	5	
Zulu	119.3	170.1	147.1	50.0	38.0	29.8	28.0	145.8
Sudax	129.7	131.0	146.3	49.2	35.1	23.3	28.1	135.7
Sorghum almum	130.0	161.7	179.9	55.6	43.7	29.8	28.1	157.0
NK300F	121.7	138.6	191.4	50.8	38.4	29.8	31.5	150.5
Mean	125.2	150.4	166.2					

*Nitrogen content of the dry matter was estimated only for four harvests (2, 3, 4 and 5). N0—no nitrogen; N1—66.4 kg/ha; N2—132.8 kg/ha.

under grazing. These were grazed every month over an eight-month period. The sorghums were grazed with other pasture grasses with a set number of cattle and actual stocking rate was not calculated. Zulu appeared to have performed better than others in terms of persistence, plant population, tillering and yield. NK300F was very sensitive to grazing and its production reduced to a minimum level after four grazings. The reduction in yield occurred in terms of reduced plant population, reduced tillering and poor growth.

DISCUSSION

This study has indicated that forage sorghums can play an important role in supplying food during dry periods. In the cutting trial, all four sorghums persisted for more than 12 months, responded to nitrogen and their nitrogen content was quite high to fulfil the protein requirement of the grazing cattle. However, under actual grazing, Zulu appeared to be the best performer in terms of production and persistence. Zulu variety also gave the highest response at the lower level of nitrogen under cutting. Superiority of Zulu was also reported in Queensland, by Fletcher, Henzell and Moor (1965). Although NK300F did not persist long under grazing, it can be useful as a dual purpose variety, so that it can be grown for grain and then ratooned for subsequent grazing. Already quite a large area in the Markham Valley is under grain sorghum and planting of a slow-establishing legume such as stylo (*Stylosanthes guyanensis*) could give a high quality forage after grain harvesting. This stand could be either grazed or harvested for hay. Stylo grown with sorghum on some properties appeared to have no adverse effect either on grain yield or on harvesting of grain; however, no yield records are available. Combination of legumes with *Sorghum almum* was also reported by Yates *et al.* (1971). Sudax grew well under cutting but it was seriously affected by leaf spot disease, and under grazing its regrowth and yield was not as encouraging as that of Zulu. Similarly, *Sorghum almum* performed well under cutting, but its performance under grazing was not very encouraging under the present growing conditions, although it has been reported to have performed well elsewhere (Gangstad 1963; Yates *et al.* 1964). Both millets gave very low dry matter yields and persisted for only a short period under cutting. Surprisingly, they did not respond to nitrogen application at any stage of growth. The greater part of their dry matter yield came from the matured inflorescences, rather than leaf or stem.

Various yield attributes studied should also be considered while choosing a suitable variety. Given preference, cattle will eat the inflorescence, leaves and top portion of the stem which is soft. Zulu, although it appeared to be the best under grazing, had a low proportion of leaves, which means cattle would have less acceptable feed. A variety with high tillering capacity and high leaf percentage would be an obvious choice. However, under dry conditions, persistence and high dry matter yield may need to be given first preference. Under grazing, it was noted that plants broken from near the roots by cattle did not grow. This effect was further intensified when the plants were allowed to grow too high. It was also noted that tillering after grazing had increased if the plant was slashed at about 15 cm high. For maximum utilization these sorghums should be grazed when they are about 60 to 70 cm

high as they have been reported to be safe then from cyanide poisoning (Vincent pers. comm.). This height will be achieved within 2 to 3 weeks, depending on the prevailing growing conditions and this will also encourage maximum utilization, as the plant would be soft and tender at that age.

Although no direct comparison was made to show whether forage sorghums were superior to pasture grasses under similar conditions, results from a nearby trial on grass species evaluation can be compared approximately for the same growing period. The results are presented in *Table* 3. Figures for the grasses are averaged over eight species, with 25 kg of nitrogen applied per hectare at each harvest and compared with average figures of sorghum species treated with 16.6 kg N/ha at each harvest.

Although the dry matter yield (kg/ha/day) reduced with time in sorghum species, it was always higher than that of grass species. The low yield of sorghums at the sixth harvest was because the plots were grazed by the cattle

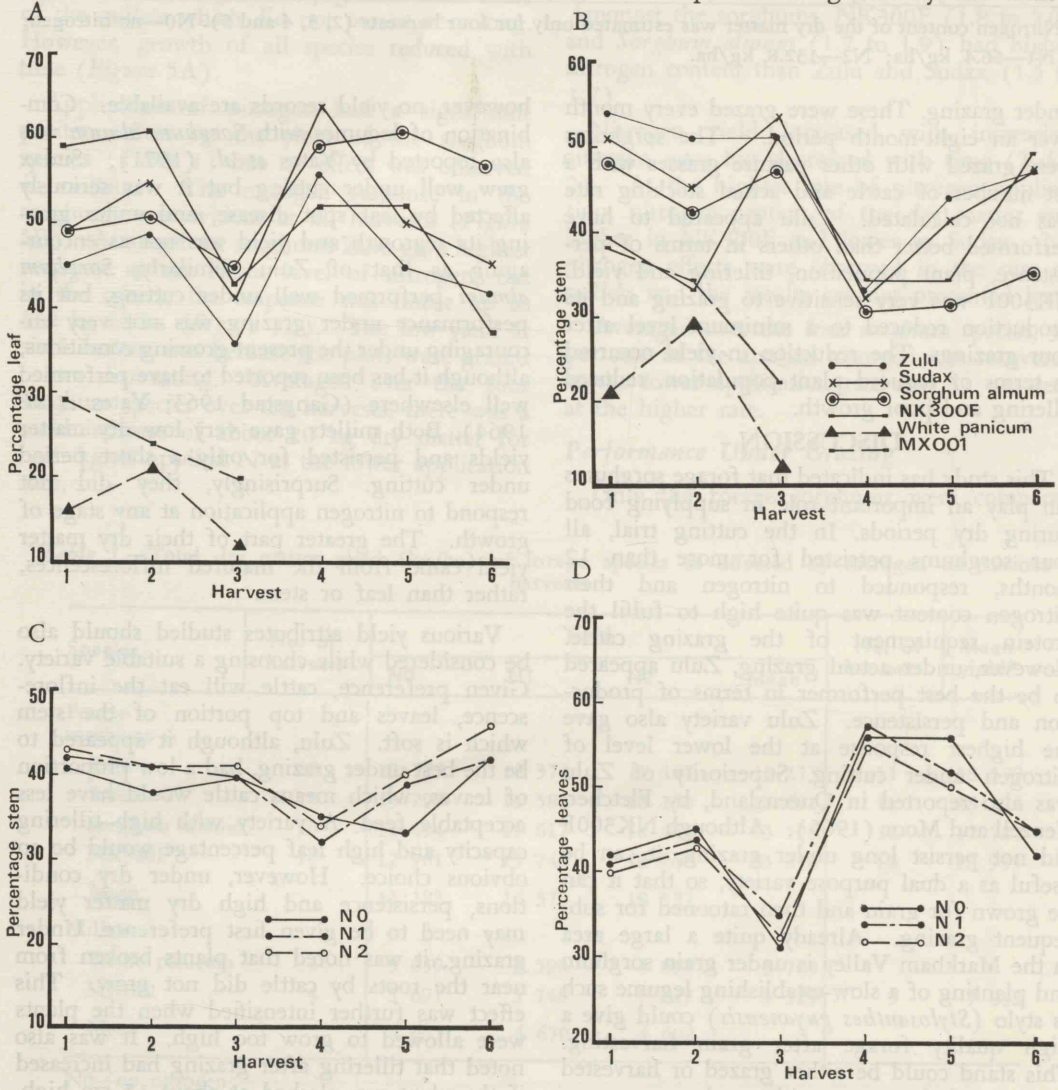

Figure 4.—a. Percentage leaf in the dry matter of various forage species. b. Percentage of stem in the dry matter in various forage crops. c. Percentage stem in the dry matter as affected by nitrogen application. d. Percentage leaves in the dry matter as affected by nitrogen application.

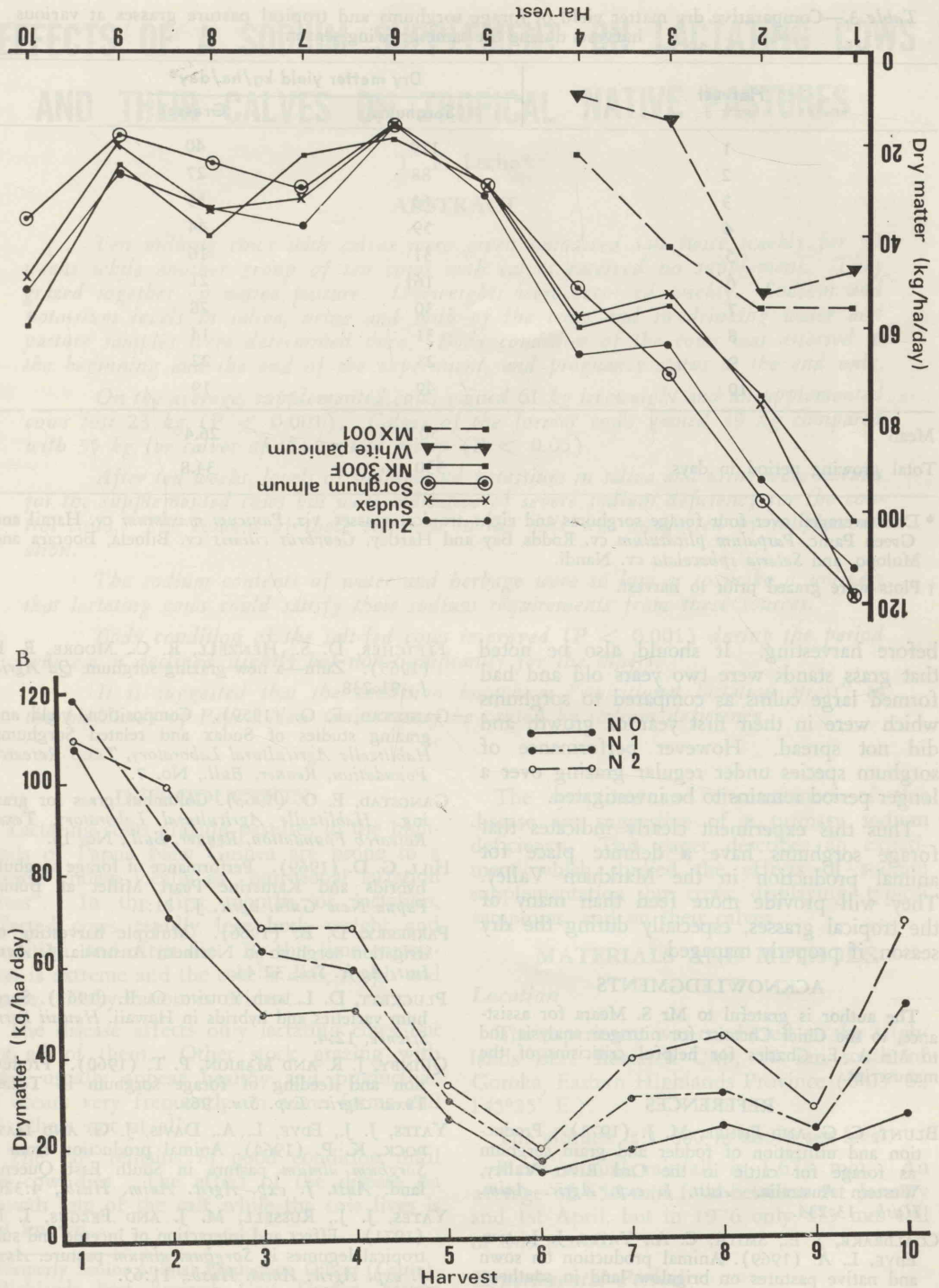

Table 3.—Comparative dry matter yield of farge sorghums and tropical pasture grasses at various harvests during the same growing season

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Harvest	Dry matter yield kg/ha/day*	
	Sorghums	Grasses
1	119	40
2	88	27
3	63	33
4	59	44
5	31	16
6	16†	21
7	30	28
8	31	14
9	23	22
10	49	19
Mean	50.9	26.4
Total growing period in days	330	34.8

* Data averaged over four forage sorghums and eight tropical grasses, viz, *Panicum maximum* cv. Hamil and Green Panic, *Paspalum plicatulum* cv. Rodds Bay and Hartley, *Cenchrus ciliaris* cv. Biloela, Boorara and Molopo, and *Setaria sphacelata* cv. Nandi.

† Plots were grazed prior to harvest.

before harvesting. It should also be noted that grass stands were two years old and had formed large culms as compared to sorghums which were in their first year of growth and did not spread. However performance of sorghum species under regular grazing over a longer period remains to be investigated.

Thus this experiment clearly indicates that forage sorghums have a definite place for animal production in the Markham Valley. They will provide more feed than many of the tropical grasses, especially during the dry season, if properly managed.

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