# CARIBBEAN FOOD CROPS SOCIETY (C F C S)

## XIV th Meeting

*Quatorzième Congrès de la*

*SOCIETE INTERCARAIBE POUR LES PLANTES ALIMENTAIRES*

*Guadeloupe* — *27 - 29 Juin*

*Martinique* — *30 Juin - 2 Juillet 1977*

*Sponsored by*

*Organise par*

L'INSTITUT NATIONAL DE LA RECHERCHE AGRONOMIQUE (I.N.R.A.)

*with the aids of*

*Avec les aides*

*de la*

DELEGATION GENERALE A LA RECHERCHE SCIENTIFIQUE ET TECHNIQUE

(D.G.R.S.T.)

*and of the*

*et des*

CONSEILS GENERAUX

CHAMBRES D'AGRICULTURE

DE LA GUADELOUPE ET DE LA MARTINIQUE

*with the technical assistance of the following organisms*

*avec le concours technique des organisations suivantes*

*ORSTOM - IRFA - IRAT - CTGREF - DDA -*

*And the participation of Institutions of 15 Caribbean territories*

*Et la participation des Institutions de 15 pays de la Caraïbe*

SOUS le PATRONNAGE de MM. LES PREFETS de la GUADELOUPE et de la MARTINIQUE

Hôtel Arawak

Gosier - Guadeloupe

Hôtel Méridien

Trois Ilets - Martinique

Nouv. agron. Antilles-Guyane, 3, 3 4, 256-272 1977.

# FORAGE GRASSES AND LEGUMES FOR DRIER PARTS OF THE CARIBBEAN

J.M. KEOGHAM[°] - C.L. DEVERS[°]

---

The theme of this paper is that biological nitrogen fixation and the cycling of this nitrogen for production should be the main basis of increased animal production in the Caribbean. Failure to capitalise on this through the use of well adapted and productive forage legumes and grasses under good cutting and or grazing managements is a failure to recognise the most economical and effective method for our fragile Caribbean economies to achieve more self-sufficiency in livestock products. This paper will not be confined to the results of pasture research by the University of the West Indies in Antigua ; some of these have been summarised in tabular form and hopefully will be used for topics of discussion during this conference. Also, some key details in these tables will be pointed out in overheads. Instead, the authors will take this opportunity to present some ideas and philosophy on pasture improvement and animal production in the region.

In the past, plans for improvements in livestook production in the Caribbean appear to have been too attached to what can be described as : "The Pangola Grass Syndrome", "The Fertilizer Nitrogen Spendout" and "The Expensive Protein Supplement Addiction". Perhaps the energy orisis with its resultant increases in fertizer costs has at last fored those who plan the future livestook systems of the region to begin to think more positively about forage legumes and biological nitrogen fixation - we certainly hope so.

All Pangola grass in the Caribbean represents a single introduction of a species, *Digitaria decumbens*. It has several outstanding attributes - excellent persistence under grazing, a great ability to suppress weeds, excellent quality when well supplied with nitrogen, coupled with high production when moisture stress is low or absent. Its strengths are in some respects also its weaknesses, especially in dry areas of the region when irrigation is not available : it needs plenty of nitrogen and moisture to produce high yields of good quality feed and its ability to suppress weeds also holds true for virtually all commercially available legumes. Needless to say there is a problem when the farmer cannot afford to supply plenty of fertilizer nitrogen, whilst in the dry season in Antigua it is just about as dormant as any potentially useful grass we have measured. Reference to tables 1 and 2 will clearly demonstrate this. Furthermore, there are few grasses as susceptible to leaf rust and aphids as Pangola. Essentially then, the potential of Pangola cannot be capitalised on by most livestock owners in the Caribbean - most cannot irrigate it, most cannot afford to apply sufficient nitrogen fertilizer and yet, as an alternative, they will not be able to maintain a high enough proportion of legumes with it to cycle sufficient "biological nitrogen" to substitute for fertilizer nitrogen. Given the climatic conditions of drier parts of the Caribbean and its economic limitations and priorities, coupled with the fact that it has to be vegetatively propagated, Pangola is often the the wrong grass to continue to plant or to recommend. If this region wants to use Digit grasses in its future pasture development, it should be first looking at the potential of seeded species such as *D. pentzii*, *D. smutsii* and *D. milanjiana* or at least using Transvala instead of Pangola.

The accompanying tables clearly demonstrate that the Forage Legume Project has measured some quite impressive yields from several grass and legume species, varieties and lines under dry land conditions in Antigua. You will also agree that the rainfall figures tell a story of some prolonged periods of severe moisture stress. Probably the fertilizer application used on the grass plots is about as low as possi-

.../...

ble without markedly jeopardising yields. Reference to the annual grass yields will reveal that those summarised in table 3 are considerably less than those in table 4, a reflex ion of the much higher yields from December 1975 to April 1976 when the wet season was prolonged, than from december 1976 to april 1977 when the wet season finished early. Part of the difference could also be due to the fact that whereas 105 kg N/ha were applied in the first annual regrowth period, only 50 kg/ha were applied in the second. Certainly a minimum input of 100 kg Nitrogen/ha/year for a relatively intensive grassland system is a very conservative estimate indeed, especially if a considerable amount of the herbage is removed from the field as hay or silage or as green feed for stall fed animals - even when we have a long dry season when fertilizer responses will be low. It is very reassuring then that microbiological studies conducted in Antigua by Mr. B. Ahmed have indicated that well adapted forage legumes are capable of fixing large amounts of nitrogen. This is after all a region rich in naturalised legumes ; it is for example, probably the centre of diversity of *Stylosanthes hamata*, which has tremendous potential as a species for pasture improvement in the dry tropics. A form collected in Venezuela that is adapted to relatively low soil pH, has been commercially released in Australia as "Verano" - Caribbean lines of *S. hamata* are in contrast, very well adapted to high pH soil. This is probably also the centre of origin of *Desmanthus* spp. and *Desmodium canum* while many other useful and potentially useful legumes are well and truly naturalised ; *Teramnus labialis*, *Centrosema pubescens*, *C. virginianum*, *C. plumieri*, *Galactia* spp., several other *Desmodium* spp., *Leucaena leucocephala*, *Alysicarpus vaginalis* and *Rhynchosia* spp. So, it is not surprising that Ahmed has found that most soils are rich in the right type of *Rhizobia bacteria* and that his measurements with the Acetylene Reductase Technique indicate that many of the Caribbean legumes and introductions are capable of fixing large amounts of nitrogen. Based on these measurements we can assume that well adapted and productive legumes can probably fix sufficient nitrogen to provide a net input of a least 100 kg/ha/year to a grazed grassland ecosystem, recognizing again that this is probably a very conservative estimate. Now, let us turn that figure into a monetary value :

To provide 100 kg of nitrogen/ha (2.47 aeres) we will need 91/3 bags of Ammonium sulphate (21 % N). Since a bag of this in Antigua contrains 10.7 kg of N and costs 24.00 EC, we are now looking at a biological system that can provide 224.00 EC/ha/year, *in nitrogen input alone*. There are of course, other advantages in making full use of forage legumes in our livestock feeding systems and this leads to our next topic, protein supplements.

"The Caribbean region can and should produce all of its protein supplements" and basic requirements by using, in a systemmatic and efficient way some of the very legumes that grow naturally here as well as promising introduction". Let us get this statement into clear perspective by giving an example. *Clitoria ternatea* has tremendous potential as a dual purpose forage/grain species especially when grown as a special-purpose intensively managed stand. Our results show that even when grown without irrigation in Antigua this species can produce at least 10,000 kg DM/ha containing 15 - 20 % Crude Protein, when out at mature stages of growth (20 - 25 % C. P. when out at a vegetative-early flower stage). In other words, 1,500 - 2,000 kg of crude protein per ha per year. Just how much would that amount of protein cost if bought in as Soyabean meal for example ? Furthermore, *Clitora* can produce very large yields of grain containing 44% crude protein and 2.8 % lysine (Bravo, 1971). The Project plans to investigate the use of special-purpose, intensively managed (irrigated, topdressed and sprayed) legume stands to produce high quality protein meal. Solar drying can probably fit into such a system which need not, and should not be capital intensive and highly technical. At the other end of the spectrum of possible systems for producing protein rich feed is the growing of dry season active forage legumes in backyards and small plots by the many small-scale farmers and livestock owners of the region, especially to help feed their small animals. Socially and economically this has great significance, and the encouragement and implementation of it is a worthwhile challenge to the Livestock Officers and Agricultural Extension personnel in this region.

Another interesting and potentially important source of protein when the dry season is long and severe are the seedpods of *Stylosanthes hamata* either when grazed from the plant itself or licked by animals from the ground after being shed. Work in Northern Australia has shown that the closely related species *S. humilis* can produce nearly 1,000 kg/ha of intact seedpods each year ; work in Antigua as well as that in Australia indicates that *S. hamata* is also capable of producing very high seed yields. Dr Martin Playns of the C.S.I.R.O. Division of Tropical Crops and Pastures has shown that the seed of *S. humilis* forms 62 % of the D.W. of the intact seedpod, and is high in protein (48 %), sulphur (0.34 %) and Phosphorus (0.58 %) and low in fibre (20 %), the pod itself is high in fibre (80 %) and in Calcium (1.7 %). When Playne fed beef cattle 500 g of intact seedpods per day they ate 30 % more low quality grass than these fed low quality grass alone - the former gained 0. 5 kg/head liveweight/day and the latter lost 0.1 kg. No doubt animals in Antigua do better than one would expect on our low quality hay - and seymour grass (*Andropogon* spp.) pastures in the dry season because of the presence of naturalised legumes such as *S. hamata* and *T. labialis* which not only provide the quality part of their diet but also enhance their uptake and utilization of the low quality associated grasses.

Since the production potential of pastures in most wet seasons is very high, surplus herbage is almost inevitable unless the area is totally overstocked. An efficient livestock system in drier parts of the Caribbean must capitalise as much as possible on this surplus to alleviate the stress placed on animals especially in the latter part of the dry season. Silage and hay making in a more or less conventional way is an integral and successfull part of the Government Livestook scheme in Antigua ; it represents a feasible system for other large producers in this region but how much can the all important small producers capitalise on the principals of forage preservation ? That is a very difficult question to answer because there are so many combinations of economic, social, environmental and technical factors involved.

Perhaps those farmers who own or rent relatively large areas of land of suitable topography could contract to have their hay and or silage made on their farm by an organisation such as Government, with the necessary machinery.

Or, perhaps hay made from Government meadow could form a pool of emergeney feed to be sold to farmers later in the dry season.

Also, it will probably be feasible for many small farmers to make at least some of their own hay with a low capital outlay, using for example a two-wheel tractor fitted with a sickle bar mower. Essentially though, any marked increase in forage conservation by small farmers themselves will only come about if the Agricultural Officers and Advisers of this region can demonstrate feasible, worthwhile systems on the farm itself, in conjunction with the farmer himself, i.e. less advise and more example !

Of course, the less dependence we have on forage conservation the cheaper and simpler our systems will be and this, is a very important consideration. How can we reduce the need to conserve wet season feed for the dry ? The answer is to grow species which can produce substantially more herbage in the dry season than those often used at present. Tables 1 and 2 and Figure 1 clearly indicate that several grass species are markedly better than Pangola and haygrasses *(Andropogon caricosum)* from this standpoint alone. Furthermore, the dry season productivity of herbaceous legumes such as *Macroptilium stropurpureum* and *Glycine wightii* and of the browse legume *Leucaena leucocephala* has been remarkable (tables 6, 7 and 8).

The use of drought-tolerant tall grasses such as elephant grass and sugar cane, mainly as stand by dry-season feed, should be an integral part of most livestock systems whether large or small. When the sugar cane grown by the farmer is primarily for sugar production then the cane will of course, be grown on its own and protein supplementation will be necessary. Hopefully, this will be locally produced - even on the same farm. However, when sugar cane, or elephant grass, is grown solely for livestock feeding, every effort should be made to grow them in association with a climbing legume such as *T. labialis*, *M. atropurpureum*, *C. wightii* or *C. pubescens*. to give an *in situ* protein supplement plus nitrogen supply.

In conjunction with the increased use of dry season-active species some of the surplus feed of the wet season can of course, be carried in to the dry season as standing hay and then ration fed. Dry season dormant species such as *Andropogon caricosum* are well suited to this. Hopefully it will be possible in the future to increase the proportion of legume in such "natural" pastures by pasture renovation, in order to improve both the overall feed quality and the utilization of the low quality grass.

The authors are fully aware that there are many difficulties involved in the choice of, and establishment and management of grass legume pastures, and in the increased dependence on forage legumes as such for livestock production. There is not time to deal with these problems in detail, but some will be discussed briefly.

Firstly, not one of the legumes under test in Antigua at present is without some limitations - not that one can ever expect to get "the perfect legume"! Many legumes are not well adapted to the long periods of moisture stress in Antigua and many are not well adapted to either or both heavy cracking clays (Vertisols) or highly calcareous soil (tables 6-10). Reassuringly though, some are well adapted and these results clearly confirm this. Assuming reasonable adaptation to the climate and soils, a major limitation to production in the wet season (tables 8 and 9) is a high susceptibility of most of legume accessions to insect damage - mites, tingids, plant bugs *(Heteroptera)*, leaf hoppers and *Lepidopterus* pests such as *Heliothus*, *Plusia*, *Pseudoplusia* and *Spodoptera*. *Clitoria ternatea* is however, very tolerant and *Leucaena leucocephala*, relatively tolerant. *Clitoria* on the other hand, is quite susceptible to *Cercosporella* leaf spot but this is one of the few minor limitations it has.

The search for compatible grass/legume associations and management systems to maintain a favourable grass/legume balance is important and challenging. Understandably, it is one of the main priorities of trial work in Antigua.

Establishment of new, improved pastures in the region will pose a number of problems. Conventional cultivation and establishment is expensive, is difficult on heavy cracking clays and may be impossible or inadvisable on sloping and/or stony areas. The challenge is to find other cheap and yet effective methods as well as conventional ones, to improve our pastures i.e. through pasture renovation rather than pasture replacement. The Forage Legume Project has had mixed success in its pasture renovation trials, using a Connor Shea chizzel needer ; there are many problems to solve. Further pasture renovation trials will be the main work that wille be carried out on pasture establishment in the next 2-3 years ; most of it will be done with a Power Till seeder which can be used on existing pastures to produce mini seedbeds and sow in a once-over operation. The Project will also be looking at the possibilities of increasing the proportion of legumes in our hay grass pastures by such practices as oversowing, topdressing and burning and using different cutting and grazing managements.

The authors cannot imagine a viable programme of pasture improvement that relies heavily on seed supples from outside this region because of the high cost and transport problems involved. Australia is the chief source of commercial pasture seed at present and it is worth noting too, that as well as high cost and delivery delay, their varieties have of course been selected for their conditions, not ours. It is also worth mentioning that the International Organisation CIAT, in Colombia, is concentrating its efforts on the selection of species for the Llanos, a huge region of intermediate rainfall with soils of very low pH and mineral levels. In Antigua, it is the plan of the Forage Legume Project to begin producing small commercial quantities of seed for pasture development in the region, including lines well adapted to high pH, heavy clays and calcareous soils.

CONCLUSION. Compared with growing crops, producing meat from pastures is an inefficient method of "harvesting the sun". Even under ideal feed-lot conditions three units of grain energy will produce only one unit of meat energy and grazing animals will rarely reach this level of efficiency. Even so, even on these islands where land is such a precious and limited resource, grazing animals will always have a place, to turn plants that humans cannot digest into edible protein in the areas that cannot be cropped. In the short term at least, this also holds true for those potential cropping areas which lie idle. Also, it is highly probable that in the future, some Caribbean forage legumes will be used for the extraction of protein directly edible by humans.

## *PASTURE SPECIES FOR DRIER PARTS OF THE CARIBBEAN : SOME PRELIMINARY RECOMMENDATIONS.*

1°/ *Urochloa bolbodes*, *U. mosambicensis* (Sabi grass) and "Bambatsi" *Panicum coloratum* as seeded grasses for intensive rotational grazing, hay and silage, when combined with selected lines of drought-tolerant legumes such as *Macroptilium atropurpureum*, *Glycine wightii*, *Teramnus labialis* and *Stylosanthes hamata*.

2°/ Coastal Cross I Bermuda grass and other selected *Cynodon* spp. for pastures to withstand considerable periods of set-stocking and general mismanagement. Such pastures will perform much the same role as Pangola grass does at present, but with more dry season production and a higher proportion of associated legumes such as *M. atropurpureum*, *G. wightii*, *T. labialis* and *S. hamata*.

3°/ High-yielding *Panicum maximum* varieties such as "Makueni", "Uganda" and "Likoni" for zero grazing, rotational grazing, and hay, when combined with drought-tolerant climbing legumes such as *M. atropurpureum*, *G. wightii* and *T. labialis*.

4°/ The browse legume, *Leucaena leucocephala* which has very high quality (25 % or more of crude protein in edible herbage) could also be combined in wide rows with *Panicum maximum* type grasses, to form a special-purpose pasture especially for dry season feeding, the important prerequisite to its successful use being the presence of more grass than *Leucaena* herbage. Certainly until either low mimosine lines are released from the Australian Breeding Programme or a suitable treatment to counteract the deleterious effects of mimosine is available the use of *Leucaena* should be limited and careful. Selection of vigorous lines of other browse legumes such as *Desmanthus virgatus*, which do not contain a toxic principal is being conducted by the Forage Legume Project.

5°/ Sugar cane, Elephant grass, Enano (dwarf) Elephant grass and possibly Guatamala grass, preferably when combined with climbing legumes such as *M. stropurpureum*, *G. wightii*, and *Centrosema pubescens*, to alleviate the dry season feed deficit, the sugar cane, Guatamala grass and Elephant grass for a cut and carry system but with emergency grazing as well from the Elephant grass while, the dwarf Elephant grass could be used both for rotational grazing and cutting.

6°/ Small areas of special-purpose, intensively managed (irrigated, top-dressed and sprayed) stands of legumes such as *Clitoria ternatea*, *M. atropurpureum* and *G. wightii*, to provide high-protein feed as meal and hay.

7°/ Buffel grass *(Cenchrus ciliaris)* varieties such as "Biloela", "Nunbank" and "Tarewinnabar" have outstanding adaptability and dry season productivity on shallow calcareous soils and can also be recommended for droughty, skeletal volcanic soils. Because of their relatively low palatability, they should be sown in association with legumes, but without other more palatable grass species, in order to obtain good utilization by animals.

8°/ Climbing legumes such as *T. labialis, M. atropurpureum, G. wightii,* and *C. ternatea* for backyard and small-plot production of protein-rich animal feed. Ideally such species should have a support system such as fences or stakes but *C. ternatea* which is semi-self-supporting could be combined with a climber such as *T. labialis* which also shows strong stoloniferous creep.

9°/ *Hemarthria altissima,* "Big Alta" has proved to be very poorly adapted to the long dry season and high pH soils of Antigua but in a trial at Beausejour St. Lucia, where the dry season is less severe and soils, more acid, it has been outstanding, yielding 50 % more herbage than either Coastal Cross Bermuda grass or Pangola grass. In areas with non-calcareous soils and receiving an annual RF of at least 50" (1270 mm), *Hemarthria* plus legumes should be seriously considered for intensively managed pastures.

10°/ Considerable areas of "natural" pastures dominated by grasses such as Seymour and hay *(Andropogon* spp.) can be retained. Such pastures should be renovated by introducing legumes such as *T. labialis* and *S. hamata* and perhaps grasses, such as *U. bolbodes.*

-!-!-!-!-!-!-!-!-!-!-!-!-

## REFERENCES BIBLIOGRAPHIQUES

BRAVO (F.O.), 1971. - Tecn. Pecuaria, Mex. 18, 100-102.

Table 1 - Contrasts in dry season productivity - 1976.
A. Total dry season yield. 222 days
PPT - 11.61" (295 mm)
Estimated P.E.T. 42" (1,067 mm)
Fertilizer added : 15 kg Nitrogen/ha.

| Species | Variety of Line | DM Yield kg/ha |
|---|---|---|
| *Urochloa bolbodes* | CPI 47122 | 6,600 |
| *Brachiaria decumbens* | Signal grass | 6,200 |
| *Pennisetum purpureum* | Elephant grass | 6,150 |
| *Panicum maximum* | Likoni and Uganda | 5,930 |
| *Cenchrus ciliaris* | Nunbank Buffel grass | 4,900 |
| *U. mosambicensis* | Sabi grass | 4,650 |
| *Cynodon* | Coastal Cross I Bermuda | 3,900 |
| *Chloris gayana* | Florida 161 Rhodes grass | 3,600 |
| *Digitaria* | Transvala Digit grass | 3,550 |
| *Andropogon* | Local Seymour grass | 3,150 |
| *Digitaria decumbens* | Pangola grass | 2,200 |
| *Andropogon caricosum* | Local Hay grasses | 1,575 |

Table 2 - Contrasts in dry season productivity - 1976.
B. march 15 - August 29 (167 days)
PPT = 7.97" (202 mm)
Estimated P.E.T. 30" (762)
No fertilizer added

| Species | Variety or Line | DM Yield Kg/ha |
|---|---|---|
| *Pennisetum purpureum* | Elephant grass | 4,350 |
| *Brachiaria decumbens* | Signal grass | 3,800 |
| *Urochloa bolbodes* | CPI 47122 | 3,700 |
| *Cenchrus ciliaris* | Nunbank Buffel grass | 3,500 |
| *Panicum maximum* | Makueni, Likoni & Uganda | 3,335 (3,150 - 3,450) |
| *P. coloratum* | Bambatsi | 2,650 |
| *U. mosambicensis* | Sabi grass | 2,150 |
| *Digitaria* spp. | Transvala Digit grass | 1,750 |
| *Cynodon* spp. | Coastal Cross I Bermuda | 1,600 |
| *Chloris gavana* | Florida 161 Rhodes grass | 1,400 |
| *Digitaria decumbens* | Pangola grass | 1,200 |
| Local *Andropogon* spp. | Seymour and hay grasses | 815 (775 - 850) |

Table 3 - Annual DM production october 18, 1975 - october 22, 1976.
Total PPT. 30. 64" (778 mm)
Total added fertilizer : 105 kg/ha nitrogen, 25 kg phosphate & 25 kg potash.

| Species | Number of Varieties Lines | Mean DM Yield Kg/ha | Range | Highest/Lowest Variety or Line |
|---|---|---|---|---|
| *Urochloa* spp. | 2 | 13,875 | (12,150 - 15,600) | H = *U. bolbodes* 47122<br>L = *U. mosambicensis* 6559 |
| *Pennisetum purpureum* | 2 | 12,950 | (10,650 - 15,250) | H = Elephant grass<br>L = Enano grass |
| *Panicum maximum* | 6 | 10,440 | (6,400 - 14,200) | H = Uganda<br>L = Antigua Guinea |
| *Cenchrus ciliaris* | 4 | 10,075 | (6,900 - 13,900) | H = Nunbank Buffel<br>L = Local Buffel |
| *C. setigerus* | 1 | 10,000 | | Birdwood grass |
| *Cynodon* spp. | 5 | 8760 | (8150 - 10,200) | H = C.C. I<br>L = Stargrass I |
| Local *Andropogon* spp | 3 | 8485 | (6950 - 10,550) | H = Seymour grass<br>L = Haygrass II |
| *Digitaria* spp. | 3 | 8250 | (7100 - 10,100) | H = Transvala<br>L = Slendersterm |
| *Brachiaria* spp. | 5 | 7590 | (5200 - 12,350) | H = Signal grass<br>L = Tanner grass |
| *Chloris gayana* | 2 | 7425 | (7150 - 7700) | H = Florida 161<br>L = Pioneer |

Table 4 - Annual DM production march 15, 1976 - April 5, 1977.
Total PPT. 30.77" (780 mm)
Total added fertilizer : 50 kg/ha nitrogen, 25 kg phosphate & 35,4 kg potash.

| Species | Number of Varieties Lines | Mean DM Yield kg/ha | Range | Highest/lowest Variety or Line |
|---|---|---|---|---|
| *Pennisetum purpureum* | 2 | 9220 | (7465 - 10,970) | H = Elephant grass<br>L = Enano Elephant grass |
| *Urochloa* spp. | 2 | 8945 | (8085 - 9805) | H = *bolbodes* 47122<br>L = *mosambicensis* 6559 |
| *Cenchrus ciliaris* | 5 | 8365 | (4310 - 11,130) | H = Nunbank Buffel<br>L = Gayndah Buffel |
| *C. setigerus* | 1 | 8555 | | Birdwood grass |
| *Panicum maximum* | 10 | 7815 | (5430 - 11,070) | H = Uganda<br>L = Antigua Guinea |
| *P. coloratum* | 3 | 7710 | (4310 - 10,525) | H = Bambatsi<br>L = Kabalabala |
| Local *Andropogon* spp. | 3 | 6325 | (5680 - 6710) | H = Seymour grass<br>L = Haygrass I |
| *Cynodon* spp. | 5 | 6230 | (5925 - 7120) | H = Seymour grass<br>L = Haygrass I |
| *Brachiaria* spp. | 5 | 5490 | (2830 - 8970) | H = Signal grass<br>L = Tanner grass |
| *Digitaria* spp. | 3 | 5175 | (4610 - 5765) | H = Transvala<br>L = Pangola |

Table 5 - New Buffel and Guinea grass Lines. DM Production kg/ha. 1976/77.

| Species | Variety or Line | DM Yield* Oct. 20 - April 5 2 harvests 167 days | DM Yield** Aug. 29 - April 5 3 harvests 219 days |
|---|---|---|---|
| *Cenchrus ciliaris* | Biloela | 9,435 | 13,725 |
| | CPI 48218 | 8,805 | 13,525 |
| | Tarewinnabar | 8,530 | 13,420 |
| | Q 11086 | 9,860 | 13,420 |
| | Q 1224 | 8,840 | 13,150 |
| | CPI 22370 | 10,180 | 12,910 |
| | American | 8,475 | 11,765 |
| | Q 11014 | 7,645 | 11,700 |
| | CPI 29024 | 7,675 | 10,975 |
| | Q 10077 | 8,020 | 10,720 |
| | W.A. | 6,745 | 9,145 |
| | Y 38 | 7,715 | - |
| | Y 141 | 7,680 | - |
| *Panicum maximum* | Y 73 | 9,930 | - |
| | Y 107 | 8,145 | - |
| | Y 116 | 6,760 | - |

* RF = 15.60" (396 mm) ; ** RF = 25.06 (636 mm).

Table 6 - Herbage production under drought conditions - 1976 ;
Heavy clay site. 75 days of regrowth.
RF = 2.41" (61 mm)
Estimated PET 14" (362 mm)

| Species | Number of Lines Measured | DM Yield kg/ha X | Range | Highest/Lowest Line |
|---|---|---|---|---|
| *S. hamata* | 34 | 960 | Neg. 1,640 | H = BA - 8 & CPI 33205<br>L = CPI 34148 & M = 2 |
| *Teramhus labialis* | 16 | 1,060 | 380 - 1,530 | H = B - 1 & 1G - 36<br>L = SK - 2 |
| *T. uncinatus* | 2 | 1,245 | 1,005 - 1,480 | H = CPI 40307<br>L = Florida 1550 |
| *S. guyanensis* | 4 | 960 | 765 - 1,145 | H = CIAT 18<br>L = Schofield |
| *Macroptilium atropurpureum* | 6 | 2,460 | 1,910 - 2,975 | H = M - 7<br>L = SK - 8 |
| *Glycine withtii* | 4 | 2,315 | 1,795 - 2,735 | H = Cooper<br>L = N - 15 |
| *Teramnus labialis Glycine* mixture | 1 | 3,190 | | |
| *Centrosema virginianum* | 9 | | Negligible yield | |
| *C. pubescens* | 9 | 1,225 | 835 - 2,375 | H = CIAT 1733<br>L = D - 1 |
| *Clitoria ternatea* | 6 | 900 | 290 - 2,735 | H = SV - 10<br>L = M - 10 |
| *Leucaena leucocephala* | 7 | 1,405 | 970 - 1,750 | H = SK - 12<br>L = SV - 4 |
| *Galactia* spp. | 6 | 975 | 280 - 1,460 | H = Q 6998 & AG - 54<br>L = AG - 52 |
| *Desmodium* spp. | 5 | 406 | Neg. - 600 | H = *Tortuosum* (Barbados)<br>L = *canum* (Barbados) |
| *Alysicarpus vaginalis* | 4 | 140 | Neg. - 410 | H = AG - 76<br>L = AG - 65 & SK - 27 |
| *Macrotyloma axillare* | 1 | 2,140 | 1,825 - 2,460 | Archer |

Table 7 - Legume recovery growth, 60 days after the third grazing on december 17-21, 1976. Heavy clay (ottos) site. Mainly drought conditions. 0.78" (19.8 mm).

| | Number of Lines Measured | Mean Vigour Index 0 - 10 | Range | Highest/Lowest Line |
|---|---|---|---|---|
| *S. hamata* | 34 | 1.15 | Neg. - 4.0 | H = AG - 2<br>L = CPI 34148<br>BA - I & M - 2 |
| *S. guyanensis* | 2 | 0.5 | - | Schofield & Cook |
| *Teramnus labialis* | 15 | 3.6 | 1.75 - 5.0 | H = Semilla negra<br>L = AG - 38 |
| *T. labialis* + *Glycine withtii* | 1 | 7.0 | 6.0 - 8.0 | Semilla roja + Tinaroo |
| *T. uncinatus* | 2 | 2.4 | 1.75 - 3.0 | H = Florida 1550<br>L = CPT 40307 |
| *Glycine wightii* | 4 | 5.25 | 3.0 - 8.0 | H = Tinaroo<br>L = Malawi |
| *Macroptilium atropurpureum* | 6 | 3.83 | 3.0 - 4.5 | H = M - 7<br>L = Cu - 4 & 5 |
| *Clitoria ternatea* | 6 | 1.80 | 1.0 - 3.0 | H = SK - 15<br>L = AG - 62 & 63 |
| *Centrosema verginianum* | 9 | Negligible yield | | |
| *C. pubescens* | 7 | 1.32 | 0.5 - 2.0 | H = Cu - 4<br>L = Florida |
| *Centrosema* spp. | 1 | 2.25 | 1.5 - 3.0 | CIAT 1733 |
| *Leucaena leucocephala* | 7 | 4.86 | 4.0 - 8.0 | H = CIAT 871<br>L = SL - 7, 1G - 57 & AG - 59 |
| *Macrotyloma axillare* | 1 | 4.0 | 3.0 - 5.0 | Archer |
| *Alysicarpus vaginalis* | 3 | 2.60 | 1.5 - 4.25 | H = SK - 27<br>L = SV - 9 |
| *Galactia* spp. | 3 | 1.33 | 0.5 - 3.0 | H = Q 9164<br>L = SK - 9 & AG - 54 |

Table 8 - Legume Production November 20, 1976 - February 9, 1977.
Fitches (Calcereous) Site. 81 days of regrowth. Growth for the final 6 - 7 weeks under high moisture stress.

| Species | Number of Lines Measured | DM Yield kg/ha X | Range | Highest/ Lowest Line |
|---|---|---|---|---|
| *S. hamata* | 64 | 605 | Neg. - 1,700 | H = 1G - 4<br>L = CIAT 122 & Verano |
| *S. scabra* | 4 | Negligible yield only 34925 surviving | | |
| | | " " Died out | | |
| *S. guyanensis* | 9 | 1,310 | 900 - 1,800 | H = Semilla negra<br>L = AG - 38 |
| *T. uncinatus* | 1 | 1,000 | 890 - 1,045 | CPI 40307 |
| *Glycine wightii* | 3 | 1,445 | Neg. - 2,400 | H = Tinaroo<br>L = Malawi |
| *Macroptilium atropurpureum* | 4 | 2,150 | 1,600 - 2,400 | H = Y - 103<br>L = Y -61 |
| *Clitoria ternatea* | 3 | 1,470 | 1,200 - 1,740 | H = AG - 62<br>L = SK - 15 |
| *Centrosema virginianum* | 7 | Negligible yield. Nearly all plants dead. | | |
| *C. pubescens* | 5 | " " " " " " | | |
| *C. elegans* | 1 | 1,270 | - | Y = 89 |
| *Leucaena leucocephala* | 3 | 2,770 | 1,300 - 3,100 | H = CIAT 871<br>L = 7 - 145 |
| *Desmanthus depressus* | 2 | 190 | Neg. - 385 | H = Co - 9<br>L = AG - 67 |
| *Desmanthus virgatus* | 1 | 1,100 | 945 - 1,255 | Co - 10 |
| *Desmodium distorium* | 3 | 800 | 600 - 1,000 | H = CIAT 335<br>L = CF - 5 |
| *Galactia* spp. | 4 | 460 | Neg. - 990 | H = Q 9164<br>L = AG - 54 |
| *Macroptilium lathyroides* | 1 | Negligible yield. Nearly all plants dead. | | |

Total rainfall, 4.89" (124 mm) with only 0.95" (24 mm) for the last 8 weeks.

Table 9 - Production under wet season conditions - 1975 : Heavy clay site.
74 days of regrowth.
RF = 11.80" (300 mm)
Estimated PET 11.30" (287 mm)
Excluding lines established in July, 1975.

| Species | Number of Lines Measured | DM Yield kg/ha X | Range | Highest/Lowest Line |
|---|---|---|---|---|
| *S. hamata* | 7 | 1,550 | 630 - 2,700 | H = 1G - 2<br>L = BA - 1 |
| *Terammus labialis* | 12 | 2,590 | 1,800 - 3,200 | H = M - 1<br>L = SV - 2 |
| *T. uncinatus* | 1 | 1,320 | | Florida 1,550 |
| *S. guyanensis* | 4 | 1,140 | 660 - 1,880 | H = Endeavour<br>L = Schofield |
| *S. scabra* | 3 | 560 | 320 - 1,040 | H = CPI 40205<br>L = CPI 40289 |
| *Macroptilium atropurpureum* | 6 | 2,400 | 1,800 - 3,200 | H = CU - 5<br>L = AG - 74 "Baja" |
| *Glycine wightii* | 1 | 2,800 | | Tinaroo |
| *Centrosema virginiamum* | 7 | 450 | 160 - 1,180 | H = M - 6<br>L = SK - 6 |
| *C. pubescens* | 5 | 2,280 | 2,000 - 2,500 | H = Centro<br>L = AG - 41 |
| *C. brazilianum* | 1 | 2,040 | | Florida 1,238 |
| *C. plumieri* | 1 | 3,990 | Edge effect | Cu - 12 |
| *Clitoria ternatoa* | 4 | 3,760 | 3,200 - 4,000 | H = SK - 15<br>L = AG - 63 |
| *Leucaena leucocephala* | 1 | 1,460 | | SV - 4 |
| *Desmodium* spp. | 4 | 630 | 300 - 1,390 | H = *uncinatum*<br>L = *canum* M - 8 |
| *Rhynchosia minima* | 4 | 90 | Neg. - 185 | H = AG - 71<br>L = CF - 13 & SK - 24 |
| *Alysicarpus vaginalis* | 4 | 880 | 910 - 1,380 | H = AG - 79<br>L = 1G - 65 |
| *Macroptilium lathyroides* | 1 | 720 | | AG - 51 |
| *Macrotyloma axillare* | 1 | 1,460 | 1,270 - 1,650 | Archer |

Table 10 - Legume Production September 22 - Novembre 20, 1976. Fitches (Calcareous) Site. Wet season production.

| Species | Number of Lines Measured | DM Yield kg/ha x | Range | Highest/ Lowest Line |
|---|---|---|---|---|
| *S. hamata* | 66 | 1,040 | 120 - 2,500 | H = Cu - 1<br>L = Y - 85 |
| *S. scabra* | 4 | Negligible yield | | |
| *S. guyanensis* | 9 | Negligible - Died out | | |
| *Teramnus labialis* | 13 | 590 | Neg. - 1,650 | H = CPI 33232<br>L = Semilla negra |
| *T. uncinatus* | 1 | 270 | Neg. - 540 | CPI 40307 |
| *Glycine wightii* | 3 | 515 | Neg. - 1,435 | H = Tinaroo<br>L = Malawi |
| *Macroptilium atropurpueum* | 4 | 1,465 | 1,250 - 1,760 | H = Y - 103<br>L = Y - 61 |
| *Clitoria ternatea* | 3 | 1,870 | 1,660 - 2,110 | H = Co - 8<br>L = SK - 15 |
| *Centrosema virginianum* | 7 | Negligible yields. Highly chlorotic | | |
| *C. pubescens* | 5 | " " " " | | |
| *C. elegans* | 1 | 430 | | Y - 89 |
| *Leucaena leucocephala* | 3 | 770 | 300 - 1,100 | H = Y - 23<br>L = CIAT 871 |
| *Desmanthus depressus* | 2 | 180 | 170 - 190 | AG - 67 & Co - 9 |
| *Desmanthus virgatus* | 2 | 2,325 | 1,920 - 2,725 | H = Co - 10<br>L = Y - 98 |
| *Demodium distortum* | 3 | 2,370 | 1,200 - 3,600 | H = Y - 78<br>L - CIAT 335 |
| *Galactia* spp. | 4 | 145 | Neg. - 240 | H = SK - 9<br>L = AG - 54 |
| *Macroptilium lathyroides* | 4 | Negligible Yield. Highly chlorotic. | | |

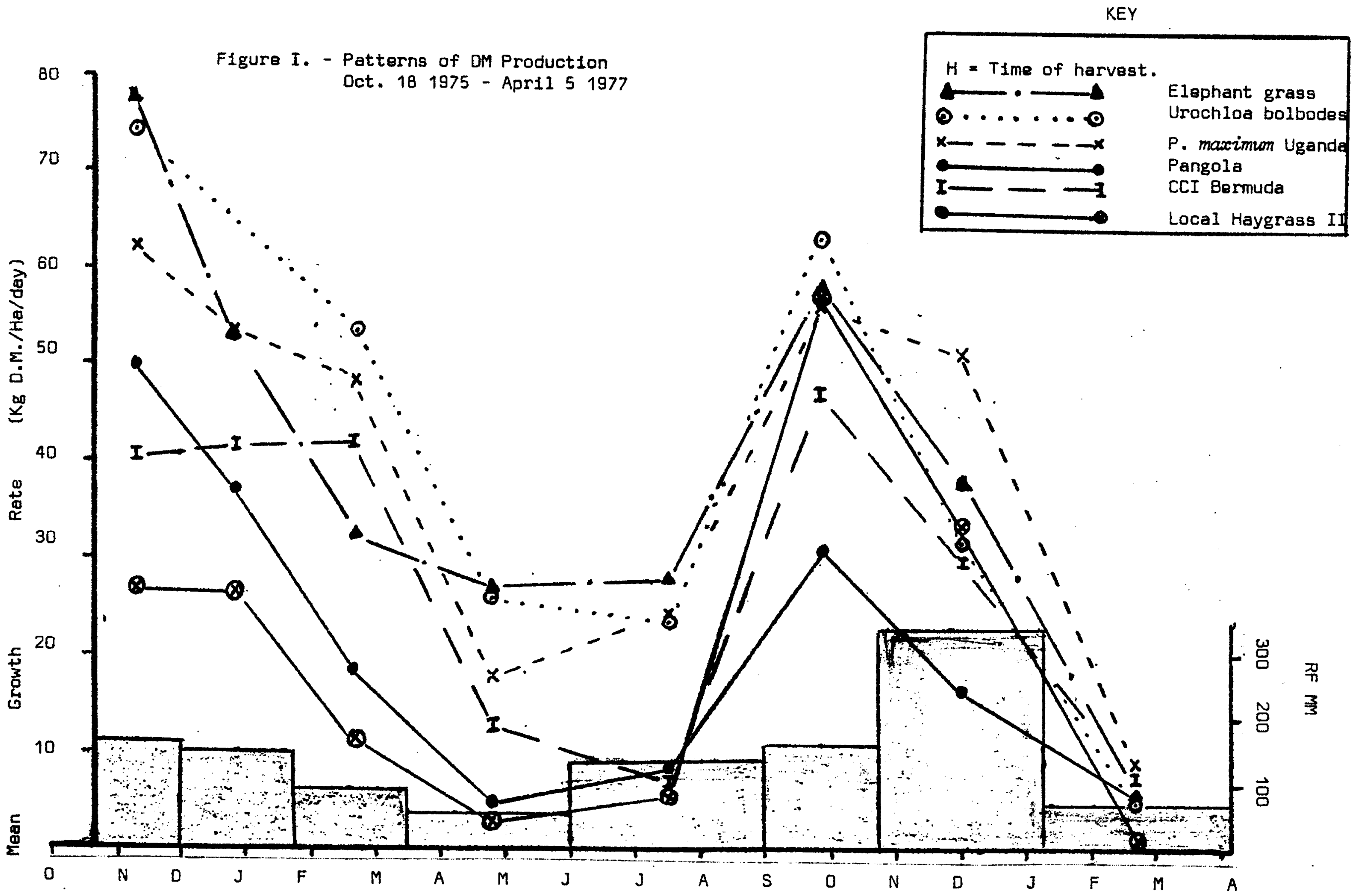


Figure I. - Patterns of DM Production
Oct. 18 1975 - April 5 1977