

ADAPTABLE AND PRODUCTIVE FORAGE LEGUMES AND GRASSES FOR MORE INTENSIVE SMALL RUMINANT LIVESTOCK SYSTEMS IN THE CARIBBEAN

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The use of well adapted and productive forage legumes and grasses should be the basis of most systems designed to improve small ruminant livestock production in the Caribbean.

The Forage Legume Project in Antigua has identified a wide range of grass species and accessions which can be recommended with confidence. Understandably though, very few of the large number of legume accessions tested appear to have all the traits necessary to enable them to withstand not only prolonged periods of moisture stress, insect attack and competition from inherently more aggressive associated grasses, but long periods of mismanagement such as overgrazing by sheep and goats as well. Essentially, very few productive legume species are morphologically adapted to withstanding repeated close defoliation. Consequently, several promising species such as *Glycine wightii*, *Macroptilium atropurpureum* and *Clitoria ternatea* will require judicious grazing management to ensure their persistence in grass/legume associations when grazed by sheep and goats. *Teramnus labialis* and *Stylosanthes hemata* however, show excellent persistence when subjected to hard grazing by sheep and goats. In fact, the proportion of these two species in grass/legume associations can be increased by such management.

The use of browse legumes is strongly recommended. At present the recommendation is to use an improved variety of *Leucaena leucocephala*, "CIAT 871", but accessions of other species such as *Desmanthus virgatus*, *Desmodium distortum* and *D. Leonii* show considerable promise.

The use of "protein/energy banks" of tall grasses such as Elephant grass (*Pennisetum purpureum*) and sugar cane (*Saccharum officinarum*) preferably when grown with climbing legumes such as *C. ternatea*, *M. atropurpureum* and *G. wightii*, as well as pure legume stands of these and browse types, is also highly recommended mainly to provide supplementary cut and carry feed, as well as emergency grazing. Such banks could also form the basis of highly intensive feedlot systems, the realistic basis of which would be the use of the legumes as sources of "home-grown" protein supplements and biological nitrogen.

Key words: Review, legumes, grasses, tropics, small ruminants

In the past, plans for improvements in livestock production in the Caribbean have been too attached to what can be described as the "Pangola grass syndrome", the "fertilizer nitrogen spend-out" and the "expensive protein supplement addiction" (Keoghan & Devers 1977a). Biological nitrogen and the cycling of this nitrogen for production should be the main basis for increasing animal production in areas such as the Caribbean. Failure to capitalise on this through the use of well adapted and productive forage legumes and grasses is a failure to recognise the most effective and efficient method for fragile economies to become more self-sufficient in animal products (Keoghan & Devers 1977b). Furthermore, the Caribbean region can and should produce most of its animal protein supplements and basic requirements by using some of the very legumes that grow naturally here as well as promising introductions (Keoghan & Devers 1977a).

The Caribbean region offers a multitude of livestock systems and potential systems which reflect the diverse nature of the Caribbean livestock farmer and his environment. The farmer could well be a family with a small backyard operation with rabbits and/or pigs, and/or poultry, sheep and goats, or a land owner of a

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considerable flock of sheep and goats and perhaps cattle as well. He could be the owner of a small amount of land or a large landowner, including Government. Essentially, however, most of the land, apart from the large Government holdings, is often owned by a small proportion of the total farming population.

There are adaptable and productive forage grasses and legumes to suit any conceivable livestock system and most environments in this region.

Systems

Intensive Pastures: Although there are many well adapted and productive legumes or the Caribbean, the maintenance of an adequate proportion (25 - 40%) of these in a grass/legume mixture can be difficult. Most of our productive legumes are climbing/scrambling types which show poor persistence when set stocked at a high stocking rate for long periods, by sheep and goats. Essentially, many are not well adapted morphologically to withstanding repeated close defoliation. Far too many pastures in the Caribbean are haphazardly set stocked at high stocking rates, with sheep and goats until completely overgrazed, but we must also be realistic and expect periodic mismanagement even in well managed, improved systems. Intensive systems should include either some rotational grazing or at least periodic spelling to allow the recovery of legume plants weakened by mismanagement. Many grasses can withstand hard grazing better than legumes because they usually have many growing points below the level of grazing. Another main reason for the suppression of legumes by associated tropical grasses is the much higher growth rate of tropical grasses under favourable conditions than either temperate grasses or legumes. They can probably use the energy of the sun more efficiently to produce herbage than any other member of the plant kingdom.

However, changes in the relative palatability of our legumes and grasses will often help us to maintain an adequate proportion of legume in the pasture. For example, during the wet season ruminant animals tend to selectively graze the more competitive grass component in preference to associated legumes such as "Mother Segel" (*Stylosanthes hamata*), "Mexican Macro" (*Macroptilium atropurpureum*) and Perennial Soyabean (*Glycine wightii*). This increases the chance of facing the dry season with an adequate proportion of legumes which are increasingly preferentially grazed. This is important not just because of the high quality of the legume as such or because of the excellent dry season productivity of some of them (e.g. *G wightii* and *M. atropurpureum*) but because the utilization of the legume component by the ruminant animal enhances the intake and utilization of low quality associated grasses such as *Dichanthium aristatum* and *Bothriocloa pertusa*.

In trials on a droughty, relatively free-draining calcareous clay soil, the Forage Legume Project in Antigua has shown that, given adequate rest periods, *G wightii* and *M. atropurpureum* have remarkable persistence and productivity when grazed by sheep and goats. On the other hand, the prostrate, non-climbing, drought tolerant legume *S hamatha* has shown its greatest persistence in grass/legume mixtures when hard grazed for long periods; under a lenient management system such as rotational grazing at wide intervals, it is often suppressed by associated grasses. *Teramnus labialis* ("Winner") is also a highly persistent legume which can withstand periodic mismanagement by overgrazing. Persistence is the most important criterion for selecting legume accessions for long-term improved pastures; far too much importance has been given to productivity in some selection programmes.

Protein/energy feed banks: The use of highly productive feed banks is one of the keys to increased livestock production in this region. The main ingredients are tall, highly productive grasses, preferably *Pennisetum purpureum* (Elephant grass), but *Tripsacum laxum* (Guatemala grass) and *Saccharum officinarum* (sugar cane) may also have a place, combined with climbing legumes such as *Centrosema pubescens*, *C schottii*, *Clitoria ternatea* ("Blue pea"), *G wightii*, *M atropurpureum* and *Pueraria phaseoloides* ("Kudzu"). The choice of legume will be strongly determined by edaphic and climatic conditions. The other key component in this system, is the browse legume (*Leucaena leucocephala* ("Wild tamarind")). With its deep root system, leucaena can produce more forage in the dry season than most other forage plants. It is very high in protein (leaves contain about 25% crude protein); measurements have shown that even in areas of the Caribbean with a long dry season, improved varieties such as Cunningham (CIAT 871) can produce 2500 to 3750 kg of protein per ha per year. It is also high in minerals such as phosphate, potassium, magnesium calcium and trace elements and in vitamins (especially vitamin A). To minimise the danger of metabolic problems caused by the amino acid mimosine and its breakdown product (DHP), Leucaena can be planted with Elephant grass in the ratio of 3 - 4 Elephant grass plants or rows to one of leucaena. Alternatively, it can be grown as a pure "protein bank" and a safe ration formulated after separate cutting. Leucaena forage is best suited to feeding ruminants. However, it probably should not form more than 30 - 40% of the diet of cattle and sheep for prolonged periods. Goats relish it more than any other domesticated animal and for them, it can form about half of their total diet for long periods of time without having deleterious effects. The toxic compounds affect simple stomached animals more than ruminants. However, a ration with 5 - 10% leucaena can be fed to pigs and up to 5% for poultry. Rabbits also relish it and are less affected than pigs and poultry. Nevertheless, they should not be fed large amounts until they have had time to adjust.

Because leucaena seedlings have notoriously low vigour, direct seeding of all but larger areas cannot be recommended in the Caribbean. It is best to establish seedlings in a nursery first and then to transplant.

Several other browse or semi-browse legumes show promise as alternatives to leucaena including accessions of *Desmanthus virgatus*, *Desmodium distortum*, and *D leonii* (*Cadarioralyx gyroides*), none of which appear to contain toxic compounds.

Protein supplements: The import of expensive protein supplements from outside this region is a ludicrous and unnecessary loss of overseas funds. Quality determinations of a wide range of legumes by the Forage Legume Project (Devers & Keoghan 1978) have given an unequivocal demonstration of the folly of buying North American protein. Several types of meal have been produced from dried forage legume components and the crude protein levels of these are summarised in Table 1.

The production of protein supplements does not necessarily require expensive technology or extensive systems. The "backyard" producer can for example, produce a protein meal from *Desmanthus virgatus* or *L. leucocephala* simply by cutting off branches, drying them and then shaking off the small leaves. These can be mixed with a highly digestible, high energy feed such as corn or sorghum grain to produce balanced rations for high production.

A summary of the adaptability of a wide range of forage grass species is presented in Table 2.

Table 1:
Protein supplements from local legumes

Legume component	Protein in DM, %
<i>Stylosanthes hamata</i> "Caribbean selected" (racemes, leaves, some stems and pods)	19.3
<i>Desmanthus virgatus</i> (leaf, seeds, pods and some stems)	19.0
<i>Desmanthus virgatus</i> (mainly empty pods with some leaf, stem and seeds)	9.1
<i>Clitoria terratea</i> (mainly leaf and pods)	23.0
<i>Clitoria terratea</i> (whole plants including mature woody stems)	14.8

Table 2:
A summary of the adaptability of a range of grass species

Species	Seeding rates in mixture	D ¹	W ²	SS ³	C ⁴
<i>P maximum</i>					
a)("Green Panic")	1 - 6 lb/ac ⁵	Good	Fair	Good	Good
b)("Gatton" and others)	1 - 6 lb/ac	Fair	Fair	Good	Good
<i>P coloratum</i>					
("Bambatsi" & "Burnet")	2 - 4 lb/ac	Good	Very good	Very good	Fair
Rhodes grasses	1 - 6 lb/ae	Good	Fair	Very good	Fair
Signal grasses "Basilisk"	2 - 5 lb/ac	Fair good	Fair	Good	Fair
Buffel grasses	1 - 4 lb/ac	Excellent	Fair	Good	Excellent
Dubi grass	1 - 4 lb/ac	Very good	Fair	Good	Very good
Sabi grass	1 - 4 lb/ac	Good	Fair	Good	Good
Gamba. grass	2 - 6 lb/ac	Good	Not yet determined		
Elephant grass	Vegetative	Good	Good	Good	Fair good
Pangola	Vegetative	Fair	Good	Good	Fair
<i>Hemarthria altissima</i> ("Big alta")	Vegetative	Poor fair	Very good	Good	Poor
Star grasses	Vegetative	Good	Fair	Good	Fair good
Bermuda grass (CC-1" & Calle")	Vegetative	Good	Fair	Fair good	Good

¹ D = Drought tolerance

² W = Tolerance of periodic waterlogging

³ SS = Tolerance of heavy clay soils with saline/sodic subsoils

⁴ C = Tolerance of droughty, high pH, calcareous soils

⁵ 1 - 6 lb/ac = 1 - 6 kg/ha approximately

Forage legumes and grasses for heavy clay soils in drier parts of the Caribbean (875 - 1250 mm).

(1) For long term pastures: *S hamata* ("Caribbean Hamata"); *Centrosema* spp (CIAT 438; *T labialis* ("Semilla roja" and CPI 52793); *G wightii* "Clarence", "Tinaroo". "Cooper" and CPI 52614 and *L leucocephala* (CIAT 871).

Recommended grasses to grow in association with Caribbean hamata: Coast Cross 1 Bermuda, Calle Bermuda and Stargrasses (*Cynodon* spp); Green Panic (*Panicum maximum* var *trichoglume*); Sabi grass (*Urochloa mossambicensis* and Dubi grass (*Urochloa bolbodes*).

In addition to the grasses shown in Table 2 the following species are recommended for associations with the other legumes; Makarikari grass (*Panicum coloratum*), Signal grass (*Brachiaria decumbens*), Rhodes grass (*Chloris gayana*), Guinea grasses (*Panicum maximum*), and Buffel grasses (*Cenchrus ciliaris*).

(2) For short-term pastures with high early legume production: "Mexican Macro or "Siratro" (*M atropurpureum*), *D distortum* CIAT 335; Phasey bean (*M lathyroides*); *Centrosema pascuorum*; *C schottii*; "Blue pea" (*Clitoria ternatea*); *Desmanthus virgatus* and *T uncinatus*.

Grasses; as for (1), but it could prove to be uneconomical to include vegetatively propagated grasses in short-term pastures.

(3) For cut and carry systems: As for (2) and also including *L leucocephala* and *G wightii*, *Centrosema* spp. (CIAT 438) and *T labialis*.

Grasses; most of those recommended in (1) could be successfully used.

(4) For Protein/Energy banks: *Leucaena*, *Desmanthus virgatus*, *G wightii*, *M.atropurpureum*, *Clitoria ternatea*, *Centrosema* spp., CIAT 438 and *C schottii*.

Recommended grass for Protein/Energy Banks is *Pennisetum purpureum* (Elephant grass).

Forage legumes and grasses for volcanic soils in drier parts of the Caribbean (875 to 1250 mm)

(1) For long term pastures: *S hamata* ("Caribbean Hamata"), CIAT accessions and "Verano" ; *M atropurpureum*, *G wighii* ("Cooper", Clarence, "Malawi" and "Tinaroo"), *Centrosema* spp (CIAT 438), *T labialis* and *L leucocephala* (CIAT 871).

Recommended grasses to grow in association with the above legumes: Coast Cross-1 and Calle Bermuda grasses, Star grasses, Sabi grass, Dubi grass, Rhodes grasses, Buffel grasses and Guinea grasses. Note however, that the last three grasses tend to smother *S hamata*.

(2) For short-term pastures with high early legume production: *Clitoria ternatea*, *M lathyroides*, *T uncinatus*, , *D distortum* CIAT 335, *Desmanthus virgatus*, *C pascuorum* and *C schottii*, *S sympodialis* and *S guianensis* and *Macrotyloma axillare*.

Grasses: As for (1), but note the earlier comment made about vegetatively propagated grasses.

(3) For cut and carry systems: All of the above legumes could be used. The erect or semi erect "Verano" and CIAT *S hamata* lines will probably be more suitable than the semi-prostrate "Caribbean Hamata".

Grasses: Most of those recommended in could be successfully used.

(4) For Protein/Energy banks: *Leucaena*, *Desmanthus virgatus*, *G wightii*, *Clitoria ternatea* and *M atropurpureum*.

Grasses for Protein/energy banks: *P purpureum* and *S officinarum*.

Forage legumes and grasses for calcareous soils in drier parts of the Caribbean
(35 - 50" RF ie 975 - 1250 mm)

(1) For long-term pastures: *S hamata* ("Caribbean Hamata"); *G wightii* ("Cooper", "Tinarco", "Clarence" and CPI 52614); *M atropurpureum*; *L leucocephala*, (CIAT 871).

Recommended grasses to grow in association with "Caribbean Hamata": Coast Cross 1, and Calle Bermuda, Green Panic, Sabi grass and Dubi grass. In addition to the above grasses the following species can also be grown with the other legumes: Buffel grasses (on shallow soils), Rhodes grasses (on deeper soils). and Guinea grasses (on deeper soils).

(2) For short-term pastures with high early legume production: *Clitoria ternatea*, *T uncinatus*, *D distortum* CIAT 335, *Desmanthus virgatus*, *C pascuorum*, *C schottii* and *S sympodialis*.

Grasses: As for (1) but note the earlier comment made about vegetatively propagated grasses.

(3) For cut and carry systems: All of the above legumes could be used.

Grasses: Most of those recommended in (1) could be successfully used.

(4) For Protein/Energy banks: *Leucaena*, *G wightii*, *M atropurpureum*, *C schottii* and *Clitoria ternatea*.

Recommended grass for Protein/Energy banks: *P purpureum*.

Forage legumes and grasses for volcanic soils in wet areas (1875 mm)
and intermediate rainfall (1250 to 1875 mm) in the Caribbean

(1) For long-term pastures: *Centrosema* spp (CIAT 438); *C pubescens* ("Centro" and "Belalto"); *Pueraria phaseoloides* ("Kudzu"); *Calapogonium mucunoides* ("Calapo") and *C caeruleum*; *D heterophyllum* ("Hetero"); *D ovaliofolium* and *D heterocarpon* ("Florida Carpon"); *G wightii* (for intermediate rainfall areas) and *M atropurpureum* (for intermediate RF areas); *Leucaena leucocephala* (CIAT 871),

Recommended grasses to grow in association with the above legumes: Pangola, Transvala and Slenderstem Digit grasses, with the "Hetero", *D ovaliofolium* and "Florida Carpon".

Other grasses: *Panicum maximum*, Signal grass, *Hemarthria* ("Big alta"), Para grass (low-lying areas); Coast Cross 1, and Calle Bermuda grasses, Star grasses (mainly for intermediate rainfall areas).

(2) For short-term pastures: *Stylo* {*S guianensis*}; *Clitoria ternatea*; *Desmanthus virgatus*; *D distortum* (CIAT 335) *D leonii*, *M lathyroides* and *Lab Lab purpureum*.

Grasses: *Panicum maximum* and Signal grass.

(3) For cut and carry systems: All of the above legumes could be used.

Grasses: Most of those recommended in (1) could be used,

(4) Protein/Energy banks for intermediate rainfall areas with phase-droughts: *Leucaena*; *Desmanthus virgatus*; *Clitoria ternatea*; *Pueraria phaseoloides*; *Lab lab purpureum* and *D leonii*.

Grasses for Protein/Energy banks: *P purpureum*, *S officinarum*, *T laxum*.

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