Stockpiling herbaceous tropical legumes for dry season feed in Jamaica

I.F. ANDRADE[1], L.G. ATKINSON[2], L.E. SOLLENBERGER[2], G.J. RUEGSEGGER[3], P. MISLEVY[4] AND R.S. KALMBACHER[4]

[1] *Agricultural Research Institute, Minas Gerais, Brazil*

[2] *Agronomy Department, University of Florida, Gainesville, Florida, USA*

[3] *Dairy Nutrition Services, Chandler, Arizona, USA*

[4] *Range Cattle Research Station, Ona, Florida, USA*

Abstract

Quantity and quality of forage available during the dry season limit livestock production in Jamaica. The objective of this research was to assess stockpiling of forage legumes as an option for dry season feeding. Six forage entries were compared, including Siratro (*Macroptilium atropurpureum*), rabbit vine (*Teramnus labialis*), rhizoma peanut (*Arachis glabrata*), pinto peanut (*Arachis pintoi*), a mixture of Siratro, rabbit vine, and glycine (*Neonotonia wightii*), and a stargrass (*Cynodon nlemfuensis*) control fertilised with 100 kg/ha N per year. Other treatments were date of initiation of stockpiling (October, November and December 1) and length of stockpiling period (45, 75, 105 and 135 days). With few exceptions, stargrass yield (average of 4.6 t/ha) was 2–3 times greater than that of the legumes. After 2 years, percent cover of Siratro declined from 95% to 25%, but rabbit vine and the mixture maintained more than 50% legume cover. Rhizoma and pinto peanut established slowly, were defoliated only in the second year, and had 81% and 44% cover, respectively, at the end of the experiment. The crude protein of herbage from legume plots averaged 1.5 to 2 times that of stargrass, and digestibility averaged 10 percentage units higher than that of stargrass. Initiation of stockpiling between November 1 and December 1 may allow cattle to remain on pastures to be used for stockpiling while rains continue in October and may provide relatively high quality forage for use during most of the December–March dry season.

Correspondence: Dr L.E. Sollenberger, Agronomy Department, PO Box 110300, University of Florida, Gainesville, Florida, USA

Introduction

Forage production in Jamaica is highly seasonal. During the December–March dry season, forage quality and quantity decline. This period of shortfall is the greatest concern of livestock farmers on the island.

There are a number of potential methods for transferring surplus forage from a peak growing period to a period of deficit. Hay and silage generally are not compatible with the climatic and economic conditions in the region. Stargrass (*Cynodon nlemfuensis*) is planted widely in Jamaica, but its quality declines rapidly with increasing maturity (Mislevy 1989). Thus, stockpiled stargrass has limitations as a dry season feed for growing or lactating animals. The use of forage banks and stockpiling of forage legumes to meet energy and protein requirements of these animals has gained favour in the Caribbean, with emphasis being placed on shrub legumes like leucaena (*Leucaena leucocephala*), gliricidia (*Gliricidia sepium*) and calliandra (*Calliandra calothyrsus*) (Morikawa *et al*. 1995). Logan (1979) identified Siratro (*Macroptilium atropurpureum*), glycine (*Neonotonia wightii*) and rabbit vine (*Teramnus labialis*) as herbaceous legumes that are well adapted to Jamaica. However, Siratro and glycine have not persisted well under grazing (Jennings and Logan 1987; Atkinson 1993), but may perform better if utilised less intensively. Forages in the *Arachis* genus have demonstrated outstanding persistence at other locations in the American subtropics and tropics

(Carulla *et al*. 1991; Ortega-S. *et al*. 1992) and may be of use in Jamaica.

Information is needed regarding the potential and management of herbaceous legumes as stockpiled forage for use by growing or lactating animals during the dry season in Jamaica. The objective of this experiment was to study the effects of 3 dates of initiation of stockpiling and 4 lengths of stockpiling period on the productivity, nutritive value and short-term persistence of 6 forage entries.

Materials and methods

The experiment was conducted at Grove Place Research Station in Manchester, Jamaica (18°7′ N, 77°33′ W; 520 m above sea level) between October 1991 and May 1993. The soil was a Chudleigh clay loam (clayey, gibbsitic, isohypothermic Typic Eutrudox) characterised by moderate permeability, low cation exchange capacity and a pH of approximately 6.7. Rainfall is bimodal and averages 1800 mm/yr with large within-year and year-to-year variation. Rainfall is greatest during April–May and September–October, with mid-November–March being the driest months (Table 1).

Table 1. Monthly rainfall during the experiment and the 46-yr average for 1931–1977 at Grove Place, Jamaica.

Month	Year				46-yr average
	1990	1991	1992	1993	
		(mm)			
January	—	21	32	30	60
February	—	39	133	28	66
March	—	52	174	110	94
April	—	113	170	129	193
May	—	345	436	565	245
June	—	0	29	58	159
July	—	43	57	19	118
August	—	64	135	100	178
September	297	111	69	—	190
October	306	212	266	—	296
November	232	75	87	—	138
December	44	32	27	—	64

Treatments were all combinations of 6 forage entries, 3 dates of initiation of stockpiling period and 4 lengths of stockpiling period. There were 3 replicates of each treatment. Forages were Siratro, a local accession of rabbit vine, stargrass cv. Florico, rhizoma peanut (*Arachis glabrata*) cv. Arbrook, pinto peanut (*Arachis pintoi*) cv. Amarillo and a mixture of Siratro, rabbit vine and glycine cv. Tinaroo. Stargrass was included for comparison because it is the most widespread planted forage on the island. Dates of initiation were October 1, November 1 and December 1 in both 1991 and 1992. Stockpiling periods were 45, 75, 105 and 135 days. Forage entries were main plots. For ease of management, the main plots of forage were split in a strip-plot arrangement as described by Gomez and Gomez (1984). Strips extending across all main plots in a block were randomly assigned to 1 of 3 dates of initiation. Within each forage × initiation date subplot, 4 stockpiling periods were assigned at random. Size of the sub-subplots was 1.5 × 3.0 m.

Siratro, rabbit vine and glycine were established using seed. Seeding rates in pure stands were 6 kg/ha for Siratro and 2 kg/ha for rabbit vine. In the mixture, Siratro was seeded at 2 kg/ha, rabbit vine at 0.6 kg/ha and glycine at 1.3 kg/ha. Rhizoma peanut (1500 kg/ha rhizomes fresh weight), pinto peanut (1200 kg/ha stem bases fresh weight) and stargrass (1500 kg/ha stems fresh weight) were planted using vegetative material. Legume plots were established during October 1990 and stargrass was planted in March 1991. During establishment, weeds were controlled in all plots by hand weeding and grass weeds in legume plots were controlled chemically at 8 weeks after planting. Siratro and rabbit vine were affected by *Phomopsis* spp. (die back disease) and *Puccinia* spp. (rust) at several times during the experiment. Die back was controlled using fungicide during the establishment period only. By August 1991, complete cover was achieved for all forages except both *Arachis* spp. As a result, *Arachis* plots were not included in the first year (1991–1992) of study. They were allowed to establish more fully and were included in the second year of the experiment. Thus, first-year data include only 4 forage entries, but second-year data include 6.

All plots received 34 kg/ha P, 68 kg/ha K and 10 kg/ha micronutrient mixture (F-503 oxide containing 30 g/kg each of boron and copper, 180 g/kg iron, 75 g/kg manganese, 2 g/kg molybdenum, and 70 g/kg zinc) in Autumn 1990 and also at initiation of stockpiling in Autumn 1991 and 1992. In addition, 100 kg/ha N was broadcast as urea on stargrass plots at initiation of stockpiling.

Each plot, except those of *Arachis* spp. in the first year, was clipped to a 10-cm stubble in May

and July and 6 weeks before initiation of stockpiling in both years. At the initiation date, herbage was again clipped to a 10-cm stubble height. At the end of the stockpiling period, two 0.25-m^2 quadrats per plot were clipped to a 10-cm stubble. Limited resources prohibited separation of clipped samples into botanical components, so yield and nutritive value data are for total herbage harvested, not only the planted species. Samples were dried at 60°C, weighed and ground to pass a 1-mm screen. Ground herbage was analysed for crude protein using a micro-Kjeldahl method described by Gallaher *et al*. (1975) and *in vitro* organic matter digestibility using the modified two-stage procedure of Moore and Mott (1974). In both years, cover of the planted species was estimated visually by 2 observers 4 weeks after the harvest that ended the stockpiling period.

Data were analysed using the general linear models procedure of the Statistical Analysis System Package (SAS Institute 1987). Years were analysed separately because number of forage entries differed in the 2 years. Comparisons of forage entry means and dates of initiation were made using Fisher's Least Significant Difference test (LSD). Orthogonal polynomial contrasts were used to describe responses to length of stockpiling period.

Results

Rainfall during the autumn initiation of stockpiling period was similar in 1991 and 1992 (Table 1). February–April 1993 was considerably drier than the same period in 1992 (Table 1).

Dry matter harvested

When initiation of stockpiling occurred in October or November 1991, dry matter harvested at the end of stockpiling was greater for stargrass than for any of the legumes (Table 2). When initiation was in December 1991, there were no differences among forages. There was no effect of length of stockpiling period on dry matter harvested when stockpiling was initiated in October or November 1991, but dry matter harvested increased linearly as length of stockpiling period increased following initiation in December 1991 (Figure 1).

Table 2. Dry matter yield as affected by forage × initiation date interaction in 1991 and forage in 1992.

Forage	1991 initiation date			1992[1]
	Oct 1	Nov 1	Dec 1	
	(t/ha)			
Stargrass	6.87a[2]	5.63a	1.80a	4.47a
Rabbit vine	2.39b	2.13b	1.79a	2.65b
Mixture	2.38b	2.30b	2.12a	2.34bc
Siratro	1.73b	1.83b	1.76a	2.03bc
Rhizoma peanut[3]	—	—	—	1.71c
Pinto peanut[3]	—	—	—	2.20bc

[1]No forage × initiation date interaction in 1992.
[2]Forage means within a column not followed by the same letter are different (P<0.05).
[3]Not harvested during 1991.

Following initiation of stockpiling in Autumn 1992, stargrass consistently outyielded the legumes regardless of initiation date (Table 2). Across all forage entries, dry matter harvested more than doubled between 45 days and 135 days after initiation when stockpiling started in November and December (Figure 1). There was no increase in dry matter harvested as length of stockpiling period increased beyond 45 days following initiation in October (Figure 1).

Herbage crude protein and in vitro *digestibility*

Differences among legume treatments were few in number and small in size, so crude protein and digestibility data will be presented comparing stargrass with the average of the legume plots. In the first year, crude protein concentration of herbage from legume plots averaged 20.1% compared with 10.5% for stargrass. In the second year, the corresponding values were 15.7% and 11.4%.

Stargrass crude protein increased as date of initiation was delayed from October (8.5%) to November (10.4%) to December (12.7%) 1991. In contrast, legume crude protein changed relatively little and was 19.5% for October initiation, 19.4% for November initiation and 21.4% for December initiation. Date of initiation in 1992 did not affect crude protein concentration. Changes in crude protein concentration with increasing length of stockpiling period were not consistent among dates of initiation. When initiation occurred on October 1, total forage crude protein decreased linearly from 18.8% to 15.1% in 1991 and from 16.2% to 12.8% in 1992 as length of stockpiling period increased. Generally, forage crude protein decreased between

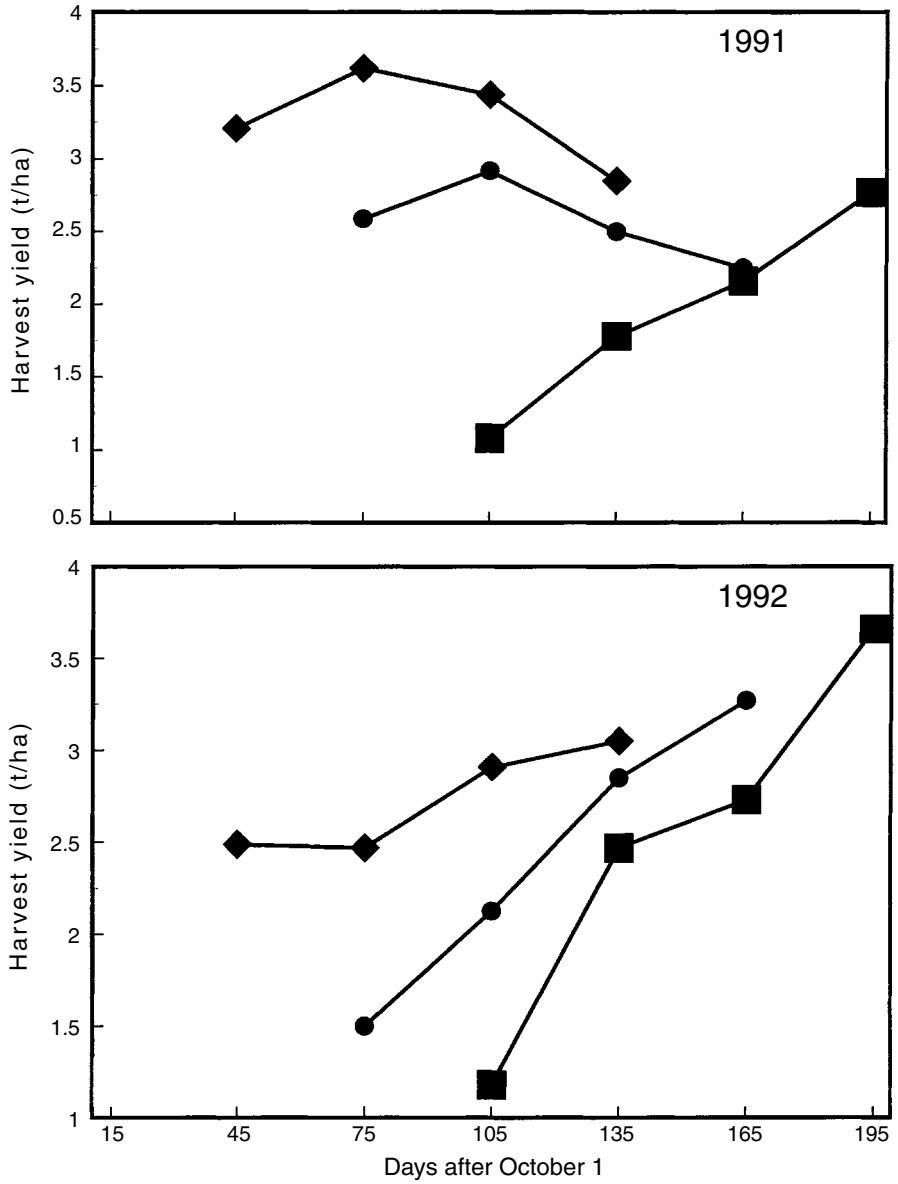

Figure 1. Harvest yield at 45, 75, 105 and 135 days after initiation of stockpiling at Day 0 (October 1; r), Day 31 (November 1; d) and Day 61 (December 1; j). For October 1, there was no significant effect of length of stockpiling period in either year; for November 1, there was no significant effect in 1991 but there were linear and quadratic effects in 1992; for December 1, there was a linear effect in 1991 and 1992.

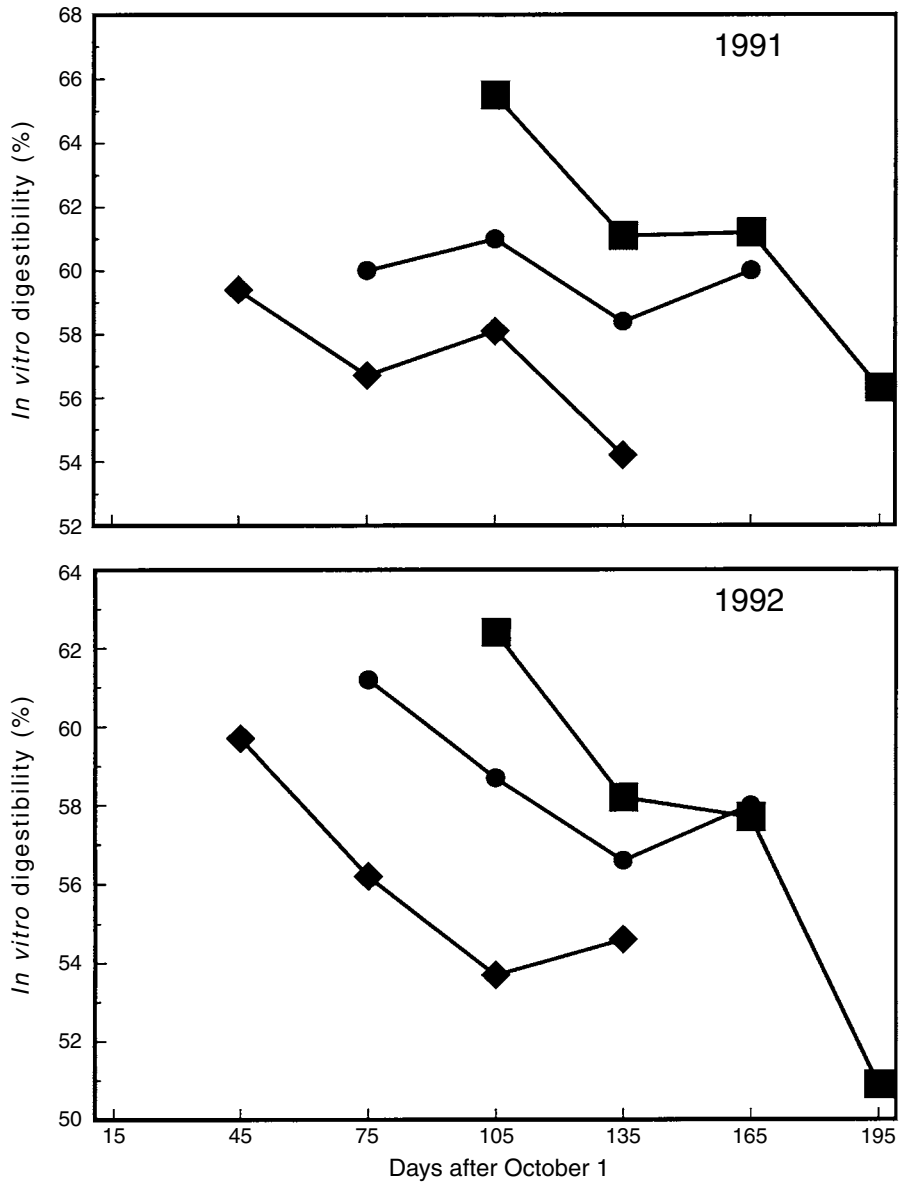

Figure 2. *In vitro* digestibility of herbage harvested at 45, 75, 105 and 135 days after initiation of stockpiling at Day 0 (October 1; r), Day 31 (November 1; d) and Day 61 (December 1; j). For October 1, there were linear and quadratic effects of length of stockpiling period in both years; for November 1, there was no significant effect in 1991 but there were linear and quadratic effects in 1992; for December 1, there was a linear effect in 1991 and linear and quadratic effects in 1992.

Day 45 and Day 135 when initiation occurred in November or December, but the decline was neither as large nor as consistent as observed for October initiation.

In vitro digestibility averaged 50.8% for stargrass and 62.2% for legumes in Autumn 1991. In the second year, corresponding values were 51.4% and 58.4%. Digestibility of legume herbage decreased from 63.4% to 60.8% as stockpiling period in the first year increased from 45 days to 135 days. Stargrass digestibility decreased at a faster rate, from 56.3% to 45%, during the same period.

In both years, herbage *in vitro* digestibility was lowest when initiation occurred in October (Figure 2). The change in herbage digestibility as length of stockpiling period increased was not consistent, but, except for November 1991, digestibility was lower after 135 days than after 45 days (Figure 2). This difference was most pronounced in both years for the December initiation date (Figure 2).

Ground cover

After the first year of stockpiling, stargrass and rabbit vine had the highest percentage cover (Table 3). Rhizoma and pinto peanut were slow to establish, but by the end of the second year, rhizoma peanut had the greatest ground cover (81%, Table 3). Of those forages harvested in both years, rabbit vine and stargrass maintained the greatest cover. Siratro cover was least, decreasing to 25%.

Table 3. Percentage cover of forage 4 weeks after the stockpiling harvest.

Forage	1991	1992
	(%)	
Stargrass	99a[1]	66b
Rabbit vine	92a	71b
Mixture	81b	52c
Siratro	80b	25e
Rhizoma peanut	—	81a
Pinto peanut	—	44d

[1]Forage means within a column not followed by the same letter are different ($P<0.05$).

Discussion

With the exception of the December 1, 1991 initiation date, legume plots yielded about one half as much as stargrass plots receiving 100 kg/ha N. Legume yield varied little with initiation date in either year, while stargrass yield was much lower with December than October or November initiation in the first year. Length of the stockpiling period beyond 45 days had no effect on yield in either year when stockpiling was initiated in October. This occurred because a large proportion of the dry matter harvested was produced during the first 45 days following October 1 initiation when soil moisture and daylength were greater. When initiation of stockpiling was delayed to December 1, 1991 or to November or December 1, 1992, yield increased throughout the entire stockpiling period.

Crude protein concentration of herbage from legume plots was 1.5 to 2 times that from stargrass plots. These data are comparable with those of Asiedu *et al*. (1993) who reported crude protein concentrations of 10.5–11.7% for stargrass and 17–18.3% for a mixture of glycine, Siratro, rabbit vine, and centrosema (*Centrosema pubescens*). Crude protein of herbage from legume plots was greater in the first (20.1%) than the second (15.7%) year because *Brachiaria decumbens* and stargrass were gradually invading.

Digestibility of herbage from legume plots was generally 5–10 percentage units greater than that from stargrass plots for 45-day-old herbage and 14–18 units greater for 135-day-old herbage. Stargrass digestibility declined more than 11 units between Days 45 and 135, while legume digestibility declined only 2–4 units. Hacker and Minson (1981) suggested that the slower rate of decline in legume digestibility is due in part to abscission of old leaves in legumes. This may have played a role in the current study, particularly in the shaded regions at the base of the canopy of the viney legumes. Digestibility of herbage harvested from Siratro plots in 1992 was only 2.7 units greater than that harvested from stargrass plots, primarily because of grass invasion that decreased percentage cover by Siratro to 25% by the end of the second year of study.

For a given length of stockpiling period, digestibility generally was greater for the November and December dates of initiation. Higher digestibility for later initiation dates was probably influenced by lower rainfall. Moderately drought-stressed plants have been shown to have a greater proportion of leaf relative to stem, greater *in vitro* digestibility of plant parts, and a slower rate of decline in *in vitro* digestibility than well-watered plants (Wilson 1983). In addition,

leaf diseases generally were less prevalent on Siratro and rabbit vine during drier months.

Rapid declines in stargrass crude protein and digestibility with increasing length of stockpiling period indicate that it is not ideally suited for use as a stockpiled forage. Ease of establishment, generally superior competitiveness, greater disease resistance, and higher yields than legumes, however, favour use of stargrass as a component of a stockpiling program. Despite lower yields than stargrass, nutritive value of the legumes was high and declined slowly with increasing maturity. Since there was a relatively small amount of variation in yield and nutritive value among this group of legumes, choice of species to use for stockpiling may be dictated by persistence. Of forage entries defoliated in both years, rabbit vine had the highest ground cover at the end of the trial. Rhizoma peanut was defoliated only during the second year, but cover was 81% at the end of the experiment. Longer-term studies that characterise changes in sward botanical composition are needed to identify the most persistent legumes for Jamaica. Our data and those of Jennings and Logan (1987) suggest that Siratro may not persist well enough in this environment to merit further consideration.

October 1 initiation appears to be of limited value because rainfall generally is high during October and stockpiled yield reaches near maximum levels within 45 days. In addition, herbage from October 1 initiation is lower in digestibility at a given date and length of stockpiling period than is herbage from later initiation dates. Initiation of stockpiling around November 1 provides approximately 2–2.5 tonnes/ha of forage (average across forages tested) for use in December or January. Since legume yields were not affected greatly by initiation date, sequential initiation starting in November of portions of an area planted to legumes should provide forage throughout the majority of the dry season.

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(Received for publication December 23, 1996; accepted March 9, 1998)