Utilization of Limpograss for Grazing

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Introduction

First extensively evaluated in 1974, 'Floralta' limpograss (*Hemarthria altissima* var. 'Floralta') is the most widely utilized of the available limpograss varieties in south Florida. This tropical grass originates from the Limpopo River in the Republic of South Africa. Floralta is a stoloniferous perennial tropical grass that was specifically selected for its persistence under grazing conditions. Limpograss can withstand short periods of seasonal flooding and grows best in areas of heavier soil which retain moisture. Limpograss produces very little seed and is established through vegetative propagation.

A 1998 survey of cattle producers in south Florida revealed that 79% of beef operations fed stored forage in the winter and early-spring months (1998 Survey of Beef and Forage Practices – South Florida Beef-Forage Program). Due to unpredictable weather with frequent rain during the growing season, production of stored forage can be very difficult in many areas of south Florida. The need to identify forages that produce significant dry matter (DM) yield in the winter months is of major importance to cattle producers in south Florida to reduce the need for stored forage or annual crops. Floralta has superior winter yield compared to other warm season perennial grasses. In south Florida, limpograss can be expected to produce as much as 30 to 40% of its annual growth during the winter months (Kretschmer and Snyder, 1979).

Nutritive Value of Limpograss

A distinct characteristic of limpograss as compared with other tropical grasses is the maintenance of its energy value with advancing maturity during the growing season. Sollenberger et al. (1988) used steers to continuously graze 'Pensacola' bahiagrass (*Paspalum notatum* Flugge) and 'Floralta' limpograss pastures during the summer and early-fall. At all sampling dates, in vitro organic matter digestion (IVOMD) of limpograss pasture (whole plant samples) was approximately 10 units greater than that of bahiagrass pasture (Table 1). Although limpograss is usually greater in energy value than most other tropical grasses at similar regrowth intervals, CP concentration can be low. At each sampling date, CP concentration of limpograss was much less than that of bahiagrass, and less than levels thought to limit intake and gain (Minson, 1980). Limpograss also has a more rapid growth rate compared to many tropical grasses and at each sampling date, DM yield of limpograss pasture was greater than that observed from bahiagrass pasture.

Moore et al. (1981) utilized sheep in voluntary intake and total fecal collection digestibility trials to

Table 1. In vitro organic matter digestion (IVOMD), CP, and yield of bahiagrass (*Paspalum notatum* Flugge) and limpograss (*Hemarthria altissima*) pastures during the grazing season.[a]

	IVOMD, %		CP, %		Forage yield, lbs DM/acre	
Month	Bahiagrass	Limpograss	Bahiagrass	Limpograss	Bahiagrass	Limpograss
July	50	60	7.2	5.0	3,200	5,000
August	45	55	6.1	3.5	3,200	6,810
September	43	53	9.0	4.2	2,810	6,610
October	40	49	7.9	4.2	2,600	5,800
November	37	48	7.5	4.8	2,200	4,800

[a]Data from Sollenberger et al. (1988).

Table 2. Intake and digestibility of tropical grass hays harvested after four, six and eight weeks regrowth.[a]

Regrowth interval, wk	Grass [b]	OMI, % BW[c]	TDN, % DM[c]	TDNI, g/MW[c]
Four	Limpograss	2.46	62.6	44.5
	Bahiagrass	2.26	56.0	35.6
	Bermudagrass	2.28	57.3	37.6
	Stargrass	2.32	59.3	40.5
Six	Limpograss	2.33	63.2	42.1
	Bahiagrass	2.11	55.4	32.9
	Bermudagrass	2.24	52.4	33.2
	Stargrass	2.36	52.6	34.0
Eight	Limpograss	2.22	56.3	34.8
	Bahiagrass	1.74	53.5	25.7
	Bermudagrass	1.84	43.8	22.0
	Stargrass	2.20	53.2	34.6

[a] Data from Moore et al. (1981).

[b] Limpograss = *Hemarthria altissima*; Bahiagrass = *Paspalum notatum* Flugge; Bermudagrass = *Cynodon dactylon*; Stargrass = *Cynodon nlemfuensis*.

[c] OMI = organic matter intake; TDN = total digestible nutrients; TDNI = intake of total digestible nutrients, grams per unit of metabolic weight.

determine the nutritive value of various tropical grasses at four, six, and eight weeks of regrowth (Table 2). The total digestible nutrients (TDN) content of the hays was measured at voluntary intake. At each regrowth interval, sheep consumed more limpograss hay compared to the other tropical grass hays with the exception of stargrass hay at some regrowth intervals. Further, the TDN concentration of limpograss hay was greatest at each regrowth interval, resulting in much greater intake of TDN for limpograss relative to the other hays, again with the exception of stargrass hay at some regrowth intervals.

The increased energy value, intake potential and growth rate of limpograss relative to bahiagrass led Sollenberger et al. (1988; 1989) to hypothesize that cattle grazing limpograss would gain more weight than those grazing bahiagrass and that limpograss pasture would have a greater carrying capacity than bahiagrass pasture. To investigate this, yearling steers (528 to 660 lbs) were used to graze limpograss and bahiagrass pastures in either a continuous (Sollenberger et al., 1988) or a rotational (Sollenberger et al., 1989) manner. When pastures were grazed continuously, steer ADG, carrying capacity and gain/acre were similar between limpograss and bahiagrass pastures (Table 3). When pastures were grazed in a rotational manner, ADG by steers was similar between limpograss and bahiagrass pastures; however, limpograss pastures had a greater stocking rate and gain/acre as compared to bahiagrass pastures.

Protein Supplementation for Cattle Grazing Limpograss

A database developed by Moore et al. (1995) from a large number of publications involving CP supplementation of temperate and tropical grasses and crop residues revealed that forages with TDN:CP ratios of 7.0 or greater contained marginal CP relative to TDN, and positive responses to CP supplementation were found in many cases. Due to marginal CP relative to energy in limpograss pasture samples from the studies discussed above (Sollenberger et al., 1988; 1989), subsequent studies evaluated protein supplementation as a means of improving the performance of cattle grazing limpograss pasture. In these studies, "protein supplementation" was achieved either through the feeding of various high-CP feedstuffs, incorporation of a legume into limpograss pasture, or through frequent N fertilization of the limpograss pasture.

Holderbaum et al. (1991) used yearling steers (693 lbs) to graze limpograss in a rotational manner and either fed a corn-urea supplement at two levels of supplemental CP (supplements contained 21 or 50% CP and were fed at levels to provide a dietary CP concentration of 9 or 12%), or seeded aeschynomene (*Aeschynomene americana* L.) into the limpograss pasture. Providing supplemental CP in the form of corn-urea or aeschynomene increased steer ADG as compared to the unsupplemented control (Table 4).

Table 3. Yearling steer ADG, carrying capacity, stocking rate, and gain/acre on bahiagrass (*Paspalum notatum* Flugge) and limpograss (*Hemarthria altissima*) pastures grazed in a continuous or rotational manner.

	Continuous grazing[a]		Rotational grazing[b]	
Item	Bahiagrass	Limpograss	Bahiagrass	Limpograss
ADG, lbs/day[c]	0.83	0.72	0.92	0.90
Carrying Capacity, # of 700 lbs steers/acre/d of grazing[c]	2.35	2.46		
Stocking rate, lbs BW/acre/d[d]			1,450	1,900
Gain/acre, lbs	330[c]	307[c]	283[d]	410[d]

[a] Data from Sollenberger et al. (1988).
[b] Data from Sollenberger et al. (1989).
[c] Treatment comparisons within studies are not different (P > 0.05).
[d] Treatment comparisons within studies are different (P < 0.05).

Table 4. ADG, gain/acre and plasma urea nitrogen (PUN) concentration of yearling steers grazing limpograss (*Hemarthria altissima*) and fed protein supplements or grazing limpograss-aeschynomene (*Aeschynomene americana*) pastures and in vitro organic matter digestion (IVOMD), CP and IVOMD:CP of limpograss and limpograss-aeschynomene pastures.[a]

	Animal performance			Pasture nutritive value		
Item[b]	ADG, lbs/day	Gain, lbs BW/acre	PUN, mg/dL	IVOMD	CP,%	IVOMD:CP
Control	0.64	149	6.0	59	6.90	8.70
Low CP	1.16	258	8.2			
High CP	1.30	257	11.4			
Aeschynomene	1.14	151	11.0	65	9.90	6.60ou
Significance (P <)[c]						
C vs L and H	0.01	0.05	0.05			
L vs H	NS	NS	0.10			
A vs L and H	NS	0.05	NS			
Limpo vs A				NS	0.01	0.05

[a] Data from Holderbaum et al. (1991).
[b] Low CP = corn and urea formulated to 21% CP; estimated to provide a dietary CP of 9%; High CP = corn and urea formulated to 50% CP; estimated to provide a dietary CP of 12%.
[c] C = Control; L = Low CP; H = High CP; A = limpograss-aeschynomene pasture; Limpo = limpograss pasture; NS = not significant, P > 0.10.

Gain/acre was increased by providing the corn-urea supplement as compared to the unsupplemented control. However, gain/acre was not increased for steers grazing the limpograss-aeschynomene pastures due to the absence of N fertilization of limpograss-aeschynomene pastures, which reduced limpograss growth relative to the control pastures which received 44 lbs N/acre. Plasma urea nitrogen (PUN) concentration of steers receiving no supplement averaged 6.0 mg/dL, which was below the 8 to 10 mg/dL level suggested by Hammond et al. (1993) as indicative of low dietary CP relative to energy. Concentration PUN was increased to 8.2 to 11.4 mg/dL in cattle receiving CP supplement either through corn-urea or aeschynomene. Also, IVOMD:CP ratios of greater than 8.5 in the limpograss pasture were suggestive of a potential positive response from protein supplementation (Moore et al., 1995). Overseeding aeschynomene into the limpograss pasture decreased the IVOMD:CP ratio below 7.0.

In another study at the same north Florida location also evaluating limpograss-aeschynomene pastures, Rusland et al. (1988) observed improvements in yearling steer (660 lbs) ADG (0.85 vs 1.55 lb) and gain/acre (234 vs. 336 lbs/acre) by overseeding aeschynomene into limpograss pastures compared to N fertilized limpograss pasture. Similar to results of Holderbaum et al. (1991), carrying capacity of limpograss-aeschynomene pastures was less than that of limpograss only pastures (1,500 vs. 1,970 lbs liveweight/acre/d) due to greater forage production from limpograss pastures as a result of N fertilization.

In other limpograss grazing studies also conducted in north Florida, da C. Lima et al. (1999) found an interaction between N fertilization rate of limpograss pasture and CP supplementation for ADG of yearling heifers (770 lbs). In their studies, a factorial arrangement of treatments including N fertilization rate (44 and 132 lbs N/acre) and CP supplement (none, corn-urea, corn-urea-undegradable protein) was utilized. The undegradable protein was a mixture of blood meal and corn gluten meal. Supplements were formulated to provide approximately 50% CP, 40% degradable intake protein, and 25% undegradable intake protein for the corn-urea-undegradable protein supplement. Heifers grazed limpograss pastures in a rotational manner with a variable stocking rate used to add or remove animals in order to maintain a stubble height of 7.8 to 9.8 inches for all pastures at the end of a rotational grazing cycle. At the lower N fertilization rate, the IVOMD:CP ratio of the limpograss forage was greater than 9.0 suggesting that an imbalance between CP and energy existed in the forage, and a positive response to CP supplementation might be observed (Table 5). Also, PUN concentration of heifers grazing the low N fertilization rate pastures and fed no supplement was very low (4.2 mg/dL), also indicative of low dietary CP relative to energy. At the low N fertilization rate, heifers fed no CP supplement had a very low ADG, and live weight gain/acre was also very low. Both ADG and live weight gain/acre were increased by feeding a CP supplement at the lower N fertilization rate. At the higher N fertilization rate, the IVOMD:CP of the limpograss forage was decreased compared to the lower N fertilization rate, and was in the range where a response to protein supplementation might be less likely (Moore et al., 1995). Also, PUN concentration of heifers grazing the higher N fertilization rate pastures and fed no supplement (9.2 mg/dL) was in the range where a response to CP supplementation might not be expected (Hammond et al., 1993). Providing a CP supplement to heifers grazing limpograss pastures fertilized with 132 lbs N/acre did not result in an increase in ADG or live weight gain/acre.

To investigate CP supplementation for cattle grazing limpograss in south Florida, Brown and Adjei (2001) used weaned steers (594 lbs) to graze limpograss pastures in a continuous manner at a stocking rate which ensured that forage was available from early-spring through late-fall. Using this strategy, forage accumulated in the pastures during the summer for use in the fall. Molasses-based supplements containing no supplemental CP, urea or urea plus feather meal were fed at the rate of 3.0 lbs DM daily. In yrs 1 and 2, large quantities of forage accumulated in the pastures, with significant quantities of leaf material present in the upper portions of the canopy (Table 6). Forage samples obtained in a manner designed to simulate the grazing animal's diet had IVOMD:CP ratios of 6.5 to 6.8, and PUN concentration in the blood of steers fed no CP supplement was high (10.6 to 12.4 mg/dL), both suggesting that a balance between CP and energy existed in the forage the cattle were consuming. Consistent with this, ADG was not influenced by CP supplementation in these years. A drought persisted during much of the trial in yr 3 and limpograss forage production was significantly decreased as compared to yrs 1 and 2. Stem material made up a greater proportion of the upper layers of the canopy as compared to yrs 1 and 2, leading to lower forage CP concentration and greater IVOMD:CP ratio in yr 3 as compared to yrs 1 and 2. In yr 3, PUN concentration in the blood of steers fed no CP supplement was low suggesting an imbalance of dietary CP relative to energy. In yr 3, ADG was improved by the addition of supplemental CP from urea but was not further influenced by the addition of slowly degraded protein from feathermeal.

Forage and Canopy Composition and Response to Protein Supplementation

Limpograss plant parts vary widely in their nutritive value. In most cases, the limpograss leaf is balanced in terms of its energy to CP ratio, while the stem is unbalanced (low CP relative to energy). This relationship can have profound effects on grazing management strategy and potential responses to CP supplementation.

Pitman et al. (1994) used yearling cattle to graze

Table 5. Supplement by N rate interaction means for ADG and live weight gain per acre of yearling heifers grazing limpograss (*Hemarthria altissima*) pastures and fed supplements varying in ruminal degradability, and in vitro organic matter digestion (IVOMD), CP and IVOMD:CP of limpograss pasture fertilized with 44 or 132 lbs N/acre.[a]

	Animal performance								
Item [b]	ADG, lbs/day			Gain, lbs BW/acre			Pasture nutritive value		
N fertilization rate, lbs/acre	Control	Urea	Urea + BM + CGM	Control	Urea	Urea + BM + CGM	IVOMD,	CP,%	IVOMD:CP
44	0.13	0.94	1.23	33	216	296	50.9	5.6	9.1
132	0.79	0.86	1.03	207	219	300	54.2	7.3	7.4
Preplanned contrasts (P <)[c]	ADG	Gain/acre							
50-c vs 150-c	0.001	0.001							
50-c vs 50-u + 50-UBC	0.001	0.001							
150-c vs 150-u + 150-UBC	0.26	0.07							
50 vs 150							0.002	0.001	0.001

[a] Data from da C. Lima et al. (1999).

[b] BM = blood meal; CGM = corn gluten meal.

[c] 50 and 150 refer to N fertilization rate in lbs/acre; C = Control; U = Urea supplement; UBC = Urea + BM + CGM supplement.

Table 6. ADG and plasma urea nitrogen (PUN) concentration in the blood of steers grazing limpograss (*Hemarthria altissima*) pasture and fed molasses-based supplements containing urea and (or) hydrolyzed poultry feather meal, and yield, in vitro organic matter digestion (IVOMD), CP and IVOMD:CP of limpograss pasture.[a]

	Animal performance			Pasture yield and nutritive value			
	Control	Urea	Urea + FM	Forage yield, lbs DM/acre	IVOMD,%	CP,%	IVOMD:CP
Year 1				10,600	44.1	6.5	6.8
ADG, lbs/day	1.34	1.45	1.32				
PUN, mg/dL	12.4	13.0	16.5				
Year 2				9,880	47.9	7.4	6.5
ADG, lbs/day	0.92	0.94	0.99				
PUN, mg/dL	10.6	12.9	14.3				
Year 3				4,700	45.6	4.1	11.1
ADG, lbs/day	0.66^{b}	0.88^{c}	0.97^{c}				
PUN, mg/dL	6.6^{b}	13.1^{c}	15.5^{c}				

[a] Data from Brown and Adjei (2001).

[b,c] Means in the same row without a common superscript letter differ ($P < 0.05$).

'Floralta' limpograss at a stocking rate which resulted in standing herbage values (9,800 to 14,200 lbs DM/ acre) similar to those observed by Brown and Adjei (2001). Pasture samples were obtained during the summer and fall and separated into leaf and stem fractions. Esophageally fistulated steers were also used to sample the pastures. At both summer and fall sampling times, leaf and stem samples were similar in IVOMD; however, leaf samples were much greater in CP concentration than the stem (Table 7). This resulted in IVOMD:CP values of less than 7.5 for the leaf, but greater than 16 for the stem. Samples from the esophageally fistulated steers obtained during the summer were similar in nutritive value to the leaf samples (IVOMD = 52.6%, CP = 7.0%, IVOMD:CP = 7.5). The authors noted that at the grazing pressures utilized, the upper grazed portion of the canopy was composed primarily of leaf material with a stemmy stubble layer which formed at the base of the canopy. This stubble layer was mostly ungrazed by cattle unless forage availability declined to a low enough level which forced cattle to graze from this horizon.

da C. Lima et al. (1999) fertilized limpograss pastures at two N rates (44 and 132 lbs N/acre) and collected hand-plucked pasture samples in a manner designed to simulate forage consumed by the grazing cattle. Samples were separated into leaf and stem components and analyzed for CP and IVOMD. Consistent with the results of Pitman et al. (1994), IVOMD of the leaf and stem fractions were similar; however, CP of the stem was much less than that of the leaf, leading to IVOMD:CP which was balanced between energy and CP for the leaf but unbalanced for the stem (Table 7). Increasing N fertilization rate increased the CP concentration and IVOMD of both the leaf and stem fractions. Also, leaf percentage in the hand-plucked samples was increased by increasing the N fertilization rate. Increasing N fertilization rate may result in decreased IVOMD:CP in the leaf and increased leaf percentage in the forage, which may lead to a scenario where positive responses to protein supplementation are less likely to occur. However, frequent application of N fertilizer may be required to maintain this effect throughout the grazing season.

To further investigate the influence of limpograss canopy structure and composition on the response to CP supplementation, Newman et al. (2002) varied animal stocking density to establish three canopy heights (7.8, 15.7, and 23.6 inches), and therefore differing forage availabilities. Yearling heifers (748 lbs) grazed these three pasture treatments and were either fed no CP supplement or 1.40 lbs of a corn-urea supplement containing 44% CP on a DM basis. Average daily gain of heifers fed no supplement responded in a quadratic manner with increasing canopy height (Table 8). As canopy height increased from 7.8 to 15.7 inches ADG increased. However, heifer ADG decreased as canopy height increased further to 23.6 inches. The decrease in ADG between the 15.7 and 23.6 inches canopy heights was attributed to trampling and lodging of accumulated limpograss forage at the 23.6 inches pasture canopy height. An interaction existed between canopy height and CP supplementation. At the 7.8 and 15.7 inches canopy heights, CP supplementation improved ADG, while at the 23.6 inches canopy height, providing a CP supplement did not influence ADG. The positive response to CP supplementation in heifers grazing the 7.8 and 15.7 inches canopy heights was attributed to decreased intake of limpograss leaf, although for different reasons. At the 7.8 inches canopy height, bulk density of both total forage and leaf in the upper layer was high; however, the authors suggested that the close association of leaf with stem made it difficult for cattle to select the leaf without consuming the stem. At the 23.6 cm canopy height, trampling and lodging reduced the bulk density and percentage of leaf in the upper layer, perhaps resulting in reduced intake of leaf material. Positive responses to CP existed in some cases even though the PUN concentration in the blood of all heifers was not below 14 mg/dL and the IVOMD:CP of pasture samples collected in a manner to simulate diet selection by the heifers was below 6.5, both indicative of a situation where positive responses to CP are less likely.

The practical application of these observations is that under conditions where large quantities of leaf material are consumed by the animal, the diet is more likely to be balanced in CP and energy and therefore responses to CP supplementation are less likely. Also, increasing CP concentration of the forage through N fertilization may increase the proportion of leaf in the grazed horizon and reduce the IVOMD:CP. Frequent

Table 7. In vitro organic matter digestion (IVOMD), CP and IVOMD:CP of leaf and stem fractions of limpograss (*Hemarthria altissima*) pasture and canopy composition of limpograss pastures fertilized at two levels of N fertilization.

		Leaf			Stem		
	Leaf Percentage	IVOMD	CP	IVOMD:CP	IVOMD	CP	IVOMD:CP
Pitman et al. (1994)							
Summer		52.1	7.1	7.3	49.9	2.1	23.8
Fall		57.3	9.8	5.8	55.2	3.3	16.7
da C. Lima et al. (1999)							
44 lbs N/acre	24	49.5	9.7	5.1	48.9	3.8	12.9
132 lbs N/acre	28	52.1	11.5	4.5	53.3	5.1	10.5
P value[a]	0.008	0.08	0.001	0.01	0.008	0.002	0.01

[a] Alpha level for the N fertilization rate effect.

Table 8. Daily gain of yearling heifers grazing limpograss (*Hemarthria altissima*) pastures in response to canopy height and CP supplementation, and limpograss pasture characteristics in response to canopy height.[a]

	ADG, lbs/day			Pasture characteristics[b]			
Canopy height (inches)	No supplement	Supplement	P value	Herbage mass (lbs DM/acre)	Total BD	Leaf BD	Leaf percentage (%)
7.8	0.99	1.36	0.01	2,700	247	47	19
15.7	1.40	1.18	0.10	4,100	145	29	20
23.6	0.72	1.23	< 0.01	5,280	142	25	18
Contrast[c]	Q	NS		L	L, Q	L, Q	L, Q

[a] Data from Newman et al. (2002).

[b] BD = bulk density, lbs DM/acre/inch.

[c] Orthogonal polynomial contrasts for the effect of canopy height on the response; L = linear, Q = quadratic, P < 0.01, NS = not significant, P > 0.10.

Table 9. Response of heifers grazing limpograss (*Hemarthria altissima*) pasture and fed molasses-based supplements containing urea or urea plus hydrolyzed poultry feather meal.[a]

	Year 1		Year 2	
Item	Urea	Urea + feather meal	Urea	Urea + feather meal
BW, lbs				
Initial	528	528	557	557
Start of breeding	669	676	640	654
End of breeding	711[b]	751[c]	737[b]	770[c]
ADG, lbs/day				
Initial to start of breeding	1.10	1.14	0.27	0.31
Initial to end of breeding	0.88[b]	1.10[c]	0.88[b]	1.05[c]
Initial to first frost	2.31	1.03	0.64	0.75
First frost to end of breeding	1.98[b]	1.40[c]	1.16[b]	1.38[c]

[a] Data from Brown and Arthington, unpublished.

[b,c] Within a year, means in the same row without a common superscript letter differ ($P < 0.05$).

N fertilizer application beyond practical production practices may be needed to achieve this effect.

The studies of Rusland et al. (1988), Holderbaum et al. (1991), da C. Lima et al. (1999) and Newman et al. (2002) were conducted in north Florida and shared a common grazing management strategy which was different than the grazing management strategy utilized by Pitman et al. (1994), Brown and Adjei (2001) and other trials conducted in south Florida. These differences are primarily related to the manner in which limpograss is utilized by livestock producers in these parts of the state. Studies conducted in north Florida began in the summer and ended in the early fall with the objective of utilizing the maximum amount of forage before the trials ended due to freezing temperatures. Frequent freezing temperatures limit the use of limpograss during the winter in north Florida, and livestock producers generally transfer cattle to annual pasture or feed stored forage. Also, pastures in the north Florida trials were utilized more intensively, with less forage available at the beginning and end of a grazing cycle compared to trials conducted in south Florida. In the north Florida studies, total available forage from limpograss pastures ranged from 6,690 to 3,390 lbs DM/acre and the authors indicated that large quantities of stem material accumulated in the pastures during much of the trial. In these trials, where positive responses to CP supplementation were observed, the cattle's diet was composed of a relatively greater amount of stem material which contained a relatively greater IVOMD:CP suggesting that insufficient CP was available in the forage relative to available energy and a positive response to CP supplementation was likely. Trials conducted in south Florida began earlier in the year and were extended later into the fall, with larger quantities of forage remaining in the pastures when the trials were terminated. In these trials, total available forage from limpograss pastures averaged approximately 10,700 lbs DM/acre in years where no response to protein supplementation occurred. In those years, significant quantities of leaf material were present in the upper layers of the canopy suggesting that the animal's diet was balanced with respect to CP and energy and a positive response to CP supplementation was not likely. In the year where a positive response to CP supplementation was observed, excess forage was available in the pastures at the start of the trial, but availability declined to approximately 5,100 lbs DM/acre by the end of the trial. Crude protein concentration of hand-plucked pasture samples collected near the end of the trial was lower than that of samples collected near the beginning of the trial leading to a IVOMD:CP of approximately 11.0 which was more suggestive of a positive response to protein supplementation. In south Florida, trampling and lodging of limpograss forage to a degree which limited ADG was not observed as suggested by Newman et al. (2002) for trials conducted in north Florida.

Limpograss in Heifer Development and Cow-Calf Production Systems

Because of its cool-season growth potential, opportunity to decrease the need for stored forage or annual pasture during the winter and early-spring, and generally greater energy value as compared to other tropical grasses, with appropriate supplementation strategies limpograss may work well in heifer development programs and cow-calf production systems.

Heifer development

In each of two yrs, heifers were placed on limpograss pasture after weaning at a stocking rate of 0.75 acre/head. From previous experience and given normal rainfall, this stocking rate would provide sufficient forage growth to support the heifer from weaning (September) until the end of the breeding season (end of April) without the need for stored forage during the winter and early spring. To accomplish this, the selected stocking rate would allow for excess forage to accumulate during the summer which could then be utilized along with new pasture growth during the late fall, winter, and early spring. Limpograss pasture was subdivided into five paddocks for rotational grazing with one week of grazing followed by the paddock receiving four weeks of rest. Pastures were fertilized with 47 lbs N/acre in the fall (September) and 47, 12, and 25 lbs/acre of N, P, and K, respectively in the spring (February). From weaning until the end of the breeding season, heifers were fed one of two molasses-based supplements containing urea or urea plus feather meal. Supplements were offered three days per week at the rate of 1.21 lbs DM/d: (1) 93% molasses, 7% urea or (2) 83% molasses, 2% urea, 15% feather meal. Heifers remained on the limpograss pastures until the end of the breeding season, at which time they were combined into one group and placed on bahiagrass pasture until checked for pregnancy in August.

In both years, body weight (BW) and ADG of heifers was not influenced by feather meal supplementation from the start of the trial until the beginning of the breeding season (Table 9). Using a mature cow weight of 1,000 lbs, 70% of the heifers in yr 1 and 55% of the heifers in yr 2 reached 65% of mature weight by the start of the breeding season. In both yrs, heifers supplemented with urea and feather meal had a greater ADG from the beginning of the trial until the end of the breeding season and were heavier at the end of the breeding season compared to those supplemented with urea only. Pregnancy rate was not different between treatments and averaged 75%.

The differential response to feather meal supplementation before and after the breeding season was related to the occurrence of first frost. Prior to frost in both years, no difference in ADG was observed between the two treatments, while after frost, heifers supplemented with urea and feather meal had a greater ADG compared to those supplemented with urea only (Table 9). These results are consistent with earlier discussion in that prior to frost, extensive forage was present in the pastures due to the grazing management strategy utilized, and the upper canopy was composed primarily of leaf. This allowed heifers to consume a diet which was balanced with respect to CP and energy and therefore a response to CP supplementation from feather meal was not observed. After frost, and several grazing cycles through the rotational grazing system, the canopy contained a lower proportion of leaf in the grazed horizon and the frosted forage material was of lower nutritive value thereby resulting in a diet which was less balanced with respect to CP and energy and a positive response to feather meal supplementation was observed.

The lack of response to feather meal supplementation prior to frost led us to question whether any supplementation is needed prior to frost for heifer development on limpograss. To investigate this, the same limpograss pastures and grazing management was used, and heifers were allocated to two treatments: (1) no supplement prior to first frost and then the same amount of the molasses-urea-feather meal supplement described above until the end of breeding, or (2) the molasses-urea-feather meal supplement continuously from weaning until the end of breeding.

In yr 1, providing a supplement prior to frost did not increase BW or ADG compared to heifers grazing

Table 10. Response of heifers grazing limpograss (*Hemarthria altissima*) pasture and fed a molasses-based supplement either continuously from weaning until the end of the breeding season or after the occurrence of first frost.[a]

	Year 1		Year 2	
Item	Post-frost supplement	Continuous supplement	Post-frost supplement	Continuous Supplement
BW, lbs				
Initial	524	519	546	546
First frost	612	612	618	665
Start of breeding	632[b]	669[c]	632[b]	685[c]
End of breeding	771[b]	815[c]	738[b]	771[c]
ADG, lbs/day				
Initial to first frost	0.85	0.85	0.79[b]	1.29[c]
Initial to start of breeding	0.79[b]	1.05[c]	0.61[b]	0.99[c]
Initial to end of breeding	1.14[b]	1.36[c]	0.97	1.14
First frost to end of breeding	1.43[b]	1.82[c]	1.14	1.01

[a]Data from Brown and Arthington, unpublished.

[b, c]Within a year, means in the same row without a common superscript letter differ ($P < 0.05$).

limpograss only and receiving no supplement (Table 10). However, heifers that received the supplement throughout the study gained more weight and were heavier at the start and end of breeding indicating that when both groups of heifers were fed supplement after first frost. Heifers that had been receiving supplement since the beginning of the trial performed better than those that did not receive supplement until after the first frost. Even though heifers that received supplement throughout the trial were heavier at the start and end of breeding, pregnancy rate was very high (94%) and not influenced by treatment. In yr 2, heifers fed supplement throughout the trial had a greater ADG at first frost and the start of breeding than those not receiving supplement. However, this advantage decreased as the trial progressed so that by the end of breeding there was no difference in BW or ADG between the two treatments. Pregnancy rates were 75% for heifers fed supplement throughout the trial and 94% for those that received supplement after first frost.

Vendramini et al., (2007) studied the effects of increasing levels of cottonseed meal supplementation or part-time grazing ryegrass on performance of replacement heifers grazing stockpiled limpograss from February to May in south Florida. Treatments were 0 (control), 2.5, or 5.0 lbs/head/d of cottonseed meal or access to ryegrass pastures 3 times/week. Average daily gain was 0.8, 1.3, 1.7 lbs/d for heifers receiving 0, 2.5, and 5 lbs/head/d of cottonseed meal, respectively. Heifers grazing part-time ryegrass had the same ADG of heifers receiving 5.0 lbs/d of cottonseed meal. The authors concluded that grazing

Table 11. Effect of winter grazing stockpiled limpograss vs. supplemental stored hay on cow BW and body condition score.[a]

		BW, lbs		Body condition score	
Item	Yr	Bahiagrass	Limpograss	Bahiagrass	Limpograss
Sept. BW	1	1,140[b]	1,090[c]	5.6	5.6
	2	1,150	1,120	5.9	5.7
	3	1,160[b]	1,120[c]	5.8	5.6
April BW	1	1,015	1,039	4.9	4.9
	2	1,072	1,044	5.1	5.1
	3	1,050[b]	964[c]	4.8[b]	4.5[c]
Aug. BW	1	1,074	1,112	5.1	5.3
	2	1,120	1,096	5.5	5.4
	3	1,083	1,033	5.2	5.2

[a]Data from Arthington, unpublished.

[b,c]Within a variable, means in the same row without a common superscript letter differ ($P < 0.05$).

Table 12. Effect of winter grazing stockpiled limpograss versus supplemental stored hay on cow BW change and body condition score (BCS) change during the winter and summer months.[a]

		BW, lbs		BCS	
Item	Yr	Bahiagrass	Limpograss	Bahiagrass	Limpograss
Winter change	1	-75^{b}	-105^{c}	-0.6	-0.8
	2	-77	-86	-0.8	-0.6
	3	-112^{b}	-154^{c}	-1.0	-1.1
Summer change	1	57	73	0.2^{b}	0.4^{c}
	2	50	11.3	0.4	0.4
	3	33^{b}	68^{c}	0.4^{b}	0.7^{c}

[a] Data from Arthington, unpublished.

[b,c] Within a variable, means in the same row without a common superscript letter differ ($P < 0.05$).

part-time ryegrass was an effective alternative to supplement replacement heifers grazing stockpiled limpograss

Cow-calf production

To date there have been no reported studies investigating the ability of stockpiled limpograss to support lactating cows during the winter months. Therefore, a multi-year study investigating the effect of combined limpograss and bahiagrass grazing versus bahiagrass alone with hay feeding during the winter, on measures of cow and calf productivity was conducted. In each of 3 years, 160 Brahman-cross cows were assigned to two production systems: (1) bahiagrass pasture (1.8 acres/cow) plus hay and supplement during the winter (typical production system in south Florida) or (2) bahiagrass (1.5 acres/cow) – limpograss (0.7 acres/cow) rotational grazing plus supplement during the winter. All pastures were fertilized in the spring with 60 lb N/acre. Limpograss pastures received an additional fall application of fertilizer (60 lb N/acre). During September, October, and November, cows assigned to the bahiagrass/limpograss combination treatment were grazed primarily on bahiagrass alone allowing the limpograss to stockpile for winter utilization. All cows were provided 5 lbs DM/day of a molasses-urea supplement (16% CP) from November 1 to mid-April. A 90 d breeding season was initiated on January 1. Pregnancy was determined by rectal palpation in July of each year. Calves were weaned during the first week in August each year.

Cows grazing limpograss pastures during the winter were provided no hay compared to an average of 1,400 lbs/head provided to cows on the bahiagrass only treatment during each winter feeding period (January to late March). September cow BW was less for cows assigned to the bahiagrass-limpograss treatment in yrs 1 and 3 compared to cows assigned to the bahiagrass only treatment; however, BCS did not differ (Table 11). At the end of the winter grazing season (April), cows grazing bahiagrass-limpograss were lighter than cows grazing bahiagrass in yr 3 only. Cow BCS in April was less for bahiagrass-limpograss cows only in yr 3. At weaning (August) there were no differences in cow BW or BCS among treatments. Cows assigned to the bahiagrass-limpograss treatment lost more BW during the winter months in Yrs 1 and 3, although loss of BCS did not differ between treatments (Table 12). Summer BW gain was greatest for bahiagrass-limpograss cows in yr 3 and had greater increases in BCS in Yrs 1 and 3. Grazing treatment had no effect on calf weaning weight (mean = 548 lbs; SEM = 8.1). Pregnancy rates were also not affected by grazing treatment (3-yr mean = 92.2 and 91.6 % for bahiagrass and bahiagrass-limpograss cows, respectively).

Grazing strategies which incorporate stockpiled limpograss could be economically effective for fall calving beef cattle in south Florida. Even though limpograss has appreciable winter yield, the majority of growth occurs during the summer rainy season. Cows assigned to the bahiagrass-limpograss treatment spent much of June and August exclusively grazing limpograss. An important consideration to this management strategy indicates that limpograss may limit calf growth compared to bahiagrass, as non-weaned calves grazing summer limpograss gained an average of 11 lbs less ($P = 0.06$; SEM = 2.1) than those grazing bahiagrass.

An economic analysis of both pasture systems is appropriate for each individual ranch. Calving seasons that differ from those used in this study may have a significant impact on the value achieved from the limpograss. As well, persistence of stand will greatly impact economic return, as the high-cost of establishment is spread over greater or fewer production seasons.

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