YIELD AND NUTRITIVE VALUE OF AFRICAN STAR GRASS AND TIFTON 85 BERMUDA GRASS PASTURES ON COMMERCIAL DAIRY FARMS IN JAMAICA

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ABSTRACT

In order to build awareness among Jamaican dairy farmers of the untapped nutritional and economic advantages of improved tropical grass pastures for internationally competitive milk production, the Jamaica Dairy Development Board , in 2001, initiated a series of site-specific evaluations of pastures as managed on commercial dairy farms.

The protocol involved the sampling of a representative paddock, pre- and post-grazing, for herbage dry matter yield and composition. The farms which have participated to date are Serge Island Farms Ltd. (SIFL), Seaforth, St. Thomas (April 2001- March 2003) and West Indies Alumina Company's (WINDALCO) Manchester Pastures Dairy situated near Williamsfield, Manchester (July 2003-present).

The species evaluated at SIFL were African Star Grass (Cynodon nlemfuensis) and Tifton 85 Bermuda Grass hybrid (Cynodon sp.), while African Star was the sole cultivar at WINDALCO.

Mean Net Herbage Accumulation (NHA) at SIFL was, respectively, 55.74 and 71.54 kg DM/ha/d for African Star and Tifton 85. Mean daily NHA during the fist full year at WINDALCO was 56.90 kg DM/ha. Corresponding annual herbage dry matter yields were 20.35, 26.10 and 20.8t/ha.

N fertilizer application rates were 447 and 78 kg/ha/yr at SIFL and WINDALCO respectively.

Cost of producing the grasses were J$528.50 (African Star) and J$402.00 (Tifton 85) at SIFL and J$470.00/t/DM at WINDALCO.

Mean crude protein (CP) / IVOMD values at SIFL were 140/583 and 134.5/580 g/kgDM for African Star and Tifton 85 respectively. Corresponding values for Star grass at WINDALCO were 171.3/569 g/kg. Applying standard published conversion equations, corresponding metabolizable energy values at both sites were 8.75 and 8.70 MJ/kg DM respectively for African Star and Tifton 85 at SIFL and 8.51 on the WINDALCO Star grass. The results of gross energy determinations on a representative subset of the simulated grazing samples taken over the course of the evaluations, confirmed the validity of these estimates.

The results of to date, suggest that African Star grass and Tifton 85 are capable of supporting individual yields of 2500 litres per year without recourse to supplementary feeding. The 28 percent superiority in annual dry matter yield on Tifton 85 support the choice of this hybrid in any strategy aimed at maximizing carrying capacity and milk output per hectare, key elements in achieving sustained competitive advantage in the production of milk.

INTRODUCTION

Jamaican dairymen have traditionally exhibited an over-dependence on the use of concentrate feeds for producing milk. In an increasingly competitive environment, this approach to managing dairy cattle has contributed to a relatively high cost of producing milk on Jamaican farms (Ffrench *et al*, 2000- 2004); compared to countries such as New Zealand which have retained predominantly pasture-based management systems, resulting in on-farm costs of US$0.18 - 0.20 per litre (NZ Agritech, 2003).

A growing body of evidence has become available over the past two decades, which has dispelled earlier conventional 'wisdom' regarding the nutritive value of improved tropical pastures for milk production (Caro-Costas *et al*, 1976, Jerez *et al*, 1984; Jerez *et al*, 1985; Jennings and Holmes, 1985; Hill *et al*, 1995).

In order to contribute to awareness by Jamaican dairymen, of the high nutritive value and the tremendous economic advantage of improved tropical grass pastures for enhanced competitiveness in milk production, the Jamaica Dairy Development Board, in 2001, initiated a series of site-specific evaluations on pastures. To date, a two-year (2001-2003) study at Serge Island Farms Ltd. (SIFL), Seaforth, St. Thomas, has been completed. A second study, which commenced at WINDALCO's Manchester Pastures Farms, near Williamsfield, Manchester, in July 2003, is currently nearing completion.

Miller *et al* (2003) reported on the cost of producing grass at SIFL and summarized aspects of the yield and nutritive value of pastures either of African Star grass or Tifton 85, a Bermuda grass hybrid. This report complements that of Miller et al (*op cit*) by focusing on the nutritive value of the pastures as indicated by their **Crude Protein (CP)**, **digestibilit**y (**IVOMD**) and **Metabolizable Energy (ME)** contents and incorporates data collected during the first year (2003/2004) of the Manchester Pastures study.

METHODOLOGY

The procedure applied in the assessment at SIFL was described by Miller et al 2003. This procedure was similarly applied to the evaluation at Manchester Pastures, except that this latter included only African Star Grass.

In brief, the methodology entailed:

- Pastures were sampled pre- and post- grazing using a 0.5 sq. metre quadrat at 21-day intervals (SIFL) and 14-21 day intervals (WINDALCO) to provide an estimate of **Herbage Mass** from 10 samples cut at ground level.

- Daily **Net Herbage Accumulation (NHA)** was estimated from the difference in herbage mass between successive post- and pre-grazing cuts.

- Herbage quality and nutritive value were estimated from simulated grazing samples taken randomly at 10 sites within the paddock. These hand-plucked sub-samples were pooled to give a single sample for each harvesting date.

- Determinations were made at the Bodles Animal Nutrition Laboratory on CP, Neutral Detergent Fibre (NDF) and IVOMD, the latter using a modification of the two-stage Tilley and Terry procedure after Moore *et al* (1972).

- Metabolizable Energy (ME) Value (MJ/kg. Dry Matter)was calculated using an adaptation of MAFF (1975):

ME = 0.15 IVOMD ……. (1)

- In order to test the validity of these estimates, 16 representative samples from the two years of sampling at SIFL and 8 from the first year of the WINDALCO study were analyzed for Gross Energy content **(GE – MJ/Kg DM)** on the Parr 1261 Adiabatic Bomb Calorimeter at the chemistry Department, University of the West Indies, Mona.

- The crude results were adjusted by a factor of 0.9 to account for the ash content (zero energy) of the sampled herbage. Metabolizable energy value was then estimated using the following formulae:

Digestible Energy (DE) = GE x IVOMD … (2)
ME = 0.81DE … (3) (Minson, 1979)

PASTURE MANAGEMENT

SIFL:

- Grasses: African Star (*Cynodon nlemfuensis*) and Tifton 85 Bermuda grass. (*Cynodon sp*.)
- Grazing cycle: 21 days
- Grazed by a herd of multiparous Jamaica Hope cows.
- Mean stocking rate: 5.4 cows/ha.
- Paddock size: 0.8 ha
- Fertilizer N rate:
  - Yr 1 – 526.25 Kg/ha (8 applications)
  - Yr 2 – 368.75 Kg/ha (6 applications)
- Irrigation: 86 days (Yr 1); 35 days (Yr 2)
- Major Soil Type: Serge Island gravelly sandy clay loam (Fluventic Eutropepts)
- Altitude: 120 metres above sea level.
- Mean ambient temperature: Min. 20^{o}C/ Max. 29.6 ^{o}C
- Mean (30yr) annual precipitation: 2121mm
- Mean Herd Production level: 2900 litres/lactation
- Concentrate Feed per lactation: 1.45t

WINDALCO:

- Grass: African Star
- Grazing cycle: 14-21 days.
- Grazed by a herd of primiparous Jamaica Hope cows
- Stocking rate: 2.3 cows/ha.
- Paddock size: 0.8 ha
- Fertilizer N rate: 78 Kg/ha (2 applications).
- No irrigation.
- Major Soil type: Chudleigh Clay Loam (Typic Eutrorthox)
- Altitude: (App.550 m above sea level).
- Mean ambient temperature: Min. 14.1^{0}C Max. 27.9^{0}C.
- Mean (30yr.) precipitation level: 2033 mm
- Mean herd production level: 2725 litres/lactation.
- Concentrate Feed per lactation: 1.40t

RESULTS AND DISCUSSION

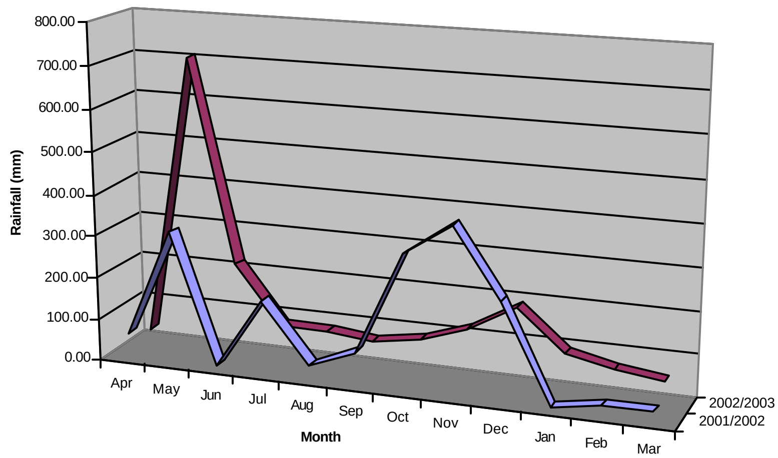
RAINFALL

Precipitation recorded at both sites during the course of each evaluation is shown in Table 1 and Figs.1&2. For the period April 2001 to March 2003, mean annual precipitation at SIFL was 1749mm; lowest rainfall (on average 6 percent of annual) recorded during the period January-April. At WINDALCO 1249mm were measured during July 2003- June 2004, the months December to March being the typical driest period with 5.9 percent of total rainfall occurring then. While the wettest period at WINDALCO was consistently August to October (64-83% of total precipitation), a shift in weather pattern between both years was evident at SIFL; Oct-Dec. (57% of total) and May-June (51%) recording the highest cumulative precipitation during 2001/2002 and 2002/2003 respectively. Partial data for the 2004/2005 year indicate that at WINDALCO, 83% of total rainfall occurred during August- October, reflecting the passage of Hurricane Ivan in September 2004, when over 500mm were recorded at Manchester Pastures. During the subsequent quarter, average monthly rainfall was only 26.0 mm.

Table 1: Mean Annual Precipitation, no. Rain Days and Diurnal Temperature at SIFL and WINDALCO during the Period of Pasture Evaluation

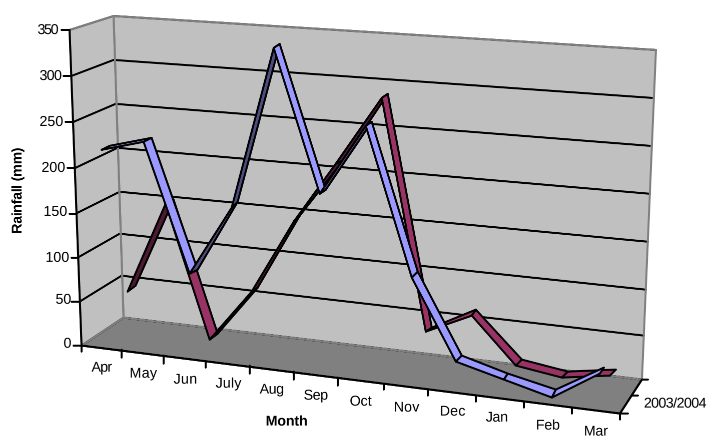
	SIFL		WINDALCO	
	2001/2002	**2002/2003**	**2003/2004**	**2004/2005**
Total Rainfall (mm)	1683.9	1813.1	1249.0	1123.0
Monthly Ave.	140.3	151.1	104.1	124.8
% During peak period	57% (Oct – Dec)	51.1% (May – June)	64.4% (Aug – Oct)	83.3% Aug – Oct)
% During trough period	3.1% (Jan – Mar)	8.8% (Feb – Apr)	5.9% (Dec – Mar)	8.2% (Dec –Mar)
No. Rain Days/yr	98	105	119	N/a
Mean Max Temp. (^oC)	29.6		26.9	
Hottest Month (^oC)	Aug (30.9)		Jul (28.2)	
Mean Min. Temp.	20.1		16.9	
Coolest Month (^oC)	Feb (18.0)		Feb (14.1)	

Fig. 1 Serge Island Rainfall April 2001- March 2003



	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
2001/2002	57.10	318.90	7.80	176.10	33.20	79.20	321.10	400.00	238.10	5.00	22.50	25.00
2002/2003	34.80	705.50	220.60	81.30	80.00	70.00	89.00	123.70	189.70	93.40	69.30	55.80

Fig. 2 Annual Rainfall At Manchester Pastures (Apr 2003-Mar 2005)



	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
2003/2004	220	232.5	90	169.5	342.3	193.2	269	113	27.2	14	2	33
2004/2005	45.7	151	0	60	146	214	287	37.5	62	12	5	13.5

In the absence of irrigation, it is critical that dairymen apply available weather data to estimate **safe carrying capacity,** as determined by herbage yields during the driest periods of the year.

NET HERBAGE ACCUMULATION AND DRY MATTER YIELD

Mean NHA's (kg DM/ha/d) were respectively 55.74; 71.54 and 56.90 for African Star, Tifton 85 (SIFL) and African Star (WINDALCO Yr 1) - Table 2. These converted to equivalent annual herbage dry matter yields of 20.35, 26.10 and 20.77 and indicative costs of $528.50, $402.0 and $470.00 per Kg. respectively.

Table 2: Mean NHA (Kg DM/ha/d), Dry Matter Yield (t/ha/yr) and Cost of Production (J$/t DM)

	Serge Island Farms				**WINDALCO**
	African Star		**Tifton**		**African Star**
	Year 1	**Year 2**	**Year 1**	**Year 2**	**Year 1**
Mean NHA	52.96	58.52	76.38	66.70	56.90
Peak (mth)	138.28 (Aug)	116.35 (July)	154.76 (Aug.)	130.84 (May)	104.30 (June)
Lowest (mth)	11.10 (Oct.)	18.63 (Aug.)	26.88 (Jul.)	5.83 (Jan.)	38.20 (Dec)
Annual DMY	19.33	21.36	27.88	24.33	20.77
Prod. Cost	671.00	386.00	465.00	339.00	470.00
2 yr Av. Cost	528.50		402.00		n/a

Tifton 85 out-yielded African Star by 28.25 percent at Serge Island, which converted to a 24 percent cost advantage to the hybrid. McLeod (Pers. comm.) reported a distinct superiority in yield to Tifton 85 over other improved tropical species, this hybrid producing twice the yield of Pangola grass at WINDALCO's Grove Place Station since 2001.

Dry matter yield on African Star grass at WINDALCO during 2003/2004, was similar to that of the two year mean at SIFL despite the substantial difference in the levels of fertilizer N applied (447 v 78 Kg/ha) and a 29-percent disadvantage in recorded precipitation. Factors implicated were differences in soil characteristics particularly with respect to the advantage in soil moisture availability on the less free-draining bauxitic clay loams at WINDALCO; altitude and its mediating influence on diurnal temperatures, which would have conferred Manchester Pastures with a distinct advantage over the warmer conditions at SIFL.

Cost of herbage production, even at the high of $528.00 on African Star (SIFL), contrasts with current prices for proprietary concentrate feeds of between J$10,000 – J$13,000 per ton ($11,630 - $15,350 on an equivalent dry matter basis).

Herbage yields from African Star grass compare with those as high as 48.8 tonnes DM/ha in Cuba (Jerez *et al*., 1984) where the pastures received 400 Kg N/ha/yr and were grazed at 21 day intervals. A cutting trial conducted earlier at Bodles (Jennings 1992), indicated yields of 47.0 and 55.6 t/ha/yr on African Star grass fertilized with either 150 or 300 Kg N/ha/y respectively and harvested at 21-day intervals. Caro-Costas *et al* (1976), from a study of African Star grass, conducted in the humid regions of Puerto Rico, reported yields of Total Digestible Nutrients (TDN) between 6905 – 11,324 Kg/ha/yr on pasture fertilized at levels ranging from 270-672 Kg N/ha/yr. Assuming a TDN of 55%, these yields convert to 12.5 and 20.6 tonnes DM/ha/yr.

Few reports are available on the more recent cultivar Tifton 85. From trials conducted at Tifton, Georgia, USA, Hill *et al* (1995) reported hay yields as high as 33.8 t/ha during the first year of establishment. McLeod (Pers. Comm.) reports dry matter yields estimated at 51.0 t/ha from Tifton 85 at WINDALCO's Grove Place Station in Manchester.

The yields of both grasses in our study are within the ranges reported in the literature; their position at the lower end of the range possibly reflective of the contrasting climatic and edaphic conditions.

NUTRITIVE VALUE OF HERBAGE

Table 3 shows the mean contents of CP, IVOMD (g/kg DM) and ME (MJ/kg DM), the latter estimated using the approximation:

ME = 0.15 IVOMD

Mean IVOMD at SIFL was similar for both grasses at 583.7 (African Star) and 580.0 g/kg DM for Tifton 85. These converted to corresponding estimated ME's of 8.76 and 8.70 MJ /kg DM.

Table 3: Mean Crude Protein Content, IVOMD (g/kg) and estimated Metabolizable energy (ME-MJ/kg) value of African Star Grass and Tifton 85

	Serge Island Farms				WINDALCO	
	African Star		Tifton 85		African Star	
	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2
Mean CP (%)	14.5	13.5	13.3	13.6	17.13	N/A
Mean IVOMD (g/kg)	571.0	596.0	584.0	576.0	533.3	601.9
Est. ME (MJ/kgDM)	8.57	8.94	8.76	8.64	8.00	9.02

At WINDALCO, corresponding values for year 1 were 533.33g/kg and 8.00MJ/kg DM respectively. The data available to March 2005 indicate that nutritive value was likely to have been higher in Year 2 at 601.9 g/kg DM (IVOMD) and 9.02 MJ ME/kg DM.

Crude protein content of the grasses at SIFL differed by 0.55 percentage units; an advantage to African Star grass. The higher protein content at WINDALCO is not unexpected as disregarding the year differences, the generally more equable climatic conditions at this location would have been expected to confer such an advantage (Deinum and Dirven, 1973).

Crude protein on African Star ranged between 77.9 and 192.3 g/kg at SIFL and 122.8-197.9 g/kg at WINDALCO. The corresponding values in respect of IVOMD were 461.6 - 669.9 and 481.9 - 689.2. With respect to Tifton 85 the ranges were 60.2-186.3 and 352.0 - 642.0 respectively for crude protein and IVOMD.

The values measured for African Star in our evaluations compare with a range in CP of between 174 and 263 g/Kg and 560-730 in dry matter digestibility reported from Puerto Rico (Caro-Costas *et al*, 1976). Jerez *et a*l (1985) reported lower crude protein values of 114 – 154 and organic matter digestibilities of 540-565 g/kg from their study of the effects of mowing on the quality of grazed African Star grass pastures.

With respect to Tifton 85, Hill *et al* (1995) reported CP values of 114-156 g/kg and IVOMD's of 573-619 g/kg DM from a comparison with Tifton 78, both grazed by steers at the Coastal Plain Experiment Station, Univ. of Georgia. These bear close similarity to the values found at SIFL.

It is to be noted that notwithstanding a 3 percentage-point superiority in crude protein content at WINDALCO, mean IVOMD was1.6% units and ME - 0.76 MJ - lower than at SIFL during the preceding two years. This might have been reflective of a higher rate of senescence in the herbage on offer at WINDALCO given the absence of the mediating effect of irrigation during the prolonged dry spells characteristic of the Manchester uplands.

Crude protein content is highly correlated with dry matter digestibility on improved tropical pastures (Thomas and McLaren, 1971). This correlation should facilitate the prediction of nutritive value from the less expensive assay of crude protein. In an attempt to develop a predictive relationship, simple linear regressions were investigated between the IVOMD and CP values determined in these studies. As determined by their coefficients of determination (R^2), the best relationship was estimated from the 2001/2002 data collected on African Star at SIFL. This is described in the equation:

$$\text{IVOMD (\%)} = 30.93 + 1.183\text{CP (\%)}$$
$$n = 12;\ R^2 = 0.698$$

For crude protein values of 12.5 and 14.0% the equation estimates IVOMD at 53.59 and 56.3 percent respectively.

In order to apply these to an estimate of the Metabolizable energy value of the herbage the formula below is applied:

$$\text{ME} = 0.15\ \text{IVOMD}$$

(Adapted from MAFF (1975) which uses D-value i.e Digestible Organic Matter in the dry matter).

Applying this equation to the fore-mentioned estimates of CP and IVOMD predicts ME (MJ/kg DM) at 8.04 and 8.45 respectively.

Reference to Table 3 suggests that at the two-year mean for African Star grass of 14.0% CP the application of the regression equation might underestimate IVOMD by 2.1% units and ME by 0.31 MJ/kg DM.

The determinations of the gross energy content (GE) of the herbages were conducted to test the robustness of these predictors (Tables 4, 5). GE showed little variation, the combined means from SIFL for African Star and Tifton 85) being 16.70 +/- 0.104 and for African Star at WINDALCO - 17.2 +/- 0.088. Corresponding coefficients of variation were 2.4% and 1.4% respectively. These converted to ash-adjusted values of 18.53 and 19.10 MJ GE/kg and fits closely with values of 17.2 -18.4 reported by Minson (1989).

Table 4: Metabolizable Energy (ME) Value of Grasses from Gross Energy (GE) and IVOMD

	Serge Island Farms Limited			**WINDALCO**
	African Star	**Tifton**	**Combined (Y1)**	**African Star (Y1)**
GE (MJ/kgDM)	16.628	16.720	16.670	17.20
GE (Adj.)	18.475	18.578	18.526	19.103
IVOMD	57.71	59.40	58.55	54.26
Dig. Energy	10.66	11.04	10.85	10.37
ME (MJ/kgDM)	8.64	8.94	8.79	8.40

The results from bomb calorimetry suggest that the prediction of ME from IVOMD as base is sufficiently robust for estimating ME value of African Star grass or Tifton 85 within the ranges in IVOMD found in this study.

Using the foregoing regression of IVOMD on CP and applying this to either grass species in combination with MAFF (1975) predicts overall IVOMD in these studies at 57.87% and ME at 8.68 MJ, a marginally (0.08 MJ) upward bias.

Table 5: Comparison of ME content, estimated from IVOMD only (1) or from Gross Energy Determination (2)

	Serge Island Farms Limited			**WINDALCO**
	African Star	**Tifton 85**	**Combined**	**African Star**
GE (MJ/kgDM)	16.63	16.72	16.67	17.20
IVOMD	58.35	58.00	58.18	53.33
ME (1)	8.76	8.70	8.73	8.00
ME (2)	8.73	8.72	8.73	8.25

On the basis of ME content, the quality of the herbage apparently selected by the cows grazed at SIFL and WINDALCO would be classified as medium, based on the classification scheme proposed by Soldevila (1987) - reproduced in Table 6. The lower corresponding values for crude protein in the Soldevila scheme might be reflective of herbage sampled at ground level.

TABLE 6: Classification Scheme for Tropical Grass Pastures

Chemical Composition				
Quality	**Dry Matter (%)**	**Crude Protein (%)**	**Metabolizable Energy (MJ/kgDM)**	**TDN (%)**
High	20-24	>11	>9.0	>55
Medium	20-24	6.1-10.9	7.9-8.9	50-55
Low	20-24	<6	<7.9	<50

Source: Soldevila(1987)

GE determinations were simultaneously made on two proprietary feeds marketed, respectively, as high energy and standard complete dairy feeds, as well as one marketed as a beef ration and commonly used by dairy farmers as a dry season supplement. The corresponding gross energy values for these were 18.70, 17.76 and 17.96. IVOMD assays of one of the complete concentrated feeds and the beef ration gave values of 84.06 and 74.61 respectively. Applying the value of 84.06 to both complete concentrates gives estimated ME's of 12.73, 12.09 MJME/kg DM respectively. The GE and IVOMD values for the Beef Ration yielded an equivalent ME value of 10.85 MJ.

Typical ME contents for high-energy dairy concentrate feed in the U.K are 13.5 and 12.5 MJ/kg DM respectively. This speaks to a need to revise current standards for proprietary concentrates for lactating dairy cows, to establish minimum standard for energy; the primary limiting nutrient in milk production as against the existing standard based solely on crude protein content.

IMPLICATIONS OF STUDIES FOR IMPROVING THE EFFICIENCY OF LOCAL MILK PRODUCTION

The earlier assessments of the potential of tropical pastures for milk production concluded that cows were unlikely to yield significantly beyond 7 litres per day of lactation while grazing unsupplemented tropical pasture (Stobbs and Thompson, 1975). Subsequent studies however, have shown that with management systems aimed at maximizing available leaf (Chacon and Stobbs, 1976), this limit could easily be surpassed. Thus, McDowell *et al* (1975) reported unsupplemented lactation yields above 2,900 litres from heavily fertilized Pangola grass pastures stocked with 2.5 cows per hectare in Puerto Rico. Even higher individual yields of 4,125 litres per cow were reported by Cuban workers (Martinez *et al,* 1980) from well-managed unsupplemented Coast Cross I pastures fertilized at the rate of 350 Kg N/ha/yr and grazed at 20-day intervals. Corresponding per hectare output was 14,850 litres per hectare. Australian workers (Kerr, 1979) reported even higher outputs from unsupplemented Pangola and Star grass pasture 19,553 litres/ha/yr at a stocking rate of 5.9 Holstein cows per hectare.

From a review of thirteen (13) experiments conducted across a range of geographical tropical conditions, Jennings and Holmes (1985) concluded that unsupplemented tropical pastures might support lactation yields of approximately 2,623 litres per cow/yr and corresponding outputs of 11,550 litres/ha/yr.

These yields belie the long-held notion among Jamaican dairymen, that tropical pastures were incapable of providing nutritional support for daily yields beyond 4-5 litres per cow. This inadvertent underestimate has led to over-dependence on concentrate feeds for commercial milk production at the expense of any sustained competitiveness in the local production of milk.

The modest results from our trials with respect to pasture quality and nutritive value, lend strong justification to the need for a paradigm shift with respect to the management of the nutrition of the grazing dairy cow. Mean energy values

of the order of 8.75 MJ ME/kg DM suggest that Jamaican pastures can provide metabolizable energy at levels equivalent to 2.2 times the maintenance requirement of a typical Jamaica Hope cow. This would be adequate to support average daily yields of approximately 8.5 litres per cow or in excess of 2,500 litres per lactation, without recourse to supplementary feeding. Given the seasonal fluctuations in available herbage, digestibility and hence metabolizable energy content, however, a strategic approach to the use of concentrate feeds is indicated.

Jennings (2005) at this conference outlines the elements of a strategic approach to feeding dairy cattle toward sustained competitive advantage.

The site-specific nature of the response by grasses to fertilizer N, due to climatic and edaphic interactions on this response, dictates the necessity to continue this series of studies in order to develop practical approaches appropriate to the wide-ranging ecological conditions under which dairying is practiced in Jamaica.

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