THE BANANA PLANT AS CATTLE FEED: COMPOSITION AND BIOMASS PRODUCTION[1]

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On the basis of the hypothesis that feeds which contain starch support a higher rate of animal productivity than those which do not contain this nutrient, an evaluation is being race of different tropical crops in terms of their production per unit area, ease of production with reference to establishment, maintenance and harvesting, and usefulness as animal feed. The banana appears to offer important advantages in this respect in that, combined in one single plant, is high quality protein (in the leaves), starch (in the fruit) and fermentation energy (in the trunk and petiole). Moreover, the plant has a high potential in terms of production of biomass per unit area. Samples were taken from a commercial plantation used for fruit production in Santo Domingo, Dominican Republic and from an experimental farm in the Seychelles Islands. At the moment of harvesting 8 complete plants were taken at random from each site and the different components weighed and analysed. The average fresh weight of the complete plant was 35.3 ± 7.74 kg (x ± SEx) and 58.0 ± 4.2 for the two sites respectively. Comparable dry matter weights were 3.90 x and 5.99 kg. Proportions on a DM basis were 24 46 and 38 for leaves, trunk and fruit (Santo Domingo). The DM content (%) was 15.6 ± .72, 8.15 ± .50 and 26.6 ± .40 and N (% in DM) 2.81 ± .58, .71 ± .04 and 1.31 ± .09 respectively for these different components. A limited revision of the literature indicated a range of dry matter production of 3.6 to 15.4 kg for mature plants at harvest with a median value of 5.5. Assuming each root system produces 1.5 harvests annually, then total DM production (kg/ha/yr) would be 20,630 for the whole plant and 13,000 for the residual forage (e g. after harvesting the fruit for sale). This represents stocking rates (300 kg steer) of 7.5 and 5.0 an animals/ha/yr.

Key words: Cattle, bananas, composition, stocking-rate

It is well documented that feeds for ruminants which contain high levels of soluble carbohydrate i.e. sugar and starch, support a high rate of animal productivity. In diets of high digestibility, there is evidence that starch can pass undegraded through the rumen and be digested in the intestinal tract (Kerr et al 1966). In a similar way, it has been demonstrated by Preston and Munoz (1971), Preston and Molina (1972), and Morciego et al (1972) that less soluble types of feed protein supplement the amino acid pool without degradation in this way. Protein and starch which avoid ruminal degradation have been termed "bypass" nutrients (Kempton et al 1977; Preston and Leng 1978 Leng and Preston 1976).

It seems to be reasonable to assume that the overall effect of offering a highly digestible diet, which also provides a source of by-pass starch and protein in addition to readily fermentable carbohydrate and nitrogen, should be a level of productivity approaching the full genetic potential of the animal.

Bearing in mind these factors, it would seem that the banana plant has important advantages as a potential animal feed. First, most of the nutrients required by ruminants are combined in a single plant. Fermentable energy is present in the trunk and petioles; the leaves contain high quality protein and immature fruit is mainly starch. Secondly, biomass yield per unit area is extremely high. A well managed

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commercial plantation for example, will have between 2 500 and 5 000 plants/ha depending on the variety, and each will produce about 1.5 mature plants/year Thirdly, when the bananas are harvested, it is normal practice to cut down and die card the old plant to make room for a younger plant shoot which will provide the next fruit. Therefore, using the discarded plant for animal feed would in no way interfere with production of bananas for human consumption. On the contrary, such a practice would complement banana production by converting otherwise wasted, material into animal protein.

Experimental

Samples were taken from a commercial banana plantation in Santo Domingo[1] and from an experimental farm in the Seychelles. Twelve mature plants were harvested in the former (7 Jan 1978) and eight in the latter (31 March 1978). The trunks were severed at the base and the leaves at their junction with the trunk; the fruit was the whole hand including the inner stalk In Santo Domingo, samples were taken for DM and N analysis using drying to constant weight and micro Kjeldahl procedures, respectively.

The soil in Santo Domingo was moderately fertile but had received negligible fertilizer. In Seychelles, the soils were poor (eroded red earths of volcanic origin) but had been heavily fertilized with liquid slurry from the cattle feedlot. A wide range of varieties was used in each location.

Results and Discussion

Weights and composition data for the banana plants sampled in each location are given in table 1. It is apparent that the fresh weight composition of the whole banana plant varied little as between Santo Domingo and Seychelles, however the fresh weight of the whole plant and its principal constituents were some 50% greater for the sample taken in the Seychelles.

Table 1:
Mean values (X + SEx) for composition of mature plants in Dominican Republic and Seychelles

Measurement	Trunk	Leaves	Fruit	Total
Fresh weight, kg				
Dominican Rep	22.1±2.0	5.02±.33	8.12±.57	35.2±2.7
Seychelles	31.9±2.9	7.80±.60	14.3±1.7	54.0±4.2
Proportion, % fresh basis				
Dominican Rep	63	14	23	
Seychelles	59	15	26	

[1] We are grateful to Sr David Carrasco Recio for his interest and support in making available forage from his banana plantation

Table 2:
Mean dry weights of banana plants (fruit stem and leaves) in different countries

Country	Dry weight (kg)	Authors
St Lucia	3.63[1]	Twyford & Walnsley 1973
French Antilles	3.85-6.84[1]	Martin-Prével al 1967
Jamaica	3.85-9.0	Bolan 1962,63
Dominican Rep	3.90	This paper
St Lucia	4.75[1]	Twyford & Walnsley 1973
St Vincent	5.54	Twyford & Walnsley 1973
French Guinea	5.56[1]	Martin- Prével 1962
Seychelles	5.99	This paper
Grenada	13.0	Twyford & Walnsley 1973
Canary Islands	15.4[1]	Baillon et al 1933
Range	3.63 to 15.4	
Median value	5.5	

[1] Calculated from the original data assuming that the corm accounted for 15% of the total try weight of the plant (according to data taken from Twyford & Walnsley 1973)

Table 3:
Dry matter proportions (%) of banana plants in the Caribbean

	Component parts			
Country	Leaves	Stem	Fruit	Author
Dominican Rep	20	46	34	(1)
St Lucia	20	37	43	(2)
Grenada	25	38	37	(2)
St Lucia	27	44	29	(2)
St Vincents	31	30	40	(2)
Mean values	25	39	37	

(1) This paper
(2) Twyford & Walnsley 1973

Table 4:
Dry matter and nitrogen contents in leaves, trunk and fruit of banana plants

Country	Component parts			
	Leaves	Trunk	Fruit	Author
Dry matter content, %				
Dominican Rep	15.6±.72	8.15±.50	26.6±.40[1]	(1)
Philippines		5.27±.31		(2)
Trinidad		5.1	20.9	(4)
N content in DM, %				
Dominican Rep	2.81±.58	.71±.04	1.31±.09[1]	(1)
Philippines		.70±.09	1.36[1]	(2)
Windward Isl	1.64±.12	50±.05	.86±.13	(3)
Trinidad	2.56	.64	.77	(4)

(1) This paper
(2) Lopez-Gerpacio & Castillo 1974
(3) Twyford & Walnsley 1974
(4) Gohl 1970

[1] Average for peel (15.6±.66) and flesh (35.2±.13) in ratio found normally in the fruit (stem of raceme not included)

In table 2, a comparison is made of the yield of DM from a single banana plant (excluding the corm/root) as reported by workers in nine different count tries. The range is considerable -- from 3.63 to 15.4 kg DM with a median value of 5.5 kg. Assuming a plant population of 2,500/ha, this median value would be equivalent to a combined forage|fruit yield of 13,750 kg DM/ha per harvest, which increases to 20,630 kg if it is assumed that 1.5 harvests can be made per year from the same rootstock.

Table 3 compares the proportions (DM basis) represented by leaves, trunk and fruit at the time of harvest. The mean values: leaves 25%, trunk 39% and fruit 37%, indicate that if only the residual (by-product) forage was used for cattle feeding, then this would amount to 13,000 kg/ha for an average crop fruiting 1.5 times a year.

We have as yet been able to collect only limited compositional data on the banana plant and this is summarised in table 4 and in table 5. The DM content of the component parts of the plant differs markedly with only 5 to 8% in the trunk, 16% in leaves and 26% in fruit. The N content (DM basis) appears to vary in the range 1.6 to 2.8% (median figure is 2.6%) for leaves, 0.5 to 0.7% for trunk and 0.9 to 1.4% in fruit. These data indicate that the average N content may vary from 0.92 to 1.37% for the whole plant and from 0.95 to 1.34% for the residual forage

Table 5:
Dry matter and starch in banana fruit (skin and flesh only) (n=10)

	Flesh	Skin	Total
Fresh weight, g	81.8 ± 6.8	65.1 ± 5.7	147 ±12
DM content, %	35.2 ± .13	15.6 ± .66	26.5 ±.40
Starch, % of DM	65.0 ± 3.0		48.0*
Starch, % of fresh weight			12.7*

*Derived from original data by calculation

The analysis of the fruit (table 5), indicates that the starch content is some 48% of the DM or 12.7% of the fresh weight. This is equivalent to some 18% in the total dry weight of the plant. Assuming the minimum quantity of starch in the diet to ensure adequate supplies of glucose precursors is of the order of 300 to 500 g/d (Elliott et al 1978; Preston and Leng 1978),then only about one third of the fruit would be needed to provide the starch to balance the residual forage when this was fed to cattle. In other words, some two thirds of the fruit could be used for human consumption. It is worth noting that in packing stations preparing fruit for export, the rejection rate is normally of the order of 20%.

Assuming a fattening steer of 300 kg live weight, consumes 7.5 kg DM daily, then the potential stocking rate would be 7.5 head/ha/year if the whole plant including the fruit were fed and 5 head/ha/year if only the residual forage was used. If yields equivalent to those reported from the Canary Islands (Baillon et al 1933) or from Grenada (Twyford and Walmsley 1973) were obtained then the potential stocking rates would be about 19 and 13 steers/ha/year for whole plant and residual forage respectively. This order of potential productivity is approaching what was previously thought to be obtainable only with sugar cane; which does not however supply any by-pass nutrients (Preston 1977).

Information on the nutritive value of the banana plant for ruminant feeding will be presented in subsequent papers.

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