YIELDS OF PLANTAIN GROWN FOR FRUIT AND FORAGE: THE EFFECTS OF DEFOLIATION AND SPACING[1]

B Pound[2] and A Fernandez

Centro de Investigacion Pecuaria (CENIP)/CEAGANA,
Aptd 1256, Santo Domingo, Dominican Republic

The effect on yields of plantain leaf, stem and fruit of three intensities of defoliation and two spacings was studied. Fully expanded lower leaves were harvested 12 times, 8 times or not at all during the main vegetative growth period (22-52 weeks after planting). The two spacings used were 2 m x 2 m (2,500 stands/ha and l m x l m (10,000 stands/ha). Only those plants which produced mature fruit to the 65th week after planting were included in the fruit and stem yields.

The yield of leaf was very dependent upon spacing (P <.001) but stem and fruit yields were unaffected by spacing, possibly because e a lower percentage of plants in the high population plots produced fruits by the 65th week. Leaf yield was not significantly affected by the number of defoliations and it would appear that there is a strong tendency for the plant to maintain its leaf area index and shoot:root ratio.

Maximum residual biomass (leaf + stem) was 7.9 tonnes DM/ha/year. The stocking rate this could support, assuming 300 kg animals received 6 kg DM/d would be 3.6 animals/ha.

Key words: Plantain, defoliation, spacing, biomass, cattle production

Farm surveys in Costa Rica (Progress Report, CATIE 1978)showed that 76% of cattle enterprises in that country combined cattle production with crop production. The residues from this type of integrated system are conveniently used as cattle feed. One of the crops which features prominently in such systems is the plantain or cooking banana (*Musa paradisiaca* L.) which is a staple food crop in Southern India, Africa and tropical South America (Purseglove 1972). Each pseudostem fruits only once and is then immediately cut so that the suckers growing round its base can develop.

The percentage of plantain fruit wasted (5 - 10%) is much less than that for the banana export trade (20 - 30%) where there may be sufficient waste bananas to form the basis of a cattle fattening enterprise, such as in St Lucia where Heifers gained 0.92 kg/d on a diet of brewers grains, waste fruit, sweet potato foliage, Leucaena leucocephala and urea (Hughes-Jones et al 1980).

The leaves from the cut plantains, if not indispensable as mulch to maintain nutrient levels and protect the soil, can be fed to cattle,and chopped pseudostems are also an important item in the diet of stall-fed cattle in the traditional systems of the Wachagga people of Tanzania (Purseglove 1972).

The objectives of this study were to see if the plantain could be grown as a dual-purpose crop (forage and human food) and how the management practices of spacing and partial defoliation affected vegetative and fruit yields.

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[2] *Technical Cooperation Officer, Overseas Development Administration, London*

Materials and Methods

Treatment and design: A 3 x 2 randomised block factorial design with replicates was used. Treatments were:

a) Spacing	(i)	2 m x 2 m (2,500 stands/ha)
	(ii)	1 m x 1 m (10,000 stands/ha)
b) Defoliation	(i)	Removal of green, fully expanded lower leaves 12 times in the year after planting, starting 22 weeks after planting
	(ii)	Lower leaf removal 8 times during the same period
	(ii	No leaf removal (control).

Planting details: Plots of 6 m x 6 m were used and the suckers were treated with a nematocide and systemic insecticide at planting. A basal dressing of 100 kg/ha N, 100 kg/ha P_2O_5 and 150 kg/ha K_2O was applied at planting. Thereafter fertilization was by the periodic application of anaerobically digested cattle slurry.

The soil was an organic loam of pH 7.5 with medium drainage.

Rainfall for Santo Domingo averages 1390 mm /year and mean temperatures for August and January are 27.1°C and 24.0°C respectively.

Measurements: The fresh weight of leaves at each defoliation and of stem and fruit at harvest were taken, and dry matters obtained from 100 g samples by drying to constant weight at 100°C. Total nitrogens were determined by the Kjeldhal method.

Results and Discussion

The effects of spacing and defoliation intensity on yields of fruit and forage for this trial are set out in Table l and 2. The yield of leaf dry matter resulting from defoliations

Table 1:
Effect of spacing on yields of plantain fruit and forage

Spacing	Leaf yield/defoliation (t DM/ha/cut)	Total leaf yield (t DM/ha/yr)	Stem yield[1] (t DM/ha)	Fruit yield[2] (t FW/ha)
1 m x 1 m (10,000 plants/ha)	0.49	4.8	3.84	7.84
2 m x 2 m (2,500 plants/ha)	0.22	2.1	4.32	8.42
$\bar{x}$	0.36	3.45	4.08	8.13
$SE_{\bar{x}}$	0.049	-	0.3	0.63
P	< 0.001	-	NS	NS

[1] Yield of pseudostem from those plants which produced fruits up to the 65th weeks after planting

[2] Yield of marketable fruit produced up to the 65th week after planting

Table 2:
Effect of defoliation frequency on yields of plantain fruit and forage

Number of defol-iations/yr	Leaf yield/defoliation (t DM/ha/defoliation)	Total leaf yield (t DM/ha/yr)	Stem yield[1] (t DM/ha)	Fruit yield[2] (t FW/ha)
12	0.32	3.78	4.46	7.5
8	0.39	3.17	4.13	8.8
0	-	-	3.66	8.1
$\bar{X}$	0.36	3.48	4.08	8.1
$SE_{\bar{X}}$	0.06	-	0.3	0.63
P	NS	-	< 0.05	NS

[1] Yield of pseudostem from those plants which produced fruits up to the 65th week after planting

[2] Yield of marketable fruit produced up to the 65th week after planting

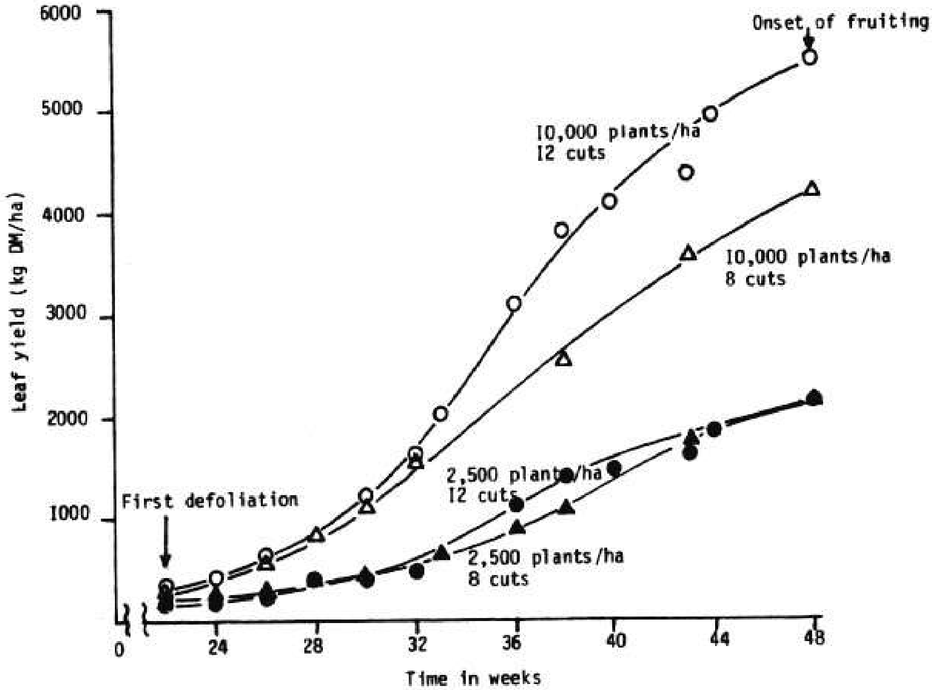
was very dependent upon spacing (P<0.001), over twice the dry matter being obtained from plants at the closer spacing. The leaf yield is not, however, proportional to the plant density. This suggests that there was competition between plants at the higher density. Previous work by Meyreles and Preston (1979), in which lower leaves were harvested during vegetative growth between 5 and 10 months after planting, and at populations from 1,800 and 5,500 plants/ha, suggested that the optimum population for leaf production was 3,800 plants/ha. Leaf production at that population and up to 10 months after planting, was 2 t DM/ ha compared to 4.8 t DM/ha obtained at 10,000 plants/ha in this study.

Stem yield and fruit yields were unaffected by spacing probably because a much lower percentage of plants in the high population plots had produced fruit by the 65th week. Only stems of those plants which had fruited are included in the results. It is probable that a much higher total biomass/unit area was present at this time in the close spacing plots, and one could use a higher plant density if biomass rather than fruit or dual-purpose production was the principal objective.

Leaf yield was not significantly affected by the number of defoliations. This could be explained by the fact that the plant tries to maintain a constant Leaf Area Index and shoot:root ratio. It also demonstrates that the plantain plant has a high capacity for regrowth, as is observed when a plantation is badly damaged by a hurricane. This point is emphasised in Figure 1 which shows accumulative leaf yield with time for the different treatments. There is very little reduction in leaf production during the vegetative period. In this context it could be interesting to try to maximize leaf production by "decapitating" the plant leaving only the stem to regrow. Stem yield surprisingly increased as defoliation became more intense, although this pattern is not followed by fruit yield.

Maximum biomass (leaf + stem + fruit) yield was 9.5 t DM/ha/year which is lower than the 13.8 t DM/ha / year calculated by Ffoulkes et al (1978). Excluding fruit yields the leaf + stem yields were in the range 2.9 - 7.9 t DM/ha/year, the former figure

Figure 1:
Accumulative plantain leaf yield (kg DM/ha) harvested ted during vegetative growth



being for the non-defoliated plots (i.e. stems only). The estimated stocking rate that this production could support would be 1.3 - 3.6 animals/ha (assuming consumption at 2% of liveweight as dry matter by 300 kg animals). Considering this forage as a byproduct of plantain fruit production, this stocking rate is very acceptable. It is probable that in the second and subsequent year biomass production will be higher as the number of stems/stand increases.

The feeding value of the three major fractions (leaf, stem and fruit) of plantain and banana plants have been elaborated in a number of papers (Ffoulkes et al 1978; Bobadilla and Rowe 1979; Rowe et al 1979; Rowe and Preston 1978; Ffoulkes and Preston 1978; Pezo and Fanola 1980; Martinez et al 1980; Hughes-Jones et al 1980; Alvarez et al 1978; Fernandez 1980).

The range of values obtained in these studies for dry matter, nitrogen, crude protein, degradability, digestibility and consumption index are presented in Table 3.

Conclusions

1. The lower, fully expanded leaves can be harvested during the vegetative period without apparently affecting fruit yields. Leaf yields are higher for higher plant densities.

2. Leaf regrowth is fast, as the plants appear to try to maintain a constant Leaf Area Index and shoot:root ratio.

3. Stocking rates of up to 3.6 animals/ha appear possible, feeding the by-product, leaves and pseudostems to stall-fed cattle.

Table 3:

Characteristics of the leaf, stem and fruit of plantains

	Leaf	Stem	Fruit
Dry matter, %	14.3 - 21.8[1-7]	6.8 - 8.2[1,3,5]	21.6[8], 26.6[1]
Nitrogen, %	1.95 - 2.88[1,5,7,9]	0.71[1], 0.38[5]	1.31[1]
Crude protein, % (N x 6.25)	12.2 - 18.0 [1,5,6,7,9]	2.4[5], 4.4[1]	8.2[1]
DM Degradability ($t_{1/2}$ in hours)	46.4[10], 89.0[11]	28.3[10], 62.0[11], 42[14]	6.5[12]
Digestibility, %	65.2[13], 45.9[5]	75.4[13], 77.4[5], 74.5[15]	-
Consumption index*	2.29[4], 2.15[13]	1.23[13]	-

* kg feed DM/100 kg liveweight

1 Ffoulkes et al 1978
2 Meyreles & Preston 1979
3 This work
4 Rowe et al 1979
5 Pezo & Fanola 1980
6 Rowe & Preston 1978
7 Alvarez F J et al 1978
8 Hughes-Jones et al 1980
9 Bobadilla & Rowe 1979
10 Santana & Hovell 1979[a]
11 Ruiz & Rowe 1980
12 Santana & Hovell 1979[b]
13 Ffoulkes & Preston 1978
14 Encarnación (unpublished data)
15 Fernandez (unpublished data)

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