caribbean food crops society

19

Nineteen Annual Meeting

August 1983

PUERTO RICO

Vol. XIX

CROPPING SYSTEMS RESEARCH INVOLVING BANANA AND FOOD CROPS ON FARMERS' HOLDINGS IN THE WINDWARD ISLANDS

M.M. Rao and J. E. Edmunds [1/]

SUMMARY

On-farm cropping systems research involving banana (*Musa* sp.) dasheen (*Colocasia esculenta*) and cowpeas (*Vigna unguiculata*) was initiated on six sites with similar production environments and soil type (Aquic Tropudults) in Fond Assau, St. Lucia. The prevalent farmers' pattern (Control) was compared against experimental alternatives. The use of partial budgets and performance criteria such as returns above variable costs (RAVC) showed that the alternatives are 16-30% superior than that of the control. Alternative patterns indicated a marginal benefit-cost ratio (MBCR) varying from 2.4 to 4.7 as compared to the farmers' existing pattern. Yield, yield parameters, leaf characteristics and growth of banana at 7 months after planting were unaffected by the various treatments. However, the production cycle was extended to a maximum of 17 days in banana + 2 dasheen + 3 cowpeas. The cropping systems significantly reduced the weed growth.

INTRODUCTION

The system approach is gaining prominence in the tropics and humid tropics in the development of cropping patterns aimed at a more efficient utilization of farm resources. This approach is gradually replacing the traditional single-crop-oriented research usually found at experiment stations. In recent years, researchers have become more aware that the impact of a new technology is measured, not by its excellence in experimental plots but rather by the extent to which it is adapted on farmers holding. The growing consensus among agricultural scientists is that the technologies developed on experiment stations are not transferred quickly enough to farmers holdings for adaptation. The reason for this are many. Nevertheless, it is generally agreed among scientists that there is need for more research on farmers holding in

---

1/ Windward Islands Banana Growers Association (WINBAN)
Research and Development Division
P. O. Box 115, Castries, St. Lucia, W. I.

order to characterize, quantify and reduce the technological gaps that exist between experiment station and farmers' holdings.

The concentration of some research activities from the experiment station to farmers fields has attracted much attention. Performing research in farmers' field would, supposedly eliminate the most serious reason for farmers' reluctance to adopt new technologies, namely, the objection that the new technology developed in the experiment station does not work in farmers' fields (Gómez, 1977).

In the Windward Islands, banana, an economically important crop, is grown in association with a wide variety of permanent tree and food crops on small holdings (Henderson and Gomes, 1979) in order to (1) offset some of the overhead costs of plantation establishment (Fongyen, 1976), (2) have extra food or cash returns (Ruthenberg, 1976) and (3) suppress weed growth (Fongyen, 1976). Most of the reported research on banana cropping systems have been conducted at experimental stations (Devos and Wilson, 1979 and Rao and Edmunds, 1983). For better acceptance of technology change, Zandstra et al (1981) opined that the farmers' pattern should be included for evaluating the performance of experimental patterns. On-farm cropping systems research involving banana and food crops was initiated by WINBAN in 1978 in different production environments in the Windward Islands, to determine (1) agronomic productivity, (2) biological stability, (3) land-use efficiency, (4) resource requirements and (5) economic profitability. The results of an experiment reported herein form a part of the on-going Cropping Systems Research Project at WINBAN.

MATERIALS AND METHODS

The experimental sites were located on Assor Clay (Aquic Tropudults) within a similar production environment in Fond Assau, St. Lucia. The annual rainfall for the area averages 1630 mm. Analysis of representative soil samples to a depth of 30 cm prior to initiation of the experiment showed pH:4.6; electrical conductivity: 81 umhos, Truog P : 8 ppm, exchangeable Mn: 73 ppm and exchangeable cations (m.e./100g of soil) K : 0.92, Ca: 13.9 and Mg : 12.2.

The plots were forked and levelled manually prior to planting of the crops. Both banana and intercrops were grown according to prevalent farmers' practices. Clean and uniform sword suckers of banana cv Robusta were planted on June 3, 1982 at a spacing of 2.5m x 2.5m. One randomized block comprising four treatments was set up on each of six farmers' holdings with 30 plants per plot. The treatment details are:

Treatments	Symbol	Planting Pattern ← 2.5m →
1. Banana + 2 rows Dasheen (control)	B + 2D	B D D B
2. Banana + 2 rows Dasheen + 3 rows Cowpeas	B + 2D + 3C	B C D C D C B
3. Banana + 3 rows Dasheen	B + 3D	B D D D B
4. Banana + 3 rows Dasheen + 4 rows Cowpeas	B + 3D + 4C	B C D C D C D C B

Treatment 1 was basically farmers' existing practice in the locality, hence, it was considered as control with respect to intercropping. The banana received fertilizer and nematicide according to recommended rates (WINBAN, 1981). Intercrops were planted on July 15, 1982 and no fertilizer was applied. The varieties of cowpeas and dasheen used were California blackeye No. 5 and 'local' respectively.

An area of 1 m^2 was left unweeded in each plot to estimate the weed growth at 240 days after banana planting. Cowpeas and dasheen were harvested at 62 and 229 days after planting, respectively. During the growth of banana, girth and height of the mother plants were measured at 4 and 7 months and that of the daughter at 6 and 8 months after planting. Leaf characteristics were recorded at harvesting on 5 plants per plot whereas yield and yield parameters were recorded from 30 plants per plot. The farmers attended to most of the cultural practices and supplied all the chemical inputs. A record of cost of labour and inputs was kept in order to work out some economic analyses.

RESULTS AND DISCUSSION

INTERCROPS:

COWPEAS:

The cowpeas were included in two cropping systems with varying plant population (Table 1) and in both treatments the grain legume was harvested in 62 days. A protein-rich seed of 467 kg/ha was obtained from cowpeas in B+2D+3C. Increasing the number of rows of cowpeas from three to four increased the seed yield only marginally (4.7%). Plant height and yield parameters also showed no appreciable difference between treatments.

Table 1: Yield and yield parameters of cowpeas in different cropping systems

Particulars	Cropping Systems	
	B + 2D + 3C	B + 3D + 4C
Seed yield (kg/ha)	467 ± 138	489 ± 194
Mean plant height at harvest (cm)	73.7 ± 6.6	74.3 ± 10.4
Mean No. of pods/plant	16.4 ± 3.3	14.3 ± 3.1
Mean No. of seeds/pod	7.4 ± 0.8	7.1 ± 0.6
100-seed weight (g)	18.5 ± 0.7	18.6 ± 0.8

DASHEEN:

Dasheen was grown in all cropping systems because it is the most important intercrop for the farmers of the locality in meeting part of their food requirement and realizing additional cash.

The tuber crop was grown at two densities and in association with a legume (Table 2). Increase in the density of dasheen increased the tuber yield significantly suggesting that the tuber production can be improved over the farmers' existing level. The associated growth of cowpeas in the intensive interplanting (B + 3D + 4C) reduced the tuber yield of dasheen significantly thereby indicating possible occurrence of interplant competition. A comparison of legume versus no legume in banana+ dasheen combination showed a loss in tuber yield of 16.5% with cowpeas. In this trial, both dasheen and cowpeas were planted at the same time, cowpeas being a fast growing crop, shaded the slow growing tuber crop considerably and by the time the legume was harvested, the banana canopy was dense enough to affect the dasheen yield.

Table 2: Effect of Cropping Systems on tuber yield of dasheen

Cropping Systems	Tuber Yield (t/ha)	Relative to Control (%)	Mean Tuber Weight (g)
B + 2D (Control)	7.6	-	356
B + 2D + 3C	7.5	98.6	347
B + 3D	13.1	172.3	330
B + 3D +4C	9.8	128.9	279
LSD = 0.05	1.9	-	-
C.V. (%)	16.6	-	14.5

EFFECT OF CROPPING SYSTEMS ON WEED GROWTH

Alternative cropping systems reduced the weed growth significantly as compared to the existing farmers' practice

(Table 3) and the presence of cowpeas in the cropping pattern lowered the weed growth more than its absence. However, the differences in weed growth among the various experimental cropping systems were non-significant. This reduction in weed growth was due to better light interception by crops. Chako and Reddy (1981) observed no weed growth by adopting high planting density (440 to 6950 suckers/ha) and intercropping with cowpeas.

Table 3 : Effect of Cropping Systems on weed growth

Cropping Systems	Weight (g) of weeds/m^2			
	Fresh	Relative to Control (%)	Dry	Relative to Control (%)
B + 2D (Control)	122 (11.05)*	-	30.0 (5.48)	-
B + 2D + 3C	38 (6.18)	31.1	8.9 (2.98)	29.7
B + 3D	43 (6.56)	35.2	11.4 (3.38)	38.0
B + 3D + 4C	17 (4.13)	13.9	4.7 (2.18)	15.7
LSD = 0.05	(3.46)	-	(2.04)	
C.V. (%)	40.4	-	47.0	

* Values given in the parenthesis are transformed to $\sqrt{n + 1}$

GROWTH OF BANANAS AS INFLUENCED BY CROPPING SYSTEMS

Initially, the cropping systems significantly influenced the girth of the mother plant and height of both mother and daughter (Table 4). Both girth and height of mother at 4 months after planting was significantly lower in Banana + 3 Dasheen + 4 Cowpeas, whereas, the daughter was significantly shorter in Banana + 2 Dasheen + 3 Cowpeas. However, with time, the differences in growth characteristics were non-significant.

Table 4: Effect of cropping systems on growth of banana

Cropping Systems	Girth (cm) of Mother (months after planting)		Height (cm. of mother (months after planting)		Height (cm) of daughter (months after planting	
	4	7	4	7	6	8
B + 2 D (Control)	47.6	64.8	149	228	126	145
B + 2 D + 3C	44.4	65.2	143	226	93	146
B + 3D	43.2	64.2	138	225	116	150
B + 3D + 4C	40.0	64.0	127	221	116	138
LSD = 0.05	4.1	-	15	-	15	-
C.V. (%)	7.6	3.5	8.9	3.2	10.9	5.5

EFFECT OF CROPPING SYSTEMS ON LEAF CHARACTERISTICS OF BANANA

The number of leaves per plant both at shooting and harvesting and leaf area of mother were slightly higher in cropping systems with cowpeas viz. B + 2D + 3C and B + 3D + 4C. However, the differences in all leaf characteristics were non-significant (Table 5)

Table 5: Leaf characteristics of banana as affected by cropping systems

Cropping Systems	No. of leaves per plant at		Decrease in leaves between shooting and harvesting (%)	Length (L) (cm.)	Width (W) (cm)	Leaf Index (L/W)	Area Mother (m^2)	Petiole length (cm)
	Shooting	Harvesting						
B + 2D (Control)	10.2	7.3	28.4	192	71	2.72	8.07	32.0
B + 2D + 3C	11.2	7.9	29.4	197	72	2.73	9.08	32.0
B + 3D	10.8	7.5	30.5	194	73	2.68	8.47	31.1
B + 3D + 4C	11.3	8.1	28.3	191	71	2.69	8.71	32.4
LSD = 0.05	-	-	-	-	-	-	-	-
C.V. (%)	7.3	7.8	-	2.9	3.6	2.9	8.5	4.7

EFFECT OF CROPPING SYSTEMS ON PRODUCTION CYCLE AND YIELD OF BANANA

The cropping systems significantly influenced the number of days taken from planting to shooting but not days to harvesting, nor yield and yield parameters of banana (Table 6). This is consistent with the findings of Maddineni and Edmunds (1982) who reported that the experimental pattern did not reduce banana yield significantly as compared to the farmers' existing practice. In the present study, the alternative cropping systems delayed shooting and harvesting by 3 to 24 days and 2 to 17 days, respectively, as compared to the farmers' existing pattern. Inclusion of cowpeas in the cropping system lowered the number of days from shooting to harvesting by 5 to 6 days possibly inferring that the nitrogen fixed by the legume was already available to the banana.

Table 6: Production cycle, yield and yield parameters of banana as affected by cropping systems

Cropping Systems	Days taken from planting to		Yield (t/ha)	Mean bunch wt. (kg)	Mean No.of hands/ bunch	Mean hand wt (kg)	Mean no. of fingers/ bunch	Mean finger wt. (g)
	Shoot-ing	Harvest-ing						
B + 2D (control)	187	293	30.0	17.9	7.12	2.50	112	154
B + 2D +3C	211	310	30.5	17.4	7.14	2.54	111	164
B + 3D	190	295	29.1	16.8	6.98	2.44	110	157
B + 3D + 4C	209	309	29.2	17.7	7.00	2.52	109	157
LSD = 0.05	17	-	-	-	-	-	-	-
C.V. (%)	6.4	3.9	7.3	8.1	2.7	5.2	5.0	5.9

ECONOMIC EVALUATION OF CROPPING SYSTEMS PERFORMANCE

The farmers existing cropping patterns are those based upon years of experience, observation and socioeconomic circumstances. Two relatively simple tests were used for comparing experimental cropping patterns with that of the farmer. The comparisons, however, were no substitute for farmers' carefully recorded comments about experimental patterns. A simple cost-and-return analysis and some common performance criteria such as returns above variable costs (RAVC) and returns to selected production factors (labour and material costs) are presented in Table 7.

Zandstra et.al. (1981) suggested that experimental technology whose RAVC is not at least 30% greater than that of the prevalent farmers' pattern has doubtful promise for farmer adoption. The RAVC for B + 2D + 3C, B + 3D, B + 3D + 4C was 16%, 30% and 20% respectively, higher than B + 2D (control) which means that only B + 3D passed the first criterion. However, this tests' reliability rested on the assumption that farmers wish to increase their returns above variable cost. The simple RAVC 30% rule, could be misleading if a new experimental pattern, while offering 30% higher net returns, offers a lower rate of return on additional cost than a prevalent farmers' pattern.

To overcome this error, a second test was used based upon the marginal benefit-cost ratio (MBCR). The MBCR for B + 2D + 3C, B + 3D and B + 3D +4C was 4.7, 4.5 and 2.4, respectively as compared to B + 2D (control) indicating that the marginal returns were not proportional to marginal costs in the last cropping pattern. In addition, this pattern also failed the 30% rule. Farmers have the option of selecting either B + 2D + 3C or B + 3D. Though the pattern B + 2D +3C was only 16% more profitable than B + 2D, provision of a protein-rich food and increase in N status of soil may encourage farmers to accept a profit incentive lower than 30%. The cropping pattern B + 3D could prove more attractive to farmers because it resulted in a RAVC greater than 30% and MBCR close to B + 2D + 4C. Nevertheless, this pattern had de limitation of lacking a grain legume which could provide a cheap protein-rich food and improve Soil N.

These cropping patterns should be further evaluated. The final acceptance of a cropping system will depend inter alia on the market, location, availability of inputs and farmers' choice.

Table 7: Partial budget and a test of system acceptability of alternatives for banana + 2 dasheen in Fond Assau (St. Lucia)

PARTICULARS	CROPPING SYSTEMS			
	B + 2 D	B + 2 D + 3 C	B + 3 D	B + 3 D + 4 C
Yield (t/ha)				
i Banana (Less 15% rejects)	25.50	25.93	24.74	24.82
ii Dasheen	7.6	7.5	13.1	9.8
iii Cowpeas	-	0.46	-	0.49
Gross returns ($/ha)				
i Banana ($550/t)	14,025	14,261	13,607	13,651
ii Dasheen ($1100/t)	8,360	8,250	14,410	10,780
iii Cowpeas ($5940/t)	-	2,732	-	2,910
Total (A)	22,385	25,243	28,017	27,341
Labour Cost ($/ha) (B)	4,011	4,511	4,259	4,925
Material Cost ($/ha) (C)	3,928	4,030	4,925	5,043
Total variable costs ($/ha) (D)	7,939	8,541	9,184	9,968
Returns above variable costs (RAVC) ($/ha) (A-D)	14,446	16,702	18,833	17,373
Rate of return to variable costs ($/$) (A $\div$ D)	2.82	2.96	3.05	2.74
Returns to labour costs ($/$) $\frac{(A - C)}{B}$	4.60	4.70	5.42	4.52
Returns to material costs ($/$ $\frac{(A-B)}{C}$	4.68	5.14	4.82	4.44
Marginal Cost ($/ha) (E)	-	602	1,245	2,029
Marginal returns ($/ha) (F)	-	2,858	5,632	4,956
Marginal Benefit-Cost Ratio (MBCR) for replacing B + 2D (F $\div$ E)	-	4.7	4.5	2.4

ACKNOWLEDGEMENTS

The authors are thankful to the International Development Research Centre of Canada for funding Cropping Systems Project at WINBAN and making our attendance possible at this meeting. We are also grateful to Messrs H. George and C. Flavius and Miss M. Polimus for their assistance and to those farmers on whose holdings the experimental plots were set up for their co-operation and willingness to provide land and other inputs.

LITERATURE CITED

Chacko, E. K. and Reddy, A. (1981) Effect of planting distance and intercropping with cowpea on weed growth in banana. Proc. 8th Asian-Pacific Weed Sci. Soc. Conf. pp. 137-142.

Devos, P. and Wilson, G.F. (1979). Intercropping of plantains with food crops: maize, cassava and cocoyams. Fruits 34: 169-174.

Fongyen, A. D. (1976). The problems of plantain production in Cameroon. Fruits 31: 692-694.

Gómez, K.A. (1977) On-farm testing of cropping systems. In Sumposium on Cropping Systems Research and Development for the Asian Rice Farmer. The International Rice Research Institute, Phillippines, 1977 pp 227-239.

Henderson, T. H. and Gomes, P. I. (1979). A profile of small farming in St. Vincent, Dominica and St. Lucia. Report of a baseline survey. Dept. Agric. Ext. Faculty of Agric. U.W.I. St. Agustine, Trinidad.

Maddineni, M.R. and Edmunds, J.E. (1982) Studies on banana intercropping with different food and vegetable crops in the Windward Islands. A paper presented at the 18th Annual Caribbean Food Crops Society Meeting held in Barbados from the 22nd to 27th August, 1982.

Rao, M.M. and Edmunds, J.E. (1983). Intercropping of banana with food crops: Cowpeas, Maize and Sweetpotato. Trop. Agric. (Trinidad). In Press.

Ruthenberg, H. (1976). Farming Systems in the Tropics. 2nd. Ed. Clarendon Press, Oxford, 1976

WINBAN (1981). Banana Growers' Manual (Summary) June, 1981

Zandstra, H. G., Price, E. C., Litsinger,J.A. and Morris, R. A. (1981). A methodology for on-farm cropping systems research. The International Rice Research Institute, Philippines, 1981.