Intercropping of plantains with food crops: maize, cassava and cocoyams.

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RESUME - Dans les systèmes de production locaux, les plantains sont cultivés en association à d'autres plantes vivrières. Cependant, en dépit de l'usage très commun de cette pratique, aucune étude expérimentale sérieuse sur les cultures mixtes comprenant les plantains n'est rapportée . Pour combler cette lacune, quelques-unes des combinaisons les plus fréquentes comportant le plantain ont été comparées au plantain en culture pure.

Les poids des régimes de plantain n'étaient pas abaissés lorsque les autres cultures étaient du macabo, et des combinaisons de maïs et de manioc. La réduction de population de plantains, pour qu'ils s'accommodent des autres productions, affecte négativement le revenu économique. La combinaison plantain-macabo a eu une utilisation de main-d'oeuvre moindre et un revenu le plus élevé. La performance médiocre du manioc fait penser qu'il n'est pas adapté à des associations avec le plantain.

INTRODUCTION

Plantain (*Musa*, AAB group, plantain subgroup (SIMMONDS, 1966) is an important carbohydrate source over large areas of the humid tropics of Africa and America. Traditionally, all plantains are intercropped and even now a large proportion are grown in various multiple cropping systems. Although there are several technical advantages in an intensified sole cropping system (CHAMPION, 1976), a considerable group of farmers keep on growing other food crops among their plantain stands in order to have extra food or cash return. Moreover, in Puerto Rico, where half of the plantain farmers still practice mixed cropping, an economic survey showed that fruit yields of intercropped plantation were only slightly less than in the sole cropped fields (ESPINET COLON et al, 1973).

Food crops observed in combination with plantain include maize (JURION and HENRY, 1967 ; KARIKARI, 1972), cocoyam (ESPINET COLON et al, 1973 ; KARIKARI, 1972 ; RUDDLE, 1974) and cassava (KARIKARI, 1972 ; MULLER, 1947 ; RUDDLE, 1974).

Other crops mentioned are vegetables, rice, beans, yams and sugarcane (OKIGBO and GREENLAND, 1976 ; KARIKARI, 1972 ; RUDDLE, 1974 ; VAN SANTEN, 1974).

In spite of these observations there appear to have been no tangible experimental studies on multiple or mixed cropping system involving plantains. Consequently, little is known of plant interactions, yields and economic returns of crop mixtures in which plantain is a major component. An attempt has been made to fill this gap through a series of experiments aimed at quantifying the productivity, establishing relationships and determining methods of increasing

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yields of the crops in plantain intercropping systems. This report covers a preliminary experiment to study the effects of cocoyam (*Xanthosoma sigittifolium* SCHOTT.) and combinations of maize (*Zea mays* L.) and cassava (*Manihot utilissima* POHL) as intercrops on plantain yield in the first cycle.

MATERIALS AND METHODS

The trial was established at the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria,in August 1976 at the beginning of the late rains. Treatments were (1) plantain as sole crop, (2) plantain with cocoyam, (3) plantain at normal density with maize and cassava and (4) plantain at low density with maize and cassava. Spacings for the plantain are shown in Table 1.

The plantain variety used was the «False Horn» type (cv. 'Libanga' DE LANGHE, 1961), which is commonly grown all over West Africa and tropical America. The cocoyam was collected from farmers' fields. The maize variety TZPB is an improved cultivar developed at the International Institute of Tropical Agriculture (IITA, 1977). The cassava was a local variety named 'Isunikakiyan'. The experiment was laid out in a randomized complete block design with four replications on a total area of 5700 m^2.

The plantain was planted in holes 40 cm deep and 30 cm wide, filled with topsoil. Maize and cocoyam were planted immediately after, but cassava was planted six weeks later. All intercrops were planted 1m x 1m apart, the maize at 2 - 3 plants per hill.

In the first year the plantain received fertilizer at the rate of 1000 g NPK 15:15:15 per plant split into 10 equal applications.Maize was fertilized with 400 kg/ha of NPK 15:15:15 before planting and an additional 100 kg/ha of ammonium sulphate after four weeks. Insecticide (Sevin) was applied three times to the maize at a rate of 1000 g a.i/ha. In sole cropped plantain weeds were controlled with a contact herbicide (Paraquat). How weeding was used in the other treatments until after the harvest of the intercrops, when herbicide was used. Weekly irrigation was applied to the trial during the dry season (December - March).

Maize was harvested after 110 days, artificially dried and shelled by hand. Cocoyam was harvested after nine months. Cassava was harvested after twelve months. Monthly records were kept of plant size of plantains. Records were also taken of shooting date, plant height, girth at 100 cm and height of the biggest sucker at shooting. At harvest the dimensions of the fifth leaf, bunch weight and number of fruits were recorded. Means were calculated from the 75 % of the plants that flowered first. Plantain yields per hectare were then determined on a mean bunch weight basis. Labour used on each operation during the first year was recorded and calculated in mandays/ha.

RESULTS AND DISCUSSION

1. Yields.

Yields of the different crops involved are given in Table 2. As expected, plantain yields were lowest in treatment 4 where the planting density was halved but the mean bunch weight was slightly higher than that of the control. In the high density treatments yield of the pure stand was lowest, but not significantly lower than any of the others.

The cocoyam yielded about 3 tons per hectare. Maize yields with a mean stand count of about 16000 plants per hectare, were 2.94 and 3.35 t/ha for treatment 3 and 4, respectively. Yields were not significantly reduced by dense spacing of the plantains. Cassava yield in the closely spaced plantain was exceptionally low. Shading by plantains appears to be the cause of the yield reduction. Between the widely spaced plantains, light penetration was better and cassava yield was proportionately higher.

TABLE 2 - Plantain Intercropping : yields (t/ha)

Treatment	1	2	3	4
Plantain	17.5b*	18.2b	18.7b	9.8a
Cocoyam	-	2.96	-	-
Maize	-	-	2.94	3.35
Cassava	-	-	2.58a	10.24b

* - Means in each row followed by the same letter are not significantly different at the 5 % level using Duncan's Multiple Range Test.

TABLE 1 - Plantain intercropping : treatments.

Treatment No.	Crop combination	Plantain planting distances
1	Plantain	2 x 3 m
2	Plantain-cocoyam	2 x 3 m
3	Plantain-maize-cassava	2 x 3 m
4	Plantain-maize-cassava	2 x 6 m

Photo 1. The plantain - cocoyam crop combination.

Photo 2. The plantain - maize - cassava cropping system.

TABLE 3 - Plantain performance.

Treatment Intercrops	1 -	2 cocoyam	3 Maize-cassava	4 Maize-cassava
Days to 50 % shooting	267ab*	356a	279bc	283c
Days to 50 % harvest	375	355	394	394
Plant height at harvest (cm)	336a	367b	387b	361ab
Leaf ratio (lenght/width)	2.78	2.83	3.02	2.89
Height of following sucker at shooting (cm)	140	131	114	112
Bunch weight (kg)	10.5a	10.9ab	11.2ab	11.7b
Yield (t/ha)	17.5b	18.2b	18.7b	9.8a

* - Means in each row followed by the same letter are not significantly different at the 5 % level using Duncan's Multiple Range Test.

2. PLantain Performance.

The effect of the intercrops on plantain development and performance is shown in Table 3. Compared to plantain in pure stand, average plantain height was about 30 cm taller when interplanted with cocoyam and 50 cm taller when interplanted with maize and cassava. Yields followed the same pattern although yield increase was not proportional to the increase in plant size. Since taller plants are much more subject to wind damage (STOVER, 1972), the occurrence of larger plants without significantly higher yields may be considered a serious disadvantage.

On the average shooting occurred 10 days earlier for plantain interplanted with cocoyam than for plantain in pure stand and about 25 days for plantain intercropped with maize and cassava. These differences were accentuated at harvesting time. Height of biggest sucker at shooting indicated, but not significantly, a delay in growth of the ratoon crop in plantain intercropped with maize and cassava. Bunch weights were highest where plantain was intercropped with maize and cassava : however, average bunch weights were only slightly higher than for plantain in pure stand. Yield per hectare followed the same pattern as bunch weight except in treatment 4 (plantain - maize - cassava with widely spaced plantain) where low yield reflected the low plantain population.

3. Labor Requirements.

Labor requirements were calculated in mandays per hectare from actual working time recorded in the field. An attempt was made to partition total labor requirements into the components related to specific needs for each crop (Table 4). Some very interesting differences were observed in the amount of labor devoted to weeding. In one hectare of plantain in pure stand, one ring-weeding around the plantain and seven herbicide applications still required 89 mandays per hectare in the first cycle. In the plantain cocoyam combination two weedings, after which the cocoyam with

TABLE 4 - Plantain Intercropping : labor distribution

Treatment	Plantain	Plantain-cocoyam	Plantain (close)-maize-cassava	Plantain (wide)-maize-cassava
	Mandays/ha			
Land clearing	25	25	25	25
Plantain : planting, fertilizing and harvesting	77	77	77	40
Cocoyam : planting and harvesting	-	94	-	-
Maize : planting, fertilizing and harvesting	-	-	71	71
Cassava : planting and harvesting	-	-	94	94
Weeding or herbicide application	89	70	128	128
Total :	191	266	385	348

TABLE 5 - Plantain Intercropping : input-output balance (US$/ha)

Outputs	Treatments 1	2	3	4
Plantain @ $ 240/t	4200	4370	4490	2350
Cocoyam @ $ 240/t	-	710	-	-
Maize @ $ 200/t	-	-	590	670
Cassava @ $ 80/t	-	-	210	820
Seed	100	160	170	120
Total	4300	5240	5460	3960
Inputs				
Labor @ $ 4/day	765	1065	1540	1390
Seed	100	160	180	130
Tools	65	40	65	65
Fertilizer @ $ 255/t and pesticides	440	340	510	340
Supporting stakes @ $ 0.15 each	150	150	150	80
Irrigation ($ 2000/5 year and labor)	670	670	670	670
Total	2190	2325	3115	2675
Balance	2110	2915	2345	1285

its dense canopy shaded out all weeds, were sufficient. During cocoyam harvest, weeds present were removed by hand. This kept the field clean until the end of the first plantain cycle. In plantain interplanted with maize and cassava, two weedings were necessary for maize, and two more for cassava. In terms of labor, discounting the time required for planting and harvesting, the plantain-cocoyam combination was the most efficient. The highest amount of labor for weeding was required b- the plantain-maize-cassava combination.

4. Input - Output Relationships.

This economic evaluation is a very rough outline of cost and revenue per hectare of second season planted crops with about five months of irrigation during the main dry season. The most subjective item, the cost of irrigation per hectare was drawn from MELIN and PLAUD (1975) and inflated with a factor of 2. All outputs were calculated at wholesale prices, estimated as half the current retail prices.

A summary of the input-output balance is given in Table 5. Main emphasis should be put on labor cost which amounted to 37 % of the total input for plantains in pure stand, 45 % for the plantain-cocoyam combination, 49 % and 52 % for plantain with maize and cassava at high and low plantain densities respectively.

Gains were highest for the plantain-cocoyam crop combination, where outputs were 225 % of the inputs. They were lowest for low density plantain interplanted with maize and cassava. The crop prices used for determining the revenue are seasonal, thus the total income from the crop combination depends on prevailing prices.

CONCLUSION

Plantain yields were not suppressed by any of the crop combinations tested but for some reasons certain combinations may not be recommended. The poor performance of the cassava indicated its unsuitability for this cropping system, as yields were not enough to compensate for the extra labor required. It appears that a maize-plantain combination without cassava would be feasible. This agrees with the general observation in intercropping that the wider the competition gap between two crops in the mixture the closer the yields are to the sole crop yields (ANDREWS, 1970).

Reducing plantain density to facilitate maize and cassava is not worthwhile as yields and prices of these crops compared to those of plantain resulted in lower income to the farmer.

Plantain with cocoyam appears the ideal combination. The labor input and cost of production is relatively low and returns are high.

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