Farmers' use of Banana instead of Plantain as Shade Crop in Cocoa Establishment: A Case of Cross River State, Nigeria

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Abstract: The study focused on why farmers use banana shade crop instead of plantain for cocoa establishment. A systematic simple random sampling technique was used to select 120 cocoa farmers from four villages in two Local Government Areas of Cross River State, Nigeria. Descriptive and inferential statistics were used to analyze the data collected. Results revealed that the mean age of farmers was 42 with farming experience of 15-21 years. Most of the farmers were youths who had secondary education which is a good factor in adoption of technology. Information on cocoa farm establishment was sourced by 63% of the farmers mainly from fellow farmers. Majority (71.7%) used banana as shade crop regularly in planting cocoa in their farms while 44.2 % adopted plantain which CRIN recommended. Farmers use more of banana shade crop due to its high economic benefits and weather related reasons. They believe that the practice does not economically restrict the growth and yield of cocoa. Soil analyses showed that soil nutrient and acidity levels in areas planted with banana/plantain were similar. Plant-parasitic nematodes distribution was not different in places where banana/cocoa and plantain/cocoa intercrops were planted. The literacy level of farmers had significant influence on the use of banana shade crop. The study recommends that farmers should be educated on good farm management practices that could enhance yield and income. Research on the use of banana suckers in young cocoa farms should be revisited by farming system scientists to cope with the current adoption of banana shade crop in Cross River State.
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1.0 Introduction

Cocoa is an important cash crop which is mainly produced by small-scale farmers in Nigeria. It contributes significantly to the Gross Domestic Product of the country. In 2014, cocoa beans export contributed $666.45m being the highest non-oil export earner in Nigeria (Ejiofor, 2014). It provides employment and income for over 200,000 households in areas of the country that grow the crop (NCDC, 2008). Cocoa is used in the production of cocoa powder, chocolate, beverages, wine, bread, butter and other products. Cocoa is grown in the field with shade crops because it requires shade for survival at the early period of production. Different shade crops are used by farmers but must be used according to recommendations in order to preserve the soil. Plantain was recommended as shade crop for cocoa establishment by CRIN in Nigeria. Farmers in Cross River State currently use Banana as shade crop. Over the past decade, global production of bananas has increased by over 40%. Some of the most marked changes have occurred in Asia. Production has increased by 83% in China, 73% in the Philippines and 87% in India (FAOSTAT, 2012).

Banana is grown in nearly 130 countries. Uganda is the largest producer of banana and plantain in Sub-Saharan Africa (SSA), followed by Rwanda, Ghana, Nigeria, and Cameroon (IITA, 2009). Banana and plantain are high yielding and form integral component of farming systems in these regions. Banana is much difficult to eradicate than plantain after establishment. It occupies a lot of space in cocoa farms unlike plantain. In the initial stages of cocoa establishment from one to two years, the appropriate combination of food crops like plantain, cassava, maize, etc. may provide cocoa seedlings with the much needed temporary shade, windshields and reduce competition from weeds since food crops grow faster than trees. It also provides income and food for the household until the main cash crop is ready for harvest (Asare, 2006). However, the food crops grown should not have negative effect on the main crop so as to perform optimally.

Research efforts that will ensure cocoa sustainable production at the early stage of establishment are seen as a step in the right direction. The provision of shade using the proper material remains sacrosanct for the survival of young cocoa in the field. Therefore, this research is necessary in order to know why farmers change to banana and other shade crops for establishing new cocoa farms. The study provides information on effects of the practice

on the soil where cocoa is planted by farmers. This will be used to improve cocoa farming systems in Nigeria.

1.1 Objective of the study

The main objective of the study is to assess why farmers in Cross River State use banana as shade crop instead of plantain for cocoa establishment.

The specific objectives are to:

1. describe cocoa farmers' selected socio-economic characteristics;
2. identify farmers' sources of information about cocoa farm establishment.
3. determine the type of shade crops that farmers use during new establishment of cocoa in the study area;
4. ascertain the reasons why farmers use such shade crop(s) in the establishment of cocoa in the study area;
5. examine whether the establishment of cocoa with banana restricts its growth economically and
6. examine the effect of banana/plantain as shade crops on soil nutrient status and nematode association.

1.2 Hypothesis: There is no significant relationship between selected cocoa farmers' socio-economic characteristics and banana/plantain shade crops used in young cocoa farm establishment.

2.0 Methodology

The study was carried out in Cross River State (CRS) of Nigeria. This was purposively selected because the use of banana as shade crop in establishing cocoa is predominant in the State. Two Local Government Areas (LGAs) noted for cocoa production were selected. These include Boki and Etung. From each LGA, two villages: Biakwan and Orimekpang (Boki, LGA) Effraya and Ajassor in (Etung, LGA) where cocoa is well produced, were selected to make four villages. Forty farmers each were selected in two villages and twenty each from the other two villages to make a total of 120 respondents using simple random sampling technique. A list of cocoa farmers in the two LGAs selected was obtained from the Tree Crop Unit (TCU) in the State Ministry of Agriculture. A structured interview schedule instrument was used for field data collection from cocoa farmers in the study areas. The data were analyzed with descriptive and inferential statistics.

2.1 Collection of soil sample: Soil and root samples were collected from the rhizosphere region about 50-70 cm from the base of the plants and at a depth of 20 cm in Biakwan and Effraya cocoa growing communities. This was to determine the nutrient status and nematode association with the crops. Two adjacent cocoa plantations (one with banana as shade crop and the second with plantain as shade crop) situated in Lat 5^0 52.4^1 and Long. 8^0 44.4^1 were selected. The plantations were both 4 years old and about 0.5 hectares each. Ten core soil samples were randomly collected from each of the plantations and bulked into two composite soil samples. Two adjacent cocoa plantations of age 3 located in Lat 6^0 5.8^1 and Long. 8^0 55.2^1 were selected in Biakwan in Boki local government of Cross River state. Ten core soil samples were also collected randomly from each of the plantations to generate two composite samples. The four composite soil samples collected were properly labelled, processed and analyzed in the laboratory for some of their physical and chemical properties according to methods earlier described under analytical procedure (IITA, 1979).

2.2 Processing of soil and root samples: Aliquots of $250cm^3$ sub-sample soil from $500cm^3$ each composite sample were assayed for nematodes by sieving and decanting (Cobb, 1918). After decanting, the sediment was assayed for nematodes using the Whitehead & Hemming (1965) tray modification of Baermann (1917) technique as described by Coyne *et al*. 2007. The root samples were washed, pooled, chopped into approximately 1-cm-pieces and thoroughly mixed. A 5g sub-sample was put in 100ml water in a kitchen blender. The root was macerated 3 times for 10 seconds, separated by 5 seconds intervals, and the nematodes were extracted from the resulting homogenate using sieve method (Speijer and De Waele, 1997). The nematode suspension was diluted with water in a graduated cylinder to 10ml.

Prior to counting, solution containing nematodes were agitated thoroughly and nematode populations were determined in 1 ml distilled water suspension in a counting dish (Doncaster, 1962) under a stereomicroscope and expressed per $250cm^3$ soil or 5 g roots. A mean of 3 counts was taken in each case. Nematodes were transferred with an eye lash picker to a slide with a drop of water, covered (with a cover slip) and examined under a compound microscope with a 40, 60 and 100X objective for identification using taxonomic keys (Hunt *et al.*, 2005) and counted. The identification and counting was repeated three times and mean population of nematodes/sample calculated.

3.0 Results and Discussion

Socio-economic characteristics of cocoa farmers

The result in Table 1 revealed that cocoa farmers were more of males than females and majority (82.5%) of them being married. They had more of secondary education which is a good factor in adoption of technology. The youths (51.0%) having in

between 32 and 43 years had the highest educational group. It means that young people were involved more in cocoa production than old ones in Cross River State of Nigeria. The result also showed that the mean age of farmers was 42 years and 27.5% of the cocoa farms were between 10-13 years old with a mean of about 14 years. It suggests that most of the farmers and farms were still in their productive age while those farms of less than 9 years were 30%. It indicates that there are potentials in cocoa production and young cocoa farms exist in the study areas. About 38% of the farmers had farming experience of 15-21 years while a lesser proportion (9.2%) had 1-7 years. It means that most of them had long years of farming experience in cocoa production in Cross River State. Some of the results disagree partly with the study of Adebiyi *et al* (2013) which reported ageing and non formal education of cocoa farmers in Oyo State. They however agreed that male dominated cocoa production and farmers had long years of farming experience.

Table 1: Selected farmers' socio-economic characteristics N=120

Variables	Frequency	Percentage	Mean
Sex			-
Male	97	80.8	
Female	23	19.2	
Marital status			-
Married	99	82.5	
Single	21	17.5	
Educational status			-
Primary	30	25.0	
Secondary	68	56.7	
Tertiary	22	18.3	
Age of farmers in Years			41.5
20-25	6	5.0	
26-31	13	10.8	
32-37	26	21.8	
38-43	35	29.2	
44-49	22	18.3	
50 & above	18	15.0	
Farming experience in years			16.9
1-7	11	9.2	
8-14	36	30.8	
15-21	45	37.5	
22-28	16	13.3	
29 and above	12	10.0	
Age of cocoa farms in Years			13.5
2-5	12	10.0	
6-9	25	20.0	
10-13	33	27.5	
14-17	17	14.2	
18-21	24	20.0	
22 and above	9	7.5	

Source: Field survey, 2015

Farmers' sources of information about cocoa farm establishment

The distribution of farmers' sources of information on cocoa farm establishment shows that about 63% of farmers obtained information from fellow farmers compared with other sources such as Agric extension agents, CRIN, cocoa buyers, farmers' association and non-governmental organization (Table 2). It means that fellow farmers constitute the major source of information for the cocoa farmers. CRIN and extension agents should be encouraged to enlighten farmers regularly on Good Agricultural Practices (GAP). This will go a long way in updating their Knowledge Attitude and Practice (KAP) which aid adoption of technology innovation. This result is supported by (Dankwah *et al* 2014). They reported that cocoa farmers sourced their production information from friends, relatives and neighbours.

Table 2: Distribution of farmers' sources of information on cocoa farm establishment

Information sources	Frequency	Percentage
Cocoa buyers	7	5.8
CRIN	12	10.0
Fellow farmers	75	62.5
Agric extension agents	18	15.0
Farmers' association meeting	5	4.1
Non-governmental organization	3	2.5
Total	120	100

Source: Field survey, 2015

Type of shade crops used by farmers in establishing young cocoa plants

From Table 3, most farmers (71.7%) used banana as shade crops regularly in planting cocoa in their farms while 44.2% adopted plantain which was CRIN recommendation. A few of them used cassava in the process of establishment. It means that banana had really taken over plantain in establishing new cocoa farms in the study area. Asare (2006) and Yakah (2012) reported that cocoa is intercropped with banana, plantain and cassava as shade crops and provide revenue for the farmers during early establishment.

Table 3: Distribution of shade crops used by farmers in establishing young cocoa N=120

Shade crops used	How regular, Never	Occasionally	Always
Banana suckers	10 (8.3)	24 (20.0)	86 (71.7)
Plantain suckers	-	67 (55.8)	53 (44.2)
Plantain-Banana	50 (41.6)	38 (31.6)	33 (27.5)
Cassava	48 (40.0)	57 (47.5)	15 (12.5)
Economic trees	22 (18.3)	78 (65.0)	20 (16.7)

Source: Field survey, 2015; Figures in parentheses are percentages

Reasons why farmers use banana shade crops to establish cocoa

The results in Table 4 shows that the major reasons why farmers use banana as shade crops in establishing cocoa are economic and weather related. It was found that banana is more profitable than plantain and it sustains cocoa better than plantain during dry season. The work of Dand (1997) pointed out that cocoa growers used banana and plantain to give extra shade to the young cocoa plants and for economic gains. Also, Nwaiwu *et al* (2012) reported that the economic importance of plantain and banana makes the crops invaluable in a country like Nigeria where health, nutrition and dietary implications of foods are of top priority in most intellectual discourse.

Table 4: why farmers use banana shade crops to establish cocoa N=120

Reasons	Frequency	Percentage
Banana business is more profitable than plantain		
Yes	116	96.7
No	4	3.3
Banana lasts longer than plantain in cocoa farm		
Yes	105	87.5
No	15	12.5
Banana sustains cocoa better than plantain during dry season		
Yes	110	91.7
No	10	8.3

Source: Field survey, 2015

Shade crops with highest market demand

Banana fruit bunches (72.5%) had the highest market demand with plantain coming behind having 20%. It means that banana is having more economic benefit than plantain in the study area (Fig. 1). This could be attributable to part of the reasons why farmers use more of banana as shade crops to establish cocoa farm.

Price sold for a bunch of banana and plantain

In table 5, almost half of the farmers (49.1%) sold a bunch of banana for between ₦500 to ₦700 at farm gate while plantain was about 47% of the same price

range. Those who sold above ₦700 for banana was about 26 %. The implication is that banana has more economic potentials than plantain in the market. Farmers would want to establish their cocoa farm with banana instead of plantain due to its profitability. This explains why banana suckers were used as shade crops in young cocoa farms. Royal farms (2014) supported this findings that in Nigeria a bunch of banana sells for between ₦700 to ₦1,500 and could be more than this amount during period of scarcity.

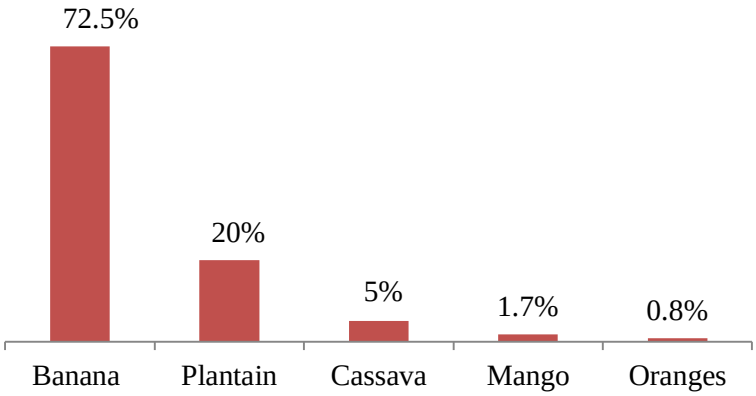

Fig. 1: Shade crops producing fruit bunches/yield with highest market demand

Figure 2: Picture showing type of banana bunches from the banana planted as shade crop within cocoa plot

Table 5: Distribution of price sold for a bunch of banana and plantain

Price/bunch (₦)	Frequency	Percentage
Banana		
200-400	30	25.0
500-700	59	49.1
800-1,000	26	21.7
1,100-1,300	2	1.7
1,400-1,600	3	2.5
Plantain		
200-400	23	19.2
500-700	56	46.7
800-1,000	28	23.3
1,100-1,300	3	2.5
1,400-1,600	10	8.3

Source: Field survey, 2015

Farmers' belief whether establishing cocoa with banana suckers economically restricts growth and development of cocoa

Cocoa farmers in Cross River State believe that the establishment of cocoa with banana suckers does not economically restrict its growth and development. A larger proportion (74%) indicated that the practice does not disturb cocoa while about 26% believes banana suckers will disturb it (Table 6).

Table 6: Distribution of farmers' believe weather establishing cocoa with banana suckers restricts growth and development of cocoa

Farmers' response	Frequency	Percentage
Yes	31	25.8
No	89	74.2
Total	120	100

Source: Field survey, 2015

Effect of banana shade crop on cocoa yield of farmers

A lot of farmers (72.5%) observed that there is no effect on the yield of cocoa when planted with banana as shade crops while a few said there was effect (Fig. 2). This claim was verified with the results of soil samples collected (Table 7). It shows that the acidity, nitrogen, potassium and phosphorus in soil planted with banana and plantain as shade crop for cocoa were similar.

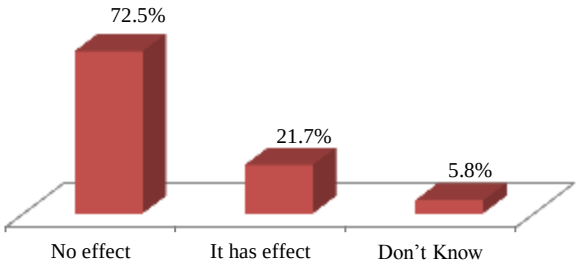

Fig. 2. Distribution of farmers' observation on effect of banana shade crop on cocoa yield N=120

Table 7: Soil properties of cocoa plantations with banana/plantain as shade crops

Soil properties	B/C(Effraya)	P/C(Effraya)	B/C(Biakwan)	P/C(Biakwan)
pH	6.81	5.56	5.45	5.48
O.C (g/kg	17.7	20.6	16.5	16.7
N (g/kg)	1.3	1.6	1.4	1.2
P (mg/kg)	4.54	2.87	4.21	5.50
K (cmol/kg)	0.64	0.24	0.35	0.33
Ca (cmol/kg)	41.26	26.38	26.27	33.01
Mg (cmol/kg)	3.92	2.83	2.21	2.28
Na (cmol/kg)	1.22	0.46	0.69	0.66
Exch. Al (cmol/kg)	0.08	0.13	0.06	0.07
ECEC(cmol/kg)	47.12	30.04	29.58	36.35
Base saturation (%)	99.83	99.57	99.80	99.81
Mn (mg/kg)	323.8	111.6	53.6	393.2
Fe (mg/kg)	3.70	27.65	28.70	14.90
Cu (mg/kg)	0.50	2.45	0.75	1.85
Zn (mg/kg)	7.10	7.55	5.25	15.10
Sand (g/kg)	844	814	862	872
Silt (g/kg)	94	104	76	66
Clay (g/kg)	62	82	62	62

Key: B/C: Banana/Cocoa; P/C: Plantain/Cocoa; Source: Field survey, 2015

Effect of banana/plantain as shade crops for cocoa on soil nutrient status and nematode association

a. Evaluation of the soil properties of cocoa plantations with banana/plantain as shade crops

The soil pH values of the cocoa plots shaded with plantain and those shaded with banana in both locations were slightly acidic ranging from 5.45 and 5.81 (Table 7). There was no marked difference between the pH of the soils of the two locations shaded with either banana or plantain.

The nitrogen contents of the cocoa plots in the two locations were also similar irrespective of the shade crops. The nitrogen contents of the soils were above the critical values of 0.9g/kg required for cocoa under the two shade crops as earlier reported by (Egbe *et al* 1989).

Available soil phosphorus in the cocoa plot shaded with banana was about 37% higher than what obtained under plantain in Effraya. However, in Biakwan available soil phosphorus under plantain (5.5mg/kg) was higher than the values obtained under the plot shaded with banana (4.21mg/kg). The available soil phosphorus under the two shade crops and in both locations as indicated in Table 7 was grossly below the critical values required for cocoa (Egbe *et al* 1989).

Exchangeable potassium was consistently higher under banana shaded cocoa in the two locations. However, it was about 62.5% higher in Effraya and was only slightly higher (5.7%) in Biakwan. Exchangeable calcium and magnesium soil contents under both shade crops and in the two locations were adequate and above the critical values required for cocoa. The soil contents of micronutrients (Zn, Fe and Cu) were also similar under the two shade crops (Table 7).

b. Association of plant-parasitic nematodes on cocoa/plantain and cocoa/banana intercrops

Six genera of plant-parasitic nematodes were found associated with cocoa/plantain and cocoa/banana intercrops in Biakwan and Effraya cocoa growing communities of Cross River State. *Meloidogyne* spp., *Radopholus* spp., and *Pratylenchus coffeae* were widespread in all the locations irrespective of whether the shade crop is banana or plantain, while *Helicotylenchus* spp. was widespread only in Biakwan. *Rotylenchulus reniformis* was common in all locations, while the frequency of *Xiphenema* spp. was low (Table 8). *R. similis* together with *P. coffeae* are amongst the most important biotic constraints of banana and plantain in Nigeria (Coyne *et al*., 2007). *Meloidogyne* spp., though initially multiplied at the first cycle, remained at low population density during the ratoon crops (Orisajo *et al*., 2012). Similar observation was made by Rotimi (2003) during the first crop cycle. The use of banana as shade crop instead of plantain did not change nematode distribution on the intercrops.

Table 8: Distribution of plant parasitic nematodes associated with Cocoa /Plantain; Cocoa/Banana intercrops in selected locations of Cross River State of Nigeria

Nematode species/ Location	Biakwan Cocoa /Plantain	Biakwan Cocoa/Banana	Effraya Cocoa /Plantain	Effraya Cocoa/Banana
Meloidogyne spp.	+++	+++	+++	+++
Radopholu sspp.	+++	+++	+++	+++
Helicotylenchus spp.	+++	+++	++	++
Pratylenchus coffeae	+++	+++	+++	+++
Rotylenchulus reniformis	++	++	++	++
Xiphenema spp.	+	+	+	+

+ = present; ++ = common; +++ = widespread; Source: Field survey, 2015

Table 9: Analysis of relationship between selected cocoa farmers' socio-economic characteristics and banana/plantain shade crops used for young cocoa establishment

Socio-economic variables with Banana	df	χ^2 value	Contingency coefficient	P value
Educational status	2	12.63	0.309	0.002*
Membership of farmers association	2	2.97	0.161	0.227
Socio-economic variables with Plantain				
Educational status				
Membership of farmers association	2	1.59	0.114	0.453
	2	2.21	0.140	0.332

Source: Field survey, 2015

Testing of hypothesis

The result of chi-square analysis in Table 9 shows that a significant relationship existed between educational status (χ^2=12.63, < 0.05) and banana shade crop. Membership of farmer's association was however not significant. The implication of this is that the literacy level of farmers had significant influence on the use of banana shade crop in cocoa farm establishment. These variables were not statistically significant with the use of plantain as shade crop.

4.0 Conclusion and recommendation

Based on the findings of the study, the following conclusions were made:

1. Male farmers dominated cocoa production and most of them were married. Many of them attended secondary school and were experienced in cocoa farming.
2. Majority of farmers use banana suckers as shade crops to establish young cocoa farm while lesser proportion adopted plantain which was CRIN recommendation.
3. The reason for adoption was that banana business is more profitable than plantain.
4. Fellow farmers constituted the major source of information about cocoa farm establishment.
5. Cocoa farmers observed that the use of banana suckers in establishing cocoa did not have any significant effect on growth and yield of cocoa.
6. Soil analyses revealed that soil nutrient and acidity levels in areas planted with banana/plantain were similar. Plant-parasitic nematodes distribution were not different in places where both banana/cocoa and plantain/cocoa intercrops were planted.

The study recommends that farmers using banana should be educated on good farm management practices that could enhance yield and income. Research on the use of banana suckers as shade crops in cocoa farm should be revisited by farming system scientists to cope with the current adoption of banana shade crop in Cross River State.

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