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Experimental Title: Effects of Organic Amendments on Establishment, Growth and Yield of Cocoa (*Theobroma cacao* L) in Southwestern Nigeria

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Introduction

Cocoa is one of the most important tropical crops (FAOSTAT, 2014) and West Africa contributes about 70% of the world's cocoa production. The crop significantly contributed to the economies of countries in this sub-region, as well as economies of many other countries in Central America and Southeast Asia. Nigeria is the fourth largest producer of cocoa in the world with an estimated production of 485,000 metric tons in 2006 (FAOSTAT, 2014). Cocoa is therefore a major commodity crop cultivated in Nigeria and a major raw material used in the production of cocoa powder for beverage drink, various chocolate-based products, biscuits and confectioneries. Processed cocoa beans are also used to make sweets, sweetening products, cocoa butter, perfume, and some pharmaceutical materials. In Nigeria, young cocoa cherelles are also used in cooking soup that has resemblance of okra soup and in treating various abdominal problems or ailments (Opeke, 2005).

The production of cocoa in Nigeria has witnessed a downward trend since the early 1970s due to numerous factors like ageing of trees, ageing of farmers, wrong application of recommended agronomic techniques by farmers, effects of pests and diseases and deficiencies in macro and micronutrients in the cocoa soils (Adejobi *et al*., 2011a). Previous studies have attributed the yield decline essentially to soil nutrients imbalance (Ojeniyi *et al*., 1981). One way of combating this problem is the use of fertilizer. However, African farmers use very little fertilizer (8kg/ha) compared to their counterparts in other parts of the agrarian world, hence Africa's soils are increasingly depleted of nutrients (IFDC, 2008/2009). This is particularly true with cocoa farmers in Nigeria. Ogunlade *et al*. (2009) reported that more than 85% of cocoa farmers in Nigeria do not use fertilizers on their cocoa crops. Reasons for this low usage of fertilizers vary from lack of farmers' knowledge of the nutrients' status of their soils to scarcity and high cost of fertilizers where available. The need to pay attention to soil fertilization is now almost as important as the control of capsids and black-pod disease in cocoa. Ayanlaja (2002), Adejobi *et al.* (2011 a, b, c) and Moyin-Jesu (2008) reported the use of organic residues such as animal manures, urban refuse, agro-industrial processing wastes, refuse dump compost, pit latrine compost, foot of the hill compost, mulching, passive refuse dump in home gardens and alley cropping with appropriate nitrogen fixing shrubs, have been found capable of increasing and balancing soil nutrients with consequential increase in yield and crop performances. Also, it has been reported that manures are capable of enhancing yield of tree crops such as coffee (Michori, (1998); Obatolu 1991), Teak (Fagbenro,1988) and Tea (Ipinmoroti and Adeoye, 2002; Ipinmoroti *et al.,* 2004). Recent findings indicated that leaf chlorophyll, K: Na and C:Na ratios of organic fertilizer treated crops were higher than those on inorganic NPK fertilizer. These high K and Ca contents might have been responsible for the enhancement of growth, yield and yield quality for manured crops, compared to inorganic NPK fertilizer treated crops (Adediran *et al.,* 1999; Alabi and Odubeba, 2001). Therefore, the main objective of this study was to examine the influence of different organic, organo-mineral and inorganic NPK fertilizers on cocoa seedlings establishment, growth and yield on the field.

Materials and Methods

Experimental sites and condition

Field experiments were conducted at Ibadan, the headquarters of the Cocoa Research Institute of Nigeria (CRIN), and in Owena, a CRIN Substation in Ondo State.

Ibadan experimental site

The site in Ibadan, Oyo State, is located on Latitude 07^0 10' N and Longitude 03^0 52'E, and an altitude of about 122 meters above sea level in the humid tropical rain forest zone of Nigeria. Ibadan is characteristically hot and humid, reputed for seasonal rainfall, high temperatures and high humidity and distinct dry and rainy seasons. The dry season extends from early November to March and is characterized by dry atmosphere and intense scorching sun. The rainy season is characterized by high humidity and cloudy skies which runs from end of March to early November. There is usually a two-week dry spell in August. The annual rainfall is between 1200-1500 mm. The maximum temperature ranges between 26 to 35°C

with an average of about 30.1°C while the minimum temperature ranges from 15 to 24°C with an average of 19.5°C. Relative humidity is high throughout the year and ranges from of 50 to 89% with an average of 79%. There are seasonal variations in the values of relative humidity, which varies from 65 to 89% during the rainy season and 46 to 70% during the dry season.

Owena experimental location

The Owena substation of the Cocoa Research Institute of Nigeria in Ondo State lies on Latitude 07°N and Longitude 05°, 7¹E and at an altitude of about 22.5 meters above sea level. Owena is situated at about 21 km Southeast of Akure between Akure and Ondo town. There are two seasons: rainy (wet) season which spans late from March to November of the same year and a dry season that runs from December to late March of the following year. The dry season on the contrary to the situation in Ibadan` has characteristic of scanty rainfall, the average ranges between 1500 – 1600 mm per annum. The maximum temperature in Owena is usually between 28 and 34° C while the daily minimum temperature ranges between 18 and 23° C. The relative humidity during the rainy season ranges from 69 to 80 %, and between 56 and 64 % during the dry season.

Acquisition and preparation of experimental materials

Seedlings of cocoa F3 Amazon genotype were raised from pods collected from CRIN Seed Garden, while plantain suckers were collected from experimental plots in Ibadan and Owena. Experimental plots of about 30 by 120 m were mapped out and the experiment was laid out in rows of 3 x 3 m. Organic and organo-minerals fertilizers used for the experiments were obtained from the Ondo State Ministry of Agriculture while the inorganic N.P.K. 15:15:15 was obtained at Ayedaade Local Government Council in Gbongan, Osun State. The guoat dung used was obtained from Ilesha Garage, Akure, Ondo State. The goat dung were collected dried and carefully sorted out to remove foreign and unwanted materials before being packed in 50 kg bags for application on the field.

Field experiments

Treatments and experimental design

Field experiments were conducted in two stations of the Cocoa Research Institute of Nigeria (CRIN), Ibadan Headquarters and Owena Sub-Station, Ondo State. The experiments were conducted between June, 2011 and June, 2014. The experiments were set up using Randomized Complete Block Design (RCBD) with 3 replications. The 4 fertilizers were: Goat Dung (GD), Organic Fertilizer (OF) otherwise called Sunshine Organic Fertilizer, Organo-Mineral Fertilizers (OMF) and the inorganic NPK 15:15:15 Fertilizer (NPK 15:15:15) while the rates of application were: 0, 200, 400 and 600 kg/ha. Four hundred and Thirty-two (432) plantain suckers were planted at 3 x 3m spacing as shade crop while 432 cocoa seedlings (F3 Amazon) were also transplanted at 3 x 3m respectively at each experimental site in 2011. The layout of each experimental site (measurement, pegging and holing) were carried out before planting. Four hundred and Thirty-two (432) plantain suckers were planted as shade crop at the spacing of 3 x 3m in each of the experimental sites in Ibadan and Owena between second and third week of June, 2011. Four hundred and thirty-two (432) of 5 months old cocoa seedlings of F3 Amazon variety with an average height of 46cm (raised in the CRIN nursery) were transplanted at the spacing of 3 x 3m on each of the sites in Ibadan and Owena, four plants were randomly tagged for data collection. For 2012 experiments, plantain suckers were established in June, 2011 and thus, cocoa seedlings were transplanted into one year old plantain planation in 2012. In each experimental site, plantain suckers were planted at 3 x 3m spacing as shade crop. Top soil samples were collected randomly at the depth of 15cm from each experimental site (Ibadan and Owena) using soil auger. The samples were bulked and air dried before being subjected to routine laboratory analysis of particle size analysis as determined by the hydrometer method (Kettler *et al.*, 2001) and organic carbon (OC) content by the potassium dichromate oxidation method (Zhang *et al.*, 2001). Soil pH was determined with a pH meter (1:1 water). Organic matter content was determined by Walkley-Black acid digestion method (Murphy and Riley, 1962). Soil available potassium (K), calcium (Ca) and magnesium (Mg) were extracted with lMNH_4 OAC, pH_7 and were determined with flame photometer; Mg was determined with an atomic absorption spectrophotometer. The total nitrogen (N) was determined by the Microkjedahl method (AOAC, 1990).

Two grammes (2g) each of the organic fertilizers used were also analyzed for nutrient composition. The

fertilizers were applied to treatment plots one month after transplanting using ring method of fertilizer application at 5cm away from the base of cocoa (July, 2011). Monthly Data collection on growth parameters (plant height, stem diameter, number of leaves and number of branches) commenced 3 months after transplanting. The experiments were monitored for 36months (144 weeks after planting). Survival count was carried out 12 months after transplanting.

Data collection

Data were collected on the growth parameters of cocoa seedlings such as: Plant height measured in centimeter using a meter rule on the surface and the tip of the main stem; Number of leaves was counted. Stem diameter was measured in centimeter with the use of Vernier caliper 30cm above the ground level. Number of branches was also determined. These growth parameters were taken monthly for 24 months commencing from 3 months after transplanting (3 MAT).

Statistical analyses

Analysis of variance was performed on all data to test the treatment effect on different parameters and significant means were separated using Tukey's Honest Significant Difference (HSD) ($P < 0.05$).

Results and Discussion

The result of the initial physical and chemical properties of the soil used for the experiments is presented in Table 1. The particle-size analysis of the soils of both Ibadan and Owena 2011 experimental sites showed that the soils were sandy loam and Alfisols (Soil Survey Staff, 1999). The silt + clay contents of the soils at Ibadan and Owena 2011 (23.98 % and 27.9 %) experiments respectively, were below the 32% estimated to be adequate for soils considered to be ideal for tree crops production especially cocoa (Egbe *et al.*, 1989). Based on the established critical levels for soils in southwestern Nigeria, the soils at Ibadan and Owena were acidic with pH ranging from 4.56 to 5.76 and low in organic matter (0.99 – 2.51 %) compared to the reported critical levels of 3% organic matter (Agboola and Corey, 1973). The total nitrogen of Owena soil was less than 0.15% which is considered optimal for most crops including cocoa and the soils also had low CEC (Ogunwale *et al*., 2002). This suggests the need to improve on the soil organic matter and hence the CEC for enhanced nutrient retention and the release of same to crops upon external fertilizer application (Agboola and Omueti, 1982). The application of inorganic fertilizer to a soil with low organic matter content is a waste of resources and time (Agboola and Obigbesan, 1975). Hence there is need for proper SOM management on Ibadan and Owena soils to reduce the deleterious effects on soil physical and chemical properties. Although, available P was also low, this level of available P is considered inadequate for cocoa (Wessel, 1971; Egbe *et al*., 1989). Both Ibadan and Owena soils gave exchangeable potassium below the critical value of 0.3 cmol/kg required for cocoa. The exchangeable Ca^{+} of Owena soil fell below the critical value of 5 cmol/kg required for cocoa growth. At Ibadan, the exchangeable Mg^{+} was adequate for cocoa production. Obatolu (1991) earlier observed the general low Mg^{+} nutrient content of Owena soil. The low nutrient contents of the soils implied the need for external input of nutrients in order to meet the requirements for optimal cocoa growth. It is obvious that the soils of both Ibadan and Owena were inherently low in fertility and were therefore expected to show positive response to soil amendment. The insufficient levels of the major nutrients in the soils in both locations showed that the soils were depleted in nutrients and would not be able to meet the nutritional needs of cacao plants unless external nutrients supply is made to support optimum growth of cacao plants.

Table 2 presented data on the nutrient composition of the organic materials used for the experiments. Among the organic fertilizers applied, goat dung (GD) had the highest pH, though all the organic and organo-mineral fertilizers had pH above 5 (acidity levels) which indicated that they could be effective as liming materials. The organo-mineral fertilizer (OMF) had the highest available P followed by GD and organic fertilizer (OF) had highest percentage N. The results were in agreement with the works of Adejobi *et al.* (2011a) who found out that GD, OMF and OF were as effective as NPK fertilizer which can be used as effective sources of plant nutrients. In particular, OF had the highest OM, K, Mg, Ca and Na concentrations relative to other organic fertilizers, this implied that OF could be a good source of these nutrients for plant growth.

Effects of organic and inorganic fertilizers on survival count of cocoa seedlings are represented in Table 3. 600 kg/ha OF, 400 kg/ha OF, 600 kg/ha GD, 600, 400 and 200 kg/ha OMF significantly improved the survival count of

cocoa in Ibadan relative to other fertilizer types, rates and the control while 600 kg/ha OF and 400 kg/ha NPK gave the highest survival count in Owena experiment compared with other fertilizer treatments and the control (Table 3). The highest seedlings survival count recorded across the two locations (Ibadan and Owena) under 600 kg/ha OF could be as a result of increased soil organic matter after fertilizer application. This could have led to greater water retention to sustain plant survival on the field during dry spell. This finding was in agreement with Adeoye (1988) who reported significant greater amount of water retention on the soil following application of 5t/ha cow-dung. The manuring effects on soil water retention may be explained by enhanced stability of soil structure.

Effect of fertilizers on growth parameters of cocoa is presented in Tables 4 to 11. The fertilizer treatments enhanced plant height of cacao seedlings than control in both locations at 3, 4 and 5 months after transplanting (MAT). Cocoa plants were taller at Ibadan than Owena at 5 MAT. The differences in height between both locations were attributed to the differences in the nutrient- releasing pattern and growing environmental conditions between the two locations. Application of OMF at 400 kg/ha significantly ($P< 0.05$) increased number of leaves than other treatments and control at 3, 4 and 5 MAT in Ibadan experiment. But at Owena experiment, GD applied at 200 kg/ha gave higher number of leaves at 3 and 4 MAT than the other treatments and the control. At both locations (Ibadan and Owena 2011 experiments), the fertilizers applied increased number of branches relative to the control plot. The significant increases in the growth parameters of cocoa seedlings at 3, 4 and 5 MAT in Ibadan and Owena (2011experiments) relative to the control under the fertilizer treatments can be attributed to the nutrient contents of organic fertilizers applied which enhanced cocoa seedlings growth. This finding that the manure (GD, OMF and OF) improved the growth of cocoa is consistent with earlier findings of Adeniyan and Ojeniyi, (2005) and Moyin-Jesu, (2007) who reported that manures supported the growth and development of maize and coffee. Poor growth of cocoa seedlings as a result of low nutrient status of soil was generally observed in the unfertilized treatment plots in the two locations in 2011 indicating that the soils of both locations were low in fertility and not supportive of good cocoa growth.

The values of growth parameters due to manures of both animal and plant origins were higher compared to that of inorganic origin (NPK 15: 15: 15 fertilizer). This might be due to presence of other vital nutrient elements like Ca, Mg, OC and other micro-nutrients that are required for cocoa seedlings growth which are absent in the NPK 15:15:15 fertilizer.(Ipinmoroti *et al*., 2002)

At 15, 16 and 17 MAT in Ibadan and Owena, the fertilized treatments and rates reflected in higher plant height relative to the unfertilized control. This result indicated short supply of nutrients to cocoa seedlings under the control and consequently led to poor seedlings growth. The relatively higher plant height under 400 kg/ha OMF, 400 kg/ha OF in Ibadan and 200 kg/ha GD in Owena at 15, 16 and 17 MAT could have stemmed from the nutrient contents of the organic fertilizers (essential soil nutrients) which though released slowly, last longer in the soil for optimum crop performance (Lombin, 1981). Agboola *et al.* (1981) and Titiloye *et al.* (1985) have reported a survey of 45 waste materials which were found to be rich in the nutrient elements (N, P, K, Ca, Mg, Zn, Cu, Fe and Mn contents). The farm wastes therefore represent a potential source of nutrients that could be harnessed to boost crop growth and productivity (Solomon and Ogeh, 1995). The number of branches recorded at control was not significantly different from plots where the fertilizer types were applied in Ibadan and Owena at 3 MAT. Though application of fertilizers improved number of branches relative to the control plot.

Application of GD at 600 kg/ha gave the highest number of flowers at both 24 and 36 MAT relative to all other treatments in Owena experiment. At 24 MAT, GD applied at 600 and 400 kg/ha gave the highest number of cherelles followed by 200 kg/ha GD. But at 36 MAT, only 600 kg/ha GD gave the highest number of cherelles followed by 600 kg/ha OMF and 200 kg/ha GD. These yield results authenticate the importance of organic fertilizer in crop production, and that they are capable of enhancing yield of tree crops such as coffee (Michori, 1998; Obatolu 1991), teak (Fagbenro,1988) and tea (Ipinmoroti and Adeoye, 2002; Ipinmoroti *et al.,* 2004). Recent findings indicated that leaf chlorophyll, K: Na and C: Na ratios of organic fertilizer treated crops were higher than NPK fertilizers. These high K and Ca contents might have been responsible for the enhancement of growth, yield and yield quality for manured crops compared to NPK treatment (Adediran et al., 1999; Alabi and Odubeba, 2001). It was

also observed from the result of this study that flowers and cherelles produced did not translate to mature pods in all the treatments at 24 MAT, only GD applied at 600 and 400 kg/ha gave one pod each. This could be attributed to the fact that the cocoa stems were too tender at 24 MAT for fruit bearing, incompatibility during cross pollination or as a result of adverse weather situation at the period of flowering, and as a result of pest infestation. This observation was different from that of Murray (1955), who observed that the increase in cocoa yield due to fertilizer application was as a result of an increase in the production of cherelle per tree rather than a decrease in the amount of wilt. But at 36 MAT, GD applied at 600 kg/ha gave the highest number of pods, followed by 200 kg/ha GD. Ayeni *et al.* (2008) reported that soil OM, macro and micro-nutrients and yield of maize were increased by cocoa pod ash. Adeyeye *et al.* (1994) reported that wood ash amendment increased soil nutrients and yield of yam. During five years trial on the effect of fertilizer on the yield of cocoa in Colombia, it was observed that the highest yield was produced with 150, 90 and 200 kg/ha of N, P_2O_5 and K_2O treatment respectively, produced the greatest response with an average of 620 - 802 kg dry bean/ha for the five year period which were more than double the yield produced by traditional farmer practices (Armondo *et al*, 2001). This affirmed that adequate and balanced fertilization of cocoa was not only profitable but also sustained and built higher yield over time. These contents might have been responsible for better plant growth, yield and yield quality for crops under organic treatments compared to NPK treatment (Adediran *et al*., 1999; Alabi and Odubeba, 2001).

Table 1: Physical and chemical characteristics of the soils before planting in Ibadan and Owena (2011 experiments)

Soil Properties	Ibadan 2011 Experiment	Owena 2011 Experiment
Sand (%)	76.1	72.1
(Silt (%)	16.3	18.2
Clay (%)	7.6	9.7
Textural class	Sandy loam	Sandy loam
pH (water)	5.44	5.76
Organic carbon (g/kg)	3.20	0.57
Organic matter (%)	2.51	0.99
Nitrogen (%)	0.32	0.06
Available P (cmol/kg)	11.67	9.96
K^+ (cmol/kg)	0.28	0.22
Ca^{++} (cmol/kg)	6.60	1.00
Mg^{++} (cmol/kg)	3.40	0.40
Na^+ (cmol/kg)	2.87	0.16
Al^{+++}	1.22	2.36
H+(cmol/kg)	6.32	7.89
ECEC (cmol/kg)	28.69	12.03

Table 2: Chemical composition of the organic materials used

Properties	Goat dung (GD)	Organo-mineral fertilizer (OMF)	Organic fertilizer (OF
pH (water)	8.17	7.00	7.30
Organic carbon (g/kg)	2.86	0.63	3.64
Organic matter (%)	4.80	1.09	6.27
Total nitrogen (%)	1.26	0.06	2.16
Available P (cmol/kg)	113.24	138.06	7.08
K^+ (cmol/kg)	0.41	0.19	5.56
Mg^{++} (cmol/kg)	1.20	1.00	6.00
Ca^{++} cmol/kg)	2.60	2.00	13.10
Na^+ (cmol/kg)	0.38	0.18	2.30
C:N	1:4	1:1	1:6

Table 3: Survival of cacao seedlings as affected by organic and inorganic fertilizers at Ibadan and Owena (2011 experiments) at 12 MAT).

Treatments		Ibadan	Owena
Fertilizers	Rates (kg/ha)	2011	2011
Goat dung	600	94.44a	69.45ab
	400	91.67ab	69.44ab
	200	88.89abc	86.44ab
	Control	80.54abcd	55.55b
Organo mineral fertilizer	600	94.44a	83.33ab
	400	97.22a	55.56b
	200	94.44a	77.78ab
	Control	80.53abcd	55.54b
Organic fertilizer	600	100.00a	94.45a
	400	97.22a	77.78ab
	200	97.22a	83.33ab
	Control	80.67abcd	55.86b
NPK 15: 15: 15	600	66.67cd	77.78ab
	400	61.11d	91.67a
	200	69.44bcd	69.44ab
	Control	80.55abcd	55.56b

Treatment means within each column followed by the same letters are not significantly different from each other using Tukey's HSD at 5% level.

Table 4: Effects of fertilizer types and rates on plant height (cm) of cacao at (Ibadan and Owena, 2011 Experiments

Treatments		Ibadan experiment Months after planting			Owena experiment Months after planting		
Fertilizers	Rates (kg/ha)	3	4	5	3	4	5
Goat dung	600	46.33ab	55.83ab	59.62a	40.10b	52.92ab	58.75bcd
	400	40.67ab	5058ab	53.33ab	39.80b	49.92ab	64.42abc
	200	39.58ab	47.00ab	48.33ab	46.10a	55.83ab	76.17a
Organo-mineral fertilizer	600	47.58ab	58.08a	58.90a	43.77b	65.67a	75.42ab
	400	49.67ab	59.40a	56.94a	43.77b	50.00ab	55.42cde
	200	46.42ab	59.42a	60.16a	43.00b	50.42ab	57.92cde
Organic fertilizer	600	49.25ab	55.67ab	56.19a	46.43a	53.67ab	72.33abc
	400	47.04ab	55.83ab	53.29ab	46.50a	55.00ab	67.75abcd
	200	51.17a	56.17	57.33a	40.27b	48.33b	65.33abcd
NPK 15: 15: 15	600	43.33ab	47.75ab	50.00ab	44.83b	55.29ab	61.75abcde
	400	39.92ab	45.58ab	46.02ab	42.83b	52.58ab	66.67abcd
	200	43.37ab	49.50ab	50.35ab	49.19a	56.51ab	65.33abcd
Control		36.83b	41.25b	41.32b	37.10c	42.50b	49.08e

Treatment means within each column followed by the same letters are not significantly different from each other using Turkey's HSD at 5% level

Table 5: Effects of organic and inorganic fertilizer types and rates on number of leaves of cocoa seedlings (Ibadan and Owena 2011 experiments)

Treatments (kg/ha)		Ibadan experiment Months after planting			Owena experiment Months after planting		
Fertilizers	Rates	3	4	5	3	4	5
Goat dung	600	22.58abcd	25.42abcd	26.43adc	9.13ab	12.00ab	16.33ab
	400	17.42cdef	21.83bcde	22.84bcd	12.12a	13.67ab	22.50a
	200	23.42abc	26.92abc	27.29ab	13.67a	16.18a	22.00a
	Control	13.39ef	14.93e	15.54d	7.56b	9.15b	7.22b
Organo-mineral fertilizer	600	24.75ab	28.33ab	28.27ab	13.27a	15.15ab	22.83a
	400	26.92a	32.00a	33.10a	10.85ab	12.50ab	21.08a
	200	19.42bcde	25.50abcd	26.10abc	11.58ab	13.08ab	17.83ab
	Control	13.41ef	14.93e	15.52d	7.57b	9.18b	7.30b
Organic fertilizer	600	21.33abcd	24.33abcde	24.96abcd	11.83ab	14.75ab	23.83a
	400	18.83bcde	23.08abcde	23.66abcd	11.08ab	11.92ab	16.08ab
	200	21.63abcd	22.88abcde	24.63abcd	9.83ab	12.83ab	20.25ab
	Control	13.40ef	14.94e	15.51d	7.56b	9.16b	7.25b
NPK 15:15:15	600	15.50def	16.25de	17.59cd	9.52ab	9.38b	11.92ab
	400	11.42f	15.93de	16.28d	10.85ab	12.77ab	16.13ab
	200	17.33cdef	18.50cde	19.05bcd	4.50ab	11.58ab	15.50ab
	Control	13.42ef	14.94e	15.53d	7.60b	9.17b	7.25b

Treatment means within each column followed by the same letters are not significantly different from each other using Tukey's HSD at 5% level

Table 6: Effects of organic and inorganic fertilizer types and rates on stem diameter of cacao seedlings (Ibadan and Owena 2011 experiments)

Treatments		Ibadan experiment Months after planting			Owena experiment Months after planting		
Fertilizers	Rates(kg/ha)	3	4	5	3	4	5
Goat dung	600	0.85a	1.28a	1.29b	0.85a	1.13ab	1.56ab
	400	0.74ab	1.18ab	1.19b	1.03a	1.11ab	1.54ab
	200	0.78a	1.15ab	1.14b	1.09a	1.19ab	1.81a
	Control	0.64ab	0.94b	1.29b	0.91a	1.03b	1.09b
Organo-mineral fertilizer	600	0.81a	1.33a	2.31a	0.92a	1.28a	1.53ab
	400	0.66ab	1.25a	1.33b	1.09a	1.16ab	1.35ab
	200	0.79a	1.8a	1.2ab	0.71a	1.10ab	1.48ab
	Control	0.65ab	0.93b	1.28b	0.90a	1.02b	1.07b
Organic fertilizer	600	0.74ab	1.29a	1.31b	0.95a	1.14ab	1.56ab
	400	0.57b	1.27a	1.29b	1.07a	1.15ab	1.41ab
	200	0.84a	1.33a	1.34b	1.01a	1.26a	1.61ab
	Control	0.67ab	0.91b	1.26b	0.90a	1.02b	1.08b
NPK 15: 15: 15	600	0.65ab	0.95b	1.01b	0.93a	0.87b	1.06b
	400	0.56b	0.94b	0.95b	1.01a	1.12ab	1.24ab
	200	0.65ab	1.09ab	1.13b	0.94a	1.14ab	1.45ab
	Control	0.66ab	0.95b	1.29b	0.91a	1.04b	1.09b

Treatment means within each column followed by the same letters are not significantly different from each other using Tukey's HSD at 5% level.

Table 7: Effects of organic and inorganic fertilizer types and rates on number of branches of cocoa seedlings in Ibadan and Owena (2011 experiments)

Treatments (kg/ha)		Ibadan Months after transplanting (MAT)			Owena Months after transplanting (MAT)		
Fertilizers	Rates(kg)	3	4	5	3	4	5
Goat Dung	600	0.58abc	1.20ab	2.04ab	0.58b	1.08ab	2.00ab
	400	0.15c	0.95ab	1.46ab	1.25a	1.50ab	3.42ab
	200	0.92abc	1.62a	3.00a	0.42b	1.15ab	3.50ab
	Control	0.12c	0.18c	0.18b	0.32bc	0.36b	1.25b
Organo-	600	1.50ab	1.60a	2.74a	0.75b	1.33ab	3.30ab
Mineral	400	1.62a	1.82a	1.80ab	0.92ab	1.75a	4.33a
Fertilizer	200	0.28bc	0.48bc	1.10ab	1.00a	1.20ab	3.17ab
	Control	0.11c	0.19c	0.18b	0.31bc	0.36b	1.23b
Organic	600	0.67abc	0.72ab	1.75a b	0.83ab	0.84ab	4.33a
manure	400	0.37abc	0.55ab	1.05ab	0.92ab	0.73ab	2.75ab
	200	0.28bc	0.39bc	1.84ab	1.17a	1.17ab	2.75ab
	Control	0.11c	0.18c	0.17b	0.31bc	0.35b	1.25b
NPK	600	0.50abc	1.50ab	1.89ab	0.92ab	1.67a	2.67ab
15:15:15	400	0.37abc	1.60a	1.72ab	0.58b	1.83a	2.43ab
	200	0.45abc	0.38bc	1.36ab	0.50b	1.33ab	4.25a
	Control	0.12c	0.19c	0.19b	0.33bc	0.37b	1.25b

Treatment means within each column followed by the same letters are not significantly different from each other using Tukey's HSD at 5% level

Table 8: Effects of organic and inorganic fertilizer types and rates on plant height of cocoa seedlings at 15, 16 and 17 MAT (Ibadan and Owena 2011 experiments)

Treatments		Ibadan			Owena		
		Months after transplanting			Months after transplanting (MAT)		
Fertilizers	Rates (kg/ha)	15	16	17	15	16	17
Goat Dung	600	59.42ab	74.17ab	92.58ab	71.17abc	88.17ab	99.55a
	400	56.92ab	77.58ab	88.33ab	69.77abc	77.00ab	79.00ab
	200	57.08ab	70.83ab	80.33abc	82.83a	94.90a	101.17a
	Control	43.65b	46.65b	50.54c	56.98c	58.23b	65.51b
Organo-Mineral Fertilizer	600	61.23ab	72.08ab	90.75ab	79.25ab	81.95ab	86.17ab
	400	66.92a	72.17ab	81.50abc	60.17bc	67.97ab	78.17ab
	200	63.75a	80.08ab	90.50ab	75.67abc	83.59ab	91.69ab
	Control	42.56b	45.98b	51.11c	56.12c	57.90b	64.01b
Organic manure	600	66.08a	81.92a	95.42ab	76.75abc	82.17ab	90.92ab
	400	66.33a	73.83ab	109.83a	71.08abc	73.49ab	89.00ab
	200	63.75a	71.75ab	82.42abc	67.75abc	71.75ab	73.50ab
	Control	42.89b	47.65b	49.98c	58.21c	59.98b	65.32b
NPK 15:15:15	600	51.67ab	67.67ab	68.89bc	70.83abc	73.93ab	83.33ab
	400	49.58ab	54.50ab	64.08bc	68.52abc	74.17ab	78.92ab
	200	51.67ab	55.17ab	68.33bc	70.92abc	73.82ab	81.70ab
	Control	44.78b	46.58b	50.42c	57.42c	58.83b	64.51b

Treatment means within each column followed by the same letters are not significantly different from each other using Tukey's HSD at 5% level

Table 9: Effects of organic and inorganic fertilizer types and rates on number of leaves of cocoa seedlings in Ibadan and Owena (2011 experiments)

Treatments		Ibadan			Owena		
		Months after transplanting (MAT)			Months after transplanting (MAT)		
	Rates (kg/ha)	15	16	17	15	16	17
Goat Dung	600	31.25a	43.75a	48.17ab	19.85ab	32.05ab	41.17a
	400	27.17ab	33.00abc	40.58abc	24.78ab	28.50ab	33.08ab
	200	28.27ab	39.83ab	44.92abc	22.50ab	28.00ab	37.42ab
	Control	15.54c	15.32c	19.34c	11.76c	15.32b	17.54c
Organo Mineral Fertilizer	600	25.13abc	36.00ab	54.08ab	24.00ab	26.03ab	39.75ab
	400	32.27a	37.72ab	46.00abc	22.33ab	32.75ab	36.36ab
	200	24.92abc	26.37abc	29.83bc	26.00a	38.17a	44.11a
	Control	14.32c	16.75c	18.43c	11.89c	17.11b	16.98c
Organic fertilizer	600	27.50ab	39.25ab	55.92ab	26.75a	33.42ab	40.50ab
	400	24.33abc	31.75abc	61.33a	26.25a	26.86ab	33.00b
	200	25.30abc	35.00ab	41.42abc	20.93ab	16.02b	20.50c
	Control	15.90c	16.09c	20.32c	12.98c	17.21b	18.56c
NPK 15:15:15	600	16.25c	23.33bc	31.45bc	14.92bc	25.92ab	33.50b
	400	16.00c	26.92abc	30.58bc	17.81abc	22.25ab	23.72c
	200	19.00bc	29.17abc	36.06abc	18.42abc	21.05ab	30.42b
	Control	15.54c	16.75c	19.50c	12.83c	16.25b	17.56c

Treatment means within each column followed by the same letters are not significantly different from each other using Tukey's HSD at 5% level

Table 10: Effects of organic and inorganic fertilizer types and rates on stem diameter of cocoa seedlings in Ibadan and Owena (2011 experiment)

Treatments		Ibadan			Owena		
		Months after transplanting			Months after transplanting (MAT)		
	Rates (kg/ha)	15	16	17	15	16	17
Goat Dung	600	1.43ab	1.85abcd	2.46abc	17.3ab	2.06ab	2.26ab
	400	1.57a	2.24a	2.47abc	1.85ab	2.05ab	2.42ab
	200	1.23ab	1.28de	2.27abc	2.11a	2.34a	2.38a
	Control	1.18ab	1.24e	1.45c	1.22b	1.32c	1.40b
Organo Mineral	600	1.47ab	1.54bcde	1.99abc	1.70ab	2.17ab	2.60a
	400	1.47ab	1.59bcde	2.09abc	1.39ab	1.65abc	1.93ab
	200	1.24ab	1.61bcde	1.97abc	1.72ab	1.86abc	2.19ab
	Control	1.17ab	1.43e	1.65c	1.11b	1,23c	1.40b
Organic manure	600	1.33ab	2.09ab	2.59ab	1.71ab	1.99abc	2.07ab
	400	1.39ab	1.91abc	2.79a	1.58ab	1.71abc	1.99ab
	200	1.35ab	1.74abcde	2.23abc	1.68ab	1.71abc	1.86ab
	Control	1.20ab	1.24e	1.65c	1.22b	1.23c	1.34b
NPK 15:15:15	600	1.06b	1.54bcde	1.97abc	1.38ab	1.64abc	2.17ab
	400	1.04b	1.45cde	1.65bc	1.37ab	1.65abc	1.89ab
	200	1.12b	1.97abc	2.23abc	1.35ab	1.52bc	1.81ab
	Control	1.19ab	1.26e	1.56c	1.23b	1.25c	1.39b

Treatment means within each column followed by the same letters are not significantly different from each other using Tukey's HSD at 5% level

Table 11: Effects of organic and inorganic fertilizer types and rates on number of branches of cocoa seedlings in Ibadan and Owena (2011 Experiments)

Treatments		Ibadan			Owena		
		Months after transplanting (MAT)			Months after transplanting (MAT)		
Fertilizers	Rates (kg/ha)	15	16	17	15	16	17
Goat Dung	600	4.50a	8.33a	8.83a	2.43ab	4.16ab	4.42ab
	400	4.09a	6.75a	6.92ab	4.37ab	5.08ab	5.42ab
	200	4.25a	7.42a	8.08ab	3.83ab	4.92a	5.42ab
	Control	0.35b	1.69b	2.65c	1.45b	1.56b	1.87b
Organo-Mineral Fertilizer	600	5.14a	8.75a	7.83ab	3.82ab	4.19ab	5.50ab
	400	2.27ab	4.92ab	5.57abc	4.65a	4.73ab	5.57ab
	200	3.08ab	5.28ab	5.50bc	3.68ab	5.00ab	5.07ab
	Control	0.40b	1.89b	2.50c	1.50b	1.60b	1.70b
Organic Fertlizer	600	4.08a	7.67a	9.33a	4.42a	6.67a	6.93a
	400	2.33ab	5.33ab	7.00ab	3.72ab	4.49ab	5.05ab
	200	3.08ab	6.28a	6.5ab	2.89ab	4.14ab	4.43ab
	Control	0.34b	1.87b	2.50c	1.49b	1.60b	1.74b
NPK 15:15:15	600	3.75a	5.83ab	6.47ab	4.03ab	5.08ab	5.52ab
	400	3.00ab	5.33ab	5.52abc	2.95ab	3.12ab	3.83ab
	200	3.33a	4.63ab	4.56bc	4.83a	5.27ab	5.42ab
	Control	0.37b	1.95b	2.53c	1.52b	1.63b	1.75b

Treatment means within each column followed by the same letters are not significantly different from each other using Tukey's HSD at 5% level

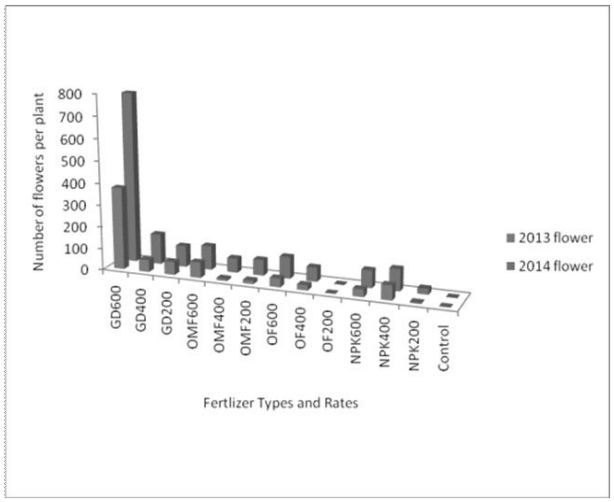

Figure 1: Number of flowers as influenced by organic and inorganic fertilizer types and rates at 24 and 36 MAT Owena (2011 experiment).

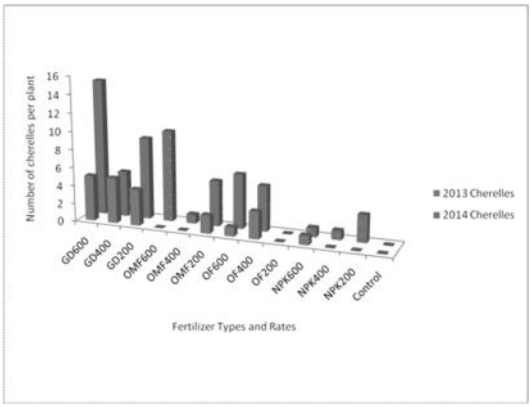

Figure 2: Number of cherelles as influenced by organic and inorganic fertilizer types and rates at 24 and 36 MAT Owena (2011 experiment).

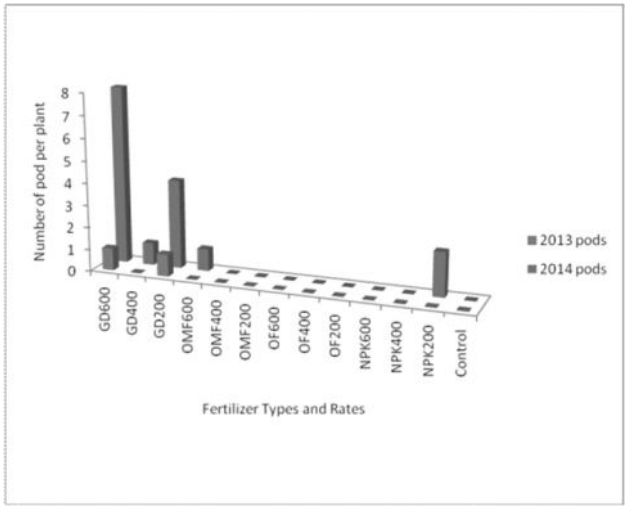

Figure 3: Number of pods as influenced by organic and inorganic cherelles types and rates at 24 and 36 MAT Owena (2011 experiment).

Conclusion

Cocoa (*Theobroma Cacao L*) Is An Important Perennial Cash Crop Worldwide. The Average Cocoa Yield in the world and West Africa is about 0.5 t/ha while for Nigeria is around 0.4 t/ha. This suggests that yield in Nigeria is low compared to the world average. Low soil fertility and poor agronomic practices are among the causes of low cacao productivity in Nigeria. Therefore, the use of fertilizer to address low soil fertility problem in cocoa production cannot be over emphasized. Application of 600 kg/ha OF to cocoa seedlings enhanced survival count (100 - 94.45 %) at 12 MAT at Ibadan and Owena. Also, application of at 600 kg/ha significantly increased plant height at 15, 16 and 17 MAT relative to the control at Ibadan. At Owena, GD applied at 200kg/ha gave higher number of leaves at 3, and 4 MAT, while 600 kg/ha OF significantly increased the number of leaves compared with the control at 5 MAT. The fertilizer treatments enhanced the growth parameters of cacao seedlings than the control in both locations, organic manures performed better than the organo-minerals (OMF), while the organo-mineral fertilizers were better than NPK. 600 kg/ha GD is recommended for optimum yield of cocoa in Owena. Also, there were no yield parameters obtained for Ibadan at 24 and 36 MAT. These results have clearly shown that organic fertilizers (GD, OF and OMF) supplied cocoa nutrients, water availability and conservation. These attributes cumulated in improved growth, yield and nutritional status of cocoa.

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Experimental Title: Evaluation of the Diversity of *Phytophthora* Species causing *Theobroma cacao* L. Pod Rot in Nigeria

Investigator: Otuonye A.H.

Introduction

Cocoa, (*Theobroma cacao* L.) was introduced into Nigeria in 1874. Since its introduction, cocoa has become a cash crop of considerable economic importance to Nigeria. It contributes to the national economy by being one of the most important non-oil foreign exchange earners for the country. The foreign exchange earnings from a production figure of 240-336 metric tons of cocoa and cocoa products export in 2009 and 2010 were $66,925,709 and $88,812,813 respectively. This accounted for about 38.5% of the non-oil export of Nigeria for the year 2010 (The Guardian Newspaper, April 14, 2011). The cocoa industry also has played an important role in creating employment and as a source of income for the teeming population of traditional small-scale farm holders in Nigeria.

Although, the important contribution of *Theobroma. cacao* is appreciated, maintenance for optimum production level is beset with problems. Prominent among these are the scourges of diseases. Members of the Oomycetes genus *Phytophthora* are among the most devastating plant pathogens attacking cocoa. All parts of the crop are vulnerable to attack by the black pod pathogen. The major economic loss is from the infection of the pod that bears the bean of commerce. Gorenze and Okaisabor (1974) reported that 30% loss in the yield of cocoa was recorded in Nigeria due to the attack of one the species of the pathogen, *P. palmivora*. Gregory and Maddison (1981) noted that direct crop losses of up to 90% occurred in wetter areas of the country when the two species, *Phytophthora palmivora,* and *Phytophthora megakarya,* combine to cause multiple diseases on the same host cocoa in Nigeria.

Small-scale farm holders that produce 95% of *Theobroma cacao* beans in Nigeria, the world fourth largest producer country, employ cultural practices that involve general farm sanitation, application of synthetic and biodegradable pesticides and biological measures for the management of *Phytophthora* species scourges. However, erroneous diagnosis and inadequate knowledge of the molecular biology and pathogenesis of the species

associated in a disease or disease complex limit the success of these control strategies in the cost-effective management of *Phytophthora* diseases on cocoa. Therefore, early detection and accurate diagnosis of the *Phytophthora* species on cocoa in Nigeria is necessary so that appropriate control measures can be developed to prevent disease epidemics, the major crop yield losses, and mitigate for a long-term impact that could result from such events. Consequently, the objectives of this study are:

- To evaluate the pathogenic variability among the isolates of *Phytophthora* species in cocoa using the leaf disc method.
- To characterize *Phytophthora* species associated with black pod disease of cocoa in Nigeria based on pathogenic variability, morpho-cultural, and molecular techniques.
- To evaluate host resistance by the response of cocoa genotypes to infection by isolates of *Phytophthora* species

Materials and Methods

Infected and infested cocoa pods and soil were collected from some selected farmers' farm at Idanre, and Odigbo in Ondo East and Ondo West Local Government Areas of Ondo States as well as from CRIN headquarters in Ibadan, Oyo State of Nigeria, using stratified sampling technique. These infected pods' specimens were inoculated on both organic (Carrot agar) and synthetic (PDA) media (Carrot agar, per liter: 200g of chopped fresh carrot, 15g agar powder, 20g dextrose, 10% solution streptomycin antibiotics) in 9cm diameter disposable plastic petri-dishes. Three replicates were kept per pod samples collected. The plastic Petri-dishes arranged in a Completely Randomized design format (CRD) were incubated at 25±2^{0}C for 5-7 days in the dark with the aid of Gallenkamp cooled digital incubator. Subsequent transfer of hyphal tip of the emerging colony from the tissue pieces onto sterile Carrot agar medium plates were made to obtain pure cultures of the isolates of *Phytophthora* species.

Pathogenicity test

Pathogenicity test of the isolates of the black pod pathogen using detached pod test spray method (DPT-SM) inoculation technique was carried out. The reproduction of watery soaked brownish lesion with irregular extending margin and milky-whitish-downy moldy sporulation following right behind irregular extending lesion on the detached pods shows typical *Phytophthora* infection.

Morpho-cultural Studies

Microscopic examination of the sporangium characteristics to describe the various morph-cultural features of the various *Phytophthora* species collected from these agro-ecological zones were carried out with x10, x40 and x100 objectives of the scope mounted digital Olympus light microscope.

Molecular studies

Isolates obtained are kept augmenting it with collections from 2017. This saved scarce fund as it eliminates piecemeal shipment to overseas. This aspect was validated by the findings from the traditional or morphological methods used to determine the true identities of the *Phytophthora* species on cocoa in Nigeria.

Results

Table 1 highlights the number of farms visited and the number of isolates of *Phytophthora* species collected. Microscopic examination of the sporangium characteristics shows that the organisms are of the genus *Phytophthora*. The result further indicates that there could be other species, other than *P. palmivora* and *P. megakarya* on cocoa which was originally identified by Brasier and Griffin (1979). The 5 isolates collected from Ondo States were all *P. megakarya w*hile the 10 isolates of *Phytophthora* obtained mixed infection of cocoa pods from the headquarters were delineated as *P. megakarya* 7, *P. palmivora* 2 and *P. capsici* 1.

Conclusion

The microscopic examination of *Phytophthora* isolates indicates that other species of *Phytophthora,* other than the recognized two could be on cocoa in Nigeria. Results of the molecular analysis if done to validate morpho-cultural result will confirm these findings.

Further works

Collection of isolates from cocoa agro-ecological zones of Ondo, Oyo and Osun States will be continued in 2017 if funds are made available.

Table 1. Cocoa Producing States Sampled and Number of Isolates collected Per State 2016 cocoa production seasons

States	Number of Cocoa Producing Local Government Areas	Number of Farmers' farm Sampled	Number of Trees Sampled in Farmers' farm	Number of Pods collected from Farmers' farm	Number of Isolates obtained	Number of Isolates Targeted for collection Per State
Ondo	14	22	27	30	5	100
Oyo(Hqs)*	16	1	14	31	15	100

*Hqs = CRIN Headquarter

Experimental Title: Evaluation of bio-treatments on nursery performance of cacao seedlings

Investigator: Nduka, B. A.

Introduction

Theobroma cacao L. is one of the most important perennial crops used worldwide due to its economic relevance for chocolate and cosmetics industries (Almeida and Valle, 2007). 80% of seedlings raised are from polythene bags and have greater chances of establishment and survival after transplanting than planting in-situ (Opeke, 2006). Meanwhile, Coffee (*Coffea* species) is another important commodity in Nigeria because of the economic value of its berry, the husk forms over 40% of the matured seeds and it isa a major bye-product. However, the husk is being utilized as fertilizer in cashew nursery (Nduka *et al*.,2015) and has lignocelluloses materials, which make n it ideal substrate for microbial processes. Bio-fertilizers have been successfully used not only to control plant diseases but also to promote the growth and development of plants in the nursery, greenhouse, and field production. *Trichoderma* spp as a bio-control agent was reported by Adeniyi *et al*., (2013) and its ability to decomposed organic materials suitable for the organization of soil fertility was also reported by Guimarães *et al*., (2013). However, this species also promote growth of plants in greenhouse and on-field (Kaewchai *et al*.,2009). This study thus evaluates *T. harzianum* and *Streptomyces* spp. on degraded coffee husk as an enhancement for nursery performance of cacao seedling.

Materials and Methods

Coffee husk samples of *C. arabica* and *C. canephora* were collected from Crop Processing Unit and pure cultures of *Trichoderma harzianum* and *Streptomyces* spp. were sourced from Plant Pathology laboratory both of Cocoa Research Institute of Nigeria, Ibadan, Nigeria (CRIN). The degradation of the husks was allowed for 1, 15 and 30 days and sterilized coffee husk without either *T. harzianum* or *Streptomyces* spp. served as the control. The husk with the inoculant were incubated at ambient temperature (28° ± 2°C) on a shaker to allow homogenized degradation. The 2-week-old F3 amazon cocoa variety seeds were raised in 5 kg soil polythene bags while 6.25g each of bio-degraded coffee husks at 1, 15 and 30-day were separately incorporated into the planting soils and arranged in a completely randomized design (CRD). The soil without added materials served as control. All treatments and control were replicated in triplicates and data on vegetative growth parameters such as plant height, stem girth, leaf area, and number of leaves, started 4 weeks after application and subsequently recorded 12 and 24 weeks after application. The nursery experiment was terminated at 26 weeks after planting. The cocoa seedlings were harvested, separated into parts: roots, stems and leaves. The plants fresh weights were recorded, and plant parts were separately oven-dried and weighed. The plant samples were analyzed according to the standard methods of Association of Official Analytical Chemists (AOAC) (1990).

Results and Discussion

The essence of biological degradation of the coffee husk was to increase the fertility of the soil and make available the nutrients from the added sources to the cocoa seedling and the solubility action of organic acids produced during the decomposition of organic matter (coffee husk) applied resulting in more release of native and as well applied nutrients which corroborate the findings of Bellakki *et al*. (1998). The cocoa seedlings plant height and number of leaves at 24 weeks after planting were significantly enhanced when a combination of *T. harzianum* and *Streptomyces* was used to degrade *C. canephora* husk for 30days. But the trend was different with stem girth and leaf area as it significantly improved cocoa seedling

performance with a day of degradation of *C. canephora* husk using *T. harzinum* and *Streptomyces* treatments, respectively. However, the control treatment was significantly lower compared to other applications and significant similarities were also recorded in growth parameters ameliorated with different applications (Figure 1).

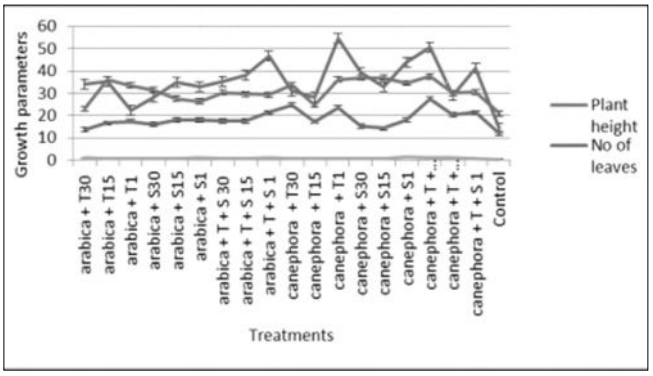

Figure 1: Influence of treatment types on growth of cacao after 24 weeks in nursery.

The *T. harzianum* and *Streptomyces* degraded coffee husk showed significant variations in fresh and dry plant weights. The dry weight was significantly high in *C. arabica* and *C. canephora* husks at 1 day degradation and differed significantly from control either *T. harzianum* or *Streptomyces* was used to degrade the coffee husk (Figure 2). The shoot fresh weight was similarly comparable in all treatments whereas the dry weight shows significant difference only when the husk was degraded for 1 day using *Streptomyces*. In the root, a 30-day *T. harzianum* and *Streptomyces* degraded *C. canephora* husk increased the root thickness by 1.57 mm when compare to other applications (Figure 2).

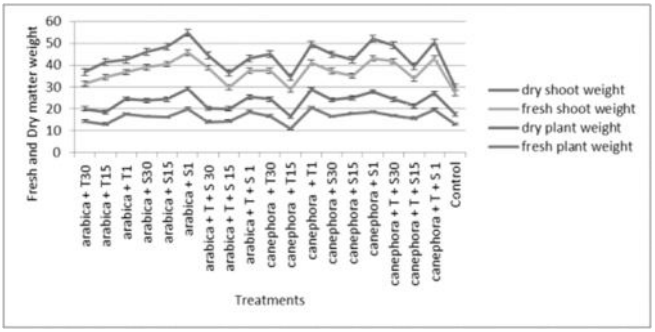

Figure 2: Effect of applications on plant and shoot weight of cacao after nursery.

Figure 3 showed the effect of treatment types on the fresh and dry root weight and its thickness. The fresh root weight of a 30-day *T. harzianum* degraded *C. canephora* treated cacao seedling was significantly higher than other treatments; it was also the same for the fresh root of cacao treated with 15-day *Streptomyces* degraded *C. arabica* husk while other applications had significant similarities in their fresh root weight.

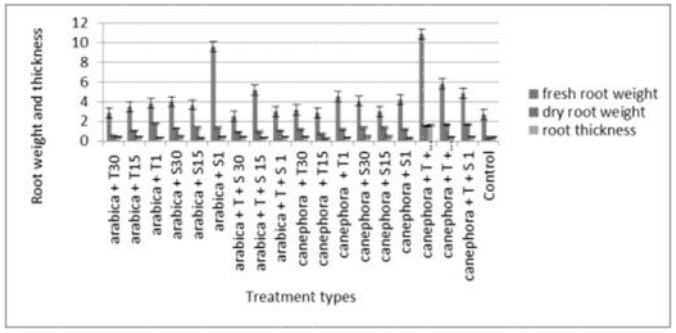

Figure 3: Effect of applications on root weight and thickness of cacao stem after nursery.

The content of mineral nutrients and organic matters was increased in the soil in this study and was translated to uptake of such by the cacao seedlings. Westerman and Bicudo (2005) reported that increase in using organic fertilizer contributed to improve the physical, chemical and biological characteristics of soil and sustainable agricultural cultivation. The findings in this study are also comparable to the work of Rudresh *et al*., (2005) and Shaban and El-Bramawy (2011) that described the improvement in growth parameters under glasshouse and field experiments due to the combined inoculation of *Trichoderma spp*. with other fungus. Therefore, *Trichoderma* with *Streptomyces spp* can be used for bio-decomposition of coffee husk and added as a good substitute for producing positive growth of cocoa seedlings by improving the soil fertility. This also corroborate the findings of Harman (2006) who reported that *Trichoderma* - plant association, instead of producing deleterious effect, are of benefits to the host plant in health, growth, and productivity while *Trichoderma sp* are also reported as growth promoting fungi by enhancing the availability of nutrients and minerals (N and P) for plants, producing plant growth hormones and decomposing organic material (Kaewchai *et al*., 2009).

Conclusion

The amelioration of soils for raising cacao seedlings with *T. harzianum* and *Streptomyces* degraded coffee husks positively enhanced nursery performance of cacao. The

effect of *T. harzianum* and *Streptomyces* degraded *C. arabica* was more evident on growth during initial stages, however *T. harzianum* and *Streptomyces* degraded *C. canephora* gave a lasting effect on cacao growth by end of nursery experiment. There was increase in the macro elements and organic matter contents by the bio-degraded *C. arabica* and *C. canephora* husk in the soil. These treatments could be further tried on field establishment to determine their effect on field performance and yield of cacao.

Table 1: Post treatment analysis of cacao soil ameliorated with degraded coffee husk

Soil treatment	pH	OC (%)	OM (%)	N (%)	P (%)	K (%)	Na (Cm ol/kg)	Ca (Cm ol/kg)	Mg (Cm ol/kg)
C. arabica + Trichoderma	7.13^{a}	1.32^{c}	3.09^{c}	0.38^{a}	4.96^{b}	0.45^{a}	0.44^{c}	2.23^{ab}	0.83^{a}
C. arabica + Streptomyces	6.77^{b}	2.09^{ab}	3.23^{b}	0.43^{a}	4.45^{b}	0.48^{a}	0.42^{c}	2.30^{ab}	1.03^{a}
C. Arabica + Trichoderma + Streptomyces	6.58^{bc}	2.48^{a}	4.07^{a}	0.46^{a}	7.34^{b}	0.46^{a}	0.47^{b}	2.80^{a}	1.03^{a}
C. canephora+ Trichoderma	6.75^{b}	2.01^{ab}	3.35^{b}	0.44^{a}	3.72^{b}	0.57^{a}	0.47^{b}	1.80^{b}	1.10^{a}
C.canephora+ Streptomyces	6.37^{c}	1.84^{bc}	3.40^{c}	0.42^{a}	4.46^{b}	0.56^{a}	0.40^{d}	1.93^{b}	0.93^{a}
C. canephora+ Trichoderma+ Streptomyces	6.99^{d}	1.55^{bc}	2.63^{d}	0.46^{a}	11.84^{a}	0.48^{a}	0.52^{a}	1.47^{b}	1.10^{a}
Initial soil sample	5.70	1.51	2.77	0.12	3.80	0.32	0.10	1.30	0.60

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Experimental Title: Mass Propagation of Some Cacao (Theobroma Cacao L.) Hybrids Through In-Vitro Culture

Investigator: Mapayi E.F.

Introduction

Cacao is one of the most important cash crops in Nigeria.

Cacao production is mostly valued for its bean product, which has its nitch in the world of confectionaries, cosmetics and pharmaceuticals. Currently, eighth new cacao hybrids were released by Cocoa Research Institute of Nigeria (CRIN) to the country.These have better performance in terms of yield, bean quality and earliness to fruiting. Application of tissue culture techniques, in order to produce somatic embryos and consequently plantlet regeneration from the flora explants of these hybrids becomes imperative for efficient mass propagation and distribution across the country. Hence, this research was targeted at generating embryogenic callus from cacao flora explants (staminode and petal) of the eight new hybrids (TC-1, TC-2, TC-3, TC-4, TC-5, TC-6, TC-7 and TC-8) and subsequently plantlet regeneration.

Objectives

- To develop somatic embryos from the individual tissues of cacao flower (staminode and petal)
- To regenerate plantlets through *in vitro* techniques for mass distribution of elite cocoa materials
- To evaluate the regeneration potential of the individual tissues of cacao flower
- To ascertain amino acid distribution in callus material and embryos to ascertain the biosynthesis pathway that supports the cacao somatic embryogenesis.

Materials and Methods

Floral explants were collected from TC-1, TC-2, TC-3, TC-4, TC-5, TC-6, TC-7 and TC-8 *cacao* hybrids, in hybrid pod garden at CRIN, Ibadan and subjected to *in-vitro* culture at CRIN tissue culture laboratory. The established cocoa tissue culture media protocol developed by the Pennsylvania State University Tissue Culture Laboratory was adopted for the study. Unopened immature flower of medium to large sizes with the base of their filaments attached were collected in a clean McCartney bottle containing distilled water early in the morning between 8am-9am. The flower buds were then surface sterilized in 4% of sodium hypochlorite solution for twenty minutes by gently rocking the tube back and forth every five minutes while ensuring contact of the hypochlorite solution with the flower buds. The hypochlorite solution was then completely removed by washing with sterile distil water and inverting the tubes several times. The flower buds: in the sterile petri-dishes were transferred inside laminar flow hood (leaving behind as much water as possible) until ready for dissection. The flower buds were sliced across at a position approximately one-third of the flower length from the base of filament using a sterile scalpel No. 11 blade. Staminode and petal tissues were then extracted. Staminode and petal-based explants were transferred into a petri-dishes containing 25-30ml of primary callus growth medium (P.C.G). Petri-dishes were then sealed with parafilm, labelled, and kept in a box. Cultures were maintained in the dark at 27^{o}C+. 2^{o}Cfor fourteen days and were transferred into 30ml of the secondary callus growth medium (S.C.G 1) for another two weeks to produce callus in the dark. This was also transferred after two weeks into secondary callus growth medium (S.C.G 2). Callus from SCG medium were sub cultured and maintained every two weeks in embryo development medium (ED) till large number of somatic embryos were developed. The callus generated was subjected to Amino Acid Analysis.

Indicators

- Consumables for culture induction purchased
- Callus was developed on staminode tissue for all the eight cocoa genotypes
- Callus was developed on petal tissue for all the eight cocoa genotypes

Results and Discussion

There were formations of callus in both explants (Fig.1) at two weeks on PCG medium (Fig.2a and 2b) and at four weeks on SCG media (Fig.3) for all the eight genotypes considered for the study. Production of embryogenic callus from *cacao* floral explants has been demonstrated and this offers a high potential in the future production of elite *cacao* variety (Li, Z. *et al*.; 1998) and efficient in vitro propagation systems in multiplication of the materials, conservation and in the gene transformation. The concentration of free amino acids in cacao tissue depends on the ontogenic stage of the somatic embryos and the culture conditions. This will help in understanding the biosynthesis pathway that helps in the development of ontogenic stage of cocoa.

Conclusion

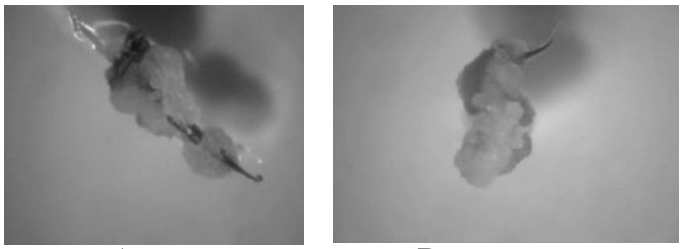
Production of embryogenic callus from the floral explants (staminode and petal) of the *cacao* genotypes has high potential for plantlet regeneration. Also, somatic embryo induction method (adopted from Pennsylvania protocol for *cacao*) was found to be effective and efficient in the somatic embryogenesis of these eight (8) *cacao* genotypes considered for the study.

Recommendation

Since these genotypes callused at two weeks, it indicates that they can be directly selected for mass propagation and improvement programme.

Staminode Petal

Fig.1: *Cacao* staminode and petal tissues



A B

Fig.2: Callus formation from staminode explant at two weeks on Primary Callus Growth (PCG) medium. (A)TC-1, (B) TC-2

Experimental Title: Health Risk Appraisal of Selected Heavy Metals in Some Imported Chocolates Sold in Southwestern, Nigeria

Investigators: Aikpokpodion Paul E. and Asowata F.E

Introduction

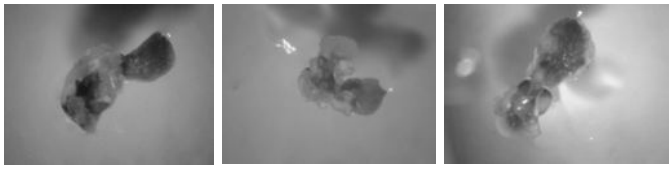
Chocolate is a typically sweet, brown food preparation of *Theobroma cacao* seeds. The seeds are usually roasted and ground in form of a liquid paste or in block. Much of the chocolate consumed today is in form of sweet chocolate, a combination of cocoa seeds, cocoa butter or other fat and sugar. Milk chocolate is a sweet chocolate that additionally contains milk powder or condensed milk, while the white chocolate contains cocoa butter, sugar, and milk but no cocoa solids (Miller *et al*. 2006).

Challenges

Lack of reagents and fund to move the callused materials to the Temporary Immersion Bioreactor Sytems (TIBS) to speed up its plantlet regeneration and electricity to power the Bioreactor.

Reference

Li Z, Traore A, Maximova S, Guiltinan M (1998) Somatic embryogenesis and plant regeneration from floral explants of cacao (*Theobroma cacao* L.) using thidiazuron. In Vitro Cell Dev. Biol Plant 34:293–299



A B C

Fig.2b: Callus formation from petal explant at two weeks on Primary Callus Growth (PCG) medium. (A)TC-1, (B) TC-2, (C) TC-3

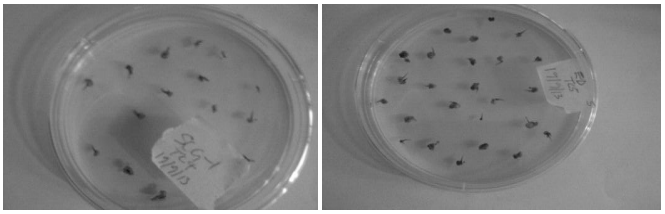


Fig.3: Callus formation at four weeks on Secondary Callus Growth (SCG) medium and Embryo Development (ED) medium.

Another type of chocolate which is not so popular among children is the dark chocolate. This contains 70-80% cocoa solid. It is loaded with nutrients that can positively affect human health. Dark chocolate contains more antioxidant activity polyphenols and flavanols than many fruits (Stephen *et al.* 2011). The flavanols in dark chocolate can stimulate the endothelium, the lining of arteries to produce nitric oxide which lowers resistance to blood flow and therefore reduces blood pressure and improves blood flow (Fisher *et al*. 2003); increases high density lipid (HDL) and lowers total low density lipid in men with elevated cholesterol (Baba *et al*. 2007); protects lipoproteins against oxidative damage (Rein *et al*. 2000) reduces insulin resistance- a common risk factor for many heart disease and diabetes (Grassi *et a*l. 2005); reduces risk of cardiovascular death (Buijsse *et al* 2006); lowers the risk of calcified plaque in the arteries (Djousse *et al.* 2011);

improves blood flow to the skin, increases skin density and hydration (Heinrich *et al*. 2006); increases blood flow to the brain (Francis *et a*l. 2006); improves cognitive function in elderly people with mental impairment (Desideri *et al*. 2012). Though some industries produce chocolate in Nigeria, but greater proportion of chocolates in Nigerian markets are imported from different parts of the world.

Despite the various health benefits and pleasure associated with the consumption of chocolates of cocoa origin, the issue of heavy metal contamination in the product has become a global concern. Since the product passes through diverse industrial processes which involve machinery and packaging (which provides means of protection, marketing and safe handling). Some of the colored printing done on the wrappers for the purpose of enticement, beautification have metals origin. Heavy metals such as Pb, Cr, Ti, Zn and Cu can migrate from the printed surface to the product through blocking, rubbing, peeling and diffusion (Bradley et al. 2005). The consumption of chocolate is common among Nigerian children especially those in the cities. Contamination of imported food products with heavy metals may cause a serious risk for human health because of the physiological effects of heavy metals. Consumption of even small quantity of metals can lead to considerable bio-toxic effects. Though individual metal exhibit specific signs of toxicity, much illness like gastrointestinal disorders, diarrhea, stomatitis, depression, pneumonia and many other have been reported as general signs associated with Cd, Pb, As, Hg, Zn, Cu and Al. In addition, young children are at greatest risk due to their ability to effectively absorb metals and thereby suffer physiological development retardation (Kocak *et al*. 2005).

Apart from natural source and production chain, heavy metal contamination in chocolate can arise from environments where these products are kept (Ashraf, 2006). Except for supermarkets, many of these products are not stored under safe hygienic conditions. They are often displayed in open trays or containers in the markets or hawked along the streets (Iwegbue, 2011). Contamination may arise from such unsafe storage conditions.

Data on metals concentration in foods at the point of consumption is necessary in order to estimate health risk associated with heavy metal contamination in chocolate. In Nigeria, data on heavy metal contamination in chocolate and potential health risk associated with long term consumption among children is limited. Hence, this study evaluates the level of selected heavy metals and potential health risk indices associated with consumption of common brands of chocolate in Ibadan, southwestern Nigeria.

Materials and Methods

The sampling was carried out in June 2014. Thirty (30) chocolate samples containing 26 milk chocolate and 4 dark chocolates were purchased from selected supermarkets within Ibadan metropolis. Ibadan is the largest indigenous city in West Africa which is located in the southwestern part of Oyo state, Nigeria. Each of the samples was homogenized by blending in a stainless-steel blender. After homogenization, 2g of each sample was weighed into a 50ml beaker followed by the addition of 20ml Nitric /Perchloric acids (3:1 v/v) and digested for 2 hours at the temperature of 150^{o}C. After digestion, the digests were analyzed for Fe, Cu, Zn, Pb, Cr and Ni using Buck 210 VGP Atomic Absorption Spectrophotometer.

Quality control

For every metal analysis, samples were prepared in triplicates. All glass wares used in the course of the study were soaked in 10% HNO_3 for 18 hours and later rinsed with deionized water to prevent contamination from glass ware. The Atomic absorption spectrometer was re-calibrated after analyzing ten samples. Accuracy of the analytical procedure was determined by introducing known amount of heavy metal and re-analyzed. Spiked recovery was 98% for Pb, 97% for Fe, 99% for Cu, 98% for Zn, 97.5% for Cr and 98% for Ni. Blank solutions were prepared in order to make room for contamination from analytical reagents used. The detection and quantification limits (LOD and LOQ) were obtained based on the concentration of the analyte that produced signal-to noise ratio of 3x standard deviation of low concentration/slope of the calibration line and 10x standard deviation of low concentration/slope of the calibration line respectively. The detection limits in mg kg^{-1} of the heavy metals were Ni (0.003), Pb (0.05), Zn (0.003), Cu (0.003), Cr (0.002) and Fe (0.001).

Estimated Daily Intake

In order to appraise the health risk associated with heavy metal contamination in the studied chocolates, estimated

daily intake of metals was calculated using the formula:

$$EDI = \frac{C \times CR \times EF}{Bw} \quad \text{..... (1}$$

EDI = Estimate Daily Intake: It is generally the number of milligrams of the contaminant that enters the body for each kilogram of body weight (mg/kg/day).

C = concentration of the contaminant in the exposure pathway being considered (mg/g) of food.

CR= contact rate; Amount of food taken per day (g/day) (chocolate of 20g per day was considered for each child in the study)

EF = Exposure Frequency: This number indicates how often the individual is exposed during a year and the number of years (365 days for 6 years was considered in the study)

Bw = Body weight (kg) (Since the study was concentrated on children, an average weight of 20kg was used)

Target Hazard Quotient: The health risk associated with heavy metals expose through the consumption of chocolate was evaluated using the target hazard quotient (THQ) (Liu et al 2006). Though THQ does not provide quantitative estimate on the probability of an exposed population experiencing a reverse health effect, it offers indication of the risk level due to contaminant exposure. The THQ index can be defined as the ratio of determined dose of a pollutant to the reference dose (RfD) (µg/kg bw/d). The following were the values used for oral reference dose: Fe (0.700), Zn (0.300), Cu (0.040), Ni (0.02), Pb (0.0035) and Cr (1.5) (USEPA, 2010).

$$THQ = \frac{EF \times FD \times DIM}{RfD \times W \times T} \quad \text{..... (2)}$$

Where EF is the exposure frequency (365d/year), FD is the exposure duration (6 years), DIM is the daily metal ingestion (mg/person/day), RfD is the oral reference dose (mg/kg/day), W is the average body weight (20kg), T is the average exposure time for non-carcinogen (365 days/year x number of exposure years). THQ is a highly conservative and relative index (Wang et al, 2005). If THQ is less than 1, there is no obvious risk from the substance over a lifetime exposure, while if THQ is higher than 1, the toxicant may produce an adverse effect. The higher the THQ value, the higher the probability of experiencing long term carcinogenic effects. (Song et al. 2009)

Results

Results of metals in imported chocolate

Observation from the study shows that, milk chocolate predominates the population of chocolate within the city where the study was carried out. Among the chocolates obtained at random, dark chocolate was 13.33% of the whole population while milk chocolate was 86.70% of the population.

The concentration of lead (Pb) in the chocolate ranged between 0.11 and 0.47 $mgkg^{-1}$ with a mean value 0.23 $mgkg^{-1}$. There was however no detectable Pb in 10% of the samples analyzed. Results show that Pb concentration was higher in most of milk chocolate than dark chocolates.

Concentration of nickel in the chocolate ranged between 1.26 and 3.79 with an average value of 2.60 $mgkg^{-1}$. The concentration of zinc in the chocolate ranged between 8.80 and 25.62 with a mean value of 13.95 $mgkg^{-1}$. The concentration of Fe in the studied samples ranged from 21.92 to 71.85 with a mean value of 41.88 $mgkg^{-1}$ while Cu level in the analyzed chocolates ranged from 2.39 to 18.62 with an average value of 5.79 $mgkg^{-1}$. Results show that all the dark chocolate among the studied samples had much higher copper residue compared with milk chocolate. On the other hand, the level of chromium in the chocolates ranged between 2.30 and 6.26 with a mean value of 4.13 $mgkg^{-1}$.

Estimated daily intake

The calculated estimated daily intake of Pb in the studied samples ranged between 0.10 and 0.43 with a mean value of 0.22 µg kg bwd^{-1} (Figure 1). The calculated daily intake of Cr obtained from the consumption of 20g of studied chocolates ranged from 2.3 to 6.25 µg kg bwd^{-1} while the estimated daily intake of Cu in the studied chocolates ranged from 0.24 to 1.86 µg kg bwd^{-1}. The calculated daily intake of Fe from the daily consumption of 20g of the chocolates ranged between 20.35 and 71.85 with an average value of 39.21 µg kg bwd^{-1}. Estimated daily intake of Cu in the studied chocolates ranged from 0.24 to 1.86 with a mean value of 0.58 µg kg bwd^{-1}. Daily intake of Zn from a daily consumption of 20g of the selected chocolates ranged between 8.90 and 131.5 with a mean value of 19.41 µg kg bwd^{-1}. On the other hand, the calculated estimated daily intake of Ni in the samples ranged from 1.25 to 5.55 with an average value of 3.0 µg kg bwd^{-1} per 20g chocolate.

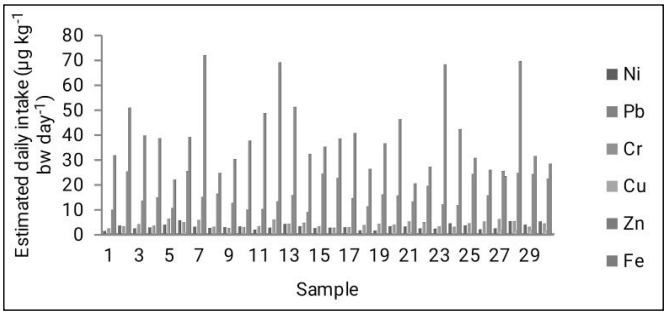


Figure 1: Estimated daily Intake of metals in chocolate brands

Table 1: Levels of heavy metals in various chocolate brands.

	Concentration of heavy metals in chocolates (mgkg^{1})					
	Ni	Pb	Cr	Cu	Zn	Fe
1(milk)	1.26 ±0.05	0.25±0.03	2.30±0.07	3.33±0.10	9.79±0.13	31.66±1.02
2(milk)	3.43±0.06	0.00±0.00	3.18±0.12	5.16±0.21	14.20±0.10	50.79±2.13
3(milk)	2.29±0.02	0.32±0.02	4.03±0.08	4.96±0.20	13.15±0.15	39.65±1.41
4(milk)	2.69±0.10	0.19±0.02	3.40±0.10	4.10±0.15	14.75±0.20	38.52±1.26
5(milk)	3.79±0.13	0.12±0.01	6.26±0.21	2.39±0.12	10.56±0.23	21.92±0.93
6(milk)	2.56±0.09	0.43±0.01	4.78±0.13	6.58±0.11	13.40±0.21	39.00±1.02
7(milk)	3.50±0.08	0.47±0.03	3.68±0.10	2.93±0.10	10.00±0.114	71.85±2.07
8(milk)	2.52±0.04	0.23±0.01	3.01±0.11	3.16±0.13	12.30±0.13	24.61±1.14
9(milk)	2.78±0.10	0.30±0.02	2.52±0.07	5.07±0.20	12.61±0.09	30.20±1.03
10(milk)	2.37±0.09	0.31±0.03	2.84±0.14	3.56±0.09	9.92±0.12	37.62±1.30
11(milk)	3.48±0.07	0.00±0.00	3.20±0.10	2.76±0.05	10.11±0.24	48.58±1.20
12(milk)	2.62±0.06	0.36±0.05	5.86±0.16	4.21±0.12	13.21±0.21	69.02±2.16
13(milk)	3.10±0.09	0.11±0.02	6.15±0.20	3.65±0.06	11.71±0.15	51.11±1.83
14(milk)	2.24±0.04	0.28±0.05	4.60±0.15	4.50±0.10	8.89±0.17	32.26±1.24
15(milk)	2.42±0.07	0.17±0.03	5.18±0.10	5.10±0.12	14.31±0.13	35.12±1.13
16(milk)	2.61±0.05	0.42±0.06	2.62±0.11	3.29±0.16	12.62±0.10	68.41±1.41
17(milk)	2.76±0.08	0.20±0.01	2.81±0.09	4.23±0.10	14.48±0.24	40.62±1.30
18(milk)	1.72±0.07	0.10±0.02	6.21±0.15	3.17±0.07	11.02±0.21	26.20±1.20
19(milk)	1.46±0.04	0.26±0.01	4.13±0.96	3.84±0.09	13.02±0.14	36.46±1.03
20(milk)	1.80±0.05	0.32±0.04	3.79±0.12	6.20±0.13	14.56±0.30	46.13±0.92
21(milk)	3.04±0.06	0.45±0.03	5.12±0.14	6.98±0.16	13.14±0.16	70.36±1.60
22(milk)	2.32±0.08	0.33±0.04	4.86±0.05	5.06±0.06	10.28±0.04	27.05±0.83
23(milk)	2.18±0.03	0.18±0.03	5.72±0.17	3.80±0.05	12.00±0.08	68.17±1.48
24(milk)	2.36±0.06	0.21±0.04	2.98±0.10	3.65±0.13	11.63±0.10	42.21±1.36
25(milk)	2.21±0.06	0.29±0.02	4.42±0.21	4.31±0.15	14.18±0.14	30.62±2.53
26(milk)	1.96±0.03	0.00±0.00	5.10±0.08	4.62±0.18	13.62±0.16	25.84±1.16
27(dark)	3.12±0.11	0.14±0.02	4.12±0.13	16.56±0.14	25.40±0.21	23.32±1.81
28(dark)	3.28±0.12	0.12±0.03	3.61±0.10	14.28±0.12	24.86±0.26	69.52±1.10
29(dark)	3.43±0.25	0.11±0.01	3.02±0.11	18.62±0.09	25.62±0.24	31.41±1.82
30(dark)	3.52±0.36	0.12±0.03	4.30±0.21	13.76±0.07	23.29±0.18	28.29±1.06
Mean	2.60	0.23	4.13	5.79	13.95	41.88
Min	1.26	0.00	2.3	2.39	8.89	21.92
Max	3.79	0.47	6.26	18.62	25.62	71.85

Key: milk= milk chocolate; dark= dark chocolate

Target hazard quotient

The calculated target hazard quotient of Ni for a child that consumes 20g chocolate every day of the week for six years (THQ_{365}) ranged between 0.06 and 0.28.

The calculated Target hazard quotient of Pb ranged from 0.03 to 0.13 for a child that consumes 20g chocolate every day of the week while the calculated total hazard quotient of Cr, Cu, Zn and Fe had range of 0.0015 – 0.0042, 0.06-0.47, 0.03 – 0.08 and 0.029-0.10 respectively for a child who consumes 20g of the chocolates on a daily basis for a period of six years.

Table 2: Calculated Total hazard Quotients of heavy metals in chocolates.

	Target Hazard Quotient 365 $_{days}$					
	Ni	Pb	Zn	Cu	Cr	Fe
1(milk)	0.06	0.07	0.03	0.08	0.0015	0.044
2(milk)	0.17	0.00	0.04	0.13	0.0021	0.071
3(milk)	0.11	0.09	0.04	0.12	0.0027	0.056
4(milk)	0.13	0.06	0.05	0.10	0.0023	0.054
5(milk)	0.26	0.03	0.04	0.06	0.0042	0.031
6(milk)	0.18	0.13	0.06	0.16	0.0032	0.055
7(milk)	0.25	0.05	0.05	0.07	0.0038	0.100
8(milk)	0.13	0.07	0.05	0.08	0.0020	0.034
9(milk)	0.14	0.09	0.04	0.13	0.0017	0.042
10(milk)	0.16	0.09	0.03	0.09	0.0019	0.053
11(milk)	0.09	0.00	0.03	0.07	0.0021	0.068
12(milk)	0.13	0.10	0.04	0.11	0.0039	0.097
13(milk)	0.21	0.03	0.05	0.09	0.0028	0.072
14(milk)	0.16	0.08	0.03	0.11	0.0031	0.045
15(milk)	0.12	0.05	0.06	0.13	0.0021	0.049
16(milk)	0.13	0.12	0.06	0.08	0.0018	0.054
17(milk)	0.14	0.06	0.05	0.11	0.0019	0.057
18(milk)	0.08	0.03	0.04	0.08	0.0025	0.037
19(milk)	0.07	0.08	0.05	0.10	0.0028	0.051
20(milk)	0.16	0.09	0.05	0.16	0.0025	0.065
21(milk)	0.15	0.12	0.04	0.17	0.0034	0.029
22(milk)	0.12	0.10	0.06	0.13	0.0033	0.038
23(milk)	0.11	0.05	0.04	0.10	0.0021	0.095
24(milk)	0.22	0.06	0.04	0.10	0.0020	0.059
25(milk)	0.18	0.08	0.05	0.11	0.0030	0.043
26(milk)	0.10	0.00	0.05	0.12	0.0034	0.036
27(dark)	0.12	0.04	0.08	0.41	0.0041	0.033
28(dark)	0.26	0.10	0.07	0.36	0.0035	0.097
29(dark)	0.19	0.13	0.09	0.47	0.0020	0.044
30(dark)	0.26	0.04	0.08	0.34	0.0029	0.040
Mean	0.15	0.07	0.05	0.15	0.0027	0.055
Min	0.06	0.03	0.03	0.06	0.0015	0.029
Max	0.26	0.13	0.09	0.47	0.0042	0.100

Key: milk= milk chocolate; dark= dark chocolate

Table 3: Correlation among heavy metals in chocolates

	Fe	Cu	Zn	Pb	Cr
Cu	0.259				
Zn	0.413	0.961**			
Pb	-0.073	-0.093	-0.179		
Cr	-0.374	0.175	0.163	0.196	
Ni	0.059	0.353	0.470	-0.458	0.703*

Discussion

Nickel

The range of Ni concentration in the study was lower than the range reported by Dahiya *et al*. (2005) during the assessment of 69 different brands of chocolate and candies in Mumbai, India. Observations showed that, out of the 30 brands of chocolates, the dark chocolates were higher in nickel than several of the milk chocolates except a few milk chocolates (4) that had higher concentration of Ni than the dark chocolate. Similar observation of high nickel in dark chocolate was reported by Dahiya *et a*l. (2005). Prakash *et al*. (2014) reported nickel concentration ranging between 0.77 and 5.29 $mgkg^{-1}$ in five brands of chocolate from Tiruchirappalli, India. However, the highest value recorded for nickel in their study was higher than the highest value obtained in the study. A good proportion of nickel in the chocolate was supplied by cocoa beans which is a major component of dark chocolate. Though cocoa solids could be a source of nickel in chocolate, the major source of nickel contamination in chocolate results from the manufacturing process when hardening is done by hydrogenation of unsaturated fats using nickel as catalyst (Dahiya *et al*. 2005). Nickel is regarded to be a natural constituent of diet and its compounds are generally recognized as safe when used as ingredient in human food (IRIS, 2003). The range obtained in the study is similar to that reported by Ochu *et al*. (2012) from the assessment of the level of nickel in imported chocolate sold in Nigeria. This suggests that chocolates sold in various parts of Nigeria may have common production origin but different points of entry into Nigerian markets. Nickel is found in small quantities in many foodstuffs ($0.001\text{-}0.01 mgkg^{-1}$) and in higher concentrations in grains, nuts, cocoa products, and seeds (up to $0.8mgkg^{-1}$) (National Food Agency of Denmark, 1995). Nickel is found as complex bound Ni^{2+} ions in diets (Codex, 1995). According to Codex (1995) nickel intake via foodstuff does not cause hazards for most consumers. Food intake, gastric emptying and peristalsis movement of the intestine are the substantial significance for the bioavailability of nickel. The absorption of trace nickel ions released in the gastrointestinal tract may be 40 times higher than that of complex-bound nickel from foodstuff (Sunderman et al. 1989).

The estimated daily intake of nickel in the study falls within the World health organization tolerance daily intake for nickel ($5\mu gkg^{-1}bwday^{-1}$). Acceptable or tolerable daily intake is a measure of the amount of a specific substance originally applied in food or drinking water that can be ingested orally daily over a lifetime without an appreciable health risk (WHO, 1987). It is expressed usually in milligrams of the substance per kilogram of body weight per day. Even though the range of estimated daily intake obtained for nickel falls within the acceptable values, over-indulgence of children in relation to excessive chocolate consumption may lead to exceedance of the limit. The study focused on situation where a daily consumption of 20g of chocolate is made by a child who weighs 20kg. The range of estimated daily intake of nickel reported by Ochu *et al*. (2012) is like what was obtained in the study. On the other hand, Iwegbue reported a higher range of estimated daily intake of nickel (0.9-58.6 $\mu g\ kg^{-1}bw\ day^{-1}$) in some ready-to-eat foods consumed in Southern, Nigeria. In addition, much higher dietary Ni contributions ranging from 200 to 900 $\mu g\ kg^{-1}bw\ day^{-1}$ have been reported (Clemente *et al*., 1984; Larsen *et al*. 2002), 240 – 3900 $\mu g\ kg^{-1}bw\ day^{-1}$ (Krishnamurti and Puspha, 1991). According to Dahiya et al. (2005) and Duran et al (2009), the dietary intake of Ni does not lead to any health risk in the general population but could be troublesome to some sensitized individuals. Nickel at trace amount may be beneficial as an activator of some enzyme systems (Under Wood, 1977). At higher levels, it accumulates in the lungs and may cause bronchial hemorrhage. Other symptoms of nickel toxicity include nausea, weakness, dizziness (Nielson, 1977).

he calculated target hazard quotients for nickel (Table 2) indicates that, a child who weighs 20kg and consumes 20g of chocolate every day of the week for a period of six years is not likely to have any health concern as a result of low THQ calculated for nickel in all the 30 samples which was found to be less than 1. A hazard quotient is the ratio of the potential exposure to a substance and the level at which no adverse effects are expected. If the target hazard quotient is calculated to be less than 1, then no adverse health effects are expected because of the exposure. However, if the calculated target hazard quotient (THQ) is greater than 1 then, there is a reason for health concern (Sharma and Agrawal, 2005). It must be noted that THQ is not a measure of risk (Chien et al. 2002; Wang et al. 2005 and Hague et al. 2008) but indicates a level of concern. In a related account, Iwagbue *et al*. (2013) also reported THQ for 15 ready –to –eat food in southern Nigeria where 11

samples had THQ values less than 1 while the rest 4 samples had THQ values higher than 1. It is however advisable for children who are regular consumers of chocolate to be moderate in eating the commodity.

Lead

Result shows that several of the milk chocolates had higher concentration of Pb than the dark chocolates. The range of Pb (0.23-0.47 $mgkg^{-1}$) found in the study was lower than the range (0.009 – 0.92 $mgkg^{-1}$) reported by Al-Mayaly (2014) for Pb in some kinds of candy imported from Turkey and China. Iwagbue *et al*. (2013) reported a range of 0.009 to 3.8$mgkg^{-1}$ Pb in some ready-to-eat foods in Nigeria. The reason given for high Pb content of the foods was as a result of the way and manner the foods are being handled by vendors who usually display them in trays without cover or hawked along the major roads where contamination with Pb and other metals from automobiles emission cannot be ruled out. The concentrations of Pb in the various brands of chocolates were below 1$mgkg^{-1}$ guideline value for Pb in foods. The Codex Alimentarius, Global foods Standards developed by FAO and WHO limits the Pb contents of cocoa powder or beans to 1mg of Pb per kilogram product (www.Codexalimentarius.net/web/standards_list.Jspl). Based on the distribution of Pb metal in the examined chocolates, it is clearly evident that, the proportion of cocoa solid in chocolate does not solely determine the amount of Pb that is present in the commodity. This suggests possible contributions from manufacturing and other ingredients that make up milk chocolate. Other authors had earlier suggested possible means of Pb contamination in chocolates and candies. Fuortes and Bauer, (2000) suggested the possibility of Pb leaching into the product from tainted wrappers. Pb can be introduced into the product during processing such as drying, storing and grinding. Processing or storing products in Pb contaminated containers may also contribute to Pb transfer in chocolate. Due to cases of Pb contamination in foods, the US Food and Drug Administration (FDA) and State Health Department sometimes issued warnings about contamination of Pb in candy imported from Mexico (FDA, 2001). According to the report of Fuortes and Bauer, 2000), the Centre For Disease Control reported the case of six Californian children who suffered from Pb toxicity after eating candy imported from Mexico. That was detected during routine blood Pb screening. It is generally assumed that Pb contamination cannot be avoided in cocoa products due to the fact that majority of cocoa beans used for the production of cocoa based products are grown in locations that still use leaded gasoline (www.sciencenews.org/blog/food-thought/leaden-chocolate). This may not be totally correct as there are other means through which Pb transfer can occur. In a study conducted by Aikpokpodion *et al*. (2013), an attempt was made to evaluate the impact of post-harvest handling and processing on Pb contamination in cocoa beans. Standard procedures were used in processing the beans as well as drying them in environment free of vehicular movement. In spite of all the necessary precautions adopted to prevent cross contamination, 73% of the total number of cocoa samples analyzed exceeded 1mg Pb kg^{-1} cocoa beans set as the maximum residue limit. Analysis of varieties of chocolate products from various countries completed by Swiss group in 2002 showed that the Pb content of these items ranged from 0.0011 to 0.769mg Pb kg^{-1} chocolate which was below International standard limit (1mg kg^{-1}) (Mounicou *et a*l., 2003). It has been reported that, 5 to 7 % of Pb contained in cocoa is bio-available to the body (Mounicou *et al*. 2002). However, this may not be the same for children who react more to Pb toxicity compared with adults. The study by Yanus *et al*. (2014) reported that more heavy metals entered a child's blood streams than an adult's due to lower body weight and higher digestive tract uptake. Studies have suggested Pb exposure can delay kids' intellectual development (Huang et al 2012).

Estimated daily intake of Pb (0.10 to 0.43 $\mu g\ kg^{-1}\ day^{-1}$) in the study was lower than the range reported by Iwegbue (2013) (0.1-4.3 $\mu g\ kg^{-1}\ day^{-1}$) on the study of heavy metals in selected food in southern Nigeria. The values of estimated daily intake of Pb obtained in the study were lower than the values (3.6 $\mu g\ kg^{-1}\ day^{-1}$) set by FECFA as the provisional Tolerance Daily Intake (WHO, 2000). Observation from the study showed that milk chocolate presented higher values of estimated daily intake of Pb compared with dark chocolate.

The level of target hazard quotient for Pb obtained for the 30 brands of chocolate investigated in the study (0.03-0.13) shows there may not be any health concern for a child (20kg) who consumes 20g of the chocolate every day of the week. However, children who are lovers of chocolate should not be encouraged to go into excessive consumption of the product considering the physiological

implication of abnormal concentration of Pb in human system, with emphasis on young children. According to the study published in Talanta , young children risk exceeding recommended limits for Pb when consuming chocolate in excess. Yanus *et al.* (2014) assessing the human risk of trace metals in chocolate stated that although the Pb concentration found in a variety of global brands of chocolates, were below the USA Phamacopeia (USP) 1,000ngg^{-1} limit, the Pb concentration should still be considered a health concern.

Children who are big consumers of chocolate may be at risk of exceeding the daily limit of Pb due to their low body weight and higher digestive tract uptake (Israeli researchers). Children may be vulnerable to Pb exposure via chocolate consumption. One cube of dark chocolate can contain up to 20% of oral limit of Pb in the body. In addition, chocolate may not be the only source of heavy metals in their nutrition as other diets taken may also contain trace metals thereby increasing the risk of exceeding the daily limit. The risk does not apply to adults in the same degree because their digestive absorption of metals is poor (Oliver, 2014). Giving the various observations good considerations, it is advisable for children to eat milk or white chocolate in large quantity than eating dark chocolate which contain higher proportion of cocoa solid.

Copper

Copper at trace level is an essential metal and serves as antioxidant which helps the body to remove free radicals, prevent cell structure damage (Salama and Radwan, 2005). The level of copper in the 30 brands of chocolate examined ranged from 2.39 to 18.62 mgkg^{-1}. The higher values were recorded for dark chocolates while the lower values were recorded for milk chocolates. Result (Table 1) shows that the range of Cu concentration was like the range reported by Joo and Bett (1996). The level of copper obtained in dark chocolate in our study (13.76-18.62mgkg^{-1}) was higher than the level (4.12-6.34mgkg^{-1}) reported by (Falandysz and Kotecta, 1994) in dark chocolate in Malaysia.

Generally, cocoa solid is a major source of copper intake. Little wonder why its concentration in milk chocolate was significantly lower than Cu levels in dark chocolates with have higher proportion of cocoa solid. Naturally, cacao as a crop has the ability to bio-accumulate copper in its tissue which makes the seed (cocoa beans) naturally high in copper content. (Olaofe, 1987) reported a mean concentration of copper residue (8.2mgkg^{-1}) in 11 cocoa samples originating from Ondo State. Aikpokpodion *et al*, (2013) reported mean values of 25.00, 26.00 and 18.00 mg Cu kg^{-1} for cocoa beans obtained from Ogun, Ondo and Cross River States respectively while a mean value of 36.4mgkg^{-1} was reported for copper in cocoa beans in a study carried out by European commission (Annex 111, Council Directive 85/572/EC). In a study carried out by Sager, (2012), copper concentration in cocoa and its products ranged from 3.47 – 31.60 mgkg^{-1}. The presence of considerable amount of copper in cocoa-based products is not peculiar to chocolate. In USA, chocolate drinks and chocolate cakes were found to range among the 20 top foods for copper (Sager, 2012). The total dietary copper intake by males and females was positively associated with the consumption of chocolate foods, which is the main source of Cu intake (Sager, 2012). Among chocolate foods, the dark chocolate made the highest contribution to the mean daily copper intake within a 3-day dietary record study, followed by chocolate pie and chocolate milk (Joo and Belts, 1996). Joo *et al.* (1995) reported a mean copper concentration of 8.8mgkg^{-1} in dark chocolate while Dos Santos et al. (2005) reported copper concentrations ranging between 26.6 and 31.5mg kg^{-1}. These values were higher than copper level recorded in the present study.

Africa produces 73% of the world cocoa (WCF, 2012). Hence, the issue of copper residue in chocolate cannot be discussed without a mention of the level of metals in cocoa beans. A comparison of copper content of cocoa beans obtained from south western Nigeria at different times as reported by Olaofe, (1987) (8.2mgkg^{-1}) and Aikpokpodion *et al*. (2013) (26.0mgkg^{-1}) suggests that copper concentration in cocoa beans increases with time. Between 1987 and 2013, there was a mean increase of 17.8mg Cu kg^{-1}cocoa beans obtained from Ondo State, Nigeria. The increase in copper concentration of the beans with time is mainly due to continuous use of copper-based fungicides by cocoa farmers. Most cocoa farmers in Nigeria and other cocoa producing countries in West Africa use copper-based fungicides to manage black pod disease infestation in the plantations. After application, greater portion of the fungicide goes to the soil while the rest is absorbed in cocoa tissue. As a result of the non-biodegradability of copper in soil, it accumulates over

time thereby increasing the concentration of copper in soil which ultimately leads to high copper content of cocoa beans via translocation and bioaccumulation. The report Lee and Low (1985) also support the contribution of cocoa solid to copper content of dark chocolate. In their study, they observed that, the level of copper in chocolate increased with the proportion of cocoa solids in the final product. A range of 13.78 - 18.28mgkg^{-1} Cu was recorded for dark chocolate while a range of 2.54-2.87mgkg^{-1} was recorded for milk chocolate. The conclusion was that dilution by the addition of other ingredients in place of cocoa mass was responsible for the decrease in copper content of milk chocolate.

Among the 30 brands of chocolates examined in the study, only the dark chocolates exceeded 10mgkg^{-1} limit set for Cu in foods (European Commission, 2006). This suggests that excessive consumption of dark chocolate by children may expose them to copper toxicity. The milk chocolates on the other hand had copper concentration below the European limit.

The estimated daily intake of copper in the study ranged between 0.24 and 1.86 µgkg^{-1} bw day^{-1} with a mean value of 0.58 µgkg^{-1} bw day^{-1}. The Joint Expert Committee on Food Additives (JECFA) set Provisional Maximal tolerable daily intake (PMTDI) of Cu at 500 µgkg^{-1} bw day^{-1} while the safe upper level recommended by EVM (2003) is 160 µgkg^{-1} bw day^{-1}. The mean estimated daily intake of Cu obtained in the study was 0.17% and 0.36% of PMTDI and safe upper limit respectively.

Target hazard quotient calculated for copper in the study ranged from 0.06 to 0.47. This suggests that consumption of 20g chocolate daily may not pose health threat to chocolate consumers since the obtained values are much lower than 1.

Chromium

Chromium is a mineral that humans require in trace amount although its mechanisms of action in the body and the amounts needed for optimal health are not well defined. It is found primarily in two forms: first, trivalent Cr^{3+} which is biologically active and found in food. The second form is hexavalent (Cr^{6+}) - a toxic form that results from industrial pollution. Chromium is known to enhance the action of insulin (Mertz, 1993) a hormone critical to the metabolism and storage of carbohydrate, fat and protein in the body (Porte *et al*. 2003). It has been estimated that humans require mainly 1 µg day^{-1}. The concentration range of chromium in the study (2.3 – 6.26 mgkg^{-1}) was lower than the range (0.8 – 21.4mg kg^{-1}) reported by Iwagbue *et al*. (2013) in selected ready-to-eat foods from Southern Nigeria. Chromium was found higher in milk chocolate than dark chocolate which suggests that various ingredients added to milk chocolate introduced a measure of chromium metal into the product. Milk chocolate is usually made from 27-30% cocoa solid by weight, 12% milk solids, cocoa butter, sugar, lecithin, vanilla, fruits and nuts while dark chocolate is made of 47-85% cocoa solid, cocoa butter, sugar, lecithin and any other flavor. Iwagbue (2011) reported Cr content of some chocolates and candies in Nigeria ranging from 0.04 to 3.0 mgkg^{-1}. The main form of Cr found in food is the trivalent form (Anderson, 1994). In order to prevent deficiency of Cr in human, the committee on medical aspect of food policy (COMA) recommended that Cr should be above 0.1 and 1 µg kg^{-1} bw d^{-1} for children and adolescent respectively (MAFF, 1999).

The EVM guidance value for trivalent Cr is 150µg kg bw d^{-1} (EVM, 2003). The range of estimated daily intake of Cr in the study (2.3 – 6.25 µg kg^{-1}bwday^{-1}) was lower than the range (1.1 – 28.4 µg kg $^{-1}$bw day^{-1}) reported by Iwagbue (2013) in some foods in Nigeria. The calculated daily intake of Cr in all the samples considered in the study was found to be between 1.53 and 4.17% of the EVM Guidance level. This is an indication that chocolate sold in Ibadan city, Nigeria, are safe with regard to chromium contamination in chocolates.

The low values of target hazard quotient obtained for Cr in the investigated chocolates (Table 2) is an indication that a child who has a daily consumption of 20g of any of the imported chocolate examined in the present study is not likely to have any health concern as a result of Cr toxicity. This is since the THQ values obtained in the study ranged between 0.15 and 0.42% of the safe THQ value.

Zinc

Zinc is an essential mineral that stimulates the activity of about 100 enzymes in the body. It also supports human healthy immune system. It is necessary for the synthesis of DNA, essential for wound healing, supports healthy growth and development of the body during adolescence, childhood, and pregnancy. Though the actual amount of

zinc necessary to support human body is quite small, its effects on the body are astronomical (www.fitday.com/fitness-articles/nutrition/vitamins). The mean (13.95mg kg^{-1}) concentration of Zn in the studied chocolates was lower than the mean value of Zn reported by Sagar (2012) in dark chocolates but higher than value (12mg kg^{-1}) reported for milk chocolate. The level of Zn in the study (8.89 – 25.62 $mgkg^{-1}$) was like Zn level (8.90 – 20.00 $mgkg^{-1}$) observed by Iwagbue *et al.* (2013) in some ready-to-eat foods in Nigeria. The pattern of zinc distribution within the 30 chocolate samples analyzed followed that of copper. All the dark chocolate were higher in zinc than the milk chocolate which shows that, cocoa solids are rich in zinc and its proportion in chocolate could determine the level of zinc in the product. According to Edward group (2015), the occasional indulgence in a square of dark chocolate may offer boost to human zinc level. Soylak *et al.* (2005) reported mean concentration of Zn ranging from 6.8 to 20.4 $mgkg^{-1}$ in appetizers and snacks. Salaman and Radwan (2005) reported Zn in the range of 2.35 – 13.70 $mgkg^{-1}$ in cereals, Saracoglu *et al.* (2004) reported Zn levels in the range of 3.1 and 16.1$mgkg^{-1}$ in biscuits in Turkey while Gopalani et al. (2007) reported Zn level in Indian biscuit ranging from nd-13.4 $mgkg^{-1}$. The values of Zn obtained from all the studied chocolates were below the guidance value of 150 mg kg^{-1} set for Zn in foods. The Joint Expert Committee on Food Additve (JECFA) Provisional Maximal tolerable daily Intake (PMTDI) for Zn is 1000µhkg^{-1} bw day^{-1} (WHO. 1982). The expert group on vitamins and minerals (EVM) safe upper level for Zn per day is equivalent to 700µgkg^{-1} $bwday^{-1}$ in 60kg adult and 233.33µ$gkg^{-1}bwday^{-1}$ in 20kg child for a total dietary intake (EVM, 2003), the range of estimated daily intake in the study (8.90-131.50 µ$gkg^{-1}bwday^{-1}$) was found to be between 3.8 and 56.4% of the recommended upper safe level. The findings show that the daily recommended intake of Zn cannot be attained by the consumption of 20g of chocolate for a child that weighs 20kg. This is in consonance with the report of Sagar (2012) whose study on trace element in chocolate concluded that the recommended daily intake of 150 mg kg^{-1}; Zn in diet can be hardly reached. The estimated target hazard quotient (0.03 -0.08) ranged between 3 and 8% of the safe THQ value. This indicates that the daily consumption of 20g chocolate by a child of average weight of 20kg is not likely to pose health threat on children who eat chocolate on daily basis.

Iron (Fe)

Iron is essential for the proper growth and development of the human body. It helps metabolize proteins and plays a role in the production of hemoglobin and blood cells. Iron deficiency can lead to conditions like anemia, chronic anemia, cough, and pre-dialysis anemia. The health benefits of Fe include the eradication of different causes of fatigue. Fe also plays a key role in strengthening the immune system by making it strong enough to fight off infections. Fe treats insomnia and regulates body temperature (www.newsmax.com/ tlnewsmax/ article/ 371069). Among the various metals considered in the study, Fe is the most abundant. It ranged between 21.92 and 71.85$mgkg^{-1}$ with an average value of 41.88 $mgkg^{-1}$. The range of Fe obtained in the study was higher than concentration range (1.7 – 12.3$mgkg^{-1}$) reported by Iwagbue (2011) but lower than concentration range of Fe (nd – 102$mgkg^{-1}$) in Chocolate and candies reported by Ochu *et al*. (2012). The range was also lower than the level (20.1 – 167$mgkg^{-1}$) obtained in selected chocolate in Austria as reported by Sagar, (2012). Result show that the concentration of Fe in many of the milk chocolate was higher than Fe content of some dark chocolate. On the other hand, some dark chocolates had higher Fe content than some milk chocolates. The high Fe content of the milk chocolate may be due to Fe content of the ingredients used. In a related but different report, Pennington and Young (1990) reported that US milk chocolate contained 8 times less Fe than dark chocolate. Among nutritional food intakes in Poland, chocolate contained significant higher Fe (25$mgkg^{-1}$) than milk, honey and eggs (Falandysz and Kotecta, 1994). This implies that, chocolate is a good source of mineral iron that the body requires.

Iron is mainly a deficiency problem and not a toxicological problem and it is generally acknowledged to be the most common single nutritional deficiency in both developing and developed countries (Nordic Council of ministers, 1995). Under normal conditions, about 5-15% of Fe in food is absorbed (Elinder, 1986). Iron salts like ferrous sulphate and ferrous succinate are commonly used for the treatment and prevention of iron deficiency in humans (Beliles, 1994).

The estimated daily intake of Fe from the consumption of 20g of chocolate per day in the study (20.35-71.85 µ$gkg^{-1}bwday^{-1}$) is similar to the range (10.8 – 71.80 µgkg^{-1}bw day^{-1}) reported by Iwegbue *et al*. (2013). The estimated

daily intake in the study was found to be in the range of 4.07 and 7.8% of the lower limit (10mg day^{-1}) of the recommended dietary allowance of iron (Demirezen and Uruc, 2006). This implies that, the consumption of chocolate daily is a good source of nutritional iron and not likely to cause health concern.

Correlation analysis (Table 3) showed that copper and zinc had significant (P = 0.1) positive relationship. This indicates that, the proportion of cocoa solids in the investigated chocolates was mainly the determining factor for copper and zinc levels in the products. Chromium and nickel also had significant (P = 0.05) positive correlation which indicates similar sources of the metals in chocolates.

Conclusion

The study revealed that the concentration of the metals considered in the study were within the acceptable limits except for copper in dark chocolates. The study showed that, daily consumption of 20g of any of the investigated chocolates cannot supply the required daily amount of Cr, Zn and Fe needed by the body. Hence, other food sources will be required to supply the nutritional deficit. Quantity of cocoa solids in chocolate determined the level of copper and zinc in the commodity.

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KOLA PROGRAMME

Experimental Title: Grading of Kolanut (*Cola* spp.) in Producing areas in Southwestern Nigeria

Investigators: Adeniyi, D. O., Aroyeun, S. O., Ogunwolu, S. O., Abdulkareem, I. F., Yahaya, A. T., Mokwunye, I. U. and Ugioro, O.

Introduction

Kolanut is a potential export product in Nigeria because of its acceptability across all the geopolitical zones of Nigeria. A major tribal group in Nigeria give much spiritual and social recognition to kola consumption. Kolanut are presented as a mark of honour to kings, chiefs and in-laws during marriages and during naming ceremonies The major constraint for kola exportation in Nigeria is the grading system and literature is scarce on kola grading when compared to cocoa beans that have repleted information. Standard grading scale is necessary for the purpose of export; different grades of kolanut were sampled from study locations and subjected to physico-chemical analyses, microbial assay and insect pest damage evaluation.

Objective

To develop a standard grading scale for kolanut in Nigeria

Methodology

The study locations were selected by random sampling method while kolanut farmers, traders and markets were visited in study areas. Information on kolanut grading were sought through structured questionnaire on the varied names, grades, prices, measurement tools and both dry and wet samples of different kolanut grades were collected. The kolanut samples were assayed for microbial and associated organisms population by cultured them in Potato Dextrose Agar (PDA) medium for mycoflora and Nutrient Agar (NA) for bacteriological studies. The media were routinely prepared in the laboratory and kolanut samples were assayed through serial dilution and direct plating methods, pure cultures of associated microbes were obtained and identified based on morphological features according to Barnett and Hunter, 1983. The insect pest evaluation was carried out by storing the kolanut samples for a month and then assayed based on some physical attributes such as number of weevil feeding signs, number of oviposition holes and presence of weevils. The

returned questionnaire was analyzed and comparison of findings across study locations was reported.

Results and Discussion

The kolanut samples collected from the study areas in Ogunmakin, Mamu and Sagamu comprised of the Gooria (wet & dry), Zaara (wet & dry) and Mini (wet & dry). The nuts count of the kola ranges from 30 – 51, 69 – 72 and 86 – 181 nuts per kg of the grades respectively. The colony count of the microbes associated with kolanut grades in Ogunmakin showed the highest microbial count of $15.0x10^{-5}$cfu in Gooria wet followed by $10.67x10^{-5}$cfu in Mini dry nut grade. Gooria dry kola grade in Mamu had $66.67x10^{-5}$cfu and followed by Gooria wet with microbial count of $29.67x10^{-5}$cfu. Gooria dry nut grade had $190x10^{-5}$cfu and the least microbial count in Sagamu was $63x10^{-5}$cfu (Table 1). All kolanut grades in Sagamu had the highest microbial counts compared to other study areas though the mycoflora genera; *Aspergillus, Fusarium, Rhizopus, Lasiodiplodia* and *Penicillium* were common to kolanut grades in the study locations. The kola nut count was significantly higher in Mini wet and dry than other grades, but Gooria and Zaara grades showed significant similarities in Ogunmakin nut count. The number of nuts in Mini wet grade was significantly higher than other grades, Mini dry gave a higher kola nut count compared to Gooria and Laboji dry kolanut while similarities were recorded in the nut count of Gooria wet and dry and Laboji dry kolnaut. The kola nut count in Sagamu showed significantly highest number of nuts in Mini grades, followed by Zaara and the Gooria was least (Table 1).

Table 1: Characteristics of Grades of Kolanut samples in selected study locations in Ogun State

Kolanut Grade samples	Nut count of sample (nuts/kg)	Colony count (x10 ^{5} cfu)		% Moisture content	% Infestation level	Insect feeding signs & holes	Oviposition hole	Weevil infestation
		Mycoflora	Bacteria					
Ogunmakin study location								
Zaara Wet	35	5.67	2.84		16.67	+	-	-
Zaara Dry	71	5.0	1.14		14.3	+	-	-
Gooria Dry	32	6.67	2.08		12.5	+	-	-
Gooria Wet	32	15.0	1.06		60	+	-	-
Mini Dry	164	10.67	1.10		25	+	-	-
Mini Wet	137	5.0	9.80		42.1	+	-	-
Mamu study location								
Laboji Dry	53	4.67	4.20	1.54	14.3	+	-	-
Mini Wet	181	43.0	1.72	7.19	29.5	+	+	-
Mini Dry	86	16.67	7.0	6.68	32.5	+	+	-
Gooria Dry	28	66.67	4.65	5.02	0	-	-	-
Gooria Wet	51	29.67	1.90	6.88	31.3	+	+	-
Sagamu study location								
Zaara Wet	69	67.0	1.13	28.74				
Zaara Dry	72	74.0	2.90	22.29				
Gooria Dry	30	190.0	1.57	65.05				
Gooria Wet	39	127.0	4.78	54.83				
Mini Dry	132	128.0	1.28	14.45				
Mini Wet	144	63.0	1.16	11.44				

Present (+), Absent ( ).

The results shows that almost all the kolanjt grade samples had varying levels of weevil infestation ranging from 14.3% to 60% though no weevil was observed throughout storage. Oviposition holes were recorded only in Mamu study location and were common to Mini wet, Mini dry and Gooria dry grades. It is most likely that the kola nut samples were already treated with insecticides before purchase. It would be interesting to run residue analysis but for fund constraint. The analysis of returned questionnaire, bacteriological assay, physicochemical analysis and insect damage evaluation of kola samples are on – going.

Status: On-going

COFFEE PROGRAMME

Experimental Title: Adopting Top-grafting to Rehabilitate Moribund Coffee Plantations for Increased Production in Nigeria

Investigators: Oloyede, Amos. A., Dada, Keji. E., Famaye, Amos. O., Famuyiwa, Busayo .S., Ipinmoroti, Rotimi. R and Orisasona, Taiwo.

Introduction

The prédominant coffee spécies in Nigeria is Robusta coffee which constitutes up to 94% of total production. Average yield on farmers' plots is less than 500kg/ha. The low yield is attributable to poor planting materials, self incompatibility and old age of most coffee plantations. However, inter-mixing of clones has been reported to increase *Coffea canephora* yield (Pochet,1991).To triple yield on-farm, in-situ top grafting of improved Robusta clones and Arabica was done on regenerated chupons of unimproved, low yielding materials in 2016/17 season at CRIN Headquarters Demonstration plot. Arabica top grafting was done to extend cultivation to lowland areas from the traditional upland areas where land is limiting.

Materials and Methods

3-4cm stem length as scion were cut into water inside a plastic bucket early in the morning from three high yielding clones C111, C36, T1049 and Arabica variety. Four grafts were made on orthotropic shoots from each stand of the existing clones (root stock). The selected clones were the treatments and in three replicates of CRD design. At 21st day, percentage graft take and monthly growth parameters of number of leaves, stem diameter and height of shoot were evaluated. Data were subjected to statistical analysis using SAS package and means separated by Duncan Multiple range test (DMRT) at 5% level of probability.

Results

The percentage grafts-take were significantly different in order of T1049 (66.67%)> C111 (53.33%)>C36 (46.67%) while Arabica had >50% graft success on Robusta. Growth in terms of height and stem diameter were C36>T1049>C111 however. number of leaves were not statistacally different among coffee clones although, C36 still the highest number of leaves.

Conclusions & Perspectives

Replacement of poor materials by improved ones through top-grafting can triple yield on farmers farms to between 1300-1500kg yield/Ha while inter-specific grafting of *Coffea arabica* on Robusta can make its cultivation possible in lowland locations.

Arabica graft

Fully grown Arabica graft

Fruited Robusta

Fully grown

On-farm demo

Robusta graft

Experimental Title

Development of a Motorized Coffee De-husking Machine

Investigator: Adeleke, S. A

Introduction

Coffee is produced for economic purposes in many nations of the World, and it is highly consumed in Europe and North America mostly for stimulating effects (ICO, 2001). Benefits of coffee include consumption, industrial uses, animal feed, medicine and bio fuel (Akinwale and Oduwole, 2001, ICO, 2001 and Habtamu L. D., 2014). It is also promising for employment and poverty alleviation (Oduwole and Sanusi, 2001 and IACO, 2006)

Deusking/dehulling is one of the key processing stages in coffee; it was described by Oduwole and Akinwale (2001) as the removal of the outer covering of the bean after drying. Abandonment of coffee plantations by Nigerian farmers was caused by lack of processing machines (Famaye and Ibiremo, 2001) and poor processing method attributed to lack of appropriate machinery leads to poor quality beans (IACO, 2006). Correct and proper primary processing is one of the key determinants of coffee quality (FAO, 2005) and quality of beans demanded in the international market is high and cannot be compromised (IACO, 2006)

Traditionally, dehulling was done by pestle and mortar; but mechanical dehullers are available (Practical Action, 2011) in some major coffee producing regions in the World. There is high demand for coffee processing equipment to reduce drudgery in coffee growing areas in Nigeria. High field and post-harvest losses is also against high potential of economic coffee production in Nigeria, especially with the current need for economic diversification. This work intends to provide a medium capacity machine for dehusking dry coffee berries suitable for local processors/farmers.

Materials and Methods

Fabrication and assembling of machine components followed relevant engineering principles and theories. The dehusking unit involves shearing and frictional principles to remove husk from the beans while the cleaning system adopts screen-aerodynamic method. The mixture of the husks and coffee beans released through the concave cylinder is separated and cleaned by air blast from a centrifugal fan and an oscillating metal screen. The

unshelled berries, husks and MOG fall from the screen to the front of the machine while clean beans are collected below the machine through the grain outlet. Performance evaluation will be conducted to determine optimal operating conditions from data collected and analyzed through appropriate statistical tool.

Results and Discussion

Materials for the construction have been purchased while fabrication work of the machine is on-going. When the construction and evaluation of the machine are completed, it is expected that the machine will adequately be useful for dehusking dry coffee berries at a small-scale level.

Conclusion

Development of a powered machine for dehusking coffee at a small-scale level has commenced. When the work is completed, it is hoped that acceptable dehusking and cleaning efficiencies comparable to similar machines will be achieved. This project will therefore partly solve the problem of coffee processing in Nigeria.

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Experimental Title: Genetic Diversity Studies of Coffee

Investigator: Adepoju, A.F.

Introduction

Coffee belongs to the genus *Coffea* L. of the family Rubiaceae which contains over 10,000 species that are grouped into 640 genera. The genus is made up of about 100 distinct species. Among these species, only *C. arabica* L. (arabica coffee) and *C. canephora* Pierre ex A. Froechner (robusta coffee) are economically important worldwide, while others and wild forms are used for breeding purposes (Davis *et al*., 2006). Coffee is one of the cash crops in Nigeria. In Nigeria, cultivation on a large scale started as far back as the 1940s but gain momentum in the early 1950s. in the early 1950s, farmers were motivated to plant coffee owing to good income made from it. Bu 1989, approximately 250,000 farmers' cultivated coffee in Nigeria, thus providing livelihood for about 1 million people spread in fourteen states of Nigeria (Williams, 1989).

Knowledge of genetic diversity and relationships among elite breeding materials is important for the improvement of crop plants. It can be applied for selection of promising parents in hybrid variety and inbred line development, in assigning inbed lines to heterotic groups, variety registration and protection (Pejic *et al*., 1998) and to estimate the potential of genetic gain in a breeding programme (Almanza- Pinzon *et al.*, 2003). It is essential for identification of duplicate accessions among collections and for efficient conservation and utilization of available genetic resources (Sakiyama, 2000). Molecular markers techniques are based on naturally occurring polymorphisms in DNA sequence (Wetermeiier, 1993). Molecular marker can be considered as a constant land marks in the genome. They are only identifiable DNA sequences found at specific locations of the genome and transmitted by the standard law of inheritance from generation to the next. They work by either measuring directly or indirectly a specific DNA sequence diference between various genotypes. They rely on DNA assay in contrast to morphological and biochemical markers that

are based on visible traits and proteins produced by genes respectively (Semagn *et al.*, 2006, Marica, 2008).

Objective

To understand the diversity of *Coffea* sp in Nigerian coffee germplasm at genomic level

Materials and Methods

Accessions of coffee from the gene bank of Cocoa Research Institute of Nigeria (CRIN), Ibadan headquarter, Kusuku Mambilla and Ibeku substations of the institute were used in this study for characterization. DNA extraction was carried out at the Bioscience Laboratory, International Institute of Tropical Agriculture (IITA), Ibadan. Total genomic DNA was isolated using CTAB method and Nanodrop was used for DNA quantification. Forty primers of SSR markers were ordered for Polymerase Chain Reaction

Indicator: Genomic DNA and forty primers.

Results

Table 1: DNA concentration of 44 genotypes of coffee

Genotypes	DNA concentration ng	Genotypes	DNA Concentration ng
A81	235.4	TG468	623.7
A110	235.1	TG375	232.8
C36	224.7	TG211	73.4
C90	270.8	TG216	418.9
C96	222.5	TG202	880.8
C105	601.4	TG126	158.3
C107	313.6	C Arabica Porto Rico	698.4
C108	313.6	TH-F1 12-2	481.1
C111	326.6	T.992 Padang	551.7
D57	160.4	Porto Rico	985.8
E1	455.1	T.1997 A187	464.6
E106	278.4	TH-F1 5-1	185.2
H139	308.6	T.971 Guadeloupe	92.1
M10	135.1	TH-F1 18-1	122.8
M53	325.39	T.977	124.3
T24	339.3	TH-F1 4-1	258.2
T921	246.2	T.990	249.3
T1049	244.21	TH-F1 9-3	415.4
W109	429.3	T.2000 Semper Florens	493.9
TG181	233.2	Nicaragua	709.2
TG107	356.9	**T.1996 Selection Fica Flora**	529.2
TG149	188		

The result above indicated good quality DNA samples from the 44 genotypes of coffee used for the extraction. These samples would be used for optimization and for PCR

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Experimental Title: Evaluation of Organic Coffee Production Using Three Levels of Low Input Organic Fertilizer in Ibadan, Southwestern Nigeria.

Investigators: A.O.,Famaye , K.B.,Adejobi, S.A.,Adeosun, T.M.,Orisasona and O.S.O., Akanbi

Introduction

After oil, coffee is the most valuable traded commodity worldwide, with global retail sales estimated to be US$ 90 billion. Brazil is the largest word's coffee producer,

followed by Vietnam and Colombia (Davies *et al*., 2006). Coffee is the major export product of some countries such as Uganda, Burundi, Rwanda and Ethiopia. About 70 % of the world crop is grown on smallholdings smaller than 10 ha and hence it is often a family business that provides maintenance for over 25 million people worldwide (Fassio and Silva, 2007). Among some 100 species of the *Coffea* genus, only C. *arabica* L and C. *canephora* (robusta coffee) are economically important worldwide, with these species being responsible for about 99 % of world bean production (Davies *et al*., 2006). Coffee is today grown in more than 60 tropical countries of the world and accounts for a significant part of the foreign exchange earnings of many of them (Baumann, 2006). Coffee cultivation began in the ninth century in Africa and since most varieties of coffee are naturally intolerant of direct sunlight coffee was originally grown under shade trees, most often fruit and nut trees which also helped to replenish the soil with valuable nutrients and allowed the land to remain fertile generation after generation. Shades land be-reported to be beneficial to coffee. (Famaye 2000; Famaye and Agboola 2003).

Williams (1989) reported that coffee is cultivated in more than 20 states in Nigeria on over 500,000 ha with the highest concentration at Mambilla Plateau, Taraba State. It is also an important source of foreign exchange to Nigeria. In the beginning all coffee was organic and shade grown. Beginning in the 1970s full sun coffee varieties were developed to increase productivity by allowing coffee plants to be grown closer together. As a result chemical fertilizers and pesticides had to be used to compensate for the lack of nutrients being added back to the soil. These types of chemicals harm the soil, surrounding wildlife, adjacent water, the farmers themselves and the taste of coffee. (Famaye, 2005)

Increasing awareness of damage to our environment and our health through harmful production methods has led to greater demand for organic products. Although organically produced consumer goods still account for a small percentage of all grocery sales and organically-grown coffee sales currently represent about 1% of the United States of America market for coffee/beans ((Famaye, 2005).

Organic coffee farming encourages sustainability, multilayer crop production and a rich array of wildlife. Organic coffee farming encourages beneficial insects and a healthier more resistant crop. The considerable potential for improving organic coffee and yield through application of organic materials is widely recognized (Adejobi *et al.,*2011; Agboola and Adeoye,1990; Rayer and Chiroma,1990; Adu-Daapah, 1994; Moyin-Jesu, 2002. Owaiye (1993) and Michori, (1981) reported that residue mulch materials including grasses and farm wastes were efficient in improving coffee yield, while Obatolu (1995) reported the use of cocoa pod husk (CPH) as fertilizer for coffee.

The objective of this study therefore is to evaluate the performance of coffee on the field using three levels of Cocoa Pod Husk (CPH) as organic fertilizer in view of economic reality without the aid of artificial chemical substances .

Materials and Methods

A field experiment was conducted at Cocoa Research Institute of Nigeria (CRIN) Ibadan. The location is on Latitude 7°25'N and Longitude 3°25'E, Alfisol in rain forest zone of Southwestern Nigeria. The annual rainfall is between 1200-1500 mm. The maximum temperature ranges between 26 to 35^{0}C with an average of about 30.1^{0}C. Relative humidity ranges from 50 to 89 % with an average of 79 %.

Soil sample and analysis

Soil samples were collected from 0-30 cm depth on the site, mixed thoroughly and the bulked samples were taken to the laboratory, air-dried and sieved to pass through a 2 mm screen for chemical analysis of particle size which was determined by the hydrometer method (Kettler *et al*., 2001) and organic carbon content (OC) by the potassium dichromate oxidation method (Zhang *et al*., 2001). Soil pH was read on pH meter (1:1 water). Soil potassium (K), calcium (Ca) and magnesium (Mg) were extracted with 1MNH_4 OAC, PH_7 and were determined with flame photometer; Mg was determined with an atomic absorption spectrophotometer. The total nitrogen (N) was determined by the Microkjedahl method (AOAC, 1990). Soil P was extracted by the Bray P1 extraction and measured by the Murphy blue coloration and determined on a spectronic 20 at 882um (Murphy and Riley, 1962)

Processing and analysis of cocoa pod husk used for the experiment

The cocoa pod husk (CPH) used for the experiment was

obtained from the Crop Processing Unit of Cocoa Research Institute of Nigeria, Ibadan at the rate of ₦200/kg. This translated of ₦ 20,000, ₦ 40,000 and ₦60,000/treatment/hectare. The CPH was air dried for 3 weeks under the shade, later ground into powder form (< 2 mm sieve) using hammer mill and packed in 50 kg bags for application on the field. Two grammes (2 g) of the organic fertilizer (CPH) was analyzed by Moyin-Jesu (2012) for nutrients composition according to standard procedures (IITA, 1992).

Collection of coffee seeds and depulping

Diseased free coffee seeds were collected from the coffee plantation of Cocoa Research Institute of Nigeria (CRIN) in early September, 2011 and depulped. The selected berries were soaked in water over night and harsh parchment removed. The berries were washed further in water to removed mucilage and the clean coffee berries were air dried under shade.

Pre-nursery and nursery establishment

In late September 2011, air-dried seeds were sown in boxes (90 x 60 x 30 cm) after filling the seed boxes with river sand. The seed boxes were thoroughly watered and kept under shade. The watering was discontinued because rain was steady at that period of time. The seeds of coffee germinated about 6 weeks after sowing. The bulk soil taken from the site (0-30 cm depth) was sieved to remove stones and plant debris and 2.5 kg of the sieved soil was placed into a polybags (25 x 15 cm) in 2011 and 2012. The germinated coffee seeds were transplanted in to polybags filled with top soil. Watering was done immediately to prevent transplanted seedlings from wilting and this continued for one week till proper establishment. A shade was constructed over the polybags containing the germinated seeds to prevent scorching by sun. Hand weeding was done at 2, 5, 8 and 16 weeks. No chemical spray in both pre-nursery and nursery stages. The seedlings were transplanted into the field, 20 weeks after sowing.

Field experiment

Field was conducted in Cocoa Research Institute of Nigeria (CRIN), Ibadan Headquarters. The experiment was conducted between 2012 and 2015. It was laid in Randomized Complete Block Design (RCBD) with 3 replications. The site was cleared and lay-out of the experimental site (Measurement, pegging and holing) was carried out before planting. Plantain suckers were planted at 3.0 x 3.0 m apart as a shade crop for the establishment of coffee seedlings. The experiment had four treatments comprising of four coffee stand applied with 100 kg/ha CPH, 200 kg/ha CPH, 300 kg/ha CPH and the control (No CPH application). Coffee seedlings were transplanted 3.0m apart. Treatments were imposed 6 months after transplanting of coffee seedlings into the field.

Data collection

Data were collected on the growth parameters of coffee seedlings such as: Plant height measured in centimeter using a meter rule on the surface and the tip of the main stem; Stem diameter was measured in centimeter with the use of Vernier'Caliper 30 cm above the ground level and leaf area (Leaf area meter).

Coffee berry yield, obtained in the first 2 years of fruit bearing were also evaluated. The results were subjected to statistical analysis of variance and LSD was used to separate the means that were significant.

Result and Discussion

The pre-planting soil physical and chemical properties of the experimental site are presented in Table 1. The result of the particle size analysis showed that the soil was sandy loam and Alfisols (Soil Survey Staff, 1999). The silt + clay contents of the soil (18.5 %) was far below the 32 % estimated as adequate soil ideal for tree crops especially coffee (Egbe *et al*., 1989). Based on the established critical level of soils in southwestern Nigeria, the soil pH of 6.3 was adequate for most tree crops including *Coffea canephora* (Agboola and Corey, 1973). The total nitrogen of the soil was less than 0.15 % which is considered optimal for most crops including coffee (Ogunwale *et al*., 2002). This suggests the need to improve on the soil organic carbon to enhance nutrient retention and the release of same to crops upon external organic manure application (Agboola and Omueti, 1982). There is need for proper soil management on Ibadan soil to reduce the deleterious effects on soil physical and chemical properties. Available P was also low (7.41 mg/kg), this level of P is considered inadequate for cacao (Wessel, 1971; Egbe *et al*., 1989). The soil gave exchangeable potassium above the critical level of 0.3 cmol/kg. The exchangeable Ca^{+} also felled below the critical value of 5 cmol/kg required for coffee growth. The exchangeable Mg^{+} was not adequate for coffee production. Obatolu

(1991) earlier observed the general low Mg^{+} nutrient contents of this soil. The low nutrient contents of the soil implied the need for external input of nutrients in order to meet the requirements for optimal organic coffee production. It was obvious that the soil was inherently low in fertility and was therefore expected to show positive response to soil amendment. The insufficient levels of the major nutrient in the soil showed that the soil was depleted in nutrient and would not be able to meet the nutritional needs of coffee plants unless external nutrients supply is made to support optimum growth and yield of coffee plants. The pH of 6.3 was adequate for *coffee camephora* as reported by Famaye *et al* (2003). The percentage total N, Available P and exchangeable K of 0.08, 7.41 and 0.42 respectively were also adequate.

The chemical properties of CPH used in the experiment are represented in Table 2: CPH was indicated to be high in N, P, K, Ca, and Mg. The higher P, K, N, Ca and Mg for CPH agreed with the fact that plant derived materials including those of cocoa and kola pod husk increased P, K, Ca, Mg, and yield of vegetables, rice, millet and maize (Owolabi *et al*., 2003)

The plant height, stem diameter and leaf area of coffee seedlings under different levels of CPH treatment are presented in Tables 3, 4 and 5. The application of cocoa pod husk at different levels increased significantly ($P<0.05$) the growth parameters of coffee seedlings compared to the control treatment with the exception of 3 MAT (Tables 3, 4 and 5). This might've been due to slow released of this organic fertilizer that are peculiar to organic matter contained in it. Cocoa pod husk (CPH) applied at 200kg/ha CPH gave the highest plant height, stem diameter and leaf area from 9 MAT compared to other organic manure levels and the control. Also,200 kg/ha CPH also increased the plant height, stem diameter and leaf area of coffee by 28 %, 18 % and 13 % respectively compared with the control, but when compared with 300 kg/ha CPH treatment, it also increased plant height, stem diameter and leaf area of coffee by 22 %, 17 % and 10 % respectively. This study showed that CPH, a seemingly waste product of cocoa could be used to produce organic coffee and increased availability of N, P, K, Ca and Mg in soil and their uptake by coffee plants thereby leading to enhanced growth performance of coffee. Poor growth of coffee as a result of low nutrient status of soil N, P, K, Ca, and Mg was generally observed in no treatment plot. This observation is in agreement with the work of (Moyin-Jesu, 2007). Which identified deficiency symptoms of yellow coloration, purple coloration and marginal burning of leaves signifying N, P, K deficiencies in tropical Africa soils. Also, 200 kg/ha produced the highest coffee berry yield relative to other levels of CPH application and the control in both 2014 and 2015. Again, 200 kg/ha CPH enhanced coffee berry by 10 % and 9 % compared with the control plot in 2014 and 2015 respectively, when compared with 300 kg/ha CPH, it increased coffee berry yield by 7 and 6 % in 2014 and 2015 respectively. These yield results authenticate the importance of organic fertilizer in crop production. These results have shown clearly that organic manures are capable of enhancing tree crops yield such as coffee (Michori, 1998; Obatolu, 1991), teak (Fagbenro, 1998), tea (Ipinmoroti and Adeoye, 2002; Ipinmoroti *et al*, 2004). Ojeniyi and Adejobi, (2002); Adejobi *et al.,*(2015 a and b), Ayeni *et al*.,(2008 and 2009) also found that wood ash, cocoa pod husk ash increased growth parameters and yield of crops such as amaranthus , tomatoes, pepper, kola and cashew seedlings and yam. It has also been observed that leaf chlorophyll, K: Na and C:Na ratio of organic manure treated crops were found to be higher than NPK treated crops. These contents might have been responsible for better growth, yield and yield quality for crops under organic treatments compared to NPK treatment (Adeniran, *et al.,* 1999; Alabi and Odebina, 2001).

Table 1: Soil Physical and Chemical properties of the experimented site at the beginning of the trial

Soil Properties	Values
Physical properties	
Sand	81.50 %
Silt	8.30 %
Clay	10.20 %
Textural class	Sandy loam
Chemical properties	
pH (H_20) 1:1	6.3
Organic carbon	0.75 %
Total Nitrogen	0.08 %
Available Phosphorus	7.41 mg/kg
Exchangeable Bases	
K^{+}	0.42 cmol/kg
Ca^{++}	2.43 cmol/kg
Na^{+}	0.02 cmol/kg
Mg^{++}	0.04 cmol/kg
Mn^{++}	0.03 cmol/kg
Exchangeable Acidity	
Al^{+++}	0.23 cmol/kg
H^{+}	0.12 cmol/kg
Soil Classification	Alfisol

Table 2: Analysis of the organic materials used for the experiment

Treatment	C/N Ratio	N %	P Mg/kg	K -------	Ca Mg/L -	Mg -------	Fe ------	Zn Mg/kg	Cu -------
Cocoa pod husk (CPH)	11.10	1.44	100.00	20.59	9.34	7.10	50.40	1.69	0.16

Table 3: Plant height of organic coffee using 3 levels of CPH between 2011 and 2014

	Months After Transplanting (MAT)											
Treatments	3	6	9	12	15	18	21	24	27	30	33	36
100 kg/ha CPH	24.0	32.1	36.2	38.1	42.4	44.1	47.9	50.1	52.3	54.4	57.3	60.5
200 kg/ha CPH	30.8	33.0	39.2	42.4	47.4	50.5	53.7	57.5	59.1	63.0	66.1	68.9
300 kg/ha CPH	24.2	29.1	31.7	33.3	35.1	37.3	40.4	43.3	45.4	47.1	50.3	53.2
Control	26.9	27.0	28.7	20.3	31.4	33.6	36,2	39.4	41.3	43.7	46.5	49.7
Means	24.4	30.3	33.9	36.0	39.0	4.38	44.5	47.5	49.5	52.1	55.0	58.0
LSD (P=0.05)	6.8	5.9	10.0	11.4	15.4	16.0	16.7	17.1	16.8	18.5	18.5	18.3

Table 4: Stem diameter of organic coffee using 3 levels of CPH between 2011 and 2014.

Months After Transplanting (MAT)												
Treatments	3	6	9	12	15	18	21	24	27	30	33	36
100 kg/ha CPH	0.36	0.45	0.42	0.49	0.52	0.56	0.50	0.66	0.70	0.83	0.92	1.08
200 kg/ha CPH	0.35	0.48	0.51	0.56	0.60	0.67	0.71	0.80	0.86	0.95	1.13	1.25
300 kg/ha CPH	0.36	0.41	0.48	0.50	0.53	0.58	0.42	0.65	0.72	0.86	0.94	1.04
Control	0.39	0.40	0.41	0.45	0.47	0.50	0.41	0.61	0.68	0.80	0.91	1.03
Means	0.35	0.44	0.47	0.50	0.53	0.58	0.62	0.68	0.74	0.87	0.98	1.08
LSD (P=0.05)	0.08	0.08	0.07	0.10	0.12	0.15	0.14	0.18	0.18	0.13	0.22	0.25

Table 5: leaf area (cm ^{2}) of organic coffee using 3 levels of CPH in 2011 and 2014

	Months After Transplanting (MAT)											
Treatments	3	6	9	12	15	18	21	24	27	30	33	36
100 kg/ha CPH	58.8	86.3	90.7	91.8	93.0	96.1	99.7	102.1	106.4	110.2	113.1	118.2
200 kg/ha CPH	58.7	85.0	91.1	97.3	99.8	103.2	106.8	110.5	117.1	122.6	126.7	131.8
300 kg/ha CPH	53.9	79.0	89.7	94.6	97.1	99.1	102.1	105.1	109.5	112.7	115.1	119.3
Control	59.0	79.2	86.2	90.2	91.3	93.2	96.3	100.2	103.3	106.4	110.5	114.7
Means	57.6	82.6	89.4	93.5	95.3	97.9	101.2	104.5	109.1	113.0	116.3	121.0
LSD P=0.05)	5.2	8.9	4.8	6.7	8.2	9.1	9.4	9.6	12.7	14.8	15.3	16.0

Table 6: Organic coffee berry yield (t/ha) using 3 levels of CPH in 2014 and 2015

Berry yield t/ha		
Treatments	2014	2015
100 kg/ha CPH	1,610	1,630
200 kg/ha CPH	1,750	1,800
300 kg/ha CPH	1,650	1,670
Control	1,600	1,620
Means	1,653	1,680
LSD (P=0.05)	148	179

Conclusion and Recommendation

The results indicated that the CPH applied at 200 kg/ha increased the plant height, stem diameter, leaf area and coffee berry yield. The organic manure applied at 300 kg/ha CPH might have been too much as the coffee may not be able to take more nutrient after 200 kg/ha CPH that seemed to be the optimum required for good growth of the coffee as recorded in all the morphological parameters at 36 MAT. The 100 kg/ha CPH treatment was however higher in growth parameters than 300kg/ha CPH but not adequate as the 200 kg/ha CPH treatment was higher than 100 kg/ha CPH. However, there was no significant difference in both growth parameters and yield of coffee between 100 kg/ha CPH and the control. The better performances of 200kg/ha CPH indicate no loss of nutrient or in-adequate when applied. Since organic coffee farming encourages sustainability, healthier more resistant crop, create environment friendly. However, treatment with 200kg/ha CPH with highest growth and yield will be more profitable than other treatment. 200 kg/ha CPH that gave the highest morphological parameters and highest berry yield which increases production efficiency of farmers could be recommended for coffee farmers instead of other treatments in organic coffee production in Nigeria.

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CASHEW PROGRAMME

Experimental Title: Influence of appropriate fertilizer application on yield of cashew in Ochaja

Investigators: Iloyanomon C.I., Ibiremo, O.S., and Ogunlade, M.O.

Introduction

Cashew is an important commodity crop with great potential as foreign exchange earner and source of industrial raw material. It is adapted to a wide range of soil and is often grown on very poor soils with low fertility levels. Hence, productivity of cashew is largely dependent on natural soil endowment as fertilizers are not part of its production system. Consequently, the soils upon which cashew are cultivated are maintained through litter fall and other natural endowment. This has adversely affected cashew yield.

Justification:

Fertilizer is rarely used in cashew production system. The application of fertilizer is however inevitable for the replacement of soil nutrients that are mined through cashew apple and nut harvest annually. This can be achieved through guided fertilizer application which ensures replenishment of mined nutrients. There are various types of fertilizers inorganic, organic and organo-mineral, each with its merit and demerit. There is therefore a need to study the influence of the various fertilizer types on cashew productivity.

Objectives

- To evaluate the influence of the various fertilizer types on yield of cashew.
- To assess the influence of fertilizer types on soil physical and chemical properties.
- To assess the effect of fertilizer types on cashew nut and apple quality.
- To compare the cost effectiveness of the different types of fertilizers on cashew yield

Materials and method

Cashew plantations were selected in Ibadan for the experiment. The cashew trees in the plantations used were pruned and composite soil samples collected from each of the cashew plantations at 0 – 20 cm and 20 – 40 cm soil depth. Leaf samples were also collected from the cashew tree. The soil samples collected were air dried passed through 2 mm sieve and analyzed in the laboratory for some of its physical and chemical properties. The leaf samples were oven dried to constant weight, milled and nutrient content of the leaves determined

Fertilizer based on soil test value was applied. The treatments were:

- No fertilizer (Control)
- Urea + MOP (Inorganic fertilizer)
- Organic fertilizer (Market and abattoir waste compost)
- Organo-mineral fertilizer (Organic fertilizer + urea + MOP)

The fertilizers were applied at the rate of 28 Kg N/ ha + 40 Kg K/ha based on soil test. The treatments were administered on already yielding cashew trees. Each treatment was applied on six cashew trees per replication giving a total of 72 trees. The treatments were arranged in a randomized complete block design (RCBD) with three replications. Data collected was subjected to statistical analysis and significant means separated using Duncan multiple range test at 5% level of probability

Results and Discussion

Results indicated that soils in cashew plantation at Ochaja was strongly acidic with pH values of 5.37 and 5.07 at 0 - 20 cm and 20 - 40 cm soil depth (Table 1). Organic carbon content in the top 0 - 20 cm soil depth was low with a value of 6.90 g/kg. Total nitrogen was also low with a value of 0.3g/kg at the top 0 - 20 cm soil depth (Table 1). This was well below the soil critical nitrogen value of 1g/kg required for cashew (Egbe *et al*., 1989). Hence the need for nitrogen fertilizer. This was corroborated by the leaf nutrient content of 11.4 g/kg (Table 2), which were below the soil critical N value of 12.4 g/kg required by cashew.

Soil available P was adequate with values of 6.54 mg/kg and 6.23 mg/kg at 0-20 cm and 20 – 40 cm soil depth (Table 1). This is above the soil critical P value of 3.7 mg/kg required for cashew (Egbe *et al.,* 1989). Phosphorus was therefore adequate hence no need for P fertilizer. Soil exchangeable K at the top 0-20 cm soil depth was however inadequate with a value of 0.07 cmol/kg soil (Table 1). Potassium fertilization would be required.

Soil exchangeable calcium content of the soil was high across the various soil depth and cashew plantations with values of 9.53 and 8.13 cmol/kg at 0 - 20 cm and 20 - 40 cm soil depth (Table 1). This is above the soil critical value of 8 cmol/kg required for cashew, therefore no need for Ca fertilization. This was corroborated by the high leaf calcium content of 74.54 g/kg (Table 2) which was well above the foliar critical calcium content of 1.8 g/kg required for cashew. Micronutrient Zn, Fe, Cu and Mn were sufficient in the soil (Table 1).

Table 1: Initial physical and chemical properties of soils of cashew plantations in Ochaja

pH	5.37	5.07
Organic carbon (g/kg)	6.90	4.13
N (g/kg)	0.30	0.27
P (cmol/kg)	6.54	6.23
K (cmol/kg)	0.07	0.06
Ca (cmol/kg)	9.53	8.13
Mg (cmol/kg)	0.59	0.50
Na (cmol/kg)	0.36	0.39
Ex base (cmol/kg)	10.55	9.08
Ex. Acidity (cmol/kg)	0.10	0.11
ECEC (cmol/kg)	10.65	9.19
Base saturation (%)	99.06	98.80
Zn (mg/kg)	4.11	4.39
Cu (mg/kg)	3.04	0.37
Mn (mg/kg)	27.60	9.45
Fe (mg/kg)	16.60	16.76
Sand (g/kg)	847.6	828.6
Silt (g/kg)	120.6	130.6
Clay (g/kg)	31.8	40.8
Textural class	Loamy sand	Loamy sand

Table 2: Initial leaf nutrient content of cashew plantation in Ochaja

Organic Carbon (g/kg)	51.6
N (g/kg)	11.4
P (g/kg)	0.53
K (g/kg)	14.5
Ca (g/kg)	74.54
Mg (g/kg)	6.10
Zn (mg/kg)	115.87
Mn (mg/kg)	380.23
Fe (mg/kg)	236.11
Cu (mg/kg)	18.37

Conclusion

Nitrogen, potassium were deficient in soils of cashew plantations, while phosphorous was sufficient.

Future focus

The effect of fertilizer types on flowering, cashew nut yield and quality would be determined at the cashew nut production season. Cost effectiveness of the different types of fertilizers would also be determined.

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TEA PROGRAMME

Experimental Title: Diversity Studied Among 34 Lowland Tea Genotypes in Nigeria.

Introduction

Tea belongs to family Theaceae, genus Camellia. It is most popular non-alcoholic soft beverages across the world (Chen *et. al*., 2000). Tea plant originated from southwestern China, Yunnan province. (Yu 1986). Distinct discrimination of tea at both inter and intra specific level of our germplasm is an important exercise for collection, conservation, evaluation and utilization. The understanding of genetic background will greatly assist in selecting parents for current and long-term success of breeding programme. A large number of tea germplasm have been collected and are preserved in Cocoa Research Institute of Nigeria Mambilla sub-station. Therefore, genetic characterization and phenotypic evaluation of this germplasms are prerequisite for further tea development.

Objectives: The objective of this study was to estimate the extent of genetic diversity among 34 tea genotypes using agro-morphological characters

Materials and Methods

31 lowland tea genotypes and 3 upland tea genotypes were used in this experiment. The materials were collected from Cocoa Research Institute of Nigeria tea germplasm kusuku Mambilla Taraba State. The stem cuttings used were collected from the mother bush prune 6 months before the cuttings were raised. The cuttings were raised for 1 year in the nursery before field establishment.

Experimental Design: Randomized Complete Block Design was used with 3 replicates.

Locations: The experiment was carried out in 3 locations (1) Cocoa Research Institute of Nigeria Ibadan (Latitude 7^0 12^1 and longitude 11^0 13^1), CRIN sub- station kusuku Mambilla (Latitude 6^0 43^1 and Longitude 11^0 15^1) and CRIN sub-station Mayoselbe (Latitude 6^0 55^1 and longitude7^0 13^1).

Spacing: 0.6m X 1.0m within and between rows was used bring about total land area in each location to 824m^2.

Land Preparation: The land area was cleared manually using hoe and cutlass and planted with plantain (shade crop) a year before the arrival of the cuttings so as to provide adequate shade for the materials.

Maintenance: Weeding and other cultural maintenance were done as at when necessary.

Data collection: Data were collected on the following qualitative and quantitative parameters for morphological characterization according to IPGRI description.

Table 2. List of the tea genotypes to be used.

S/N	Genotype	Source	Origin	S/N	Genotype	Source	Origin	S/N	Genotype	Source	Origin
1	NGC12	CRIN	China	13	NGC32	CRIN	China	25	NGC53	CRIN	China
2	NGC13	CRIN	China	14	NGC37	CRIN	China	26	NGC54	CRIN	China
3	NGC15	CRIN	China	15	NGC38	CRIN	China	27	NGC55	CRIN	China
4	NGC17	CRIN	China	16	NGC40	CRIN	China	28	NGC6	CRIN	China
5	NGC18	CRIN	China	17	NGC41	CRIN	China	29	NGC8	CRIN	China
6	NGC22	CRIN	China	18	NGC42	CRIN	China	30	NGC19	CRIN	China
7	NGC23	CRIN	China	19	NGC46	CRIN	China	31	NGC45	CRIN	China
8	NGC24	CRIN	China	20	NGC47	CRIN	China	32	C143	CRIN	Kenya
9	NGC25	CRIN	China	21	NGC48	CRIN	China	33	C318	CRIN	Kenya
10	NGC26	CRIN	China	22	NGC49	CRIN	China	34	C357	CRIN	Kenya
11	NGC27	CRIN	China	23	NGC50	CRIN	China				
12	NGC29	CRIN	China	24	NGC51	CRIN	China				

Quantitative Characters

- Internodes length (cm)
- Length of mature leaf (cm)
- Width of mature leaf (cm)
- No of sepals
- No of Petals
- Length of mature leaf petiole (cm)
- Filament length (cm)

- Anther length (cm)
- Fruit length (cm)
- Fruit diameter (cm)
- Number of seed/fruit
- Plant height (cm)
- No of branches
- Weight of harvested shoot (g)

15. Stem girth
16. Number of leaves

Qualitative Characters

- Leaf serration density (number/cm)
- Stem colour
- Immature leaf colour
- Young shoot colour
- Leaf blade shape
- Leaf apex shape
- Leaf blade base shape
- Leaf hairiness
- Petiole colour

Data collected were analyzed using Analysis of Variance and the means were separated using Duncan Multiple Range Test. Other analyses to be carried out were Principal Component Analysis, Dendrogram, Correlation Analysis and Path Analysis to study direct and indirect effects of the traits measured on the yield.

Indicator: In 2009, 77 tea genotypes were introduced to CRIN tea germplasms in Mambilla plateau and amongst it, these 34 genotypes were used for this experiment. Basic information about these collections is germane for further improvement. No information was made available on these genotypes other than the results below.

Results

Table 1 shows the mean performance of 34 tea genotypes in Mambilla at juvenile stage. Genotype 40 had the highest yield per hectare at one harvest with the value of 89.62kg/ha followed by NGC18 with 80.33kg/ha but not significantly different from each other. NGC25, NGC22 and NGC22 with moderate yield of 53.92kg/ha, 51.91kg/ha, and 50.20kg/respectively were not significantly different from NGC 40 with the highest yield. The least yield 11.45kg/ha was observed in NGC55 and significantly different from all the genotypes described above. The same trend of observation was observed in yield per plant. The highest yield per plant was recorded for NGC40 with average yield of 5.47g/plant while the least was 0.70g/plant observed in NGC55 and significantly different from each other. Genotype C143 had the highest plant height 107cm and the least observed in NGC55 26.50cm and statistically different from each other. The highest number of branches to the nearest whole number recorded for NGC23 was 24 while NGC6 recorded lease number of branches of 10 branches and significantly different from each other. NGC25 produced the highest number of leaves with average of 303.56 leaves and NGC55 produced 37 leaves which was statistically different from NGC25. Also, NGC25 had the highest value for stem diameter 20.23mm while the lease was observed in NGC6 with value of 10.09mm and significantly different from each other. The highest numbers of harvestable points were observed in NGC32 (12.88) while the lowest harvestable points were observed in NGC55 with 3.00 numbers of harvestable points. The two harvestable values were significantly different from each other. However, the longest internode length was 5.7cm observed from NGC 357 (5.71) followed by NGC 46 (4.42cm) and the least internode length was observed in NGC 26 (3.10cm). The mean values of the two genotypes were significantly different from each other. It was observed that NGC13 had longest leaf length followed by NGC50 with the value of 9.95cm and 9.83cm respectively but not significantly different from each other. The highest leaf breadth was found in C357with the value of 5.56cm and significantly different from NGC29 with the mean value of 2.85cm which was the least. The highest leaf length leaf breadth ration was observed in NGC50 3.25 while the least ratio was observed in NGC551.58 and statistically different from each other. Number of flower bud was 44 observed in C357 and the least which was significantly different from the later was observed in NGC55 with value of 1.07 flower buds

Table 1: Mean performance of 34 tea genotypes evaluated for 12 agronomic characters

s/n	Genotype	Yield/ha (kg)	Yield/plant (g)	PH (cm)	NL	NB	SD (mm)	HP	IL (cm)	LL(cm)	LB (cm)	LL/LB	NFB
1	**NGC40**	89.62a	5.47a	90.00a-e	203.89a-f	21.44a-c	17.66a-c	6.33b-g	3.56b	7.46b	3.46b-g	2.21b-d	4.56de
2	**NGC18**	80.33ab	4.90ab	82.71b-e	210.14a-	16.93b-	15.48c-f	10.33ab	3.75ab	8.37a-	2.84g	2.94ab	6.00de
3	**C357**	74.71a-c	4.56a-c	93.06a-d	263.56a-c	19.61a-e	19.84ab	9.44a-d	3.11b	8.72a-	5.65a	2.00cd	44.00a
4	**NGC53**	73.59a-c	4.48a-c	77.22c-g	241.17a-d	19.50a-e	16.60a-d	5.13c-g	5.71a	8.33a-	3.31d-g	2.79a-c	17.18bc
5	**NGC47**	71.95a-c	4.39a-c	60.83f-i	194.94b-f	16.83b-e	14.71c-g	9.57a-c	3.78ab	7.68a-	3.13d-g	2.75a-c	4.14de
6	**NGC6**	69.95a-d	4.27a-d	79.00c-g	161.67c-f	14.28c-f	10.09h	4.40e-g	3.38b	6.81de	3.17d-g	2.18b-d	5.74de
7	**NGC29**	68.27a-d	4.16a-d	69.63e-h	176.00b-f	14.56b-f	12.74d-h	10.43ab	3.62b	7.68a-	2.85g	2.74a-c	4.75de
8	**NGC37**	67.21a-f	4.106a-f	75.72c-g	235.28a-d	18.67a-e	15.03c-g	6.63b-g	3.61b	9.56a-	3.51b-g	2.76a-c	11.71b-e
9	**NGC46**	66.48a-g	4.05a-g	69.11e-h	234.67a-d	15.00b-f	12.69d-h	7.78b-f	4.42ab	8.32a-	3.43c-g	2.48a-c	3.22d-e
10	**NGC17**	64.21a-h	3.92a-h	47.22i	121.67e-g	14.56b-f	11.43f-h	4.33e-g	3.74ab	8.23a-	3.17d-g	2.66a-c	7.67c-e
11	**NGC23**	63.35a-h	3.86a-h	94.21a-c	261.21a-d	24.29a	16.74a-d	9.00a-e	3.16b	7.73a-	3.61b-g	2.11b-d	8.83c-e
12	**NGC42**	59.83a-h	3.65a-i	59.13g-i	105.19gf	9.69fg	13.02d-h	6.80b-g	3.27b	6.36e	3.21d-g	2.09cd	4.50de
13	**NGC54**	59.56a-i	3.63a-i	76.56c-g	192.89a-f	19.67a-e	16.22a-e	4.33e-g	3.93ab	9.23a-	3.92a-e	2.57a-c	8.25c-e
14	**NGC49**	56.10a-i	3.42a-i	86.36b-e	186.11b-f	18.67a-e	13.81c-h	7.22b-g	3.98ab	8.30a-	3.64b-g	2.34b-d	20.50b
15	**NGC13**	55.28a-i	3.37a-i	81.33b-f	162.44c-f	13.72d-f	13.38c-h	3.43fg	3.09b	9.95a	4.17a-c	2.42bc	1.07e
16	**NGC41**	54.51a-i	3.33a-i	71.00e-h	177.00b-f	15.67b-f	14.25c-h	7.13b-g	3.74ab	4.41a-	4.13a-c	2.28b-d	4.17de
17	**NGC25**	53.92a-i	3.29a-i	101.89ab	303.56a	20.67a-d	20.23a	5.13c-g	3.73ab	8.74a-	4.42a	1.99cd	8.80c-e
18	**NGC22**	51.91a-i	3.17a-i	53.25hi	155.75d-f	17.15a-e	13.69c-h	3.80fg	3.51b	8.03a-	3.00fg	2.79a-c	11.50b-e
19	**NGC24**	50.20b i	3.06b i	76.31c	202.81a f	12.69ef	13.94c h	5.75b	3.19b	7.60a	3.76a f	2.03cd	2.5de
20	**NGC26**	46.37b-j	2.82b-j	74.00c-g	204.11a-f	13.33d-f	14.85c-g	6.00b-g	3.16b	7.63a-	3.14d-g	2.50a-c	6.60c-e
21	**NGC48**	45.26b-j	2.76b-j	58.89g-i	201.94a-f	18.06a-e	13.77c-h	5.50c-g	3.10b	8.36a-	3.29d-g	2.49a-c	2.93de
22	**NGC32**	42.44b-j	2.59b-j	70.56e-h	180.67b-f	16.00b-f	13.22c-h	12.88a	3.13b	8.46a-	3.56b-g	2.41bc	12.22b-e
23	**NGC19**	40.07c-j	2.44c-j	84.33b-e	227.44a-d	17.22a-e	14.77c-g	6.83b-g	3.34b	8.93a-	3.27d-g	2.82a-c	11.25b-e
24	**NGC12**	39.71c-j	2.42c-j	89.11a-e	163.11c-f	19.44a-e	10.81gh	.371fg	3.56b	9.29a-	3.53b-g	2.69a-c	7.17c-e
25	**NGC8**	36.88c-j	2.25c-j	87.33b-e	192.72b-f	15.22b-f	15.18c-g	6.50b-g	3.72ab	7.36c-	3.11e-g	2.39b-d	5.31de
26	**NGC50**	32.58d-j	1.99d-j	87.67a-e	173.11b-f	17.22a-e	12.82d-h	4.25e-g	3.22b	9.85ab	3.07f-g	3.25a	12.64b-d
27	**C143**	32.24d-j	1.97d-j	107.67a	250.17a-d	21.83ab	16.51a-e	4.89c-g	3.31b	8.05a-	3.57b-g	2.25b-d	7.40c-e
28	**NGC51**	29.91e-j	1.83e-j	94.17a-c	277.33ab	20.50a-d	13.47c-h	7.11b-g	3.33b	9.83ab	3.03fg	3.26a	8.83c-e
29	**NGC38**	28.89f-j	1.76f-j	68.89e-h	208.78a-f	15.77b-f	15.55b-f	4.75d-g	3.62b	7.69a-	2.95fg	2.63a-c	4.78de
30	**C318**	28.07f-j	1.71f-j	76.33c-g	196.56b-f	21.89ab	17.21a-d	6.56b-g	3.83ab	8.01a-	4.26ab	1.97cd	11.00b-d
31	**NGC45**	27.27g-j	1.66g-j	74.00c-g	198.78b-f	13.00ef	14.67c-g	6.00b-g	3.72ab	7.36c-	3.40c-g	2.34b-d	11.94b-e
32	**NGC27**	25.91h-j	1.58h-j	76.50c-g	183.33b-f	15.55b-f	16.06a-e	4.43e-g	3.74ab	7.17c-	3.31c-g	2.23b-d	5.00de
33	**NGC15**	23.41ij	1.43ij	72.11d-h	229.11a-d	18.00a-e	14.24c-h	6.38b-g	3.77ab	8.58a-	3.44b-g	2.47a-c	4.30de
34	**NGC55**	11.48j	0.70j	26.50j	37.00g	6.00g	11.91e-h	3.00g	3.94ab	6.46e	3.96a-d	1.58d	1.25de

Mean with the same letter along the column are not significantly different at 5% level of probability using DMRT

Morphological characterization, Genetic variability and mean yield performance of 34 genotypes of Camallia

The quantitative characters evaluated for each tea genotypes used in this study are presented in Table 2. The leaf shape was lanceolate for all the genotypes except for NGC 55, 357 and NGC 47. The leaf base shape for the genotypes was attenuate apart from NGC 55 which was rounded. The leaf margin varies from biserrulate to serrulate and finally to entire for NGC 6 and 357. All the genotypes evaluated were indifferent in terms of leaf petiole colour which was green as well as mature leaf colour which was dark green. All the genotypes had medium leaf size except for genotype 357 with large leaf size. The leaf apex habit was between straight and recurve while the leaf venation for aa the genotypes evaluated ranges between indistinct and distinct. However, the immature leaf colour showed a vast ranges of variability from dark green observed in NGC 40 to green in NGC 6 and lastly to yellowish brown in NGC55.

S/N	Genotypes	Leaf shape	Leaf base shape	Leaf margin	Leaf petiole Colour	Leaf size	Leaf apex habit	Leaf venation	Immature leaf colour	Mature leaf colour
1	NGC48	Lanceolate	Attenuate	Biserrulate	Green	Medium	Recurved	Indistinct	Deep Green	Dark green
2	NGC29	Lanceolate	Attenuate	Serrulate	Green	Medium	Recurved	Indistinct	Deep Green	Dark green
3	NGC23	Lanceolate	Attenuate	Biserrulate	Green	Medium	Recurved	Distinct	Deep Green	Dark green
4	NGC24	Lanceolate	Attenuate	Biserrulate	Green	Medium	Straight	Indistinct	Deep Green	Dark green
5	NGC8	Lanceolate	Attenuate	Serrulate	Green	Medium	Straight	Indistinct	Deep Green	Dark green
6	NGC6	Lanceolate	Attenuate	Entire	Green	Medium	Straight	Distinct	Green	Dark green
7	NGC45	Lanceolate	Attenuate	Serrulate	Green	Medium	Recurved	Indistinct	Deep Green	Dark green
8	NGC41	Lanceolate	Attenuate	Biserrulate	Green	Medium	Straight	Indistinct	Deep Green	Dark green
9	NGC18	Lanceolate	Attenuate	Serrulate	Green	Medium	Straight	Distinct	Deep Green	Dark green
10	NGC38	Lanceolate	Attenuate	Biserrulate	Green	Medium	Recurved	Distinct	Deep Green	Dark green
11	NGC46	Lanceolate	Attenuate	Biserrulate	Green	Medium	Recurved	Distinct	Deep Green	Dark green
12	NGC40	Lanceolate	Attenuate	Serrulate	Green	Medium	Straight	Indistinct	Dark green	Dark green
13	NGC143	Lanceolate	Attenuate	Serrulate	Green	Medium	Recurved	Distinct	Greyish green	Dark green
14	NGC49	Lanceolate	Attenuate	Serrulate	Green	Medium	Recurved	Distinct	Deep Green	Dark green
15	NGC37	Lanceolate	Attenuate	Biserrulate	Green	Medium	Straight	Indistinct	Deep Green	Dark green
16	NGC51	Lanceolate	Attenuate	Serrulate	Green	Medium	Recurved	Indistinct	Greyish green	Dark green
17	NGC27	Lanceolate	Attenuate	Biserrulate	Green	Medium	Recurved	Distinct	Greyish green	Dark green
18	NGC26	Lanceolate	Attenuate	Serrulate	Green	Medium	Recurved	Distinct	Greyish green	Deep green
19	NGC25	Lanceolate	Attenuate	Biserrulate	Green	Medium	Straight	Distinct	Greyish green	Dark green
20	NGC55	Ovate	Rounded	Serrulate	Green	Small	Straight	Indistinct	Yellowish brown	Dark green
21	NGC54	Lanceolate	Attenuate	Biserrulate	Green	Medium	Straight	Indistinct	Deep green	Deep green
22	NGC53	Lanceolate	Attenuate	Serrulate	Green	Medium	Recurved	Indistinct	Green	Dark green
23	NGC357	Ovate	Attenuate	Entire	Green	Large	Recurved	Distinct	Deep green	Dark green
24	NGC13	Lanceolate	Attenuate	Serrulate	Green	Medium	Straight	Distinct	Deep green	Dark green
25	NGC17	Lanceolate	Attenuate	Serrulate	Green	Medium	Recurved	Indistinct	Grayish green	Dark green
26	NGC22	Lanceolate	Attenuate	Biserrulate	Green	Medium	Straight	Distinct	Greyish green	Deep green
27	NGC42	Lanceolate	Attenuate	Biserrulate	Green	Medium	Recurved	Distinct	Deep green	Dark green
28	NGC50	Lanceolate	Attenuate	Biserrulate	Green	Medium	Straight	Indistinct	Grayish green	Dark green
29	NGC19	Lanceolate	Attenuate	Biserrulate	Green	Medium	Straight	Distinct	Deep green	Dark green
30	NGC15	Lanceolate	Attenuate	Serrulate	Green	Medium	Recurved	Indistinct	Brown	Dark green
31	NGC12	Lanceolate	Attenuate	Biserrulate	Green	Medium	Recurved	Distinct	Grayish green	Dark green
32	NGC32	Lanceolate	Attenuate	Serrulate	Green	Medium	Recurved	Indistinct	Deep green	Dark green
33	NGC47	Ovate	Attenuate	Serrulate	Green	Medium	Recurved	Indistinct	Deep green	Dark green
34	318	Lanceolate	Attenuate	Serrulate	Green	Medium	Recurved	Distinct	Deep green	Dark green

Discussion

The tea genotypes showed wide Morphological variations in plant height, number of branches, stem diameter, leave length, leave breadth and number of leaf. It was observed that long term cross pollination of tea brought about wide variability observed and this was confirmed by Chen *et. al*., 2005. The leaf shape varies from lanceolate to ovate. The leaf margin varies from serrulate to biserrulate to entire while the immature leaf colour varies from deep green to dark green to grayish green. Basic information for the breeders for further improvement of tea is provided for the genotype listed above. Further work in lowland will bring about high yielding genotypes for the farmers willing to cultivate tea in the lowland areas.

Conclusion

NGC 40 and NGC 18 which were among lowland tea genotypes compete favourably with c143 and other upland clones that were also doing fine in the upland area of Mambilla. This experiment should be extended to other available NGC materials in Nigeria to unravelled the potentials in them.

References

Yu, F.L., 1986: Discussion on the originating of place and the originating centre of tea plant. *J. tea Sci*. 6, 1-8.

Chen, I. and S. Yamaguchi, 2005. RAPD markers for discriminating tea germplasm at the inter-specific level in China.*Plant Breeding* 124, 404-409.

Chen L., F.L. Yu, and Q.Q. Tong2000: discussion on phylogenetics classification and evaluation of sect thea. *J. Tea Sci*. 20, 89-94

Experimental Title: Evaluation of selected fast growing leguminous trees/shrubs on growth and establishment of tea (*Camellia sinensis*)

Investigators: Oloyede, A.A, Olaniyi, O.O., Adedeji, A.R., Ipinmoroti, R.R and Agbebaku

Introduction

Tea, *Camellia sinensis* L., is an evergreen bush which has been cultivated for thousands of years (Denis,1991). Research into tea cultivation in the lowland areas of Nigeria is receiving attention as land is limiting in the natural area of production on the Mambilla Plateau. Sigmund and Gustav,1991 had reported that the crop can grow in a wide range of climates. Nutrients needed by tea are large as a result of continuous harvesting of tea leaves on fortnight basis.Denis,1991 reported that for an annual yield of 1000kg/ha, the plant takes on average: 40-50kg of N,7-9kg P,20-25kgK. As a result of this heavy nutrients demand, it becomes imperative to supply the lost nutrients through inorganic fertilizers. Inorganic fertilizers are expensive for small holders and continuous usage may be damaging to the soil and the crop. Fast growing leguminous trees/crops have been documented to improve soil conditions and provide essential nutrients to associated crops(Kang et al,1999;Adeola,2015)

Objectives

The overall objective of the study is to establish a sustainable method/s of tea production in selected low land locations Nigeria using selected multipurpose trees/shubs(MPTs).

Specific objectives are:

1) To evaluate the growth of the legumes and their nutrient uptake as well as soil nutrient content
2) To evaluate the establishment of tea grown with the selected nitrogen fixing trees / shrub compare with control (plot of no nitrogen fixing trees / shrubs in the low land.
3) To determine the fertility of tea plots with nitrogen fixing trees / shrubs.
4) To determine the growth of tea seedlings intercropped with nitrogen fixing trees / shrubs.

Materials and Methods

The first phase of the experiment is the propagation of selected clones namely: NGC 18,19 &25 and selected commercial clones: C143,C318,C357 and C236. The cuttings base were put as quick dip of IBA hormone(2000mg/l).Other aspect of the work is the propagation of the legumes. 30cm x 12.5 cm polythene bags were filled with top soil. The seeds of Leucaena and Albizia were pretreated with Conc. H_2SO_4 thereafter washed with water and airdried. Seed of Cajanus and Moringa were however not pretreated. After six month in the nursery ,the seedlings were transplanted to the field for their establishment. One thousand, seven hundred and fifty seedlings of the legumes were raised and established at 4m inter-rows and 0.5m intra-rows in Ibadan. More of the seedlings shall be raised for Ajassor location in the coming season. The tea shall be planted at a spacing of 1m x 0.60m (16,393seedlings/ha).The leguminous plants

seedlings were evaluated morphologically in terms of height, leaves, stem diameter, leaf area, root nodule count, root number and root length

Table 1: Number of Tea cutting set on Mambilla Plateau 2017

S/N	Clonal types	Number set
1.	NGC 18	130
2.	NGC 19	195
3.	NGC 25	78
4.	C143	650
5.	C318	650
6.	C357	650
7.	C236	647
8.	Total	3000

Table2: Seedlings performance of leguminous trees raised

Legume type	Number raised	Number survived	% Success
Moringa oliefera	500	220	44
Leucaena leucocephala	500	400	80
Albizia lebbeck	500	300	60
Cajanus cajan	250	180	72
Total	1,750	1,100	63

Table 3: Mean growth performance of selected legumes

Legume type	Height of seedling	Stem diameter	Number of leaves	Number of branches	Shoot wet weight (g)	Root wet weight (g)	Number of nodules	Weight of nodules (g)	Taproot length (cm)
Albizia lebbeck	52.3	4.74	43.75	-	20.45	6.29	8	0.84	27.53
Leucaena leucocephala	119.75	7.84	156.5	-	40.58	14.45	3.75	0.34	48.05
Moringa oliefera	151.0	13.08	84.25	-	118.74	70.69	0	0	62.95
Cajanus cajan	197.25	8.79	39.50	4	82.95	11.34	27.75	0.33	34.73

Table 1 shows the various clones of tea set on the Mambilla Plateau consisiting of NGC series: NGC18,19 and 25. Oloyede *et al* (2015) revealed their superior growth performance of the cuttings in the nursery which Olaniyi (personal communication,2017) confirmed on the field. This is what prompted their selection for the agroforestry evaluation in the lowland. The other clones viz: C143,C318,C357 and C236 are the upland tea clones which are being adapted to the lowland. Oloyede et al(2017) have found that the biochemical constituent of tea leaves in the lowland locations of Ajassor and Ibadan to be similar or even superior to the upland tea leaves. Total of 3000 tea cuttings were set, to be transplanted in the coming season.

Table 2 reveals the success recorded in the nursery for the selected legumes. The percentage seedling performance was 63% overall. Moringa had 44%, Leucaena 80%, Albizia lebbeck 60% and Cajanus 72%

LIBRARY, INFORMATION AND DOCUMENTATION DEPARTMENT

Objectives

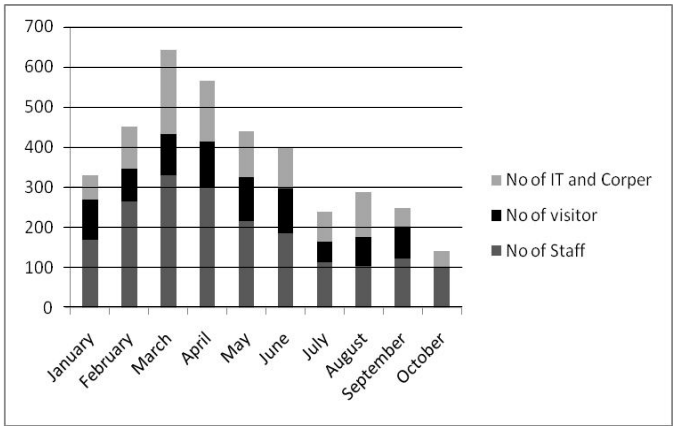
The main objective of the Department is to acquire, process, organize, store and disseminate information with a view to stimulate and guide research on CRIN mandates crops.

Library Information and Documentation Department (LID) comprises of three (3) divisions which are: Library, Information Communication Technology (ICT) and Documentation divisions. These three (3) divisions supported the research activities of the institute by providing services.

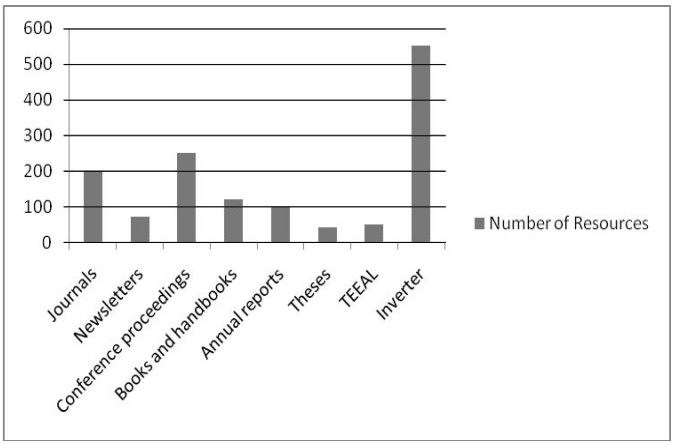
The personnel: There were thirteen (13) staff working at LID department. These included; two (2) Librarians, two(2) Programme Analysis , three(3) Library Officers, one(1) Chief Printer, one(1) Data Processing Officer, one(1) Chief Typist, two(2) Clerical Officer and one(1) Agricultural Field Attendant.

Library Division: (Dr (Mrs). Ogunjobi T.E. – Acting Head, Library Division)

A total number of 2,003 staff were recorded, 900 visitors were received, 1,200 Industrial training students and Corp members visited the library between January 2016 to December 2016. The breakdown on monthly basis is as shown below:



The library had the record of facilities used by CRIN staff and visitors, the number and facilities used were as listed below:



The following routine duties were also done:

- Accessioning, stamping and displaying of new information resources were done on regular basis.
- Charging and discharging of library materials were done regularly, while new books were catalogued and classified.
- Overdue books and journals were retrieved from users, used books and journals were shelved, while shelf readings were done occasionally.
- Four industrial attaché sent to library division were trained.

ICT Division: (Ibe Osita – Acting Head, ICT Division)
The Information Communication and Technology (ICT) division is composed of two sections: Internet/Website and Library Automation.

Personnel

The Internet/website section has two personnel. Library Automation also have two personnel.

Function

The division performed the following functions:

- Provision of Internet access to the staff of the Institute
- Troubleshooting and fixing of all Internet equipment
- Automation of Library records
- Administration/maintenance of the Institute's website
- Maintenance of computer systems at the ICT

centres

- Provision of computer related services in offices
- Training of Interns

Achievements

The division has registered some achievements since the inception of Internet in 2016 in the Institute. These are:

- Redesign of database driven website in-house to showcase Institute activities and staff profiles;
- Delivery of in-house seminar to sensitize staff on the importance, availability and use of cloud storage platforms
- Boosted the Internally Generated Revenue (IGR) through the 'contact us' platform embedded on the Institute's website.
- Liaised with the Internet Service Providers (ISP) and the Website host to keep the Internet and the website running.
- Handled online correspondences for the Institute.
- Increase in bandwidth from 128/128kbps wireless to 2mb/2mb fibre link.
- The installation of antenna at strategic locations for wired and wireless links to offices.
- Installation 3.5Kv inverter in the Internet server room
- Installation 1200 watts solar panel in the Internet server room
- Implementation of inverter/solar wired links to office of ED, accounts, audit, general admin.
- Creation of institutional e-mail address for staff
- Comprehensive inventory of all official computers and accessories in the Institute headquarters.
- In-house practical training on ICT of two staff of the Library, Information and Documentation Department (LID) – a printer and Assistant Data Processing Officer to assist the division on ad-hoc basis.

Documentation Division: (Fagbami O.O. and Babafemi Ibitope)

- Compilations of Bibliography and CRIDAN on CRIN mandate crops are in progress.
- Articles published on CRIN mandates crops by CRIN scientists and other scientists outside CRIN were added to the database in the library.
- Paper cutting was not left out, all matters on CRIN mandate crops and agriculture related matters were kept for consultation of scientists and all interested users.
- Processing of crop book was done.
- Collation, processing and editing of backlog reports submitted by scientists.
- Acquisition of The Essential Electronic Agricultural Library (TEEAL) on LAN for use by scientists.
- CRIN monthly bulletin was produced and circulated.
- Production of staff Identity card continued.

FINANCE AND ACCOUNT DEPARTMENT

This departmental report will be based on the underlisted area as directed.

- The division in Finance and Accounts Department
- Cadre and number of staff in each of the division

The Division in Finance and Accounts Department

In the year under review, Finance and Accounts department has four (4) divisions and one Section as follows:

- Finance and Account Division
- E-payment Division
- Payroll Division
- Budget Division
- Pension Section
- Office of the Acting Head

Cadre and number of staff in each of the Division

The breakdown of total number of staff in the department as at 31 December, 2016 is as follows:

Division	Accountant Cadre	Executive Cadre	Secretarial Assistant Cadre	Clerical Cadre	Total No. of staff
Office of Ag. Head	1	1	1	1	4
Final Account	5	4			9
E-payment	3	4			7
Payroll	3	1	1		5
Budget	2	1			3
Pension	1	2			3
TOTAL					**31**

ENGINEERING DEPARTMENT (Head: Engineer Bakare Taiwo)

Introduction

During the year 2015, the Engineering Works and services Department was reorganized into three technical sections and fourteen

Operational units

This became imperative in order to effectively utilize the available manpower and to deliver maximally in all Fronts of the official responsibility of the division.

Sections

The three technical sections are arranged below:

- Civil Engineering
- Electrical Engineering
- Mechanical Engineering

Units

We have fourteen operational units, which are listed below

- Civil
  - * Carpentry
  - * Mansory and Bricklaying
  - * Roads
- Electrical
  - * Generation & Protection
  - * Networks & Installations
  - * Billing & Metering
- Mechanical
  - * Agricultural & Equipment
  - * Fabrication & Welding
  - * Plumbing & Water supply
  - * Generation, Refrigeration & Air-condition
  - * Machine shop
  - * Motor vehicles
  - * Special Duties (Maintenances, Planning & Monitoring)
  - * Transport

Names of all Staff in Engineering Division

`S/N	NAME	DESIGNATION
1	Engr. Bakare Taiwo	Asst. Chief Maintenance Engineer
2	Engr. Ikpefan Patrick	Maintenance Engr. l
3	Mr. Titiloye Isaac	Maintenance Engr.
4	Adebayo Julius Babajide	Chief Tech. Officer
5	Mr. Olutola Ola	Prin. Tech. Officer l
6	Mr. Agwimah Emmanuel	Prin. Tech. Officer l

7	Mr. Ajiboye Gbenga	Prin. Tech. Officer ll
8	Mr. Yinusa Sakiru Adedoyin	Senior Tech. Officer
9	Mr Fatiregun Olufemi	Senior Tech. Officer
10	Mr. Awe Jacob	Senior Tech. Officer
11	Mr. Ogunsuyi Busuyi	Senior Tech. Officer
12	Mr. Gold Ahmed	Senior Tech. Officer
13	Mr. Oduntan Samson	Senior Tech. Officer
14	Mr Oyawale Muniru	Asst. Tech. Officer
15	Mr. Ogunwumi Oluseye	Asst. Tech. Officer
16	Mr. Ajayeoba Babatunde	Asst. Tech. Officer
17	Mr. Ogbechie Micheal	Asst. Tech. Officer
18	Mr. Mathews Dare	Higher Works Superintendent
19	Mr Akintoroye Ambrose	Higher Works Superintendent
20	Mr Ogbechie Christopher	Works Superintendent
21	Mr. Adeyanju Stephen	Senior Foreman
22	Mr. Balongun Roland	Asstd. Tech. Officer
23	Mr. Adedoyin Nkanlola	Senior Foreman
24	Mrs. Togun Olubukola	Asst. Tech. Officer
25	Mr. Oyeniran Sunday	Senior Foreman
26	Mr. Oyebanjo Toyosi	Senior Craftsman
27	Mr. Ironua Samuel	Senior Foreman
28	Mr. Ibiyemi Adewale	Senior Foreman
29	Mr. Oke Babatunde	Senior Foreman
30	Mr. Ojo L. Idowu	Senior Foreman
31	Mr. Adeogun Morufu	Senior Foreman
32	Mr. Uwaifo l. Andrew	Senior Foreman
33	Mr. Adekanbi Aderemi	Asst. Tech. Officer
34	Mr. Ismaila Salami	Senior Craftsman
35	Mr. Ojo Moses	Senior Craftsman
36	Mr. Adesida Adewumi	Senior Craftsman
37	Mr. Adeboye Kehinde	Foreman
38	Mr. Oladimeji Taofeek	Craftsman
39	Mr. Boluwade Sunday	Craftsman
40	Mr. Faniyi Jimoh Abiola	Craftsman
41	Osun Micheal	Craftsman
42	Mr. Adio Dare	Craftsman
43	Mr. Alade Gboyega	Craftsman
44	Mr Adedayo Salaudeen	Craftsman
45	Mr Adekanbi Segun	Craftsman
46	Mr. Olubode Ganiyu	Craftsman
47	Mrs. Rafiu Olaide	Asst. Executive Officer
48	Mrs. Ajekigbe Femi	Secretarial Asst. ll
49	Mr. Ajayi Olalekan	Agric. Field Attendant l
50	Mr. Gabriel Ibhazakor	Agric. Field Attendant ll
51	Mr. Omitoyinbo Segun	Work Superintendent
52	Mr. Oladipupo Kayode	Work Superintendent
53	Mr. Ajiroba Taiwo	Chief Motor Driver Mechanic (CMDM)
54	Mr. Enodumwenben Anthony	Chief Motor Driver Mechanic (CMDM)
55	Mr. Kpeleye Friday	Senior Motor Driver Mechanic (SMDM l)
56	Mr. Odeku Olufemi	Senior Motor Driver Mechanic (SMDM l)
57	Mr. Tijani Fatai	Senior Motor Driver Mechanic (SMDM l)
58	Mr. Muraina Lukman	Senior Motor Driver Mechanic (SMDM l)
59	Mr Osungbade Ayoade	Senior Motor Driver Mechanic (SMDM ll)
60	Mr. Ogunkunle Gbadebo	Senior Motor Driver Mechanic (SMDM l)
61	Mr. Arumemi Christian	Senior Motor Driver Mechanic (SMDM l)
62	Mr. Arowobusoye Akinrinsola	Senior Motor Driver Mechanic (SMDM l)
63	Mr. Oluwole Segun	Motor Driver Mechanic (MDM)
64	Mr. Adesuyi Busuyi	Motor Driver Mechanic (MDM)
65	Mr. Oyedele Bolaji	Motor Driver Mechanic (MDM)
66	Mr. Iyeh Moses	Motor Driver Mechanic (MDM)
67	Mr. Nome Peter	Senior Motor Driver Mechanic (SMDM l)
68	Mr. Rabiu Akeem	Senior Motor Driver Mechanic (SMDM ll)
69	Mr. Ajewole	Senior Motor Driver Mechanic (SMDM ll)
70	Ismaila Tajudeen	Senior Motor Driver Mechanic (SMDM ll)

Functions and Respt on the tenets of the ethnics of the engineering profession.

- Deployment onsibilities of Engineering Division
- Initialize and develop a process plan to service the research mandate goal.
- To design, construct, install and maintain any engineering related equipment to support the research mandate goal.
- Daily Maintenance of vehicle fleets, building, machinery, and equipment that drives the research mandate goals.
- Prepare tender document to facilitate excursion of capital projects.
- To advice the Executive Director and CRIN management of drivers for vehicle movement.

Some of the Jobs done during the year under review:

S/N	Job Description	Amount	Status
1	Erection construction of permanent cage for the HRM generator set	16,900.00	Completed
2	Iron rod for septic tank, windows and doors linted at event centre	59,500.00	Completed
3	Repaired of damaged shade net at nursery		Done
4	Repaired of damaged shade net at JSB gate		Done
5	F.G. 630 V03 brake system and services	7,700.00	
6	03M – 04 FG Brake system and services	15,700.00	
7	FG 308 V03 Servicing	10,700.00	
8	FG 297 V03 Horn, power fluid and gear oil	14,000.00	
9	FG 307 V03 servicing and brake system repair	17,700.00	
10	FG 260 A03 Fuel pump repaired	22,200.00	
11	FG 298 V03 servicing	9,200.00	
12	FG 677B03 Brake system and service	31,850.00	
13	45B-3FG brake system and service	24,100.00	
14	FG 604-servicing , disc, gear seat propeller bearing replaced	56,100.00	
15	FG 310 V03 servicing	13,100.00	
16	FG 309 V03 servicing and brake pad replaced	14,900.00	
17	FG 309 V03 brake disc, drum, shoe and centre bearing replaced	35,000.00	
18	FG 482 V03 servicing shock absorber (front and rear) replaced	47,100.00	
19	Servicing of the tractor FG 845 V03 engine repair of the worn-out ball joint of the Institute water FG 483 No. 3	32,200.00	
20	Servicing of the water tanker FG 483 No. 3 repair and servicing of the Institute lawn movers	14,885.00	
21	Changing of the tractor FG 629 V03 tyres	455,200.00	
22	Regular greasing of the require slaughter parts		
23	Servicing of the injector nozzles of tractor FG 845 V03		
24	Event centre toilet		
25	Construction of toilet at Dr. Dongo's office	145,900.00	
26	Flushing, replacement of pump, cable & panel of T.O Borehole	257,785.00	

Challenges

Major challenge faced by the division is the lack of an upgrade of equipment and tools in commensurate with available manpower. Also, insufficient training and re-training of staff to meet up with the global trends in maintenance techniques.

Minor challenge faced by the division is lack of an engineering inventory store which will enable closeness to maintenance share items thereby eradicating long down time delays

Scope for Future Recommendation

- Provision of upgrade equipment /tools for the day to day running of the division
- Training of staff to meet with the recent global technology
- Provision of daily needed maintenance items in the inventory store to eradicate delays in the execution of maintenance plans.
- Renovation of entire workshop.

STATISTICS SECTION

Ogunbosoye B.B (Head, Statistics Section)

Data Collection

Cocoa Yield Statistics: - Harvested pods were counted and documented as usual at the fermentary unit of the section. Summary of this is presented on Table 1; below.

Table1: 2016 Statistics Cocoa Pods Harvested

S/No	Month	Total harvested pods	No of Healthy pods obtained	No of Damaged pods	Weight after Fermentation	Dry Weight
1	Jan.	43141	19706	638	1435.6	479.6
2	Feb.					
3	Mar					
4	Aprl	12526	8852	2190	472.3	152.6
5	May	8686	5758	2427	374.2	107.9
6	June	1285	783	381	32.4	6.8
7	July					
8	Aug.					
9	Sep.	7413	5891	1147	439.6	90
10	Oct.	15919	13224	1784	1126.2	328.5
11	Nov.	48330	37854	6588	2982.8	944.5
12	Dec.	25165	18206	5191	1306	493.7
	Total	162465	110274	20346	8143	2603.9

Cashew Yield Statistics: Cashew nuts were handpicked in cashew germplasm and other areas where cashew plants exist. The table below shows records of cashew nut in kilograms picked at different location.

Table 2: 2016 Cashew nut productions

SN	MONTH	DATE	ZONE/PLOT	WEIGHT (kg)
1	January	29/01/2016	Germplasm	**3.4**
2	February	01/02/2016	"	1.0
3	"	05/02/2016	"	0.8
4	"	08/02/2016	"	1.8
5	"	06/02/2016	"	4.0
6	"	09/02/2016	3&4	14.0
7	"	11/02/2016	Germplasm	2.2
8	"	18/02/2016	3&4	18.6
9	"	"	Germplasm	1.0
10	"	19/02/2016	N7/1-3	34.6
11	"	"	Germplasm	24.0
12	"	"	6	5.4
13	"	22/02/2016	Germplasm	1.8
14	"	"	W24/1	6.0
15	"	24/02/2016	Germplasm	3.0
16	"	25/02/2016	3&4	37.4
17	"	26/02/2016	N7/1-3	14.0
18	"	"	9	3.6
19	"	"	Germplasm	3.1
20	"	"	"	5.0
TOTAL				**181.3**
1	March	02/03/2016	Germplasm	2.2
2	"	07/03/2016	"	1.5
3	"	"	3&4	16.6
4	"	"	6	2.0
5	"	08/03/2016	1	5.0
6	"	"	1	7.0
7	"	09/03/2016	Germplasm	4.0
8	"	09/03/2016	3&4	99.6
9	"	11/03/2016	Germplasm	3.2
10	"	"	"	20.0
11	"	"	3&4	40.2
12	"	14/03/2016	1	12.0
13	"	"	Germplasm	3.0
14	"	15/03/2016	"	3.0
15	"	16/03/2016	"	3.8
16	"	"	"	2.8
17	"	18/03/2016	6	20.0
18	"	"	Germplasm	2.0
19	"	"	3&4	38.6
20	"	21/03/2016	Germplasm	2.8
21	"	23/03/2016	6	8.0
22	"	24/03/2016	Germplasm	1.5
23	"	29/03/2016	"	2.8
24	"	31/03/2016	6	5.6
Total				**307.2**
1	April	01/04/2016	3&4	39.0
2	"	05/04/2016	Germplasm	4.0
3	"	07/04/2016	"	0.8
4	"	12/04/2016	6	5.0
5	"	13/04/2016	Germpalsm	1.2
6	"	15/04/2016	3&4	18.4
7	"	18/04/2016	Germplasm	1.5
8	"	18/04/2016		12.4
9	"	25/04/2016	Germplasm	2.2
Total				**84.5**

Total cashew nut production for 2016 was **576.4kg**

Agrometeorology: Meteorological records were taken from manual agrometeorological garden on daily basis. Readings of parameters include: wind direction, Rainfall, Relative humidity, vapour pressure, soil temperature at 5, 10, 20, 30, 50, and 100 (cm) depths, and sunlight hours. In 2016, there was no records of data from the Automatic weather station due to faulty nature of the equipment.

Table 3: 2016 Manual Agrometeorological Monthly Report

Parameter /Month	Max Temp (0c)	Min Temp (0c)	Morn RH(%)	After RH(%)	Morn VP	After VP	Rainfall (mm)
January	27.8	17.2	83	37	30.6	20.8	5.7
February	29.3	17.6	74.9	50.2	30.2	27.6	31.2
March	29.9	19.1	78.3	78.2	32.2	31.1	112.8
April	30.05	18.2	79.4	64	33.5	33	73.3
May	29.37	16.75	78	66.2	32.1	32.73	177.2
June	26.21	14.02	80.51	71.38	28.9	30.62	222.4
July	26.4	13.45	89	83	30.5	35.1	163.1
August	26.17	23.53	89	79	30.4	31.9	112.9
September	3	3	3	3	3	3	3
October	5.02	5.02	5.02	5.02	5.02	5.02	5.02
November	4.9	4.9	4.9	4.9	4.9	4.9	4.9
December	4.1	4.1	4.1	4.1	4.1	4.1	4.1

Statistical Analysis

Statisticians and statistical officers in the Section are attached to scientists in the department and also give statistical advice to other scientists in the Institute. They design models and carry out data analysis for Scientists on research projects. In addition, weather and cocoa production data are also analyzed for different reports.

Data Collation

Requests of Data on Agrometeorology and cocoa production were being processed and released to CRIN scientists and public based on the approval of acting executive director.

Field Work

Members of staff of the section that are attached to zones collated data from their respective zones in which the summary of record is provided in table 1 above.

Training

Under the year of review, Six students had undergone their Industrial training (IT) in the division and statistics staff participated in training them, while two students from the Polytechnics Ibadan under SIWES programme undergone training in the section.

Achievements

The achievements of the section are listed below:

* Updating of the data base created in the previous (year 2015) for cocoa and cashew production from the year of establishment in electronic formats and efforts are currently in place to extend the creation of database for production of the said crops for the CRIN substations.
* Updating of database for manual weather Station from the year of establishment in electronics formats. This has helped us to attend to various requests under 24 hours
* Continuous in-house training of members of staff of our unit to enhance their professional capability and readiness.

Challenges

In spite of the achievements enumerated above the Statistics Section still face some challenges which includes;

* Equipment/ Hardware.

The necessary hardware and equipment required for optimum operation of the section are still in shortage

The required items include but not limited to;

i A small petrol engine generator that can power a minimum of 10 desktop computer, 1 1horsepower air conditioner, 2 printers and 2 standing fans.

ii Six (6) laptop are needed by the Statistician and Statistical Officer in the section which can be taken for field work.

* **Automatic Weather Station (AWS)**

There are difficulties in accessing data from the AWS. This equipment was installed about a year ago and since then we have not had any comprehensive training on it. Initially we access data from the radio data logger for a period; however this became faulty leaving us the only option of direct downloading from the mounted modem attached directly on the AWS. This also recently developed a problem as it failed in its downloading procedures. We cannot create a back up, we cannot install antivirus. In view of this, it is suggested that the AWS engineer should come and give a thorough training on the equipment for effective use and management.

* Statistical Package: Licensed packages are required by this Section. This will enable us to analyze data with the current and acceptable packages such as;

* SAS 2014 version
* GENSTAT 2014 / GENSTAT Discovery World version
* MATLAB 2014
* R Package
* E- View

Scope for Future

* This Section will accelerate the on-going creation of database for CRIN mandate crops production figures in all CRIN substations (5). This record will help in having access to correct production statistics per plot in substations and thus determine their effective hectarage.
* Updating of Weather Data bank: Data bank for weather records for headquarters and all the substations will continue to be updated.
* Training: Statisticians need adequate and periodic training on different statistical packages to update our knowledge on the current software available and specific tools for analyzing special data.
* Effective Hectarage: Extension of the determination of information on all the mandates crops production per plots per hectare for all the substation

PLANTATION AND ESTATE MANAGEMENT DEPARTMENT

Staff Strength /Disposition

At the onset of the year 2016, staff strength stood as 158 comprising 24 Chief Principal and Senior Agricultural Superintendent, 10 Assistant Superintendents, 8 Chief Agricultural Overseer, 113 Junior Staff, 1 Assistant Chief Executive Officer, 1 Senior Executive Officer and 1 Assistant Executive Officer. By the end of March 2016, two of the PEM's office staff were deployed to Admin and Health Centre respectively while three senior officers were deployed to the division from Admin by mid of September 2016, two (2) senior Admin Officers deployed to PEM while One Chief Executive Officer was deployed to the security section.

In addition, field staff of NDM, HPU and VPU were included in Plantation and Estate Management attendance giving us total number of 203 permanent staff of 36 senior staff and 167 junior staff.

During the period under review, there was intra and inter divisional/departmental transfer within the division which involved: Messer Adeyemo R.F (DPM), Dada O.A. (GM), Ademola Sunday (GM), Osaghale G.E. (Zone ¾), Oniyide (Zone ¾), Emmanuel Felicia (Zone 2), Olorunmota R.T. (Zone 5), Adebayo K.A. (Zone 5), Enagu V.O. (Zone 6), Ojewale E.O. (Zone 6), Wada Sunday (Zone 7), Adeniyi J.O. (Zone 7), Adigun A.B. (Zone 8), Iyadunni K. (Zone 8), Sobwale M.O. (Z0ne 9), Owoduyilemi (Zone 9), Etta N.M. (Fermentary), Gbalajobi K. (SPN), Adebayo J.A. (SPN), BabalolaEunice (SPU), Magaji (HPU), Olayemi O. (HPU), Olaoba F.O. (Herbarium) at the capacity of Zonal /Unit leader Assistant?Deputy Zonal/Unit Leader.

Late Mr Adeniyi Yisa, as well as Messrs Okuade Segun and Awodumila David were transferred to substations.

Messers Ojedeji O.A., Oketokun Grace and Akinyomide O. were transferred to Pathology, Messers Okasabhor J.O., Olatunji C, Oladokun O.J., Tijani R. and Ijadunola T. were also transferred to SPN, Ojo Oluseye Abioye, Ugwoke C. Joseph and Oladunmoye Oladimeji were transferred to Agronomy. Messers Imade Charles, Oladejo G.A. Ajayi Yinusa and Ogundare O.A. were also transferred to Plant Breeding while Messers Ejikeme P.O. and Garba J.A. were transferred to Extension.

All the other field staff from Agric. Assistant, Chief Agric. Field Overseer, Assistant Chief Agric. Field Overseer, Senior Agric. Overseer, Agric. Field Assistant I, II, III were reshuffled within Zones/Units.

In addition, 91 disengaged staff were reinstated and deployed to all various zones. Also the Management approved periodical recruitment of fifty (50) Project Contract workers for Zones and twenty (20) Project Contract Workers for Ground to supplement the established staff efforts on the implementation of Plantation Management activities on the estate. Sequence to the upward review of wages for the project contract workers and in partial comprising with previous years, a considerable improvement was recorded on the general stability of the workers especially during the rainy season and the manner they carried out duties assigned to them.

Table 1: Recruitment of Project Contract Workers

Period	GM	Zone
January	40	-
May	20	-
June	20	-
July	20	47
August	20	48
September	19	49
October	12	27
November	12	27
December	5	-

Hence, the Plantation and Estate Management ended up with total number of 193 permanent staff of 60 senior staff, 133 junior staff and 5 project contract workers excluding HPU, SPU, NDM, Bakery, Winery and Soap staff.

Table 2: Staff Strength/Disposition

SN	No of PCW	Unit	Effective hectarage	Senior Staf & Admin Officer	No of Supervisors	Field Junior Staff	Total Workforce	Names of Admin Officer to Zones
1	-	PEM Office	-	8	-	-	8	-
2	8	Zone 1	34.79	3	2	17	20	Mr. Akhidime
3	5	Zone 2	15.14	4	2	8	12	Mr. Akhidime
4	5	Zone ¾	15.79	4	2	7	11	Mrs. Oluwadare
5	6	Zone 5	27.60	5	2	12	17	Mrs. Oluwadare
6	6	Zone 6	26.00	5	2	15	20	Miss Ogolowa
7	5	Zone 7	23.85	4	2	10	14	Mr. George
8	10	Zone 8	41.05	7	3	14	21	Miss Ogolowa
9	5	Zone 9	22.89	4	2	9	13	Mr. George
10	-	BCOO	6.00	-	-	2	2	
11	-	Fermentary	-	7	1	5	12	
12	20	GM	-	8	5	28	36	
13	-	Palm Oil Milling	-	1	1	4	5	
14	-	Chain Saw Operator	-	-	-	2	2	
15				60	24	133	193	

Some achievements of staff during the year under review

1. **Plantation Activities**

The following activities were effectively carried out in the existing plots in all zones and BCOO plot in Moor Plantation.

a) Under brushing and felling of forest trees

b) Cross cutting of felled trees

c) Lining, pegging, holing and planting of Tc1 – Tc8 cocoa seeds in all the zones

d) Field establishment of plantain suckers

e) Weeding (manually, mechanically and chemically controlled)

f) Supplying of missing stands on gapping up of dead stands

g) Removal of noxious parasitic plants, notably mistletoes

h) Rehabilitation of moribund/abandoned plots

2i) Pruning of excess canopies, excess branches and dead branches

j) Spraying against pest, diseases and access roads

k) Timely harvesting evacuation, breaking and processing of cocoa

l) Timely harvesting of all farm produce

m) Record keeping

n) Farm sanitation

o) Cutting of fire terraces

p) General rotational duties

q) Preparation of project contract workers wages

r) Preparation of mini cocoa and kola nursery in the zones

2. Estate Maintenance

a) Regular manual slashing and mowing of the lawn with the lawnmowers and the tractor slasher

b) Routine manual slashing of the open grounds, roadsides and residential premises

c) Regular trimming of hedges along roadsides and public places of the Institute

d) Raising of horticultural and ornamental plants

e) Watering and weeding of potted flowers

f) Established and watering of TC1 – TC8 and flowers planted at the Institute frontage

g) Picking of dropped refuse around the estate office and frontage

h) Gapping up and watering of missing stands of the masquerade trees

i) Burning of dumping debris

j) Sanitation of Estate Management

k) Planting of cashew and mangos seedlings.

3. **Farm Produce Harvested for the Year 2016**

Zone	Jan	Feb	Mar	Apr	May	June	July	Aug.	Sept	Oct	Nov	Dec	Total
1	7906	195	209	420	675	-	-	-	502	2609	4297	620	17433
2	664	-	-	255	435	-	-	-	545	1947	2359	810	7015
¾	2423	188	-	-	-	-	-	-	-	1931	1929	828	7299
5	2837	Nil	1320	10518	3625	-	-	-	1689	2122	3050	1730	26891
6	9399	391	-	4744	4098	-	-	-	2020	2628	5094	1130	29504
8	11,634	2876	2198	1337	210	230	-	-	1547	4105	19784	11527	55448
9	6199	-	-	-	-	1306	-	-	1196	3976	8515	2410	23592
BCOO	1725	-	-	-	-	-	-	-	-	-	1808	980	4513
Demonstration plot	280	-	-	-	-	-	-	-	-	-	280	-	488
Total	43067	3650	3727	17274	9043	1536	-	-	7499	19318	47043	20026	172183
Oil pal bunches	58	132	100	97	89	119	79	89	48	29	88	110	1048

Out of the total number of 172, 183 cocoa pods, 16,858 pods were given to the COCTA while 2,694 pods were also given to the NDM.

Record of other Harvested Farm Produce

Zone	Coffee in Kg	Cashew Nuts in Kg	Kola in Pods	Plantain in Bunches	Banana in Bunches	Maize in Cobs
1	-	-	-	5 bunches	129 bunches	-
2	-	-	160 pods	-	-	-
3 & 4	-	392.4kg	-	90 bunches	-	250 cobs
5	26.79	-	-	16 bunches merged to 4	83 bunches merged to 32	-
6	-	33.4kg	-	18 bunches merged to 81/2	-	-
7	-	-	3251 pods	-	-	-
8	-	-	-	8 bunches merged to 4	83 bunches merged to 32	-
9	-	3.6kg	-	44 bunches to 12	22 bunches merged to 7	-
GM	-	66.6kg	-	-	-	-
TOTAL	26.79kg	496.0kg	3411 pods	-	-	250 cob

4. Rehabilitation
Young cocoa seedlings were raised in zones and planted within the old cocoa plots in some zones to fill up the vacancies within the plots like N7 plot in Zone 1, E5/1 – 3, E6/1 and E2/1 in Zone 2, W11 and W2/1 in Zone 8, S2/5 in Zone 6.

5. Fermentary Unit. Under the period in review the following were achieved:

- 4 tons 423kg of Cocoa Dried Beans were sold while 1 ton 359.1kg is presently in the store and some are still undergoing processing. In addition; 4kg was released to CPU Department with approval of the Ag. Executive Director.
- 773kg of CASHEW NUTS was sold while 63kg was released to Mrs. Adeyemi. About 431.5kg was air dried and still kept in the store.
- 20kg of Dried Coffee Berries was sold out and 201.okg is still in the store.
- 8.6kg of Plantain Chips was sold to Mrs. Akinwale while 9.6kg was released to Mr. Oladipo which was signed by Godday.

6. Research Activities: Research scientists were assisted with labour to perform their necessary activities in their research plots that is situated in various zones and at times around the office complex and in the glass house.

7. Establishment of TC1 – TC8 Cocoa In Zones
Despite the shortage of manpower, the division was able to establish 10.3 hectares of new cocoa hybrid (TC1 – TC8) in various zones in the year under review.

8. Distribution of Farm Tools and Agro-chemicals to the Zones/Units. (Table attached)

9. Training: Training for visitors, farmers and IT students from various institutions of higher learning were conducted at the fermentary unit.

Challenges

- In adequate supply of manpower: Labour has been the major constraints to the fulfillment of the Zones/Units activities and its performance. This inadequacy affected the output of work done.

  Recommendation: The timely periodical recruitment of project contact workers to complement present available permanent field staff in maintaining our vast plot sizes and estate will go a long way to boost productivity of Plantation and Estate management and sanitation of the Institute.

- Porosity of the Zones/units for Encroachment and Stealing by unwanted visitors. There are too many foot paths leading into the various zones from the express main road and nearby community which allows for pilfering and burglary of our farm office and produce and setting of farms on face.

  Recommendation: These can be minimized or checked by fencing round the Estate/Institute, but meanwhile, the Institute security can be buckled up or be tightened up to minimize the challenges.

- Inadequate supply of Agrochemicals. There is need to supply glyphosate chemical to check the growth of weed promptly and timely especially during the rainy season to complement the work of available field staff.

- Supervisory motorcycles. The present available supervisory 'motorcycles are out of the road and need replacement.

  Recommendation. For effective and efficient supervision on our plot in the year 2017, your assistance is highly essential to produce new motorcycles for our Zonal leaders and at the same time repair should be carried out on the worn out ones so that Zonal Leader and his/her assistant could go round their plots easily for supervision.

- Insufficient Tables/Chairs. The offices allocated to the division in ERLS building as offices for Zonal Leaders and Assistant Zonal Leaders are locked up because there are not tables and chairs to sit upon after coming back from the field.

- Brakata Bridge and Zone 2 Bridge: these are the alternative routes to Zone 9 and Zone 2 respectively that need urgent repair before any onset of rainy season. Series of complaints have been made about these bridges.

- Reconstruction of PEM's Car Park. Presently, [PEM's car park where Bazuki tricycles are

parked need urgent repair due to the leaking of its roof which affected the wood used for the construction. In order to avoid entering of water into these Bazuki engines, we shall highly appreciate if immediate repair can be done before the onset of rain.

- Palm oil milling Unit's Kitchen: Due to the effect of rainfall and running water, many of the poles of the Kitchen had been destroyed and collapsed during working hours last year. We only thank God for saving our staff on that day. We shall highly appreciate the repair of this kitchen and the fencing door leading to the premises of palm oil milling unit.
- Zonal offices. Ground maintenance and Fermentary unit do not have a specific farm office/house where their workers can hide themselves during heavy rainfall or sunny period while available farmhouses are not burglary proof (door and window) hence, allows for pilfering/thefts of our properties and farm produce.
- Inadequate supply of farm tools and provision of field materials: These farm tools are necessary to provide good working condition for our field staff. Majority of tools in the zones and units are worn out and need replacement while some have been stolen away when our farmhouses were burgled.

  I wish to say that farm tools, protective clothing and foot wears were distributed to the Zones, units and field staff last in the year 2014. In order to increase production and to take care of the welfare of all field workers against field hazard and get their full commitment toward productivity, the provision of field materials for every individual field worker shall be highly necessary and appreciated. The field materials such as rain-boot, raincoat, field coat, spraying over all, cutlass, sharpening file, nozzle cover, eye goggle, aluminum bowls, reinforced wheel barrow, harvesting hooks, plastic kegs, storex tanks, low stools, chainsaw, etc. should be provided.
- Incidence of fire. There was an incidence of fire outbreak on the sexually propagative plot in the month of January which originated from local farm around the forest teak plantation and zones closed to the main library. It took the combined efforts of the Institute's staff/workers to put the fire under control. The effect of the fire on the Institute's scheduled crop was significant.
- Repair of Chainsaw, Bazukis, Lawn mower and Broken Tractors: It is highly necessary to repair the six available bazuki for easy evacuation of cocoa pods palm fruits and other farm produce from various zones to the fermentary or their destination, likewise, the repair of all broken down lawn movers, chain saw, and tractors up in that which are farm implement is highly essential before the rainy season set likewise, those that are repairable from the farm implement should be repaired before the rainy season set up. Likewise, those that are repairable from the farm implement should be repaired before the rainy season. We cannot do without them if we are to increase productivity and sanitation of the Institute environment.
- Promptly and Timely release of fund. There used to be inadequate fund to run the affairs of the PEM. Late release of fund for the running of PEM highly jeopardizes farm activities/operations hence, we shall appreciate prompt and early release of fund for the division's use so as to boost productivity.
- Skipper Machine. We are in dare need to purchase skipper machine to hasten separation and picking of farm fruits from the palm fruit bunches which will reduce the cost of production and increase palm oil productivity and output.

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Immediate and Long Future Term Plan of the Division

1. Continuation of rehabilitation of old plots gapping up all missing stands within the plots
2. Continuation of rehabilitation of old plots by pruning cocoa and cashew plantation
3. Cutting and removal of non-economic trees throughout the zones
4. Establishment of ½ hectare of hybrid parental plots

within the zones

5. Supply of dead young cocoa plants within the TC1 – TC8 plots
6. Establishment of more plots of CRIN scheduled crops
7. Establishment of lawn such as carpet grass in all our open field gradually
8. Raising of flower hedges cutting to gap-up all the missing stands and other asterisk beautification of the CRIN Estate
9. Continuation of gapping up of all the missing stands of masquerade trees and the umbrella tree.

SUBSTATIONS

AJASSOR SUBSTATION

Dr Kayode Ayegboyin (Head of Station)

Background

Cocoa Research Institute of Nigeria (CRIN), Ajassor substation, was founded in the year 1965 as a Research Substation and Extension Centre to CRIN, Ibadan. CRIN Ajassor is located along Ikom –Ajassor Border Road near Cameroun Border in Etung Local Government Area of Cross River State of Nigeria. It is bounded in the West by Ikom township, South by Effraya town, North by Ajassor plantations (Etigefe) and East by Ajassor Mission town. CRIN Ajassor substation is predominantly cultivated with Cocoa but because of its soil fertility and ability to sustain most tree crops, some handful of plantations of Kola, Coffee and Tea are also located at the station. In fact, it is well established that Cashew can also thrive in CRIN Ajassor. Consequently, all the five mandate crops of CRIN can be grown on CRIN Ajassor soil.

CRIN Ajassor substation is the largest Substation with a landmark of about 768 hectares. However, only about 88Ha of these lands had ever been cultivated with CRIN mandate crops. There are 56.86Ha of effective cultivated plots while about 23.7Ha and 7.5Ha are categorized as non-effective and abandoned plots, respectively. These figures are exclusive of the ground cover of approximately 113,436m^2 of land area that accommodates the Administrative and Planation Management Blocks, Staff Residential Quarters, Crop Nursery and Post-Harvest Unit, Mechanical Workshop, Rest House, Fermentary Building, Cocoa Dryer Compartment, a Staff Clinics as well as a Primary School (now under the control of Cross River State Government). Aside the main substation in Ajassor, there is two other experimental outposts. The first is located at Enoghi near Kalime, along Ikom –Ajassor Boeder Road and mainly cultivated with Cocoa. This outpost used to be erroneously thought to be within Kalime. The second outpost, popularly called Okonde Outpost, is located at Ikom-Okonde-Etome Road and predominantly cultivated with Cocoa and Coffee.

Cocoa Research Institute of Nigeria, Ajassor Substation, engage in exclusive training programme and extension services by disseminating research findings and many relevant information to the farmers, cooperative societies, corporate organizations, local and state governments in her immediate neighborhoods, and other surrounding States.

Staff Disposition

As at 31 December 2016, the staff strength across different sections and units stood at 32. Aside the Head of Station who is a Research Officer, there are 2 Agricultural Superintendents, 1 Clerical Officer (Administration), 1 Executive Officer (Account), 1 Store Keeper, 1 Nursing and Midwifery Superintendent, 1 Health Attendant, 1 Typist, 1 Driver, 1 Craftsman and 5 Security men. Out of the current 5 Security men at CRIN Ajassor, 4 of them had been coveted to Agricultural Field Attendants. Last but not the least, there were 14 Field workers. Many of these people FO's, old and are only struggling t. The details are in Table 1

Table 1: List of staff members with their designations, CONRAISS and Date of Last Promotion as at 31 December 2014 in Ajassor Substation

S/N	Name	PF No	Designation	Date of last promotion
1.	Dr Kayode O. Ayegboyin	256	Principal Res Officer (Head of Station)	01/10/2013
2.	Mr Maroof A. Olayiwola	294	Asst. Chief Agric Superintendent	01/10/2015
3.	Mr Mohammed BabaNitsa	318	Principal Agric. Superintendent II	01/10/2014
4.	Mrs Joy Awunghe	309	Principal Nursing Superintendent	10/10/2013
5.	Mrs Eunice Ojua	1143	Executive Officer (Account)	01/10/2014
6.	Mrs Ekama B. Isong	1288	Chief Clerical Officer (Admin)	01/10/2009
7.	Ms Esther Echi	1203	Principal Health Assistant	01/10/2011
8.	Mr Effiong N. Udoh	1142	Foreman	01/10/2014
9.	Mr Edet R. Akpan	1541	Chief Field Overseer	01/10/2015
10.	Mr Edim Okpokam	1556	Chief Store Keeper	01/10/2015
11.	Mr James Okoi	1543	Senior Craft man	01/10/2013
12	Mr Ezekiel Effiong	1289	Assistant Chief Field Overseer	01/10/2013
13.	Mr John E. Asuquo	1409	Asst. Chief Driver/Mechanic	01/10/2015
14.	Ms Pauline U. Ugi	1566	Senior Typist	01/10/2015
15.	Mr Samuel Udoh James	1702	Senior Agric. Field Overseer	01/10/2015
16.	Mr Bassey Igbang	1709	Senior Agric. Field Overseer	01/10/2015
17.	Mr Iwara Eteng	1760	Senior Agric. Field Overseer	01/10/2015
18.	Mr Abraham Samuel	1701	Senior Agric. Field Overseer I	01/10/2015
19.	Mr Godwin Idagu	1703	Senior Agric. Field Overseer	01/10/2015
20.	Mr Peter Ogar	1704	Senior Agric. Field Overseer	01/10/2015
21.	Mr Patrick Iyaji	1706	Senior Agric. Field Overseer	01/10/2015
22.	Mr EkereObong Sunday	1700	Senior Agric. Field Overseer	01/10/2015
23.	Mr Azogor Echeng Isong	1707	Agric. Field Attendant I	01/10/2013
24.	Mr Augustine Ubi	1698	Agric. Field Attendant I	01/10/2013
25.	Mr Ime Asua Sunday	1705	Agric. Field Attendant I	01/10/2014
26.	Mr Anthony David	1816	Agric Field Attendant I	01/10/2015

27.	Ms Mercy Umontia	1814	Agric Field Attendant I	01/10/2015
28.	Mr Idorenyin Okpo	1950	Agric Field attendant II	01/10/2014
29.	Mr Udo Johnny	1951	Agric Field Attendant II	01/10/2014
30.	Mr Godwin Peter	1815	Agric Field Attendant II	01/10/2015
31.	Mr Augustine Uzichu	1699	Head Watchman	01/10/2013
32.	Mr Ele Eleng Emeng	1708	Head watchman	01/10/2014

Retirees on the payroll of CRIN Ajassor Substation

As at 31 December 2016, there were no retirees on the payroll of CRIN, Ajassor. This is because all the CRIN retirees are receiving their pensions through IPPIS, Abuja. The current system of paying Pensioners through IPPIS started in August 2015.

Plantation Management

In spite of various challenges due to inadequate labour force (field workers) as well as unavailability of enough agro-chemicals for field and ground maintenance. Adequate cultural maintenance of all the Cocoa, Coffee, Kola and Tea plots under CRIN Ajasor were done throughout the period of time under review. The details of the production plantations and research plots under CRIN Ajassor as at 31 December 2016 are in Table 2:

Table 2: Plantations/ Research Plots with their hectares and status in Ajassor as at 31 December 2015

Cocoa Research Plots Cocoa plots	Hectares	Status
1967 Trinidad	2.9	Maintained
1975 F Amazon	1.6	Maintained
CRIN/NIFOR 1	6.0	Maintained
CRIN Elite Seed Multiplication	2.2	Maintained
T38 Kalime	2.8	Maintained
Commercial	2.0	Maintained
Cocoa Cuttings	1.0	Maintained
15 Acres Extension	2.0	Maintained
Amelonado	2.0	Maintained
1973 F Amazon	2.0	Maintained
Seed Garden Multiplication	2.2	Maintained
Okondi	10.69	Maintained
Planting at stake	1.6	Maintained
Farming System Experiment	2.0	Maintained
Adaptability/Tolerant Trial	2.1	Maintained
65 Lines Experiments	1.0	Maintained
CRIN Elite Seed Multiplication	2.2	Maintained
Cocoa Research Plot	1.32	Maintained
Ornamental Cocoa Plot	0.5	Maintained
Okondi (Cocoa) Plot	0.4	Maintained
Kola Research Plots		
Kola Progeny	1.6	Moribund
Kola Cuttings	0.65	Maintained
Kola Germplasm	2.92	Maintained
Kola Fertilizer Trials	2.0	Moribund
Coffee Research Plots		
Okondi	1.46	Moribund
1989 Ajassor	1.57	Moribund
Tea Research Plots		
Tea Ajassor	0.28	Maintained

Research Experiments
A pocket of research experiments were on-going at CRIN Ajassor Substation as at 31/12/2016. These were mainly the screening trials for some herbicides and fungicides as well as PhD projects of two Research Officers with CRIN Ibadan.

Vehicles/Motorcycles/Generators at Ajassor
The list of the vehicles/motorcycles/generators (and their conditions) are as below:
1. Toyota Hilux Van with registration number FG 09 V03 (functioning).

2. Peugeot 404 Pick-Up with registration number FG 2326 B034 (not functioning; recommended for boarding).

3. Mercedes 911 Water Tanker with registration number FG 237 B02 (functioning BUT below optimal level; should be overhauled as soon as possible).

4. The Eicher Truck with no registration number (it is already a scrap; recommended for boarding).

5. Mitsubishi L200 Van with registration number FG 741 B03 (not functioning; could be boarded, repaired for the use of CRIN Ajassor Substation or be sold after repair).

6. Bedford with registration number FG 238 BO3 (already a scrap; recommended for boarding)

7. Tractor 1 (serviceable) with registration number FG 239 B03 MF 265 (functioning but its tires and few parts needed replacement).

8. Tractor 2 (unserviceable) already a scrap; recommended for boarding.

9. Motor-cycles 3: We have 1 Daylong Wolf150 which is new and functioning well but the 2 Suzuki 185 motor bikes with registration numbers FG 335 B03 and FG 335 B03 are old and not functioning, and are recommended for boarding.

10. 50 KVA Generator plant (functioning but some of its parts needed replacement).

Infrastructure/Capital Projects
CRIN Ajassor did not have any capital project in 2016. However, I am using this medium to plead with the CRIN Management to help complete the 2013 Electrification of CRIN Ajassor project. This will positively change the living standards of staff and all other residents of CRIN Ajassor quarters in no small measure.

Cocoa Fermentary/Drying slab/Shade nets
The CRIN Ajassor fermentary was not in perfect working condition in 2016. We recommend that the building be re-roofed and some other renovations work be carried out on its walls. However, the drying slab was obsolete and non-presentable. We recommend its replacement with more recent and highly acceptable raised platforms. Meanwhile, only one of the 3 shade nets for raising seedlings was in good working condition during the period under review. So, the repair of the two other shade nets is urgently needed.

Environmental Sanitation
At CRIN Ajassor, we know that 'health is wealth' and so we placed a high premium on the cleanliness of our offices and the residential quarters. Against this backdrop, a Monthly Environmental Sanitation on every last Saturday of the month was observed throughout the year under report. We also implore CRIN management to provide more public toilet for the staff in their residential quarters in 2017.

Visitors to the Substation in 2016
More than 500 visitors came to CRIN Ajassor in 2016 but only 35 of them were sampled for report. The names, addresses, phone numbers and purpses of visit of the sampled visitors at CRIN Ajasor in 2016 are in Table 5.

Table 5: Name, address, purpose of visitation and phone number of some sampled visitors to CRIN Ajassor in 2016

	Names	Address	Phone number	Purpose of visit	Date of arrival
1.	Chief Ausaji Ayide	Ikom LGA	07087001899	Official	08/01/2016
2..	Hon Assam Emi	Etung LGA	08062007155	Official	11/01/2016
3.	Mr Felix Okoi	Ikom	08136292957	Official	15/01/2016
4.	Mr Oyama Phillip	Ikom	08103173114	Official	24/02/2016
5.	Mrs O.O. Akinwande	CRIN Ibadan	08056640132	Stock taking	24/02/2016
6.	Mr A.E. Tawo	Boki LGA	08036157059	Official	24/02/2016
7.	Mrs Getrude Osadim	Ikom	08039348150	Official	29/02/2016
8.	Chief Obi Okorn	Calabar	07038824422	Official	10/03/2016
9.	Mr Abang Aganyi	Ikom	0808852589	Official	13/03/2016
10.	Dr Kayode Adejobi	CRIN, Ibadan	08174111274	Research	21/03/2016
11.	Njom O. Nyambi	Ikom	08035964012	Official	29/03/2016
12.	Ntufam Williams Ogar	Calabar	08059011797	Official	31/03/2016
13.	Mr P.N. Eku	Ikom	08064938948	Official	12/04/2016
14.	Dr Ope Ogunmodele	Ekpoma, Edo State	08058135150	Research	18/04/2016
15.	Mr Kunle Oguntona	CRIN Ibadan	08038786313	Junior Staff Prom Exer	25/04/2016
16.	Mr Abang Obi	Calabar	08058525690	Official	04/05/2016
17.	Dr J.A. Ayang	Ikom	08123768655	Official	20/05/2016
18.	Dr A.R.Adedeji	CRIN Ibadan	07064715028	Resaerch	22/05/2016
19.	Mr Patrick Ekun	Calabar	08033074682	Official	23/05/2016
20.	Mr Bassey Ojong	Etung LGA	08050842760	Official	23/05/2016
21.	Mr Rapheal Okon	Bekwara LGA	08064232601	Official	25/05/2016
22.	Mr Ekom Ogonyi	Boki LGA	08126025042	Official	06/06/2016
23.	Hon C.T. Takon	Ikom	09057676560	Official	09/06/2016
24.	Mr Erim Ebi	Boki LGA	07036249832	Official	14/06/2016
25.	Mr Walter Osim	Calabar	07033820121	Official	28/06/2016
26.	Hon Victor Ushei	Ikom	08035678901	Official	10/07/2016
27.	Hon J.A. Achu	Ikom	07056786709	Official	14/07/2016
28.	Dr S.B. Orisajo	CRIN Ibadan	08033066574	Research	19/07/2016
29.	Mr Cosmas Obi	Ajassor	08064864070	Official	21/07/2016
30.	Mrs N.N. Neji	Ikom	80767898090	Official	26/07/2016
31.	Dr J.A. Ayang	Calabar	08025563167	Official	26/07/2016
32.	Mr Odu Egom	Etung LGA	08075678762	Official	26/09/2016
33.	Mr Agianpuye A. Francis	Ikom LGA	08084328497	Official	01/11/2016
34.	Mr Patrick Agbor	Etung LGA	08139556648	Official	04/11/2016
35.	Mr Tayo O. Adenuga	CRIN Ibadan	08162450467	CRIN/WCF	12/11/2016

Internally Generated Revenue

A total amount of Two Million, Five hundred and eighty six, Eight hundred and eighty naira (₦2,586,880) only was generated by CRIN Ajassor in 2016. The breakdown of the revenue generated is in Table 6

Table 6: Internally Generated Revenue analysis for 2016 (January-December 2016)

	ITEMS	JAN.	FEB.	MAR.	APR.	MAY	JUN	JUL	AUG.	SEP	OCT	NOV	DEC	TOTAL
Farm produce (A)														
1,	Cocoa pods	-	-	-			7,000	400	24,400	-	112,250	198,650	33,250	375,950
2,	Kola nuts	3,600	2,200	2,400	4,200	-	-	-	-	-	2,000	8,240	14,180	36,820
3	Cocoa beans	-	-	-	-	-	-	70,000		120,000	205,000	535,000	278290	1,208,290
4,	Plantain/Banana	-	-	-			2,900	4,800	-	-	2,500	-	-	10,200
5,	Seized planks	-	-	-	-	-	-	-	-	-	15,400	14,900	12,000	42,300
6	Palm fruits	-	12,000	-			10,500	17,500	-	-				40,000
7,	Cocoa seedlings	53,200	17,500	42,000	30,000	-	17,500	2.250	-	-	-	-	244,920	407,370
8	Pine apples	-	-	-	-	-	600	-	-	-	-	-	-	600
	SUB TOTAL (A)	56,800	31,700	44,400	34,200	-	38,500	94,950	24,400	120,000	337,150	756,790	582,640	2,121,530
Services (B)														
1	Staff rent	22,000	17,000	20,000	4,000	10,000	9,000	4,750	8,000	16,500	22,500	4,500	10,000	148250
2	Tenant rent	44,000	82,600	50,500	22,000	34,500	25,500	4,000	1,000	9,000	17,000	19,000	8,000	313,100
	SUB TOTAL (B)	66,000	99,600	70,500	26,000	44,500	34,500	8,750	9,000	25,500	39,500	23,500	18,000	465,350
	Total (A + B)	122,800	131,300	114,900	60,200	44,500	73,000	103,700	33,400	145,500	376,650	780,290	600,640	2,586,880

Challenges and Prospects

In 2016, CRIN Ajassor substation's challenges revolve around inadequate workforce, lack of modern tools and equipment, lack of electricity and other infrastructural facilities as well as unavailability of agro-chemicals. We were also faced with land encroachment problem by the indigenes. However, we were able to control, to some extent, this particular problem with diplomacy and, as the last option, confrontation against the intruders. We urgently need to salvage the situation in 2017 and reclaim all stolen lands from the indigenes.

CRIN Ajassor substation has the capacity for unprecedented expansion and productivity, if more staff is engaged and adequate agro-chemicals are provided. Be as it stands now, CRIN Ajassor requires nothing less than 60 field staff to cope with the 56.86Ha of Cocoa, Kola, Coffee, and Tea plantations in 2017 and beyond.

Besides, in order to effectively secure lives, properties and forestall against land encroachment by the indigenes, there is a need for employment of more security men at CRIN Ajassor. As a recommendation, the substation will need an additional 15 Watchmen to complement the effort of the current 5 staff at the station We also need at least one Cleaner to maintain the sanitation of the 9 toilets in the newly renovated office complexes and CRIN Ajassor's Guest House, 1 officer to collect data and monitor the substation's Meteorological Station and a new Administrative Officer to assist the current Chief Clerical Officer (Administration) in the station. Other pressing needs for 2017 include:

- A new Toyota Hilux Pick-up since the current station's Hilux is old and needs replacement.
- Motorbikes: Based on the volume of the field work and the need for constant patrol of our plots by the security, there is need for us to have 10

motorbikes.

- Surveying and fencing of the station: This will permanently stop the encroachment problem presently being faced by the station.
- Construction of concrete and metallic signposts in all plots for easy identification.
- An internet connection: This could be a broadband internet facility that will facilitate easy access information on the web as well as provision for a speedy transfer of research related information to and fro the headquarters.
- Renovation of residential quarters: Most buildings at CRIN Ajassor Staff residential quarters are highly dilapidated while toilet facilities for the occupants had become a mirage. Although, government quarters had been monetized, there is an urgent need to rescue our buildings to avoid total collapse of these 'farmhouses'. Once collapsed, both staff and tenants who currently occupy these buildings will be forced to move out. This would spell doom for the safety of our offices and plots.
- Supply of more storage tanks and the expansion of our bore storage capacity to increase supply.
- Construction of farmhouses in the zones for the field workers to serve as coverage during rainy season.
- Renovation of the fermentary house, drying oven shed and construction of raised platforms for drying cocoa.
- Renovation of worn-out seedling shade nets at CRIN Ajassor.
- Provision of a modern and better equipped laboratory for CRIN Ajassor.

Once again, on behalf of the entire members of staff of CRIN Ajassor Substation, I thank the Acting Executive Director and the entire CRIN IMC for their kind gesture to CRIN Ajassor in 2016. We appeal that the Ag. ED should consider most of our requests, especially in employment of more staff at the substation as soon as possible.

OCHAJA SUBSTATION

Staff Strength

The Substation's staff strength stands at 38 with the following breakdown:

Research Officers	-	2 (1 CRO and 1PRO)
Agric Superintendents	-	3 (1 ACAS, 2 PAS II)
Higher Executive Officer (Accts)	-	1 (Station Accountant)
Foreman	-	1 (Due for retirement on 16/06/2017)
Assistant Executive Officer (Accts)	-	1 (Store Officer)
Senior Secretarial Assistant	-	1 (SSA II)
Agric Field Overseers	-	4 (2 CAFO and 2 SAFO)
Agric Field Attendant	-	10 (AFA 1)
Watchmen (newly nomenclature AFA 1)	-	5 (AFA 1)
Health Attendant	-	1 (SHHA)
Drivers	-	2 (1 SD&M and 1 D/M)
Cashew Factory Workers (Casuals)	-	7

The staff strength of the Substation was 38 (as analyzed above) as at 31st December, 2016. However, more workers are needed for the work in the Substation especially on the field.

Staff Disposition

The members of staff at the Substation are of good disposition to work and every official assignment given them. However, there is always a room for improvement.

Land Area

The Substation has a total land area of **351 hectares** with **55.5 hectares** on utilisation for both commercial and research plots, the routine maintenance of the plots and data collection are carried out as at when due. However, some of the plots are highly weedy with shrubs due to lack of manpower.

2016 Activities

Plots were maintained as and when due. However, some of these plots could not be weeded as a result insufficient field worker. With the help of the Special Project Workers for 2 months (September to November 2016), we were able to clear some thickly weeded plots like (SW5 and NW/9). Other plots were also maintained within the confine of our field staff. The details of the Substation's 55.5 hectares existing cropped plantation and their coverage, purpose of establishment, planting distance, plot title and year of establishment are as follows:

SN	Name	Spacing	Pedigree	Year Planted	Purpose	Hectarge
1.	Demonstration Plot	9M X 9M	Oro Selection Cashew	1997	Commercial	3.0
2.	Demonstration Plot	3.1M X 3.1M	Cocoa Trial Plot	2011/2012	Trials	0.45
3.	Plot NE2/NW2	3.1M X 3.1M/ 9M X 9M	Cocoa/Oil palm Geometry	2009	Expt. Trial	2.0
4.	Plot SE 5	9M X 9M	Cashew Nut Size Trial/Oro Collection	1999	Expt. Trial	7.0
5.	Plot SW 1	6.2M X 6.2M	Small Nut Cashew	1976	Commercial	3.2
6.	Plot NW 1	6.2M X 6.2M	Medium and Small Nut Cashew	1976	Commercial	3.2
7.	Plot NW/7	6.2M X 6.2M	Germplasm Collection	1977	Germplasm	2.2
8.	Plot SW/2	6.2M X 6.2M	Small and Medium Nut Cashew	1977	Fertilizer Trial Expt.	4.2
9.	Plot NW/9	3.2M X 3.2M	Varied Nut Cashew	1988	Intercrop Expt.	0.45
10.	Millennium Plot	9M X 9M / 8M X 8M / 6M X 6M	Small and Medium Nut	2000	Systematic Spacing Experiment	4.0
11.	Plot SW/3	6.2M X 6.2M	Small and Medium Nut	1976/1977	Pruning Experiment	6.4
12.	Plot SW/4	9.1M X 9.1M	Small and Medium Nut	1982	Experimental Plots	2.0
13.	Plot SW/5	6.2M X 6.2M	Germplasm	1976/1977	Germplasm collection	4.1
14.	Plot NW/4	6M X 6M	Varied Nut Cashew	2011	Commercial	2.0
15.	Higher Density Plot	9M X 9M / 8M X 8M / 6M X 6M	Varied Nut Cashew	2001	Experimental Trial	5.0
16.	Germplasm Plot	6M X 6M	Oro Collection	2009	Germplasm Collection	5.0
17.	Plot NW/3	4M X 4M	Varied Nut Sizes	2001	Nut size and Planting Spacing Expt.	1.5
18.	CRIN Acharu	9M X 9M	Kola	2011/2012	Demonstration Plot	2.5

Research

There are various on-going research experiments within the year under review that are set up by some scientists from the Headquarters. It is noteworthy that no scientist has come on research trip since I assumed office as the Head of Station on 01/08/2016.

Lists/titles of the on-going research experiment in the station are as follow

- Physical effect of inter-cropping of cashew with some arable crops – Mrs Nduka B. A.
- Growth and yield of cashew as influenced by leguminous cover crops – Mrs Iloyanomon C.I.
- Preliminary studies on yield differential and soil

nutrient status of cashew plantations of different nut sizes in Ochaja Substation, Kogi State – Mrs Iloyanomon C. I.

- Leaf litter fall and soil nutrient dynamics of cashew plantations of different ages in Ochaja Substation, kogi State – Mrs Iloyanomon C.I.
- Field establishment of cashew as influenced by shade plants and phosphate fertilizer – Dr. Ibirimo O. S.
- Effect of coppicing period and height on cashew rehabilitation – Mrs Adeyemi

Data were duly collected on all the on-going research experiment in the station within the year under review. The scientists who set up experiments at the Substation are to provide the Ag. Executive Director with the reports of their experiments for this year.

Ground Maintenance

The ground maintenance of the quarters and office complex of the station was carried out promptly in the year 2016 to enhance cleanliness and proper sanitation. There were a lot of termite infestations which were combated chemically with the available chemicals in store at the Substation. Similarly, weed control was done periodically using herbicides, hand weeding and mechanically with the aid of hand mower.

Achievements

Internally Generated Revenue (IGR)

The IGR of the station is greatly dependent on cashew nut harvested from the Substation cashew plots and rent paid by the occupant of the residential quarters. Some of the harvested cashew nuts were processed and sent to the Production and Substation Department of CRIN Headquarters as aforementioned above while the remainder is kept in the produce store as raw materials for the Cashew Processing Factory in the station.

It is very germane to note that as at 31/12/2016, Twenty-Eight bags of raw cashew nuts (₦ 360,000.00 worth) were in store for Cashew Kernel Processing in the Substation. Also, within the year under review, 440kg of Jumbo Nuts (₦660,000.00 @ ₦1,500/kg) were sent to CRIN Headquarter, Ibadan from the Substation.

The breakdown of the IGR remitted from the Substation in the year under review is shown below:

S/N	Description (Details)	Amount (₦)
1.	Cashew Seedling	4,000.
2.	Cashew Nuts	122,600.
3.	Casava Tuber	6,500.
4.	Oil Palm Fruit	4,500.
5.	Firewood	33,500.
6.	Maize	16,000.
7.	Lease of Farmland	16,000.
8.	Ogbono Seeds	1,500.
9.	Water Sales	15,100
10.	Rent	4,000=
	Total	223,700

Cashew Juice Production

In the year under review, there was no Cashew Juice Production.

Cashew Nut Kernel Production

The station produced processed cashew kernels from the harvested raw cashew nuts in store at the Substation to generate IGR for the Institute. The processed cashew kernels were packaged and sent to the Production and Substation Department, CRIN Headquarters. Within the span of four months of my resumption alone, over 900 bottles of processed Cashew Kernels had been remitted to the Headquarters.

The Cashew Processing Factory had some of the damaged equipment (Baby boiler, Nut Deshelling Machines and Roasting Chamber) due to persistent usage and they were adequately fixed from out-of-pocket expenses so that kernel production will not stop in the Substation.

The Hermetic Storage Facility for processed cashew nut in the Substation was installed so as to store processed cashew kernels till Packaging Bottles that have been exhausted will be provided by the Headquarters to the Substation.

Cash Received and Spent

No capital or overhead fund was received from the Headquarters in the year under review. However, an imprest of ₦ 150,000.00 (One Hundred and Fifty Thousand Naira Only) in total was sent to the Substation in 5 installments within the year. It is noteworthy that a total amount of ₦ 30,000.00 (Thirty Thousand Naira Only) out of the above-mentioned amount was sent since my resumption (1st August, 2016) till 31/12/2016. The fund was judiciously used for smooth running of the Substation.

Events/visitors within the Year 2016

1. **Pension Verification Exercise:** No pension verification exercise was carried out by the Headquarters in the Substation within the year.

2. **Student Visited the Substation of Field Trip**: Student from college of Education Ankpa visited the Substation on field trip within the year 2016 to learn more about CRIN and its Mandate crops.

Visitors Received from the Headquarters and other Places in the Substation in 2016

S/N	NAME	ADDRESS	DATE	Purpose of Visit
1	Mr. A.I. Ndubuamun	FBN, Ayingba	21/01/2016	Bank Products Sensitization
2	Mr. Alabi N.I	FBN, Ayingba	26/01/2016	
3	Mr. Jimoh Adebayo	FBN, Ayingba	28/01/2016	"
4	Mr. Salawu Dare	Egume	04/02/2016	Official Visiti
5	Mr. Ozor H.N.	Produce Dept., Enugu	16/02/2016	Official Visit
6	Mr. Frank Ugwu	Udenu	16/02/2016	Official Visit
7	Mr. Charlse Adejoh	Ayingba	29/03/2016	Official Visit
8	Mr Taiwo Ayobami	Makurdi	01/04/2014	Inquiry on Cashew Nuts
9	Dr. Ak in Oloniruha	College of Agric., Kabba	14/04/2016	Courtesy Visit
10	Mr. Adeniyi D.O.	CRIN HQ	21/04/2016	Official Visit
11	Mrs. Mokwunye I.U.	CRIN HQ	21/04/2016	Research Visit
12	Mrs. Adeyemi E.A.	CRIN HQ	21/04/2016	Research Visit
13	Arowolo Damilola .B	K.S.U	22/04/2016	Research Visit
14	Ojo Grace	K.S.U	22/04/2016	Research Visit
15	Dr.Famuyiwa B.S.	CRIN HQ	24/04/2016	Junior Staff Promotion
16	Adamu A.	KSCOE, Ankpa	12/05/2016	Excursion
17	Dr. Aina D.O.	K.S.U Ayingba	07/06/2016	Setting up Experiment
18	Mr. Ayodele Stephen	NTA Lokoja	10/06/2016	Official Visit
19	Adegede A.P and F.O. Sulayman	RMRDC, Lokoja	21/06/2016	Official Visit

ADMINISTRATION AND PERSONNEL DATA

Administration and Supplies Department

The Administration and Supplies Department of the Institute applied itself meritoriously to its primary responsibilities of supporting and assisting the Executive Director in the day-to-day administration of the Institute in conformity with the Institute's Mandate and mission statements.

Structure of the Department

To facilitate the activities of the Department, the Department is structured into three (3) Divisions, viz Administration Division, Supplies Division and Health Services Division.

Two of these Divisions are further structured into the following Sections.

Administration Division - Human Resources Management Section, Legal and Corporate Matters Section, Pension Section
and
Catering Services Section.
Supplies Division - Purchase and Supply Section and Stores Section.

Staff Strength
The department has a total number of 77 staff.

They are summarized as follows:
10 Professional in Administration 20 Executive Officers; 1 Confidential Secretary 11 Secretarial Assistants; 18 Clerical Officer; 10 Nurses 4 Health Attendants; 1 Data Processing Assistant, 2 Catering Offices; 2 Catering Assistants; 2 Stewards; 1 Store Officer, 4 Storekeeper; and 2 Field Attendants.

Functions/Activities of the Department
Detailed reports of the functions of the Department are as follows:

- Cost-effective management of all the administrative activities of the Institute, including all elements of Personnel function, Legal and Corporate Matters, incorporating Governing Board affairs and Public Relations.
- Planning, organizing, co-coordinating and control of all activities, personnel, funds, materials, equipment and infrastructural resources in the Administration and Supplies Department of the Institute.
- Identifying, articulating, formulating and reviewing from time to time the administrative activities of the Institute in compliance with the statutory mandate of the institute, current Government policies and priorities, as well as all rules and regulations for the management of Government Institutions and they affect the Institute, the demands of farmers for the Institute mandate crops and manufacturers of products derivable from the Institute's mandate crops, promotion of staff welfare and public image of the Institute.
- Human Resources Management, including appointments, staff training and development, promotions, discipline, disengagement, post-disengagement and staff welfare. Records of the aforementioned administrative functions are highlighted below:

Achievement/Progress of the Department

Promotions
Year 2016 promotions.

2016 Left the Service

S/N	NAME	SEX	DESIGNATION	SAL-ARY GR-ADE	DATE OF BIRTH	DATE OF FIRST APPT	DATE OF LAST PROM-OTION	DATE OF RETIR-EMENT
1	Akpan Rosemary (Mrs)	F	Chief Agric Field Overs	6	15/1/56	1/8/1994	1/10/2010	15/1/2016
2	Onyebuchi Cletus	M	Snr. Clerical Off.	5	2/6/59	17/7/95	1/10/2013	12/1/2016
3	Mrs. Namiah Peter	F	Agric. Field Attd. I	6	12/12/57	1/12/1997	1/10/2004	10/5/2016
4	Olutade Ann (Mrs)	F	Chief Clerical Officer	6	28/6/56	10/9/2003	1/10/2010	28/6/2016
5	Patrick Micheal Oyinbe	M	Head Security Guard	5	20/8/56	1/9/1993	1/10/2009	20/8/2016
6	Dan-fulani Moses	M	Agric Field Attendant I	3	20/7/56	1/10/1997	1/10/2004	20/7/2016
7	Haruna John	M						23/7/16
8	Ulikhifo Michael	M						24/7/16
9	Idi Mohammed	M	Princ. Agric. Supt. I					3/5/2016
10	Moshood Owolabi	M						
11	Ozigbo Zaccheus	M	Asst. Chief Agric Field Overs	5	11/12/56	9/12/1996	1/10/2012	11/12/2016
12	Magaji Odilia Lukong (Mrs.)	F	Senior Executive Officer	8	9/5/62	23/11/1981	1/10/2013	23/11/2016
13	Iloko Emeng	M	Head Watcman	3	12/12/56	1/10/1997	1/10/2004	12/12/2016
14	Adeniyi Yisa	M	Princ. Agric. Supt.	9	24/4/70	9/4/2008	1/10/2014	29/11/16
15	Dr.(Mrs.) Okelana Feyisara Abiodun	F	Director	15	13/9/51	1/4/1982	1/10/2007	13/92016
16	Fademi Omoditunu	F	Clerical	3				

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ANNUAL REPORT

OF THE

COCOA RESEARCH INSTITUTE OF NIGERIA, IBADAN

2017

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Research Activities

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Sub-Stations

CASHEW PROGRAMME

Experiment Title: Development of activated carbon from cashew nutshell (CNS) as low cost adsorbent.
Investigator: L.E. Yahaya.

Introduction

Water pollution is a serious problem of the environment. Heavy metal contaminations abound in many industrial processes such as mining, tanneries, textile industry. Lead for example, a product of these industrial processes is considered as cumulative substance. Acute lead poisoning can affect nervous system and gastrointestinal track. The harmful of cadmium include number of acute and chronic disorders such as "itai-itai" disease, emphysema and hypertension. Conventional technique for heavy metals removal from water and wastewater include electroplating, evaporating, oxidation, reduction, membrane separation, ion exchange and adsorption and these involved the use of synthetic materials which are economically prohibitive and rather expensive. The cashew industry generates high volume of cashew nutshell (CNS) as waste from its processing. This can be used to generate activated carbon which can serve this very purpose. This is a renewable material which will add value to the crop. The cashew nut shell has also found important commercial usage as the phenolic raw material for the manufacture of certain resins and plastics having unusual electric and frictional properties. Therefore, it is interesting to develop the cashew nut shells as activated carbons with large surface area as low cost adsorbent as alternative to the expensive conventional adsorbents. This will no doubt add value to the crop.

Methodology: Carbonization of Cashew Nut Shell: The carbonization of CNS was carried out in developed small capacity single drum kiln; to produce chars. Chars was prepared from cashew nut shells by carbonization in the absence of air through the process of pyrolysis. These chars were subjected to further treatments. Activated carbon produced was characterized by instrumental method (FT-IR spectrometer, Spectrum GH, Perkin Elmer) to determine the presence of surface functional groups in samples. Adsorption experiments were conducted using the activated carbon at varying initial concentrations, pH, particle size of adsorbate etc. using different heavy metal ions solutions.

Results and Discussion: Adsorption capacity: The amount of lead and zinc ions was calculated and the results presented in Figure 1. The effect of contact time on adsorption by cashew nut activated carbon (CAC) indicates that 30 minutes was required for the metal ions to achieve optimum adsorption. For lead (II) ions, it required 30 minutes to remove 95% of the ion from aqueous solution while it took the same time period to remove 97.5 % Zn (II) from aqueous solution. From the plot, it can be seen that metal ion uptake increases with contact time for the adsorbent, however, adsorption of both ions tends to decrease after 30 minutes and no significant increase was observed even after 180 minutes contact period. It is clear that CAC can adsorb appreciable amount of these ions at a relatively short period.

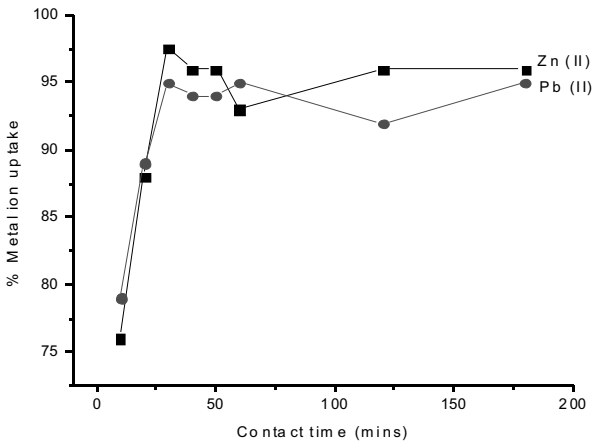

Fig.1. Effect of contact time on the adsorption of Pb^{2+} and Zn^{2+} by CAC

It is well known that the adsorption of metal ions by adsorbents is pH dependent. Metal ion adsorption on the surface of an adsorbent is described in terms of molecular mechanisms which may probably include cation exchange in the interlayer and specific adsorption that results from surface complexation. Metal ion complexation is affected by hydrogen ions because of the affinity they have for the adsorption sites. The effect of initial pH on the adsorption of Pb and Zn ions by CAC was studied and the result shown in Figure 2. From the figure, it is observed that there was an increase in the adsorption of the heavy metal ions with increase in pH from 1- 4 where maximum adsorption of 87% was recorded for Zn and 1-5 and with maximum adsorption of 96% for Zn (II) and Pb (II) respectively

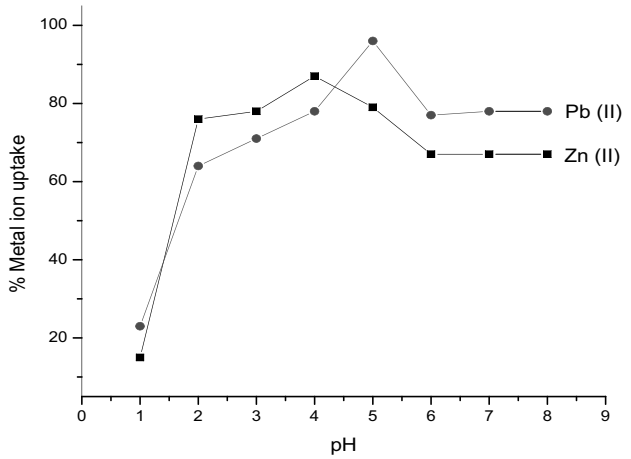

Fig. 2. Effect of pH on the adsorption of Pb (II) and Zn (II) ion CAC

Weber- Morris intraparticle model was used to analyze the experimental data in order to estimate its fitness with the experimental data. Table 1 presents the kinetic parameters of the data. It was observed that R^2 values for the two metal ions are in the range of 0.9309 - 0.9889. As shown in the table, K_{id} which is the rate factor of the adsorption mechanism is high for both metal ions. The implication of this is that CAC is effective in the uptake of these metal ions..

Constants	Pb (II)	Zn (II)
N	0.0041	0.0067
K_{id} (min^{-1})	94.47	89.65
R^2	0.9309	0.9889

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Experimental Title: Cashew Insect Pests Surveillance in Oyo and Osun States, South West Region Of Nigeria

Investigator: E.U. ASOGWA

Introduction

The effects of climate change have resulted in the change of status of the various insect pests of cashew. Cashew farmers have also reported an unprecedented outbreak of insect pests in their farms. There is therefore the need to study the seasonal and geographical distribution of these pests with a view of appropriately classifying and reconfirming their economic status.

Methodology

Study location: The survey was carried out in the South West (Oyo and Osun) states of Nigeria.

Insect pests sampling: The survey was carried out in three (3) different Local Government Areas of each of the state (Oyo and Osun) where cashew is grown in commercial quantity. In each LGA, three (3) large commercial farms, subsistence plantings, spontaneous farms by the way side and back yards were sampled. In each farm, a total of 100 randomly selected stands of cashew trees were sampled by systematically traversing the farms at both diagonals and longitudinal ends.

Each selected cashew plant was closely observed for insect species around the leaves, twigs, stems, flowers, apples, nuts and soils around the bases of plants. The insects were handpicked or brushed into 2lb sized kilner

jars containing cotton wool covered with filter paper soaked in ethyl acetate and labeled with the location, farm name, LGA, crop, date, and plant part found. Each insect intercepted was identified and briefly characterized stating its full names and description their damage characteristics.

Insect pest incidence mapping

The percentages of insect pest infestation of the farms were assessed, and the pest mapping of the areas was carried out using three points scale below:

1. + (? 5% trees affected) - Low pest incidence
2. ++ (6 - 25% trees affected)- Moderately spread
3. +++ (? 30% trees affected) - Widely spread

Finally, field pictures were taken with digital camera and all the farms sampled were geo-referenced using the GPS (Table. 1).

Table 1: Geo-reference locations of representative cashew plots in each state

Locatio	Latitude	Longitud e	Altitud e	Far m area
Oyo state	N07.22382^{O}	E 003.86965^{O}	141m	2 ha
Osun state	N 07.49980	E 004.69841^{O}	142M	2 ha

Results

Insect pest incidence and intensity across the states

Major insect pests recorded in the two states include cashew stem girdler, trunk and root borer, grasshopper and termite. The stem girdler infestation was widely distributed across the states ranging from 47.2% to 39.6% in Oyo and Osun states respectively. The trunk and root borers, termites, grasshoppers and fruit scraper had moderately distributed infestation rate in both states **(Table. 2).** The taylor ants and honey bees were also intercepted but their incidence/intensity was not accessed as they are beneficial insects (natural enemies/ pollinators).

Table 2: Incidence and intensity of insect pests intercepted in cashew farm in Oyo and Osun States of Nigeria

Pest	% incidence	
	Oyo	Osun
Stem girdler	47.2+++	39.6+++
Trunk & root borer	11.3++	9.5++
Termites	21.9++	18.9++
Grasshopper	10.4++	12.3++
Fruit scrapper	7.4++	5.9++
Taylor ants	-	-
Honey bee	-	-

Cashew insect pest intercepted

Cashew stem girdler (Analeptes trifasciata*) Coleoptera: Cerambycidae*

Plate 1: Adult *Analeptes trifasciata*

Damage characteristics: Their damage is usually noted by the presence of small holes and girdled proportions on stems and branches. Such affected stems and branches have deep groves as a result of which the stems and branches are left with thin woody tissue at the centre to temporarily support the weight of the branch, leading to the sudden snapping of such branches.

Termites (Nasutitermes spp) Isoptera: Termitidae

Plate 2: Termite shelter tunnels from subterranean nest up to the trunk

Damage characteristics: The young plants in the nursery and the field may be attacked mainly in the collar region but also in the taproot and the basal portion of the stem. Many termites make narrow covered runways or shelter

tunnels from subterranean nest up to the trunk to suitable tissues on the tree. The 'runs', which can be regarded as nest extensions, may be constructed of particles of earth or of chewed wood and lead to death of the stems and branches.

Grasshopper (Zonocerous variegatus) Orthoptera: Acrididae

Plate 3: Scrapping of cashew apple by *Zonocerous variegatus*

Damage characteristics: The grasshopper, *Z. variegatus* attack young seedlings, ripe and mature cashew fruits. The adults have been observed to scrape the fruit wall of mature and ripe fruits. In most cases, there was always a thin layer left before the juicy part of the fruit.

T*runk and root borer* *(Plocaederus ferrugineus* L. (Coleoptera: Cerambycidae)

Plate 4: Boring effects of cashew T*runk and root borer (Plocaederus ferrugineus* L.

Damage characteristics: Their attack could easily be recognized by the presence of small holes in the collar regions of the tree trunk, gummosis, extrusion of chewed up fibres and excreta near the base of trunks as the grub expels them out. The grub causes extensive damage to both old and young cashew plantations. They make irregular tunnels inside the trunk and cause extensive gum leakage, which will eventually kill the tree.

Cashew pseudo-apple scraper (*Pachnoda cordata* (Coleoptera: Scarabidae)

Plate 5: Cashew pseudo - apple scraper **(***Pachnoda cordata*

Damage characteristics: The pseudo-apple scraper feeds on the buds, blossoms, leaves, and mostly fruits of cashew. By their feeding activities they destroy the cashew apples and cause them to rot and fall down from the tree.

Cashew integrated pest management (IPM)

Cashew integrated pest management (IPM) is a process consisting of the balanced use of cultural, biological and chemical procedures that are environmentally feasible and socially acceptable to reduce pest populations to tolerable levels in plantations. The IPM has evolved in recent years as an alternative approach to the sole use of pesticides because of increasing **problems associated with** over-reliance on pesticides, which has usually resulted in development of resistance pest biotypes, high costs, elimination of natural enemies, environmental contamination and unacceptable residues in final product. The adoption of IPM practices will empower the farmers to be able to minimize pest damage and reduce the costs of production, leading to sustainable increases in crop production and farm income.

Conclusion

The insect species have been implicated with economic losses estimated between 52 and 75% of the cashew production level (Ojelade, 1998) and needs to be routinely

monitored and controlled. Finally, the benefits of IPM is beyond financial gains by producers but extends to substantial gains in human health for producers and consumers, further advantage is farming efficiency and the environment also benefit as leaching of chemicals into water resources is reduced or avoided altogether, while natural enemies are also preserved and biodiversity of production systems is enhanced.

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Experimental Title: Effect of site-specific application of N and K fertilizers on the growth and yield of cashew at Ochaja, Kogi State Nigeria

Investigators: Ibiremo, O. S and Akanbi, O.S.O

Introduction

Cashew is an important commodity crop with great potentials as foreign exchange earner and source of industrial raw materials with the prospect of becoming a major commercial tree crop in Nigeria. Cashew as a result of its wide adaptation is often grown in very poor soils and this has affected its survival and establishment (Topper, *et al.* 2001). Cashew cultivation is variously limited by both biotic and abiotic factors particularly in poor soils. The soils upon which cashew is grown are of poor to low fertility level, this is due to the misleading assertion that cashew can survive in any soil regardless its fertility status. In most cashew plantations, productivity is largely dependent on natural soil endowment as fertilizers are not part of its production input system (Ibiremo *et al,* 2017 and Agbongiarhuoyi, *et al,* 2014). Consequently, the soils upon which cashew are cultivated are maintained through litter fall and other natural endowment which hinders the crop from realizing its full potentials.

In cashew production, fertilizer is rarely used as an input in the production system and when it is used blanket application is employed. Hence, application of fertilizer is inevitable for the replacement of soil nutrients that are being mined through apple and nut harvest annually. This can be achieved through fertilizer application based on soil test value. At Ochaja substation, the site being considered is deficient in nitrogen and potassium and for effective management of the soil, the addition of nitrogen and potassium based fertilizers will enhance its productivity. Conventionally, the use of solid fertilizers of major nutrients of nitrogen, phosphorus and potassium are common with few farmers that use fertilizers on the crop in Nigeria.

The objectives of the study were to evaluate the effect of application of N and K fertilizers based on soil test value on the yield of cashew and to assess its effect on soil properties.

Materials and Methods

Soil samples were collected randomly within the plantation at Ochaja and the samples were processed and analyzed for both physical and chemical characteristics using standard laboratory procedures using IITA laboratory manual (1982). The fertilizer computed was based on the analytical result of samples at 0-20cm soil depth. The result of the analysis indicated that the total nitrogen was 0.04g/kg soil which is in adequate to sustain cashew as it requires 1g/kg soil and the available P was adequate while the exchangeable potassium was also deficient having a value of 0.012cmol/kg which is far below the critical of 0.12cmol/kg soil. From these values, four treatment combinations were formed from two rates of nitrogen fertilizer and two rates of potassium fertilizer that were applied to young cashew trees in the field. The Nitrogen fertilizer was applied at 0 and 54 kgN/ha while the Potassium was applied at 0 and 84kgK/ha and the treatments were arranged in a RCBD with 3 replications and crop morphological parameters, nut yield and soil nutrient characteristics would be measured. The fertilizers were applied in two splits application. The first dose was applied in June while the second dose was applied in September of 2019 and 2020. Initial plant growth parameters were taken to form the basis for assessing the effect of the fertilizer treatments. The data collected were subjected to ANOVA and means were separated using LSD at 5% level of probability.

Results and discussion

The pre-cropping soil characteristics indicated that the soil is sandy loam with the average values of sand, silt and clay were 888, 20 and 92g/kg soil respectively (Table 1). The pH is slightly acidic and very close to neutral with a mean value of 6.7 while the organic carbon (OC) was low with an average value of 0.82g/kg soil. The OC in block B was

higher that the OC in Block A. The total Nitrogen in the soil was 0.41g/kg soil which is below the critical value of 1g/kg soil. The deficiency of 0.6g/kg soil will require 54kg N for optimum production while the mean value for available P was 5.28mg/kg soil. This value is above the level required by cashew for optimum productivity. The average value of potassium was 0.012cmol/kg soil. The deficiency of 0.108cmol/kg requires 84kg/ha. The exchangeable calcium ranged from 1.26 to 2.26cmol/kg across the soil depth of 0-40cm with a mean value of 1.68cmol/kg. The mean value of exchangeable Mg was 0.29cmol/kg across the two soil depths. The pH of the soil at the two soil depths of 0 - 20 and 20 - 40cm was significantly ($p<0.05$) affected by application of nitrogen and potassium fertilizers ($P<0.005$). Application of N fertilizer had significant depressive effect on the pH of soil at both soil depths compared to the control and when N and K fertilizers were applied jointly. This could be as a result of the property of urea fertilizer that lowers soil pH as observed by Agbede (2009) and Adejumo, (2010). Similarly, application of N and K fertilizers significantly ($P < 0.05$) affected total soil nitrogen at 0 - 20cm soil depth. However, the effect was not significant at 20 - 40cm soil depth. Specifically, the total soil N in places where urea was applied seemed to be lower than the control (without fertilizer). The high level of sand in the soil might be the reason for low retention of applied N which is contrary to the observation by Adejumo, (2010) that application of urea increases total soil N. The soil available P was significantly ($P < 0.05$) influenced ($P<0.05$) by the application of N and K fertilizers across the two soil depths. Application of potassium alone depressed significantly ($P<0.05$) the available P at both depths (Table 2). The available P at both depths in the control plot was higher than when either of the fertilizers was applied. The initial **soil** P content was high**,** that informed its non-inclusion in the fertilizer formulation. The exchangeable K at both soil depths was not significantly affected by the application of N and K (Table 2). The exchangeable K ranged from 0.09 to 0.16 cmol/ kg soil at the two soil depths.

The nut yield of cashew was significantly ($P < .05$) improved as a result of nitrogen and potassium fertilizers (Figure 1). Specifically, application of N fertilizer enhanced the nut yield of cashew significantly compared to the control. Similarly, N application increased the nut yield of cashew significantly ($P<0.05$) than when K alone or N and K fertilizer were applied together. The application of N enhanced the growth of cashew which translated to increase in the nut yield of cashew. This observation is consistent with the result obtained by Adejumo, (2010) in the improvement of the yield **of** cashew by N application.

Recommendations and Conclusion

Application of fertilizer based on the result of soil test and the need of the site in question will give an optimum result in terms fertilizer use efficiency and improve crop yield relative to blanket application of fertilizer without recourse to native nutrients of the soil.

Table 1: Initial soil physical and chemical properties of the cashew plot

Block	Soil Depth (cm)	Sand g/kg soil	Silt g/kg soil	Clay g/kg soil	pH	O.C g/kg	Total N g/kg	Ava. P Mg/ kg	Exch K^+ Cmol /kg	Exch Ca^{2+} Cmol /kg	Exch Mg^{2+} Cmol /kg	CEC Cmol /kg	Base saturation %
A	0-20	885.20	22.80	92.00	6.7	0.78	0.07	5.03	0.012	2.26	0.35	2.78	95.83
A	20-40	895.20	12.80	92.00	6.8	0.66	0.02	5.20	0.011	1.73	0.29	2.18	95.05
B	0-20	895.20	12.80	92.00	6.6	0.97	0.05	5.35	0.012	1.26	0.27	1.70	92.81
B	20-40	875.20	32.80	92.00	6.7	0.86	0.02	5.55	0.012	1.34	0.25	1.15	91.62
Mean x		887.70	20.30	92.00	6.7	0.82	0.04	5.28	0.012	1.65	0.29	1.95	93.83

Table 2: Influence of Nitrogen and Potassium fertilizers on some soil chemical properties at Ochaja cashew plot.

Treatment	pH (H_2O)		Total N (g/kg)		Available P mg/kg		Exchangeable K cmol/kg	
Soil depth	0-20cm	20-40cm	0-20cm	20-40cm	0-20cm	20-40cm	0-20cm	20-40cm
. $_0K_0$–T1Control)	5.13	4.94	0.07	0.03	11.17	10.35	0.16	0.10
N_1K_0-T2	5.77	4.77	0.05	0.03	10.22	9.74	0.14	0.11
N_0K_1-T3	5.27	5.17	0.07	0.03	7.39	8.98	0.14	0.09
N_1K_1-T4	5.54	5.37	0.05	0.04	9.37	10.32	0.13	0.10
LSD (P<0.05)	0.19	0.20	0.01	0.02	0.72	0.60	0.01	0.01

Legend: N $_0K_0$–T1Control), N $_1K_0$-T2, N $_0K_1$-T3, N $_1K_1$-T4

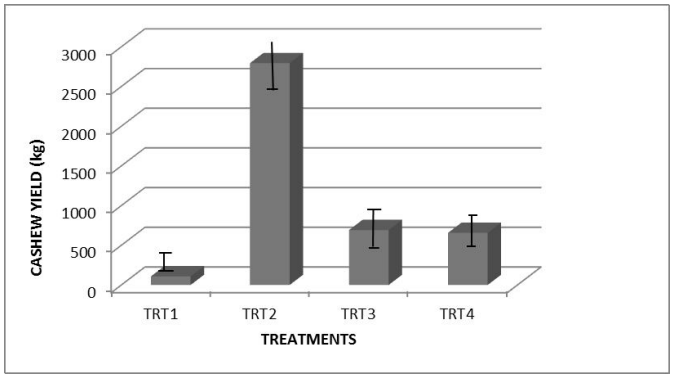

Figure 1: Effects of Nitrogen and Phosphorus based fe rtilizer on raw cashew yield (kg)

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Experimental Title: Assessment of soil fertility in some selected cashew farms in Enugu, Kogi and Oyo States for proper management and enhanced productivity

Investigators: Ibiremo,O.S, Ogunlade, M.O, Iloyanomon, C.I, Akanbi O.S.O and Olasupo, F.O

Introduction

Cashew *Anacardium occidentale L.* is grown largely by smallholder farmers in all agro-ecological zones of Nigeria, (27 out of 36 States). However, economic production is concentrated around the middle belt and northern parts of the Southwest. Cashew is a major source of income to Nigerian government, farmers, processors, marketers and other stakeholders along the value chain and has average yield per hectare of 450-500kg/ha (The Guardian online, 2019). Currently, the land area cultivated to cashew in the country has increased to almost 400,000 hectares (FAO, 2018; Olubode *et al*., 2017) and this cultivation progression may be attributed largely to increase in world market demand of its nuts. Cashew is grown from the rainforest zone to savanna area of Nigeria and is grown on wide range of soils. It is known that cashew farmers in Nigeria use little or no fertilizer as they rely on natural means of supplying nutrients through leaf litter fall (Ibiremo and Iloyanomon, 2015, Agbongiarhuoyi, *et. al* 2014). The application of fertilizer is however inevitable for the replacement of soil nutrients that are mined through cashew apple and nut harvest annually. The objectives of this study were to assess the fertility status of soils of some cashew plantations across the three States of Enugu, Kogi and Oyo and evolve strategies for effective management to enhance cashew productivity.

Materials and Methods

Two farms were selected from each Local Government Area (LGA) and two LGAs were selected in each of the three States of Enugu, Kogi and Oyo which form the bulk of cashew producing States in Nigeria. Soil samples were collected from each farm using a soil auger at soil depths of 0-20cm and 20-40cm, and at a distance of 10m apart. Soil samples were collected at a distance of 1m from the base of selected cashew mother tree. The soil samples were bulked to make composite samples and analysed for some physical and chemical properties using standard laboratory procedures according to IITA (1982). The information obtained were used as basis for fertilizer computation and recommendations.

Results and Discussion

Soil textural characteristics of cashew plantations in Enugu, Kogi and Oyo States

The sand fraction of soils in the two farms selected in Udi Local Government Area, Enugu State had an average value of 890g/kg soil at 0-20cm soil depth while the sand fraction in soils of the two farms evaluated in Nsukka LGA was 849g/kg soil which was slightly lower than that of Udi LGA (Table 1). In Kogi state, the mean value of the sand content across the two farms at 0-20cm soil depth in Ofu LGA was 869g/kg soil while that of Dekina LGA was 809g/kg soil which is about 7% lower. However, the sand content of the farms in the two locations of Orire and Surulere LGAs Oyo State had an average value of 809g/kg soil. The clay content in the two farms of Udi LGA had an average value of 84g/kg soil while that of Enugu was 104g/kg at 0-20cm. In Kogi state, the two farms evaluated in Ofu LGA had a mean value of 94g/kg at 0-20cm while that of Dekina LGA was 154g/kg at the same depth which indicated that the clay in Ofu LGA was much lower than that of Dekina LGA. The mean clay content of the soils of farms locations in Orire and Surelere LGAs was 109g/kg soil. The mean silt content of the soil in the farms evaluated in Udi and Nsukka LGAs of Enugu State was 31g/kg soil at 0-20cm which was relatively lower than the silt content in the soils of farms in Kogi State with an average value of 36g/kg soil at 0-20cm (Table 1). In the farm locations of Oyo State, the mean silt content in the soils of Orire LGA was 86g/kg while that of Surulere LGA was 76g/kg at 0-20. The soils in the three States under consideration indicated that sand fraction was very high and could be classified texturally as sandy loam and suitable for cashew (Egbe *et.al* 1989, Ohler, 1989).

Soil chemical characteristics of cashew plantations in Enugu, Kogi and Oyo States

The pH of the soils in the two farms in Udi LGA was 5.55 at 0-20cm while that of the Nsukka LGA was 4.85 (Table 1). The pH of the soils in Ofu and Dekina LGAs ranged from 5.40 to 6.50. The mean pH of the soils in the two farms in Orire LGA was 6.00 while that of Surulere LGA was 6.30. Cashew thrives well in a wide range of pH and the range obtained in this study is suitable for cashew (Ohler 1989. The organic carbon in the soils of the farm locations in Udi and Nsukka LGAs was 14g/kg which is much lower than the organic carbon obtained in the farm locations of Kogi state with a value of 17g/kg. The organic carbon in the soils of Oyo state was higher with an average value of 17.9g/kg soil compared with soils of Enugu and Kogi States with mean values of 14.12 and 17.09 g/kg soil respectively. The organic carbon content in the soils of the farms in Orire LGA was 19g/kg soil. The higher organic carbon in the soils of Oyo State may impact positively on the fertility status than the soils in Enugu and Kogi States. The N in the soils in the farms evaluated across the three States was generally low and there is need for N supplementation. The N in cashew farms in Enugu State ranged from 0.26 to 0.65g/kg soil while that of Kogi State ranged from 0.35 to 0.77g/kg soil. The N in Oyo State had a mean of 0.44g/kg soil in Orire LGA and 0.66g/kg soil in Surulere LGA. The total nitrogen in the soils of the farms in Udi LGA ranged from 0.26 to 0.65 g/kg. The average total N in the farms evaluated in Udi LGA and Nsukka LGA was 0.45g/kg. In Kogi state, the N in the soils of the farms in Ofu LGA was 0.5g/kg soil while that of Dekina LGA was o.63g/kg soil at 0-20cm. The total N for the soils in the two farm locations in Orire LGA was 0.44g/kg while that of Surulere LGA was 0.66g/kg soil at 0-20cm (Table 1). The average total N across the farm locations in the three States was 0.54g/kg which was less than the critical value (1g/kg soil) for cashew cultivation (Ohler, 1989; Egbe, 1989). The available P in the farm locations in the three states ranged from 2.98 to 5.35 mg/kg soil. The available P in the two farms in Udi LGA was 4mg/kg soil while that of the two farms in Nsukka LGA was 4.6mg/kg at 0-20cm depth. In Kogi state, the farms in Ofu LGA had 3.75mg/kg soil as average value for available P at 0-20cm while that of Dekina LGA was slightly higher with 5.35mg/kg. However, the available P in the two farms of Orire LGA was 3.06 mg/kg and that of Surulere LGA was 2.98mg/kg. The available P in Enugu and Kogi States was adequate for cashew cultivation with an average value of 4.3 and 4.5mg/kg soil respectively. However, the available P in the cashew farms in Oyo State was below the level required for good cultivation of cashew with an average value of 3.0mg/kg soil. It is evident that the level of available P in the soils of cashew farms evaluated in Enugu and Kogi States does not require amendment as at now but this may likely shift toward deficiency in the future. The exchangeable K in Enugu and Kogi States was low with an average value of 0.08 cmol/kg soil. There will be need for addition of potassium fertilizer. Conversely, the exchangeable K in farms in Oyo State was adequate with an average value of 0.14cmol/kg soil. The exchangeable K in soils of farms evaluated in Enugu state was 0.06cmol/kg which is much lower than the critical value

required for cashew cultivation which is 0.12cmol/kg soil. The average values of exchangeable K in the four locations evaluated in Kogi and Oyo states were 0.09 and 0.16 cmol/kg soil respectively. These values are also below the critical value of 012cmol/kg. Hence, the need for management of potassium based fertilizers. The exchangeable sodium, magnesium and calcium in the twelve cashew farms evaluated were 0.15, 1.16 and 1.34 cmol/kg soil respectively (Table 1). These values are adequate for good cashew production according to Ohler (1989) and Opeke (2005). The soil available copper across the farms locations in the three states ranged from 0.17 to 2.43mg/kg soil while available Iron ranged from 2.45 to 19.25mg/kg soil. The average values of Zinc and Manganese in the soils of the farms evaluated in the three states were 1.25 15.68mg/kg soil respectively.

Fertilizer computation based on the results of soils at 0-20cm depth

The interpretation of the samples on the various farms is based on the interpretation rules generally adopted for tropical soils. Considering the soil test values from the various farm sites across the three States and the already established critical values for these elements; the fertilizer recommendation indicated that in Enugu, the two farms in Udi LGA required 134 Nkg/ha and 58kgK_2O/ha while in Nsukka LGA the farms will need 78kg N/ha and 65 kg K_2O /ha. In Kogi the two farms in Ofu LGA will require 100khN/ha 38 kg K_2O /ha while the two farms in Dekina will need 74 kgN/ha and 9 kg K_2O/ha. However, in Oyo, the two farms in Orire LGA will require 112kgN/ha and 3kgP_2O_5/ha while that of Surulere LGA need 68kgN/ha and 3kgP_2O_5/ha.

Recommendations and Conclusion

Site specific fertilizer is required for optimum returns on its usage and the fertilizers required for optimum cultivation of cashew in the three States ranged from 68 to 134 kg N/ha, 2.8 to 3.2 kgP_2O_5/ha and 9 to 66kg K_2O/ha.

KOLA PROGRAMME

Experimental Title: Setting Standards for Kolanut Grading in Nigeria

Investigators: Jayeola, O., S.O. Aroyeun, D.O. Adeniyi, S.O. Ogunwolu, M. O. Ogunlade, Abdulkareem, I.F, Yahaya, A.T., Mokwunye, I.U. and Ugioro, O.

Introduction

Kola is a tropical genus of the family Sterculiaceae. It is native to coastal regions of West Africa. It comprises of about 125 species. In Nigeria, *Cola acuminata and Cola nitida* are the most commonly planted. *Cola nitida* has two cotyledons while *C.Acumminata* and *C.Anomala* have between three and seven. However, colour is used to differentiate between three subspecies of *Cola nitida* red, white or intermediates shades of pink. The white though sold in large quantities in Northern Cameroon is imported from Nigeria and is not reported been grown in Cameroon. Kola is comparatively richer in caffeine than cocoa and coffee. Kolanuts are widely consumed in West and Central Africa as a masticated to counter fatigue, surpress thirst and hunger and are believed to enhance intellectual capacity. It is for this reason that kolanut chewing has become very popular among students, drivers and many other consumers who need to remain active for unusually long periods. In some developed countries, kolanut extract is used industrially for the manufacturing of many cola types of drinks flavours, as a source of caffeine used used for manufacture of pharmaceutical products and essential oils and as a main ingredient in the production of heat tolerant chocolate bars. In addition, caffeine is known to be a fat burner and therefore beneficial in assisting weight loss.

Most crops are graded in Nigeria but there is no legalise standard for kola nuts in Nigeria. Retailers inspect the nuts by setting aside anyone showing insect damage and then grade them according to colour and size. The most careful and repeated examination is for weevil infestation. The quality of the product is very important for the value and determination of market price. This objective of this work was to carry out physicochemical properties of kolanut in order to develop standard for kolanuts as regards grading in order to produce an exportable products of equal consistency and also to construct sieve for grading of kolanut for export. This is to ensure that high quality produce are able to attract premium prizes. The essence

was to standardize kolanut grading system for adoption nationally by kolanut marketers.

Materials and Method

Material sourcing

Fresh kolanuts used for this study C.nitida were sourced from Ogunmakin market in Ogun state. Kolanut purchased are of both dry and wet with varying colour shades ranging from red, pink to white.

Physical Grading

The grading started with sorting into different colours and the followed by sizing them according to weight. Weighing scale was used to grade from 1 gram -10 gram, 11gram-20gram and 21 gram and above >. Weeviled or diseased nuts were sorted out.

Construction of grading sieves

One hundred nuts were randomly picked from each lots of kolanuts of varying colours ranging from red, pink and white of big, medium and small sizes. The size of each nuts was determined by measuring the major, intermediate and minor diameter. The arithmetic and geometric mean diameter of each nut were computed as a measure of size (Mofolasayo, 2013). The surface area of the nuts were determined by measuring the shape of each nuts with digital plarimeter. The true and bulk density were determined on five structural surfaces, stainless steel, mild steel, plywood, perspex sheet and glass.

Chemical analysis

This was carried out using AOAC, 2010 for crude protein, fat, crude fibre, ash, moisture carbohydrate and dry matter.

Results

Result of Chemical Analysis on Kola Samples Proximate Composition Determination

Sample	%CP	%CFAT	%CFIBRE	%ASH	%M	%DM	%CHO
Red Kola Dry (11-20)	15.29	2.98	4.13	2.27	9.87		
Red Kola Dry >21	17.38	3.15	6.79	2.69	9.65		
Red Kola (11-20) (Wet)	3.17	2.47	3.26	1.88	66.01		
White Kola Dry (11-20)	13.88	2.56	3.92	2.49	9.97		
Pink Kola Dry >21	18.96	3.23	6.87	2.75	9.58		
White Kola (11-20) Wet	2.98	2.39	3.47	2.05	66.46		
White Kola Wet (1-5)	2.39	2.17	3.21	1.93	64.89		
White Kola Wet >21	4.27	2.28	3.27	2.22	62.91		
White Kola (1-10) Dry	9.28	2.79	4.12	2.39	10.23		
White Kola (Dry) >21	14.27	2.63	3.88	2.54	9.92		
Kola Red Wet (1-10)	2.68	2.26	3.18	2.31	63.05		
Pink Kola (11-20) Dry	14.58	2.95	4.69	2.63	9.66		
Pink Kola (1-10) Wet	2.77	2.29	3.24	2.42	63.18		
Pink Kola Wet (11 - 20)	4.38	2.32	3.21	2.17	62.89		
Pink Kola Dry (1-10)	11.07	2.51	3.45	2.48	9.43		
Red Kola (1 10) Dry	13.09	2.72	3.97	2.61	9.24		
Red Kola>21wet	5.89	2.45	3.38	2.36	62.97		
Pink Kola>25 Dry	17.88	2.84	3.91	2.68	9.47		
Dried Leaves	16.78	3.29	13.77	9.25	7.96		

Result of Phytochemicals Chemical analysis on Kola Samples

Sample	%TANNIN	%SAPONIN	%FLAVANOIDS	%ALKALOIDS	%GLYCOSIDES	%CAFFEINE	%PHENOLICS
Red Kola Dry (11 20)	0.031	0.236	0.0038	0.356	0.128	0.167	0.189
Red Kola Dry >21	0.037	0.245	0.0044	0.369	0.136	0.175	0.194
Red Kola (11 20) Wet	0.0019	0.133	0.0013	0.126	0.089	0.102	0.113
White Kola Dry (11 20)	0.023	0.221	0.0026	0.324	0.113	0.145	0.166
Pink Kola Dry >21	0.028	0.227	0.0031	0.331	0.116	0.157	0.175
White Kola (11-20) Wet	0.0012	0.124	0.0015	0.137	0.103	0.126	0.134
White Kola Wet (1-5)	0.0008	0.107	0.0010	0.115	0.057	0.118	0.125
White Kola Wet >21	0.0015	0.129	0.0017	0.121	0.073	0.129	0.144
White Kola (1-10) Dry	0.021	0.196	0.0023	0.307	0.109	0.138	0.154
White Kola (Dry) >21	0.025	0.218	0.028	0.329	0.123	0.149	0.172
Kola Red Wet (1-10)	0.0018	.131	0.0021	0.131	0.089	0.123	0.138
Pink Kola (11-20) Dry	0.033	0.225	0.0035	0.342	0.131	0.161	0.185
Pink Kola (1-10) Wet	0.0010	0.112	0.0008	0.145	0.107	0.126	0.141
Pink Kola Wet (11 -20)	0.0009	0.105	0.0006	0.152	0.111	0.132	0.139
Pink Kola Dry (1-10)	0.017	0.131	0.0019	0.334	0.119	0.146	0.167
. Red Kola (1 - 10) Dry	0.014	0.158	0.0016	0.337	0.122	0.153	0.171
Red Kola>21wet	0.0013	0.149	0.0015	0.129	0.078	0.112	0.121
Pink Kola>25 Dry	0.041	0.257	0.0040	0.386	0.153	0.184	0.208
Dried Leaves	0.069	0.289	0.0075	0.532	0.235	0.215	0.239

Discussions

The results of proximate compositions, mineral analysis and phytochemical components of the samples based on sizes and colour are shown above. The results are undergoing statistical analysis.

The mean values of the parameters obtained were computed using descriptive statistics. The parameters obtained were used in the design considerations of the sieves which are under Construction.

Conclusion

The grading of kola nuts into colour and sizes have been done. The availability of sieve that is been constructed will ease the grading by kolanuts farmers. There is need for continuation of this project to enhance construction of the grading sieves to be given to the kolanut stakeholders for onward adoption during grading.

Status: On-going

COCOA PROGRAMME

Experimental Title: Influence of Low Molecular Weight Organic Acids on Phosphorus Bioavailbility In A P-Fixed Cocoa Soil In South Western Nigeria.

Investigators: Aikpokpodion P. E. and Asowata F.E

Introduction

Phosphorus is a critical element in natural and agricultural ecosystems throughout the world. Its limited availability in soil is the main constrain for plant growth in highly weathered soils of the tropics (Bunemann *et al*. 2004). At least 70-90% of phosphorus that enters the soil is fixed, making it difficult for plants to absorb and utilize (Lei *et al*. 2004). In tropical and sub tropical soils, the application of phosphorus is important for most crops because of its low availability in the soil due to P-fixation (Adepetu, 1986). In selected cocoa plantations in Ondo State Nigeria, Aikpokpodion reported phosphorus deficiency in the soils. Ogunlade and Aikpokpodion (2006) reported phosphorus deficiency in selected cocoa soils across Nigeria. Owing to the importance of phosphorus in plant nutrition, cell development and biochemical reactions, its deficiency in cocoa soil has contributed to low yield in Nigerian cocoa production (Aikpokpodion, 2010).

To enhance crop yield, cocoa farmers in Nigeria are being encouraged to apply fertilizers on nutrient depleted soils. However, only 15-20% of applied phosphorus fertilizer is available for plant uptake (Camargo *et al*. 2000) while the rest is mainly fixed by Al and Fe oxides.

Whenever, there is phosphorus deficiency in soil, plants adopt a mechanism to salvage the situation by exuding carboxylates from the root to the rhizosphere, thereby enhancing phosphorus supply for plant uptake. The P availability enhancing effects of carboxylates can be grouped into direct and indirect effects. The direct effects generally results in immediate phosphorus release while the indirect effects which includes both the stimulation of microbial activity and soil pH decrease does not cause immediate phosphorus release. The direct effect refers to the blocking of P adsorption sites (ligand exchange) and oxide dissolution by complexing Al or Fe in soil minerals (Staunton and Leprince, 1996).

Authors like Bhatti *et al* (1998), Agbenin and Igbokwe (2005) and Palomo *et al*. (2006) reported the complexing and chelating ability of naturally occurring soil organic acids released during plant and animal residue decomposition with metals ions like Al, Fe, Cu, Zn and Mn. Palomo *et al*, (2006) reported that citrate, tartrate and tannate derived from degradation of humic substances have greater affinity for Al and Fe oxides than phosphate (Violanite and Huang, 1989). Hence, organic acids can strongly compete with phosphorus for adsorption sites on Al and Fe oxides in soil environment. According to Bhatti *et al*, (1998) soils where Fe and Al oxides abound, the presence of organic ligands will significantly reduce the sorption of phosphate. Consequently, the adsorption of these organic acids will physically block phosphate adsorption sites on the soil colloids ultimately reducing phosphate adsorption and increasing its phytoavailability in soil solution. Due to the great challenge of low phosphorus availability and high P-fixation in Nigeria cocoa soils, it becomes expedient to apply some chemical strategy which will reduce P-fixation in cocoa soils and increase P-bioavailability for plant uptake. To this end, the study was aimed at evaluating the impact of selected low molecular organic acids on phosphorus bioavailability in a highly P-fixed cocoa soil.

Materials and Methods

Soil physicochemical properties

Soil samples were collected with a hand trowel under a 30 years old cocoa plantation in Bodo (7°13N and 3°42 E) in Ogun State, Nigeria. The sampling was done from several points within the cocoa plantation and later bulked. The composite soil sample was air-dried, sieved and processed according to standard procedure (AOAC, 1995). The particle size was determined by hydrometer method (Bouyoucos, 1951). Soil pH was measured in 1:1 soil-water ratio while nitrogen was determined using Kjeldahl digestion method (AOAC, 1995). Available phosphorus was determined by Bray P1 method (Bray and Kurtz, 1945) while organic carbon was determined by the wet digestion dichromate acid-oxidation method (Olsen and Sommers, 1982). Exchangeable cations (Ca^{2+}, Mg^{2+}, K^{+}, and Na^{+}) were extracted with 1N ammonium acetate buffered at pH 7.0 (Thomas, 1982). Exchangeable K^{+} and Na^{+} were instrumentally quantified using flame photometer (Jenway PFP7) Model) while Ca^{2+}, Mg^{2+},Zn^{2+} and Mn^{2+}) were quantified using Buck Scientific 200A model Atomic Absorption Spectrophotometer. Exchangeable acidity was determined by extracting the soil samples with 1N KCl and titrating the extract with 0.05N NaOH using phenolphthalein indicator (Mclean, 1965). Effective cation exchange capacity (ECEC) was determined by summation method.

Soil Incubation

The processed soil sample (100g) was placed in plastic pots in triplicates. 100mM of succinic and oxalic acids which have been adjusted to 6.5 with NaOH was added to each of the soil samples in the plastic pots. Equal weight of the soil sample was weighed into a plastic pot but without the application of organic acids. The untreated sample served as the control. All samples were kept moist by the addition of 50 ml of deionised water every other day. The soil incubation was done for 30 days under ambient temperature. At the expiration of incubation, the samples were air-dried and sieved prior to batch adsorption.

Batch adsorption process

One gram (1g) of each of the treated and untreated soil samples was placed into 50 ml centrifuge tubes. The soil samples were equilibrated in 20 ml of 0.01M $CaCl_2$ containing range of concentrations of phosphorus as KH_2PO_4 to give 20, 40, 60,80 and 100 mg P L^{-1}. Two drops of toluene were added to each sample to minimize microbial activities (Verchot and Borelli, 2005). The batch equilibrium was done in a mechanical shaker for 24 hours at a temperature of 25°C. Preliminary experiment had earlier showed that, equilibrium is reached at 24hours of agitation on mechanical shaker. After equilibration, the samples were centrifuged at 4,000 rpm for 30 minutes. The supernatants were filtered with Whatman filter paper No 1 and phosphorus was subsequently determined according to AOAC procedure (AOAC, 1995). The amount of P adsorbed was calculated from the difference in phosphorus concentration of solution P before and after equilibration.

Data obtained from the experiment were subjected to statistical analysis using SPSS version 20.

Results and Discussion

Soil physicochemical properties

Results show that the soil sample obtained from the cocoa

plantation was sandy loam with 79.20, 8.30 and 12.50% sand, silt and clay respectively (Table 1). The soil was slightly acidic with pH value of 6.35. organic carbon content of the soil was 2.36% which is lower than the critical level of organic carbon (3%) required for cocoa cultivation according to Egbe et al. (1989). Total Nitrogen of the soil was 0.69%, an amount lower than 0.9% total N required for cocoa cultivation in Nigerian soil. The available phosphorus found in the soil (8.75mgkg^{-1}) was 12.5% lower than the critical level of phosphorus required for cocoa cultivation. The result is however, an indication of phosphorus deficiency in the cocoa plantation where the soil samples were collected. Zinc content of the soil was 16.2mgkg^{-1} while Na concentration was 0.51cmolkg^{-1}. On the other hand, the value of potassium (0.6cmolkg^{-1}) was higher than the critical level (0.3cmolkg^{-1}) needed for cocoa cultivation (Egbe et al. 1989). Magnesium and calcium were deficient in the soil as the obtained values 0.24 and 4.23cmolkg^{-1} were lower than the critical level of 0.8 and 5cmolkg^{-1} respectively required for cocoa cultivation. Exchangeable manganese and iron were 42.00 and 9.5mgkg^{-1} respectively. The total exchangeable acidity of the soil was 1.17cmolkg^{-1} of which Al^{3+} accounted for 93.16% of the total acidity.

Table 1: Physichochemical properties of soil

Soil parameters	Concentrations/Amount
Particle size	
Sand	79.20%
Silt	8.30%
Clay	12.50%
Total Nitrogen	0.69%
Organic carbon	2.36%
pH (H_2O) 1:1	6.35
Available phosphorus	8.75 mgkg^{-1}
Exchangeable Bases	
K^+	0.60 cmolkg^{-1}
Na^+	0.51cmolkg^{-1}
Mg^{2+}	0.24 cmolkg^{-1}
Ca^{2+}	4.23 cmolkg^{-1}
Exchangeable micronutrients	
Zn^{2+}	16.20 mgkg^{-1}
Mn^{2+}	42.00 mgkg^{-1}
Fe^{2+}	9.50 mgkg^{-1}
Exchangeable Acidity	
Al^{3+}	1.09 cmolkg^{-1}
H^+	0.08 cmolkg^{-1}

Effect of solution concentration of P on adsorption intensity

The relationship between initial phosphorus concentration and adsorbed phosphorus is presented in Figure 1. Result shows that soil sample treated with oxalic acid adsorbed 10.7 mg P Kg^{-1} soil. Soil treated with succinic acid adsorbed 35 mg P kg^{-1} while untreated adsorbed 75mg P kg^{-1} soil when solution P concentration was 20 mg P L^{-1}. When soil sample was equilibrated with solution concentration of 40 mg P L^{-1}, soil treated with oxalic acid adsorbed 126 mg P kg^{-1} soil, succinic acid-treated soil adsorbed 130 mg P kg^{-1} while the untreated soil had significantly higher value of adsorbed phosphorus (193 mg P kg^{-1}). Similarly, when soil samples were equilibrated with solution concentration of 60 mg P L^{-1}, the untreated sample significantly ($P < 0.05$) adsorbed more phosphorus (176 mg P kg^{-1}) from the solution than soil sample treated with oxalic acid (136 mg P kg^{-1}) and succinic acid which adsorbed 136 and 152mg P kg-1 soil respectively. The graphical representation of P adsorption pattern of the studied soil shows that, the introduction of oxalic and succinic acids lowered P adsorption. It thus indicates that, the applied organic acids succeeded in blocking certain adsorption sites on Al and Fe surfaces which would have been occupied by phosphorus in solution.

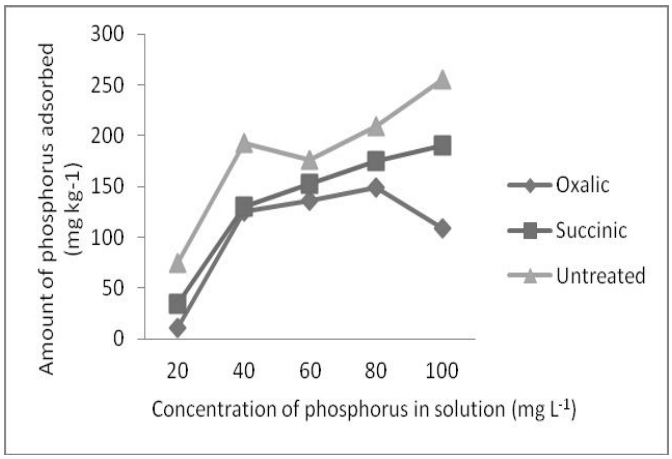

Figure 1: Adsorbed phosphorus in relation to initial solution P

In a related experiment, Sweson *et al*. (1999) observed that citric acid released equal amount of P and Al from a phosphate kaolin complex exposed to the organic acid. Similarly, Ohno and Erich (1997) in their report from a similar study concluded that the observed decrease in P adsorption in soil treated with organic acids were due to complexation of surface Al by the ligands resulting in the

dissolution of aluminium in the soil.

The treatment of the soil samples with succinic and oxalic acids gave room for complex formation between the ligands of the organic acids and Al, Fe in the soil. Al and Fe oxides are known to be mainly responsible for phosphorus fixation in Nigeria cocoa soils (Aikpokpodion *et al*. 2015). The complex formation ultimately reduced the number of active Al and Fe charged surfaces that eventually participated in the adsorption process on the introduction of phosphorus to the treated soils thus leading to low P adsorption during equilibration. On the other hand, charged aluminium and iron oxides surfaces in the untreated soil remained unaltered and were sufficiently involved in the adsorption process leading to higher P-adsorption.

Similarly, the report of Drouillon and Merckx (2003) showed that, citric acid was used to increase phosphorus bioavailability in a highly P-fixing soils in Europe. The report stated that, the main mechanism was the complexation of Al and Fe by citric acid which reduced soil surface charge that would have enhanced phosphorus adsorption. Tsado *et al*. (2012) also reported the influence of organic acids addition on phosphorus adsorption in an alfisol of Nigerian Guinea savanna. The soil which had no organic acid treatment significantly adsorbed phosphorus than same soil treated with citric and tartaric acid

Adsorption efficiency

Figure 2 showed that phosphorus adsorption increased from 15% to 32% when initial solution concentration was increased from 20 to 40mg P L^{-1} in oxalic acid treated soil. In soil treated with succinic acid, adsorption efficiency increased from 18% to 33% when initial solution concentration increased from 20 to 40mg P L^{-1}. Similar observation was made in the untreated soil where adsorption efficiency of phosphorus increased from 38% to 48% when solution P concentration increased from 20 to 40 mg L^{-1}. However, a general decrease in adsorption efficiency was observed in all the studied soil samples as the initial concentration of P in solution exceeded 40 mg P L^{-1}. Observation show that, P adsorption efficiency in succinic acid-treated soil decreased from 32 to 23% as solution P concentration increased from 40 to 60 mg P L^{-1}. It further decreased to 19 % at solution concentration of 80 mg P L^{-1} and finally dropped to 11% when solution concentration increased to 100mg P L^{-1}. Likewise, in oxalic acid treated soil, phosphorus adsorption efficiency decreased from 33 to 25, 22 and 19% when the concentration of P in solution increased from 40 to 60, 80 and 100mg P L^{-1} respectively. The pattern of P adsorption as influenced by initial solution concentration in the untreated soil was not different from the treated soils. In the untreated soil, adsorption efficiency dropped from 48% when solution concentration was 40mg P L^{-1} to 29, 26 and 25% when solution concentration increased to 60, 80 and 100 mg P L^{-1} respectively.

As phosphorus concentration in solution increased beyond 40 mg P L^{-1}, the population of P anions in solution increased. Consequently, competition among phosphate ions for the limited number of adsorption sites increased leading to lower adsorption efficiency compared with solution with lower phosphate concentration.

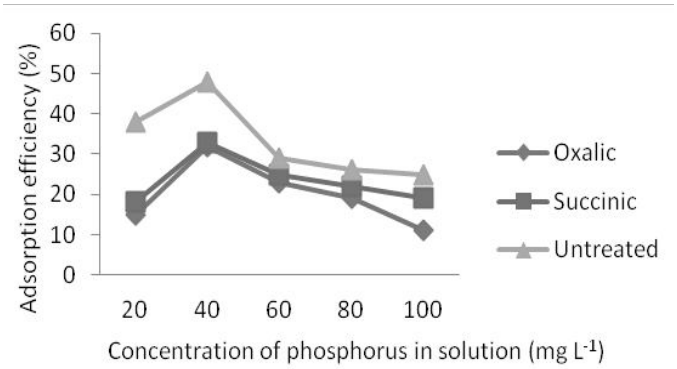

Figure 2: Phosphorus adsorption efficiency in soil

In general, phosphates adsorption efficiency decreased as the concentration of phosphorus in solution increased beyond 40 mg P L^{-1}. However, the untreated soil had higher adsorption efficiency than soil samples treated with succinic and oxalic acids. It thus indicates that, the application of low molecular weight organic acids reduces phosphorus adsorption in cocoa soil thereby making more phosphorus available for plant uptake in the treated soil. Moradi *et al*. (2012) also gave similar report where low molecular weight organic acids increased bioavailability of phosphorus in treated soils.

Effects of organic acids on Langmuir Constants

The Langmuir sorption equation is used to describe reversible sorption for monolayer formation. The linear form is expressed as

$$\frac{Ce}{x} = \frac{1}{KXmax} + \frac{C}{Xmax}$$

Where C_e is the equilibrium concentration of P (μgml^{-1}), X is the amount of P adsorbed per unit soil (μgg^{-1}), X_{max} is the adsorption maximum for monolayer; K is the binding energy or sorption affinity.

The slope ($\frac{1}{Xmax}$) and intercept ($\frac{1}{KXmax}$) were calculated from the plot of ($\frac{Ce}{x}$) against C. The values obtained from the Langmuir isotherm are presented in Table 2. The adsorption maximum (X_{max}) was calculated from the reciprocal of the slope.

The results show that the untreated and soils treated with succinic and oxalic acids had X_{max} of $30mgkg^{-1}$, $10.99mgkg^{-1}$ and $25.64mgkg^{-1}$ respectively. The application of organic acids to the studied soil successfully lowered the maximum P adsorption capacity of the treated soils compared with the untreated. The values obtained for the binding energy (K) were lower in the treated soil samples compared with the untreated soil which had K value of 0.056 while soil treated with succinic and oxalic acids had K values of 0.03 and 0.036 respectively. This

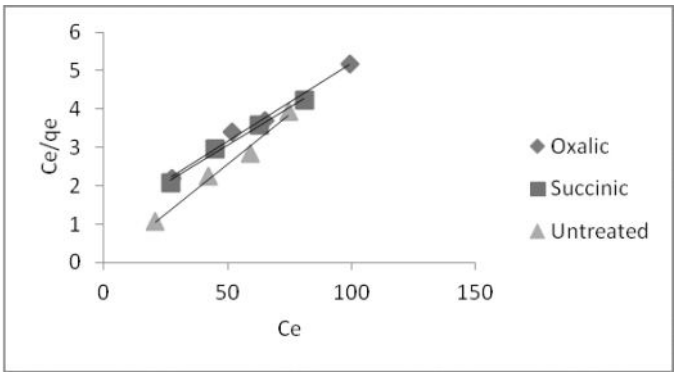

Figure 3: Effect of organic acids on the Langmuir constants

indicates that, higher energy will be required to dislodge adsorbed phosphorus from the sorption sites in the untreated soil compared with the organic acid-treated sample. From agronomic point of view, more energy will be required to desorb a unit number of adsorbed phosphorus per unit kilogram in the untreated soil compared with soil sample treated with oxalic and succinic acids. The obtained isotherm when batch equilibrium data were fitted into Langmuir equation gave linear regression (R^2) of 0.99 in both treated and untreated soil samples. Therefore, it can be stated that, the Langmuir model gave a good description of the adsorption mechanism which implies that phosphorus was adsorbed mainly on monolayer adsorption sites. Report of Sato and Comerford (2006) show that the sorption of phosphorus onto Brazilian soil followed Langmuir model. Aikpokpodion *et al* also reported the goodness-of- fit of Langmuir equation over other adsorption equations in describing phosphorus adsorption in selected cocoa growing soils in Nigeria.

Effects of organic acids on Freundlich constant

Freundlich equation has the form $X = KfC^{1/n.}$

Where X is the quantity of P adsorbed ($mg\ kg^{-1}$), C is the equilibrium concentration of P ($mg\ L^{-1}$) and K_f and n are constants related to the sorption capacity and the linearity of the sorption process respectively. The linear form of the Freundlich equation is written as

$\log X = \log K_f + 1/n \log C$

Where X is the amount of adsorbed P and C is the equilibrium concentration. The value of K_f and n were calculated from intercept and slope of log C versus log X.

Result

(Table 2) shows that, the value of K_f which is related to sorption capacity ranged between 0.22 in oxalic acid-treated soil and 2.90 in the untreated. There was an indication of higher P sorption capacity in the untreated soil compared to soils treated with organic acids. The application of succinic and oxalic acids to the soil was observed to have reduced phosphorus sorption capacity (K_f) from 2.90 $\mu mol\ kg^{-1}$ in the untreated soil sample to 1.40 $\mu mol\ kg^{-1}$ in soil treated with succinic acid and 0.22 $\mu mol\ kg^{-1}$ in soil treated with oxalic acid. The application of oxalic acid reduced P adsorption capacity by 92% while the application of succinic acid reduced P sorption capacity of the soil by 51% compared with the control. Result showed that the application of the low molecular organic acids significantly reduced phosphorus sorption capacity of the studied soil. Table 2 shows that n values ranged between 0.79 and 1.84 in which the untreated soil had the highest n value while oxalic acid-treated soil sample had the least value. A 1/n = 1 indicates linear adsorption where equal adsorption energies for all sites exist. 1/n > 1 represents s-type isotherm where marginal sorption energy increases with increasing surface concentration while 1/n < 1 represents an L-type isotherm where the marginal sorption energy decreases with increasing surface concentration. The coefficient of determination R^2 values ranged between 0.72 in the untreated sample and 0.99 in soil treated with succinic acid. This implies that the adsorption of phosphorus in the study, soil did not follow the assumption of Freundlich model

Table 2: Constants determined from various adsorption equations.

Sample	Langmuir			Freundlich			Temkin			Dubinin-Radushkevich	
	Xm	K	R2	Kf	n	R2	bT	KT	R2	qD	BDR2E
Oxalic	10.99	0.030	0.99	0.22	0.79	0.99	9.35	9.73	0.99	3.16	0.0120.996.46
Succinic	25.64	0.036	0.99	1.40	0.85	0.98	9.09	11.82	0.91	3.48	0.0140.915.98
Untreated	29.41	0.056	0.99	2.90	1.84	0.97	7.77	30.36	0.99	3.52	0.0600.992.89

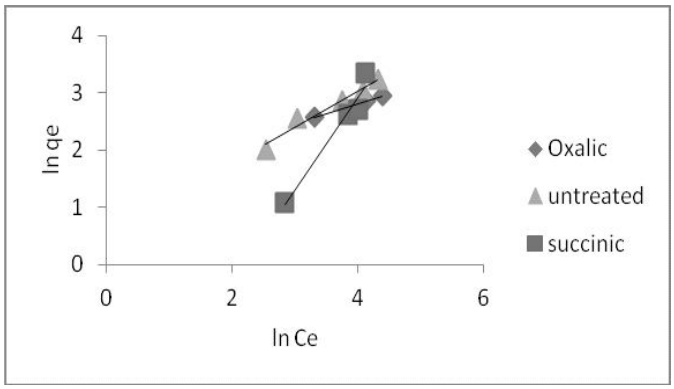

Figure 4: Freundlich isotherm of P adsorption

Temkin Isotherm

Temkin model assumes that, adsorption energy decreases linearly with the surface coverage due to adsorbent-adsorbate interactions. Unlike the Langmuir and Freundlich equation, the Temkin isotherm takes account of the interaction between adsorbent and adsorbate and is based on the assumption that the free energy of sorption is a function of the surface coverage (Chen *et al*., 2008).

$$q_e = \frac{RT}{bT} \ln (K_T.C_e)$$

The linear form of Temkin equation is

$$q_e = \frac{RT}{bT} \ln K_T + \frac{RT}{bT} \ln C_e$$

Where b_T is the Temkin constant related to heat of sorption (J/mg) and K_T is the binding constant corresponding to the maximum binding energy (L/g).

The Temkin constants b_T and K_T were calculated from the slope and intercept of the plot of q_e versus ln C_e respectively. Result show that, the maximum binding energy (K_T) ranged from 9.73 to 30.36 in which the control soil sample without organic acid treatment had the highest value while sample treated with oxalic acid had the least binding energy. This suggests that, the application of low molecular weight organic acid lowered phosphorus binding capacity of the treated soils. This can be attributed to the antagonistic effect of the COO^- group in the organic acids on the PO_4^{2-} ions in soil solution. Since both species are negatively charged, competitive adsorption is expected. In the soil sample that had oxalic and succinic acid treatment, the presence of negatively charged ions limited the chances of phosphate ions of being adsorbed on the soil surfaces thereby reducing the binding of phosphorus onto the soil surfaces resulting into higher phosphorus concentration in equilibrium solution of the untreated soil compared with soil samples that had oxalic and succinic acids treatment.

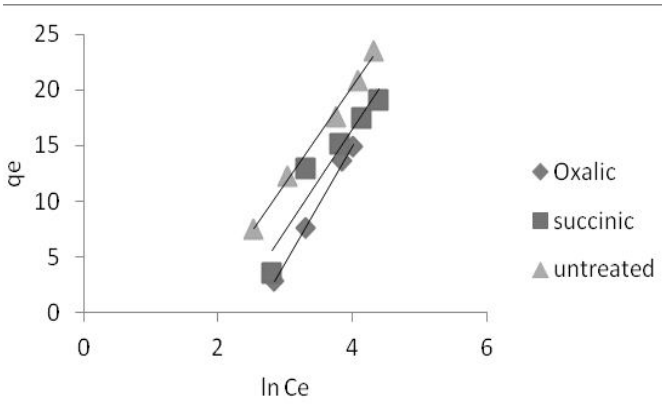

Figure 5: Temkin isotherm of P adsorption

Dubinin-Radushkevich model

The Dubinin-Radushkevich model was used in the study to estimate the characteristic porosity and apparent adsorption energy of the studied soil samples. The equation is presented as

$$qe = qD \exp(-B_D[RT \ln(1+1/Ceq]2)$$

where B_D is related to the free energy of sorption per mole of phosphorus as it migrates to the surface of soil particles from infinite distance in the solution and q_D is Dubinin-Radushkevich constant relating to the degree of phosphorus adsorption onto the soil surface. The linear form of the equation is given as

$$\ln q_e = \ln q_D - 2B_D RT \ln (1+1/C_e)$$

The isotherm was derived from the plot of ln q_e versus RT ln $(1+1/C_e)$ while the values of q_D and B_D were obtained from the intercept and slope respectively. It was observed that, adsorption of phosphorus declines with inverse of equilibrium concentration of phosphorus in solution.

Result show that B_D which relates to free energy of adsorption ranged from 0.012 to 0.06 in which soil

samples treated with organic acids had lower values of free energy of adsorption than the untreated soil. This implies that, the application of the treatments lowered the acquired energy of P in solution for migration to the various adsorption sites on the soil surface. This can be attributed to anionic repulsion between COO^- ions of the organic acids and the PO_4^{2-} in soil solutions. Conversely, PO_4^{2-} ions in the untreated soil without organic acids were able to move freely from solution to the soil surface. Hence, the PO_4^{2-} ions acquired more energy to migrate from solution to the adsorption sites. This resulted to higher phosphorus adsorption in the untreated soil sample compared with soil samples treated with oxalic and succinic acids.

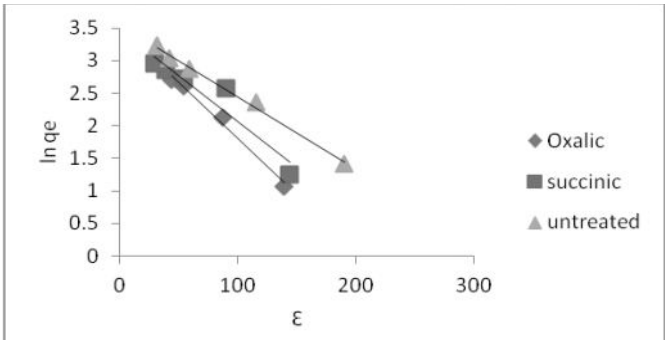

Figure 6: Dubinin-Radushkevich isotherm of P adsorption

Differential influence of Oxalic and Succinic acids on P adsorption

The study showed differential performance in the ability of oxalic and succinic acids to influence phosphorus adsorption and hence increase P bioavailability. Despite the fact that oxalic and succinic acids are dicarboxylic in nature, oxalic acid consistently demonstrated higher potential to reduce phosphorus adsorption in the studied soil. The difference in performance was factored by the chemical properties of the organic acids in question. Normally, when an acid dissociates, it releases a proton to make the solution acidic. But organic acids which are weak in nature have both dissociated specie and undissociated specie that coexist in solution. pKa is an index that expresses the acidity of weak acids. The pKa_1 of oxalic acid is 1.23 (Ka = 0.58884) while succinic acid has a pKa_1 value of 4.16 (Ka = 0.00006918) (Table 3). This indicates that oxalic acid is stronger than succinic acid in solution due to the fact that, the smaller the pKa value, the stronger the acid (Serjeant and Dempsey, 1979). In addition, the difference in performance of oxalic and succinic acids in the bioavailability of P in soil solution can be explained on the basis of the complexes formed between the organic ligands and soil metals (Al^{3+}, Fe^{2+}, Mn^{2+}) mainly responsible for phosphorus fixation. In general, stability constant of a metal complex can be calculated as K = [ML]/[M] [L] where K is the stability constant; M is the concentration of metal ion such as Al^{3+}, Fe^{2+} and Mn^{2+} ions and L is the concentration of ligand. The concentration of M that is complexed depends on the stability of constant of the complex and the concentration of the free ligand which depends on the corresponding pKa and pH values of the organic ligand. By implication, the lower the pKa value, the stronger the ligand and the corresponding metal-ligand complex. The statement infers that, oxalic acid with lower pKa value has greater potential to form stronger, more stable and less soluble Al, Fe complexes than succinic acid. As this occurred in the soil, less of the metals were made available for phosphorus adsorption in the course of equilibration leading to a scenario where P adsorption occurred in a decreasing order of untreated > succinic > oxalic.

Table 3: Selected Stability Constants (log K1) of Various Metal Chelates

Ligands	Al3+	Ba2+	Ca2+	Co2+	Cu2+	Fe2+	Fe3+	Mg2+	Mn2+	Ni2+	Sr2+	Zn2+
Oxalic	7.26	2.31	3.0	4.7	6.3	>4.7	9.4	2.55	3.90	5.16	2.54	4.90
Succinic	-	1.57	1.2	2.08	3.3	-	7.49	1.2	2.11	2.36	0.9	1.78

Conclusion

The study show that, the application of low molecular weight organic acids to highly P-fixed soil can significantly reduce phosphorus adsorption and consequently increase P bioavailability in soil. The differential performance efficiency between oxalic and succinic acids show that the chemical properties (dissociation constant, pKa and pH) of any organic acid intended for the purpose of lowering P sorption capacity of a soil is an important factor to be considered before the selection of organic ligand.

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TEA PROGRAMME

Experiment Title: Physicochemical, Phytochemical and Functional Properties of Whole and Defatted Tea (*Camellia sinenesis*) Seed Flour

Investigators: Yahaya, L.E

Introduction

Tea (*camellia sinensis)* seed remained underutilized and exploited in major part of the world, especially Nigeria. Tea plant originated in south-east Asia, probably in the region incorporating the sources and high valleys of the Brahmaputra, the Irrawaddy, the Salween and the Mekong rivers at the border separating India, China and Burma. In Nigeria, for example, tea cultivation is mostly practiced in the upland of the Mambilla plateau and production figure is enormous therefore contributing to the world production figure of 3.6 million tons a year (FAO (2006).The implication of this is that the seed resulting from the cultivation of tea is often regarded as byproduct. The increasing cultivation of tea has also resulted in the production of large quantities of their seeds as by-products, which necessitate the determination of the potential of these seeds for human and/or animal diets.

Methodology: Proximate composition determination using methods of Association of Analytical Chemists. Crude protein content was determined using the micro-Kjeldahl method as described by Pearson (1976). Ash contents were determined according to AOAC (Association of Analytical Chemists) numbers 923.03 and 984.27 (AOAC 2005). Mineral determination of samples was carried out using the methods of AOAC (2005). One gram of sample was digested with nitric/perchloric/ sulfuric acid mixture in the ratio 9:2:1, respectively, and filtered. The filtrate was made up to mark in a 5-mL volumetric flask. The filtered solution was loaded to an Atomic Absorption Spectrophotometer (model 703; Perkin Elmes, Norwalk, CT). The standard curve for each mineral, that is, calcium, magnesium, iron, aluminium, lead, copper, and zinc, was prepared from known standards and the mineral value of samples estimated against that of the standard curve. Values of sodium and potassium were determined using a Flame photometer (Sherwood Flame Photometer 410; Sherwood Scientific Ltd., Cambridge, U.K.) using NaCl and KCl as the standard (AOAC 2005). The spectrophotometric method was used for saponin analysis as described by Brunner (1984) while total polyphenol was also determined according to the method outlined by Harborne (1973). Phytic acid determination was carried out using the procedure of Wheeler and Ferrel (1971).

Results and Discussion

Table 1. Proximate composition of whole and defatted Tea seed flour (TSF)

Parameter	WTF	DTF
Moisture (%)	3.93	6.6
Ash (%)	5.33	6.5
Protein (%)	9.4	9.95
Crude fiber (%)	2.13	2.6
Ether Extract (%)	28.13	12.38
Carbohydrate	51.08	61.97
Energy (KJ/100g)	2075.26	1680.7

The value obtained in this study is in agreement with those reported for other seeds by other workers (Ige *et al*, 1984; Fagbemi and Oshodi, 1991; Olitino *et al*, 2007). The mean ash value of DF (6.5%) was slightly higher than for WF (5.33%). However, these values are not within the recommended value for animal feed stuff. The ash content of nuts and seeds are expected to be within the range 1.5 - 2.5 % to be fit for consumption as animal diet (Pomeranz and Clinton, 1981; Aremu *et al*, 2006). Crude protein mean values for both WF and DF were 9.4 and 9.95% respectively. These values indicates that Tea flour is not fully laden with protein compared to other protein rich foods such as soya bean, cowpea, melon, pumpkin, chicken bean and lima which ranged between 19.8 -33% (FAO/WHO, 1991).

Table 2. Phytochemical/ant nutritional factors of whole and defatted TSF (mg/g)

Phytochemicals	WTF	DTF
Saponin	0.112	0.141
Terpenoids	2.62	2.68
Phytate	2.93	1.95
Oxalate	0.17	0.13
Alkaloids	2.04	2.02
Phenols	0.61	0.68
Flavanoids	0.75	0.49
Tanin	1.16	1.23
Total antioxidant	2.26	1.92

Phytochemicals are natural antioxidants that provide health benefits associated with their ability to prevent damages resulting from biological degeneration. The level of phytochemicals in foods do not necessarily reflect their total antioxidant capacity, which could also depend on synergy and redox interactions among the different antioxidant molecule present in the food material. In the present study, tea seeds flours examined contain appreciable amount of phytochemicals. Phytochemical components of whole and defatted TSF (mg/g) are presented in Table 2. The mean alkaloid value for WTF and DTF were 2.04 and 2.02mg/g which are appreciable. The quality characteristics of DTF and WTF showed that great potentials abound for tea seed.

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Starches from cowpea, pigeon pea and yambean; Food Chem., 65: 469-474.

END USE RESEARCH

Experimental Title: Hypoglycemic potential of cocoa powder in Monosodium Glutamate-diet induced diabetic mice

Investigators: Jayeola, C.O., Olubamiwa, O., Okunlola, O and Oyagbemi, A.

Introduction

Diabetes mellitus (DM) popularly called Diabetes is known as the world most common endocrine disorder (WHO, 1999); it is a glucose metabolism disorder resulting from dysfunction of pancreatic beta cells and insulin resistance. It has become a serious problem of modern society due to severe long-term health complications associated with it. DM is associated with reduced life expectancy, significant morbidity due to specific diabetes related condition primarily defined by the rising level of hyperglycemia leading to increased risk of microvascular complications (retinopathy, nephropathy and neuropathy), increased risk of macrovascular complications (ischaemic heart disease, stroke and peripheral vascular disease), and diminished quality of life (WHO, 2003). Result from epidemiological data reveals that approximately 177 million people worldwide are suffering from this disease and there are postulations that this will be doubled and increase to up to 300 million by the year 2030 (WHO, 2016). About 14.2M adults (20-79) years have diabetes in Africa. Nigeria, South Africa, Democratic Republic of Congo and Ethiopia are Africa's most populous countries with highest diabetic patients with 1.6, 2.3, 1.8 and 1.3 million respectively. (International Diabetes Federation, 2015)

Diabetes is not a single disease, it's group of heterogeneous syndromes such as heart attack, obesity, stroke and peripheral vascular disease (Porter JR and Barrett TG, 2005). Diabetes also resulting in reduced haemoglobin was reported and may as well be

accompanied by a fall in the red blood cell count and packed cell volume (Moss, 1999; Muhammad and Oloyede, 2009).

Diabetes mellitus is divided into four categories. Type-1 diabetes is also called insulin dependent diabetes mellitus because this disease is characterized by an absolute deficiency of insulin. Beta cells are destructed due to invasion by virus, action of chemical toxins or due to action of autoimmune antibodies. (Patel *et al*, 2011). Type-2 diabetes is a non- insulin dependent diabetes mellitus or Type-2 and frequently accompanied by target organ insulin resistance that limits responsiveness to both endogenous and exogenous insulin (Wang *et al,* 2011). Type-3 diabetes is a type of diabetes caused by chronic pancreatitis or chronic drug therapy with glucocorticoids, thiazids diuretics, diazoxide, growth hormone and with some protease inhibitors (e.g. saquinavir). Type-4 diabetes is observed in approximately 4-5% of all pregnancies, due to placental hormones that promotes insulin resistance (Bacha *et al*, 2010). At present time best and quickest way to induce diabetes is with use of chemicals (alloxan, streptozotocin, dithizone, monosodium glutamate), viruses and genetically diabetic rats. (Tripathi,V. and Verma, J. 2014)

Monosodium glutamate (MSG) is a salt of the amino acid glutamate, (Pavlovic and Sarac, 2010; Egbuonu *et al*. 2010). It is reported to enhance flavour in certain dishes and processed foods, MSG is said to invoke a 'fifth taste' a complex, savoury flavour. (Yamaguchi and Ninomiya, 2000), through stimulation of the orosensory receptors (Fuke and Shimizu, 1993). There are assertions too, that MSG is a food additives and as a major constituent of Nigerian diets (Akpamu *et al*., 2011). It enhances appetite and palatability of meals (Yamaguchi, 1987). MSG remains a source of concern considering the controversies about their risks and benefits. Of a particular interest is the use of monosodium glutamate (MSG), which, according to Eweka and Om'Niabohs, (2011) is popularly known in Nigeria as white maggi. Many studies have shown that MSG is toxic to humans and experimental animals (Egbuonu *et al*; 2010). It induces seizures, liver damage (Egbuonu *et al;* 2010), brain damage (Nwaopara *et al.,* 2011), diabetes, obesity and anemia (Akpamu *et al*; 2011).

Pharmacological treatment of Diabetes Mellitus is based on oral hypoglycemic agents and insulin which have many side effects. In diabetes, the causes and sites of intervention in biochemical process are diverse and high serum total triglyceride level, high level of transaminase; creatinine kinase and urea have been implicated (Azzez *et. al*., 2010). Alternative strategies to the current modern pharmacotherapy of diabetes mellitus are urgently needed, because of the inability of existing therapies to control all the pathological aspects of the disorder, as well as the enormous cost and poor availability for many rural populations in developing countries (WHO, 2003).

The evaluation of medicinal plants used traditionally in treating diabetes is of growing interest (Holman and Turner, 1991). The World Health Organization also recommended and encouraged this practice especially in countries where access to conventional treatment of diabetes is inadequate (WHO, 1999). It however emphasized the fact that safety should be the major criteria in the selection of herbal medicine for use in healthcare. Some plants used locally in managing diabetes include Neem, bitter leaf, okro, pawpaw, bitter cola, plantain, ginger among others (Savi, 2015).

In recent investigation, suggestions have been made that polyphenolics components from natural sources may act as antioxidants and also prevent disease process such as nausea, abnormal pain and so on. This is a driving force to intensify the search for alternative medicine from natural source which is relatively cheap with minimal side effects, thus necessitated the use of cocoa powder for this study.

Cocoa beans contain natural compounds such as polyphenols, methylxantines, peptides and minerals. The naturally occurring compounds were reported to have significant effect on certain health symptoms and contributed to various health promoting attributes such as high antioxidant properties, cardioprotective effects (Mathur *et al.,* 2002), hypocholestrolemic property (Abbe and Amin, 2009), glucose lowering property and to reduce severity of hepatocarcinogenesis (Amin *et al.,* 2004). Studies carried out also revealed that consumption of flavanol-rich cocoa powder may extend to the brain and have important implications for learning and memory and also as prophylactic against malaria (Bayard *et al*, 2007; Jayeola *et al*., 2011).

This study therefore, determines the effect of chronic

ingestion of MSG on blood glucose level using mice as models and also the effect of cocoa powder in ameliorating diabetes in mice

Materials and methods

This experiment made use of mouse model to determine the anti-diabetic property of cocoa powder. Laboratory mice have been the most important non-human models for studying the effectiveness of new drug therapies and efficacies of medicinal plants.

The experiment was conducted at the animal house and at the departmental laboratory of the veterinary medicine, University of Ibadan. Oyo State, Nigeria.

Mice: Adult Female Naïve BALB/C mice (N=60) of 14-16 weeks old (28-30g) were used for this study and they were purchased from Animal breeding house, University of Ibadan, Oyo State, Nigeria.

Cocoa: Natural flavanol-rich cocoa powder (non-alkalized) which was produced by an innovative industrial process and packaged by Cocoa Research Institute of Nigeria (CRIN), Idi-Ayunre, Ibadan, Oyo State, Nigeria, was used for this experiment. This is to evaluate its functionality in a short-term study through the use of an experimental rodent model for anti-diabetes.

MSG : Monosodium glutamate was purchased in local Bodija market and were packaged and sold in 3gram satchet. Enough quantity needed for this study was obtained from the market.

Substance of study: Natural cocoa powder, Diabetes, Monosodiun Glutamate.

Modified experimental feed: The experimental feed was specially formulated on request to be made of the normal rat diet. The modified feed consisted of maize starch, sucrose, soybean oil, fibre (cellulose powder), mineral premix, choline bitartrate, tert-butyl-hydroquinone (Jayeola *et al*., 2011). This was made into rat feed pellet by Pfizer feed mill, Iwo road, Ibadan. The diet contained (g/kg): maize starch, 397·486; casein, 200·000; dextrinised maize starch, 132·000; sucrose, 100·000; soyabean oil, 70·000; fibre (cellulose powder), 50·000; cocoa powder, 20.000; AIN-93G mineral mix, 35·000; AIN-93 vitamin mix, 10·000; L-cystine, 3·000; choline bitartrate, 2·500; tert-butylhydroquinone, 0·014, some with inclusion of 2% natural cocoa powder and some with 8% MSG for inducing diabetes.

Experimental animals: Mice were housed in polypropylene cages maintained at standard condition (12hours light/dark cycle 25$\pm$ 3°C, 45-65% humidity). The animals had free access to modified standard mouse feed and water *ad libitum*. All the animals were acclimatized to laboratory condition for 3days before commencement of the experiment as described by Karunakar *et al,* (2009).

Experimental design: Experimental mice were grouped into six groups (A to F) randomly containing 10 animals each, according to their weight.

Group A – Normal mice + normal mice feed
Group B – Diabetic mice with normal mice feed
Group C – Normal mice + 2% cocoa feed
Group D – Diabetic mice + 2% cocoa feed
Group E – Diabetic mice + 8% MSG + 2% cocoa feed
Group F – Diabetic mice + 8% MSG feed

Induction of Hyperglycaemia: Diabetes was inducted into the mice after been fed on MSG diet for 12 weeks. At the end of 12 weeks, body weight gain and mice with blood glucose level of above 200mg|dl and signs of polyuria, polydipsia were considered as diabetic and was used for this experiment for another 12 weeks

Sample Collection: The blood sample was collected through the tail vein using Acucheck glucometer weekly.

Determination of Body Weight: The body weight was determined using a standard digital scale. The body weight of mice was monitored and recorded weekly.

Blood Sample Collection Method for the Determination of Fasting Blood Glucose

The blood sample was collected through the tail vein to determine the fasting blood level glucose using glucometer (Acucheck advantage II). The fasting blood glucose level was monitored weekly.

Blood Sample Collection Method for the Determination of Haematological Parameters

The experimental mice were fasted overnight, anesthetized with ether, dissected and their blood was collected through cardiac puncture with a 2ml syringe into an Ethylene Diamine Tetra-Acetic Acid (EDTA) sample bottle for the determination of the haematological

parameters. Total white blood cell count was determined manually using the improved Neubauer haemocytometer while the differential leucocytes counts were determined by morphological identification and counting of hundred leucocytes in Giemsa stained smears of each blood sample. Monocytes and eosinophil are expressed as percentages of the total white blood cell. Red blood cell (RBC) was counted with haemocytometer, the packed cell volume (PCV) by the microhaematocrit method and the haemoglobin (Hb) concentration by cyanmethaemoglobin method. Platelet count was determined by direct method using diluent solution. The MCV and MCHC were calculated from the values obtained for RBC, PCV and HB.

Data Analysis : Data was expressed as mean ± standard error of mean (SEM). One-way analysis of variance (ANOVA) was applied to determine differences between the groups while Duncan multiple range test.

Results

Table 1: Fasting blood glucose level of mice after 12 weeks of exposure to MSG diet.(N=100)

Weeks	GROUP A (NF+8%MSG DIET)	GROUP B (CP+8%MSG)
1-2	74.2 ± 1.5	76.3± 2.5
2-4	111.7 ± 2.5*	80.7± 6.3
4-6	155.4 ± 4.1**	90.1 ± 4.5
6-8	193.3 ± 2.2**	108.2 ± 3.3$^{\#\#a}$
8-10	220.5 ± 3.2***	128.3± 2.1$^{\#\#\#a}$
10-12	254.6 ± 4.5****	130.6± 6.2$^{\#\#\#a}$

The fasting blood glucose was measured weekly. Values are expressed as mean ± SEM
Cp = Cocoa Powder
NF= Normal feed
MSG = Monosodium glutamate
***P < 0.001 is statistically different from the normal control
###P < 0.001 is statistically different from the diabetic control
P<0.05 is statistically different from initial

Table 2 : Effect of cocoa powder on the fasting blood glucose level of mice after induction of diabetes

Groups	Initial fasting blood glucose (mg/dl)	Final fasting blood glucose (mg/dl)
Normal control	74.2 ± 1.5	83 ± 2.3
Diabetic control	252 ± 22.6***	277 ± 32.2***a
Cocoa powder feed control	130.6 ± 6.2 **	90 ± 18.5###a
Diabetic + 2% Cp	254 ± 26.5***	140 ± 32.8###a
Diabetic + MSG + 2% Cp	254 ± 30.7***	182.5 ± 21.4###a
Diabetic + MSG	252 ± 20.8***	286 ± 25.6####a

The fasting blood glucose was measured weekly. Values are expressed as mean ± SEM
Cp = Cocoa Powder
***P < 0.001 is statistically different from the normal control
###P < 0.001 is statistically different from the diabetic control
[a]P<0.05 is statistically different from initial

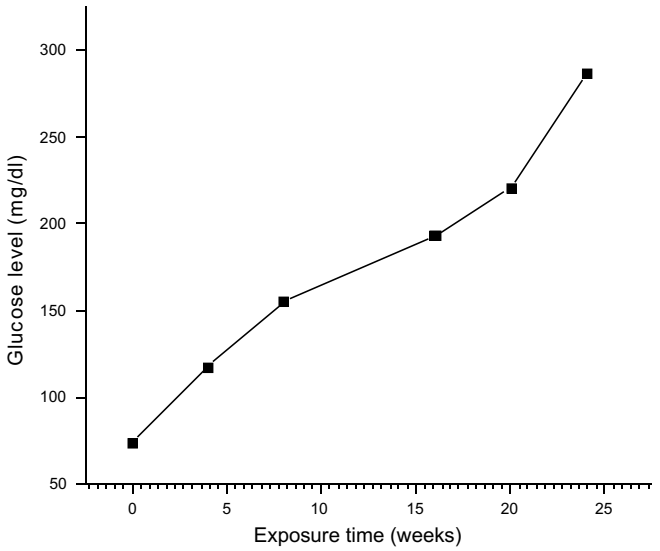

Fig 2: Rate of glucose level formation in mice as related to weeks of exposure to MSG diet

Discussion

Table 1 shows the fasting blood glucose level of mice after 12 weeks of exposure to 8% MSG diet. There was an upward trend in the blood glucose in mice fed with MSG diet as the day progresses. This was in an agreement with the report of Akpamu *et al*; 2011 that MSG consumption can lead to diabetes. According to Kate (2000) greater than 30mg/kg is a toxic dose of MSG, this correlates to about 2.1 grams in an average 70g animal. However, many individuals are considered to be allergic to or intolerant of, MSG, for these individuals, much smaller amounts (perhaps even as small as 50 or 100mg) may be considered to be a dangerous dose of MSG. When comparing group A (normal feed compounded with 8% MSG) with group B (cocoa powder diet with 8% MSG), the result indicated

that though both showed increase in the blood glucose level but the rate of increase was far more higher in group A(254.6 ± 4.5) resulting to high threshold level. This showed that MSG can induce diabetes, at the same time inclusion of cocoa powder in group B indicated that cocoa consumption might slow or prevent the formation of high blood glucose (130.6 ±6.2). The result obtained in group B is still within the normal range of blood glucose due to amelioration effect of cocoa powder in the diet. Table 2 result showed the effect of cocoa powder on the fasting blood glucose level of mice after induction of diabetes. Diet compounded with cocoa powder showed reduction in blood glucose level (90 ± 18.5) and this is an indication that cocoa has the ability to reduce blood glucose level and therefore can be termed as having prophylactic effect against diabetes in mice, consequently, the diabetic mice that was continued with 8% MSG has the highest incidence of blood glucose level (286 ± 25.6), this is an indication that prolong consumption due to addiction to use will result to diabetes. This report is in agreement with Eweka and Om'Niabohs, (2011) that reported that MSG is toxic when consumed in large quantities. The result as shown in Table 3 showed the comparative body weight of the different groups of experimental mice and their relative blood glucose levels, and the result indicated that mice with the highest body weight (38g) has the highest blood glucose level (286 ± 25.6), surprisingly those mice fed with cocoa powder diet showed reduction in weight loosing (-1.11) as against diabetic mice fed with MSD diet with weight gain (10.01)and this showed that cocoa powder exhibit weight reduction property and this is in agreement with the work of Jayeola *et al*, 2014 that reported weight reduction in obese mice fed with feed incorporated with cocoa powder

Conclusion

Excessive intake of MSG may result in diabetes, constant drinking of cocoa powder will prevent the occurrence of type 2 diabetes.

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FARMING SYSTEM RESEARCH

Experimental Title: Evaluation of Coffee Intercropped with Oil Palm in Hollow and Avenue arrangements in two locations in Nigeria

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Introduction

Inter-cropping is the practice of planting two or more crops simultaneously on the same piece of land and is mostly practiced among various forms of multiple cropping. Monoculture to which our colonial master had diverted our attention in the past is not suitable to our culture. Farming System generally is an agricultural activity consisting of a combination of inputs in number, amount, sequences and timing by inter-cropping with arables or tree crops (Adeyemi, 1997). Inter-cropping had been reported to increase crop diversity, biological stability of the ecosystem and labour efficiency (Okigbo *et al.,* 1975; Adenikinju, 1980).

The renewed interest shown in farming system in the early seventies brought tree crop plantations to grow other crops. Subsequently, many tree crops notably oil palm and cocoa have been successfully inter-cropped with other tree crops and food crops (Ofoli and Lucas, 1988; Okpala – Jose and Lucas, 1989; Famaye and Adeyemi, 2009; Famaye *et al*., 2011; Famaye and Adeyemi, 2011). Suitable inter-cropping systems have been achieved in coffee with arable crops like cassava, maize and rice (Famaye, 2000; Famaye, 2005; Famaye and Agboola, 2003).

Intercropping in coffee carried out to provide food and income to farmers in Nigeria is usually done at early stage of field establishment before they close canopy and during rehabilitation of old farms (Famaye, 2000). Coffee has been successfully intercropped with kola, without any adverse effect on the yields of the two tree crops. However, oil palm is yet to be intercropped with other tree crops. Despite the various advantages derivable from oil palm as one of the tree crops that produce palm oil apart from other benefits to peasant farmers, as well as the rich and all and sundry in Nigeria, it has not been inter-cropped with coffee, a commodity crop grown in Nigeria. With the dwindling crude oil price internationally and the shift of government attention to Agriculture as the main stay of the country economy there is need to have good agricultural practices that could be packaged to the famers in order to improve their standard of living and GDP accruable to the government through export of coffee. Therefore, the objective of this study is to evaluate the performance of coffee when intercropped with oil palm using Hollow square and avenue arrangements of oil palm.

Materials and Methods

Field trials were conducted at Cocoa Research Institute of Nigeria (CRIN) Headquarter Idi-Ayunre, Ibadan and CRIN Uhonmora Substation in Edo State. Idi-Ayunre ($7^0$25'N, $3^0$24'E) (an alfisol) and Uhonmora ($6^0$5'N, $5^0$50'E) (an alfisol) were located in rainforest and derived savanna zones of Nigeria respectively. Oil palm seedlings were obtained from the National Institute for Oil palm Research (NIFOR) Benin City, Edo State. Land preparations were done and all trash and trees were removed in both locations.

The experiment had three treatments, (a) coffee sole (b) coffee/oil palm (Hollow square arrangement) and (c) Coffee/Oilpalm (Avenue arrangement). Hollow square arrangement was where coffee was planted in the hollow of nine oil palm planted in a square. The 9^{th} oil palm standing in the middle of the square was omitted. It was in this hollow that coffee seedlings were planted. While coffee were planted in the Avenue of oil palm in the case of Avenue arrangement. Oil palm were planted 9mx9m apart while coffee were planted 3m x 3m apart. The experimental design was Randomized Complete Block Design (RCBD) replicated three times. Parameters measured were physical and chemical properties of the soil at the beginning of the experiment as well as plant height and leaf area. Yield of coffee berries and palm fruits/bunch obtained after 3 years of field establishment were also evaluated. Data collected were subjected to statistical analysis of variance and LSD was used to separate the significant means.

Results and Discussion

The Result of the physical and chemical properties of the soil of the study location is shown in Table 1. The soil pH of 6.2 and 5.2 for Idi-Ayunre and Uhonmora respectively were adequate for coffee as reported by Famaye (2005). The survival count was carried out after the first year of field establishment. Over 96% was obtained in all the treatments without any significant difference (P<O.05) among them after the first dry season of transplanting.

The plant height was higher in Hollow square arrangement than in Avenue and control in almost all the months after transplanting (MAT) except for between 3 MAT and 9 MAT (Table 2 and 4). The control had the least plant height; although it was not significantly different (P < 0.05) from the values of Avenue arrangement between 12 MAT and 36 MAT. The coffee in Hollow square was significantly higher (P < 0.05) than the coffee in Avenue arrangement and control in leaf area in almost all the months considered after transplanting (Table 3 and 5). The least leaf area was recorded in coffee in the control treatment. There was no significant difference between Avenue and control treatments. The higher growth performance recorded in Hollow square arrangement shows that there was no deleterious effect of intercropping coffee with oil palm in Hollow square of the oil palm. This agrees with earlier work reported on beneficial effect of intercropping of arable and tree crops (Adeyemi, 1997; Adenikinju, 1980), tree and food crops (Ofoli and Lucas, 1988; Okpala-Jose and Lucas, 1989; Famaye and Adeyemi, 2009; Famaye *et al,* 2011; Famaye and Adeyemi, 2011) and coffee with arable crops (Famaye, 2000; Famaye, 2005; Famaye and Agboola, 2003). Table 6 shows the average coffee berries and oil palm bunch in t/ha. The average yield of palm fruit bunch obtained in Hollow square was not significantly higher than that of Avenue arrangement but indicated additional food production than sole coffee. The reduction in Hollow square was due to the oil palm stand removed in the hollow of the square where coffee was planted.

Table1: Soil physical and chemical properties of the experimental sites at the beginning of the experiment

Soil Properties	Idi-ayunre	Uhonmora
pH (H O)	6.2	5.20
% Organic carbon	0.75	0.84
%Total Nitrogen	0.07	0.09
Available P (mg/kg)soil	7.40	7.15
Exchangeable K (cmol/kg)soil	0.42	0.05
Exchangeable Ca (cmol/kg)soil	2.45	2.65
Exchangeable Mg (cmol/kg)soil	0.03	0.04
Exchangeable Na(cmol/kg)soil	0.01	0.02
%Sand	81.60	78.8
%Silt	8.40	9.2
%Clay	10.00	12.0
Soil classification	Alfisol	Alfisol

Table 2: Mean plant height (cm) of coffee inter-cropped with oil palm in hollow square and avenue arrangement in 2011 – 2014 at Idi-Ayunre

Treatments	3 MAT	6 MAT	9 MAT	12 MAT	15 MAT	18 MAT	21 MAT	24 MAT	27 MAT	30 MAT	33 MAT	36 MAT
Coffee/Hollow Square	17.8	26.4	42.4	45.0	49.2	53.9	64.2	77.0	92.9	100.2	112.1	126.1
Coffee/Avenue	18.0	28.0	38.0	44.2	47.1	47.9	58.0	70.3	88.0	100.0	110.4	120.4
Coffee sole (control)	24.1	30.0	46.0	46.1	49.2	52.9	60.3	79.7	86.4	95.0	100.2	119.3
Mean	20.0	28.1	42.1	45.1	48.5	51.6	60.8	75.7	89.1	98.4	110.2	121.9
LSD (P = 0.05)	8.99	4.48	9.95	2.24	3.01	7.98	7.78	12.02	8.41	7.31	4.85	9.06

Table3: Mean leaf area (cm^2) of coffee inter-cropped with oil palm in hollow square and avenue arrangements in 2011 – 2014 at Idi-Ayunre

Treatments	3 MAT	6 MAT	9 MAT	12 MAT	15	18	21	24	27	30	33	36
	MAT MAT	MAT MAT	MAT MAT	MAT MAT								
Coffee/Hollow Square	79.0	87.7	93.5	117.9	130.3	141.5	157.1	164.1	175.5	183.2	195.4	310.5
Coffee/Avenue	73.0	82.1	87.8	110.3	121.5	130.3	142.6	149.0	157.6	164.7	175.3	188.4
Coffee sole (control)	74.1	82.0	86.4	105.2	116.0	119.7	132.4	140.2	150.1	158.9	164.7	180.3
Mean	75.4	83.9	89.2	111.1	122.6	130.5	144.0	151.1	161.1	168.9	178.5	193.1
LSD (P = 0.05)	7.93	8.10	9.34	15.87	17.91	27.6	30.81	30.01	32.40	31.51	38.71	88.81

Table 4: Mean plant height (cm) of coffee inter-cropped with oil palm in hollow square and avenue arrangements in 2007 – 2010 at Uhonmora

Treatments	3 MAT	6 MAT	9 MAT	12 MAT	15	18	21	24	27	30	33	36
	MAT MAT	MAT MAT	MAT MAT	MAT MAT								
Coffee/Hollow Square	15.5	24.3	38.1	42.7	45.5	50.2	57.5	63.2	70.3	84.5	90.2	178.1
Coffee/Avenue	16.3	22.1	32.0	38.5	40.8	44.6	50.1	57.2	64.4	75.1	89.0	105.3
Coffee sole (control)	15.7	22.0	30.1	35.6	39.9	42.3	47.4	52.5	60.5	70.2	80.7	100.2
Mean	15.8	22.8	33.4	38.9	42.1	45.7	51.7	57.6	65.1	76.6	89.3	107.9
LSD (P = 0.05)	1.03	3.23	10.38	8.86	7.47	10.07	12.98	18.31	12.25	18.04	21.73	22.89

Table 5: Mean leaf area (cm^2) of coffee inter-cropped with oil palm in hollow square and avenue arrangement in 2007 – 2010 at Uhonmora.

Treatments	3 MAT	6 MAT	9 MAT	12 MAT	15	18	21	24	27	30	33	36
	MAT MAT	MAT MAT	MAT MAT	MAT MAT								
Coffee/Hollow Square	64.5	78.0	105.1	116.4	125.3	137.6	145.4	159.1	168.2	125.3	187.2	198.3
Coffee/Avenue	64.1	75.5	97.8	105.3	119.0	128.1	134.7	148.7	158.9	163.1	175.1	184.5
Coffee sole (control)	64.2	73.6	90.3	99.5	113.2	120.3	128.5	140.3	149.5	154.5	169.3	175.3
Mean	64.3	75.7	97.7	107.1	119.2	128.7	136.2	149.4	158.9	164.3	177.2	186.0
LSD (P = 0.05)	0.52	4.48	18.37	21.32	15.02	21.51	27.22	23.38	23.21	25.95	22.67	28.74

Table 6: Average yield of coffee and oil palm in hollow square and avenue arrangements at Idi - Ayunre and Uhonmora

Location	Treatments	Coffee Berry	Yield (t/ha) Oil palm Bunch/Fruit
Idi-Ayunre	Coffee sole	1250	-
	Oil palm sole	-	5.0
	Coffee hollow square	1340	5.5
	Coffee avenue	1320	5.6
	Mean	1303	5.4
Uhonmora	Coffee sole	1240	5.1
	Oil palm sole	-	5.9
	Coffee hollow square	1335	5.9
	Coffee avenue	1325	5.7
	Mean	1300	5.6

Conclusion

It could be concluded that coffee Hollow square arrangement with better performance in morphological parameters than other treatments and additional palm fruits could be recommended to coffee farmers in Nigeria as against sole coffee planting or coffee Avenue planting arrangement.

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LIBRARY, INFORMATION AND DOCUMENTATION DEPARTMENT

Objective
The main objective of the Department is to acquire, process, organize, store and disseminate information with a view to stimulate and guide research on CRIN mandates crops.

Library Information and Documentation Department (LID) comprises of three (3) divisions which are: Library, Information Communication Technology (ICT) and Documentation divisions. These three (3) divisions supported the research activities of the institute by providing services.

The personnel: There are thirteen (13) staff working at LID department. These are; two (2) Librarians, two (2) Programme Analysts, three (3) Library Officers, one (1) Chief Printer, one(1) Data Processing Officer, one (1) Chief Typist, two (2) Clerical Officer and one (1) Agricultural Field Attendant.

Library Division Dr. (Mrs.) Ogunjobi T.E. – (Acting Head, Library Division)

There are four (4) sections in Library Division: Circulation section, Reference section, Cataloging and Classification section and Acquisition section.

The library provides resources both in printed and electronic formats on CRIN mandate crops and related disciplines for Scientists. Agricultural databases e.g. AGORA password is made available for the use of Scientists.

The Division coordinates day to day activities of library services, charging in and out of the library materials, loan services, collating of daily statistics of library use, acquisition of library materials, cataloging and classification of newly acquired library materials, etc.

ICT Division – (Ibe Osita – Acting Head, ICT Division.)
The ICT Division composed of Internet/website and automation sections. This Division is saddled with the responsibility of providing the Institute with Internet connection, web presence and digitalization of library collections and deployment of electronic database.

Achievement
In the year under review, the Division procures internet equipment to strengthen links at strategic locations of the Institute, maintained the Institute website and handled official local/international correspondences online.

Documentation Division: (Fagbami, O.O. and Babafemi Ibitope)

CRIN Library Automation systems comprises of electronic devices (computers) which transforms library materials (Journals, Theses, Reports, etc.) to full-fledged electronic library format. It comprises of three (3) servers; TEEAL, File and KOHA.

Achievements
TEEAL (The Essential Electronic Agricultural Library) Drive was acquired to provide up-to date e-library materials on Local Area Network (LAN) to library users.

Downloading of Journals on CRIN mandate crops (Cocoa, Coffee, Cashew, Kola, and Tea) to be uploaded into CRIN D Space

Find below the breakdown of the uploaded journals:
Cocoa – 98
Coffee - 82
Cashew – 71
Tea – 50
Kola – 31
Total - 332

Processing of submitted reports by Scientists continued. Crop book was updated by Scientists and submitted for input of computer artist graphic.

Compilation of published journals articles and CRIDAN was done.

Bibliography compilations on all mandate crops assigned to the library staff continued.

CRIN monthly bulletin was produced and circulated.
Production of staff identity card continued.

FINANCE AND ACCOUNTS DEPARTMENT

This departmental report will be based on the underlisted area as directed.

A. The divisions in Finance and Accounts Department
B. Cadre and number of staff in each of the division

A. The Division in Finance and Accounts Department

In the year under review, Finance and Accounts department has four (4) divisions and one Section as follows:

1. Finance and Account Division
2. E-payment Division
3. Payroll Division
4. Budget Division
5. Pension Section
6. Office of the Acting Head

B. Cadre and number of staff in each of the Division

The breakdown of total number of staff in the department as at 31 December, 2017 is as follows:

Division	Accountant Cadre	Executive Cadre	Secretarial Assistant Cadre	Clerical Cadre	Total No. of staff
Office of Ag. Head	1	1	1	1	4
Final Account	4	4	1		9
E payment	3	4			7
Payroll	3	1	1		5
Budget	2	1			3
Pension	1	2			3
Total					31

ENGINEERING DEPARTMENT

Preamble

During the year under review, 2016 till date, the Engineering /Works Division operated as hitherto into three (3) technical sections and fourteen (14) operational units. This help to effectively utilize the available manpower and to deliver maximally in all fronts of the official responsibility of the division tom support and service the Research mandated goal of the Institute.

Sections:

The three technical sections are arranged below:

(1) Civil Engineering
(2) Electrical Engineering
(3) Mechanical Engineering

Units

We have fourteen operational units, which are listed below

(1) Civil
    * Carpentry
    * Mansory and Bricklaying
    * Roads
(2) Electrical
    * Generation & Protection
    * Networks & Installations
    * Billing & Metering
(3) Mechanical
    * Agricultural & Equipment
    * Fabrication & Welding
    * Plumbing & Water supply
    * Generation, Refrigeration & Air-condition
    * Machine shop
    * Motor vehicles

* Special Duties (Maintenances, Planning & Monitoring)
    * Transport

Personnel

Names of all Staff in Engineering Division

`S/N	NAME	DESIGNATION
1	Engr. Bakare Taiwo	Chief Maintenance Engineer/HEW
2	Engr. Ikpefan Patrick	Principal Maintenance Engr. l
3	Mr. Titiloye Isaac	Senior Maintenance Engr.
4	Mr. Olutola Ola	Chief Tech. Officer
5	Mr. Agwimah Emmanuel	Chief Tech. Officer
6	Mr. Ajiboye Gbenga	Asst. Chief Tech. Officer
7	Mr. Yinusa Sakiru Adedoyin	Principal Tech. Officer l
8	Mr. Awe Jacob	Principal Tech. Officer l
9	Mr. Ogunsuyi Busuyi	Principal Tech. Officer l
10	Mr. Gold Ahmed	Principal Tech. Officer l
11	Mr. Oduntan Samson	Principal Tech. Officer l
12	Mr Oyawale Muniru	Higher Tech. Officer
13	Mr. Ogunwumi Oluseye	Higher Tech. Officer
14	Mr. Ajayeoba Babatunde	Higher Tech. Officer
15	Mr. Ogbechie Micheal	Higher Tech. Officer
16	Mr. Mathews Dare	Senior Works Superintendent
17	Mr Akintoroye Ambrose	Senior Works Superintendent
18	Mr Ogbechie Christopher	Senior Works Superintendent
19	Mr. Adeyanju Stephen	Higher Works Superintendent
20	Mr. Balongun Roland	Higher Tech. Officer
21	Mr. Adedoyin Nkanlola	Higher Works Superintendent
22	Mrs. Togun Olubukola	Higher Tech. Officer
23	Mr. Oyeniran Sunday	Works Superintendent
24	Mr. Oyebanjo Toyosi	Works Superintendent
25	Mr. Ironua Samuel	Senior Foreman
26	Mr. Ibiyemi Adewale	Senior Foreman
27	Mr. Oke Babatunde	Works Superintendent
28	Mr. Ojo L. Idowu	Senior Foreman
29	Mr. Adeogun Morufu	Senior Foreman
30	Mr. Uwaifo l. Andrew	Senior Foreman
31	Mr. Adekanbi Aderemi	Asst. Tech. Officer
32	Mr. Ismaila Salami	Senior Craftsman
33	Mr. Ojo Moses	Senior Craftsman
34	Mr. Adesida Adewumi	Senior Craftsman
35	Mr. Adeboye Kehinde	Foreman
36	Mr. Oladimeji Taofeek	Craftsman
37	Mr. Boluwade Sunday	Senior Craftsman
38	Mr. Faniyi Jimoh Abiola	Senior Craftsman
39	Osun Micheal	Senior Craftsman
40	Mr. Adio Dare	Asst. Technical Officer
41	Mr. Alade Gboyega	Senior Craftsman
42	Mr Adedayo Salaudeen	Senior Craftsman
43	Mr Adekanbi Segun	Senior Craftsman
44	Mrs. Ajekigbe Femi	Secretarial Asst. l
45	Mr. Ajayi Olalekan	Agric. Field Attendant l
46	Mr. Gabriel Ibhazakor	Agric. Field Attendant ll
47	Mr Rotimi Ipinmoroti	Motor Driver Mech.
48	Mr. Oladipupo Kayode	Senior Work Superintendent
49	Mr. Ajiroba Taiwo	Senior Work Superintendent
50	Mr. Enodumwenben Anthony	Senior Work Superintendent
51	Mr. Kpeleye Friday	Work Superintendent
52	Mr. Odeku Olufemi	Work Superintendent
53	Mr. Tijani Fatai	Chief Motor Driver Mechanic l
54	Mr. Muraina Lukman	Chief Motor Driver Mechanic l
55	Mr Osungbade Ayoade	Higher Technical Officer
56	Mr. Ogunkunle Gbadebo	Senior Motor Driver Mechanic
57	Mr. Arumemi Christian	Senior Motor Driver Mechanic

58	Mr. Arowobusoye Akinrinsola	Senior Motor Driver Mechanic
59	Mr. Oluwole Segun	Senior Motor Driver Mechanic
60	Mr. Adesuyi Busuyi	Senior Motor Driver Mechanic
61	Mr. Oyedele Bolaji	Senior Motor Driver Mechanic
62	Mr. Iyeh Moses	Senior Motor Driver Mechanic
63	Mr. Nome Peter	Motor Driver Mechanic
64	Mr. Rabiu Akeem	Motor Driver Mechanic
65	Mr. Ajewole	Motor Driver Mechanic
66	Ismaila Tajudeen	Motor Driver Mechanic

Achievement of the division

1. General maintenance of buildings, equipment, vehicles and road network within the Institute
2. Erection of fencing Poles and wires along the Institute outside Lawn
3. Supervision of all Contract works like road construction, the Laboratory complex, installation of solar/inverter system in the Institute and so on.
4. Re-roofing of the Event Centre.
5. Redd-roofing of the Engineering workshop.
6. General transport activities.

Functions and Responsibilities of Engineering Division

1. Initialize and develop a process plan to service the research mandate goal.
2. To design, construct, install and maintain any engineering related equipment to support the research mandate goal.
3. Daily Maintenance of vehicle fleets, building, machinery, and equipment's that drives the research mandate goals.
4. Prepare tender document to facilitate excursion of capital projects.
5. To advice the Executive Director and CRIN management on the tenets of the ethnics of the engineering profession.

Challenges (major & minor):
Major challenges faced by the Division:

- Lack of readily available working fund to solve immediate maintenance needs.
- Also, poor or rather no imprest reimbursement.
- Lack of an upgrade of equipment and tools in commensurate with available manpower.
- Insufficient training and re-training of staff to meet up with the global trends in maintenance techniques

Minor challenge faced by the division:

- Lack of an engineering inventory store which will enable closeness to maintenance spare items thereby eradicating long down time delay.
- Also, the Engineering Division lack daily logistics like availability of vehicle to move materials finished work to the site, a direct projection of poor funding.

Scope for Future Recommendation

1. Provision of upgrade equipment /tools for the day to day running of the division
2. Training of staff to meet with the recent global technology
3. Provision of daily needed maintenance items in the inventory store to eradicate delays in the execution of maintenance plans.
4. The farm machineries could be used for hiring in-order to generate IGR
5. Construction of a 33KV transmission line or a dedicated line to solve the problem of light in the Institute which could also be a source of IGR.

PLANTATION AND ESTATE MANAGEMENT

A. Staff Strength/Disposition

At the onset of the year 2017, staff strength stood at 193 permanent staff comprising 60 Senior Staff, 133 Junior Staff and 5 projects Contract Workers (PCW) excluding HPU, SPU NDM, BAKERY winery and soap staff.

During the period under review, Mr. Razak Olagunju (AFA) in zone 5, Mr. Oyebamiji Adeleke (ACAFO) in zone 1 , Mr. Oladipo John in zone 7 and Mr. Taofeek Animashaun in zone were reported death after brief illness. Messers Ethapemi Joseph – zone 7 and Chucks Okoh in

Ground maintenance were not at work throughout last year while Mr. Ogunleye Olayiwola retired from active service

Table 1

S/N	No of PCW	Unit	Effective hectare	No of Senior staff and Admin Officer	No of supervisor	Field staff & Admin	Total Work force
1		PEM	-	3	-	2	5
2		Zone 1	34.79	3	2	15	18
3		Zone 2	15.14	4	2	8	12
4		Zone ¾	15.79	4	2	7	11
5		Zone 5	27.63	5	2	12	17
6		Zone 6	26.00	4	2	15	19
7		Zone 7	23.85	3	2	9	12
8		Zone 8	41.05	7	4	14	21
9		Zone 9	22.89	4	2	7	11
10		BCOO	6.00	1	1	4	5
11		Fermentary	-	7	1	5	12
12		Ground maintenance	-	11	7	24	35
13		Palm oil milling	-	1	1	4	5
14		Chain saw operator	-	-	-	2	2
		TOTAL		57	28	128	185

Mr. Akhidime, Mr. George and Mr. Zulukas - Administrative Officers were deployed back to Admin. Mrs. Oluwadare went back to Engineering Division and Mr. Omitade Olusoji (AAS) was transferred to Farming System. Mr. Adedara Cornelius (AFA) and Mr. Oga Sunday were transferred to Security Section.

Furthermore, Mr. Ademola Sunday (PAS II), Mr. Abiade Sulaimon in Zone 1 and Mr. Tosin Ojo in zone 9 were sent to Moor Plantation BCOO plot on special assignment.

Hence, the Plantation and Estate Management ended up with total number of 185 permanent staff (involving 57 senior staff and 128 junior staff) as well as 5 project workers during the period.

B. **Achievements**

1. Plantation activities effectively carried out included:

a. Under-brushing and felling of forest trees.

b. Cross-cutting of felled trees.

c. Lining, pegging, holing and planting of TC1 – TC8.

d. Field establishment of cocoa hybrid plots.

e. Weeding (manually, mechanically and chemically controlled).

f. Supplying of missing stands on gapping up of dead stands.

g. Removal of noxious parasitic plants.

h. Pruning of excess canopies, excess branches and dead branches.

i. Spraying against pest, diseases and roads.

j. Timely harvesting evacuation and processing of cocoa.

k. Timely harvesting of all farm produce.

l. Record keeping.

m. Farm sanitation.

n. Cutting of fire terraces.

o. General rotational duties.

p. Preparation of project contract workers wages.

2. **Estate Maintenance**

a. Regular manual slashing and mowing of the lawn with the lawn mowers and the tractor slasher

b. Routine manual slashing of the open

grounds, roadsides, laboratory and residential premises.

c. Regular trimming of hedged along road side and public places of the Institute.
d. Watering and weeding of potted flowers.
e. Watering of TC1 –TC8 and flowers planted at the Institute frontage.
f. Picking of dropped refuse around the estate offices and frontage.
g. Gapping up of missing stands of the masquerade trees.
h. Burning of dumping debris.
i. Sanitation of estate management.

3. **Fermentary Unit:** Under the period in review:
1 ton of cocoa dried beans was sold while 4⅓ bags are presently in the store. 442kg of Cashew nuts is still in the store while some nuts were discarded as they are not viable for planting. 208kg of Coffee berry is till in the store.

4. **Support For Research Activities:** Some Scientists were assisted with labour to perform their necessary activities in their research plots.

5. **Planting of New Hybrid Cocoa TC1 –TC8:** The 10 hectares of new hybrid cocoa plots planted before were gapped up under the year in review. The one hectare model hybrid cocoa plot in zone 1 was also maintained. In addition 10 hectares establishment of cocoa TC1 – TC8 at zone ¾ was carried out.

6. **Digging Of Borehole:** In order to rescue our young cocoa plants from draught, two (2) boreholes sunk at zone 6 and 8 respectively were repaired while another one was sunk into zone 9.

7. **Tree Felling Activities**
Tree felling operation by the CRIN Authority and Forestry Department was carried out in some zones. They are: Zone 1, 2, 3/4, 5, 6, 7, 8, 9 & NDM.

8. Palm Oil Milling Unit is involved in:
a. Regular maintenance of oil palm plots.
b. Top dressing and pruning of oil palm trees.
c. Harvesting, evacuation, picking, boiling and processing of oil palm fruits.
d. Bottling, releasing and scaling of palm oil to the staff.
e. Table of money of palm oil sales. Remitted to the marketing

9. Farm Produce: Tables of farm produce for the year 2017 are as follows.

Farm Produce for the year 2017 cocoa pods.

ZONES	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT	OCT	NOV	DEC	TOTAL
1	486	99	2305	4719	2878	2317	1713	514	1104	772	1466	533	18906
2	576	197	70	-	5129	-	739	-	1016	426	860	2070	11083
¾ 5	598	-	-	2171	77	2566	242	-	838	-	-	684	7176
6	751	419	2902	13,000	14579	5737	934	-	1814	3312	1529	269	45273
7	1663	-	1020	3645	1424	5029	1115	-	-	1693	1679	683	17951
8	2926	2024	1969	2806	4840	1716	1640	-	3549	867	4882	6139	33358
9	4074	1111	-	3900	7346	1948	1612	-	1047	2964	4550	8040	36592
BCOO	605	-	825	1505	-	-	-	-	-	-	-	5395	8390
HTI		-	-	-	-	1336	-	-	267	-	-	-	1603
Demon	116	-	-	-	-	-	-	-	-	-	-	-	116
Oil palm	110	80	108	140	60	106	62	85	68	22	-	-	841
TOTAL	11,795	3850	9091	31,806	36,273	20,649	7995	514	9662	10,034	14,966	23,813	180,448

S/N	Date	Months	Amount Paid to the Marketers	Amount Paid to Contract Project Workers	Remarks Necessary Items Purchased from Productio Sales	
1	04/01/17	January	33,000.00	22,000.00 (January)	2 empty drum	14,000
2	07/02/17	February	84,000.00	20,000.00(February)	Petrol	400
3	04/04/17	April	13,750.00	38,000.00(March)	Spark plug, bar bolt & nut	500
4	05/05/17	May	18,000.00	20,000.00(April)	Diesel	1,530
5	08/06/17	June	72,000.00	23,000.00 (May)	Bazuki	5,050
	29/06/17		48,000.00	22,000.00 (June)	repair/servicing	
6	03/08/17	August	60,000.00	21,000.00 (July)	Empty drum	7,500
	29/08/17		55,000.00	23,000.00 (August)		
7	06/10/17	October	20,000.00	16,000.00 (September)	Big black baff	3,600
8	27/10/17	October	20,000.00	22,000.00 (October)	adogan	18,000
	TOTAL		**₦423,750.00**	**₦ 227,000.00**		**₦50,580.00**

ZONES	KOLA PODS	CASHEW NUTS IN KG	BANANA BUNCHES	PLANTAIN BUNCHES	STAR AP PLE TREE	MAIZE COBS	COFFEE
1	-	99.8KG	195 merged to 63	-	½ a tree	-	-
2	197	-	-	1,500 worth	-	-	-
¾	-	240.89KG	-	-	-	-	-
5	-	-	-	-	-	275	46.67kg
6	-	-	-	30	-	-	-
7	4352	-	-	-	-	-	-
8	-	-	-	-	-	100	-
9	-	-	10 merges to 2	16 merged to 5	-	-	-

10.Distribution of Farm Tools/Chemicals to the Zones/Unit

S/N	ITEMS	BCOO	Zone1	Zone2	Zone ¾	Zone 5	Zone 6	Zone7	Zone 8	Zone 9	GM	FER	NDM	HPU	SPU	PALM MILLING UNIT
1	Eye Goggle	-	1 pcs	-	-	-	-		1pcs	-	2 pcs	-	-	-	-	-
2	File	2	-	-	-	-	-		-	-	-	-	-	-	-	-
3	Nose mask	_	1 PCS							-		-	-	-	-	-
4	Cutlass	_								1		-	-	-	-	-
5	Hand gloves	7								-		-	-	-	-	-
6	Rain boot	_								-		-	-	-	-	6
7	Watering kegs	_								5 PCS		-	-	-	-	-
8	Chicken wire net	_								-		-	-	-	-	-
9	Lawn mower	_								-		-	-	-	-	-
10	Hard cover note	_								3		3	-	-	-	-
11	Clear weed	_										-	-	-	-	-
12	Clear weed	4 LIT								1 LIT		-	-	-	-	-
13	Weed burner	_										6 LIT	-	-	-	-
14	Biro	_										3	-	-	-	-
15	Actara	_										-	-	-	-	-
16	Glyphosate	_										5 LIT	-	-	-	5 LIT
17	Super gro	_										-	-	-	-	-
18	Actara	_										-	-	-	-	-
19	Ultimax plus	_										-	-	-	-	-
20	CP 15	_										1 PCS	-	-	-	-
21	Overall cloth	_										-	-	-	-	-
22	Rain boot	_										-	-	-	-	-

Challenges/Recommendation

1. **Inadequate Supply of Manpower:** There is a gross inadequacy of manpower to cope with various divisional operations for the CRIN scheduled crops. This inadequacy affects the output of work done. The efforts of the management to ameliorate this problem are highly commendable considering the financial constraints. Increase in labor force will further enhance the job carried out in the division such as new planting, rehabilitation of old plots, sanitation of the environment and plantations. Hence boosting of farm produce which will definitely increase the Internally Generated Revenue (IGR). It will be therefore highly appreciated if recruitment of at least 150 Assistant Field Attendants (AFA) could be embarked upon along with occasional special task force operation. Gender, age and fragility should be put into consideration whenever recruitment is carried out so as to inject male youth into field staff system.

2. **Porosity of Zones/Units Axis:** The porosity of the zones/units allows stealing by unwanted visitors especially during the dry season (Zones 1, 2, ¾, 5, 6, 7, 8, & 9).

3. Intensification of the security effort in the zones along with regular patrol gang will be highly appreciated.

4. **Late and Inadequate Supply of Agro Chemicals** e.g. glyphosate for the control of growth weed. Most of the time the supply of available agrochemicals doesn't fall into the farming appropriate time.

5. **Non-Accessibility of Dedicated Vehicle:** There is lack of transportation for the monitoring purpose in the division. If a sound and good separate vehicle could be provided for the division, and to be conveying zone borehole generators which are kept in the PEM for security reasons to their various zones when needed. Availability of vehicle would make it easier to touch all nooks and corners of various units and BCOO plots at Ibadan throughout the season than the usage of personal pleasure car which is fragile and limited.

6. **Inadequate Supply of Farm Tools and Protective Clothing:** These farm tools are necessary to provide good working condition. Tools that ate presently available in the zones are worn out and they need replacement.

7. **Insufficient Table, Chairs, Stools and Office Cabinet:** the chairs and tables in the units/zones are nothing to write home about as they worn-out. The offices allocated to the Division in ERLS building are locked up because there are no tables and chairs. No cabinet in PEM's office to keep essential documents. Prompt upgrading of furniture items will be highly appreciated.

8. **Zonal Offices:** There are no toilet in almost all the zones and other units. The effort of the management to ameliorate problem of farm offices are highly appreciated but ground maintenance and fermentary unit do not have a particular farm house where their workers could hide themselves during heavy rainfall or sunny period while available farm houses are not burglary proofed (door and window hence allows pilfering/thefts of properties and farm produce).

9. **Supervisory Motorcycles:** The Division finds it difficult to maintain supervisory motorcycles and it has to be done with individuals' personal money. For the durability of these motorcycles, we shall be grateful if certain amount could be approved and released either monthly or quarterly for such purpose. Presently, no functioning supervisory motorcycle for the zone's use.

10. **Prompt Release of Fund:** Late release of money to purchase diesel and petrol to supply water for watering young cocoa plants on the field always affect the survival rate of plants. Instead of releasing the money in bits, the amount required throughout the dry period should be released once. The lasting solution is to sink well/borehole in the zones. Prompt payment of imprest at any anytime requested for should be ensured.

11. **Poor Payment and Delay in The Payment of**

Wages: Late payment of wage to Project Contract Workers constitutes problem. If the small wages is paid as at when due to project contract workers, they will be encouraged to work more and labor will be available within the locality. Hence, early payment will encourage workers and enhance productivity. Within the present development coming up in our vicinity, the wages have to be increased so as to make them available for our use.

12. **Fencing Round the Estate Area**: Log fellers did a lot of havoc to our young cocoa plants by passing through illegal roads with their trucks. Farm produce are being destroyed by Fulani cattle rearer. Thieves are also having free access to pilfer plantain and some other products while plantain bunches are harvested prematurely. All these can only be minimized or checked or controlled by fencing round the estate.

13. **Fuelling of Zone Borehole Generators:** Presently, we have five boreholes in the zones, (zone 1, ¾, 5, 8 & ( ). For their effectiveness and efficiency, it would be necessary to allocate funds for the fuelling of their generators.

14. **Brakata Bridge and Zone 2 Bridge:** These are the alternative routes to zone 9 and zone 2 respectively that need urgent repair before rainy season. Series of complaints have been made about these bridges.

15. **Breaking Down of Tractor:** It is highly necessary and urgent to repair the three available tractors for the lifting of water to zones during the dry season for the watering of the young cocoa and kola seedlings.

16. **Bazuki Tricycle:** The division has six (6) bazuki tricycles in which none of them is functioning as at the time of writing this report. The reason being that there is no fund for their repairs.

E. **Running Expenditure Received in the Year 2017**

	N
a. Running of tractor slasher, lawn mower and chainsaw	178,440.00
b. Purchase of diesel and petro for water supply Jan, Feb, March	156,450.00
c. Purchase of petrol for the transportation of field staff to Zones/Nursery	60,900.00
d. Purchase of diesel and petrol for dry season	190,000.00
e. Request for 70 project contract workers	470,000.00
f. Request for constant maintenance of CRIN frontage field	118,480.00
g. TOTAL	**₦1,174,270.00**

F. **Scope for the Future**

- Phase of rehabilitation of old cocoa, kola and cashew plots by gapping up all the empty spaces within the plots by raising seedlings from the cocoa pods in each plots.
- Continuation with the gapping up of the newly established cocoa plots planted within three years in various zones.
- Establishment of plantain and arable crops.
- Gapping up of hedges.
- Rehabilitation of CRIN parental plots at Moor Plantation.

CRIN UHOMORA STATION

HEAD OF STATION: Dr. Adejobi, Kayode Babatunde

Staff Disposition:

Staff list

S/N	NAMES	DESIGNATION	CONRAISS
1	Dr Adejobi Kayode	PRO	11/3
2	Ogiugo Philip	PAS 11	9/2
3	Edibo Gabriel	PAS 11	9/2
4	Asein Oyakhire	HEO	7/1
5	Oaikhena Lydia	AEO	6/9
6	Musa Samuel	WS	6/7
7	Alaba Umahoin	CAFO	6/1
8	Okpaise Idowu	CAFO	6/1
9	Iruobe Elizabeth	SCO	5/4
10	Anijese Funmilayo	SAFO	4/5
11	Onoja Joseph	SMD/M	5/1

S/N	NAMES	DESIGNATION	CONRAISS
12	Ifidon Ikhuosio Teddy	HA	4/5
13	Isokpehi Daniel	AFA I	3/7
14	Kokori Paul	AFA 1	3/5
15	Imumolen Jeffrey	AFA 1	3/5
16	Edeh Simon Tochukwu	AFA 1	3/5
17	Ebiale Benjamen	AFA 1	3/5
18	Nwagala Charles	AFA 1	3/5
19	Amedu Achonu	AFA 1	3/5
20	Evbodaghe Monday	AFA 1	3/5
21	Ejimah Deniss	AFA 1	3/5
22	Ehidiamen Joseph	AFA 1	3/5
23	Jamgbadi Imoudu	AFA 1	3/5
24	Amaize Augustine	AFA1	3/5

Staff work force

The staff strength was twenty four (24) as at 31st December 2017, which was made up of eight (8) Senior staff, sixteen (16) Junior staff (consisting of 5 in Security unit (deployed from the field), 1 in dispensary unit, 1 in Admin. Office, 2 Drivers and 8 Field Staff). Mr. Osoyoba Monday retired on February 15th, 2017.

(2) Land area

The total land area of Uhonmora substation is 268.4 hectares. The total hectares put into use for farming activities is 20 hectares. Out of these 20 hectares, for matured cacao, there are 2 hectares, for growing up cacao, there are 5 hectares. For mature and growing up oil palm, there are 4 hectares. For sole plantains there are 6 hectares, for Cashew 2.5 hectares and 0.5 hectare was used as a pre-nursery and nursery site.

(3) Field and Research Activities

(A). Field Activities and Achievements

(1) Total rehabilitation of 4 hectares of cacao plantations (G1, EI, D1 & Back of office complex plots). The rehabilitation involved total clearing, pruning, removal of mistletoes, replanting of plantain suckers and TC cacao seedlings.

(2) Gapping up of 2 hectares of oil palm plantation for internal generated revenue.

(3) The old and new cocoa plantations were regularly weeded harvested as at when due.

(4) The oil palms in the oil plantation were pruned to provide good aeration for the palm trees for better fruit bunch bearing.

(5) The nursery activities for the fiscal year were increased. About 10,000 cocoa seedlings were raised against the 2018 planting season.

(6) Establishments of 1.5 hectares of TC 6 cacao, 1 hectare of TC4 cacao, 1 hectare of TCs cacao and 1.2 hectares of budded and grafted cacao clones in D1 plot, at the back of office complex, in E1 plot and WCF plot respectively making a total of 5 hectares.

(7) Establishment of 2 .5 hectares of cashew plantation in A1 plot beside the nursery.

(8) Establishment of TC4 cacao on the right and TC6 on the left along the road from the gate to the office premises

(9) Construction and erection of two iron sign posts at the two junctions that lead to the station

(10) Construction and installation of gate at the station main entrance.

(11) Building of modern toilets (2 for male and 2 for female) in the quarters to maintain good hygiene in the institute quarters.

(12) Regular provision of farm tools and inputs for smooth operation in the plots.

(B) Research Activities

1. Cocoa coppicing research was established.
2. Organic cocoa research was established awaiting treatment application.
3. Varietal response of cocoa seedlings to human and animal wastes experiments were designed in the nursery.

PARTICULARS	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	TOTAL
COCOA SEEDLINGS			700,000	120,000									820,000
COCOA BEANS	20,400	35,700								10,000	5,200		71,300
PALM FRUIT					54,000								54,000
PLANTAIN SUCKERS					100,000	100,000							200,000
PALM SEEDLINGS						25,000	100,000						125,000
FRESH MAIZE								20,000	10,000				30,000
DRY MAIZE												10,000	10,000
TOTAL	20,400	35,700	700,000	120,000	154,000	125,000	100,000	20,000	10,000	10,000	5,200	10,000	1,310,300

(4) Achievements

Revenue

Employment: Ten (10) Project Contract Workers were employed to work on the plots while four were employed as security men.

Health: No Drug was supplied to the station dispensary throughout the fiscal year 2017 by the Institute's Management. Notwithstanding, 80 pieces Measles Vaccines were received from Edo State Ministry of Health and were administered to 120 children between age 0-5 in CRIN estate and " One Man Camp". Also, a total of 1,000 Mectizan drug was got from the same state government to prevent and cure River Blindness Disease among 40 households.

Staff Relationship: Inter-personal relationship amongst staffers was very cordial throughout the fiscal year 2017 compared to 2016.

Socials: The staffers of the station organized their end of the year Co-operative Society party in honour of all the members.

(5) Challenges and Constraints

(i) Lack of fund, plans and idea will decay if there is no fund to execute them.

(ii) No security staff, this poses threat to life and properties in the station.

(iii) Inadequate staff for field work, from the very few on ground, one retired on December, 2016 while another one will retire the same month in 2017 and so on. This makes it very difficult to maintain the plantations and other new plots regularly.

(iv) The problem of annual fire outbreak around the plantations.

(v) Inadequate farm inputs and tools like agrochemicals (herbicides, insecticides and fungicides) cutlasses, field coats, rain boats, hoes, wheel barrows, poly-bags, sensitive weighing balance scale, spade, digital veneer calliper, ranging poles, watering cans , sprayers, long sickles .

(vi) Inadequate vehicles/lack of tractor

(vii) Illegal felling of economic trees

(viii) Land encroachment

(ix) Dilapidating buildings (both rest house, offices and quarters)

(x) Lack of toilets for the staff.

(6) **Additional staff request by level**

(I) 1 typist or computer operator.

(ii) 5 Security officers

(iii) 25 field attendants

(7) **Suggestion and way forward**

(I) Adequate funding of Substation: There is need for proper funding of the substation to enable it achieves its set objectives.

(ii) More field attendants (25) should be employed. Employment of 5 security officers is very germane

(iii) Station needs additional 1 tricycle BASUKI for various farm activities.

(iv) Office, rest house and HOS house need to be rehabilitated.

ANNUAL REPORT

OF THE

COCOA RESEARCH INSTITUTE OF NIGERIA, IBADAN

2018

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COCOA PROGRAMME

Experimental Title: Process documentation on indigenous practises utilized by farmers in management of cocoa pests and diseases in Nigeria

Investigator: Orimogunje Alex

Introduction

Cocoa production has been on decline in Nigeria in recent years due to many factors of which pests and diseases incidence play a very significant role. Other causes are transportation problems, lack of primary processing facilities, lack of storage facilities, issue of climate change, inadequate access to agricultural information among others.

Furthermore, there is a new twist to cocoa production in Nigeria with respect to the refusal of Nigeria's cocoa by the European Union and the United States of America because of the use of hazardous chemicals in the production process. This may have contributed indirectly to the relegation of Nigeria from the second highest producers to sixth in the world. To reduce the prevalence of pests and diseases, synthetic chemicals such as Pesticides, Fumigants, Insecticides, Fungicides e.t.c. are used by farmers on the farm and as preservatives. This is especially without the technical know-how or an in-depth knowledge on the usage in terms of dosage, time of use, interval of use and so on. The resulting negative effects of these chemicals are insects/pests developing resistance to the chemicals, mortality of targeted and non-targeted (useful) agricultural pests, environmental pollution, destruction of fresh water habitat leading to loss of various wild-life species, and putting the health of farmers and consumers into jeopardy. Therefore, to improve the production of crops, efforts must be centered on converting to organic method of crops production.

There is a reservoir of valuable and largely untapped indigenous knowledge that could be developed and used to overcome constraints faced by cocoa farmer on diseases and pests in Nigeria. It is unfortunate that despite the importance of indigenous knowledge to cocoa pests and diseases control, it is under-utilized as many cocoa farmers still rely majorly on the modern approaches for controlling pests and diseases, which is hazardous, expensive and not environmental friendly.

It is also worthy of note that indigenous knowledge and information that is being lost could provide basis for many scientific studies and solution to problems of cocoa pests and diseases among farmers in the country

Objective

The general objective of this study was to determine and document the various indigenous knowledge utilized by farmer in managing cocoa pests and diseases in Nigeria.

The specific objectives of the study area are to:

1. determine the personal characteristics of the respondents in the study area,
2. identify the various indigenous method used by cocoa farmers in management of cocoa pests and diseases in the study area,
3. examine the attitude of cocoa farmers toward the use of indigenous knowledge in management of cocoa pests and diseases,
4. identify the various sources of information used by cocoa farmers in the study area,
5. identify the constraints experienced in the use of indigenous knowledge in management of cocoa pests and diseases in the study area,
6. ascertain the level of indigenous knowledge utilization by cocoa farmers in the study area.

Methodology

The research will be carried out in the three states in Nigeria using a multi-stage approach, one state will be purposively selected from the high producing state (Ondo), second from the medium producing state (Ogun), and the third will be random selection of a state from the low producing state (Kogi). Ninety respondents will be selected randomly in the three states, so a total of 270 respondents will be interviewed. A well-structured questionnaire will be used to collect primary information and descriptive statistics and SPSS will be used to analyze the data collected.

Status of Work: On-Going

Comprehensive questionnaires have been developed. The pre-test will soon be carried out to ascertain the validity and the reliability of the questions by using a small sample size.

Experimental Title: Establishment of data bank for cocoa

Investigators: Oduwole, O.O., Oluyole, K.A., Akinpelu, A.O. and Orisasona, T.M.

Introduction

Many quarters have proved that CRIN should be the base for the collection of data on all its mandate crops. Data bank system involves a lot of information collection, generation and modeling to meet the need of various users of information such as farmers, industrialists and other stakeholders for planning of polices and even other research scientists locally and outside for research work. Data bank will be used for networking. It requires careful data collection and management for the needs of the various users of information. What have been collected previously was not adequate but need to be robust to meet the needs of the users. It has to be dynamic to meet up with the agricultural systems.

Methodology

The project was divided into two parts, the desk research as well as the field survey.

(i) Desk research involved the collection of secondary data from relevant organizations such as Nigeria Bureau of Statistics (NBS), Nigeria Export Promotion Council (NEPC) and Nigeria Shippers' Council (NSC). The data collected from these sources were analyzed with the use of descriptive statistics.

(ii) The field survey was carried out in Ondo and Osun States. Two cocoa producing Local Government Areas (LGAs) were purposively selected. From each LGA, one community was randomly selected thus making a total of four LGAs and four communities selected for the study.A total of one hundred and one respondents were randomly selected from the four LGAs. Data were collected from the respondents with the aid of structured questionnaire and the data collected included socio-economic, farm production and labour practices, marketing and sales, health and access to social amenities, government supports, psychological data, agronomic data, weather data, disease and pest data, risk or uncertainty data, pesticides and problems/constraints in cocoa production. The data retrieved from the questionnaire were analyzed with descriptive statistics such as frequencies, percentages, mean and standard deviation.

Results and Discussion

Tables 1- 4 shows the result of the analysis of the data obtained from the secondary sources. Table 1 shows the production trend of Nigeria over a period of 17 years. The table shows a steady increase in cocoa production except in 2015 when there was a sharp drop in the production. The drop was however controversial. Table 2 shows the export value of cocoa beans between 2013 and 2017. Also, there was a sharp drop in 2015 value. Table 3 shows an average yield of Nigerian cocoa farm to be 300kg per hectare. Tables 5-11 shows the result of the field survey conducted in the study area. Table 5 showed that the average age of the respondent farmers was 48.9 years indicating that on the average, some of the farmers are still in the active age. The table also showed that 88.12% of the farmers had formal education. This is a good indicator towards improved productivity as the farmers will be able to read instructions required to adopt any technology. Majority (89.11%) of the farmers were members of socio-economic groups. Out of this, 44.55% of the respondents were members of cooperative societies. Table 6 showed that the average farm size was 4.72 hectares indicating that most farmers in the study area were small scale cocoa producers. The table also showed that cocoa was mostly intercropped with other crops (both tree and arable crops). The result revealed that 45.55% of the farmers intercropped cocoa with arables while 41.58% intercropped with tree crops. Some of the crops intercropped with are kola (31.68%), plantain (21.78%), oil palm (11.88%), cassava (9.90%) and so on. Most (60.57%) of the farmers had F3 Amazon on their farms while 32.39% were still having the old variety (Amelonado) on their farms. However, only 7.04% had Hybrid cocoa on their farms. Agronomic practices were well carried out among the farmers in the study area. The agronomic practices investigated are clearing (100.00%), planting (98.02%), weeding (96.04%), spraying (92.08%), pruning (85.15%) and harvesting (98.02%). Table 7 shows that some of the common insect pests in the study area are termite (24.75%), mirid (16.83%) and grasshopper (16.83%) and some of the chemicals used to control these pests are rocket (21.78%), gamalin (14.85%) and actara (8.91%). Some prevailing diseases in the study area are blackpod (63.37%) and cherelle wilt (6.93%) and the chemicals used to control them are ridomil (43.56%), ultimax (10.89%) and red force (4.95%). The mean cocoa production in the study area per year was 1360.69kg.

Table 8 revealed that majority (81.19%) of the farmers sell their cocoa output to local buying agents. The table also revealed the roles of cooperative/farmer's groups in cocoa

production and it showed that 31.68% of the farmers received financial assistance from cooperative/farmer's groups while 27.72% of the farmers claimed that cooperative/farmer's groups purchase their proceeds from them. The result of the analysis also showed that most (33.66%) of the farmers sell cocoa beans at the rate of N650 per kilogramme while 20.79% sell their produce at the rate of N540 per kg and 19.80% sells their own at the rate of N600/kg. It was revealed in table 9 that 49.50% of the respondent farmers lives in plastered building and 45.54% lives in mud houses. As regards an access to social amenities, satisfactory proportion of the respondents had access to children education (87.13%), health centres (72.28%) and electricity (65.35%). However, only few farmers had access to water facilities (21.78%) and good road network (8.91%). Majority (75.25%) of the farmers exposed to malarial feverdisease and the other diseases exposed to by the farmers are typhoid fever, rheumatism, headache and small pox. Most (44.55%) of the farmers are exposed to accidental cutlass cut and the other farm accidents exposed to by the farmers are snake bite, slippery of the land on farm, fire outbreak, penetration of feet by thorns and so on. Table 10 revealed that majority of the farmers neither had credit support from the government nor have been provided with insurance facility against risks on their farms. However, majority (74.26%) of the farmers pay tax/levy to government and the amount they pay ranges between N200 and N6000. Shown on table 11 are the major constraints faced by farmers in cocoa production. The table revealed that majority of the farmers faced the problem of high cost of agro-chemicals (89.11%), impact of weather on production (85.15%), credit inaccessibility (69.31%), land inavailability (68.32%), labour shortage (65.35%) and lack of improved cocoa varieties (63.37%). Other constraints are lack of storage facilities (54.46%), inadequate marketing channels (51.49%) and incidence of fire outbreak (39.60%). Table 12 shows the determinants of cocoa output. The table shows that of all the factors investigated, only association membership ($p \leq 0.01$) and number of farm locations ($p \leq 0.05$) significantly affected cocoa output.

Table 1. Nigeria cocoa production trends

Year	Production (tons)
2000	145000
2001	149000
2002	141000
2003	184000
2004	195000
2005	195000
2006	184000
2007	222000
2008	242000
2009	254000
2010	236000
2011	236000
2012	225000
2013	238000
2014	248000
2015	195000
2016	200000
2017	225000

Source: NEPC, 2018

Table 2. Nigerian exports of cocoa beans

Year	Export (N)
2013	492,353,469
2014	576,875,024
2015	451,997,825
2016	691,069,207
2017	661,014,631

Source: NEPC, 2018

Table 3. Nigerian cocoa area cultivated and production

Year	Area cultivated ('000ha)	Production ('000MT)
2010	855.82	399.20
2011	1324.00	371.47
2012	1363.60	370.01
2013	1174.60	333.33
2014	1195.03	329.87
2015	1215.81	326.42

Source: NBS, 2017

Table 4. State cocoa area cultivated and production by seasons

State	Year	Area cultivated ('000ha)	Production ('000MT)
Ondo	2010/2011	320.19	91.99
	2011/2012	321.97	92.99
Osun	2010/2011	237.06	71.10
	2011/2012	251.30	74.10
Oyo	2010/2011	107.75	33.57
	2011/2012	109.03	36.06
Ogun	2010/2011	89.84	19.88
	2011/2012	92.76	19.90
Cross River	2010/2011	310.99	71.45
	2011/2012	327.91	69.42

Source: NBS, 2014

Table 5. Socio-economic characteristics of the respondents

Variable	Frequency	Percentage
Age of the farmer (Yrs)		
≤ 30	8	7.92
31-40	27	26.73
41-50	29	26.74
51-60	20	19.80
> 60	17	18.81
Total	101	100.00
Mean 48.9		
Gender		
Male	80	79.21
Female	21	20.79
Total	101	100.00
Marital status		
Single	3	2.97
Married	98	97.03
Total	101	100.00
Level of education		
Non-formal education	12	11.88
Primary education	30	29.70
Secondary education	41	40.59
Tertiary education	18	17.82
Total	101	100.00
Household size		
≤ 4	15	14.85
5-8	64	63.37
9-12	14	13.86
> 12	8	7.92
Total	101	100.00
Socio-economic/Association membership		
Member	90	89.11
Non-member	11	10.89
Total	101	100.00

Source: Field survey, 2018

Table 6. Farm production and labour practices

Variable	Frequency	Percentage
Farm size (Ha)		
≤ 5	74	73.27
5.1-10	18	17.82
10.1-15	4	3.96
15.1-20	4	3.96
> 20	1	0.99
Total	101	100.00
Mean 4.72		
Other crops planted within cocoa plantation		
No response	4	3.96
Cassava	10	9.90
Plantain	22	21.78
Yam	9	8.91
Oil palm	12	11.88
Cocoyam	2	1.98
Maize	2	1.98
Coffee	1	0.99
Kola	32	31.68
Orange	2	1.98
Cashew	5	4.95
Total	101	100.00
Variety of cocoa grown		
Amelonado	33	32.39
F3 Amazon	61	60.57
Hybrid	7	7.04
Total	101	100.00
Source of planting materials		
No response	20	19.80
Self farm	21	20.79
Inherited farm	22	21.78
Friends	13	12.87
CRIN 6 5.94 CFAN	1	0.99
ADP	1	0.99
CDU	13	12.87
Ministry of Agric	3	2.97
Agrodealer	1	0.99
Total	101	100.00
Agronomic practices carried out on farm		
Clearing	101	100.00
Planting	99	98.02
Weeding	97	96.04
Spraying	93	92.08
Pruning	86	85.15
Harvesting	99	98.02
Quantity in kg produced per year		
≤ 1000	63	62.38
1000.1-2000	22	21.78
2000.1-3000	9	8.91
3000.1-4000	1	0.99
4000.1-5000	5	4.95
> 5000	1	0.99
Total	101	100.00
Mean 1360.69		

Source: Field survey, 2018

Table 7. Pest and pest control

Variable	Frequency	Percentage
Common insect pest in cocoa farm		
No response	18	17.82
Locust	2	1.98
Termite	25	24.75
Mirid	17	16.83
Caterpillar	3	2.97
Black ant	3	2.97
Green carpet	8	7.92
Cocoa borer	1	0.99
Sugar ant	3	2.97
Grasshopper	17	16.83
Black bird	1	0.99
Epiphytes	1	0.99
Squirrel	1	0.99
Grass cutter	1	0.99
Total	101	100.00
Chemical used to control the insect pests		
No response	48	47.52
Gamalin	15	14.85
Actara	9	8.91
Axus plus	1	0.99
Matrel	1	0.99
Best	1	0.99
DD force	1	0.99
Rocket	22	21.78
Perfect killer	3	2.97
Total	101	100.00
Cultural methods used to control insect pest		
No response	64	63.37
Cutting/outright felling	1	0.99
Hand picking	4	3.96
Cleaning	22	21.78
Weeding	2	1.98
Salt solution	7	6.93
Alum solution	1	0.99
Total	101	100.00
Common diseases in cocoa farm		
No response	28	27.72
Blackpod	64	63.37
Mirids	2	1.98
Cherelle wilt	7	6.93
Total	101	100.00
Chemical used to control diseases		
No response	37	36.63
Ridomil	44	43.56
Ultimax	11	10.89
Red force	5	4.95
Machesm gold	4	3.96
Total	101	100.00
Cultural methods for controlling diseases		
No response	64	63.37
Pruning	14	13.86
Hand picking	3	2.97
Cleaning	11	10.89
Prompt harvesting	2	1.98
Remove the diseased part	5	4.95
Destroying the affected part	2	1.98
Total	101	100.00

Source: Field survey, 2018.

Table 8. Marketing and sales

Variable	Frequency	Percentage
Who do you sell your output to?		
No response	5	4.95
Local buying agents	82	81.19
Licensed buying agents	14	13.86
Total	101	100.00
Roles of cooperative/farmer's groups to assist cocoa farming		
No response	18	17.82
Purchase of the farm output	28	27.72
Financial assistance	32	31.68
Supplying of inputs	23	22.77
Total	101	100.00
Price of cocoa bean (₦/kg)		
500	9	8.91
540	21	20.79
550	1	0.99
560	3	2.97
600	20	19.80
650	34	33.66
700	12	11.88
750	1	0.99
Total	101	100.00

Source: Field survey, 2018.

Table 9. Health and access to social amenities

Variable	Frequency	Percentage
Types of residential housing system		
Mud house	46	45.54
Un-plastered building	5	4.95
Plastered building	50	49.50
Total	101	100.00
Access to social amenities		
Access to children education	88	87.13
Access to electricity	66	65.35
Access to water facilities	22	21.78
Access to health centres	73	72.28
Access to good road network	9	8.91
What diseases do you normally exposed to?		
No response	14	13.86
Malaria fever	76	75.25
Typhoid fever	1	0.99
Rheumatism	1	0.99
Headache	3	2.97
Small pox	6	5.94
Total	101	100.00
What are the common farm accidents you are exposed to?		
No response	45	45.54
Accidental cutlass cut	44	44.55
Slippery of the land on farm	2	1.98
Snake bite	1	0.99
Fire outbreak	4	3.96
Weakness of the body	1	0.99
Contamination by chemicals via spraying	1	0.99
Penetration of feet by thorns	2	1.98
Falling of tree branches on somebody	1	0.99
Total	101	100.00

Source: Field survey, 2018.

Table 10. Government supports

Variable	Frequency	Percentage
Do you have credit support from government? Yes	2	1.98
No	99	98.02
Total	101	100.00
Are you provided with insurance facility against risk on your farm?		
Yes	6	5.94
No	95	94.06
Total	101	100.00
Do you pay tax/levy to government?		
Yes	75	74.26
No	26	25.74
Total	101	100.00
How much do you pay as tax/levy?		
No response	33	32.67
200	6	5.94
250	3	2.97
300	12	11.88
500	24	23.76
700	1	0.99
750	3	2.97
1000	13	12.87
2500	1	0.99
4000	1	0.99
5000	1	0.99
6000	3	2.97
Total	101	100.00

Source: Field survey, 2018.

Table 11. Constraints in cocoa production

Variable	Frequency	Percentage
What are your major constraints		
Land inavailability	69	68.32
Lack of mproved cocoa varieties	64	63.37
Credit inaccessibility	70	69.31
High cost of agro-chemicals	90	89.11
Inadequate marketing channels	52	51.49
Lack of storage facilities	55	54.46
Labour shortage	66	65.35
Incidence of fire outbreak	40	39.60
Impact of weather on production	86	85.15

Source: Field survey, 2018.

Table 12. Determinants of cocoa output

Variables	Coefficient	P-values
Constant	- 2073.35	0.35
Level of education	- 198.78	0.20
Household size	54.99	0.24
Association membership	1454.14	0.001
Farm size	1.38	0.92
Access to credit facilities	29.83	0.96
Number of farm locations	217.91	0.04
Payment of tax	-0.02	0.86

Source: Field survey, 2018.

Experimental Title: Effective weeding regime for field establishment of new varieties of cocoa (*theobroma cacao* l.) in two contrasting ecologies.

Investigators: Idrisu M., Famaye A.O., Oloyede.A.A. Adejobi.K.B., Adeosun. S.A., Ugioro O, Nduka B.A and Baba-Nitsa M.

Introduction

Weeds are undoubtedly one of the major factors limiting crop cultivation. Weeds compete directly with the plant for growth factors such as water, nutrients, light and space. Weeds, like diseases, insects and other pests are a serious and severe constraint in crops. In West Africa, estimated yield losses due to weed may be greater than those due to other plant pests and diseases. With the above therefore, an improvement on weed management system that can be easily practiced and can be readily available to the farmers to learn with emphasis on the use of weed competitive cocoa cultivars is necessary. This would reduce labour, bring higher return on cost of production, and promote sustainable cocoa production in smallholder farms in Nigeria. This can be achieved through the development of effective weeding regime using one of the mechanical techniques (slashing to the ground level with cutlass).

Objective

The objective of this study is to improve cocoa production through effective weeding, assess the level of weed tolerance of some of the cocoa varieties under study, and have knowledge of the important weeds affecting cocoa seedlings and their level of infestation.

Materials and methods

The experiment is conducted on the research farm of CRIN headquarters and Owena substation on a split plot using a Randomised Complete Block Design (RCBD) replicated 3 times. The main plot treatments comprise the varieties of cocoa (CRIN-Tc1, Tc2 & F3 amazon) and the sub-plot treatments house 6 periods of weed interference. Plots were kept weed free and weed infested for 1, 2, 3 and 4 months after transplanting with two control treatments (5 and 6). Plantain is used as a shade crop in between the cocoa stands a year before cocoa seedlings were transplanted. Cutlass is being used for weeding by slashing the weeds to the ground level in accordance to the treatments monthly.

Work Done

The project is ongoing. However, the following activities have been carried out in both locations: Site selection and initial soil sampling, Felling /clearing of trees, pegging and holing. The 3 varieties of cocoa and plantain suckers have been planted.

Weed sample data and that of morphological parameters on cocoa collected from June to October 2018 are ready and being process for statistical analysis. The initial soil sample and weed samples collected is also being prepared for analysis.

However, some of the preliminary weed flora composition in both locations is as shown in the table below:

Conclusion: - About 40% of the work has been done and more fund is needed to complete the project.

Composition of weed flora at the experimental site

Plant family	WEED TEXA	Growth form
Poaceae	*Oplismenus burmanii* (Retz) P. Beauv.	AG
Asteraceae	*Synedrella nodiflora* Gaertn	ABL
Acanthaceae	*Asystasia gangetica* (Linn.) T. Anders	ABL
Urticaceae	*Pouzolzia guineensis* Benth.	ABL
Asteraceae	*Ageratum conyzoides* Linn.	ABL
Convolvulaceae	*Ipomea triloba* Linn.	ABL
Poaceae	*Digitaria nuda* Willd.	AG
Commelinaceae	*Commelina benghalensis* L.	PSp
Commelinaceae	*Commelina diffusa Burm*. f.	PSp
Leguminosae-papilionoideae	*Desmodium scorpiurus* (Sw.) Desv.	PBL
Euphorbiaceae	*Phyllanthus amarus* Schum. & Thonn.	AB
Portulacaceae	*Talinium triangulare* (jacq.) Willd.	PBL
Poaceae	*Rottoboellia cochinchinensis* (Lour.) Clayton	AG
Urticaceae	*Laportea aestuans* (Linn.) Chew.	ABL
Amaranthaceae	*Cyathula prostrata* (L.) Blume	ABL
Cyperaceae	*Mariscus alternifolius* Vahl.	PS
Piperaceae	*Peperomia pellucida* (L.) H.B. & K.	ABL
Poaceae	*Brachiaria deflexa* (Schumach.)	AG
Poaceae	*Panicum maximum* Jacq.	PG
Commelinaceae	*Aneilema aequinoctiale* (P. Beauv.) Kunth	PSp
Euphorbiaceae	*Alchornea laxiflora* (Benth.) Pax & K. Hoffm.	PBL
Malvaceae	*Sida garckeana* Polak.	PBL
Poaceae	*Setaria barbata* (Lam.) Kunth	AG
Poaceae	*Axonopus compressus* (Sw.) P.Beauv.	PG
Amaranthaceae	*Alternanthera pungens* H. B. & K.	PBL
Leguminosae:caesalpinioideae	*Chamaerista mimosoides* (L.)Greene	A/PBL
Fabaceae	*Centrosema pubescens* Benth. (Schultze-Kraft)	PBL
Poaceae	*Digitaria horizontalis* Willd.	AG
Cucurbitaceae	*Momordica charantia* Linn.	PBL
Euphorbiaceae	*Mallotus oppositifolius* (Geisel) Mull. Arg.	PBL
Moraceae	*Fiscus exasperata* Vahl.	PBL

Plant family	WEED TEXA	Growth form
Poaceae	*Oplismenus burmanii* (Retz) P. Beauv.	AG
Asteraceae	*Synedrella nodiflora* Gaertn	ABL
Acanthaceae	*Asystasia gangetica* (Linn.) T. Anders	ABL
Urticaceae	*Pouzolzia guineensis* Benth.	ABL
Asteraceae	*Ageratum conyzoides* Linn.	ABL
Convolvulaceae	*Ipomea triloba* Linn.	ABL
Poaceae	*Digitaria nuda* Willd.	AG
Commelinaceae	*Commelina benghalensis* L.	PSp
Commelinaceae	*Commelina diffusa Burm*. f.	PSp
Leguminosae-papilionoideae	*Desmodium scorpiurus* (Sw.) Desv.	PBL
Euphorbiaceae	*Phyllanthus amarus* Schum. & Thonn.	AB
Portulacaceae	*Talinium triangulare* (jacq.) Willd.	PBL
Poaceae	*Rottoboellia cochinchinensis* (Lour.) Clayton	AG
Urticaceae	*Laportea aestuans* (Linn.) Chew.	ABL
Amaranthaceae	*Cyathula prostrata* (L.) Blume	ABL
Cyperaceae	*Mariscus alternifolius* Vahl.	PS
Piperaceae	*Peperomia pellucida* (L.) H.B. & K.	ABL
Poaceae	*Brachiaria deflexa* (Schumach.)	AG
Poaceae	*Panicum maximum* Jacq.	PG
Commelinaceae	*Aneilema aequinoctiale* (P. Beauv.) Kunth	PSp
Euphorbiaceae	*Alchornea laxiflora* (Benth.) Pax & K. Hoffm.	PBL
Malvaceae	*Sida garckeana* Polak.	PBL
Poaceae	*Setaria barbata* (Lam.) Kunth	AG
Poaceae	*Axonopus compressus* (Sw.) P.Beauv.	PG
Amaranthaceae	*Alternanthera pungens* H. B. & K.	PBL
Leguminosae:caesalpinioideae	*Chamaerista mimosoides* (L.)Greene	A/PBL
Fabaceae	*Centrosema pubescens* Benth. (Schultze-Kraft)	PBL
Poaceae	*Digitaria horizontalis* Willd.	AG
Cucurbitaceae	*Momordica charantia* Linn.	PBL
Euphorbiaceae	*Mallotus oppositifolius* (Geisel) Mull. Arg.	PBL
Moraceae	*Fiscus exasperata* Vahl.	PBL

Experimental Title: Empirical establishment of the productivity of CRIN cocoa hybrids tc1-8 in Nigeria.

Investigators: Lawal, J.O., Adedeji, A.R., Famuyiwa, B.S., Orisasona, T.M., Aiyegboyin, K. O and Taiwo, O.A

Introduction
Cocoa is an important crop of commerce to the Nigerian economy. In Nigeria, cocoa occupies about 0.6million hectares, the average cocoa yield in West Africa is 0.5tonnes/hectare while for Nigeria it is around 0.4tonnes/ha. This suggests that yield in Nigeria is still low compared to the world average. This yield figures are affected by vagaries of weather/climate change, pests' infestation, ageing trees, irresponsive use of chemicals, non-adoption of hybrid varieties and also aged farmers with poor involvement of youths in the cocoa business. This study sets to empirically determine and establish the yield parameters of the new hybrids developed at CRIN which are resistant and tolerant to some of the aforementioned factors.

Objectives

1. To establish the actual number of dry beans per kilogram
2. To evaluate average number of cocoas beans in a pod
3. To determine the number of pods that make a kilogram dry cocoa beans
4. To estimate number of pods per tree per hectare per year.

Methodology
The study will be carried out in Cross river, Ondo and Oyo states. Where 3 local government areas per state will be sampled. Five farms will be selected randomly from the list of farmers that got the Hybrid CRIN TC1-8 seedlings from each local government area; and it is from these farms that the samples and records will be taken to achieve the objectives of the study. Data will be collected over two seasons in two years and analyzed for report and documentation.

Results and Discussion
The study is ongoing with site identification at Cross Rivers state.

Conclusion
It is better the study is made multi-locational so that conclusion can also be made as regards environmental and locational effects on the yield and production of the hybrid cocoa series.

Challenges
The major challenge of this study is the paucity of funds to carry out the study in all locations we have initially proposed.

Status
Ongoing (Cross Rivers State)

Future plan
To extend the study to Ondo and Oyo State in the 2109 research proposal grant.

Experimental Title: Cocoa farm households training on record keeping and input use efficiency in Nigeria.

Investigators: (Taiwo, O.A., Lawal J.O., Oduwole, O., Obatolu. B.O., Yahaya A.T, Akinpelu, A. and Orisasona T.M.)

Introduction
The importance of the efficient use of inputs and farm record keeping among cocoa farm household in Nigeria cannot be over emphasized; however, it is disheartening to note that from lot of field works and surveys been conducted in Nigeria, the record keeping habits of cocoa farmers is very poor generally. Recent studies carried out by Lawal and Orisasona (2016) found that the elasticity of cocoa production is 1.2134 which indicated that a 1% increase input use will lead to more than one percent proportion change in the output of cocoa. Nkamleu (2004), in his study also indicated that there is a shortfall in cocoa production due to production inefficiency in the use of inputs by farmers growing cocoa. They concluded that improving the managerial skills and technical capacity of farmers is crusial for productivity**.** By implication therefore, training of farmers on basic record keeping and efficient use of scarce resource inputs is germane for sustainability of cocoa production and the value chain in Nigeria.

Objective
The training is aimed at improving the managerial skills of the cocoa farmers on the efficient use of inputs and proper record keeping for their cocoa farms. This will ultimately enhance and sustain cocoa production in Nigeria.

Methodology
Three states are purposely selected namely, Ondo, Osun and Cross River State. However, for paucity of funds Ondo state is selected as a pilot state. In each of the States, Two Local Government Areas will be randomly selected where their cocoa farmers' association /cooperatives will be grouped for the training using training manual and projectors to show slides where necessary. The training duration shall be for four days each for Ondo and Osun while a week (including travels) will be used for Cross River state. Certificate of participation will be awarded to the participants.

Conclusion
Questionnaires have been developed and contacts made for the training in the pilot state.

Challenge(s)
Funds to replicate the training in the other high cocoa producing states to help boost production and production recordkeeping.

Status: Ongoing (Ondo state)

Future plan
To get more funds to move the capacity building training to states like Cross Rivers and Osun in the 2019 research proposal grant. This is in order to ensure farmers begin the normal practice of record keeping and proper input use for increased and sustainable production and documentation in the producing states.

Experimental Title: Assessment of Insect Prevalence in Cocoa Storage in South-Western Nigeria: Prospect for Botanical Control.

Investigators: Olorunmota, R.T; Ogundeji, B A and Mokwunye, I.U

Introduction
Assessment of cocoa bean quality in the international trade is based on a number of factors among which are percentage of mould, flat, slaty, purple, germinated and insect infested beans. Amongst others, beetles and moths are common insect pests of stored cocoa beans. Beetles like *Lasioderma serricone* (Fab), cigarette beetle and *Araecerus fasciculatus* (Deg) coffee bean weevil pierce shell of cocoa bean thus creating access for tropical warehouse moth *Ephestia cautella* and mould (Jonfia-Essien, 2001, 2004) Chemical control of stored products insect pests being the most efficient and effective means in the protection of stored produce is associated with many negative impacts of incredible magnitude on human health. There is a need therefore to provide safe and environmentally friendly alternatives to minimize insect pests whose activities promote mould growth in stored cocoa beans.

Materials and methods
An assessment of insect prevalence in two cocoa stores in Oyo and Ondo states would be carried out. Collection of insect from cocoa beans in stores would be done by sieving using 0.4 mm sieve. Identification of collected insects would be made and a bioassay will be carried out against the commonest insect pest in the stores using powders of *Aframomum melegueta, Piper guinensis and Azadiracta indica*. Treatments will be applied at three levels of 1g, 2g, 3g/kilogram of dried cocoa beans in three replicates. A standard control using Aluminium phosphide and a no treatment control will be set up and replicated three times.

Status: Ongoing

Experimental Title: Cherelle Wilt Disease

Investigators: Adedeji, A.R. and Otuonye, A.H.

Introduction
The cocoa tree, an understory tree crop that belongs to the Malvaceae, is of considerable economic importance to the producing countries and chocolate or cocoa product based companies of the Western Nations. The recent discovery of the health benefits of the polyphenols and flavonoids in processed cocoa products as a good antioxidant has led or resulted in increased demand for cocoa-based products around the world. With this development, meeting the local and international demand has become a herculean task for the producing countries of Western Africa that supply between 70-80% of processed raw bean which is an industrial raw material for finished cocoa products such as cocoa mass, used in making chocolate, biscuits, and confectioneries. Furthermore, obtained from the commercial bean seed are melted cocoa, intended for various food industries for sweetening products. Cocoa butter is used in making sweets, perfume, pharmaceuticals and finished products that include, cocoa cake and various chocolate-based products, among others. Although having these benefits, obtaining an optimum yield from cacao is faced with serious challenges. Chief among these factors that affect cocoa production is the plethora of cacao

diseases, soil, and climatic conditions prevailent in the humid tropics where the perennial tree crop is grown. This hinder genetic yield potential of the tree crop. Cacao pathogens reduce the potential crop by an estimated 810,000 tons annually (30% of world production) and individual farm losses can approach 100%, (Guiltinan, 2007). The pathogenic organisms, soil microflora, fauna and plant nutrients in the tropics are variable due to the inconstant weather conditions of the tropics. The weather could be hot with low relative humidity and then suddenly change becoming cloudy with accompanying heavy rainfall that could results to leaching down and washing off of soil nutrients, microflora and fauna. The rainfall also results in reduced temperature and high relative humidity of over 90%. This development affects the physiology of the cacao plant and encourages the infection and thriving of diseases of which cherelle wilt has suddenly become an important limiting factor to the cacao production in Nigeria. Matured cacao plant of fruit-bearing age produces abundant flowers of which only 0.5 to 5% set fruits that become young *Theobroma cacao* pods, known as cherelles. These young fruits are commonly lost to physiological thinning known as cherelle wilt, although some evidence is now available that indicates other possible causes that include abiotic such as sunscald and drought and biotic such as insect pest and disease causing pathogenic organisms. Between 20-90% of cherelles (young fruit) produced by a cacao plant can be lost to cherelle wilt. Cherelle wilt was considered a physiological thinning mechanism involving vessel occlusion in the cherelle peduncle (Melnick et al., 2013) but other possible causes have also been adduced of which diseases causing organisms such as *Phytophthora* species, *Moniliophythora roreri*, *Lasiodiplodia theobromae*, *Fusarium* species among others have been implicated, (Thorold, 1975: Opeke, 1992: Melnick et al., 2013). Symptoms manifest when wilting cherelles stop growing, turn yellow after a week, turn blackish-brown, and mummify remaining attached to the tree (Melnick, et al., 2013). Peak wilt occurs 50 days after pollination followed by a second stage occurring around 70 days after pollination (Melnick, et al., 2013). Biotic factors, such as insect pest and disease causing organisms, can also cause loss of cherelles. Cacao insects such as adult menbracid and adult tree hoppers has been shown to cause 40% cherelle wilt (Bartolome, 1954). Other factors such as hormonal influence and defiency of certain essential nutrient elements such as potassium, nitrogen, calcium, magnesium, copper, manganese, zinc and boron coincides with high cherelle wilting, (Kasran et al., 1991). This study therefore was initiated to study factors responsible for the different types of cherelle wilt in the cacao field in order to be able to proffer effective management measures to increase production and to update the results of previous research in the face of changing climate.

Materials and Methods

As a result of the complaint of cacao farmers that reached the Institute in 2017, on a continuous heavy losses of cocoa to cherelle wilt since 2014, with the year of report of incidence witnessing the highest, a team of scientists from the Institute from various disciplines was assigned with the responsibility of ascertaining possible remote causes and management options available to proffer to farmers. The cocoa-producing states of the country were divided into 3 cacao producing agro-ecological zones and from each zone, a state(s) with high cherelle mortality according to reports and preliminary study conducted was selected. This resulted in the selection of Oyo, Osun and Ondo states in the West, Abia state in the South East, Cross River and Akwa Ibom states in the South-South for survey. However, due to limiting fund, the South-South states and Oyo could not be covered. In the states covered, three local government areas (LGA's) were selected starting with the localgovernment with the highest production, followed by the next, and the third one, with marginal production. Within these LGA's, three cocoa farming communities per LGA and a cocoa farm per community were randomly selected and surveyed. Three cacao trees were selected. Soil samples were collected at different depths around the rhizosphere that is close to the cacao plant stand and three spots farther from the stand around the canopy. Leaves and diseased sample cherelle were also collected from the cacao plant and put in Ziploc plastic bags and labeled properly. Insect pests were also sampled and collected. GPS reading of the farms and selected cacao plant stands were also taken. Other data obtained includes count of disease and healthy cherelle per tree (disease severity index), status of farm (neat, weedy or abandoned), terrain (sloppy or flat), nearness to body of water (water- logging during and after rainy season), types of vegetation around and within the farms (insight into nutrient status of the soil) and other insect pest and disease problems. Questionnaires were further distributed to 20-25 farmers per community to obtained further information.

Pathological Analysis of Diseased Pod Samples from the States Surveyed

The diseased pod samples obtained were taken to the plant

pathology section laboratory at CRIN headquarters and pieces of lesion sections excised from the cherelle pods were then plated after normal laboratory routine on extract of Potato Dextrose agar (PDA) medium (per liter: 200g peeled and sliced *Solanum tuberosum*, 15g agar powder, 20g dextrose, 10% solution (Streptomycin antibiotics) in 9cm diameter disposable plastic Petri-dishes at 3 pieces per dish for the 3 replicates dishes/per cherelle pod collected. Emerging hyphae were transferred by hyphal tip on to new PDA plates to obtain pure cultures. Morphological data were taken of relevant colony cultural characteristics (pigmentation, colony appearance top and bottom of plates and conidia or spore structure under x100 and x400 objectives of Olympus microscope mounted with scope 9.0 digital imagery camera) to described them. The isolates after the morphological study was sent to CABI, UK for molecular analysis.

Pathogenicity Test of the Fungal Isolates

Pathogenicity was conducted on the fungal isolates obtained from the various states surveyed to see fungal isolates that will produce the same symptom(s) observed in the field.

Statistical Analysis

Percentage colony count of the organisms was done using Otuonye *et al*., (2014) formula, while percentage disease severity index was calculated by dividing the total infected cherelle over total number of pods (both healthy and disease) then multiply by 100

Results

Table 1, shows percentage disease severity index obtained per state surveyed and frequency of occurrence of disease organisms as showed by the percentage colony count. The percentage disease severity index indicates that Ondo state had 94.23% followed by Abia with 73.35%, Table 1. Frquency of isolation showed that *Lasiodiplodia* spp had the higest percentage occurrence of 64.4%, 56.0% and 49.6% in Ondo, Abia and Osun states respectively, while *Fusarium* spp with 51.8%, 50.3% and 46.3% respectively, followed (Table 1). Pathogenicity test conducted of the the fungal isolates implicated *Lasiodiplodia* spp and *Fusarium* spp. Results of molecular identification from CABI, idenified, *Lasiodiplodia* spp, *Fusarium* spp-(*Fusarium solani* species complex, *Fusarium decemcellulare*), *Aspergillus* section *nigiri*, *Colletotrichum gloeosporioides*, *Bionectriaceae*, *Trichoderma ovalisporum*. Based on the pathogenicity test and identification by CABI, it is obvious that *Fusarium solani* species complex, *Fusarium decemcellulare*, *Lasiodiplodia* spp and *Bionectriaceaei* have been implicated elsewhere to be wilt pathogen of cocoa organs and several plant host.

Conclusion

The high disease severity index from the states surveyed shows that cherelle wilt could be exerbated by pathogenic organisms aided by some soil factor, management practices and prevailing climatic condition of the area involved.

Challenges

Fund limitation and difficult terrain of areas surveyed

Status: On-going

Future Plans: Conclusion of survey of listed states and field trials of pathogenicity test fungal isoaltes in three cocoa agroecological zones of some management options to control cherelle wilt

Table 1. Percentage Disease severity index and frequency of isolation of fungal isolate

State Surveyed	% Disease severity Index	% frequency of fungi isolated from infected cherelle pods														
		Lasiodiplodia spp	Aspergillus niger	Fusarium species	Rhizopus nigircans	Trichoderma spp	Colletotrichum	Botrytis spp	Aspergillus spp	Pythium spp	Curvularia spp	Penicillium spp	Yeast	Streptomyces	Fusarium Oxysporium	Neurosopora spp
Abia	72.35	56.0	17.0	50.3	-	-	-	-	-	22.3	-	6.10	31.0	9.55	-	2.87
Osun	68.16	49.6	8.11	46.3	2.10	7.11	9.01	-	2.34	11.0	-	1.00	-	-	8.42	-
Ondo	94.23	64.4	11.1	51.8	48.1	3.70	22.2	25.9	7.40	3.70	22.2	3.70	-	-	14.8	-

Experimental Title: Field evaluation of cocoa pod husk biochar fortified with fertilizer on cocoa yield and soil physiochemical properties

Investigators: Ogunlade, M. O., Asowata F.E., Akanbi, O. S. O., Iloyanomon, C., Daniel, M. A., Adebowale, L. A., Taiwo, N., Ibiremo, S. O, Ipinmoroti, R. R., and Adejobi K.A

Introduction

Soil degradation and low soil fertility are among the causes of low cocoa productivity. Most tropical soils including those in Nigeria are inherently infertile due to dominance of low activity clay types, high acidity, low organic matter and low cation exchange capacity (Babalola 2002). Use of organic materials whether applied alone or in combination with mineral fertilizer decompose very fast under the prevailing climatic conditions such that their benefits are often for a short period (Bol et al. 2000). Biochar technology is an emerging and very promising way of meeting the challenges of soil fertility and organic matter maintenance in the tropical. Therefore, the objectives of this study is to evaluate the effects of fertilizer and its combination with biochar on cocoa yield and some soil properties.

Materials and Methods

The field experiment is carried out in Ibadan and CRIN substation at Uhomorah.

Four treatments

((1). 0.5ton/ha biochar plus inorganic fertilizer at soil test level,

(2). 1ton/ha biochar plus inorganic fertilizer at soil test level,

(3). Inorganic fertilizer alone at soil test level and

(4). Control without fertilizer application is being evaluated in this trial.

The treatments were replicated three times in a Randomized Complete Block Design (RCBD) and data on cocoa and bean yield will be taken for two years. Effects of treatments on some soil properties will also be determined. Data will be statistically analyzed and means separated with Duncan multiple range test.

Project Status: Ongoing

Expected outputs Improved soil productivity Enhanced cocoa yield.

Additional Funds of N 2,900,000 is needed to complete this project.

Experimental Title: Complementary Shade Effects on Fiel Establishment of Cacao.

Investigators: Adeyemi, E.A., Ogunlade, M.O. and Oloyede, A.A.

Introduction

Plantain is recommended as shade/nurse plant in the establishment of *Theobroma* Cacao. Because of the present changes in climate, plantain no longer provides adequate shade for T. c*acao* especially in the dry season. This results in low establishment which may be less than

30% in some cases. It is therefore imperative to source for plant(s) that will complement the shade from plantain in-order to achieve higher field survival of T. c*acao* for better establishment.

Objectives

To identify complementary shade plant(s) to plantain for improved *T. cacao* field establishment To increase field establishment of *T. cacao* to not less than 70%. To evaluate the impact of the complementary shade plant(s) on soil nutrient dynamics

Methodology

The land area used is 1080 m^2. Land preparation was done by manual weed clearing and felling of trees. Pre-cropping soil sampling was made for analysis so as to determine the initial soil nutrients status of the site. Layout of the experimental site was done by pegging at 3.0 m x 3.0 m each for *cacao* and plantain. Complimentary shade plants used were pigeon pea and *Gliricidia sepium*. Pegging for complimentary shade was 3.0 m apart along the line of *cacao*. There were three treatment combinations namely:
cacao + plantain (control) *cacao*
+ plantain + pigeon pea *cacao* +
plantain + *Gliricidia*
The treatments were replicated three times in a randomized complete block design (RCBD). The shade crops were planted in July 2018 along with cacao transplanting. Weed control was achieved through the combination of manual (use of cutlass) and chemical (systemic herbicide) methods. Morphological data (plant height, stem diameter, number of leaves and leaf area) collection on *cacao* commenced at four months after transplanting. Data were analyzed using ANOVA and means separated with Duncan multiple range test DMRT at 5% probability.

Results and Discussion

Total nitrogen content of the soil is inadequate (Table 1), compared with the critical value of 0.9 g/kg, and will require nitrogen fertilizer supplementation. The pH value of 7.47 placed the soil at a neutral state which will likely enhance nutrient availability to the transplanted cocoa by eliminating the risk of nutrient fixation

Table 1: Pre-cropping physical and chemical properties of cocoa soil

Soil property per	Unit	Value
N	g/kg	0.10
OC	g/kg	1.34
pH (H_2O)		7.47
P	mg/kg	4.81
Na	cmol/kg	0.27
K	cmol/kg	0.38
Ca	cmol/kg	8.45
Mg	cmol/kg	0.10
Mn	mg/kg	60.50
Fe	mg/kg	5.85
Zn	mg/kg	7.36
Cu	mg/kg	0.50
Sand	g/kg	792
Silt	g/kg	154
Clay	g/kg	54

Available P of 4.81 mg/kg is lower than the critical value of 10 mg/kg soil. There will be the need to add phosphorus to the soil for proper development of the *cacao* seedling. Exchangeable K content of the soil is sufficient for *cacao* cropping. This is because the value obtained is higher than the critical value of 0.3 cmol/kg soil. Likewise, the calcium content is adequate for cropping *cacao*. The sand, silt and clay contents placed the soil as sandy loam. The height of *cacao* seedlings ranged from 41.1 – 45.0 cm at 4 MAT (Table 2). The height was highest in *cacao* + plantain+ pigeon pea and least in *cacao* + plantain + *Gliricidia*. Similar trend was observed at 5 MAT. The order of seedling height at 7 MAT was pigeon pea treatment > *Gliricidia* > control. Percentage increase in seedling height on monthly basis was 2.2, 8.7 and 10.0 in the control treatment; 7.1, 17.4, 14.5 in pigeon pea treatment and 10.0, 10.2, 21.1 in *Gliricidia* treatment.

Table 2: Effects of complimentary shade on plant height of *cacao* seedling in the field

Treatment	Plant height (cm)							
	4	5	6	7	8	9	10	11
	MAT							
Cacao+Plantain	44.8	45.8	49.8	54.8	62.3	65.3	65.4	76.8
Cacao+Plantain+ Pigeon pea	45.0	48.2	56.6	64.8	67.0	70.3	71.8	73.7
Cacao+Plantain+Gliricidia	41.1	45.2	49.8	60.3	61.3	66.5	67.2	79.0
DMRT (p≤0.05)	ns	ns	ns	ns	ns	ns	ns	ns

Legend - *MAT = Months after transplanting*

In Table 2, *cacao* in the control treatment had the least growth rate. Higher growth rate in pigeon pea and *Gliricidia* treatments could be as a result of some additional shade provided, couple with ability of the pigeon pea and *Gliricidia* to fix atmospheric nitrogen to enhance the fertility of the soil to the benefit of *cacao* planted in these two treatments. The difference was not significant ($p \leq 0.05$) probably because the seedlings were still young and the shade plants had not been fully established. The trend was maintained till 11MAT.

Table 3: Effects of complimentary shade of stem diameter of*cacao* seedling on the field

Treatment	Stem diameter (cm)							
	4	5	6	7	8	9	10	11
	MAT							
Cacao+Plantain	0.87	1.01	1.13	1.17	1.21	1.34	1.52	1.64
Cacao+Plantain+ Pigeon pea	0.87	1.15	1.33	1.46	1.53	1.69	1.79	1.92
Cacao+Plantain+Gliricidia	0.82	1.07	1.21	1.25	1.31	1.43	1.55	1.85
DMRT (p≤0.05)	ns	ns	ns	ns	ns	ns	ns	ns

As observed in *cacao* plant height, the stem diameter was least generally in the control treatment and greatest in the pigeon pea treatment (Table 3). The growth rate in seedling stem diameter under the various shade treatments ranged from 0.82 to 0.87 cm at 4 MAT. Percent increase in the stem diameter from 4 to 7 MAT were 34.4, 67.8 and 52.4 for control, pigeon pea and *Gliricidia* treatments respectively The highest percent increase was obtained in *cacao* with pigeon pea. The difference was not significant ($p \leq 0.05$) probably due to the reasons adduced for the plant height. The trend persisted until 11 months after transplanting. The number of *cacao leaves* followed similar pattern as observed in plant height and stem diameter with highest number of leaves in pigeon pea treatment > *Gliricidia* > control throughout the periods of observation (Table 4). The difference was not significant ($p \leq 0.05$) as observed in plant height and stem diameter. Similar trend occurred until 11 MAT

Table 4: Effects of complimentary shade on number of leaves of cacao seedling on the field

Treatment	Number of leaves							
	4	5	6	7	8	9	10	11
	MAT							
Cacao+Plantain	18.5	14.0	13.0	20	17.5	18.0	18.5	24.3
Cacao+Plantain+ Pigeon pea	18.8	19.8	20.5	29	22.2	22.3	21.2	27.8
Cacao+Plantain+Gliricidia	17.8	15.2	16.3	26	24	32.2	36.3	42.7
DMRT (p≤0.05)	ns	ns	ns	ns	ns	ns	ns	ns

With respect to leaf area of cacao seedling, the control treatment had the highest leaf area at the 4 and 5 MAT but the pigeon pea complimentary shade treatment assumed its leading status as from 6 MAT and maintain it at 7 MAT (Table 5). The difference in leaf area was not significant ($p \leq 0.05$) as reported earlier for other growth parameters. This was the situation until 11 MAT

Table 5: Effects of complimentary shade on leaf area of cacao seedling on the field

Treatment	Leaf area (cm^2)							
	4	5	6	7	8	9	10	11
	MAT							
Cacao+Plantain	105.19	95.8	77.06	84.1	99.8	97.13	93.7	103.2
Cacao+Plantain+ Pigeon Pea	73.46	88.75	95.60	103.4	99.7	89.92	90.2	98.6
Cacao+Plantain+Gliricidia	65.48	65.26	78.24	79.9	67.38	113.58	98.8	116.9
DMRT ($p \leq 0.05$)	ns	ns	ns	ns	ns	ns	ns	ns

Status: On-going

Conclusion

The combination of cacao + plantain + pigeon pea seemed promising for enhanced growth and establishment of cacao in the field

Future Plan: Soil sampling on treatment basis and analysis will be done to assess the soil nutrient dynamics in each treatment

Experimental Title: Pesticides Residue Assessment and Safety Standard of Cocoa Beans in Nigeria

Investigators: Agbeniyi, S. O., Famaye, A. O., Adedeji, A. R., Ogunwolu, S. O., Ogunlade, M. O., Orisajo, S. B., Lawal, J. O., Ayegboyin, K. O., Okeniyi, M. O., Adejobi, K. B., Adeniyi, D. O., Oyedokun, A. V., Asogwa, U., Otuonye, A. H., Mokwunye, I. U., Famuyiwa, S. B., Kolawole, O. O., Asowata, F. E., Ogundeji, B. A. and Olorunmota, R. T.

Introduction

Cacao, like many other economic crops, is faced with the challenges of pests and diseases across the regions where it is being grown. An estimated 30 to 80% loss due to diseases and pests has been recorded across various localities. The implication of this is that approximately $2 billion is lost annually by cocoa farmers across the globe to the problem of pests and diseases. These losses no doubt, have impacts throughout the cocoa supply chain, and are concentrated more on the already impoverished farmers. In a bid to curb the devastating effects of pests/diseases, cocoa farmers have resorted to the use of synthetic pesticides (sometimes indiscriminately) across the growing communities mainly because of their quick, effective action (Adejumo, 2005). This has however led to the heavy pollution of plantation environments including the underground waters, nearby rivers/streams, and the disruption of the ecosystem (due to the non-selective nature of the chemicals). The problems of development of resistance by pests/pathogens, persistence of the chemicals, and the attendant health hazards on farmers as well as consumers of the crop and/or its by-products have also come to the fore (Ambang *et al.,* 2010; Daxl, *et al.,* 1994). In spite of the many health benefits of cocoa and cocoa products, there are still safety worries in respect to the occurrence and levels of heavy metals such as cadmium (Cd), chromium (Cr), nickel (Ni) and lead (Pb) in cocoa and cocoa products. It was reported by Rankin *et al*. (2005) that cocoa and cocoa products from Nigeria contains high amount of lead (Pb) ascribable to pesticides usage. The discovery of high pesticide residue in crops, particularly cocoa beans exported from Nigeria, has led to their rejection at the international market. In fact, the European Union (EU) had given the Nigerian government a June 16, 2016 deadline to put a management system in place to reduce pesticide contaminated food products the country exports to the region or face continued rejection of exports (Ogbebeo and Okeke, 2015). This no doubt, will bring great losses to the farmers, discourage the practice of Agriculture and in the long run, impart negatively on the nation's economy. In view of the above, this study aims to determine the degree of synthetic pesticides usage by cocoa farmers across growing states in Nigeria and its resultant effect on the heavy metal residues in the crop's beans and surrounding soils.

Methodology

A. Physicochemical/heavy metal analyses

Soil samples were collected from randomly selected cocoa farms and adjacent forests from three cocoa producing local government areas in Abia, Akwa Ibom, Cross River and Edo States. The samples were separately taken at 0-20cm (top soil) and 20-40cm (sub-soil) depths with the aid of a soil auger. Six (6) core soil samples were randomly collected at about 6m intervals within each plantation to obtain a representative sample of each farm. The composite soil samples were properly labeled and their respective locations geo-referenced to produce a field map (Figure 1). The samples were properly processed and sieved. Each of the composite samples was then sub-sampled for laboratory (heavy metals, pH, texture, total nitrogen and cations) analyses using standard methods.

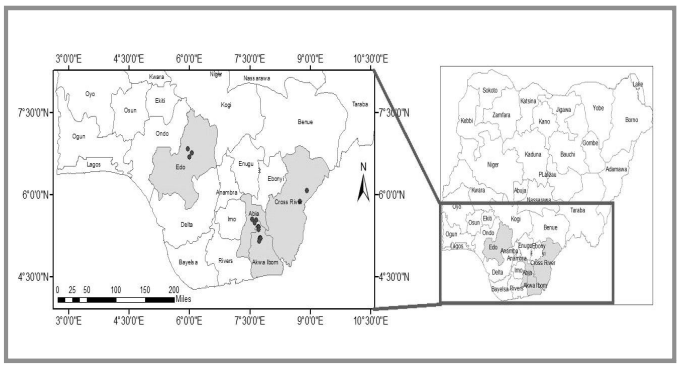

Fig.1: Location Map of Sampling sites

B. Pesticide usage analysis

Structured questionnaires were administered on cocoa farmers and store owners in Abia, Cross River, Edo and Akwa Ibom States. Three cocoa producing Local Government Areas (LGAs) were selected in each of the States. Twenty cocoa farmers were randomly selected in each of the LGAs (making a total of 240 farmers) for questionnaire administration. The questionnaires were designed to obtain information on demography of the farmers, use of pesticides in farm practices, the brands of pesticides (government approved and banned) used on cocoa farms, and farmers' attitudes to the use of chemicals. Results obtained from the questionnaire were analyzed using descriptive statistics.

C. Pesticide Residue Awareness

After the conclusion of the pesticide usage and physico-chemical analysis of collected soil and cocoa beans samples, an awareness programme was organized for farmers, agro dealers, extension agents and other stakeholders in Abia, Akwa Ibom, Cross River and Edo States.

Results and Discussions

The heavy metals concentration (Cd, Pb, Cr and Ni) in soils across the study areas is presented in Table 1. The distribution of heavy metals shows an increasing order of Cr > Pb > Cd > Ni across the states. Cd, Pb, Cr and Ni contents of the soils varies across locations.

The Cadmium, Lead, Chromium contents is higher both in cocoa farms and adjacent forest in Abia, followed by Cross River, Edo and Akwa-Ibom states while the Nickel content is higher in Abia, Akwa-Ibom, Edo and Cross River states. Table 2 show the range of values of some heavy metal obtained from soil samples in the study areas.

Cadmium (Cd)

Cadmium concentration in soils of cocoa farms across the selected local Government Areas in Akwa-Ibom state ranges between 0.325mg/kg and 0.775mg/kg, with a mean value of 0.523mg/kgin the farms while the adjacent plots (forest) Cd values ranges between 0.325mg/kg and 0.675mg/kg with a mean value of 0.558mg/kg showing no significant difference in cadmium between cocoa farms and adjacent forest in Akwa-Ibom state. The range of Cd contents in selected farms and adjacent plots in Abia, Edo and Cross River as seen in table 2 shows that Abia has a mean value of 0.675mg/kg for cocoa farms and 0.691mg/kg for its adjacent plots. Some locations are slightly higher than the permissible valueswith all the states having a mean value less than the permissible range. In Akwa-Ibom, there is nosignificant difference in the soil cadmium contents between cocoa farms and adjacent forest in Abia, Edo and Cross River states. This suggests an edaphic nature of Cadmium in the area due to weathering of parent rocks (Alloway,1995) which collaborates earlier findings by Ogunlade *et al* (2011) that most farmers don't use fertilizers in their cocoa farms but the use of agrochemicals is already gaining momentum amongst cocoa farmers (Issa, 2016).

The cadmium values in both cocoa farms and adjacent plots across the states are within the permissible levels of cadmium by various authorities (0.8mg/kg WHO, 1996, 0.76mg/kg, Commentuijn *et al*.,1997, 0.5mg/kg Saadia *et al*, 2016). It is important to stress that excessive levels of cadmium in soil (>1 mg/kg) presently found in samples maybe due to closeness of such farms to some industrialized areas and may largely be as a result of

emissions (Oversteyns.,1992).

Lead (Pb)

The lead contents of the cocoa soils and adjacent forest soils across the states is generally lower than permissible standards. Abia state has Pb content between 0.450mg/kg and 2.725mg/kg for cocoa farms and 0.725mg/kg and 2.875mg/kg in adjacent plots. Table 2shows the ranges of values of lead contents in soils across the states which is very low when compared to the National Environmental Quality Standard(NEQS) of 25mg/kg as reported by Saadia et al (2016) and 85mg/kg (WHO,1996) as seen in table 3. This shows that lead content is natural in the samples and lead does not pose any contamination threat to cocoa or other crops and the food chain in the area under evaluation. Also, lead uptake is pH dependent Saadia et ta., (2016). There is no cause for alarm regarding lead exposure.

Chromium (Cr)

The results shows that Cr has highest values in Abia, Akwa-Ibom, Edo and Cross-River states of 6.553mg/kg, 7.748mg/kg, 6.373mg/kg and 5.448mg/kg in both cocoa farms and adjacent plots and its far below the permissible level of 20mg/kg(NEQS), 150mg/kg(EU,2002) and 100mg/kg (WHO., 1996) showing there is no contamination threat as regards Cr.

Nickel (Ni)

The Ni contents both in the soil of cocoa farms and adjacent plots is very low (Zarcinas., *et al.,* 2004) and does not pose any contamination threats to consumption of cocoa and cocoa products from the area.

Mn, Fe, Cu and Zn

The concentration of Mn, Fe, Cu and Zn which are required for cocoa production in very small quantities falls below the permissible levels for soil (Cu: 140mg/kg EU 2002, 100mg/kg, WHO/FAO 2001, Zn: 50mg/kg WHO,1996). The metals are all within the permissible levels in soils as seen in Table 3.

Table 1. Heavy metals parameters in some selected cocoa farms and adjacentforest in the study area

States	LGA/community	Cd mg/kg		Pb mg/kg		Cr mg/kg		Ni mg/kg	
		Cocoa plot	Adj plot	Cocoa plot	Adj plot	Cocoa plot	Adj plot	Cocoa plot	Adj plot
Akwa-Ibom									
1	Ini-1	0.575	0.650	0.150	0.625	3.528	1.805	0.289	0.215
2	Ikot-1	0.555	0.675	0.507	0.350	3.493	3.860	0.278	0.197
3	Kono-1	0.525	0.375	0.075	2.014	5.528	5.005	0.203	0.166
4	Konco-2	0.375	0.675	0.745	1.750	6.210	7.428	0.145	0.128
5	Ini-2	0.775	0.650	1.775	0.150	7.448	3.998	0.219	0.178
6	Ikot-2	0.325	0.325	0.975	0.450	5.025	5.630	0.141	0.138
7	Mgbe	0.575	NA	0.950	NA	2.923	NA	0.115	NA
8	Udeoro-3 Bende	0.875	NA	1.975	NA	1.558	NA	0.255	NA
9	Uguanta-2	0.732	0.875	0.925	1.550	6.553	3.085	0.208	0.213
10	Uguanta Bende	0.725	NA	1.117	NA	2.693	NA	0.220	NA
11	Ukaluuta	1.115	1.012	2.725	0.725	6.135	5.485	0.281	NA
12	Isieruote iyienyi	0.987	0.375	1.875	2.875	3.790	4.725	0.302	0.133
13	Umu north LGA	0.725	0.500	1.975	1.650	4.663	5.338	0.236	0.096
Edo									
14	Owan west LGA	0.725	0.550	2.711	1.475	3.443	4.715	0.098	0.101
15	Uhunode LGA	0.775	0.875	2.329	0.708	6.373	3.133	0.211	0.180
16	Esan west	0.904	0.713	0.275	0.425	0.918	0.375	0.085	0.076
Cross River									
17	Ikom LGA	0.825	NA	0.341	NA	3.675	NA	0.090	NA
18	Etung LGA	1.075	NA	0.725	NA	4.188	NA	0.123	NA
19	Boki	1.075	NA	2.425	NA	5.448	NA	0.137	NA

Table.2: Ranges of values per states of Heavy metals across the states

Soil properties	Ranges of values per states mg/kg							
	Abia		Akwa Ibom		Edo		Cross River	
	Cocoa	Adjacent	Cocoa	Adjacent	Cocoa	Adjacent Forest	Cocoa	Adjacent
Mn	4.265-10.900	3.580 - 7.350	3.125-5.755	2.155-4.355	2.605-12.355	2.755-14.755	2.895-6.745	-
Fe	0.995-4.155	1.230-2.290	1.525-5.400	1.645-4.415	2.590-6.395	1.840-6.785	1.205-8.015	-
Cu	0.315-2.090	0.330-2.170	0.305-0.575	0.280-0.400	0.265-1.215	0.285-0.755	0.525-1.190	-
Zn	0.439-2.723	0.633-1.777	0.669-5.564	0.619-2.456	2.021-5.867	1.945-2.224	0.691-1.704	-
Cd	0.323-1.115	0.375-1.012	0.325-0.775	0.325-0.675	0.725-0.904	0.550-0.875	0.825-1.075	-
Pb	0.450-2.725	0.725-2.875	0.075-1.775	0.150-2.014	0.275-2.711	0.425-1.475	0.341-2.425	-
Cr	1.558-6.553	3.085-5.485	3.493-7.748	1.805-7.428	0.918-6.373	0.375-4.515	3.675-5.448	-
Ni	0.115-0.302	0.096-0.213	0.141 - 0.289	0.128-0.215	0.085-0.211	0.076-0.180	0.090-0.137	-

Table 3. Heavy metal permissible levels in soils and plants

Heavy metals	Soil (mg/kg)	Plants (mg/kg)
Cadmium	0.8	0.02
Zinc	50	0.6
Copper	36	10
Chromium	100	1.3
Lead	85	2
Nickel	35	10

Source : WHO, 1996

Physiochemical Properties

The baseline analysis of the physical and chemical properties of the soil samples across the states is presented in Table 4. The textural classes of the samples are sandy-loam. The pH, a useful factor that influences heavy metals availability in agricultural soils tends towards acidity, ranging from between 4.22 and 6.38. At high pH (alkalinity), some metals are not available for uptake. Mg, Ca, and K are available at pH>8 but Fe, Zn and Cu are less available (Saadia, 2016). The nitrogen content of all the samples is adequately above the critical value of 0.0 %N for cocoa soil (Egbe *et al.*, 1989). Phosphorus and potassium values are adequate in sample some locations why majority of the samples did not meet the critical values of 10mg/kg and 0.3cmol/kg require for cocoa cultivation. The exchangeable calcium and magnesium is moderately adequate across the states for cocoa soils (Egbe et al., 1989). The physiochemical properties of soils influence the mobility and pathways of nutrients and pollutants in soils. Similarly, the accumulation of heavy metals in soils is also govern by a number of soil properties such as pH, organic matter, conductance, inorganic ions (Vern and Don, 2011).

Table 4. Distribution of soil properties of cocoa plantations and adjacent forests in some states

Soil properties	Ranges of values per states							
	Abia		Akwa Ibom		Edo		Cross River	
	Cocoa	Adjascent	Cocoa	Adjascent	Cocoa	Adjascent	Cocoa	Adjascent
Ph	4.43-6.22	4.46-6.14	4.37-5.87	4.67-5.73	6.06-6.38	5.86-6.29	4.22-5.56	-
% Sand	71.52-79.52	73.52-83.52	77.52-87.52	81.52-87.82	87.52	85.52-87.52	73.52-77.52	-
% Silt	12.56-20.56	8.56-16.56	4.56-10.56	4.56-10.56	4.56	4.56-6.56	12.56-18.56	-
% Clay	7.92-13.92	5.92-9.92	7.92-11.92	7.92-9.92	7.92	7.92	7.92-13.92	-
Ca(cmol/kg)	7.95-28.44	5.09-30.61	7.09-14.59	4.92-15.10	3.42-11.14	5.05-7.89	4.42-16.68	-
Mg(cmol/kg)	1.39-2.18	1.30-1.96	0.65-1.76	0.86-1.38	0.96-1.82	1.29-1.48	1.03-1.43	-
Na(cmol/kg)	0.27-1.04	0.27-0.77	0.13-0.65	0.13-0.60	0.10-0.47	0.13-0.33	0.47-0.57	-
K(cmol/kg)	0.18-0.40	0.20-0.48	0.16-0.31	0.14-0.24	0.18-0.26	0.16-0.18	0.18-0.22	-
Total N %	0.13-0.36	0.17-0.34	0.16-0.26	0.13-0.17	0.16-0.26	0.15-0.27	0.13-0.24	-
Org- C (g/kg)	1.60-3.80	2.23-3.69	1.20-2.62	1.01-2.04	2.12-2.96	1.54-2.77	1.66-3.08	-
Avail-P (mg/kg)	1.33-14.72	0.67-9.37	4.68-26.44	7.03-21.42	1.67-7.03	0.84-13.34	0.33-2.21	-

Table 5 shows the frequency of usage of pesticides on cacao in Abia State. Data obtained from the structured questionnaires showed that farmers in Bende LGA often used up to eighteen (18) different pesticides on their cocoa farms, followed by those of Ikwuano (13), and Umuahia North (12). About 19.78% of farmers sampled in Bende used Ultimax Plus and Ridomil Gold; 8.79% used Gamalin 20, while 7.69% used each of Blue Bolt, Actara, and Red Force pesticides (Table 5).

The highest proportion of farmers (20.48%) in Ikwuano either Snipper or Combat chemicals on the farm, followed by those that used Ultimax (18.07%) and Red Force (16.87%). Very few percentage (1.20%) of farmers in this area were used to applying Copper sulphate, Champ DP and Safato/Sarosate (Table 5). Highest percentage (28.13%) of farmers in Umuahia North indicated their preference for Ridomil Gold. This was followed by those who preferred Copper Sulphate, while Cypermethrine, Gamalin 20 and Safato/Sarosate were the least used in the LGA (Table 5). The highest proportion of the farmers visited/interviewed in Abia State were used to the application of Ridomil Gold, Ultimax and Red Force pesticides on their cocoa farms, while the least figure (1.10%) was recorded against cocoa farmers that used Safato, Champ DP, Snipper/Combat and Cypermethrine (Table 5). The frequency of pesticide usage on cocoa in Cross River State is as depicted in Table 6. A total of twelve pesticides were commonly used by farmers in the State. Only two pesticides were mostly applied on cocoa farms in Etung LGA, while about twelve were used in Boki. In Etung local government area, only Ridomil Gold (33.33%) and Actara (66.67%) were often applied on cocoa farms. This was clearly different from what obtained for the other LGAs in the State. Findings also showed that Actara (36.00%) and Ridomil Gold (32.00%) were mainly used by farmers in Ikom. These were followed by Funguran OH (12.00%), while Round up/Touch down, Cofresh and Proteus (4% each) were least used. The trend was similar for farmers in Boki and Obudu. Ultimax Plus, DDForce, Esiom and Safato (8.33% each) however showed least farmer usage in the latter (Table 6). Out of the thirteen pesticides often used on cocoa farms in Edo State, only three (Best, Proteus and Bush Fire) were not used in Owan West LGA. Ultimax, DDForce and Actara had the highest frequency of use (15.79% each) in the LGA. These were followed by Ridomil Gold, Funguran OH and Tackle (10.53% each), while Tricel, Cypermethrine and Termex had the least. DDForce (35.72%) and Ridomil Gold (21.43%) were however mostly used in Esan West. These were followed by Best (14.29%) and Tackle (14.29%), while Proteus (7.14%), like Bush Fire, gave the least frequency of usage in the local government (Table 7). As shown in Table 8, the highest number of pesticides used on cocoa farms in Akwa Ibom State was recorded for Ini LGA, with Ikot Ekpene and Ikono LGAs distantly following. Results showed that Ridomil Gold (16.23-19.64%) and Actara (13.64-33.33%) were mostly used by farmers inIni LGA. The least frequencies of usage were however recorded for Round-Up (0.65%), Copper nordox (0.65%) and Proteus (1.79-2.0%) across the LGA. Ridomil Gold, Actara and Esiom had same highest frequency of usage (28.57%) in Ikot Ekpene. The highest frequency of usage (50.00%) was also recorded for Ridomil Gold in Ikono LGA (Table 8). Tables 5a, 6a, 7a, and 8a depict the percentages of pesticides usage on cocoa farms in Abia, Cross River, Edo and Akwa Ibom States respectively. Findings from this study showed that 60.23% of the farmers sampled in Ikwuano LGA in Abia State, followed by those of Bende (59.34%) in the same State, used government approved chemicals on their farms. Contrary to what obtained for the duo, higher percentage of farmers (53.10%) in Umuahia North used unapproved (banned) pesticides on their cocoa farms (Table 5a). Results obtained from Cross River State revealed that significantly high percentage (89.66-100%) of farmers applied government approved pesticides on their cocoa farms. Virtually all the farmers in Etung LGA (100%), followed by those of Ikom (96.00%) and Boki (89.66%) with the least percentage, used government approved chemicals (Table 6a). Unlike what was observed in Cross River State, 28.57 and 57.90% of farmers in Esan West and Owan West LGAs of Edo State made use of government approved pesticides on their cocoa farms (Table 7a). Findings from farmers in Akwa Ibom State on the use of government approved pesticides were similar to those obtained from the selected local governments in Cross River (Table 8a). The use of pesticides on farms has raised a lot of concerns about the safety of residues in cocoa beans, soils and water. This also potends a huge harm to humans and the environment (Denkyirah, *et al.,* 2016). Previous research conducted across six cocoa producing LGAs in Osun State revealed that Ridomil Gold pesticide had the highest frequency of usage among the farmers interviewed (Adeniyi, *et al.*, 2017). The discovery agrees with the findings of this research across the LGAs visited in Abia, Akwa Ibom and Edo States (Tables 5, 7 and 8). The pesticide however had

the second-highest frequency of usage after Actara among the farmers visited in Cross River State (Table 6). The authors (Adeniyi, *et al.*, 2017) also discovered that most of the cocoa farmers in Osun State (about 74%) used government approved chemicals on their farms. This is in line with findings from this research among farmers in Akwa Ibom and Cross River States where at least 81% of the respondents used government approved chemicals. However, contrary to the authors' findings, the percentages of banned pesticides used by farmers in Esan West (Edo State) and Umuahia North (Abia) were significantly higher than those of the government approved ones (Tables 5 and 7). The higher number of pesticides used in some of the LGAs sampled compared with others across the States visited may be due to the level of the farmers' education. The continuous use of banned chemicals by some farmers interviewed across the States visited (even despite their knowledge of government approved ones) may be due to their perceived effectiveness in the control of cocoa pests/diseases, cost effectiveness/affordability, and ready availability. Inadequate information and appropriate registration of the agrochemicals also contribute significantly to this (Antwi-Agyakwa *et al.,* 2015). The use of government approved pesticides by virtually all the farmers interviewed in Etung LGA (Cross River State), Ikot Ekpene and Ikono LGAs (Akwa Ibom State) may however be due to a better understanding of pesticides/pesticide hazard control, coupled with relative availability of the said pesticides as explained by Damalas and Koutroubas (2017) and Antwi-Agyakwa *et al.* (2015).

Table 5: Frequency of use of pesticides on cocoa in Abia State

State	Local government/ Community	Pesticide																	
		UT	RG	DDF	KN	BB	RF	ACT	FOH	BST	CYP	SNPC	TDM	GM	CDP	CUS	TMX	RUP	SFB
Abia	Bende/Isiala	19.78	19.78	2.20	2.20	7.69	7.69	7.69	2.20	5.49	1.10	1.10	1.10	8.79	1.10	3.30	5.49	2.20	1.10
	Ikwuano/Nkalunta	18.07	15.66	4.82			16.87	4.82		3.61	2.41	20.48	3.61		1.20	1.20		6.02	1.20
	Umuahia North/Iyienyi	3.13	28.13	12.5	6.25		9.38	3.13	3.13		3.13			3.13		18.75		6.25	3.13

Key:

UT: Ultimax Plus RF: Red Force SNPC: Snipper/Combat/Attack TMX: Termex/Termikill
RG: Ridomil Gold ACT: Actara CYP: Cypermethrine/Cypertex RUP: Round up/Touch down/Clear weed
FOH: Funguran OH GM: Gamalin 20 SFB: Safato /Sarosate/Supertex DDF: DD Force/Force up/Paraforce/Paraquote/DDVP
KN: Knock out BST: Best/Action 40 CDP: Champ DP BB: Blue Bolt TDM: Tandem CUS: Copper sulphate

Table 5a: Percentage of usage of government approved pesticides on cocoa in Abia State

	Pesticides	
Local Government Area	**Approved (%)**	**Not approved (%)**
Bende	59.34	40.66
Ikwuano	60.23	39.77
Umuahia North	46.90	53.10

Table 6: Frequency of use of pesticides on cocoa in Cross River State

State	Local government/Community	Pesticide											
		UT	RG	DDF	KCD	RF	ACT	FOH	RUP	CFR	PRT	ESM	SFB
Cross River	Etung		33.33				66.67						
	Obudu	8.33	25.00	8.33		8.33	25.00	16.67				8.33	8.33
	Ikom	8.00	32.00				36.00	12.00	4.00	4.00	4.00		
	Boki	6.90	24.14	3.45	10.34	3.45	24.14	13.79	3.45	3.45	3.45		3.45

Key:

UT: Ultimax Plus KCD: Kocide RUP: Round up/Touch down/Clear weed ESM: Esiom RG: Ridomil Gold
ACT: Actara PRT: Proteus CFR: Cofresh RF: Red Force FOH: Funguran OH
SFB: Safato (Bordaeux mixture)/Sarosate/Supertex DDF: DD Force/Force up/Paraforce/Paraquote/DDVP

Table 6a: Percentage of usage of government approved pesticides on cocoa in Cross River State

Local Government Area	Pesticides	
	Approved (%)	Not approved (%)
Etung	100.00	-
Obudu	91.66	8.34
Ikom	96.00	4.00
Boki	89.66	10.34

Table 7: Frequency of use of pesticides on cocoa in Edo State

State	Local government/Community	Pesticide											
		UT	RG	DDF	TMX	ACT	FOH	RUP	BST	PRT	BF	TCO	TRC	CYP
Edo	Esan West		21.43	35.72					14.29	7.14	7.14	14.29		
	Owan West	15.79	10.53	15.79	5.26	15.79	10.53	5.26				10.53	5.26	5.26

Key:

UT: Ultimax Plus RUP: Round up/Touch down/Clear weed TMX: Termex/Termikill BF: Bush Fire
CYP: Cypermethrine/Cypertex/Cyperforce ACT: Actara RG: Ridomil Gold BST: Best/Action 40
TCO: Taco/Tack le FOH: Funguran OH PRT: Proteus TRC: Tricel
DDF: DD Force/Force- up/Paraforce/Paraquote/DDVP

Table 7a: Percentage of usage of government approved pesticides on cocoa in Edo State

Local Government Area	Pesticides	
	Approved (%)	Not approved (%)
Esan West	28.57	71.43
Owan West	57.90	42.10

Table 8: Frequency of use of pesticides on cocoa in Akwa Ibom State

Local government/ Community	Pesticide															
	UT	RG	DDF	CDP	MCN	RF	ACT	FOH	RUP	KCD	SNPC	PRT	CYP	TCO	ESM	CUN
Ikot Ekpene/		28.57					28.57		14.29						28.57	
Ibiakpan Ikono		50.00					25.00									25.00
Ini/Eben	16.07	19.64	8.93	5.36		3.57	21.43	3.57	3.57			1.79	12.50		3.57	
Obom Ini/Ikot ibom	14.00	18.00		8.00	2.00	4.00	18.00	12.00				2.00	10.00	6.00	6.00	
Ini/Ikot Abia	7.14	16.23	8.44	11.04	4.55	10.39	13.64	7.14	0.65	3.25	1.30	2.60	5.19		7.79	0.65
Ini/ Ikot Ofon	16.67	16.67					33.33						16.67		16.67	

Key:

UT: Ultimax Plus — MCN: Mackechnie Gold — CDP: Champ DP — SNPC: Snipper/Combat/Attack

CUN: Copper Nordox — RG: Ridomil Gold — RF: Red Force — CYP: Cypermethrine/Cypertex/Cyperforce

KCD: Kocide — ESM: Esiom — PRT: Proteus — DDF: DD Force/Force up/Paraforce/Paraquote/DDVP

ACT: Actara — FOH: Funguran OH — TCO: Tackle/Taco — RUP: Round up/Touch down/Clear weed

Table 4a: Percentage of usage of government approved pesticides on cocoa in Akwa Ibom State

	Pesticides	
Local Government Area	**Approved (%)**	**Not approved (%)**
Ikot Ekpene	100.00	-
Ikono	100.00	-
Ini	81.11	18.89

Conclusion and Recommendation

The number/type of pesticides used on cocoa farms in the study areas varied with location and farmers' perceived effectiveness/availability of those chemicals. Farmers in Akwa Ibom and Cross River States impressively made use of government approved chemicals to control pests and diseases on their cocoa farms. This was a clear contrast to what obtained in Edo State. An average compliance was however noticed among farmers in Abia State. There is therefore an urgent need by government at all levels to further intensify efforts at educating cocoa farmers on the health and economic implications of continuous use of pesticides not approved by the federal government through its regulatory agency (Cocoa Research Institute of Nigeria) on their crop. They also need to be cautioned against an over-use of the recommended pesticides in order to forestall any undesirable long-term residue accumulation in their cocoa beans.

Status: On going

Future Plans

Soil samples, cocoa beans and questionnaires obtained from other cocoa growing States in Nigeria will be analyzed. Pesticide Residue Awareness programme will also be organized for stakeholders in other cocoa growing States in the country. Development and integration of Integrated Crop and Pest Management (ICPM) strategies will be carried out.

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Experimental Title: Effect of Knowledge of Certification Process on Bean Quality Among Cocoa Farmers in Nigeria

Investigators: Famuyiwa, B. S., Adedeji, A. R., Ogunwolu, S. O., and Taiwo O A

Introduction

- Despite the efforts of certification trainings undergone by Nigeria farmers, their cocoa beans are still facing threat of ban in the world market. This is due to discovery of some chemical residues injurious to human health found in their exported beans.
- Consequently, the farmers are going to lose their sources of income leading to poor livelihood and less contribution to the National Gross Domestic Product.
- Literature support that knowledge is necessary but not sufficient to influence practice. Hence, there is need to look into those factors that encourages responsive use of chemicalto improve farmers bean quality, make them more economically sustainable, better livelihood and for cocoa to contribute favourable to the National economy.
- This study is proposed to look into these factors to save the cocoa sector.

Research Questions

- How does knowledge in Cocoa Certification process have effect on bean quality?• Why is knowledge of cocoa certification not enough for bean quality?

Objectives

The objective of the study is to evaluate the adherence of farmers to training on cocoa certification

- To identify the effect of knowledge of certification process on bean quality among cocoa farmers in Nigeria

- To evaluate the level of indiscriminate use of pesticides among cocoa farmers, in spite of knowledge on certification is resulting to rejection of Nigeria Cocoa at the World Market

Hypothesis

- Knowledge of certification process does not have effect on bean quality.

Methodology

Identification of the trained farmers on cocoa certification. The study is in collaboration with Tulip Cocoa. Two major factors will be identified; the causal and outcome factors. The two factors will be correlated to determine the level of discrepancy. Cocoa Research Institute will be responsible for the causal factor (Knowledge), while the outcome factor will be the responsibility of Tulip Cocoa

- Causal factor – Knowledge
- Outcome factor – Bean quality

Data to be collected

Quantitative – Questionnaire
Quantitative - Experiment
Qualitative – Focus Group Discussion

Status: On-going

Questionnaire administered and Focus Group Discussion performed

Challenges

We consulted Tulip for collaboration in the survey by providing their farmers for easy survey but it was turned down.

Experimental Title: Participatory Diagnostic Research on The Prevalent and Incidence of Premature Cherelle Wilt (Yellow Okra) on Cocoa Tree in Major Growing Area in Nigeria

Investigators: Adedeji, A. R., Famaye, A. O., Famuyiwa, B. S., Taiwo, O. A., Otunoye, A. H., Akanbi, O. S. O., Mokunoye, I. U. and Adeigbe, O. O.

Introduction

The term "Cherelle" refers to a limited size-range of immature fruits. Thorold (1975) noted that all cherelles are immature fruits, but that not all immature fruits are cherelles because they may be either smaller or larger than arbitrary size-range. Thorold (1975) and Opeke (1992) reported that cocoa trees generally mature 40-50% of total produced by individual tree while the remaining 50% mostly shrivel but remain attached. This phenomenon is what is loosely referred to as "cherelle wilt" following reference by Pound (1932c) to "wilting cherelles".

Opeke (1992) reported that it is a major disease that affects cocoa production as only about half of the developing pods on a tree actually reach maturity as a result of death of the rest caused by cherelle wilt. Elsewhere it has been suggested that it is a way that the tree regulates the number of pods it is able to carry and nurture to maturity, that is, results of certain physiological changes taking place in the tree. Other schools of thought have accused a number of fungi of causing cherelle wilt, and even insect pests (Opeke, 1992). Therefore, there is the need to study the different types of cherelle wilt in the field in order to be able to proffer effective management measures to increase production.

Justification

Incidence of cherelle wilt in cocoa is an aged long issue. Reports have it that it was noticed in about 1932 and was aalso reported by McKELVIE in 1960. However, it became a subject of concern in Nigeria cocoa plantations when farmers and Syngeta Company who participated in Cocoa Research Institute of Nigeria, 2017 In-House Review complained that the situation is really affecting their cocoa productivity negativily. Hence the need to investigate the prevalence causes and consequently recommends preventive or coping mechanism.

Objectives

Broad objective: to assess farmers' participatory diagnostic survey on the prevalence of premature cherelle wilt in major cocoa growing areas in Nigeria.
Specific:

1. Assess the demographic information of respondents
2. Examine the health status of the farm
3. Determine the percentage occurrence of the cherelle wilt
4. Evaluate the leaf, soil and cherelle on trees
5. To determine Pathogenic organisms associated with cherelle wilt of cocoa
6. To determine severity and percentage losses from cocoa farms

7. To proffer effective management measures for the control of cherelle wilt of cocoa.

Method

The project is farmers' participatory diagnostic survey on the prevalence of premature cherelle wilt in major cocoa growing areas in Nigeria. A multi stage sampling procedure will be used in selecting the respondents' farms. The first stage is a purposive selection of the major growing state and areas of prevalence as revealed by Syngenta who among other farmers raised the alarm. Stage 1: will purposively select Osun, Ondo and Cross Rivers. Stage 2: 3 Local Government Areas (LGAs) in each state based prevalence report using snowball technique, to give 9 LGAs. Stage 3: Five communities from each LGAs to give 45 communities. Stage 4: Ten farms from each community to give a total of 450 farms to form the sample areas. Demographic, production and prevalence information will be solicited using structured for quantitative and unstructured questionnaire (Focus Group Discussion) for qualitative analyses.

Discussion

From the result analysed, majority 92.31% of the farmers are aware of the incidence of cherelle wilt and confirm that there are occurrences of cherelle wilt on their farm. Most of them (90%) acknowledge that they are aware of its presence on other people farm. Most of the farmers (42%) further reveal that there is a high level of prevalence of cherelle wilt on their farm and assert that it is a major problem for their cocoa production. The study reveals that most (94%) of the farmers do not have a regular spacing for their cocoa plantation and 45% of them constituting the majority indicated that they sometime prune their cocoa farm while 25% do not prune at all. Most have shade trees present in their cocoa farms with “Akintola” weed being the most prevalent critical weed present in most of the farms. The farmer uses various means of weed control measures. However, manual brushing of weeds with the aid of cutlass is mostly used as means of weed control while chemical herbicide applications constitute the second highest means of weed control while manual control with the use of cutlass constitute the highest (24%). Further analyses show that 87% of the cocoa farmers claimed that cherelle wilt has serious effect on their farms. The result analysis for the three state shows that the cocoa farmers has an average of 13Ha of cocoa farm with an average age of 60 years. The farmers have an average of 48 years in cocoa farming experience. Furthermore, the result analysis shows that majority (80%) of the cocoa farmers do not carry out soil test before planting their cocoa. The reason adduce to this is the fact that it's too expensive for them to carry out soil test as most of them are financially handicap. Most of the farmers (77%) do not apply fertilizer on the cocoa farm while those who apply it (22%) use chemical fertilizer. only 1% of them make use of organic fertilizer. Most of the farmers (46%) claimed that lack of fund and scarcity of fertilizer was major reasons for not applying fertilizer. Majority of those that applied fertilizer got it from the open market and most do not have any training on fertilizer application. Most of those who use it (97%) assert that there where remarkable improvement in cocoa production. The result of analysis further reveals majority of the farmers (75%) claiming that weather is a major cause of cherelle wilt while 22% adduce it to insect and pathogen. Most of them 46% remove cherrele wilt by hand as a means of control indicating that they do not have any specific means of controlling cherrele wilt. Table 2 show the correlation analysis of the variables considered. The correlation analysis carried out show that there is positive correlation between the effect of cherelle wilt and the awareness of cherelle wilt by the farmers at 5% signiant level, prevalence of cherelle wilt at 1% level of sig. size of cocoa farm at 1% as well as the cocoa farmers' years of experience at 1% level of sig. indicating that the higher the farm size the more the effect of cherelle wilt. Although not significant, the analysis also shows that the farmers knowledge of cherelle wilt and action taken by farmers during occurrence are inverselyrelated to the effect of cherelle wilt on cocoa farm. This implies that the more knowledge and action taken to combat cherelle wilt the less is the effect on the cocoa farm.

CASHEW PROGRAMME

Experimental Title: Influence of Appropriate Fertilizer Application on Yield of Cashew in Ochaja

Investigators: Iloyanomon C.I., Ibiremo, O.S. and Ogunlade, M.O.

Introduction

Cashew is an important commodity crop with great potential as a foreign exchange earner and source of industrial raw material. It is adapted to a wide range of soils and is often grown on very poor soils with low fertility levels. The productivity of cashew is therefore largely dependent on litter fall and natural soil endowment, as fertilizers are largely not part of cashew production system in Nigeria a. This has adversely affected cashew yield. The application of fertilizer is however inevitable for the replacement of soil nutrients that are mined through cashew apple and nut harvest annually. This can be achieved through guided fertilizer application which ensures replenishment of mined nutrients. There are various types of fertilizers inorganic, organic and organo-mineral, each with its merit and demerit. There is therefore need to study the influence of the various fertilizer types on cashew productivity.

Objectives

i. To evaluate the influence of the various fertilizer types on yield of cashew.
ii. To assess the influence of fertilizer types on soil physical and chemical properties.

Materials and Methods

Trees in the selected cashew plantation were pruned and composite soil samples collected from the cashew plantations at 0-20 cm and 20-40 cm soil depth. Leaf samples were also collected from the cashew tree. The soil samples collected were air dried passed through 2 mm sieve and analyzed in the laboratory for some of its physical and chemical properties. The leaf samples were oven dried to constant weight, milled and nutrient content of the leaves determined**.** Fertilizer was applied based on soil testing. The treatments were:

a. No fertilizer control
b. NPK + MOP (Inorganic fertilizer)
c. Organic fertilizer
d. Organo-mineral fertilizer

The fertilizers were applied at the rate of 28 Kg N/ ha + 40 Kg K/ha. The treatments were arranged in a randomized complete block design (RCBD) with four replications. Each treatment was applied on six cashew trees per replication giving a total of 96 trees. These treatments were administered on eighteen-year-old cashew trees of Oro selection with medium sized nuts. Yield data such as number and weight of cashew nuts of the various experimentalunits were studied at cashew nut production stages. Data collected were subjected to statistical analysis and significant means separated using Duncan multiple range test at 5% level of probability.

Results and Discussion

Results indicated that soils in cashew plantation at Ochaja was strongly acidic with pH values of 5.30 and 5.07 at 0-20 cm and 20-40 cm soil depth (Table 1). Organic carbon content in the top 0- 20 cm soil depth was low with a value of 4.10 g/kg. Total nitrogen was also low with a value of 0.3g/kg at the top 0-20 cm soil depth (Table 1). This was well below the soil critical nitrogen value of 1g/kg required for cashew. Hence the need for nitrogen fertilizer. This was corroborated by the leaf nutrient content of 11.4g/kg (Table 2), which were below the soil critical N value of 12.4g/kg required by cashew. Soil available P was adequate with values of 6.54 mg/kg to 6.23 mg/kg at 0- 20 cm and 20 – 40 cm soil depth (Table 1). This is above the soil critical P value of 3.7 mg/kg required for cashew (Egbe *et al.,* 1989). P was therefore adequate hence no need for P fertilizer. Soil exchangeable K at the top 0-20 cm soil depth was however inadequate with a value of 0.07 cmol/kg soil (Table 1). K fertilization would be required. Soil exchangeable calcium content of the soil was high across the various soil depth and cashew plantations with values of 9.53 and cmol/kg at 0- 20 cm and 20 40 cm soil depth (Table 1). This was well above the soil critical value of 8 cmol/kg required for cashew, hence no need for Ca fertilization. This was corroborated by the high leaf calcium content of 74.54 g/kg (Table 2) which was well above the foliar critical calcium content of 1.8g/kg required for cashew. Micronutrient Zn, Fe, Cu and Mn were sufficient in the soil (Table 1).

Table 1: Initial physical and chemical properties of soils of cashew plantations in Ochaja

	Soil depth (cm)	
Parameters	**0 - 20**	**20 – 40**
pH	5.37	5.07
Organic carbon (g/kg)	6.90	4.13
N (g/kg)	0.30	0.27
P (cmol/kg)	6.54	6.23
K (cmol/kg)	0.07	0.06
Ca (cmol/kg)	9.53	8.13
Mg (cmol/kg)	0.59	0.50
Na (cmol/kg)	0.36	0.39
Ex base (cmol/kg)	0.55	9.08
Ex. Acidity (cmol/kg)	0.10	0.11
ECEC (cmol/kg)	10.65	9.19
Base saturation (%)	99.06	98.80
Zn (mg/kg)	4.11	4.39
Cu (mg/kg)	3.04	0.37
Mn (mg/kg)	27.60	9.45
Fe (mg/kg)	16.60	16.76
Sand (g/kg)	847.6	828.6
Silt (g/kg)	120.6	130.6
Clay (g/kg)	31.8	40.8
Textural class	Loamy sand	Loamy sand

Table 2: Initial leaf nutrient content of cashew plantations in Ochaja

Parameters	Value
Organic Carbon	51.6
N (g/kg)	11.4
P (g/kg)	0.53
K (g/kg)	14.5
Ca (g/kg)	74.54
Mg (g/kg)	6.10
Zn (mg/kg)	115.87
Mn (mg/kg)	380.23
Fe (mg/kg)	236.11
Cu (mg/kg)	18.37

The influence of various fertilizer treatments on number and weight of cashew nuts was significant ($P < 0.05$) (Table 3). Only inorganic and organomineral fertilizers enhanced number of cashew nuts per tree by 292 % and 146 % respectively when compared with control. Though organic fertilizer treatment increased the number of cashew nuts, the increase was not significant. Inorganic fertilizer treatment also had 218 % and 59 % higher number of cashew nuts per tree than organic and oganomineral treatment respectively, while organomineral treatment and organic treatments were at par. Similar trend was observed in number of cashew nuts per hectare. The non- response of cashew nut yield to the organic fertilizer could be attributed to the slow mineralization of organic fertilizer, hence the effect was not observed on yield in the first year. However, it is possible that the effect of organic fertilizer on yield might be visible in the second and subsequent years. Weight of cashew nuts was also significantly ($P < 0.05$) enhanced by fertilizer treatments in (Table 3). Inorganic and organomineral fertilizers resulted in 251 % and 256 % heavier cashew nuts per tree when compared with control, while inorganic and organomineral fertilizers treatments were at par with organic fertilizer. Weight of cashew nuts from organic treatment was also at par with that with no fertilizer treatment. Cashew nut yield from the cashew plot was generally low 38.13 – 139 kg/ha. This was due to pilfering which led to loss of cashew nuts.

Table 3: Number and weight (kg) of cashew nuts as influenced by various fertilizer types at Ochaja

Treatments	No of nuts /tree	No of nuts / ha	(kg) Weight of nuts/tree	(kg) Weight of nuts/ha
No fertilizer	56c	5,226d	0.31b	38.13b
Inorganic fertilizer	220a	27,091a	1.09a	134.10a
Organic fertilizer	69bc	8,579cd	0.68ab	83.86ab
Organomineral fertilizer	138b	17,066b	1.13a	139.24a
SE±	44.0**	5408.9**	0.36*	44.6*

Conclusion

Nitrogen and potassium where deficient in soils of cashew plantation at Ochaja, while phosphorus was adequate. Inorganic and organomineral fertilizers enhanced cashew yield by increasing both number and weight of cashew nuts. The use of fertilizer is therefore beneficial for cashew productivity.

Status: On-going

Future plan

Evaluate residual effect of the fertilizers on cashew nut yield

Reference

Egbe, N. E., Ayodele, E.A. and Obatolu, C.R. (1989) Soils and nutrition of cocoa, coffee, kola, cashew and tea. In: Progress in the Crop Research in Nigeria (2nd Edition), CRIN Ibadan.

Experimental Title: Agronomic and Physiological Efficiency of Intercrops to Cashew Vegetative Growth Characters.

Investigator: Nduka B.A

Introduction

Competitive interactions need to be avoided in order to properly design and manage tree-based intercropping systems. Thevathasan *et al*., (2004) stated that "tree-influenced microclimatic modifications may act in such a way as to increase the overall productivity of the associated agricultural crop". He went further and concluded that tree-based intercropping systems will minimize competitive interactions between non-woody (annual agricultural crop) and woody (tree) components, while exploiting beneficial interactions between these components, affecting availability of soil water, available light for crop photosynthesis and available nutrients for use by the adjoining agricultural crop. However, the success of cashew production with food crop depend on whether the food crops compete with the young cashew for growth resources. Andersen *et al*., (2007) reported that intercropping advantage is achieved when the species that are mixed differ markedly either morphologically, phenologically or physiologically. However, the use of resources (Fertilizer) availability is essential for production process in order to increase productivity, sustain and reduces risk of total crop loss according to Prothanee *et al*., (2007). Enhancing efficiency and productivity of these nutrients can be regarded as an important management factor also in crop production. This experiment was conducted to investigate cashew productivity and performance on interactions by using plants (Sesame) with complementary resource.

Material and Methods

A field experiment was conducted at the Cocoa Research Institute (CRIN) of Nigeria sub-station Ochaja on an existing three years old jumbo size Cashew plantation. Experimental treatments were bases on Sesame responses to Cashew intercrops as alley crops to Cocoa pod husk (CPH) and NPK fertilizer. Replicated three times in a split plot arrangement and fitted into an RCBD design. Result obtain from the intercrop was used to calculate the agronomy and physiological efficiency and these were further used for the determination of the cashew growth parameters.

Results and discussion

In tree crops intercrop, the pattern of radiation distribution is different from crop-crop situation. In the former, a situation usually exists whereby the trees dominate the under-storey crops except when all the component crops are young or of comparable heights (Mohamadu *et al.,* 2009) as seen in Table (1), taller trees will always intercept incoming radiation first and only that transmitted will be

available to short crops. According to this study, improved tree growth comes from stimulating the soil biomass and mineralizing nitrogen through intercropping. This has led to increase in Cashew development of its canopy spread, due not significantly different irrespective of the nutrient resource as time progresses. The fertilizers used in this study affected most of the parameters indicators of nutrient use efficiency measured in Table 2. The effects were significant on Agronomy efficiency (AE), Agronomic N-use (ANUE), apparent recovery efficiency (RE), Utilization efficiency (UE), and partial factor efficiency (PEP). NPK fertilizer enhances the Physiology efficiency (PE), Partial factor production (PFP) on nutrient use compare to CPH and un-manure plants. The use of Cocoa Pod Husk (CPH) significantly influence (RE), (PE) and Internal use efficiency (IE). The IE and N-removed at harvest were compared with the un-manure plants. Agele *et al,* (2011) reported that the nutrient release of organic manure depends on the type of material use in the production of the manure and the soil temperature. According to their report Nutrient P is reported to deceased competition place on nutrient resources. Contrary Alizadeh *et al,* (2010) attributed high yield of Beans to improvements in efficient of resource use under monoculture compared to intercropping treatments. The results also show that Agronomy efficiency, and utilization efficiency were significantly ($P \leq 0.05$) influence in the sub plot effect (Crop type) and an effect of fertilizer type on other treatments at $P \leq 0.05$ as shown in Table 2.

Table 1: Cashew growth characters and Canopy structure performances as influenced by Sesame intercrops and manuring.

Treatments		Height (m)	Girth (cm)	Canopy Volume (m^3)	Crown Diamete r (m)	Canopy Spread(m)	Canopy Radius(m)	Canopy Ground Cover(m^2)
Fertilizer Types	Crop Types							
		3 Months after intercropping						
Un manure	Cashew + Sesame	3.38a	44.33 A	14.73a	8.10a	16.20a	2.67a	5.34a
Cocoa pod husk		3.24a	36.83 A	7.00b	4.02b	9.52b	1.95b	3.89b
NPK		2.94a	34.17 A	7.34ab	4.76ab	8.05ab	2.06ab	4.12ab
		6 Months after intercropping						
Un manure	Cashew + Sesame	4.98a	51.17 A	38.23a	13.65a	27.30a	7.14a	14.27a
Cocoa pod husk		5.13a	39.00 A	25.50a	9.32b	20.94ab	6.14ab	12.29ab
NPK		4.74a	43.00 A	26.18a	10.47ab	18.64b	5.89b	11.78b
		9 Months after intercropping						
Un manure	Cashew + Sesame	5.37a	53.50 A	45.35a	15.59a	31.17a	7.57a	15.13a
Cocoa pod husk		5.44a	50.50 A	33.04a	11.30a	22.59a	6.43a	12.86a
NPK		5.24a	51.33 A	35.08a	12.61a	25.22a	6.55a	13.11a
		12 Months after intercropping						
Un manure	Cashew + Sesame	5.36b	59.50 A	53.64a	18.65a	37.29a	8.02a	16.05a
Cocoa pod husk		6.81a	55.67 A	51.33a	13.81a	27.63a	7.11a	14.21a
NPK		5.40a	54.83 A	44.55a	15.60a	31.20a	7.30a	14.60a
		15 Months after intercropping						
Un manure	Cashew + Sesame	5.88a	60.00 A	1.89a	19.34a	38.68a	8.14a	16.28a
Cocoa pod husk		7.55a	67.17 A	2.62a	17.36a	34.72a	7.93a	15.86a
NPK		6.28a	63.50 A	2.09a	17.45a	34.89a	7.58a	15.15a

Means with the same letters along each column are not significantly different at 0.05 level of probability.

Table 2: Manuring effect on agronomic and physiological efficiencies of N use in a Cashew/Sesame based intercropping system

Treatments		Agronomy Efficiency-(AE)Kg	Apparent Recovery Efficiency (RE)	Apparent Recovery Efficiency By Difference	Physiological Efficiency (PE)	Utilization Efficiency (UE)	N removed @harvest	Internal Utilization Efficiency (IE)	Partial-Fertilizer Productivity of Fertilizer N (PFPN)
Fertilizer Types	Crop Types								
Un manure	Sole	0.00b	0.00b	0.00b	0.00c	0.00b	0.00a	0.01c	0.00c
Cocoa pod husk	Sesame	0.00b	0.07b	0.07b	0.01b	0.00b	0.01a	0.01b	0.01b
NPK		0.01a	0.53a	1.09a	0.02a	0.01a	0.01a	0.01a	0.021a
Fertilizer Types effect									
Un manure		0.00c	0.00c	0.00c	0.00c	0.00c	0.00c	35.43b	0.00c
Cocoa pod husk		4.35b	0.05b	20.59b	0.01b	4.54b	-47.33b	50.84a	23.02b
NPK		53.44a	0.64a	52.89a	0.01a	53.44a	-55.50a	50.92a	140.44a
Interactions									
Fertilizer Types		1.19	0.05	0.26	0.01	1.19	0.83	1.74	0.78
Crop Types		1.59	0.02	0.25	0.01	1.59	0.36	1.26	0.74

Means with the same letters along each column are not significantly different at 0.05 level of probability.

Conclusion

Effective management strategies to improve Cashew productivity at the early stage developed, this indicate increased in crop diversity (Cashew + Sesame) and the knowledge of Cashew canopy spread determined. However, the nutrient availability was higher in plots with CPH manure.

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Experimental Title: Income Diversification of Cashew Farmers in Nigeria

Investigators: Lawal, J.O., Orisasona, T.M., Obatolu, B.O., Yahaya, A.T., Akinpelu, A.O and O.A, Taiwo

Introduction

Cashew (*Anacardium Occidentale L.*) is a tree crop of considerable economic importance to Nigeria and other tropical countries. Apart from being a source of useful

products and by products for food, medicinal and industrial applications, cashew gives also a useful shade, while as ornamental and alley trees are suitable for the control of soil erosion, particularly for the protection of watersheds and dams (NEPC, 2002 report). Cashew is among the first nut crops exported in theworld with 5.35 million hectares of plantation in 2011 (FAO, 2014). Its production can solve the economic, social and environmental problems in the world (Balogun *et al.,* 2014). Cashew is an important cash crop owing to its nuts, balm and cashew nut shell liquid (CSNL).

The changing socio economic, political, environmental and climatic atmosphere in Nigeria and other developing countries generally known as "Global economic meltdown" across the globe has continued to aggravate the living conditions of most households especially those living in rural areas (Oluwatayo,2009) as Cashew farming households are not left out. The accompanying increase in poverty level has led residents of these economies to search for numerous strategies to cushion the negative effects of changes. This has led to diversification in their income which canvasses them to engage in other income generating activities. Income diversification refers to the allocation of productive resources among different income generating activities, both farm and off-farm (Abdulilah and Crolerees, 2001). The tendency for rural households to engage in multiple occupations is often remarked, but no known attempts have been made to link this behavior in a systemic way as to ascertain the potentials of the cashew farmers in breaking the poverty line when fully engaged in cashew production and utilization which is capable of reducing poverty among the cashew farmers.

Objectives

- identify the socio economic characteristics of the respondents
- identify secondary crops on cashew farms
- Identify the determinants of income diversification among rural households.
- investigate the reasons for income diversification
- Investigate the constraints to maximizing the income potentials in cashew
- determinants of income diversification

Methodology

A multistage sampling process is being used to carry out the study. Kogi state was purposively chosen for the study, purposive sampling of two cashew growing communities from each states that practice multi cropping agro forestry in each of the states will be achieved; random sampling of 20 farmers from each cashew growing communities will be done; administration of questionnaires to farmers and focus group discussions will be used to solicit for qualitative and quantitative data from respondents.

Conclusion

Questionnaires have been developed and contacts made for the training in the pilot state.

Challenge(s*):* funds to carry out the study in other cashew producing states

Status*:* Ongoing (Kogi state)

Future plan

To get more funds to survey states like Kwara, Abia and Benue to ascertain their practice and income diversification methods in the 2109 research proposal grant.

Experimental Title: Farm Demonstration of CRIN Perfected Technology (Cashew Milk) to Farmers in Two Local Government Areas of Kogi State Toward Sustainable Livelihood

Investigators: Yahaya, L.E; Jayeola, C.O; Ogunwolu, S.O & Igbinadolor R.O

Introduction

Nigeria is endowed with a lot of natural resources. Among these is cashew which is planted across the cashew ecological zon-es. The need to diversify is also germane to the Nigerian economy. Cashew is produced mainly for its kernel and embedded in it is cashew milk which can be harnessed to supplement the known conventional milks. Milk production from cashew is one of the CRIN perfected technologies. Farmers need income to supplement what they get from cashew production and thus sustain self as they engage in cashew business. Milk production from cashew can be one of such sources of income. This project seeks to train farmers on this perfected technology of the Institute.

Objectives

To train farmers on cashew milk production Increase income generation to farmers Adding value to cashew

Materials and Methods

Participatory approach shall be used in the training session. Cashew Milk shall be produced according to standard methods.

Status: On going

Challenges: Inadequate and late release of fund

Experimental Title: Effect of N and K Fertilizers on the Growth and Yield of Cashew in Ochaja

Investigators: Ibiremo, O.S, Ogunlade, M.O and Adeyemi, E.A

Introduction

Cashew is an important commodity crop with great potentials as foreign exchange earner and source of industrial raw materials with the prospect of becoming a major commercial tree crop in Nigeria. Cashew as a result of its wide adaptation is often grown in very poor soils and this has affected its survival and establishment (Topper, *et al.* 2001). Cashewcultivation is variously limited by both biotic and abiotic factors particularly in poor soils. The soils upon which cashew is grown are of poor to low fertility level. This level of productivity is largely dependent on natural soil endowment as fertilizers are not part of its production system. Consequently, the soils upon which cashew are cultivated were maintained through litter fall and other natural endowment. In cashew production, fertilizer is rarely used as an input in the production system. Hence, application of fertilizer is inevitable for the replacement of soil nutrients that are being mined through apple and nut harvest annually and for better seedling establishment. This can be achieved through guided fertilizer application based on soil test value. At Ochaja substation, the site being considered is deficient in nitrogen and potassium and for effective management of the soil, the addition of nitrogen and potassium based fertilizers will enhance its productivity. Conventionally, the use of solid fertilizers of major nutrients of nitrogen, phosphorus and potassium are common with few farmers that use fertilizers on the crop in Nigeria.

Objectives

- To evaluate the effect of application of N and K fertilizers based on soil test value on the growth and yield of cashew.
- To assess the residual effect of the fertilizer on soil and produce.

Materials and Methods

Soil samples were collected randomly within the plantation at Ochaja and the samples were processed and analyzed for both physical and chemical characteristics using standard laboratory procedures. The result of the analysis indicated that the total nitrogen was 0.04g/kg soil which is in adequate to sustain cashew as it requires 1g/kg soil and the available P was adequate while the exchangeable potassium was also deficient having a value of 0.012cmol/kg which is far below the critical of 0.12cmol/kg soil. From these values, four treatment combinations shall be formed from two rates of nitrogen fertilizer and two rates of potassium fertilizer that were applied to young cashew trees in the field. The Nitrogen fertilizer was applied at 0 and 54 kgN/ha while the Potassium was applied at 0 and 84kgK/ha and the treatments were arranged in a RCBD with 3 replications and crop morphological parameters, nut yield, kernel quality and soil nutrient characteristics would be measured. The fertilizers were applied in doses in which the first dose has been applied in June 2019 while the second will be applied in August/ September 2019. Initial plant growth parameters were taken to form the basis for assessing the effect of the fertilizer treatments.

Results

Table 1 showed the physico-chemical properties of the soil at Ochaja, the soil is sandy loam and the average values of sand, silt and clay were 888, 20 and 92 respectively. The pH is very close to neutral with a mean value of 6.7 while the organic carbon was low with an average value of 0.82g/kg soil. The total Nitrogen in the soil was 0.41g/kg soil which is below the critical value of 1g/kg soil. The deficiency of 0.6g/kg soil will require 54kg N for optimum production while the mean value for available P was 5.28mg/kg soil. This value is above the required by cashew for optimum productivity. The average value of potassium was 0.012cmol/kg soil. The deficiency of 0.108 requires 84kg/ha.

Table 1: Initial soil physical and chemical properties of the cashew plot

Block	Soil Depth (cm)	Sand g/kg soil	Silt g/kg soil	Clay g/kg soil	PH	O.C g/kg	Total N g/kg	Ava .P Mg/ kg	Exch K^+ Cmol/ kg	Exch Ca^{2+} Cmol/kg	Exch Mg^{2+} Cmol/kg	CEC Cmol/ kg	Base saturation %
A	0-20	88.52	2.28	9.20	6.7	0.78	0.072	5.03	0.012	2.26	0.35	2.78	95.83
A	20-40	89.52	1.28	9.20	6.8	0.66	0.023	5.20	0.011	1.73	0.29	2.18	95.05
B	0-20	89.52	1.28	9.20	6.6	0.97	0.049	5.35	0.012	1.26	0.27	1.70	92.81
B	20-40	87.52	3.28	9.20	6.7	0.86	0.021	5.55	0.012	1.34	0.25	1.15	91.62
Mean x		**88.77**	**2.03**	**9.20**	**6.7**	**0.82**	**0.041**	**5.28**	**0.012**	**1.65**	**0.29**	**1.95**	**93.83**

Status: On-going

Challenges: The delay in funding did not allow the project to commence on time**.**

Experimental Title: Assessment and Selection of Peelable Cashew Varieties in Nigeria

Investigators: Olasupo, F.O., Adeigbe, O.O., Ibiremo O.S., Ogunlade, M.O., Agbeniyi, S.O., Adeniyi, D.O., Ogunwolu, S., Yahaya L.E., Igbinadolor, R., Jayeola, C.O., Adeyemi, E.A., Iloyanomon, C.I., Mokwunye, I.U., Nduka, B.A., Uwagboe, E., Agbonghiarruyi, A., Babalola Obatolu

Introduction

Cashew is of a considerable economic importance in Nigeria because of its numerous local uses and as a source of foreign exchange earnings. Like cocoa, cotton, Palm produce and sesame, cashew provides considerable contribution to Gross Domestic Production, National Income and Generation of Foreign exchange. It is a major source of cash income to many small holder farmers in the central and northern parts of Nigeria (Topper *et al*. 2001; Aliyu 2008). It is next to cocoa in terms of contribution to gross domestic products as non-oil revenue earning in Nigeria (Aliyu and Awopetu, 2007). In addition to this, cashew has tremendous potentials to create employment, especially for women, as well as curb desertification in the North and erosion in the Southern part of the country. Of many products derived from the crop, the kernel is the most important because it commands high prices both at local and international markets. However, over 65% of the cashew trees growing in the country are still in the wild state and these trees produce nuts with low quality that command very low price in the global trade of nuts (Aliyu and Awopetu, 2007). The Kernels of Nigerian cashew were difficult to peel (i.e. remove the testa which cover the kernel) to the extent that 64% of the total labour required for processing 180MT raw nuts by a small-scale plant per month were expended on peeling (Chemonics International inc., 2002) unlike nuts produced from our neighbor, Benin Republic. It has also been reported by Topper (2008) that ninety-five percent (95%) of Nigeria nuts is being exported to Vietnam for processing as Indian workers refuse to process because of difficulty in peeling the testa from the kernel. As a result of these, Nigeria raw nuts are discounted in the region of 20% - 30% in the global market because the kernels were difficult to peel (Nugawela and Oroch 2005; Oroch 2005; Topper 2008). In addition to this, raw nuts produced by some farmers in Nigeria are of low quality due to diseases infections, premature harvesting and poor post – harvest handling (OLAM per. com.).

Objectives

The main objective of this project is to investigate what is responsible for the poor quality of Nigerian cashew nuts as it affects difficulty in peeling testa from the kernel.

Materials and Methods Samples collection

Two (2) cashew farms were pre-selected per local government in 2 local governments each from 3 states (Enugu, Kogi and Oyo). Three (3) high yielding cashew trees in the Jumbo, Medium and Small nut ranges were selected per farm for sample (nuts and budwoods) collection. All the nuts produced by each tree were dried and bagged separately for further analysis. Budwoods were collected from each of the trees to produce clonal seedlings of the sampled trees. Weather data were collected from metrological stations nearest to each of the sampling locations. Samples were collected in the following locations:

Enugu State
Nsuka LGC (Akwari village and Ibuko village), (2) Udi LGC (Okpatu village)

Kogi State
Dekina LGC (Etiukpolo village and Ajeenejo village), (2) Ofu LGC (Akpagidigbo village and Adumu)

Oyo State
Surulere village (Gambari), (2) Orire (Temidire village)

CRIN Research Stations

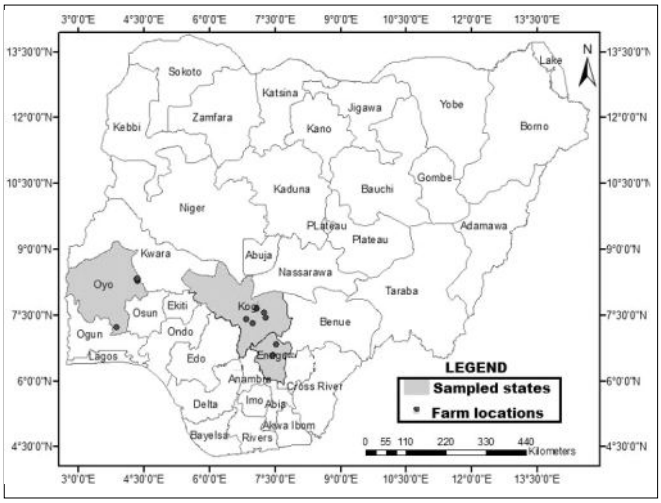


Figure 1: Map showing sample collection points and questionnaires administration

CRIN headquarters Ibadan, (2) CRIN Ochaja station

Soil sampling and analysis
Top soil and sub-soil samples were collected from 3 positions beside each of the cashew trees sampled above.

Survey of factors affecting the quality of cashew nuts production
Structured questionnaires were administered among cashew farmers in each of the selected local governments. Forty questionnaires were administered per local government area to collect data relating to cashew farming and quality nuts production in Nigeria.

Nuts processing and testa peelability data collection
The raw cashew nut samples were processed for data collection at ABOD Success Nigeria Limited, Ikorodu. Raw cashew nuts were cooked in a vessel for 30min to 45min using steam generated through the boiler. Thereafter, the boiler was allowed to cool down for 5 minutes before the nuts were offloaded. Then nuts were spread on the floor to cool down at room temperature for 18 to 24hrs. Then the cooled boiled cashew nuts were taken to the shellers to remove the outer shell from the kernels. Data were collected on the nut shelling output (i.e. whole nuts, split, broken, bad and empty shells). Shelled cashew nuts were loaded into the oven and allowed to dry at a maximum of 70°C during the day and 60°C in the night period to have even distribution of heat. Then, the kernel was taken to thermal shock chamber steam was released to the kernel for 5min to 10min. depending on the colour desired (for white and. 15 to 20min for scotch or brown after which the kernels were oven dry at 70°C for 48hrs. The testa peeling activity on each sample was carried out by 3 women peelers to serve as 3 replications for peelability data collection. For each of the samples, the time taken for each of the women to peel 1Kg kernel was taken with the aid of stop watch. Data was also collected on the nuts peeling output.

Clonal Propagation of selected cashew trees
Medium and small cashew nuts obtained from CRIN cashew germplasm were used to raise rootstocks. The bud-woods collected from each of the sampled trees were grafted on the rootstocks to produce the clones of the sampled trees for new clonal germplasm establishment.

Field establishment of selected genotypes in clonal and half-sib germplasm plots
Clonal seedlings generated from the sampled trees and seedlings produced from the open pollinated nuts (half-sib) were established in clonal and half-sib germplasm plots at CRIN, Ibadan and Ochaja respectively.

Results and Discussion

Varieties of Cashew Grown by Farmers in Nigeria
The results in table 1 showed that 43% of farmers sampled have local cashew cultivars on their farms while 33% and 2% cultivate Brazilian and Indian varieties, respectively. Others have a combination of two or the three varieties grown on their farms. Most of the local varieties produce nuts with low quality, in terms of nut size, kernel output ratio (KOR) and nut peelability.

Table 1: Cashew varieties grown by farmers in Nigeria

Cashew varieties grown by respondents	Frequency	Percent	Valid Percent	Cumulative Percent
No response	16	8.3	8.3	8.3
Local	82	42.5	42.5	50.8
Brazilian	64	33.2	33.2	83.9
Indian	3	1.6	1.6	85.5
Local & Brazilian	13	6.7	6.7	92.2
Local & Indian	11	5.7	5.7	97.9
Local, Brazilian & Indian	4	2.1	2.1	100
Total	193	100	100	

Diseases and Pests Affecting Production and Nut Quality of Cashew

In figure 1, the respondents were guided to identify some diseases and pest prevalence on their cashew farms. Fruit rot (33%) and inflorescence blight (21%) were found to be predominant diseases on the respondent farmers' fields. Other diseases and pest that respondents could not identify was about 18%. Without any doubt, disease infections and pest incidence contribute a lot to reduce crop production and produce quality. These may have significant contribution to the problem of cashew nut peelability in Nigeria.

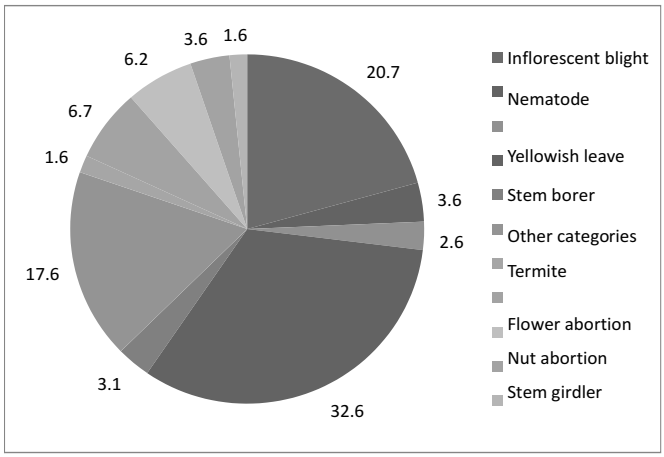


Figure 1: Diseases and pests affecting cashew on the farms

Inter-Character Correlation of Cashew Production

Table 2 shows the correlation coefficients among cashew farm characteristics, farmers' practices and buyers' behavior. There is a weak positive correlation of (.167) between the size of cashew farm and yield from cashew farm. Therefore, there are uphill increases between the two variables. The age of cashew farm is moderately and positively correlated (.518) to yield from cashew farm which leads to an uphill increase between the two variables. There is a low positive linear relationship of 0.044 between the varieties of cashew grown and yield from cashew farm. There is a weak negative correlation (-.309) between the size of cashew farm and sources of planting materials. Plant spacing and yield from cashew farms have a weak positive linear relationship of 0.392. Therefore, there are uphill increases between the two variables. There is a significant positive correlation (.165) between yield and pesticide application which results into a uphill increase between the two variables. Farm yield of cashew is also significantly correlated (.218) to buyers' preference for large nuts. However, cashew yield is negatively correlated (.175) to buyers' preference for medium nuts.

Selection of peelable cashew clones

The Out-Turn or Kernel Output Ratio (KOR) and Kernel Peeling Time (PELT) were used as the main evaluation criteria for selecting good accessions among the samples. Results of the evaluation are presented in figure 2. Most of the accessions have good KOR except EU102, KD102, KO201, KO202 and YO203. Only 13 (CR201, EN102, EN203, EU201, EU203, KD103, KD202, KO203, YS201F, YS201B, YS203 and YO102) out of the 32 accessions were observed to have PELT below 3,000 sec. EU203 has the shortest PELT (19 sec) and therefore regarded as the best peelable accession among all the samples.

Clonal propagation of sampled trees

The results of clones of sampled trees produced by grafting at CRIN nursery are presented in figures 3 and 4. All the survived clones have been established at Zone 3/4 of CRIN Ibadan and Ochaja sub-station as new clonal germplasm plots.

Conclusion

In this study, 13 out of 42 cashew accessions evaluated were selected for peelability trait. Clones of these accessions have been established in germplasm plots at CRIN, Ibadan and Ochaja. Factors associated with testa peelability shall be presented when other parameter are put into consideration.

Experimental Title: Development, Utilization and

Table 2: Correlation coefficient of cashew farm characteristics and farmers cultural practices affecting the nuts production quality in Nigeria

	SOF	AOF	VAR	SPM	BIO	SPA	YLD	PEC	FZR	BPJ	BPL	BPM	BPS	BPD
SOF	1	.215**	.198**	-0.309	0.037	-0.063	.167*	0.069	-0.074	-0.194	.192**	.150*	0.059	-0.067
		0.003	0.006	0	0.608	0.385	0.02	0.342	0.308	0.007	0.008	0.037	0.418	0.353
AOF		1	0.037	-.160*	0.073	0.028	.516**	0.029	-0.031	-0.029	.147*	-.169*	0.064	0.102
			0.61	0.026	0.314	0.695	0	0.686	0.671	0.688	0.041	0.019	0.38	0.157
VAR			1	-.242**	0.112	0.006	0.044	0.024	-0.063	0.118	0.065	.163*	.146*	.154*
				0.001	0.122	0.938	0.54	0.737	0.384	0.101	0.368	0.024	0.043	0.033
SPM				1	0.048	.155*	0.045	-0.105	-0.002	.229**	-0.249	-0.354	0.049	-0.004
					0.506	0.032	0.536	0.145	0.982	0.001	0	0	0.5	0.96
BIO					1	-0.011	.147*	0.032	.161*	0.131	-0.091	-.176*	-0.023	0.064
						0.881	0.042	0.663	0.025	0.07	0.209	0.014	0.751	0.377
SPA						1	.392**	.161*	-0.116	-0.019	0.058	0.048	0.111	.183*
							0	0.025	0.109	0.796	0.42	0.509	0.123	0.011
YLD							1	.165*	0.012	0.063	.218**	-.175*	0.126	0.072
								0.022	0.868	0.388	0.002	0	0	0
PEC								1	.313**	-0.066	.250**	.213**	0.078	0.056
									0	0.364	0	0.003	0.28	0.44
FZR									1	0.09	-0.014	0.042	-0.125	-0.057
										0.214	0.843	0.56	0.083	0.428
BPJ										1	-.424**	-.268**	.195**	.181*
											0	0	0.007	0.012
BPL											1	.413**	.143*	0.013
												0	0.047	0.852
BPM												1	.262**	.151*
													0	0.036
BPS													1	.416**
														0
BPD														1

Pearson correlation coefficient and probability value, N = 193, **, * = Correlation is significant at the 0.01 and 0.05 level (2-tailed) respectively. SOF = Size of farm, AOF = Age of farm, VAR = Varieties of cashew grown, SPM = Source of planting materials, BIO = Cashew biotypes planted, SPA = Planting spacing, YLD = Nut yield in Kg/ha, PEC = Pesticide application, FTZ = Fertilizer application, BPJ = Buyers preference to jumbo nuts, BPL = Buyers preference to large nuts, BPM = Buyers preference to medium nuts, BPS = Buyers preference to small nuts, BPD = Buyers preference to madras nuts

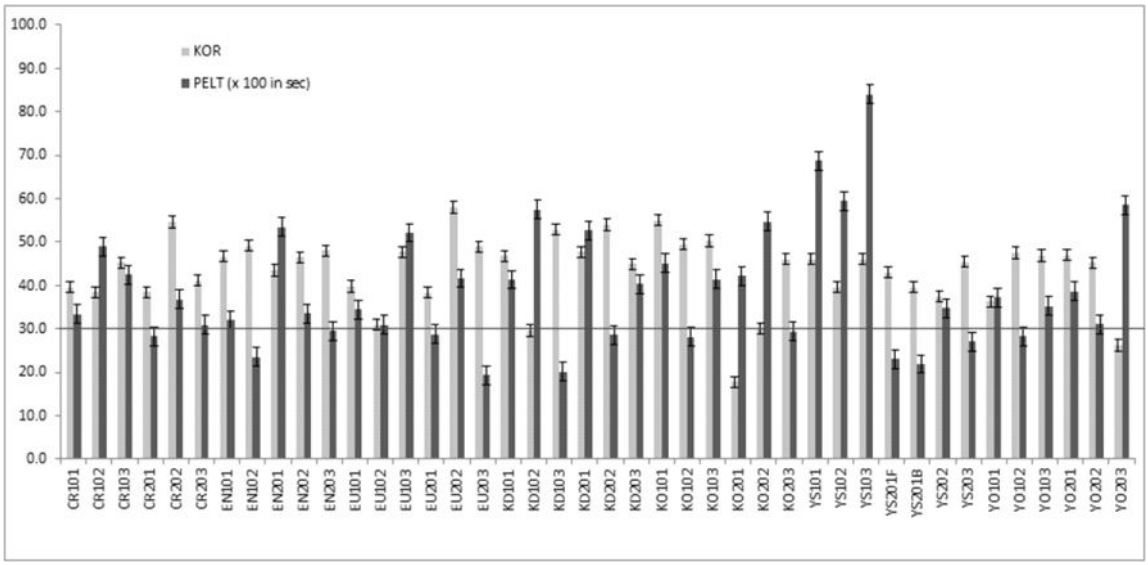


Figure 2: Kernel output ratio and testa peelability properties of cashew accessions sampled in Nigeria

Figure 3: Grafted cashew seedlings that have just started sprouting

Figure 4: Well-developed grafted seedlings 7 weeks after grafting

Evaluation of Cashew Apple-Wheat Composite Flour for Confectionery Production

Investigators: Ogunwolu, S. O, Yahaya, L. E., Ogunjobi, M. A. K. Oluyole, A. O, and Olalekan- Adeniran, M. A.

Introduction

Nigeria is one of the top ten cashew producers in the world. The production of cashew is estimated to about 160,000 tons of raw nuts per annum. About 60 to 70% of the local production is commercialized, of which about 90% is exported in the form of raw nuts. Nigeria is considered as one of the cheapest sources of raw cashew nuts supply to the Asian market. Only about 5 to 10% of total production are processed locally for local and export market consumption by handful of Nigerian entrepreneurs with various capacities ranging from 500 to 1,000 MT/year. Also, Cashew farmers lose the opportunity for enhanced income generation by selling raw nut cheaply to traders and leave the apple wasting in the farm. Bread and flour confectioneries are popular staple foods of all ages in Nigeria. Bread and Confectionery products vary widely around the world, as do their production techniques. Basic ingredients are Cereal flour, water, yeast and salt. Optional ingredients can be added to improve processing or to produce speciality and novelty breads and confectioneries which often have an increased nutritional and organoleptic values. The formulation of cashew nut-wheat and cashew apple-wheat composite flour for bread and Confectioneries production in Nigerian will increase the local utilization and consumption of Cashew. This will reduce the tendency of selling raw cashew nuts to importers at cheaper rate and provide a new use for cashew apple which hitherto wasted in cashew plantations across Nigeria.

Objective: To utilize the Cashew apple powder in the formulation of composite flour for bread and other flour confectioneries production, so as to increase the local

utilization and consumption of Cashew.

Materials and Methods

Materials: Fresh matured ripped cashew apple, polyethene sheet, knives, stainless trays, preservatives

Cashew apple powder processing

Cashew apple powder was produced from fresh apple at CRIN Ochaja Substation. Matured cashew apple were harvested and the nuts detached from the apple manually. The apples were then sorted, weighed and washed with Sodium metabisulphite solution (350 ppm) to remove any contaminants from the farm. Cashew apples were cut into small pieces of approximately 1.0 x 1.0 cm with sterilized stainless steel knife and spread on stainless trays for drying. The samples were oven dried at 65^{0}C for 12 hrs, until final moisture content of 7%. Another set of diced cashew apples were also dried under the Sun until 7% moisture content was attained. Dried cashew apple slices were allowed to cool and then ground in domestic blender (Phillips) at low velocity for 5 mins, sieved to obtain a powder with an average particle size of 6μm. The weight of cashew powder obtained was recorded, sealed immediately in polyethene bags and stored at room temperature (about 28^{0}C).

Physicochemical analysis of Cashew apple powder

Cashew apple powder samples were analysed for moisture, ash, crude protein, crude fat, crude fibre, carbohydrate (by difference) and vitamin C content according to the methods of Kirk and Sawyer (1991).

The physicochemical components of sun and oven dried cashew apple powder are as shown on Table 1. There were significant different between sun dried and oven dried cashew powder apple in moisture crude protein, crude fibre and vitamin C, while there were no significant different in crude fat, ash, carbohydrate and pH of the two samples. Sun drying resulted into higher crude protein and vitamin C content of the cashew apple powder compared with that of oven drying, this may be as a result of decomposition of vitamin C during oven drying of the powder. Also, oven drying method resulted to higher fibre content of the cashew apple compared with sun drying method.

Table 1: Physicochemical components of Sun- and

Parameters	Sun-dried Cashew apple powder	Oven-dried Cashew apple powder
Moisture (%)	7.05^a	6.50^b
Crude protein (%)	12.75^a	10.25^b
Crude fibre (%)	4.08^b	5.19^a
Crude fat (%)	4.85^a	5.21^a
Ash (%)	2.70^a	3.10^a
Carbohydrate (%)	68.60^a	69.00^a
pH	4.72^a	4.65^a
Vitamin C (mg/100g)	52.60^a	47.53^b

Values are means of three replicates; sample means with the same alphabets along the rows are not significantly different at $p<0.05$

Conclusion

It could be concluded that, both sun drying and oven drying methods are suitable for the production of cashew apple powder. However, for high crude protein and vitamin C, sun drying is recommended, while for high fibre cashew apple, oven drying method is recommended.

Status: On-going

Future plans

Formulation of cashew apple Powder-Wheat flour composite flour

Formulation and production of confectioneries from cashew apple powder-wheat flour composite flour.

Evaluation of the cashew apple powder- wheat flour confectioneries Feasibility studies of Composite flour and Confectioneries produced

Experimental Title: Biochar Generation from Cashew Litter and its Influence on Yield of Cashew in Ibadan and Kogi.

Investigators: Iloyanomon, C.I., Ibiremo, O.S., Ogunlade, M.O. and Akanbi, O.S.

Introduction

Leaf litter is an important component of tree cropping system. This is because it builds up on the forest floor and creates a layer of nutrient and litter on the soil. It is a major source of soil organic matter as it returns nutrients back to the soil through nutrient recycling. It reduces nutrient loss through leaching and erosion (Sunita and Uma, 1993). It also increases biological activities by providing biomass and suitable microclimate for various micro-organisms responsible for the release of mineral nutrients in available form to trees. It improves soil structure, water infiltration and water holding capacity of the soil. Therefore, planting

tree species with high biomass production rich in foliar and plant nutrient is important in maintaining soil organic matter (Young, 1977). Cashew generates 9.33 – 12.3 tons/ha of litter which contain substantial nutrients. However, release of nutrients from these cashew litter is slow due to the slow decomposition of cashew litter. This results to presence of lots of cashew litter on the floor of the cashew plantation, hence disrupting the ease of picking cashew nuts. Some cashew farmers at the beginning of cashew nut harvesting season gather the cashew litter on the floor of the cashew plantation and burn to allow for ease of picking of cashew nuts. This practice leads to loss of valuable nutrients. There is however need to discourage the practice of burning cashew litter by finding ways to enhance quick decomposition of the cashew litter and faster release of nutrients for use by the cashew trees. Biochar technology is an emerging and very promising way of meeting the challenges of soil fertility and organic matter maintenance in the tropical and has been found to be effective in tree arable and tree crops. There is therefore need to evaluate the effects cashew litter biochar and fertilizer on cashew yield and some soil properties.

Objectives

i. To produce of cashew litter biochar.
ii. Analyse chemical properties of cashew litter biochar.

Materials and Methods

Two cashew plantations of different ages were selected each at Ibadan and Ochaja. Each plantation was divided into four blocks. Leaf litter was collected in demarcated area of 20 m x 20 m from each block for use as biochar. Three such spots were demarcated per block. The 4th leaf of the cashew plant was also sampled, while soil samples were taken at 0-20cm and 20-40 cm depth using a soil auger at the points at where leaf litter was collected. A representative sample of the litter was oven dried at 60^{o}C milled to be analysed for its nutrient content. Soil and plant samples were also taken to the laboratory for analysis of some of its chemical properties. Analysis of soil, plant samples, leaf litter and preparation of cashew leaf litter biochar are on –going.

Status: On-going

Future plan: The influence of cashew biochar on yield of cashew nut.

References

Sunita, M and Uma M. (1993). Environment and Afro forestry. India farmer Digest. 25(3):29-36.

Young, A. (1977). Agroforestry for soil conservation. CAB International, Wallington.UK, 2nd edition.

Experimental Title: Plantation Diversification Through Bee-Keeping Under Cashew Orchard in Ochaja Substation

Investigators: Ibiremo O. S, Ogunwolu S.O, Ogunlade M.O, Oyedokun V. A and Olorunmota R.T

Introduction

One of the ways of ensuring sustainability of cashew production in Nigeria is through engaging the cashew plantation in other income – generating ventures in order to boost the income base of the cocoa – farming households. One of these productive activities is honeybee keeping under the natural habitat of cashew plantation. The raising of honeybees under cashew plantations will encourage farmers to return to their abandoned cashew plantations producing honey under cashew plantation is also one effective and efficient way of converting and utilizing cashew products with minimal wastes. This project was aimed at promoting cashew production through additional income generation from the cashew plantation.

Materials and methods

Twenty-five beehives were constructed by a wood worker were placed under cashew plantations in Ochaja substation of the Cocoa Research Institute of Nigeria. The hives were constructed with wooden boards of dimensions 108cm by 44cm. The numbers of top bars for each hive will be about twenty-six. The hives are the 'Kenya Top-bar hive model. The hives were placed with their flight entrance towards the eastern direction. The hives were colonized between September and December 2018. The total number of Kenyan Top bar hives brought from the Headquaters were 25. They were installed, baited and managed. Hive Management: All the hives were repositioned for ease of colonization by the bees. All hives were sterilized to disinfect the hives against all pests and diseases at different developmental stages that are posing threat to the bees. All the bars on each hives were sterilized and were rubbed wax and other aggregating materials All hives have to be re-baited with effective attractant (bait). Colony multiplication were carried out especially when there are strong colonies in order to prevent swarming of

the bees. Food supplement were made available to the bees during the time natural food substrates were not readily available. All the frames in the hives have to be wired and provided with foundation wax. The development and strength of the bee colony within the observation period was highly encouraging. Sensory evaluation is yet to be done.

Result

15 percentage colonization was recorded in the entire hives baited. In all, about 25 litres of pure and highly graded honey had been harvested since inception. Beekeeping equipment like hive tool, decapping knife, better smoker and hive tool were procured for the project. We would have harvested more than 300 litres of honey in 2019 but the herdsmen vandalized and harvested 14 heavily colonized and matured hives out of the 15 that we worked on just at the verge of harvesting them. We gave a time lag of 2 weeks for all the combs to be sealed and fully mature so as to have high quality honey but the herdsmen came in within the window period and harvested the honey, vandalized the hives and even burnt some. The nutritional quality of the honey harvested indicated that the carbohydrate content was 27.2%, sugar was 29.3% fructose was 12.3% and glucose sucrose was 9.2%.

Packaging

Customized plastic bottles of 33cl were used for the packaging of the product with labels showing the nutritional details of the product. The total weight of the honey was 450g per bottle.

Challenges

Fund should be made available for periodical visits to the hives with provision for food supplement.

Suggestions

We will like to suggest that the project should be replicated at the Headquarters in all the Cashew Plots so as to ensure the safety of the hives from vandalization.

Experimental Title: Sowing Media Effects on Emergence and Morphology of Cashew Seedling (*Anacardium Occidentale* L)

Investigator: Adeyemi, E.A

Introduction

Cashew propagated in Nigeria is usually achieved using the cashew nut. Nuts of cashew are sown in polythene pots filled with topsoil medium and nursed in the nursery for about 2 months before transplanting to the field. Top soil for raising tree crops like cashew in the nursery is fast becoming limiting and expensive. In view of this, it becomes imperative to investigate into alternate potting media for the production of cashew seedling in the nursery. The objectives of this study therefore are to determine the effects of potting media on the emergence of cashew seedlings and the morphological growth of the seedlings in the nursery.

Materials and Methods

The study was carried out at the nursery of Cocoa Research Institute of Nigeria (CRIN), Ibadan. Five potting media that were evaluated for emergence and growth of cashew seedlings were:

i.) 100% top soil;
ii.) 50% top soil + 50% saw dust; 1:1 ratio by volume
iii.) 75% topsoil + 25% sawdust; 3:1 ratio by volume
iv.) 25% topsoil + 75% sawdust; 1:3 ratio by volume
v.) 100 % sawdust

Topsoil used was obtained from cashew plantation at CRIN headquarters, Ibadan, while cured sawdust was collected from a saw mill at Orile-Odo village in Ibadan. Medium cashew biotype of good quality obtained from cashew germplasm plot at CRIN was used for the study. The topsoil was air-dried, pulverized and sieved with 2 mm sieve. Each of the sowing media was filled into 5.0 kg capacity plastic buckets. The treatments were laid out in a randomized complete block design (RCBD) in four replicates. Cashew nut was sown in pot adopting flat placement orientation (Hammed and Adeyemi, 2005). Application of water using watering-can was done thrice per week and hand weeding was done monthly. Insects control was achieved with ZAP 2.5 EC (Lambda cyhalothrin-based insecticide).

Data were collected on seedling emergence daily until 28 days (4 weeks) after cashew nut sown. Seedling growth parameters (plant height, stem diameter, number of leaves and leaf area) were recorded at fortnight interval until 10 weeks after sown (WAS). The data obtained were analysed with descriptive (mean, percentage) and analytical (ANOVA) statistics. Means were separated using DMRT at 5% level of probability.

Results and Discussion

Sawdust and topsoil/sawdust 1:1 had the highest total N

content value of 0.34 g/kg each while the least (0.13 g/kg) was in topsoil medium (Table 1). Similarly, sawdust had the highest organic carbon (OC) content compared to topsoil and other growing media. The pH of the topsoil is slightly below neutral level while other media tended towards alkalinity as shown in Table 1.

Effects of Potting Media on Emergence of Cashew

Medium property	Unit	Potting Media				
		Topsoil	Topsoil/Sawdust 1:1	Topsoil/Sawdust 3:1	Topsoil/Sawdust 1:3	Sawdust
Total N	g/kg	0.13	0.34	0.29	0.15	0.34
OC	g/kg	1.65	5.78	4.32	3.86	8.76
pH(H_2O)		6.77	7.35	7.10	7.52	7.78
Avail. P	mg/kg	3.27	5.40	2.44	3.88	2.01
Exch.Na	cmol	0.41	0.66	0.53	0.40	0.73
Exch.K	cmol	0.47	1.30	0.90	1.20	2.89
Exch.Ca	cmol	7.23	7.90	7.23	7.60	4.90
Exch.MG	cmol	2.38	2.52	2.87	2.75	4.43
Mn	mg/kg	270.1	217.1	154.6	200.3	9.0
Fe	mg/kg	4.90	14.70	7.10	6.65	32.0
Zn	mg/kg	9.67	12.18	9.16	10.98	39.80
Cu	mg/kg	0.86	1.06	0.92	0.82	1.10
Sand	g/kg	89.80	858.0	838.0	817.8	-
Silt	g/kg	4.40	84.0	94.0	88.2	-
Clay	g/kg	5.80	58.0	68.0	94.0	-

Seedling

Cashew seedling emergence commenced on the 16th day after sowing which occurred only in topsoil/sawdust 1:1 medium (Table 2) though the difference was not significant ($p \leq 0.05$) over the other sowing media. At 21 DAS, topsoil medium had the least percent emergence of 72.9 while sawdust medium attained 100 % emergence been higher than all other sowing media and the difference was significant ($p \leq 0.05$) as shown in Table 2. It took additional one week for the topsoil medium to attain the 100 % emergence as did sawdust medium. Early and higher cashew seedling emergence was enhanced in sawdust medium than in topsoil and the other sowing media. Table 2: Emergence in cashew as affected by potting media

	Days to emergence (%)												
Potting media	16	17	18	19	20	21	22	23	24	25	26	27	28
Topsoil	0	10.4ab	35.4b	56.3b	60.1c	72.9c	77.1a	87.5c	91.7c	91.7c	91.7c	91.7c	100.0a
Sawdust	0	4.2bc	50.0	83.3	83.3	100.0a	100.0A	100.0a	100.0a	100.0a	100.0a	100.0a	100.0a
Topsoil/Sawdust 1:1	1.0	12.5a	29.2c	62.5b	83.3a	87.5b	91 .7b	91.7b	95.8b	95.8b	95.8b	95.8b	95.8b
Topsoil/Sawdust 3:1	0	0c	16.7d	58.3b	70.8b	83.3b	83.3c	87.5c	91.7c	91.7c	91.7c	91.7c	91.7c
Topsoil/Sawdust 1:3	0	0c	0e	56.3b	70.8b	75.0c	75.0c	83.3d	83.3d	83.3d	83.3d	83.3d	83.3d
	ns												

Means in the same column followed by the same letters are not significantly different by Duncan Multiple Range Test (DMRT) at $p \leq 0.05$
n.s not significant

Effects of potting media on morphology of cashew seedling

A) Effects of potting media on plant height

Seedling plant height at 4 WAS, ranged from l1.5 to l3.5 cm in the five sowing media investigated (Table 3). The sawdust medium produced seedlings with the highest height while topsoil was one of the media with least seedling height. Percent increase in height of seedlings in sawdust over topsoil at each period of observation was 17.4, 14.8, 12.3 and 10.6. However, the seedling plant heights were not significant ($p \leq 0.05$) among the media throughout the periods of observation.

Table 3: Cashew seedling height as affected by potting media

Potting media	4	6	8	10
			WAS	
Topsoil	11.5	14.9	18.7	20.8
Sawdust	13.5	17.1	21.0	23.0
Topsoil/Sawdust 1:1	12.0	16.1	18.8	22.9
Topsoil/Sawdust 3:1	12.0	16.1	18.8	20.5
Topsoil/Sawdust 1:3	11.5	15.5	19.3	21.0
	ns	ns	ns	ns

n.s — not significant

B) Effects of potting media on stem diameter

Cashew seedling stem diameter at 4 WAS, in Table 4 was greatest in topsoil/sawdust 3: l and least in topsoil/sawdust 1:3 but the difference was not significant ($p \leq 0.05$). The similarity in seedling stem diameter among the sowing media occurred till 8 WAS.

At 10 WAS, seedling in topsoil medium produced the greatest stem diameter (0.95 cm) which was significant ($p \leq 0.05$) over seedling in topsoil/sawdust 1: 1 and 3:1 but comparable to seedling in sawdust and in topsoil/sawdust 1: 3 (Table 4).

Table 4: Cashew seedling diameter as affected by potting media

Potting media	4 WAS	6 WAS	8 WAS	10 WAS
Topsoil	0.54	0.69	0.89	0.95a
Sawdust	0.53	0.65	0.83	0.86ab
Topsoil/Sawdust 1:1	0.53	0.67	0.77	0.83b
Topsoil/Sawdust 3:1	0.56	0.64	0.79	0.82b
Topsoil/Sawdust 1:3	0.52	0.68	0.81	0.87ab
	ns	Ns	ns	

Means in the same column followed by the same letters are not significantly different by Duncan Multiple Range Test (DMRT) at p ? 0.05
n.s — not significant

C) Effects of potting media on number of leaves

Number of leaves in cashew seedling in the five sowing media ranged between 5.8 and 6.3 at 4 WAS but the difference was not significant ($p \leq 0.05$) as shown in Table 5. The similarity in number of leaves of seedlings in the different sowing media was maintained till 8 WAS

At 10 WAS, seedling in topsoil medium had 14.8 leaves which were significantly higher than those in equal ratio of topsoil/sawdust mixture but comparable to number of leaves of seedling in the other three sowing media (Table 5)

Table 5: Number of leaves in cashew seedling as affected by potting media

Potting	Number of leaves			
	4	6	8	10
			WAS	
Topsoil	5.8	7.4	10.8	14.8a
Sawdust	6.3	8.7	9.8	12.4ab
Topsoil/Sawdust 1:1	5.8	8.9	10.0	11.6b
Topsoil/Sawdust 3:1	6.3	7.8	9.6	12.3ab
Topsoil/Sawdust 1:3	6.0	8.4	9.8	1l.8ab
	ns	ns	ns	

Means in the same column followed by the same letters are not significantly different by Duncan Multiple Range Test (DMRT) at p ? 0.05
ns = not significant

D) Effects of potting media on leaf area of cashew seedling

Leaf area of cashew seedling in all the five sowing media was similar at each period of observation all through the period of investigation (Table 6).

Table 6: Leaf area of cashew seedling as affected by potting media

Potting	Leaf Area (cm^2)			
	4	6	8	10
			WAS	
Topsoil	37.2	47.6	55.4	61.4
Sawdust	43.7	48.1	54.2	61.2
Topsoil/Sawdust 1:1	43.6	52.6	59.4	64.9
Topsoil/Sawdust 3:1	40.3	49.5	56.5	64.4
Topsoil/Sawdust 1:3	41.1	45.9	53.1	57.0
	ns	Ns	ns	ns

Conclusion

Results obtained from this investigation are indications that sawdust could be used as a replacement for topsoil in cashew seedling production. Consequently, a part of the cost of production (purchasing topsoil) is eliminated for seedling production. Topsoil is retained only for field cultivation. Sawdust that is hitherto a waste is converted to wealth.

Reference

Hammed, L.A. and Adeyemi E.A. (2005) Germination and Seedlings performance of cashew (*Anacardium Occidentale*) as affected by nut-showing orientations and cotyledon removal. Nigeria Journal of Horticultural Research Vol. 10, 59-64p

Title: **Cashew Germplasm Enhancement and Maintenance**

Investigators: Adeigbe O.O. and Olasupo F.O. Adeniyi D.O. Nduka B.,

Introduction

The important of germplasm to the breeding and development of new variety of crop cannot be over-emphasized. It serves as a reservoir of diversity and a ready source of desirable variety of traits for selection and crop improvement. The main germplasm for cashew in Cocoa Research Institute of Nigeria (CRIN) headquarters is a field germplasm of 2.5 ha plot consisting of 8 blocks of different nut sizes of Brazil and India origin. The plot was established in 2005 and resupplying made at different times in the subsequent years. Presently however the trees have outgrown their branches and are interlocked with neighboring trees thus disrupting observations and data collection in the plot. The varieties planted per block have also caused or roused some kind of controversy because of lack of standard identification tags per tree and absence of sign post. As a germplasm, it is important to ensure strict separation and identification of individual materials on the field, thus the need for this proposal.

Methodology:

The activities carried out on the germplasm plot were:

1. Erection of a larger sign post stating the types of materials planted per block.
2. Removal of interlocks
3. Pruning of trees
4. Clearing
5. Fire tracing
6. Spraying with herbicides

Result

A large signpost has been erected stating the types of materials planted per block (i.e. Brazilian jumbo, extra-large, large, medium, and Indian large, medium small and madras). Iron identification tags labelling each of the tree from 1-40 have been put at the base of individual trees in each of the blocks. The trees in the plot have been pruned. Weeding including fire tracing have been done.

Recommendation

Annual pruning in addition to frequent clearing and fire tracing is recommended to keep the plot in good shape as well as prevent spread of any unforeseen fire incidence.

Title: Influence of appropriate fertilizer application on yield of cashew in Ochaja

Investigators: Iloyanomon C.I., Ibiremo, O.S. and Ogunlade, M.O**.**

Introduction

Cashew is an important commodity crop with great potential as a foreign exchange earner and source of industrial raw material. It is adapted to a wide range of soils and is often grown on very poor soils with low fertility levels. The productivity of cashew is therefore largely dependent on litter fall and natural soil endowment, as fertilizers are largely not part of cashew production system in Nigeria a. This has adversely affected cashew yield.

The application of fertilizer is however inevitable for the replacement of soil nutrients that are mined through cashew apple and nut harvest annually. This can be achieved through guided fertilizer application which

ensures replenishment of mined nutrients. There are various types of fertilizers inorganic, organic and organo-mineral, each with its merit and demerit. There is therefore need to study the influence of the various fertilizer types on cashew productivity.

Objectives

i. To evaluate the influence of the various fertilizer types on yield of cashew.
ii. To assess the influence of fertilizer types on soil physical and chemical properties.

Materials and Methods

Trees in the selected cashew plantation were pruned and composite soil samples collected from the cashew plantations at 0-20 cm and 20-40 cm soil depth. Leaf samples were also collected from the cashew tree. The soil samples collected were air dried passed through 2 mm sieve and analyzed in the laboratory for some of its physical and chemical properties. The leaf samples were oven dried to constant weight, milled and nutrient content of the leaves determined**.**

Fertilizer was applied based on soil testing. The treatments were:

a. No fertilizer control
b. NPK + MOP (Inorganic fertilizer)
c. Organic fertilizer
d. Organo-mineral fertilizer

The fertilizers were applied at the rate of 28 Kg N/ ha + 40 Kg K/ha.

The treatments were arranged in a randomized complete block design (RCBD) with four replications. Each treatment was applied on six cashew trees per replication giving a total of 96 trees. These treatments were administered on eighteen-year-old cashew trees of Oro selection with medium sized nuts.

Yield data such as number and weight of cashew nuts of the various experimental units were studied at cashew nut production stages. Data collected were subjected to statistical analysis and significant means separated using Duncan multiple range test at 5% level of probability

Results and Discussion

Results indicated that soils in cashew plantation at Ochaja was strongly acidic with pH values of 5.30 and 5.07 at 0-20 cm and 20-40 cm soil depth (Table 1). Organic carbon content in the top 0-20 cm soil depth was low with a value of 4.10 g/kg. Total nitrogen was also low with a value of 0.3g/kg at the top 0-20 cm soil depth (Table 1). This was well below the soil critical nitrogen value of 1g/kg required for cashew. Hence the need for nitrogen fertilizer. This was corroborated by the leaf nutrient content of 11.4g/kg (Table 2), which were below the soil critical N value of 12.4g/kg required by cashew.

Soil available P was adequate with values of 6.54 mg/kg to 6.23 mg/kg at 0-20 cm and 20 – 40 cm soil depth (Table 1). This is above the soil critical P value of 3.7 mg/kg required for cashew (Egbe *et al.,* 1989). P was therefore adequate hence no need for P fertilizer. Soil exchangeable K at the top 0-20 cm soil depth was however inadequate with a value of 0.07 cmol/kg soil (Table 1). K fertilization would be required.

Soil exchangeable calcium content of the soil was high across the various soil depth and cashew plantations with values of 9.53 and 8.13 cmol/kg at 0- 20 cm and 20 40 cm soil depth (Table 1). This was well above the soil critical value of 8 cmol/kg required for cashew, hence no need for Ca fertilization. This was corroborated by the high leaf calcium content of 74.54 g/kg (Table 2) which was well above the foliar critical calcium content of 1.8g/kg required for cashew. Micronutrient Zn, Fe, Cu and Mn were sufficient in the soil (Table 1).

Table 1: Initial physical and chemical properties of soils of cashew plantations in Ochaja

	Soil depth (cm)	
Parameters	0 - 20	20 – 40
pH	5.37	5.07
Organic carbon (g/kg)	6.90	4.13
N (g/kg)	0.30	0.27
P (cmol/kg)	6.54	6.23
K (cmol/kg)	0.07	0.06
Ca (cmol/kg)	9.53	8.13
Mg (cmol/kg)	0.59	0.50
Na (cmol/kg)	0.36	0.39
Ex base (cmol/kg)	0.55	9.08
Ex. Acidity (cmol/kg)	0.10	0.11
ECEC (cmol/kg)	10.65	9.19
Base saturation (%)	99.06	98.80
Zn (mg/kg)	4.11	4.39
Cu (mg/kg)	3.04	0.37
Mn (mg/kg)	27.60	9.45
Fe (mg/kg)	16.60	16.76
Sand (g/kg)	847.6	828.6
Silt (g/kg)	120.6	130.6
Clay (g/kg)	31.8	40.8
Textural class	Loamy sand	Loamy sand

Table 2: Initial leaf nutrient content of cashew plantations in Ochaja

Parameters	Value
Organic Carbon	51.6
N (g/kg)	11.4
P (g/kg)	0.53
K (g/kg)	14.5
Ca (g/kg)	74.54
Mg (g/kg)	6.10
Zn (mg/kg)	115.87
Mn (mg/kg)	380.23
Fe (mg/kg)	236.11
Cu (mg/kg)	18.37

Conclusion: Soils of the plantation was deficient in Nitrogen and potassium. The is need for a appropriate fertilizer application to enhance cashew nut yield

Status: On-going

Future plan: Evaluate residual effect of the fertilizers on cashew nut yield

References

Egbe, N.E., Ayodele, E.A. and Obatolu, C.R. (1989) Soils and nutrition of cocoa, coffee, kola, cashew and tea. In: Progress in the Crop Research in Nigeria (2nd Edition), CRIN Ibadan.

KOLA PROGRAMME

Title: Evaluation of some agricultural wastes for the control of kola storage weevil Balanogastiskolae in South-western Nigeria

Investigators: Olorunmota, R.T; Asogwa, E.U; Oyedokun, V.O

Introduction

The kola weevils are the most destructive pests of kolanut in West Africa, one of which is Balanogastriskolae (Daramola, 1973). Weevil infestation of 30-70% and 100% in late harvest had been reported in Ivory Coast and Nigeria (Daramola, 1973). Farmers and traders often employ the use of synthetic pesticides.

Use of phostoxin (aluminium phosphide) fumigants which produces toxic phosphine gas to control weevil was reported being effective, with all the developmetal stages of weevils killed in 1 tablet of aluminium phoshide in 100litres air-tight drum containing 3.5kg of kolanut. However most kolanut produced in Nigeria is consumed raw with high level of pesticide residue while treating the nuts against weevil infestation. Authors have reported the efficacy of different plant parts in controlling insect pest of stored products. Udo (2005) investigated the use of five plants: Piper guineense (Schum) and Thonn, Allium sativum (L.), Afromomummelequata K. Schum., Xylopiaaethiopica (Dunal) A. Rich. and Tetrapleuratetraptera (L.) as possible protectants against the maize weevil, Sitophiluszeamais (Mots.) (Coleoptera: Curculionidae) in stored maize in the tropics, and discovered that all spices had higher mortality of insects more than the control after 96 hours of exposure. Olorunmotaet al 2017 reported higher mortality in beans treated with ash of rice husk and melon shell against bean weevil, Callosobruchusmaculatuus(Fab). Hence there is a pertinent need to survey existing methods of kola nut curing among farmers and traders and evaluate the effect of some agricultural wastes as a potential alternative to synthetic insecticides thus checking the hazardous effects of persistence consumption of insecticide residue in treated kola nut on human health.

Based on the findings above, this study will check the possibility of controlling kola weevil, Balanogastriskolae, using powder and ash of rice husk and melon shell

Objectives

i to determine the prevailing kolanut curing methods among farmers and traders

ii. to determine the effect of powder and ash of rice husk and melon shell in the control of kola weevil

Materials and methods

Field survey

A total number of one hundred and twenty kola nut traders in three kola producing states of the southern Nigeria (Oyo, Osun, Ogun) were interviewed using structured questionnaires

Data on socio- economic characteristics of the respondents, methods of insect pests control employed by each trader and post-treatment effect were collected. Data was analysed with the aid of SPSS version 23. The socio-economic characteristic of the farmers and their methods of insect pest control were analysed using frequency and percentage.

Bioassay

Freshly harvested unskinned kolanuts (Cola nitida) and weevil-infested kolanut were bought from local markets in Ogun state of Nigeria. Unskinned kola nuts were cured and sorted into healthy and infested nuts in the Entomology laboratory. The kola weevil, Balanogastriskolae used for the experiment was obtained from already infested nuts purchased from the market. The nuts were kept in a polyethene bag and checked at three days' intervals to collect new emergent. Rice husk and melon shell were purchased and grinded into fine powders.

The experiment was laid out in a Completely Randomized Design (CRD) and each treatment applied at four levels of: 4.0, 8.0, 12.0 and 16.0 g per kg of healthy kolanut in a black polyethene sheet kept in a woven basket. A standard control with 0.8g of Aluminium phosphide per kilogram of kolanut and no-treatment control were set up. The treatments and the two controls were replicated thrice. Each powdered material was well mixed with the kolanut for even distribution. Five pairs (♀&♂) of new emergent of Balanogastriskolae from the cultures in the laboratory were introduced into each 0.5kg kolanut in a nylon kept in woven basket.

Adult mortality of the weevils was counted and represented in percentages, at 48hrs after weevil introduction while the remaining weevils were removed. The nuts were checked on weekly basis for adult emergence and the live and dead counts of the emerged weevils were recorded for a period of four months. At the end of the experiment, kolanuts with mould growth were removed and weighed and the kolanut without entry/exit hole and mould growth were considered as healthy nuts and also weighed. Weight loss was computed by deducting the final weight from the initial weight of 500

Results

The findings of this study (Table 1) showed that majority (95%) of kola traders are women with average age of about 53years, of which 82.5% had no formal education. 80% of them were married while the remaining were widows. Those that engaged in kola nut trading solely accounted for 62.5% while others traded in both kola nut and bitter kola.

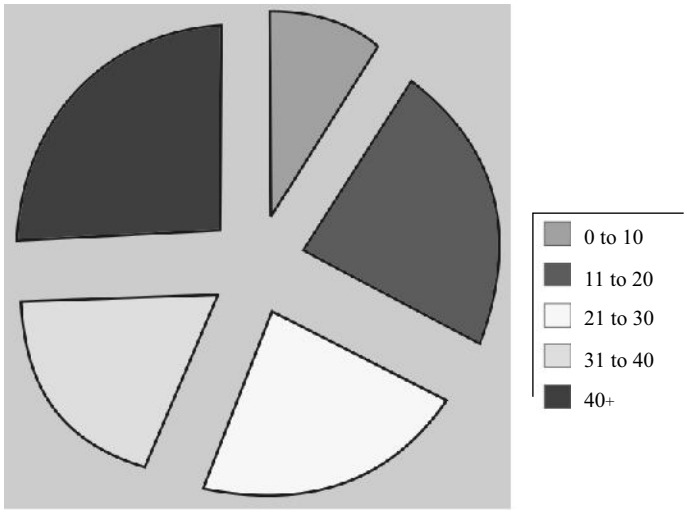
Figure 1 showed that only few traders had less (between 0 to 10) years of trading experience and most had traded with kola nut between 11 and 40 years. Figure 2 showed various curing methods employed by kola nut traders which revealed that majority of them used chemical in curing kola nut. From the chart, combined use of gammalin and phostoxin (gammaphos) accounted for the highest chemical being used while Phostoxin is high and gammalin is low. Figure 2 also showed that few traders used botanical method of curing and 'nil curing'. However, comparatively few traders employed Intergrated Pest Management as method of curing their nut.

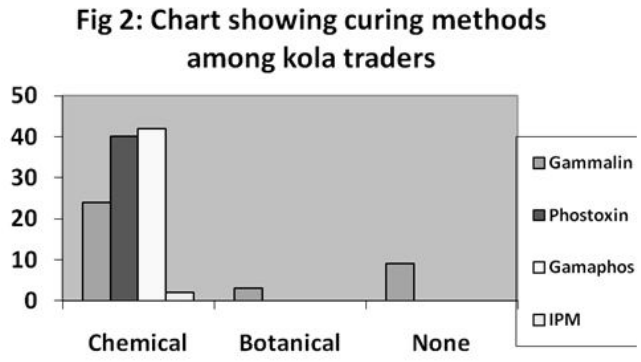
Table 1: Kola traders' personal characteristics (n=120)

Variables	Frequency	Percentage
Mean		
Sex		
Male	6	5
Female	114	95
Age (years)		
? 30	1	0.83
31-40	20	16.67
41-50	31	25.83
51-60	26	21.67
61-70	32	26.67
Above 70	10	8.33
Educational Status		53.25
None	99	82.5
Primary	21	17.5
Marital Status		
Single	-	
Married	96	80
Divorced	-	
Widow	24	20
Occupation		
Kola trading exclusively	75	62.5
Kola trading with bitter kola	45	37.5

Source: Field survey 2019

Fig 1: Chart showing kola nut traders' years of experience





Mortality of the introduced weevil in the experiment as seen in Table 2 showed significantly low (P ≤ .05) toxicity on B. kolae in both treatment and the control, unlike the standard control. The powders had significantly low toxicity when compared with the conventional Phostoxin used by kolanut traders. The MSP treatment at all levels of application recorded zero mortality just as the 'no treatment' control, while the RHP treatments though at 4.0 and 8.0 level of application recorded zero kill also, but at 12.0 and 16.0 recorded 3.33 and 13.33 kill of the insect. The standard control of Phostoxin recorded significantly higher (P ≤ .05) mortality (90.00) of B. kolae.

Table 2: Percentage mortality of B. kolae in the powders

Concentration	Adult mortality	
gkg-1	RHP	MSP
0	0.00c	0.00c
4.0	0.00c	0.00c
8.0	0.00c	0.00c
12.0	3.33c	0.00c
16.0	13.33b	0.00c
Standard	90.00a	90.00a

Means with the same superscripts are not significantly different at (P ? .05) using DMRT RHP- Rice husk powder, MSP- Melon shell powder

The population growth of B. kolae in the treatments as seen in Table 3 shows that the standard control recorded significantly low (P ≤ .05) population as against the treatments. From the total adult emergent, the 'no-treatment' control recorded significantly higher value of 46.33 as against the treatments at all levels of application. RHP and MSP treatment at lower application rate of 4.0g/kg recorded 32.67 and 25.99 and at highest application rate of 16.0g/kg recorded 15.66 and 17.66 respectively. However, the standard control treatment had significantly (P ≤ .05) low population growth of 0.66 in comparison with the treatments.

Live count of adult emergent in RHP and MSP treated kolanut recorded fewer B. kolae as against the no-treatment control (46.33) as seen in Table 3, while the standard control recorded significantly (P ≤ .05) low emergent (3.33). Both RHP and MSP treatments recorded population growth capacity that are not significantly different at the same level of application. At 4.0g/kg level of application RHP and MSP treatments recorded 19.67and16.00 while at a higher application of 16.0/kg they had 13.33 and 11.67 respectively.

Mean dead count of adult B. kolae in both powders differs significantly (P ≤ .05) from the no - treatment control and the standard control which recorded 0.00 and 0.33 respectively. At lower application rate of 4.0g/kg mean dead count of B. kolae in RHP and MSP treatments were 13.00 and 9.00 while at the higher rate of 16.0g/kg they recorded 2.33 and 6.00 respectively

Table 3: Table 2: Population growth of B. kolae in the powders

Concgkg-1	Dead		Live		Total Emergents	
RHP	MSP	RHP	MSP	RHP	MSP	
0	0.00f	0.00f	46.33a	46.33a	46.33a	46.33a
4.0	13.00a	9.00bc	19.67bc	16.00bcd	32.67b	25.99cd
8.0	11.00ab	11.00ab	21.33b	15.66cd	32.33b	26.99c
12.0	4.33ef	8.67bc	14.66cd	13.33d	18.99e	22.00d
16.0	2.33de	6.00dc	13.33d	11.67d	15.66fg	17.66ef
Phoxto	0.33f	0.33f	0.33e	0.33e	0.66h	0.66h

Means with the same superscripts are not significantly different at (P ≤ .05) using DMRT. RHP- Rice husk powder, MSP- Melon shell powder

Weight of mouldy nuts was significantly higher in the 'no treatment' control than that of the treated (Table 4). Mouldy nuts accounted for 116.67g in the 'no treatment' control while the MSP treatment recorded 36.67g at a lower application rate of 4.0g/kg to as low as 16.67g at the higher rates of 8.0, 12.0 and 16.0g/kg that is not significantly different from the standard control. The RHP treatment also recorded significantly low weight of mouldy nuts at all levels of application as against the 'no treatment' control.

Percentage weight loss in the treatments at all levels differs significantly from untreated control. While the untreated control lost up to 59.33% weight, the MSP treated kolanut lost between 17.33 to 28.67% and RHP treated kolanut lost between 22.13 to 42.67%.

Table 4: Mean Percentage weight loss in treated kolanut

Conc	Weight of Mouldy nuts		% Weight loss	
gkg-1	RHP	MSP	RHP	MSP
0	116.67a	116.67a	59.33a	59.33a
4.0	58.33b	36.67b	42.67b	28.67bcd
8.0	11.33b	16.67b	22.13d	38.00bc
12.0	12.67b	16.67b	22.60cd	20.67d
16.0	54.67b	16.67b	30.67bcd	17.33d
standard	13.33b	13.33b	16.00d	16.00d

Means with the same superscripts are not significantly different at ($P \leq .05$) using DMRT. RHP- Rice husk powder, MSP- Melon shell powder

Discussion

The findings of this study revealed that women dominated kola nut trading in the study area most of whom are advancing in age, with lack of formal education. This may hinder the adoption of safer alternatives for the control of kola weevil such as botanical method. Also high dependence on synthetic insecticide for weevil control can be attributed to its efficacy to minimize economic loss. Continual use of chemical in long storage period of kola nut may result to accumulation of chemical residue.

There was a relatively high percentage mortality of B. kolae in the RHP treatments especially when compared with the no treatment control. This high mortality occurred at high level of application. It indicated that higher dosage is needed to achieve appreciable kill of the weevils. High level of efficacy at high level had been reported by many authors. Efficacy of powdered plant materials like Eugenia aromatica, Aframomummelegueta, wood ash against Sitophiluszeamais, Rhizopertadominica and Calosobruchusmaculatus at high concentrations were reported by different authors (Lajideet al, 1998: Olorunmotaet al, 2017).

In the present study the two powders induced significantly low F1adult emergence of B. kolae in contrast to the no treatment control. The reduction in F1 progeny emergence in the kolanut treated with RHP and MSP might result from increased ovicidal and larvicidal properties of powders which agrees with the findings that leaf bark, seed powders, oil extracts of plants reduced ovipositionrate of insect pests and suppress progeny production in stored grains (Shaaya et al., 1997; Tunc et al., 2000; Tapondjou et al.,2002).

These two powders, RHP (Rice Husk Powder) and MSP (Melon Shell Powder) may hinder the movement of male weevil to locate the female weevil and cause reduced oviposition. Blockage of the spiracles of the weevils by the powders may occur which will impair spiracle respiration and the subsequent death of theB.kolae (Law-Ogbomo and Enobakhare, 2007; Mulungu et al., 2007).

The need to develop potent botanicals against the kola weevils is imperative. Admixture of Rice Husk Powder (RHP) and Melon Shell Powder (MSP) with other botanical powders of insecticidal properties may serve as safer alternative.

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Title: Clonal Propagation and Development of High Yielding Kola Varieties

Investigators: Adenuga, O. O., Adebiyi, S., Oduwole, O.O., Ibiremo, O.S. and Ugioro, O.

Introduction

Cola, a tropical African genus that belongs to Sterculiaceae comprises of about 140 species (Onomo et al., 2006). Over fifty species of this genus have been described in West Africa (Adebola, 2003). Of these, only a few are fruit bearing while majority are woody species of economic importance. The most commonly used species are Cola nitida [(Vent) Schott and Endlicher], Cola acuminata [(Pal de. Beuav) Schott and Endl] and Cola anomala (Schott and Endlicher). C. nitida and C. acuminata are the two major cultivated species in Nigeria. These, in addition to many uncultivated species are of great importance for their economic, pharmaceutical, confectionery, nutritional, socio-cultural and other uses. The genus is of enormous economic and scientific importance. However, CRIN's kola germplasm, which should be the reservoir of useful genetic resources for the improvement of the crop has a very narrow genetic base.

CRIN urgently needs to assemble new kola germplasm and properly characterise its germplasm so as to develop early-fruiting kola genotypes. This is based on the fact that the existing germplasm has a very narrow genetic base and is largely uncharacterised. Furthermore, the existing germplasm consists of old trees whose fruit bearing abilities have significantly diminished. These two key factors make the existing germplasm unsuitable to solve the problems identified in kola production, which are self and cross incompatibilities and inefficient pollination, regarded as responsible for low yield. There is also the need to reduce the gestation of the crop. Solving these problems will encourage further farmer interest in the crop. The Institute at present does not have any improved or identified variety for distribution to farmers. Therefore, the use of vegetative propagation urgently need be improved upon and perfected by the Institute in its attempts to solve the aforementioned problems. The experiment was carried out to identify good performing kola accessions from farmers' plots in Osun and Ondo States in Nigeria and determine the success of clonal establishment of such accessions in CRIN's kola germplasm plot.

Materials and Methods

Collection of Scions: A pre-survey of kola farms with identified good accessions was carried out in selected locations in Okuku (Osun State) and Bamikemo (Ondo) States of Nigeria. These included two farms each in both States. Stem cuttings were collected from four accessions from each farm. This implies eight accessions from each of Okuku and Bamikemo. A total of sixteen accessions were used in the study. Stem cuttings were collected from the apical regions of the trees selected as mother tree. These trees have diverse genetic origin. They are early bearing with good tree architecture and are also resistant to diseases. Collected scions were semi-hardwood flushes (greenish brown in colour) harvested from the mother tree. The scions were between 10cm - 20cm long and possessed enough buds including an active apical bud which should develop into a new shoot. The scions were harvested very early in the morning before sunrise, and the leaves around on the scions were trimmed to reduce leaf area and thus minimize moisture loss due to transpiration. The scions were wrapped in moist cotton wool to prevent scion dehydration and transported in an empty box from the farmers' plots to the site of the experiment at CRIN headquarters.

Setting of cuttings: Dressing of the cuttings involved the removal of their leaves except two or three leaves close to the apical bud are left. The detached end of the cutting was not dressed. The cuttings were planted directly into propagation structures (wooden boxes) filled with rooting medium. The rooting medium used was a mixture of river sand and rice husk in a ratio of 1:1. The entire cuttings together with the medium were covered with transparent polythene sheet after sowing. The entire medium and cuttings are then kept under shade. Cuttings are then watered every 2-3 days and inspected for rooting and leave development. A hundred cuttings of each accession

Grafting: The detached end of the scion is shaped like a wedge using a knife and grafted unto root stocks that were six months old. Grafted plants were covered with small transparent polythene sheets to create a humid environment around the leaves and helps reduce transpiration. The plants were arranged under shade and success checked periodically for about two months. Grafting tapes and transparent polythene covering on successful grafts were removed immediately. After six months, successful grafts were transplanted to the field.

Results and Discussion

Callus formation did not occur in any of the accessions used in the setting of cuttings, though a number of them produced leaves (Figure 1), these leaves were eventually abscised in approximately three months after formation. The reason for failure of callus formation is yet to be understood.

Some level of success was recorded in the grafting exercise (Figure 2). A total of 85 individuals out of 320 (representing 26.6%) remained green after two weeks of grafting. This figure was eventually reduced to 52 out of 320 at six weeks after grafting. By eight weeks after grafting, only 6 individual sprouts were available, representing 1.88% of the original population. Sprouting among the Cola accessions was observed to have been inconsistent with the expectation of 3-4 weeks after grafting, as more than half the initial 26.6% that were green after two weeks remained green even beyond six weeks, and some sprouts were eventually recorded beyond seven weeks after grafting. These inconsistencies may be attributed to the timing of the grafting which lied between March and August, 2018. Humidity was high during this period, and could have accounted for the low success rate. Appropriate timing for ideal grafting activities (as observed with cacao) lies between October through Early December, and February through Early April.

Figure 1: Leaf formation in Cola cuttings

Figure 2: Successful grafting in Cola accessions

Conclusion

Six successful grafts were established in a new Cola germplasm plot at CRIN Headquarters, Ibadan.

Status: On-going.

Title: Fertilizer Use and Kola Production in Southern Nigeria

Investigators: Ogunlade, M.O., Ibiremo O.S., Iloyanomon C.I. Oluyole K.A., Adebowale L.A. and Taiwo N.

Introduction

Kola trees are native to the tropical rain forests of Africa. It is an evergreen tree with long, ovoid leaves pointed at both ends with a leathery texture. The caffeine containing fruit of the tree is used as flavouring ingredients in beverages and there are two popular species of cola, Cola acuminata and Cola nitida. Cola nitida was originally distributed along the West Coast of Africa from Sierra-Leone to the Republic of Benin (Opeke, 1987) with highest frequency and variability in the forest area of Ivory Coast (now Cote D' ivore) and Ghana. The importance of kola nut to Nigerian economy cannot be over-emphasized, kola nut as a tropical tree crop has over twenty species, out of these Cola nitida and Cola acuminata are the only species grown on large scale in Nigeria. Out of the two species, Cola nitida is being traded internationally, while, the consumption of Cola acuminata is confined to Southern Nigeria. Before the dependence of the Nigerian It was also estimated that the internal kola nut market in Nigeria worth's about N30 million (Pala, 1976). In 1970, kola nut exports fetched N126, 000 to Nigerian government. Kola pod husk, economy on crude oil, kola nut played a significant role (Akinbode 1982). Out of the three components of kola fruit (pods) that is kola pod husk, kola testa and nuts, only the nut has been found to be of high economic importance, either in Nigeria or in the developed countries. In 1976 Nigeria produced 127,000 tons of kola nuts which accounted for 61% of world production (FAOSTAT 2014). In 2014, Nigeria produces about 128,437 tons of the fresh nuts representing 50% of the world production (FAOSTAT, 2014). Kola pod husk which has been considered a waste on the farm in the past, has been processed as diet, this ensures significant replacement of maize in poultry feed formulation. Also, kola testa, which is found in small quantity, has been used in some feed formulation (Hamzat and Jayeola, 2002). This showed that the whole kola fruit has considerable economic uses.

The removal of essentials plant nutrients through kola pod harvest over long periods without replenishment could be one of the major causes of decline in productivity on kola farms. The tree crop farming in Nigeria has been based on the exploitation of fertility build up by the forest. It is however important to note that nutrients are removed annually from the farm through crop harvests. The calculated amounts of N, P and K removed from one hectare of kola soil per year were 130.9kgN, 10.3kgP and 138.74kgK respectively through harvesting of pods (Ayodele, 1988). Ndagi 2012 also observed that old kola nut trees need adequate soil amendments as a result of nutrient mining through harvesting of kola nut pods. Adebowale and Odesanya 2015 also reported nutrient depletion in some kola plantations which might be due to

nutrients removed through pod harvest without replacement via fertilizer application. Therefore, the aim of this study was to evaluate the level of fertilizer use on kola in the study areas.

Materials and Methods

The study was carried out in Edo and Cross Rivers States. Purposive random sampling technique was used to select three Local Government Areas (LGAs) from Cross Rivers States and four LGAs from Edo States while one community was randomly chosen from each of the Chosen LGA. A total of 66 kola farmers were randomly chosen from the two States. Information was collected from the respondents with the aid of structured questionnaire and the data retrieved from the information collected were analysed using descriptive analysis.

Results and Discussion

Table 1 show that 59.16% of the respondents were of age 60 years and below, while 40.14% were above 60 years. This shows that large proportion of the respondents were still in the active age to do farm work conveniently and this would increase the productivity of the farmers and thus having positive impact on the farm size. From the study, 4.55% had no formal education while 90.91% had formal education ranging from primary to tertiary education hence, most of the respondents in the study area had formal education and this could lead to increased productivity as the respondents would be able to read and interpret the results of the research findings with ease. Table 1 also revealed that 90.91% of the farmers cultivate five hectares and above while 9.01% of the respondent farmers had farm size that is more than five hectares. This shows that majority of the farmers are small scale farm holders. Majority (81.83%) of the respondents had their farms older than 30 years, hence the productivity potentials of such farms would have been decreasing leading to low output. Hence, there's a need for rehabilitating such farms.

Table 1. Socio-economic Characteristics of the Farmers

Variables	Frequency	Percentage
Age		
≤ 40	3	4.55
41-50	12	18.19
51-60	24	36.37
> 60	27	40.94
Total	66	100.00
Gender		
Male	66	100.00
Female	0	0
Total	66	100.00
Educational Status		
No response	3	4.55
No formal education	3	4.55
Primary	33	50.00
Secondary	24	36.36
Tertiary	3	4.55
Total	66	100.00
Marital Status		
No response	12	18.18
Married	54	81.82
Total	66	100.00
Farm Size (Ha)		
≤ 5	60	90.91
> 5	6	9.01
Total	66	100.00
Age of farm (Years)		
No response	3	4.55
≤ 30	9	13.64
31-40	3	4.55
41-50	15	22.73
> 50	36	54.55
Total	66	100.00

Source: Field Survey, 2018.

Table 2 revealed the knowledge of the application of fertilizer of the respondents. The table reveals that majority (90.91%) of the respondents do not apply fertilizer on kola plantation. This development can lead to low productivity as most plantations would have been depleted of one nutrient or the other. However, the farmers claimed that they do not use fertilizer because fertilizer is not readily available. Others claimed that fertilizer was not necessary on their farms. The few kola farmers that used fertilizer only use NPK fertilizer on their farms and the fertilizer was applied at the rate of 20g per tree, while the method of application adopted are foliar and ring methods. Meanwhile, all the farmers who responded attested that they do not test their soil before fertilizer application.

Table 2. Status of the knowledge of fertilizer application

Attribute	Frequency	Percentage
Do you apply fertilizer on kola?		
No response	3	4.55
Yes	3	4.55
No	60	90.91
Total	66	100
Reason for not using fertilizer		
No response	60	90.91
Fertilizer is not available	3	4.55
Fertilizer is not necessary on my farm	3	4.45
Total	66	100
Types of fertilizer used		
No response	63	95.45
NPK	3	4.55
Total	66	100
Rate of fertilizer used		
No response	60	90.91
20g	6	9.09
Total	66	100
Source of fertilizer application rate in use		
No response	60	90.91
Extension agents	3	4.55
NGO	3	4.55
Total	66	100.00
Method of applying fertilizer		
No response	60	90.91
Foliar	3	4.55
Ring method	3	4.55
Total	66	100.00
Do you test soil before fertilizer application?		
No response	57	86.36
No	9	13.64
Total	66	100.00

Source: Field survey, 2018.

Table 3 shows the status of utilization of kola pod husk among the respondents. The table reveals that 54.55% of the respondents are not aware that kola pod husk can be used for compost. The table also shows that 81.82% do not use kola pod husk on their farms. This shows that kola pod husk, despite the fact it is available in the farmers' farms, it is not being utilized among the respondents.

Table 3. Utilization of kola pod husk

Attribute	Frequency	Percentage
Do you have kola pod husk on your farm?		
No response	12	18.18
Yes	54	81.82
Total	66	100.00
Do you use make use of kola pod husk on your farm?		
No response	12	18.18
No	54	81.82
Total	66	100.00
Are you aware that kola pod husk can be used for compost?		
No response	30	45.45
No	36	54.55
Total	66	100.00
If yes, have you used kola pod husk for compost?		
No response	33	50
No	33	50
Total	66	100

Source: Field survey, 2018

Table 4 reveals the willingness of the respondents to accept training on the use of kola pod husk for compost making. The table reveals that 45.45% of the respondents are willing to accept training on the use of kola pod husk for compost making and 40.91% of the respondents are willing to offer their farms for demonstration. Most (40.91%) of the farmers are willing to apply the technology on their farms.

Table 4. Training on the use of kola pod husk for compost

Attribute	Frequency	Percentage
Are you ready to accept training offer on kola pod husk compost?		
No response	36	54.55
Yes	30	45.45
Total	66	100.00
If yes, can you offer your farm for demonstration?		
No response	39	59.09
Yes	27	40.91
Total	66	100.00
If trained, will you apply the technology on your farm?		
No response	39	59.09
Yes	27	40.91
Total	66	100.00

Source: Field survey, 2018

Conclusion

Majority of the farmers do not use fertilizer for kola production due to non-availability of fertilizer and this has resulted to low output from the crop. In order to avert the problem, the farmers are willing to accept a training offer on the production of compost from kola pod husk which is available as a waste material on their farms. The study however, recommended that kola pod husk compost training should be made available to kola farmers in order to solve the problem of non-availability of fertilizer for their usage.

Status: Completed.

Title: Kola nut Grading in South Western Nigeria

Investigators: Yahaya, A.T and Oluyole, K.A

Introduction

Kola as a cash crop in Nigeria does not enjoy a uniform grading it requires to make it attract the premium it deserves. No standard and uniform grading system across kola actors along the value chain in Nigeria. This has resulted into loss of revenue from kola activities and smugglings of Nigeria kola nut to other countries. The project seeks to investigate grading as well as pricing system of Kola-nut in Ondo and Ekiti state, Nigeria. It seeks to get information on kola-nut grading and pricing in the study areas. Visits were made to kola farmers as well as marketers in Ikare, Ogbagi and Irun Akoko in Ondo State Nigeria. Also, visits were made to Imesi, Ilawe and Aramoko in Ekiti State.

Materials and Methods

The study was carried out in Ondo and Ekiti State. These two states were randomly selected out of kola markets in southwestern of Nigeria. Five local Government areas (LGAs) were randomly selected from Ekiti and Ondo state, they include: Akoko North East- (Ikare) and North West (Ogbagi) in Ondo state Nigeria. Three LGAs were selected from Ekiti namely: Gbonyin – (Imesi), Southwest (Ilawe) and West (Aramoko). Ramdom sampling techniques was used to select Kola marketers in the study areas. A total of 180 respondents were sampled from all the LGAs with 36 from each of the LGAs.

Results and discussion

Table 1 shows the grading and pricing of kola nut in Akoko North East local Government of Ondo State Nigeria. It shows there are five different grading in this locality; it shows that, the white big sized kola nut is graded as "Monisa Funfun" and price per kilogram (Kg) of this grade sells for #425.00; while the big red sized kola nut "Monisa Pupa" sells for #350.00 per kg. However, the big sized mixture of white and red known as "Akala Nla" sells for #400.00 per kg in same location. Also, small sized mixture of white & red called "Akala Kekere/ Minu" sells for # 175.00 per kg. Finally, the least grade of kola nut in this location is known as "Esa/ Iparuparu" the rejected or spoilt kola-nuts # 150.00 per kg.

Table 1. Kola Grading and Prices Akoko North East- (Ikare Akoko)

S/N	Grading	Description	Price # (kg) 1.
1	Monisa funfun	Big sized white Kola nut	425.00
2	Monisa Pupa	Big sized Red Kola nut	350.00
3	Akala Nla	Big sized mixture of White & Red	400.00
4	Akala Kerere	Small sized mixture of White & Red	175.00
5	Eesa/ Iparu	Reject or Spoilt kola-nut	150.00

Source; Field survey, 2018

Table 2 shows the equivalent grading and pricing of Kola nut in Akoko North West of Ondo State. Kola nut were graded into five different ways in this area. The classification of kola- nut is in the following orders: "Oju Obi Funfun" the white big sized kola nut, which price per kilogram (Kg) of this grade sells for #375.00; while the big red sized kola nut "Oju –Obi Pupa" sells for #350.00 per kg. However, the big sized mixture of white and red graded as "Akala Nla" sells for #362.00 per kg. Also, small sized mixture of white & red is called "Minu" sells for # 200.00 per kg. Finally, the least grade of kola nut in this location is known as "Esa/ Iparuparu" the rejected or spoilt kola-nuts # 50.00 per kg.

Table 2. Akoko North West (Ogbagi)

S/N	Grading	Description	Price #(kg)
1	Oju obi funfun	Big sized white Kola nut	375.00
2	Oju obi Pupa	Big sized Red Kola nut	350.00
3	Akala Nla	Big sized mixture of White & Red	362.00
4	Minu	Small sized mixture of White & Red	200.00
5	Eesa/ Iparu	Reject or Spoilt kola-nut	50.00

Source: Field survey, 2018

Table 3 shows grading and pricing of Kola- Nut in Akoko North West of Ondo State. The classification of kola- nut is in the following orders: "Oju Obi Funfun" the white big sized kola nut, which price per kilogram (Kg) of this grade sells for #375.00; while the big red sized kola nut "Oju –Obi Pupa" sells for #350.00 per kg. However, the big sized mixture of white and red graded as "Akala Nla" sells for #362.00 per kg. Also, small sized mixture of white & red is called "Minu" sells for # 200.00 per kg. Finally, the least grade of kola nut in this location is known as "Esa/ Iparuparu" the rejected or spoilt kola-nuts # 50.00 per kg.

Table 3 Akoko North West- (Irun)

S/N	Grading	Description	Price (kg)
1	Oju obi funfun	Big sized white Kola nut	375.00
2	Oju obi Pupa	Big sized Red Kola nut	350.00
3	Akala Nla	Big sized mixture of White &Red	362.00
4	Minu	Small sized mixture of White & Red	200.00
5	Eesa/ Iparu	Reject or Spoilt kola-nut	50.00

Source; Field survey, 2018

Kola nut grading in Ekiti State of Nigeria were as shown in three local government of the State. Table 4 shows the grading in Gbonyin LGA, Kola nut were graded into five different ways in this area. The classification of kola- nut is in the following orders: "Goria Funfun" the white big sized kola nut, which price per kilogram (Kg) of this grade sells for #625.00; while the big red sized kola nut "Goria Pupa" sells for #675.00 per kg. However, the big sized mixture of white and red graded is "Akala" sells for #500.00 per kg. Also, small sized mixture of white & red is called "Minu" sells for # 175.00 per kg. Finally, the least grade of kola nut in this location is known as "Esa/ Iparuparu" the rejected or spoilt kola-nuts # 100.00 per kg.

Table 4. Gbonyin L.G.A. (Imesi Ekiti)

S/N	Grading	Description	Price # (kg)
1	Goria funfun	Big sized white Kola nut	625.00
2	Goria Pupa	Big sized Red Kola nut	674.00
3	Akala	Big sized mixture of White & Red	400.00
4	Minu	Small sized mixture of White & Red	175.00
5	Eesa/ Iparu	Reject or Spoilt kola-nut	100.00

Source; Field survey, 2018

Table 5 shows the equivalent grading and pricing of Kola Nut in Ekiti SouthWest. Kola nut were graded into three different ways in this area. The classification of kola- nut is in the following orders: "the big sized mixture of white and red graded as "Goria" sells for #500.00 per kg. Also, small sized mixture of white & red is called "Minu" sells for # 300.00 per kg. Finally, the least grade of kola nut in this location is known as "Iparu" the rejected or spoilt kola-nuts # 10.00 per kg.

Table 5. Southwest (Ilawe)

S/N	Grading	Description	Price # (kg)
1	Goria	Big sized white Kola nut	425.00
2	Minu	Big sized Red Kola nut	350.00
3	Iparu	Big sized mixture of White & Red	400.00

Source; Field survey, 2018

Table 6 shows the equivalent grading and pricing of Kola-Nut in Ekiti west. Kola nut were graded into three different ways in this area. The classification of kola- nut is in the following orders: the big sized mixture of white and red graded as "Goria" sells for #500.00 per kg. Also, small sized mixture of white & red is called " Minu" sells for # 300.00 per kg. Finally, the least grade of kola nut in this location is known as "Esa/ Iparuparu" the rejected or spoilt kola-nuts # 10.00 per kg.

Table 6. Aramoko in Ekiti West

S/N	Grading	Description	Price # (kg)
1	Goria	Big sized white Kola nut	425.00
2	Minu	Big sized Red Kola nut	350.00
3	Iparu	Big sized mixture of White & Red	400.00

Source; Field survey, 2018

Conclusion

Kola nut has varied grading and pricing system in three locations (Ikare, Ogbagi & Irun) visited in Ondo State Nigeria. Two different locations (Ogbagi & Irun) in Akoko North west local government of the state has similar grading and pricing for Kola Nut, while grading as well as pricing is different in Akoko North East of Ondo State Nigeria. However, the grading and pricing system in Ekiti State was totally different form that of Ondo State of Nigeria., Ekiti South West & Ekiti West has similar grading and pricing system while, Gbonyin local government have different grading and pricing system. Therefore, it is pertinent to say that the pricing system should be annexed in each State of the Federation for standard grading and pricing to be attainable for Nigeria as this will enhance access to foreign market as well as increasing the revenue of actors in Kola nut value chain in Nigeria.

Title: Setting Standards for Kola Nut Grading in Nigeria

Investigators: Jayeola, O., S.O. Aroyeun, D.O. Adeniyi, S.O. Ogunwolu, M. O. Ogunlade, Abdulkareem, I.F, Yahaya, A.T., Mokwunye, I.U. and Ugioro, O.

Introduction

Kola is a tropical genus of the family Sterculiaceae. It is native to coastal regions of West Africa. It comprises of about 125 species. In nigeria, Cola acuminata and Cola nitida are the most commonly planted. Cola nitida has two cotyledons while C. acuminata and C. anomala have between three and seven. However, colour is used to differentiate between three subspecies of Cola nitida red, white or intermediates shades of pink. The white, though sold in large quantities in Northern Cameron, is imported from Nigeria and is not reported been grown in Cameroon. Kola is comparatively richer in caffeine than cocoa and coffee. Kola nuts are widely consumed in West and Central Africa as a masticated to counter fatigue, surprise thirst and Hunger and are believed to enhance intellectual capacity. It is for this reason that kola nut chewing has become very popular among students, drivers and many other consumers who need to remain active for unusually

long periods. In some develop countries, kola nut extract is used industrially for the manufacturing of many cola types of drinks flavours, as a source of caffeine used for manufacture of Pharmaceutical products and essential oils and as a main ingredient in production of heat tolerant chocolate bars. In addition, caffeine is known to be a fat burner and therefore beneficial in assisting weight loss.

Most crops are graded in Nigeria but there is no legalise standard for kola nuts in Nigeria. Retailers inspect the nuts by setting aside anyone showing insect damage and then grade them according to colour and size. The most careful and repeated examination is for weevil infestation. The quality of the product is very important for the value and determination of market price. This objective of this work was to carried out physicochemical properties of kola nut in order to develop standard for kola nuts as regards grading in order to produce an exportable products of equal consistency and also to construct sieve for grading of kola nut for export. This is to ensure that high quality produce is able to attract premium prizes. The essence was to standardized kola nut grading system for adoption nationally by kola nut marketers.

Materials and Method

Material sourcing

Fresh kola nuts used for this study C. nitida were sourced from Ogunmakin market in Ogun state. Kola nut purchased are of both dry and wet with varying colour shades ranging from red, pink to white.

Physical Grading

The grading started with sorting into different colours and the followed by sizing them according to weight. Weighing scale was used to grade from 1 - 10 grams, 11 – 20 grams and 21 grams and above. Weeviled or diseased nuts were sorted out.

Construction of grading sieves

One hundred nuts were randomly picked from each lots of Kola nuts of varying colours ranging from red, pink and white of big, medium and small sizes. The size of each nuts was determined by measuring g the major, intermediate and minor diameter. The arithmetic and geometric mean diameter of each nut were computed as a measure of size (Mofolasayo, 2013). The surface area of the nuts was determined by measuring the shape of each nuts with digital plarimeter. The true and bulk density were determined on five structural surfaces, stainless steel, mild steel, ply wood, perspex sheet and glass.

Chemical analysis

This was carried out using AOAC,2010 for crude protein, fat, crude fibre, ash, moisture carbohydrate and dry matter.

Results and Discussions

The results of proximate compositions, mineral analysis and phytochemical components of the samples based on sizes and colour are shown in Tables 1 and 2. The mean values of the parameters obtained were computed using descriptive statistics. The parameters obtained were used in the design of the sieves which are under construction.

Table 1. Proximate Composition Determination

Sample	%CP	%CFAT	%CFIBRE	%ASH	%M	%DM	%CHO
Red Kola Dry (11-20)	15.29	2.98	4.13	2.27	9.87		
Red Kola Dry >21	17.38	3.15	6.79	2.69	9.65		
Red Kola Wet (11 -20)	3.17	2.47	3.26	1.88	66.01		
White Kola Dry (11-20)	13.88	2.56	3.92	2.49	9.97		
Pink Kola Dry >21	18.96	3.23	6.87	2.75	9.58		
White Kola Wet (11-20)	2.98	2.39	3.47	2.05	66.46		
White Kola Wet (1 -5)	2.39	2.17	3.21	1.93	64.89		
White Kola Wet >21	4.27	2.28	3.27	2.22	62.91		
White Kola Dry (1-10)	9.28	2.79	4.12	2.39	10.23		
White Kola Dry >21	14.27	2.63	3.88	2.54	9.92		
Kola Red Wet (1 -10)	2.68	2.26	3.18	2.31	63.05		
Pink Kola Dry (11-20)	14.58	2.95	4.69	2.63	9.66		
Pink Kola Wet (1 -10)	2.77	2.29	3.24	2.42	63.18		
Pink Kola Wet (1 1-20)	4.38	2.32	3.21	2.17	62.89		
Pink Kola Dry (1-10)	11.07	2.51	3.45	2.48	9.43		
Red Kola Dry (1-10)	13.09	2.72	3.97	2.61	9.24		
Red Kola Wet >21	5.89	2.45	3.38	2.36	62.97		
Pink Kola Dry >25	17.88	2.84	3.91	2.68	9.47		
Dried Leaves	16.78	3.29	13.77	9.25	7.96		

%CHO = 100 . (%CP+%CFAT+5CFIBRE+%ASH+%M); %DM = 100 . %M.

Table 2. Result of Phytochemicals Chemical Analysis On Kola Samples

Sample	%Tannin	%Saponin	%Flavanoids	%Alkaloids	%Glycosides	%Caffeine	%Phenolics	
Red Kola Dry (11-20)	0.031	0.236	0.0038	0.356	0.128	0.167	0.189	
Red Kola Dry >21	0.037	0.245	0.0044	0.369	0.136	0.175	0.194	
Red Kola Wet (11-20)	0.0019	0.133	0.0013	0.126	0.089	0.102	0.113	
White Kola Dry (11-20)	0.023	0.221	0.0026	0.324	0.113	0.145	0.166	
Pink Kola Dry >21	0.028	0.227	0.0031	0.331	0.116	0.157	0.175	
White Kola Wet (11-20)	0.0012	0.124	0.0015	0.137	0.103	0.126	0.134	
White Kola Wet (1-5)	0.0008	0.107	0.0010	0.115	0.057	0.118	0.125	
White Kola Wet >21	0.0015	0.129	0.0017	0.121	0.073	0.129	0.144	
White Kola (1-10) Dry	0.021	0.196	0.0023	0.307	0.109	0.138	0.154	
White Kola (Dry) >21	0.025	0.218	0.028	0.329	0.123	0.149	0.172	
Kola Red Wet (1-10)	0.0018	0.131	0.0021	0.131	0.089	0.123	0.138	
Pink Kola Dry (11-20)	0.033	0.225	0.0035	0.342	0.131	0.161	0.185	
Pink Kola Wet (1-10)	0.0010	0.112	0.0008	0.145	0.107	0.126	0.141	
Pink Kola Wet (11-20)	0.0009	0.105	0.0006	0.152	0.111	0.132	0.139	
Pink Kola Dry (1-10)	0.017	0.131	0.0019	0.334	0.119	0.146	0.167	
Red Kola Dry (1-10)	0.014	0.158	0.0016	0.337	0.122	0.153	0.171	
Red Kola Wet >21	0.0013	0.149	0.0015	0.129	0.078	0.112	0.121	
Pink Kola Dry >25	0.041	0.257	0.0040	0.386	0.153	0.184	0.208	
Dried Leaves	0.069	0.289	0.0075	0.532	0.235	0.215	0.239	

Conclusion

The grading of kola nuts into colour and sizes have been done. The availability of sieve that is been constructed will ease the grading by kola nuts farmers. There is need for continuation of this project to enhance construction of the grading sieves to be given to the kola nut stakeholders for onward adoption during grading.

Status: On-going.

Title: Determination of Kola Nut Production Volume in Nigeria

Investigators: Adebiyi, S., Oduwole, O.O., Ibiremo, O.S., Adenuga, O.O., Yahaya, A.T., Ogunlade, M.O. and Ugioro, O.O.

Introduction

Nigeria is the largest producer of kola nut with the average production of 174,000 metric tons yearly. It is a major agricultural produce of Nigeria apart from Cocoa, Cotton, Oil palm, Shea nuts and Sesame seed. Kola nut occupy a significant areas of land in Nigeria, this covers about 270,000 hectares. Despite the facts that the country produces 70% of the global kola nuts production, there is no adequate export data on kola nuts (FAO, 1982). Kola nut is produced in 17 States of Nigeria covering most of the Southwest, Southeast and some parts of the middle belt. Both Cola nitida and Cola acuminata are produced largely in South-Western Nigeria in Osun, Ondo, Ogun, Oyo, Lagos and Ekiti states. Findings showed that kola nuts are exported from Nigeria to neighbouring African countries, Europe and America. It was estimated that internal Kola market in Nigeria is worth about thirty million naira (Pala.1976). Despites its importance, kola nut is not included in the list of graded items for exportation by the Federal Government of Nigeria. This has contributed to its low growth rate over the years. Nigeria produces 88% of the Kola nuts in the whole world and 90% of this is consumed locally. Kola nut can be said to be contributing 6.8% to Nigeria's total GDP and 17.9% to the agricultural sector of Nigeria's GDP (CBN, 2000; Sanusi and Ndubuaku, 2001; and FOS, 2001). According to the FAO 2012 Statistics, the Gross Production Value is estimated at $102,012.90 (2004-2006 factor price $1000).

t obvious that cocoa and other commodity crops such as cashew and coffee are exported to European countries as Raw-materials for their industries, kolanuts is mainly traded and consumed in the northern Nigeria without passing through a standard grading system. Kolanut production volume is difficult to determine because it is consumed locally unlike cocoa and cashew that have great export potentials. Several methods have been used to determine kolanuts production volume but these have not given real estimate because the stakeholders in kola industry were not involved. This study made use of kolanut marketer most especially its movement from Southern to Northern Nigeria. The objectives of the study are to: i) identify different collection centers used in transporting kola nuts, ii) determine frequency of kola nut movement in all locations, iii) determine kola nuts production volume in all locations and iv) determine kola nuts outputs in Nigeria.

Materials and Methods

Multi-stage sampling procedure was used to select kola nut marketers in the study area. The first stage was purposive selection of four states known for trading of kola nuts. The second stage involved purposive selection of communities where kola nuts are packed and transported to Nigeria where they either consumed locally or transported to neighbouring countries. The third stage was purposive selection of kola nut marketers who belonged to kola nut associations: they took records of kola transported from collection centers to Northern Nigeria. These records were collated and sum up to give the total production volume.

Results and Discussions

Results in table 1 showed that Osun State has 31 communities with production volume of 35,675tons, Ogun State has four communities with production volume of 15,202.5tons, Ondo states has three communities with production volume of 138,015tons. Ekiti State has 2 communities with production volume of 3,020tons. The total kola nut volume obtained in the first 6 months of the survey was 191,911.5tons.

Table 1: Kola nut production according to States

States	Number of communities	Volume produced (ton)
Ondo	3	138,015
Ogun	4	15,202.5
Osun	31	35,675
Ekiti	2	3,020
Total	40	191,911.5

Conclusion

The study concluded that the use of groups and associations made it possible to get actual figure of kola nuts from production areas where they were consumed locally and probably exported to neighbouring Africa countries.

Status: On-going.

Title: Development of Bio-Pesticides for the Preservation of Stored Kola Nuts

Investigators: Agbeniyi, S.O., Adedeji, A.R., Orisajo, S. B., Asogwa, E.U., Otuonye, A.H., Mokwunye, I. U., Kolawole, O.O., Ogundeji, B.A. and Olorunmota, R. T.

Introduction

Nigeria accounts for about 70% of the total world production of kola nuts. About 90% of the kola nuts produced in Nigeria is consumed within the country while 10% is exported. A major challenge associated with kola nuts storage is the attack by weevil and moulds. In order to address this issue, kola nuts farmers and traders use various types of chemical pesticides including banned ones. These pesticides in their characteristic nature have the ability to permeate plant cells and remain as residues. Several authors have reported the presence of pesticide residues in various foods, vegetables, soils, sediments and diverse environment. Besides, since kola nuts most often undergo primary processing before consumption, it is important to develop safe pesticides with minimal or no human and environmental health consequences. This project attempts to explore safe alternative such as biopesticides. There are several documented evidences of the effectiveness of plant based materials for the management of crop pests. These include powders, essential oils and aqueous extracts of Curcuma longa, Acorus calamus, Hyptis spicigera, Cassia nigricans and Mentha spicala which have been shown to be effective against bruchids, curulionids and the tenebrionid Tribolium castaneum (Mishra et al., 1984; Lambert et al., 1985; Stoll, 1988). Seeds of Azadirachta indica and Dennettia tripala and the fruits of Piper guineese have pesticidal and behaviour modifying properties against various pests of stored products (Osisiogu and Agbakwuru, 1978; Ivbijaro and Agbaje 1986; Lale, 1992). The objective of this research is to develop safe alternative for control of storage pests of kola that can be easily administered and adopted by farmers.

Materials and Methods

Experimental laboratory: The laboratory bioassay tests are being carried out at the Entomology and Pathology Research Laboratories, CRIN headquarters, Ibadan.

Sources of kola nuts and other materials: All the fresh and infested kola nuts (pods/unskinned nuts) for this experiment were purchased from local vendors and farmers in Ogun and Osun States, Nigeria. All the other experimental materials (baskets, poly bags, Whatman filter papers, petri dishes, camel hair brush, trays, plastic bowsl etc.) were bought from reputable scientific suppliers in Ibadan, Nigeria.

Processing of kola nuts: The general method of skinning, curing and storage of experimental kola nuts according to Ndubuaku (2014) was carried out. The pods were collected into a clean platform, where they were cut diagonally with knife to extract the unskinned nuts. The unskinned kola nuts were soaked in water for 18 to 24 hours. Thereafter the testa coats were washed off easily. The skinned and washed nuts were then placed in wicker baskets for excess water to drain off. They were then aerated by spreading thinly on a table in the laboratory for 2 to 3 hours. The kola nuts were subsequently placed in unlined wicker baskets, covered lightly with banana leaves for few days to cure. Considerable "sweating" which reduced the moisture content of the nuts occurred during the curing process. This is done to increase the shelf life of the kola nuts after pods are broken and nuts skinned. The nuts were stirred periodically to avoid excessive heat buildup during curing process, which lasted for approximately 3 weeks. After curing, the kola nuts were stored in wicker baskets lined with fresh and desiccated plantain leaves. In a situation where overheating was observed, the nuts were aerated and left uncovered for 24 hours. However, if on the other hand, there was a tendency for drying, the thickness of the leaf lining was increased to check loss of moisture. The cured nuts were stored in baskets lined with fresh or dry leaves and placed in the laboratory and this serves as the stock culture of the weevils. Similarly, samples of these kola nuts are being cultured in-vitro and associated pathogens isolated for identification and subsequent work.

Results

There was focus group discussion with kola nut farmers and traders to sensitize them on the dangers of using unapproved pesticides indiscriminately and to encourage

participation in this research project.

Status: On-going.

Title: Soil fertility evaluation of some kola plantation in Ekiti and Osun states, Nigeria

Investigators: Ibiremo O.S., Ogunlade M. O., Iloyanomon C. I., Adebowale and Taiwo N.

Introduction

Kolanut is one of the several tropical tree crops used in local and international trade and was a major export earner for Nigeria before independence when the attention of the Nigerian government shifted to oil and its derivatives (Akinbode, 1982). Production of kolanut in Nigeria ranges from 85,000 to 127,000 metric tonnes annually (Ologunagba, 2009) representing around 70% of World production (Famuyiwa, 1987). The cultivation of kolanut in Nigeria is ecologically limited to the rainforest zones of southern and riverine areas of the savannah region. Kola production levels over the years have been reported to decline due to old age, incompatibility and soil nutrient imbalance. Rehabilitation of old kola plantation by coppicing and total replanting has met with low percentage of success. The increasing land use without adequate and balanced use of chemical fertilizers and with little or no use of organic manure have caused severe fertility deterioration of the soil resulting in stagnation or even decline of kola productivity in Nigeria. The need of the time is to achieve substantially higher kolanut crop yield than the present yield levels from our limited land resources on sustainable basis. The knowledge of nutrient status of soil is very much essential for the judicious application of fertilizer and its amendment for higher crop production. Hence, the objectives of the study were to evaluate the physico-chemical properties of the soil and to determine the leaf nutrient status of kola plantations.

Materials and Methods

Soil samples were taken from kola plantations across important kola producing communities covering two states; Osun and Ekiti States. In each of the plantations visited, ten core samples at 0-20cm and 20-40cm were randomly collected using soil auger and bulked into composite samples to obtain representative soil samples which were taken to the laboratory for processing and analysis. The soil samples collected were air-dried, thoroughly mixed, crushed and sieved to pass through 2mm sieve. Samples collected were analyzed for the pH, organic carbon, Nitrogen, Phosphorus, potassium, Calcium and Magnessium contents. The soil pH was measured electronically with glass rod electrode pH meter in soil/water ratio of 1: 2.5(Mclean, 1982). The soil organic matter was determined by acetate dichromate oxidation method (Nelson and Sommers, 1982). The total Nitrogen was determined by the micro Kjedahl method (Bremmer, 1996). The available P was determined using Bray 1method (Bray and Kurtz,1945), while the exchangeable cations were activated by leaching 5g of soil with 50ml of 1N NH4OAC at pH 7 and the K, Ca and Mg were measured by atomic absorption spectrophotometer (AOAC, 1990). The soil particle size distribution was determined using the hydrometer method (Bouyoucos, 1951) and soil texture determined using textural triangle. The soil textural class was determined by the hydrometer method using hexametaphosphate as the dispersing agent.

Results and Discussions

The mean soil pH of soil at Osun and Ekiti states were 5.85 and 6.10 respectively at 0- 20cm depth (Table 1). This is slightly acidic and appropriate for kola production Egbe et al., 1989), however, any activity that would further decrease the pH of the soil, such as use of ammonium nitrogen based fertilizer should be avoided.

Organic carbon content of the soil was low in kola plantations evaluated in Osun State with mean value of 16.45g/kg but moderate in Ekiti State with a mean value of 20.85g/kg. The low organic carbon in Osun State could be attributed to low natural organic matter return to the soil and other human activities such as burning (Ahmed 1995).

Total nitrogen content was low in kola plantation soils of Osun state. The mean value (0.88g/kg) was below the critical nitrogen soil content of 1.0g/kgN required by Kola as reported by Egbe et.al 1989. This is a reflection of low organic carbon content in the soil (Onyekwere et al 2009) Therefore; there will be need for nitrogen application in all the kola plantations evaluated in Osun state. The soil nitrogen content in kola plantations assessed in Ekiti State were adequate and would not require nitrogen fertilizer application.

Soil available phosphorus contents were adequate for kola in all the farms evaluated in both states hence there would be no need for application of phosphorus fertilizer. This

was well abov the soil critical level of 6mg/kg P required for kola production (Egbe et al., 1989) and this is similar to Iloyanomon et al, 2011 which reported that high Phosphorus content in leaf litter resulted into high P in the soil as a result of the fast decomposition of the Kola leaves.

Soil exchangeable potassium was adequate across the kola plantations examined in the two States. Potassium is important in fruiting of Kola; adequate potassium is required for a good quality of Kola fruit (Adebowale and Odesanya, 2015).

Soil exchangeable calcium and magnesium were adequate at both locations examined.

Table 1: Ranges and Mean values of Physical and chemical properties of soils of kola plantations in Osun and Ekiti State at 0-20cm

Parameters	Osun State			Ekiti State		
	Min	Max	Mean	Min	Max	Mean
pH	5.6	6.10	5.85	5.90	6.40	6.10
O.C(g/kg)	12.80	19.80	16.45	15.60	30.70	20.85
Total N (g/kg)	0.6	1.10	0.88	0.90	1.60	1.20
Avail P (mg/kg)	5.56	10.00	7.67	4.33	10.67	8.34
Exch K (cmol/kg)	0.14	0.24	0.20	0.17	0.38	0.24
ExchCa(cmol/kg)	7.51	12.95	10.24	7.36	16.08	11.06
ExchMg(cmol/kg)	1.40	2.04	1.76	1.33	2.50	1.71
ExchNa(cmol/kg)	0.39	0.60	0.43	0.39	0.48	0.44
Sand (g/kg)	668	728	703	648	748	693
Silt (g/kg))	160	180	165	140	290	202.50
Clay (g/kg)	112	172	132	62	132	104.50

Table 2: Ranges and Mean values of Physical and chemical properties of soils of kola plantations across Osun and Ekiti state at 20-40cm

Parameters	Osun State			Ekiti State		
	Min	Max	Mean	Min	Max	Mean
pH	5.60	6.10	5.90	5.70	6.30	6.08
O.C(g/kg)	07.20	22.70	13.28	6.80	13.60	9.30
Total N (g/kg)	0.4	1.00	0.68	0.40	1.90	1.03
Avail P (mg/kg)	6.78	8.44	8.11	5.78	11.67	7.98
Exch K (cmol/kg)	0.12	0.20	0.16	0.14	0.28	0.19
ExchCa (cmol/kg)	7.36	12.12	10.04	9.15	13.81	9.40
ExchMg cmol/kg)	1.34	3.17	2.09	0.92	1.87	1.40
ExchNa (cmol/kg)	0.39	0.51	0.43	0.36	0.46	0.41
Sand (g/kg)	648	748	683	648	708	683
Silt (g/kg))	100	180	150	180	220	195
Clay (g/kg)	132	167	167	112	132	122

Table 3: Ranges and Mean values of Leaf nutrient content (g/kg) of kola plantations across Osun and Ekiti

Parameters	Ekiti State			Osun State		
	Min	Max	Mean	Min	Max	Mean
N (g/kg)	12.7	24.6	18.7	12.1	29.2	18.9
P (mg/kg)	0.82	1.4	0.80	0.81	1.00	8.85
K(g/kg)	08.26	12.64	8.90	3.89	7.78	6.15
Ca (g/kg)	2.90	5.94	4.36	3.87	5.84	4.66
Mg (g/kg)	2.17	2.67	2.40	0.22	3.06	2.52
Na (g/kg)	1.94	2.18	2.00	1.71	2.04	1.89

The mean Nitrogen content of the kola leaf was 18.90g/kg in Osun State and 18.70g/kg in Ekiti State (Table 3) which is above the foliar critical level of 10g/kg N required for kola production (Egbe et al 1989). The phosphorus content of kola leaf in Osun and Ekiti States were above the foliar critical level of P required for kola production. This is similar to the findings of Iloyanomon and Ogunlade 2011 who reported high phosphorus content in kola plantations in Ibadan but contrary to the findings of Ogunlade and Aikpokpodion 2006 who reported low P in cocoa soils in Southwestern Nigeria. The potassium and magnesium content of the kola leaf was below the foliar critical level of 12g/kg and 3.4 g/kg respectively in Osun and Ekiti States. Calcium content of the kola leaves in both Osun and Ekiti states were slightly lower than the foliar critical level.

Conclusion

The study was carried out in Osun and Ekiti states, Nigeria to evaluate the soil nutrient status of some selected kola plantations. Soil pH in both states were slightly acidic with those of Osun State being more acidic. Therefore, any activity that will further acidify the soil should be avoided in both states. Total nitrogen was low in kola plantation soils evaluated in Osun state but adequate in kola plantations assessed in Ekiti State. Hence, Nitrogen fertilizer is needed in Osun State. While soil available phosphorus, exchangeable calcium and magnesium contents were adequate in kola plantations evaluated in both states, exchangeable potassium content was grossly inadequate. The potassium level in the kola leaf was also inadequate in Osun and Ekiti states, hence both locations would require potassium fertilizer application. The study is highly essential to recommending appropriate soil fertility management strategies that will enhance kola yield on sustainable basis in the study areas.

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Experimental Title: Effects of varying nursery periods on kola field establishment

Investigators: Ugioro, O., Adeyemi, E.A. Nduka, B.A., Famaye, A.O., Ayegbonyin, K., Oloyede., A., Mohammed I., Adeosun., S.A

Objectives

- Determine the minimum nursery time require for maximum field survival rate in order to reduce nursery cost
- Evaluate the performance of kola when intercropped with cajanuscajan and plantain at early stage of field establishment
- Harness local materials and using up- to date agronomic research methods in the field to reduce the amount of fertilizer, herbicides and hence labour in order to reduce cost in the field

Materials and Methods

The study Area

This study was carried out in Headquarters

Collection of sample

Cola nitida was collected from farmer's field in Osun states of Nigeria where C. nitidais widely grown. 50 pods was collected.

Pre- soil analysis on nursery and field establishment.

The forest topsoil that was used for raising the planting materials was collected from the 0-15, 15-30, and 30-45cm depth at the three locations. Soil wasl then be mixed thoroughly and the bulk sample was taken to the laboratory, air dried and sieves to pass through a 2mm screen for chemical analysis

The soil pH (1:1 soil/water) and (1:2 soil/0.01MCaCl2 solutions) was determined using a glass calomel electrode system (Crockford and Nowell, 1956) while organic matter was determined by the wet oxidation chromic acid digestion method (Walkley and Black, 1934). The soil nitrogen was determined by the Micro-Kjedahl method (AOAC, 2000) while available phosphorus (P) was extracted by the Bray P1 extracted, measured by the Murphy blue colouration and determine on a spectronic 20 at 882Um (Murphy and Riley, 1962). Soil K, Ca, and Na was extracted with a 1M NH4OAC, PH7 solution, then analysed with a flame photometer while Mg was determined with an Atomic Absorption Spectrophotometers (AAS) (Jackson, 1958). The exchangeable acidity (H+ and Al3+) was measured from 0.1M HCl extracts by titrating with 0.1M NaOH (Mclean, 1965). Micronutrients (Cu, Zn, and Fe) was extracted with 0.1MHCl (Ogunwale and Udo, 1978) and read on a Perkin Elmer Atomic Absorption Spectrophotometer (AAS)

Raising nuts for seedlings

A total of fifty (50) fresh pods of C. nitida nuts was collected from the state listed above. Five seed boxes of (90x60x30cm) size each was filled with a mixture weathered sawdust and topsoil (ratio 50:50). The seedlings of Cola nitida was sown on June, 2019. A shade was erected for the pre-nursery to prevent the nuts from desiccation and cultural practices such as weeding, watering and spray of pyrinex 0.5L/1L of water against termite infestation was carried out. They will thereafter be

potted in polythene bags awaiting field establishment. C. nitidanuts collected from osun state was sown in the nursery separately as follows 2 months, 4 months, 6 months and 8 months and thereafter was transplanted to the field for establishment at the same time. Shade crop such as Cajanuscaja and plantain was used as intercrop.

Data collection on planting materials

The measurement of growth parameters such as plant height, number of leaves, leaf area, stem diameter and number of branches commenced after planting the materials for one month in the field.

FIELD ESTABLISHMENT: AllC. nitida raised separately at the nursery was transplanted to the field at the same time.

Experimental design

The experimental design will be Randomized Complete Block Design (RCBD) consisting four (4) treatments replicated three (3) times making a total of 12. The treatments are:

Kola seedlings sole (No plantain) Kola seedlings + plantain

Kola seedlings +Cajanuscaja

Kola seedlings + Plantain + Cajanuscaja

Results

Table 1: Morphological parameters of C. nitida seedlings at early field establishment at a month old

Treatment	8WAP	16WAP	8WAP	16WAP		8WAP	16WAP		
Plant height	Stem girth	Plant height	Stem girth	Leaf number	Number of branches	Leaf number	Number of branches	Leaf area	Leaf area
K + S	13.30	0.43	18.05	0.61	7.65	0	8.70	0	40.96	43.60
K + C	14.90	0.40	22.30	0.84	8.15	0	13.50	1	45.30	47.95
K+ P+ C	15.20	0.42	24.00	0.69	9.95	0	15.10	1	50.15	54.45
K+ P	14.55	0.41	19.10	0.63	7.80	0	11.75	0.5	42.40	44.45

Foot note: K: Kola, C: Cajanuscaja, P: Plantain, S: Sole (control)

Table 1 shows the morphological parameters of C. nidita seedlings at early stage of field establishment. The results show that there was increase in morphological parameters as the number of weeks after planting increases. At 16 WAP, kola seedlings in combination with plantain andCajanuscajaproduced the highest mean value in plant height, stem girth, leaf number and leaf area. This was followed by kola in combination with Cajanuscajaand the least was recorded in control.

Table 2: Morphological parameters of C. nitida seedlings at early field establishment at two-month old

Treatment	8WAP	16WAP	8WAP		16WAP		8WAP	16WAP		
Plant height	Stem girth	Plant height	Stem girth		Leaf number	Number of branches	Leaf number	Number of branches	Leaf area	Leaf area
K + S	12.95	0.42	15.45	0.65	7.15	0	9.50	0	40.00	41.45
K + C	14.05	0.34	19.60	0.65	6.15	0	8.85	0.5	41.60	45.67
K+ P+ C	13.45	0.35	23.10	0.68	6.70	0	11.51	0.5	42.60	46.90
K+ P	12.60	0.32	15.45	0.68	6.50	0	10.15	0.5	41.55	43.30

K: Kola, C: Cajanuscaja, P: Plantain sucker, S: Sole (control)

Table 2 shows the morphological parameters of C. nidita seedlings at early stage of field establishment. Similar result was obtained as in table 1. At 16 WAP, kola seedlings in combination with plantain andCajanuscajaproduced the highest mean value in plant height, stem girth, leaf number and leaf area when compared to the control.

Table 3: Morphological parameters of C. nitida seedlings at early field establishment at three-month old

Treatment	8WAP	16WAP	8WAP	16WAP	8WAP	16WAP			
Plant height	Stem girth	Plant height	Stem girth	Leaf number	Number of branches	Leaf number	Number of branches	Leaf area	
K + S	21.51	0.58	29.00	0.73	11.10	0	15.00	0	41.25	43.45
K + C	24.00	0.66	32.20	0.80	9.00	0	16.50	1	42.65	43.40
K+ P+ C	25.20	0.74	35.75	0.92	11.65	0	19.00	0.5	46.85	54.20
K+ P	22.85	0.65	20.90	0.74	11.25	0	17.00	1	41.60	45.10

K: Kola, C: Cajanuscaja, P: Plantain sucker, S: Sole (control)

Table 3 shows the morphological parameters of C. nidita seedlings at early stage of field establishment. Similar result was also obtained here. At 16 WAP, kola seedlings in combination with plantain and Cajanuscaja produced the highest mean value in plant height, stem girth, leaf number and leaf area when compared to the control. This treatment that had the highest value in all the parameters could be that the Cajanuscaja which is a leguminous crop provide nitrogen or fixed nitrogen, which is one of the most important elements in the soil. The plant utilized this essential nutrient for its growth and development. Furthermore, adequate shade, was provided which makes the crop to do well than treatments.

Conclusion and recommendation

From the study, kola seedlings in combination with plantain and Cajanuscaja recorded the highest value in all the morphological parameters and therefore be harnessed. Also from the study, it is therefore recommended that establishing C. nitida seedlings, Cajanuscaja should be used as an intercrop with plantain because of the nitrogen fixation its fixes on the soil. In addition, it also reduces labour cost due to its complete shading. This shading helps to reduce weed biomass. Lastly, the use of inorganic fertilizers is also reduced, saving farmers income

Title: Kola nut grading in SouthWestern Nigeria

Investigators: Yahaya, A.T, Oluyole, K.A, Adebiyi, S, Obatolu, B.O

Introduction

Grading of the nuts into standard sizes and colour is usually for the purpose of proper storage, pricing and packaging for export. However, there is no standard grading or pricing system for kola-nuts in Nigeria and other African countries. The only information on market transaction, especially with reference to price determination, measurements, sizes of nuts as well as quality of nuts/grading are based on mutual knowledge and understanding of the buyers and sellers (Sanusi and Ndubuaku, 2001). Most of the retailers/farmers sell their products in smaller units such as cups and bowls and only through verbal agreements. The price therefore varies with the size, keeping quality and the colour of the nuts. In Nigeria, the Owode and Labozhi crops contain a high proportion of the more valuable pink nuts, while in Ghana and Sierra Leone kola maintains a high price partly on account of its good keeping quality (Voelcker, 1935). The white and bright coloured nuts attract more premium than the red and dull coloured nuts. There is therefore the needfor the formulation of standard grading system for kolanuts, as it was done for cocoa for both in the local and international markets.

Kola as a cash crop in Nigeria does not enjoy a uniform grading it required to make it fitting to attract the premium it deserved. No standard and uniform grading across kola actors along the value chain in Nigeria. This has resulted into loss of revenue from kola activities and smugglings of Nigeria kola nut to other countries. The project seeks to investigate the grading system as well as pricing system of Kola-nut in Ondo and Ekiti state, Nigeria. It seeks out information on kola-nut grading and pricing in the study areas. Visits were made to kola farmers as well as marketers in Ikare, Ogbagi and Irun Akoko in Ondo State Nigeria. Also, visits were made to Imesi, Ilawe and Aramoko in Ekiti state.

Objectives

The broad objective of the study is to examine the grading and pricing system in the study generate a standard grading system for Kola-nut in Nigeria.

Methodology: The study was carried out in Ondo and Ekiti State. These two states were randomly selected out of kola markets in southwestern of Nigeria. Five local Government areas (LGAs) were randomly selected from Ekiti and Ondo state, they include: Akoko North East-(Ikare) and North West (Ogbagi) in Ondo state Nigeria. Three LGAs were selected from Ekiti namely: Gbonyin – (Imesi), Southwest (Ilawe) and West (Aramoko). Ramdom sampling techniques was used to select Kola marketers in the study areas. A total of 180 respondents were sampled from all the LGAs with 36 from each of the LGAs.

Results and Discussion:

Table 1, shows the grading and pricing of kola nut in Akoko North East local Government of Ondo State Nigeria. It shows there are five different grading in this locality; it shows that, the white big sized kola nut is graded as "Monisa Funfun" and price per kilogram (Kg) of this grade sells for #425.00; while the big red sized kola nut "Monisa Pupa" sells for #350.00 per kg. However, the big sized mixture of white and red known as "Akala Nla" sells for #400.00 per kg in same location. Also, small sized

mixture of white & red called "Akala Kekere/ Minu" sells for # 175.00 per kg. Finally, the least grade of kola nut in this location is known as "Esa/ Iparuparu" the rejected or spoilt kola-nuts # 150.00 per kg.

Table 1. Kola Grading and Prices Akoko North East- (Ikare Akoko)

S/N	GRADING	DESCRIPTION	PRICE # (Kg)
1	Monisa funfun	Big sized white Kola nut	425.00
2	Monisa Pupa	Big sized Red Kola nut	350.00
3	Akala Nla	Big sized mixture of White & Red	400.00
4	Akala Kerere	Small sized mixture of White & Red	175.00
5	Eesa/ Iparu	Reject or Spoilt kola-nut	150.00

Source; Field survey, 2018

Table 2, shows the equivalent grading and pricing of Kola-Nut in Akoko North West of Ondo State. Kola nut were graded into five different ways in this area. The classification of kola- nut is in the following orders: "Oju Obi Funfun" the white big sized kola nut, which price per kilogram (Kg) of this grade sells for #375.00; while the big red sized kola nut "Oju –Obi Pupa" sells for #350.00 per kg. However, the big sized mixture of white and red graded as "Akala Nla" sells for #362.00 per kg. Also, small sized mixture of white & red is called "Minu" sells for # 200.00 per kg. Finally, the least grade of kola nut in this location is known as "Esa/ Iparuparu" the rejected or spoilt kola-nuts # 50.00 per kg.

Table 2. Akoko North West (Ogbagi)

S/N	GRADING	DESCRIPTION	PRICE # (Kg)
1	Oju obi funfun	Big sized white Kola nut	375.00
2	Oju obi Pupa	Big Sized Red Kola nut	350.00
3	Akala Nla	Big sized mixture of White & Red	362.00
4	Minu	Small sized mixture of White & Red	200.00
5	Eesa/ Iparu	Reject or Spoilt kola-nut	50.00

Source; Field survey, 2018

Table 3 shows grading and pricing of Kola- Nut in Akoko North West of Ondo State. The classification of kola- nut is in the following orders: "Oju Obi Funfun" the white big sized kola nut, which price per kilogram (Kg) of this grade sells for #375.00; while the big red sized kola nut "Oju –Obi Pupa" sells for #350.00 per kg. However, the big sized mixture of white and red graded as "Akala Nla" sells for #362.00 per kg. Also, small sized mixture of white & red is called "Minu" sells for # 200.00 per kg. Finally, the least grade of kola nut in this location is known as "Esa/ Iparuparu" the rejected or spoilt kola-nuts # 50.00 per kg.

Table 3 Akoko North West- (Irun)

S/N	GRADING	DESCRIPTION	PRICE # (Kg)
1	Oju obi funfun	Big sized white Kola nut	375.00
2	O ju obi Pupa	Big Sized Red Kola nut	350.00
3	Akala Nla	Big sized mixture of White & Red	362.00
4	Minu	Small sized mixture of White & Red	200.00
5	Eesa/ Iparu	Reject or Spoilt kola-nut	50.00

Source; Field survey, 2018

Kola- nut grading in Ekiti State of Nigeria were as shown in three local government of the State. Table 4 shows the grading in Gbonyin LGA, Kola nut were graded into five different ways in this area. The classification of kola- nut is in the following orders: "Goria Funfun" the white big sized kola nut, which price per kilogram (Kg) of this grade sells for #625.00; while the big red sized kola nut "Goria Pupa" sells for #675.00 per kg. However, the big sized mixture of white and red graded is "Akala" sells for #500.00 per kg. Also, small sized mixture of white & red is called "Minu" sells for # 175.00 per kg. Finally, the least grade of kola nut in this location is known as "Esa/ Iparuparu" the rejected or spoilt kola-nuts # 100.00 per kg.

Table 4. Gbonyin LGA (Imesi Ekiti)

S/N	GRADING	DESCRIPTION	PRICE # (Kg)
1	Goria funfun	Big sized white Kola nut	625.00
2	Goria Pupa	Big sized Red Kola nut	674.00
3	Akala	Big sized mixture of White & Red	400.00
4	Minu	Small sized mixture of White & Red	175.00
5	Eesa/ Iparu	Reject or Spoilt kola-nut	100.00

Source; Field survey, 2018

Table 5 shows the equivalent grading and pricing of Kola Nut in Ekiti south West. Kola nut were graded into three different ways in this area. The classification of kola- nut is in the following orders: "the big sized mixture of white and red graded as "Goria" sells for #500.00 per kg. Also, small sized mixture of white & red is called "Minu" sells for # 300.00 per kg. Finally, the least grade of kola nut in this location is known as "Iparu" the rejected or spoilt kola-nuts # 10.00 per kg.

Table 5. South west (Ilawe)

S/N	GRADING	DESCRIPTION	PRICE # (Kg)
1	Goria	Big sized white Kola nut	425.00
2	Minu	Big Sized Red Kola nut	350.00
3	Iparu	Big sized mixture of White & Red	400.00

Source; Field survey, 2018

Table 6 shows the equivalent grading and pricing of Kola-Nut in Ekiti west. Kola nut were graded into three different ways in this area. The classification of kola- nut is in the following orders: the big sized mixture of white and red graded as "Goria" sells for #500.00 per kg. Also, small sized mixture of white & red is called " Minu" sells for #

300.00 per kg. Finally, the least grade of kola nut in this location is known as "Esa/ Iparuparu" the rejected or spoilt kola-nuts # 10.00 per kg.

Table 6. Aramoko in Ekiti West

S/N	GRADING	DESCRIPTION	PRICE #(Kg)
1	Goria	Big sized white Kola nut	425.00
2	Minu	Big sized Red Kola nut	350.00
3	Iparu	Big sized mixture of White & Red	400.00

Source; Field survey, 2018

Conclusion

Kola Nut has varied grading and pricing system in three locations (Ikare, Ogbagi& Irun) visited in Ondo State Nigeria. Two different locations (Ogbagi& Irun) in Akoko North west local government of the state has similar grading and pricing for Kola Nut, while grading as well as pricing is different in Akoko North East of Ondo State Nigeria. However, the grading and pricing system in Ekiti State was totally different form that of Ondo State of Nigeria., Ekiti South West & Ekiti West has similar grading and pricing system while, Gbonyin local government have different grading and pricing system.

Therefore, it is pertinent to say that the pricing system should be annexed in each State of the Federation for standard grading and pricing to be attainable for Nigeria as this will enhance access to foreign market as well as increasing the revenue of actors in Kola nut value chain in Nigeria.

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Title: Extraction of Caffeine from Wholesome and Weevilled Kola Nut

Investigators: Mokwunye, F.C, Okunade, A.F; Jayeola C.O; Yahaya, L.E.

Introduction

Kola nut is widely known, especially in Western and Northern part of Nigeria, as an economic crop and it has a major active ingredient known as caffeine (soluble substance). Many Africans consume kola nuts regularly, even daily, for the medicinal, stimulating and sustaining properties. Kola nut has very high caffeine content, smaller amounts of Theobromine and Kolanin, which dispel sleep, thirst and hunger and act as a stimulant and anti-depressant. They also reduce Fatigue, aid digestion and work as an aphrodisiac. Kola nuts are best known outside Africa as an ingredient in Cola beverages. Commercially produced Cola drinks were developed in the late 1800s. Then Kola nuts were used as ingredients in (Beverage and Tonics). Coca Cola, the most famous beverage in the World was formulated from kola in 1886 by Atlanta druggist, Dr JOHN PEMBERTON and marketed as BRAIN and NERVE tonic. (Prevention's Healthy Ideas, 2002). Presently, the bulk of kola nuts being produced in Nigeria are either consumed fresh locally or exported as sun-dried nuts to drier areas of Africa where they are used as Masticants or as a source of Colourant for cloth dyeing with little or no industrial use in Nigeria. Globally, caffeine is widely consumed as

psychoactive drug, because it's a central nervous system stimulant of the methyl xanthine class and it gives most people a temporary energy boost and elevates mood, but despite its importance caffeine is still underutilized. Therefore, the objectives of this work are to extract caffeine from hitherto discarded weevilled kola nut and to purify the extracted caffeine for commercial use as CRIN Caffeine.

Materials and Methods

Wholesome Kola nut (*Cola nitida*) was purchased from Ogunmakin Market in Ogun State. The kola nuts were separated into two batches, while one batch was sorted into the white, red and pink varieties

Kola nut Powder Production

A modification of the method used by Ogunwolu and Akinwale (2003) was adopted. Cured healthy Kola nuts *(Cola nitida),* sorted into three different varieties, were washed and soaked in warm water (about 50^{o}C) and diced to 5mm^{2} separately. The Kola nut dices were then dried in a hot air oven at 90^{o}C for 3 hours and cooled. Each of these samples was milled with a Panasonic multipurpose blender and stored in tightly covered plastic jars and subsequently labelled as WKN for white coloured kola nut, RKN for red coloured kola nut and PKN for pink coloured kola nut. The 2nd batch of kola nut was not sorted into varieties but simply divided into two parts. One part was milled fresh and labeled MFK while the other part was diced in hot water, dried at 90^{o}C for 3 hours and milled with a blender and labeled as MDK. Both samples were separately stored in tightly covered plastic jars.

Chemical Composition of the fresh Kola nut

Proximate analysis for moisture, crude protein, ether extract, total ash, crude fiber and carbohydrate were determined using the fresh kola nut sample according to the methods of the Association of official Analytical chemist (AOAC) (2014). Estimation of caffeine was done by the method of Luigi (1968) as modified by Ogutuga (1975).

Caffeine Extraction

Two methods were used for the extraction of caffeine from the kola nut samples.

1) 400g 0f each of the kola nut samples was put into a 4 litre plastic bottle, into which 1600 ml of ethanol was added. The setup was shaken periodically for 2 hours and allowed to stand for 24 hours, then filtered using cheese cloth. The residue was further washed with 400ml of ethanol. 400g of magnesium oxide was later weighed out into another 4 litre bottle and acidified with 50 ml of 10% concentrated sulfuric acid. The filtrate was transferred into the 4 litre bottle containing the acidified magnesium oxide and shaken periodically for one hour and allowed to stand for 3 – 4 hours during which caffeine was adsorbed by magnesium oxide. The mixture was again shaken after 4 hours and then filtered using a vacuum pump. The filtrate was then transferred into a 4 litre bottle, into which 100 ml of chloroform was added, mixed thoroughly and allowed to stand for 2 hours. The supernatant was decanted while the fluid concentrate or sediment was centrifuged at 350xg for 5 min. The supernatant was decanted, and caffeine was to be removed as silky residue, allowed to dry at room temperature. (Obidike et al, 2011)

2)Place 150g of kola nut sample into a separating funnel, add 150 ml of water and shake for 5min. then add 40 ml of Dichloromathane and place the stopper on the top of the funnel. Shake the funnel further for 2 minutes. Allow the two layers of liquid to separate and drain the lower Dichloromathane layer into a flask. Add a fresh 40 ml portion of Dichloromathane to the kola nut sample in the funnel, shaking the funnel for two min. Allow the two layers to separate again then drain the lower layer into the flask that already contains the first portion of dichloromethane. Repeat this process the third time draining the solvent layer into the flask. Add 2g anhydrous sodium sulfate to the flask containing the dichloromethane, swirl the flask gently and allow to stand for 10 minutes. This will dry any water left in the funnel. Recover the caffeine by distillation using the apparatus. (Okoli et al 2012)

Purification of Crude Caffeine

The crude caffeine was transferred to a clean 50 ml beaker, followed by the addition of 5 ml of Toluene, and heated on a steam bath (or hot plate) to dissolve the caffeine. The beaker was then removed from the heating source, followed by the addition of 10 ml of petroleum ether (boiling point 60 – 90^{o}C), and the caffeine was allowed to crystallize. The product was collected by vacuum filtration, washed with 1 ml of petroleum ether, allowed to

dry and weighed. The melting point was determined, to confirm purity.

Results and Discussion

Chemical Composition

The chemical characteristics of the kola nut powder samples (WKN, RKN, PKN, MDK, MFK) are shown in table 1. There were insignificant differences in the moisture contents of the four powder samples except for the fresh kola nut, MFK, which is significantly different. Results also showed no significant variations in the values obtained for fibre, ash, fat, protein and carbohydrate contents. Sample WKN was significantly different from the other samples in the caffeine content. The fibre and ash contents ranged from 2.480 to 2.580% and 3.460 to 3.680% respectively. Protein and caffeine content of the powders were 8.600 to 8.680% and 1.560 to 1.860%, except for the MFN which has significantly low levels.

Table 1: Chemical Analysis of Kola Nut Samples

	WKN	RKN	PKN	MFK	MDK
MC	3.080^{b}	3.160^{b}	3.150^{b}	56.030^{a}	3.160^{b}
Fibre	2.560^{a}	2.480^{a}	2.520^{a}	0.240^{b}	2.490^{a}
Ash	3.680^{a}	3.660^{a}	3.543^{a}	0.750^{b}	3.460^{a}
Fat	1.010^{a}	1.010^{a}	0.990^{a}	0.070^{b}	0.940^{a}
Protein	8.680^{a}	8.660^{a}	8.650^{a}	2.730^{b}	8.600^{a}
Caffeine	1.860^{a}	1.570^{c}	1.750^{b}	0.320^{d}	1.760^{b}
Carbohydrate	79.27^{a}	79.27^{a}	79.58^{a}	42.37^{b}	79.79^{a}

Note:Means along horizontal rows with the same superscripts are not significantly different at $p < 0.05$. WKN = White, RKN = Red, PKN = Pink kola varieties, MFK = Fresh and MDK = Dried kola samples.

Caffeine Extraction

Though White kola nut sample (WKN) yielded more during the estimation of caffeine, (table 1) mixed dried kola nut sample was utilized for caffeine extraction. First it came second in yield, also it be more readily available in the market. The method used by Obidike et al, 2011 for which many devices were procured, when employed yielded no caffeine. This method was adopted because it was meant to yield 8g of caffeine from 160g of dried kola powder which is quite high compared to the other methods in literature.

Many workers found dichloromethane as the best solvent for the extraction of caffeine from most products. (Okoli et al, 2012;). This method yielded only 5.4g of caffeine from 400g of dried kola sample.

Conclusion

No conclusion yet as the work is on-going

Challenges

The challenges had been lack of funds and fake chemicals being delivered for the original.

Future Plan

The plan is to extract caffeine from weevilled kola nut which is less expensive than wholesome kola, purify and identify the caffeine obtained by standard means.

Experimental Title: Clonal Propagation and Development of High Yielding Kola Varieties

Investigators: Adenuga, O. O.; Adebiyi, S; Oduwole, O.O.; Ibiremo, O.S. and Ugioro, O.

Introduction

Cola, a tropical African genus that belongs to Sterculiaceae comprises of about 140 species (Onomo *et al*., 2006). Over fifty species of this genus have been described in West Africa (Adebola, 2003). Of these, only a few are fruit bearing while majority are woody species of economic importance. The most commonly used species are *Cola nitida* [(Vent) Schott and Endlicher], *Cola acuminata* [(Pal de. Beuav) Schott and Endl] and *Cola anomala* (Schott and Endlicher). *C. nitida* and *C. acuminata* are the two major cultivated species in Nigeria. These, in addition to many uncultivated species are of great importance for their economic, pharmaceutical, confectionery, nutritional, socio-cultural and other uses. The genus is of enormous economic and scientific importance. However, CRIN's kola germplasm, which should be the reservoir of useful genetic resources for the improvement of the crop has a very narrow genetic base.

CRIN urgently needs to assemble new kola germplasm and properly characterise its germplasm so as to develop early-fruiting kola genotypes. This is based on the fact that the existing germplasm has a very narrow genetic base and is largely uncharacterised. Furthermore, the existing germplasm consists of old trees whose fruit bearing abilities have significantly diminished. These two key factors make the existing germplasm unsuitable to solve

the problems identified in kola production, which are self and cross incompatibilities and inefficient pollination, regarded as responsible for low yield. There is also the need to reduce the gestation of the crop. Solving these problems will encourage further farmer interest in the crop. The Institute at present does not have any improved or identified variety for distribution to farmers. Therefore, the use of vegetative propagation urgently need be improved upon and perfected by the Institute in its attempts to solve the aforementioned problems. This study therefore aims to leverage upon and improve on the meagre acchievement of the previous year in which a small percentage of success was recorded in cloning techniques in the propagation of the species.

Objectives

The eperiment was carried out to identify good performing kola accessions from farmers' plots in Osun and Ondo States in Nigeria and determine the success of clonal establishment of such accessions in CRIN's kola germplasm plot.

Materials and Methods

Collection of Scions: A pre-survey of kola farms with identified good accessions was carried out in selected locations in Okuku (Osun State) and Bamikemo (Ondo) States of Nigeria. These included two farms each in both States. Stem cuttings were collected from four accessions from each farm. This implies eight accessions from each of Okuku and Bamikemo. A total of sixteen accessions were used in the study. Stem cuttings were collected from the apical regions of the trees selected as mother tree. These trees have diverse genetic origin. They are early bearing with good tree architecture and are also resistant to diseases. Collected scions were semi-hardwood flushes (greenish brown in colour) harvested from the mother tree. The scions were between 10cm - 20cmlong and possessed enough buds including an active apical bud which should develop into a new shoot. The scions were harvested very early in the morning before sunrise, and the leaves around on the scions were trimmed to reduce leaf area and thus minimize moisture loss due to transpiration. The scions were wrapped in moist cotton wool to prevent scion dehydration and transported in an empty box from the farmers' plots to the site of the experiment at CRIN headquarters.

Setting of cuttings

Dressing of the cuttings involved the removal of their leaves except two or three leaves close to the apical bud are left. The detached end of the cutting was not dressed. The cuttings were planted directly into propagation structures (wooden boxes) filled with rooting medium. The rooting medium used was a mixture of river sand and rice husk in a ratio of 1:1. The entire cuttings together with the medium were covered with transparent polythene sheet after sowing. The entire medium and cuttings are then kept under shade. Cuttings are then watered every 2-3 days and inspected for rooting and leave development. A hundred cuttings of each accession

Grafting

The detached end of the scion is shaped like a wedge using a knife and grafted unto root stocks that were six months old. Grafted plants were covered with small transparent polythene sheets to create a humid environment around the leaves and helps reduce transpiration. The plants were arranged under shade and success checked periodically for about two months. Grafting tapes and transparent polythene covering on successful grafts were removed immediately. After six months, successful grafts were transplanted to the field.

Results and Discussions

Callus formation did not occur in any of the accessions used in the setting of cuttings, though a number of them produced leaves (Figure 1), these leaves were eventually abscised in approximately three months after formation. The reason for failure of callus formation is yet to be understood.

Some level of success was recorded in the grafting exercise. A total of 85 individuals out of 320 (representing 26.6%) remained green after two weeks of grafting. This figure was eventually reduced to 52 out of 320 at six weeks after grafting. By eight weeks after grafting, only 6 individual sprouts were available, representing 1.88% of the original population. Sprouting among the *Cola* accessions was observed to have been inconsistent with the expectation of 3-4 weeks after grafting, as more than half the initial 26.6% that were green after two weeks remained green even beyond six weeks, and some sprouts were eventually recorded beyond seven weeks after grafting. These inconsistencies may be attributed to the timing of the grafting which lied between March and August, 2018. Humidity was high during this period, and

could have accounted for the low success rate. Appropriate timing for ideal grafting activities (as observed with cacao) lies between October through Early December, and February through Early April.

Conclusion
Six successful grafts were established in a new *Cola* germplasm plot at CRIN Headquarters, Ibadan.

Challenges
The late provision of fund for this research work made the execution very late, and resulted in the low response of the accessions to vegetative propagation techniques. Appropriate timing for ideal grafting activities lies between October through Early December, and February through Early April.

Status - On-going

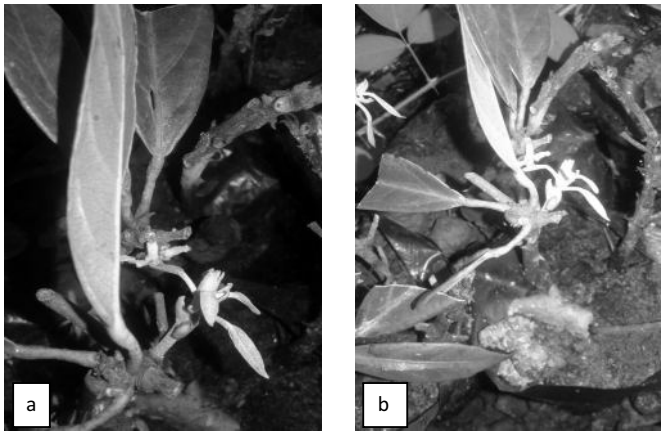

Figure 1: Leaf formation in Cola cuttings

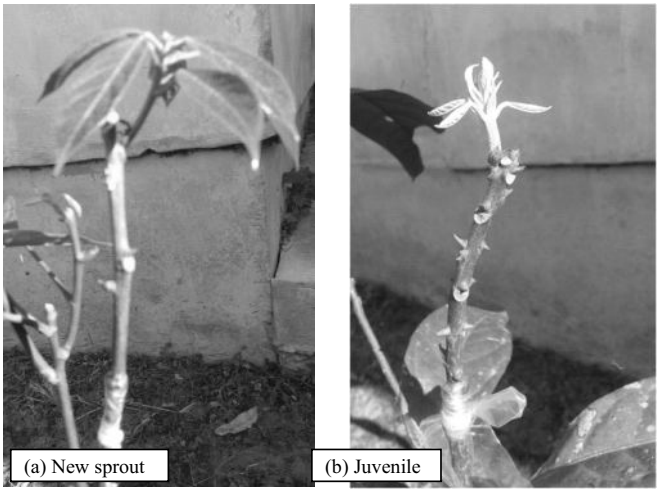

Figure 2: Successful grafting in Cola accessions

Experiment Title: The Effects of Cement Dust on Kola Productivity in Ewekoro and Sagamu L.G.A in Ogun State

Investigators: Adebowale L.A, Ogunlade M.O and Taiwo N.

Introduction
Kola plantations sited near cement factory have been reported decreasing effect on yield in kola production due to the cement dust deposited on the soil and leaves of kola. Therefore, the present attempts to find means to look inward as cement dust its affect kola production and ameliorate the effects.

Objectives
To evaluate cement dust as its affect kola soils, trees and the nuts production.

Materials and Method
Soil and plant samples would be collected at various kola plantations in the factory sited at Sagamu and Ewekoro L.G.A. Core soil sample at 0-15 and sub soil 15-30cm depth would be collectedrandomly using soil auger. Ten core soil sample collected will be bulked to form composite. Soil samples collected shall be air dried, crushed and sieve to pass through 2mm sieve. Eight kola trees will be sampled from each location for their leaves. The leaves sampled collected will be divided into two parts (washed and unwashed). Leaves samples collected shall be air drying after washing before envelope and placed into oven for oven drying. Kola pod will also be sampled. The N, P, K, Ca, Mg, Cu, Zn, Mn, Fe, Organic carbon and pH will be determined. Representative leaf sample collected and analyzed for their content.

Status: On-going.

Experimental Title: Evaluation of Kola Nut Value Chain in Nigeria

Investigators: Yahaya, A.T, Orisasona, T.M, Lawal, J.O, Obatolu, B.O, Taiwo O.A, Akinpelu, A

Introduction
Globalization, urbanization and agro- industrialization puts increasing demands on the organization of agro- food chains and network. Food and agribusiness supply chain and networks which was once characterized by autonomy and independence of actors are now swiftly moving

towards globally interconnected systems with large varieties of complex relationships which affect the ways food is produced, processed and delivered at the market (Ruerd Ruben, 2006; Readon and Barrett 2000) and also the revenue accruable from these agricultural produce. The market exerts a dual pressure on agro- food chains, forcing towards continuous innovation and agency coordination. Agricultural produce is being offered at a fairly competitive price, prices and quality issues are more important than ever, consumers can choose from an increasing number of products offered by competing chain. Kola nut one of the major cash crops in Nigeria, has contributed largely to the GDP of the country, to maximize the full potential of the economic returns; there is need for the value chain to be properly developed; hence, an evaluation of the value chain in Nigeria become necessary.

Objective

1. To map out Kola value chain in order to give the functional analysis of the actors in each of the stages of the chain in the study areas,
2. To analyze the competitiveness and the effects of policies on competitiveness at each stage of Kola value chain,
3. To determine the comparative advantage of the nodes of Kola value chain in Southwestern Nigeria and
4. To estimate the effects of price distortions on consumers' and producers' welfare in the study areas

Methodology

The study will be carried out in four Kola producing states namely (Osun, Ogun, Ondo & Ekiti) of Southwestern state of Nigeria. The purposive Sampling techniques will be used to select Three (3) local governments from each of the state of the four states; five (5) communities will be selected from each Local Government Areas. Three hundred (300) respondents from each state in the proportion of fifty (50) per node. Random sampling techniques will be used in selecting input suppliers, farmers, processors, marketers and the consumers in the study areas. Information will be elicited through the use of structured questionnaire and focus group discussion. Returned questionnaire will be sorted and analyzed.

Challenges

Funds disbursed for the project is insufficient to implement the project, hence two states will be cover and the remaining two state cover when additional funds is allocated and released

Status: Questionnaires developed and about to be administered and analysed.

Future Plan: Survey will be carry out soon

Experimental Title: Effects of Varying Nursery Periods on Kola Field Establishment

Investigators: Ugioro, O., Adeyemi, E.A Nduka, B.A., Famaye, A.O., Ayegbonyin, K., Oloyede. A., Mohammed I., Adeosun. S.A

Objective

- ❖ Determine the minimum nursery time require for maximum field survival rate in order to reduce nursery cost
- ❖ Evaluate the performance of kola when intercropped with *cajanus cajan* and plantain at early stage of field establishment
- ❖ Determine the average yield of *cajanus cajan*
- ❖ Harness local materials and using up- to date agronomic research methods in the field to reduce the amount of fertilizer, herbicides and hence labour in order to reduce cost in the field
- ❖ Determine the effect of nutrient uptake on kola.

Materials & Methods

Study Area

This study will be carried out in three locations.
Cocoa Research Institute of Nigeria (CRIN) Headquarters, Owean sub-station and Ajasor

Collection of sample

Cola nitida will be collected from farmer's field in Osun states of Nigeria where *C. nitida* is widely grown. 50 pods will be collected from the farmer's field.

Pre- soil analysis on nursery and field establishment.

The forest topsoil that will be used for raising the planting materials will be collected from the 0-15, 15-30, and 30-45cm depth at the three locations. Soil will then be mixed thoroughly and the bulk sample will be taken to the laboratory, air dried and sieves to pass through a 2mm screen for chemical analysis. The soil pH (1:1 soil/water) and (1:2 soil/0.01MCaCl2 solutions) will be determined using a glass calomel electrode system (Crockford and Nowell, 1956) while organic matter will be determined by

the wet oxidation chromic acid digestion method (Walkley and Black, 1934). The soil nitrogen will be determined by the Micro- Kjedahl method (AOAC, 2000) while available phosphorus (P) will be extracted by the Bray P1 extracted, measured by the Murphy blue colouration and determine on a spectronic 20 at 882Um (Murphy and Riley, pH (1:1 soil/water) and (1:2 soil/0.01MCaCl2 solutions) will be determined using a glass calomel electrodephotometer while Mg will be determined with an Atomic Absorption Spectrophotometers (AAS) (Jackson, 1958). The exchangeable acidity (H^+ and Al^{3+}) will be measured from 0.1M HCl extracts by titrating with 0.1M NaOH (Mclean, 1965). Micronutrients (Cu, Zn, and Fe) will be extracted with 0.1MHCl (Ogunwale and Udo, 1978) and read on a Perkin Elmer Atomic Absorption Spectrophotometer (AAS)

Raising nuts for seedlings

A total of fifty (50) fresh pods of *C. nitida* nuts will be collected from the state listed above. Five seed boxes of (90x60x30cm) size each will be filled with a mixture weathered sawdust and topsoil (ratio 50:50). The seedlings of *Cola nitida* will be sown on June, 2019. A shade will be erected for the pre-nursery to prevent the nuts from desiccation and cultural practices such as weeding, watering and spray of pyrinex 0.5L/1L of water against termite infestation will be carried out. They will thereafter be potted in polythene bags awaiting field establishment. *C. nitida* nuts collected from osun state will be sown in the nursery separately as follows 2 months, 4 months, 6 months and 8 months and thereafter will be transplanted to the field for establishment at the same time. Shade crop such as *Cajanus caja* and plantain will be used as intercrop.

Data collection on planting materials

The nuts will be assessed for percentage survival which will be determined as the number of living plants per total planted, highest peak to emergence (Days to emergence), root length, root girth. The measurement of growth parameter such as plant height, number of leaves, leaf area, stem diameter and number of branches will commence after the planting materials would have established in the field.

Field Establishment

All *C. nitida* raised separately at the nursery will be transplanted to the field at the same time.

Experimental design

The experimental design will be Randomized Complete Block Design (RCBD) consisting four (4) treatments replicated three (3) times making a total of 12. The treatments are:

Kola seedlings sole (No plantain) Kola seedlings + plantain

Kola seedlings + *Cajanus caja*

Kola seedlings + Plantain + *Cajanus caja*

Statistical analysis

The average data obtain for the growth parameters, leaves and soil chemical composition of kola seedlings for the two experiments will be analysed using ANOVA with an F-test. The treatment means will be compared

Progress report on the work so far

1. Collection of topsoil has been carried out
2. Polyethene bag has been bought
3. Top soil sample collected and taken to the laboratory for routine analysis. The result is yet to be out.
4. A day trip involving 2 scientists and a driver for the purchase of *C. nitida* nut from Osun State has been carried out
5. That nut brought has been planted patch by patch and the 3rd patch is yet to be planted based on the design of the experiment.

At this stage, the work is on-going and more funds is needed for the completion of the work.

Experimental Title: Determination of Kola Nut Production Volume in Nigeria

Investigators: Adebiyi, S. Oduwole, O.O. Ibiremo, O.S, Adenuga, O.O, Yahaya, A.T, Ogunlade, M.O and Ugioro, O.O

Introduction

Nigeria is the largest producer of kolanut with the average production of 174,000 metric tons yearly. It is a major agricultural produce of Nigeria apart from Cocoa, Cotton, Oil palm, Shea nuts and Sesame seed. Kola nut occupy a significant areas of land in Nigeria, this covers about 270,000 hectares. Despite the facts that the country produces 70% of the global kolanuts production, there is no adequate export data on kolanuts (FAO, 1982). Kola nut is produced in 17 States of Nigeria covering most of the Southwest, Southeast and some parts of the middle belt. Both *Cola nitida* and *Cola acuminata* are produced largely in South-Western Nigeria in Osun, Ondo, Ogun, Oyo, Lagos and Ekiti states. Findings showed that kolanuts are exported from Nigeria to neighbouring

African countries, Europe and America. It was estimated that internal Kola market in Nigeria is worth about thirty million naira (#30,000,000.00) (Pala.1976). Despites its importance, kola nut is not included in the list of graded items for exportation by the Federal Government of Nigeria. This has contributed to its low growth rate over the years. Nigeria produces 88% of the Kola nuts in the whole world and 90% of this is consumed locally. Kola nut can be said to be contributing 6.8% to Nigeria's total GDP and 17.9% to the agricultural sector of Nigeria's GDP (CBN, 2000; Sanusi and Ndubuaku, 2001; and FOS, 2001). According to the FAO 2012 Statistics, the Gross Production Value is estimated at $102,012.90 (2004-2006 factor price $1000). It obvious that cocoa and other commodity crops such as cashew and coffee are exported to European countries as Raw-materials for their industries, kolanuts is mainly traded and consumed in the northern Nigeria without passing through a standard grading system. Kolanut production volume is difficult to determine because it is consumed locally unlike cocoa and cashew that have great export potentials. Several methods have been used to determine kolanuts production volume but these have not given real estimate because the stakeholders in kola industry were not involved. This study made use of kolanut marketer most especially its movement from Southern to Northern Nigeria.

Objectives

The objectives of the study are to:

i identify different collection centers used in transporting kolanuts. ii.determine frequency of kolanut movement in all locations.

iii determine kolanuts production volume in all locations.

iv determine kolanuts Outputs in Nigeria.

Methodology

Multi-stage sampling procedure was used to select kolanut marketers in the study area. The first stage was purposive selection of four states known for trading of kolanuts.

The second stage involved purposive selection of communities where kolanuts are packed and transported to Nigeria where they either consumed locally or transported to neighbouring countries. The third stage was purposive selection of kolanut marketers who belonged to kolanut Associations; they took records of kola transported from collection centers to Northern Nigeria. These records were collated and sum up to give the total production volume.

Results and Discussion

Results in table in table 1 showed that Osun State has 31communities with production volume of 35,675tons, Ogun State has four communities with production volume of 15,202.5tons, Ondo states has three communities with production volume of 138,015tons. Ekiti State has 2 communities with production volume of 3,020tons. The total kolanut volume obtained in the first 6 months of the survey was 191,911.5tons.

States	Number of communities	Volume produced(ton)
Ondo	3	13,,015
Ogun	4	15,202.5
Osun	31	35,675
Ekiti	2	3,020
Total		191,911.5

Table 1: Kolanut production according to state

Conclusion

The study concluded that the use of groups and associations made it possible to get actual figure of kolanuts moving from production areas to area where they were consumed locally and probably exported to neighbouring Africa countries.

Challenges

Some associations do not want government intervention on kolanut industry.

Status: On-going.

COFFEE PROGRAMME

Experimental Title: Economic Diversification in Nigeria, Coffee Production, Processing and Marketing; a Road Map to Poverty Eradication

Investigators: Orisasona, T.M, Oduwole, O.O, lpinmoroti, R.R and Williams, O.A

Introduction

Oil has disappointed Nigeria, despite the huge revenue from the sector. The importance of coffee in the world economy could not be over-emphasized. Coffee plantation and coffee processing provides employment for over 100 million people across the globe (Jacob, 1998). Coffee trees of either type maintain aforest type ecosystem and protect the soil against erosion thus contribute to preservation of the environment. Coffee provides financial security to the farmers. Drinking coffee has continued to increase especially among office workers in Nigeria who consume it to remain alert in stressful working environments. Many now rely on coffee to ward-off drowsiness and restore alertness during work hours. Coffee is also consumed before going home toward of tiredness. Coffee is the second traded commodity in the world after oil and the second consumed liquid after water, as eight Million tonnes is consumed each globally. Diversification does not discourage specialization but requires that resources be channeled into the best alternative user. Coffee plant is native to Africa; the origin of Coffee Arabica has been traced to Ethiopia in the 9th century, while Robusta coffee was believed to come from Central to West Africa. Its preparation and cultivation was first done by the Arabs; and was introduced to most parts of Africa during the colonial era Coffee growing and drinking started in Ethiopia. Today, it is an important commodity and a popular beverage in the world. Over 2.25 billion cups of coffee are consumed in the world every day (Ponte Stefano ,2002). Over 90% of coffee production takes place in developing countries, while consumption happens mainly in the industrialized economies. Worldwide, about 25 million small producers rely on coffee for a living. It was introduced to Nigeria in the colonial times –around the same time as cocoa. It is a tropical plant which grows between the latitudes of 25 degrees N and 25 degrees but requires very specific environmental conditions for commercial cultivation Temperature, rainfall, sunlight, wind and soils are all important, but requirements vary according to varieties grown. Whereas Robusta coffee can be grown between sea-level and about 800 m, Arabica does best at higher altitudes and is often grown in hilly areas. An ideal average temperature ranges between 15 and 24 degrees C for Arabica and 24 to 30 degrees C for Robusta, which can take the hotter and drier conditions. In general, coffee needs an annual rainfall of 1500 to 3000 mm (Arabica needs less than other species). The C. arabica is grown mainly by small scale farmers in the highland area of Mambilla plateau in Taraba State, as well as Nasarawa, while the Robusta coffee grows in areas like Abia, Kogi, Kwara, Ondo, and Ogun States. Agriculture was the leading sector in the 1950s and 1960s, it then accounted for 63 percent of the GDP (1960- 1964), and 54 percent in 1965-1969. Cash crops such as coffee, cocoa, cashew, oil palm, gumArabic, and rubber were major sources of employment and livelihood to farmers and the agricultural sector contributed to the nation's foreign exchange. Coffee is a prominent commercial cash crop in West Africa as well as in over 70 countries including central and South American, Africa, Asia and Oceania. Coffee is second only to petroleum in primary commodity trade and provides over 25 percent of the foreign exchange earnings of 16 countries in Latin America and Africa, providing employment for at least 20 million people. The area under cultivation for green coffee is over 100 million hectares and green coffee production in 1986 amounted to nearly 5.2 million tons. Coffee is consumed in almost every country in the world and Europe alone imports over 2 million tones of green un-roasted coffee beans in 1981. United States used about 1,180,000,000 kilograms, or about one fifth of all the coffee grown in the world annually. Other markets for coffee are Ethiopia, Cote d' Ivory, Cameroon, Angola, Uganda, Kenya, Tanzania, Madagascar, Liberia, India, Colombian, Zimbabwe and Zambian. Coffee is consumed as a beverage in the form of ground-roasted pulp, as a flavoring for sweets and ice cream, baked products and other food items; coffee residue is used as manure, mulches and animal feed and its oil is used in the soap industry.

Coffee production and trade in Nigeria

Trends in the world production of African coffee shows that annual production in the last 10 years fluctuated between 14 and 19 million(60kg) bags, with an average of about 16 million bags; and has since fallen considerably due to varied factors. Although Coffee is grown and exported by more than 50 developing countries, it's mainly consumed in the industrialized countries namely United

States of America, Finland, Sweden, Belgium and Japan among others. In the world market, Coffee plays a vital role in the balance of trade between developed and developing countries; being an important foreign exchange earner, contributing in varying degrees to the national income of the producing countries. It is believed that coffee provides employment for a lot of people in all producing countries. Over 80% of coffee from developing countries, particularly Nigeria, is produced by small scale farmers who are mostly uneducated and are faced with low market price leading to poor management, poor productivity and abandoned farms hence a general decline in coffee production over the period between 1960 and 2008 in Nigeria. World coffee exports have been increasing up to 97.58 million bags in 2008/2009 compared to 96.08 million bags in the previous year, representing about a 1.6% increase (ICO, 2009). Similarly, the market price for coffee recorded the highest increase of 237% in 2008/2009 and 148.2% in 2006/2007. This indicates that the market for coffee is significant enough to justify an expansion in production in Nigeria and other countries. In spite of the facts that coffee is highly economical and can boost the country's revenue, coffee production is fast declining in Nigeria and the participation of farmers has become very low due to government neglect of the agricultural sector. The recent policy shifts towards diversification of the national economy; whereby certain crops such as rice, maize, cassava, cotton, and cocoa; as well as livestock and fisheries enjoy promotion under the Presidential Initiative in Agriculture; provides an opportunity for stemming the declining trend in coffee production. Reviving coffee production in Nigeria would also be consistent with the vision of the New Partnership for Africa's Development [NEPAD] that "Agriculture-led development is fundamental to cutting hunger, reducing poverty, generating economic growth, reducing the burden of food imports and opening the way to an expansion of exports of which coffee, considering Its economic importance, needs an urgent attention. Table 1 shows the top ten coffee producers in the world with Brazil as he highest producer and Guatemala the lowest. The Nigeria coffee production as shown in table 2 vary from year to year depending on the policy environment, world market price among others, with 1990 and 1964 production being the highest. Table 3 on the order hand show the quantity of coffee exported from 1961-2014, coffee export shows a decline by the year with 1976 export being the highest. Furthermore, there is evidence of consistent decline in production and export between 2009-2014 indicating the need for an urgent agricultural policy on the establishment of coffee to increase production

Table 1: Top Ten Green Coffee Producers - 2011

Country	(millions of metric tons)
Brazil	2.70
Vietnam	1.28
Indonesia	0.63
Colombia	0.47
Ethiopia	0.37
Peru	0.33
India	0.30
Honduras	0.28
Mexico	0.25
Guatemala	0.24
World Total	8.46

Source: UN Food & Agriculture Organization (FAO

Table 2: Nigeria Green Coffee Production by Year**:**

Market Year	Production	Unit of Measure	Growth Rate
1961	18	(1000 60 KG BAGS)	N A
1962	20	(1000 60 KG BAGS)	11.11 %
1963	36	(1000 60 KG BAGS)	80.00 %
1964	95	(1000 60 KG BAGS)	163.89 %
1965	45	(1000 60 KG BAGS)	-52.63 %
1966	74	(1000 60 KG BAGS)	64.44 %
1967	44	(1000 60 KG BAGS)	-40.54 %
1968	52	(1000 60 KG BAGS)	18.18 %
1969	75	(1000 60 KG BAGS)	44.23 %
1970	60	(1000 60 KG BAGS)	-20.00 %
1971	83	(1000 60 KG BAGS)	38.33 %
1972	58	(1000 60 KG BAGS)	-30.12 %
1973	45	(1000 60 KG BAGS)	-22.41 %
1974	41	(1000 60 KG BAGS)	-8.89 %
1975	42	(1000 60 KG BAGS)	2.44 %
1976	67	(1000 60 KG BAGS)	59.52 %
1977	53	(1000 60 KG BAGS)	-20.90 %
1978	43	(1000 60 KG BAGS)	-18.87 %
1979	60	(1000 60 KG BAGS)	39.53 %
1980	40	(1000 60 KG BAGS)	-33.33 %
1981	52	(1000 60 KG BAGS)	30.00 %
1982	52	(1000 60 KG BAGS)	0.00 %
1983	45	(1000 60 KG BAGS)	-13.46 %
1984	42	(1000 60 KG BAGS)	-6.67 %
1985	48	(1000 60 KG BAGS)	14.29 %
1986	60	(1000 60 KG BAGS)	25.00 %
1987	80	(1000 60 KG BAGS)	33.33 %
1988	95	(1000 60 KG BAGS)	18.75 %

1989	90	(1000 60 KG BAGS)	-5.26 %
1990	95	(1000 60 KG BAGS)	5.56 %
1991	90	(1000 60 KG BAGS)	-5.26 %
1992	90	(1000 60 KG BAGS)	0.00 %
1993	40	(1000 60 KG BAGS)	-55.56 %
1994	45	(1000 60 KG BAGS)	12.50 %
1995	52	(1000 60 KG BAGS)	15.56 %
1996	53	(1000 60 KG BAGS)	1.92 %
1997	46	(1000 60 KG BAGS)	-13.21 %
1998	45	(1000 60 KG BAGS)	-2.17 %
1999	53	(1000 60 KG BAGS)	17.78 %
2000	46	(1000 60 KG BAGS)	-13.21 %
2001	48	(1000 60 KG BAGS)	4.35 %
2002	44	(1000 60 KG BAGS)	-8.33 %
2003	50	(1000 60 KG BAGS)	13.64 %
2004	36	(1000 60 KG BAGS)	-28.00 %
2005	35	(1000 60 KG BAGS)	-2.78 %
2006	59	(1000 60 KG BAGS)	68.57 %
2007	51	(1000 60 KG BAGS)	-13.56 %
2008	35	(1000 60 KG BAGS)	-31.37 %
2009	30	(1000 60 KG BAGS)	-14.29 %
2010	30	(1000 60 KG BAGS)	0.00 %
2011	30	(1000 60 KG BAGS)	0.00 %
2012	40	(1000 60 KG BAGS)	33.33 %
2013	30	(1000 60 KG BAGS)	-25.00 %
2014	35	(1000 60 KG BAGS)	16.67 %
2015	35	(1000 60 KG BAGS)	0.00 %

Source: United States Department of Agriculture

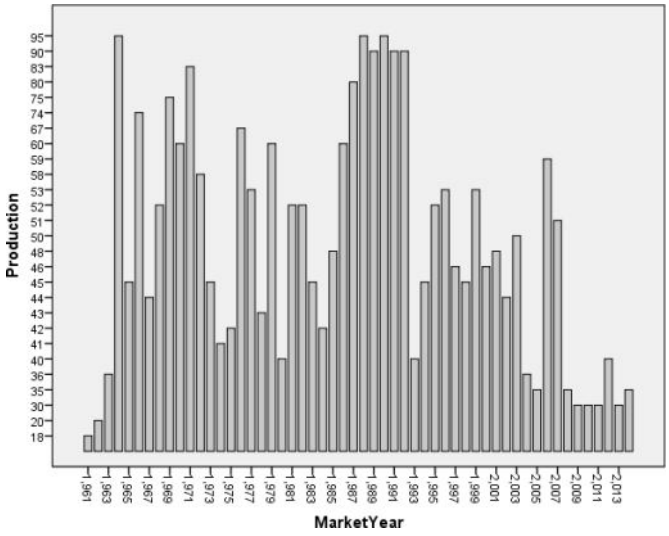

Fig 1: **Nigeria Green Coffee Production by Year (1000kg of 60kg/bag)**

Table 3: Nigeria Green Coffee Bean Exports by Year

Market Year	Bean Exports	Unit of Measure	Growth Rate
1961	9	(1000 60 KG BAGS)	NA
1962	13	(1000 60 KG BAGS)	44.44 %
1963	10	(1000 60 KG BAGS)	-23.08 %
1964	89	(1000 60 KG BAGS)	790.00 %
1965	10	(1000 60 KG BAGS)	-88.76 %
1966	121	(1000 60 KG BAGS)	1,110.00 %
1967	30	(1000 60 KG BAGS)	-75.21 %
1968	40	(1000 60 KG BAGS)	33.33 %
1969	65	(1000 60 KG BAGS)	62.50 %
1970	36	(1000 60 KG BAGS)	-44.62 %
1971	63	(1000 60 KG BAGS)	75.00 %
1972	70	(1000 60 KG BAGS)	11.11 %
1973	36	(1000 60 KG BAGS)	-48.57 %
1974	19	(1000 60 KG BAGS)	-47.22 %
1975	2	(1000 60 KG BAGS)	-89.47 %
1976	109	(1000 60 KG BAGS)	5,350.00 %
1977	31	(1000 60 KG BAGS)	-71.56 %
1978	15	(1000 60 KG BAGS)	-51.61 %
1979	53	(1000 60 KG BAGS)	253.33 %
1980	12	(1000 60 KG BAGS)	-77.36 %
1981	40	(1000 60 KG BAGS)	233.33 %
1982	42	(1000 60 KG BAGS)	5.00 %
1983	38	(1000 60 KG BAGS)	-9.52 %
1984	11	(1000 60 KG BAGS)	-71.05 %
1985	15	(1000 60 KG BAGS)	36.36 %
1986	6	(1000 60 KG BAGS)	-60.00 %
1987	7	(1000 60 KG BAGS)	16.67 %
1988	47	(1000 60 KG BAGS)	571.43 %
1989	40	(1000 60 KG BAGS)	-14.89 %
1990	35	(1000 60 KG BAGS)	-12.50 %
1991	2	(1000 60 KG BAGS)	-94.29 %
1992	9	(1000 60 KG BAGS)	350.00 %
1993	13	(1000 60 KG BAGS)	44.44 %
1994	5	(1000 60 KG BAGS)	-61.54 %
1995	11	(1000 60 KG BAGS)	120.00 %
1996	13	(1000 60 KG BAGS)	18.18 %
1997	6	(1000 60 KG BAGS)	-53.85 %
1998	5	(1000 60 KG BAGS)	-16.67 %
1999	13	(1000 60 KG BAGS)	160.00 %
2000	6	(1000 60 KG BAGS)	-53.85 %
2001	8	(1000 60 KG BAGS)	33.33 %
2002	4	(1000 60 KG BAGS)	-50.00 %
2003	10	(1000 60 KG BAGS)	150.00 %
2004	1	(1000 60 KG BAGS)	-90.00 %
2005	1	(1000 60 KG BAGS)	0.00 %
2006	30	(1000 60 KG BAGS)	2,900.00 %
2007	9	(1000 60 KG BAGS)	-70.00 %
2008	1	(1000 60 KG BAGS)	-88.89 %
2009	1	(1000 60 KG BAGS)	0.00 %
2010	3	(1000 60 KG BAGS)	200.00 %
2011	2	(1000 60 KG BAGS)	-33.33 %
2012	7	(1000 60 KG BAGS)	250.00 %
2013	1	(1000 60 KG BAGS)	-85.71 %
2014	5	(1000 60 KG BAGS)	400.00 %
2015	5	(1000 60 KG BAGS)	0.00 %

Source: United States Department of Agriculture

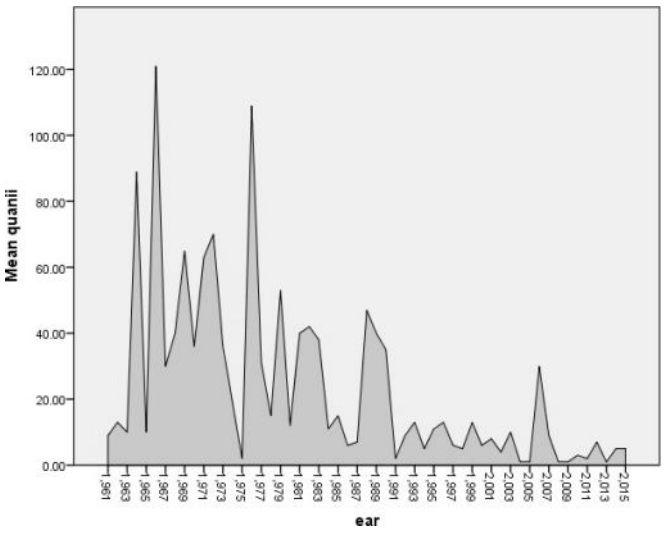

Fig 2: Nigeria Green Coffee Bean Exports by Year (1000kg of 60kg/bag)

The Coffee Value Chain

The coffee value chain is relatively simple compared with the cocoa value chain while there is considerable concentration at the processing stage of coffee as well. The relatively greater success for coffee value chain can be attributed to several factors including the fact that consumers buy coffee beans directly. The coffee manufacturing companies had less direct contact with the producers, buying most of their coffee through the traders. Coffee plants may grow as shrubs or trees to a height of 10-15 meters at maturity but are kept at three meters on plantations for harvesting purposes. The coffee shrubs live for as long as 60years and remain productive for 15- 20 years. The yield of the coffee tree peaks after 5 to 7 years. The fruits are left unpicked until they reach the ideal stage of ripeness, usually after about seven months. Each coffee fruit contains two semi-oval, furrowed seeds or beans, covered with a silver-colored membrane and enclosed in a second tougher skin called parchment. Arabica (85-90 percent of world coffee) and Robusta (10- 15 percent of world coffee production) beans are distinguishable in shape: Arabica being flatter and elongated with a crooked furrow, compared to the convex and rounder Robusta with its straight centre furrow. Given their continuous blossoming, coffee plants may carry green fruits, fully ripe red cherries and overripe ones, all at the same time. To avoid mixing the fruit and potentially contaminating a crop with either green or overripe beans, handpicking is the best method of 51 coffee harvesting. This allows for green fruit to stay on the tree for the next round of harvesting, and overripe fruit to be naturally discarded by falling to the ground. A quicker, but far less accurate and common method of harvesting is “stripping”, whereby branches are stripped of all their fruit either by hand or the use of special machines. Two ancient methods are still used today to extract coffee beans from their cherries after harvest, the dry process and the wet process. At the farm level, Arabica beans are normally processed using the wet method. The longer and more complex wet process is mostly used for coffee cherries that are handpicked, and thus more uniform in size. Once gathered, the fruit is put into pulping machines that free the seeds in their parchment from the hulls. The beans are then fermented or "washed" in large water tanks for several days to remove any remaining decomposed pulp formed during this phase. This operation also triggers off a series of chemical reactions in many Arabica varieties that enhance the coffee's aromatic and flavor qualities. The washed beans are then sun dried, freed from their parchment with the use of centrifugal force, then polished and electronically sorted to weed out defective beans and finally, graded for size, form and color and ready for selection and shipment. Robusta beans (twice as cheap as Arabica), on the other hand, are generally processed by a more straightforward method. The picked cherries are sun dried for several days before being sold to a processing plant which removes the casing with a mechanical mill before sorting, grading and packaging the beans for export. The dry process is necessary for fruits that have been harvested by stripping. Once separated from other matter such as leaves and bits of wood or pebbles, the coffee cherries are spread out in the fresh air on threshing floors to sundry for a few days. Then, they are put through a hulling machine that frees the beans by crushing the hulls and parchment. The dry method produces "natural" green coffees, also called "unwashed" green coffees. The farmer then sells the bean encased in a light skin or parchment (hence parchment coffee) to a private trader. The local trader transports coffee to a curing factory, where the parchment is removed and the beans are sorted. Afterwards, exporters take care of grading, packaging and transporting up to the port where coffee is exported. Coffee is subject to a continual series of quality control tests. Beyond the detection and elimination of defective beans, these controls ultimately serve as a basis for the final selection of green coffees that meet the quality and taste specifications required for proper blending. Expert coffee buyers perform these decisive tests on samples prior to purchase. Green beans

are shipped unroasted in 60 kg jute bags. The green bean preserves its unique characteristics longer than the roasted bean. Following liberalization, most of the green coffee is bought from farmers by private traders and exporters. These intermediaries provide an important service to coffee markets, by buying from different farmers and remote regions, as well as processing and transporting coffee in quantities big enough to be exported and bought by international traders. Because of the way the international coffee supply chain works, the link between producers and consumers is lost. Coffee is traded down a complex line of intermediaries, ranging from local traders, exporters, international traders, roasters and retailers, who each capture a percentage of the retail value of coffee. Less than 30 percent of the revenues generated by world coffee sales remains in the coffee producing countries and smallholders usually capture less than 10 percent of the retail price. Farmers receive a low share of the export price of green coffee beans. The price captured by the farmer and other local actors also depends on how much processing is done at a local level. Most farmers produce parchment coffee because it yields a price that is higher than the price of fresh coffee berries. This requires them to wash pulp and dry coffee on their farms, work usually performed by women and children. But very few small farmers have the required skills and equipment to process quality parchment coffee, which reduces the price they can get from private traders and can also hurt the overall quality of coffee production. In general, small farmers are likely to get a rough deal because they have little power over private Intermediaries, cooperatives and governments. Small farmers rarely have a choice regarding the timing of the sale or the identity of the buyer. How much farmers receive for their coffee mainly depends on the role of local traders and exporters, marketing costs and processing capacities at farm level.

Economics of coffee

Coffee is a popular beverage and an important commodity; tens of millions of small producers in developing countries make their living growing coffee. Over 2.25 billion cups of coffee are consumed in the world every day and Over 90% of coffee production takes place in developing countries, while consumption happens mainly in the industrialized economies. Worldwide, 25 million small producers rely on coffee for a living. For instance, in Brazil alone, where almost a third of all the world's coffee is produced, over 5 million people are employed in the cultivation and harvesting of over 3 billion coffee plants; it is a much more labor-intensive work of the same regions as sugar cane or cattle, as it is not subject to automation and requires constant attention. The socio economic environment of the coffee farmers is critical to farm decisions and performance; hence, factors such as the age, family size, marital status, education, sex and religion of the farmers are necessary variables to be considered. Majority of the coffee farmers are between ages 50-65years of age, with an average age of 54 years while the average age of coffee farms was 30 years. This shows that most of the coffee farmers might not be energetic and enthusiastic enough to embark on long term investment in coffee plantation; this might lead to persistently low output. Most of the farmers are married with more than one wife with an average family size of six or more people, thus making family labour a potential asset for coffee production in Nigeria. Generally, male farmers were more involved in coffee production, probably because of cultural restraints that deprive women of the right of inheriting land and hindering them from long-term use of land. Most of the respondents had no formal education, however, this varies with areas hence the ability of the farmers to comprehend and utilize technical and market information about coffee also differs from one area to another. Few farmers still pay considerable attention to coffee production as full scale coffee growers primarily due to the technical, institutional and social problems coffee production is facing in Nigeria. The modal size of coffee farms in Nigeria is less than one hectare, implying that most of the farmers produced coffee at very low scale due to the marginal /small land holding. Coffee is generally intercropped along with other crops like plantain, banana and pineapple among others. Most of the coffee farmers had a minimum of ten years of experience in coffee production with most of them acquiring land through inheritance; suggesting that most of the coffee trees would be relatively old as they were probably inherited along with the farm land. Information relating to production and marketing of coffee is usually obtained from friends and relatives, due to little or no extension work. Thus extension and mass media services did not respond to farmers' information needs with respect to coffee, and this might have implication for low output of coffee. Personal saving is the most popular source of capital available to farmers, few farmers only benefitted from Cooperative Banks, which indicates limited access to capital for proper management of coffee farm and

explains the low scale of coffee production. From all indication of past studies, Majority of the farmers lack formal training that could adequately equip them with necessary knowledge and skill for efficient production and marketing of coffee. Access of farmers to market is usually through the middlemen and cooperative groups' because farmers found it difficult to market their coffee bean and this could have a serious implication on their income.

Production Constraints of Coffee in Nigeria

Nigeria coffee which is undoubtedly low in production is faced with so many obstacles. The major constraints on coffee production and marketing were fire outbreak, poor policy, farmers' attitude (belief in demonic influence on the performance of coffee) and drought. Other constraints are poor access to market information, lack of capital, inefficient extension services, poor weed control, poor processing, poor access to farm credit, low income from coffee, and low world price; Moreover, inefficient extension services deprived them the opportunity of necessary information and skills that would have helped them improve their output level and marketing of coffee.

Another constrain in Nigeria coffee production is Coffee processing which is tedious and requires intensive labor. It is widely recognized that the proper processing and handling of coffee at all stages of coffee chain is essential for maintenance of quality and minimize the risk of contamination. Negligence in either processing or handling at any stage of the production- marketing chain can lead to mould contamination thus adversely affecting the quality of coffee. This could affect the acceptance of coffee both at the international and domestic market where the consumers are becoming increasingly quality conscious.

Prospect of Coffee Production in Nigeria

Considering the natural endowment Nigeria is blessed with, coffee production can be improved upon in Nigeria if the younger generation farmers are encouraged and given incentives in terms of adequate access to inputs, information and skills required for better agronomic and management practices as well as market information and linkage established. Furthermore, improved access to credit, active outreach by extension agents, as well as provision of irrigation facilities and drought resistant varieties.

The abandoned coffee farms can be rehabilitated, Thereby generating more revenue for the farmers and the government by contributing more to the gross domestic product and national economic development. Increase in farmers' income would contribute to improved rural livelihood; and increased coffee production would also increase availability of coffee for domestic and export markets.

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Experimental Title: - Evaluation of Selected Herbicides at Controlling Weeds in Coffee Plantation

Investigators: Idrisu M., Ugioro. O, Nduka B.A.

Introduction

Weeds infestation is one of the major setbacks in crop establishment. Quite substantial hectare of crop plantation can be lost due to weeds particularly at establishment. Hence, this studies attempt to investigate and address suitable herbicides for effective weed control in coffee plantations at the seedling stage.

Materials and methods

The trial is laid out in a Randomised complete block design (RCBD) replicated 3 times. The treatments comprise the use of 3 types of herbicides and control, assigned to the plots in accordance with the treatment

combination. Plantain is used as a shade crop on the newly established coffee stands. Data on growth parameters and those of weed parameters will be collected. 12 plots comprising of 9 plants / plot at spacing of 3mx3m was used.

Work Done

The project is ongoing. However, the following activity has been carried out: Site selection & initial soil sampling, Felling /clearing of trees, pegging& holing.

Also, some of the preliminary weed flora composition at experimental site have been collected and are being processed for characterization.

NB: - More money is needed to enable me to execute the project to the concluding end as specified in the proposal submitted**.**

Experimental Title: Soil Nutrients Dynamics in Coffee Germplasm and Other Coffee Plots at Cocoa Research Institute of Nigeria Ibadan

Investigators: Asowata Frank. E, Daniel M. A, Ipinmoroti R. R, Ogunlade M.O, Taiwo N and Dada

Introduction

Coffee production has social and economic impact locally and internationally as about two (2) billion cups of coffee is consumed worldwide on a daily basis (Renee, 2017). Adequate soil nutrition is essential in modern coffee production to increase yield therefore, agricultural practices in coffee plantations should preserve the soil fertility, which is the wealth of the growers (Charles *et al*., 2017). Healthy soils are the foundation of agriculture and indeed civilization itself (Joel, *et al*., 2010). Plant roots grow and absorb water and nutrients according to the physical, chemical and biological properties of the soil which in turn affects yield of crops amongst other factors. Leaf analysis is an efficient way to monitor the health and nutrient status of plants and the chemical composition of coffee beans is an important factor in determining the beverage quality (Joel, *et al.*,2010). Since most of the coffee plots in the Institute was established over a decade ago, the nutritional reservoir in the soil might be insufficient to completely meet the nutrients demand, it is therefore necessary to evaluate the nutrient status of the soils, leaves and berries in the coffee germplasm and other selected coffee plots in the institute.

Justification: Production can be drastically reduced in poor soils if limiting factors are not quickly detected and promptly corrected.

Objectives

- To evaluate the nutrient contents in soils under coffee cultivation, coffee leaves and beans
- To evaluate the rate of soil nutrient mining in coffee plots by plant uptake and berry harvest.

Materials and methods

Soils under coffee cultivation and plants samples (leaves and berries) were collected in seven coffee plots which include germplasm plot, zone1, zone 5A, zone 5B, zone 5C, zone 6 and the demonstration plot. Soil samples were collected at 0-30cm depth topsoil and 30- 60cm depth subsoil using soil auger and analyzed in the laboratory. Five (5) core soil samples were collected at 12m intervals within each coffee plantation and labeled accordingly.

Project Status: Ongoing Additional Funds to carryout laboratory analysis of plant samples (coffee leaves and berries) N 119,000

Experimental Titile: Profitability and Determinants of Coffee Production in Nigeria

Investigators; J.O .Lawal, T. Olayinka, Mr. T. Orisasona and B.S. Famuyiwa

Introduction

Coffee is an important foreign exchange earner, contributing in varying degrees to the national income of the producing countries. It guarantees solid base for the promotion of economic development (Cambrony, 1992). One of the major factors that affected coffee farming was the disintegration of coffee commodity board in Nigeria which regulated coffee marketing as far back as 1986. The dissolution of the board restricted markets for coffee products and this resulted to profit loss which discouraged many farmers. Coffee like other agricultural products in Nigeria contributes a large percentage in income generation, employment and raw materials for the local industries. Like many of the Nigerian cash crops the coffee sector had been neglected for years in favour of oil and this had discouraged so many of the farmers. This study is justified based on the fact that the knowledge of coffee profitability can motivate the farmers to produce more and remain in business of coffee.

Objectives

1. To determine the profitability of coffee production;
2. To determine the factors that can boost the production of coffee in the study areas

Methodology

Well structured questionnaire has been developed to be administered to 80 coffee farmers in Kogi state; five villages will be purposively selected from two different local government areas in each of the states using the multistage sampling technique. The first stage will be the selection of two local government areas (LGAs) from the state and second stage will be selection of coffee farming villages/communities from each of the LGAs and the third stage will be the random selection of coffee farmers from the existing Agricultural development programme (ADP) list of coffee farmers. This selection will be done proportionately to the size of the village population. The s tudy will employ the use of the descriptive analysis, net farm income and the multiple regression methods to achieve set objectives.

Status: ongoing (kogi state)

Challenges

The funds we got for this project is so small to enable us interview the number of farmers scheduled for this study.

Expected output

This project intends to find the factors that will boost coffee production among the farmers and also wants to determine the profitability of coffee production in the study areas.

Experimental Title: Exploring the Chemical Diversity of *Coffea Canephora* in Nigeria for Genomics Quality Improvement

Investigators: Odey, Chinyere F., Ilori Christopher, Dada K. E., Muyiwa A. A., Olaniyi O. O., Beckles D.M.

Introduction

Coffee is a highly consumed beverage, about 2.25 billions cup of Coffee is consumed daily by more than a third of the world's population (Ponte 2002, Bolvenkel *et al*. 1993, http://my.ewb.ca/). Quality coffee is important to the consumers because of its satisfactory and refreshing effects (Fisk *et al*. 2012). These effects are as a result of beneficial chemical compounds in roasted and ground coffee which can be classified into volatile and non-volatile compounds (CIRAD 2006; Leroy *et al*. 2006) and can contribute greatly to coffee flavour or to cup quality. In the present market, flavour is the most important measure for coffee quality evaluation, and also one of the major motivations for consumer preferences (Cantergiani *et al.*, 1999). Quality improvement is of great important for rural coffee farmers who produce over 70% of the world's coffee (Oxfam, 2001). High quality coffee receives a better price and higher premium (Ponte 2002) in the international market. According to International Coffee Organisation (ICO), quality determines price of coffee in the market whereas most farmers live in abject poverty because their farms lack good quality coffee clones. The lack of knowledge about the level of coffee quality has affected its production greatly, there is no structure in place to assess coffee quality in Nigeria. A lot of factors have been known to contribute to quality of coffee, these are genetic background, location, seasonal variations, primary processing, roasting intensity, presence of defects (Mancha *et al*. 2008; Pawliszyn *et al*. 2008; Gonzalez-Rios *et al*. 2007). However the high level of genetic diversity within species (*C. canephora*) which ought to be complimentary to high variability of metabolites poses great potential for genetic improvement of its quality (Poncet et al. 2007; CIRAD 2006 and Leroy et al. 2006). This improvement will be highly beneficial to Nigeria coffee production since about 90% of coffee cultivated is *C. canephora*. This project is aimed at assessing profile and diversity of metabolites (Sugar, caffeine and polyphenols) in the cultivated and conserved C. canephora in Southwestern Nigeria.

Materials and methods

Plant Materials

Thirty ripe coffee beans comprising 19 farmers' accessions and 3 genotypes conserved in CRIN coffee germplasm (Table 1). Farmers' accessions comprising Niaouli (Anagbogu *et al*. 2019) were obtained from six locations of farmers' farm in Kogi and Ekiti. The locations were chosen based on high coffee productivity in those areas.

Table 1: Sample genotypes and symbols

Farmers' accessions (Niaouli)	Can_20	Can_21	Can_22	Can_23	Can_24	Can_29	Can_32
	Can_34	Can_35	Can_36	Can_37	Can_38	Can_39	Can_40
	Can_41	Can_4 2	Can_44	Can_45	Can_46		
Kouillou	Can_49	Can_50					
Java	Can_59						

Gas Chromatography-Mass Spectrophotometer analysis

Reddish mature (ripened), coffee bean (Figure 1) of these samples were collected in ice bags and immediately transferred to -80oC. The endosperms of the coffee bean (Figure 1c) were excised using sterile blade, lyophilized and ground into powder with Udy mill (Udy Corporation) then sealed prior to metabolomics analysis. The metabolomics analysis was performed according to Fiehn et al. 2008. This comprised extraction of analyte, derivatization with N-methyl-N-trimethylsilyltrifluoroacetamide and 1% (v/v) trimethylchlorosilane for GC-TOF (Time of Flight) mass spectrometry analysis, injection of samples in an Agilent 6890 gas chromatograph controlled using LecoChromaTOF software version 2.32 (http://www.leco.com), and acquisition of data on a Mass spectrometry Instrument, a Leco Pegasus IV time-of flight mass spectrometer controlled using LecoChromaTOF software version 2.32.

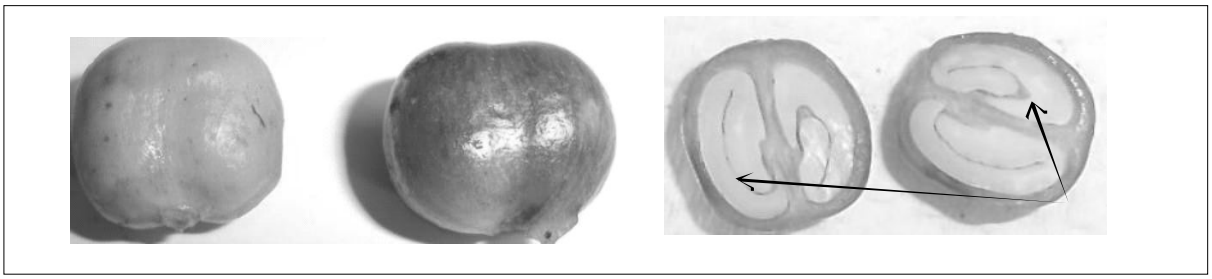

Figure 1. C. canephora coffee beans.

Two maturity stages of the beans, **(a)** unripe, and **(b)** ripened are shown. Note, only the ripe beans were used for the analysis. **(c)** The endosperm, which was the portion of the coffee bean dissected and used to extract metabolites for chemical analysis.

Statistical Analysis of metabolomics data

All metabolites, including those identified and not identified using the National Institute of Standards and Technology mass spectral library, were used for data analysis. Multivariate statistical approach was used with XLSTAT software to detect the metabolite correlation and genotypes metabolite diversity.

Results and discussion

The MS-GC analysis detected targeted metabolites as found in NIST database, the metabolites studied were of two classes: phenolic acid and sugar. The phenolic acids comprised 12 metabolites while sugar has 19 metabolites (Table 2). The most abundant metabolites were caffeine, chlorogenic acids, quinic acid and sucrose

Table 2. Metabolites found in C. canephora which are from the two biochemical classes: phenolic acid and sugar (those in bold were high in abundance)

Phenolic acid			
Caffeine	Chlorogenic acid	Quinic acid	3,4-dihydroxy-cinnamic acid
Gluconic acid	Ferulic acid	Gluconic acid lactone	Beta-sitosterol
Tocopherol beta	Isochlorogenic acid	Tyrosol	Nornicotine
NIST			
Sugars			
Sucrose	Fructose	Glucose	Galactose
Sophorose	Threitol	Palatinitol	Sorbitol
Pentitol	Inulotriose	Melezitose	Tagatose
Raffinose	N-acetyl-D-mannosamine	Beta-gentiobiose	Fucose
Xylose	Trisaccharide	Mannose	

.

Sugar metabolite profiles and diversity

The Kouilou (Can_49 and Can_50), and Java (Can_59) sugar metabolites were highly similar and clustered together (Figure 2a). The separation between Niaouli and Kouilou/Java was very obvious (Figure 2a), this was found to be of high genetic differentiation (Anagbogu et al. 2019); and this can indicate high dissimilarity in the sugar profiles between Niaouli and Kouilou/Java. It also shows uniformity of metabolites of cultivated accessions (Niaouli). Three metabolomics diversity were detected by the hierarchical structure (Figure 2b). Sucrose which is targeted high quality trait was found to be high in the cultivated genotypes than in both Kouilou and Java (Figure 2a) and genotypes likely to have high sucrose content formed cluter II (Figure 2b). Hence there exists sucrose diversity within cultivated genotypes (Niaouli).

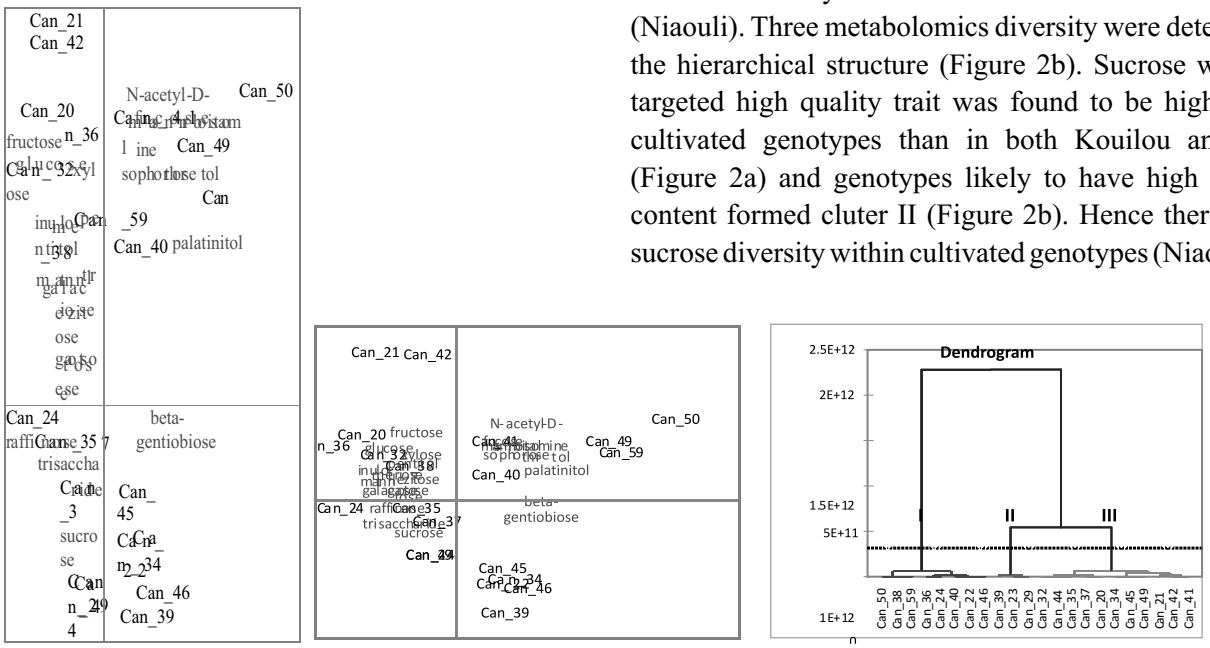

Figure 2. A. Principal Component analysis showing the sugar profiles of the genotypes.
B. Sugar metabolite diversity analysis by hierarchical clustering analysis

Caffeine and polyphenol correlation and diversity

The PCA and hierarchical cluster analyses are complimentary having formed 3 metabolomics diversity or profiles for the genotypes with respect to polyphenols metabolites (Figure 3a and b). Genotypes in cluster I are likely to have high caffeine, chlorogenic and quinic acid contents and these genotypes are mainly cultivated accessions (Niaouli). However, some of the cultivated genotypes in both clusters II and III have low caffeine, chlorogenic acids and quinic content (Figure 3b), therefore showing high variability of these metabolites in 'Niaouli' (cultivated genotypes).

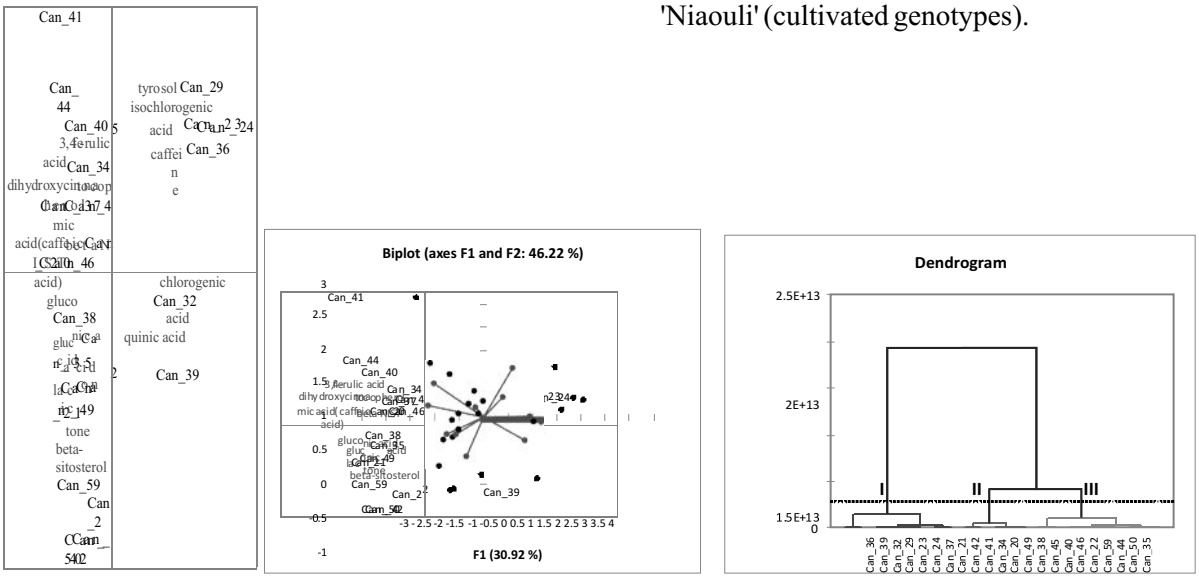

Figure 3. A. Principal Component analysis showing the sugar profiles of the genotypes. **B.** Sugar metabolite diversity analysis by hierarchical clustering analysis

Conclusion

There is high sucrose content and variability in the caffeine content among the cultivated genotypes. The high level of caffeine detected among genotypes shows that our germplasm harbours low quality C. canephora. The metabolomics profile of cultivated accessions was highly similar with regard to sugar metabolites than polyphenols. Both high and low levels of caffeine, chlorogenic acids and quinic acids were present in Niaouli. Both sugar and polyphenol metabolites profiles detected metabolomics differentiation between Niaouli and Java/Kouillou but sugar metabolites has high level of differentiation. There is a very low metabolomics difference between Java and Kouillou. Only two metabolomics profiles in the C. canephora germplasm are insufficient for worthwhile quality. There is need for germplasm acquisition especially for genotypes with high quality traits. The existing germplasm will still be utilized to generate breeding population through hybridization between high sucrose and low caffeine content genotypes.

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Experimental Title: Creating Viable Innovation Platform to Facilitate Production and Market-Linked Coffee Value Chain in Plateau State, Nigeria

Investigators:

Introduction

Coffee is an economic important crop grown in over 70 countries of the World and consumed throughout the world. However, the production is faced with soil depletion, prevalence of pests and diseases, inappropriate processing technology, which has resulted in poor marketing and consequently led to abandonment by farmers. The major challenges facing agricultural development, particularly in developing countries dominated by smallholder farming are increasingly framed in the context of weak innovation systems and capacities in the growing literature on agricultural innovation systems. Innovation systems (IS) approaches emphasize the collective dimension of innovation pointing to the need to effect necessary linkages and interaction among stakeholders. These involve paying attention to the co-evolution of innovation processes, arguing that successful innovation results from alignment of technical, social, institutional and organizational dimensions. These insights are increasingly informing interventions that focus on supporting multi-stakeholder

arrangements such as innovation platforms as mechanisms for enhancing agriculture innovation. While much emphasis in analyzing agricultural innovation systems has focused on how these multi-stakeholder platforms are organized and mechanisms through which actors interact, hence, the need to facilitate coffee production in Nigeria through creating a viable Innovation Platform.

Objectives

The main objective of the project is to increase coffee production and market-linked to enhance farmers interest

Specific objectives

1. Increasing coffee production through a viable innovation platform
2. Creating awareness of profitability in coffee production
3. Establish Public Private Practice, through market driven coffee production
4. Building farmers' capacity through participatory and learning

Methodology

Purposive selection of Taraba State based on the collaboration between CRIN and Kaldi Africa on establishment of 250 hectares' coffee farmers group. The methodology was based on process of innovation platform formation

Results and Discussion

The program was a follow-up to the Stakeholders meeting held in Lagos on 22/05/2018 in collaboration with Kaldi Africa Limited. The program was based on creating viable innovation platform to facilitate production and market-linked coffee value chain in Plateau state, Nigeria. The meeting was co-organized by Cocoa Research Institute of Nigeria (CRIN) and Kaldi Africa Limited. It started with advocacy visits to the State Hon. Commissioners for Agriculture and Rural Development, Hon. Istifanus Hosea Finangwai, Hon. Commissioner for Local Government and Chieftaincy Affairs Hon. Dalyabu Garga and the Traditional Ruler of Vom, His Royal Highness Da. Gyang Gutt Balak. The team from CRIN which included Dr. Ipinmoroti, R. R.(Leader of the Team), Mr. Oloyede, A. A., Dr. Famuyiwa, B. S. and Mr. Dada K. E. and the Plateau Executives of the Coffee Association visited some existing coffee farms along with the 31 ha proposed coffee plot at Chuni Vwang donated by the Vom community to the Coffee Farmers association. The paramount Ruler assured safety for the Innovation Platform as well willingness to provision of land. The Commissioner for Agriculture and Rural Development ably represented by the Permanent Secretary Dr. Elias Pede, commended the initiative of CRIN on the Innovation Platform at a time when the State Government is keying into economic diversification of the Federal Government in the area of Agriculture with Coffee and Tea as a priority commodity crops as a result of the suitability of the state for coffee and tea production, it was suggested that the establishment of a CRIN sub-station will facilitate the intended purpose. Conclusively the state Government requested for the training and re-training of farmers and Extension staff on coffee and tea production. The Hon. Commissioner for Local Government and Chieftaincy Affairs also assured of his support for the innovation in the state. The establishment and launching of the platform was attended by over 50 stakeholders across the coffee value chain namely; farmers, Nigeria Export Promotion Council (NEPC), Raw Materials Research and Development Council (RMRDC), Nigeria Shippers' council (NSC), National Agency for Food and Drug Administration and Control (NAFDAC), Non-Governmental Organisation (NGO), News Agency of Nigeria (NAN), Processors, Input dealers, State Ministry of Agriculture, Plateau Agricultural Development Programme (PADP), etc. The Programme Manager of PADP Engr. P.K. Gonap and one of his Directors Mr. Luka Kefas were there to encourage the participants and to assure them of the state Government readiness to support them in making the Innovation Platform a success.

Highlights

- Keynote addresses and technical presentations were made
- Presentation of improved Arabica coffee seeds to Plateau, Taraba and Cross Rivers States
- Establishment of community Nursery in the nine producing Local Governments
- Massive rehabilitation of moribund and abandon coffee plantations in the State
- Establishment of coffee seed garden
- The seedlings derivable from the seeds should be equitably distributed among the farmers
- To enhance coffee bean quality, wet processing method was emphasized
- Establishment of wash stations was also encouraged

- Establishment of cottage industries on primary and secondary processing across the State was also suggested
- Training and retraining along coffee value chain by CRIN was also requested
- Election of Executives of the Platform
- Identification of capacity development needs
- Registration of the Platform
- A proposal on development of coffee in Plateau should be written and submitted to African

Group photo after meeting with the PS Dr. Elias Ede Ministry of Agric and Rural Development

Presentation of Arabica coffee seeds to Mr. Ishaku Fei, the Secretary Plateau State Coffee Farmers' Association

Cross section of the Stakeholders at the Establishment of Coffee Innovation Platform

Experimental Title: On- Farm Demonstration of Coffee Wet Processing Method to Facilitate Production and Market-Linked Coffee Value Chain in Plateau State, Nigeria

Investigators:

Introduction

Coffee is an economic important crop grown in over 70 countries of the World and consumed throughout the world. However, the production is faced with soil depletion, prevalence of pests and diseases, inappropriate processing technology, which has resulted in poor marketing and consequently led to abandonment by

farmers. The major challenges facing agricultural development, particularly in developing countries dominated by smallholder farming are increasingly framed in the context of weak innovation systems and capacities in the growing literature on agricultural innovation systems. Innovation systems (IS) approaches emphasize the collective dimension of innovation pointing to the need to effect necessary linkages and interaction among stakeholders. These involve paying attention to the co-evolution of innovation processes, arguing that successful innovation results from alignment of technical, social, institutional and organizational dimensions. These insights are increasingly informing interventions that focus on supporting multi-stakeholder arrangements such as innovation platforms as mechanisms for enhancing agriculture innovation. While much emphasis in analyzing agricultural innovation systems has focused on how these multi-stakeholder platforms are organized and mechanisms through which actors interact, hence, the need to facilitate coffee production in Nigeria through creating a viable Innovation Platform.

Objectives

The main objective of the project is to increase coffee marketing through farmers; capacity building on wet processing to enhance coffee quality

Specific objectives

1. Increasing coffee production through a viable innovation platform
2. Creating awareness of profitability in coffee production
3. Establish Public Private Practice, through market driven coffee production
4. Building farmers' capacity through participatory and learning

Methodology

Purposive selection of Taraba State based on the collaboration between CRIN and Kaldi Africa on establishment of 250 hectares' coffee farmers group. The methodology will be based on process of innovation platform formation

Results and Discussion

Sequel to the Stakeholders' meeting held in Lagos, the representative of NCAM Engineer Ogunjirin promised to continue on the initial proposal submitted to NCAM by CRIN on the development of coffee dehusking machine. Initial visit was made to NCAM to reactivate the process of fabricating the Machine, picture indicated below. It was later agreed that both dehulling and roaster fabrication be commenced. These machines were fabricated and tested with coffee.

Status: On- going

Challenges: Banditry and Fulani herdsmen

Experimental Title: Coffee Farmers Information Needs Assessment and Search Behaviour in Nigeria

Investigator: Abdul-karim, I. F.

Introduction

In other to know the farmers, their needs and the area where the project will be executed adequately, effectively and efficiently there is need to carried out an advocacy visit to enable the researcher understand the farmers and their needs, to be able to describe the area of study and steps or procedure to be taken in order to acquire good result for the project. Therefore, the following states due to their predominant in coffee production and geo-political reasons were visited.

States visited; Ekiti, Kogi and Kwara State.

Pre visit activities Ekiti State

Agricultural Development Project (ADP) of Ekiti State was visited to confirm the major coffee growing local government areas and communities or villages and the farmers' in the state. The visitation was made through the help of one of the ADP staff in person of Mr. Tope clement Adedayo who assisted in taking us through the LGAs and community/villages that were major in coffee production among which are;

- Omuo Ekiti
- Ikole Ekiti
- Ekiti East
- Ekiti West

However, Mr. Durotola Ajagbe and Mall. Taofiq Abdulsamad was chosen to help in contacting the coffee farmers in their villages and he will assist in communicating the farmer anytime need arise. During the trip there are a lot of constraints such as poor road system,

inadequate transportation system, high rate of transport fare, political impression, expectation of sharing money among others.

Kogi State

Agricultural Development Project (ADP) of Kogi State was visited to confirm the major coffee growing local government areas and communities or villages and the farmers' in the state. The visitation was made through the help of one of the ADP staff in person of Mr. Kajogboola Owowumi Taiwo who assisted in taking us through the LGAs and community/villages that were major in coffee production among which are;

- Ijumu
- Yagba East
- Iyamoye
- Kabba bunu

However, Mr. Lapade Akinfewa and Mr. Victor Damilare were chosen to help in contacting the coffee farmers in their various villages and he will assist in communicating the farmer anytime need arise. During the trip there are a lot of constraints such as poor road system, inadequate transportation system, high rate of transport fare, political impression, expectation of sharing money among others.

Kwara State

Agricultural Development Project (ADP) of Ekiti State was visited to confirm the major coffee growing local government areas and communities or villages and the farmers' in the state. The visitation was made through the help of one of the ADP staff in person of Alh. Mohammed Kazeem and Mr. Baba Saheed assisted in taking us through the LGAs and community/villages that were major in coffee production among which are;

- Omuaran
- Oke Ayo
- Ekiti /Oro
- Oke Ero

However, Mr. Ayanda Mohammed, Mrs. Tejumola Kahinde and Kayode Tolohunlase were chosen to help in contacting the coffee farmers in their villages and he will assist in communicating the farmer anytime need arise. Some farmers complain of poor attitude of government towards coffee production, some complain the farm had been used for other purpose; price of coffee is major issue in some villages, poor yield in someplace. During the trip there are a lot of constraints such as poor road system, inadequate transportation system, and high rate of transport fare, political impression, banditry, kidnaping, and expectation of sharing money among others.

Objectives

The objectives of this study are to

- Examine the socio-economic characteristic of the farmers',
- Determine their source of information for production of coffee,
- Evaluate the behaviour of farmers towards coffee production,
- Investigate the farmers' needs in relation to technologies used in coffee,
- Identify the methods and technique used in relation to production.

Material and Methods

Some of the Agricultural Development Project (ADPs) staff was involved in the visiting of intended areas of the study. Involvement of community leaders in most of the community visited was employed.

Result and Discussion

Presently there is no result until the project is adequately executed.

Conclusion

The project is on- going it will be executed next year if the fund is released.

Challenges

Challenges faced during the advocacy visit are some farmers were not ready to cooperate due to promise and fail issue, poor road system, inadequate transportation system, and high rate of transport fare, political impression, banditry, kidnaping, and expectation of sharing money among others.

Status: On-going

TEA PROGRAMME

Experimental Title: Manipulating Shade Density for Expansion of Tea Production in Lowland Ecology of Nigeria

Investigator: Adeosun, S.A.

Introduction

Tea production over the decades has been confined to Mambilla Plateau in Taraba state, the only place where the upland tea varieties are cultivated on commercial scale in Nigeria. There is need to expand tea production to other parts of the country especially the lowland area owing to limited available land on the Mambilla Plateau. However, the hot and humid climate has been a major constraint to the cultivation of tea in Southern Nigeria. The use of shade plants is indispensable and is crucial to the amelioration of the hot ambient temperature if the goal of expansion of tea cultivation to the lowland would be achieved. Intercropping shade plants with tea and other beverage crops has been practiced in various agricultural ecologies of the world. In Nigeria, plantain and eucalyptus have been successfully grown with cacao in Ibadan and tea on Mambilla Plateau, respectively (Famaye, *et al*., 2014). Pigeon pea (*Cajanus cajan*) and *Glyricidia sepium* have been reported to provide shade for growing coffee and tea in Sri Lanka and Hawaii (Valezuella, 2011; T. R. I., 2003). Moreover, shade plants have been reported to enhance suppression of weed growth (Bermudex, 1980), increased soil organic matter (Santana and Cabala, 1985), reduction of soil erosion (Wiersum, 1984) and nitrogen fixation especially when it involves planting of leguminous crops (Escalante, 1984). Besides, Iremiren *et al*. (2010) also reported that plantain resulted in higher survival count of tea cuttings. Therefore, this trial was conducted to evaluate the effect of different densities of plantain shade on field establishment and vegetative growth of two cultivars of tea plants in Idi-ayunre and Owena, South West Nigeria.

Objectives

To evaluate the effect of different plantain densities on vegetative growth and field establishment of two tea cultivars in two locations in South West Nigeria

Materials and methods

A field trial was conducted in CRIN Headquarters, IdiAyunre, Ibadan (Latitude 07º 10'N; Longitude 03° 52'E) and CRIN Substation, Owena (Latitude 07° N; Longitude 05° 7'E). The 2x3 factorial experiment included two tea cultivars (143 and 318) and three plantain shade levels: 2222 plantain ha^{-1} (3x1.5 planting distance); 1111 plantain ha^{-1} (3x3m planting distance); zero plantain as control). The experiment was laid out in Randomized Complete Block Design (RCBD) arranged in Split- Plots with four replications (Blocks). Each block contained 2 main plots and 6 sub-plots: tea cultivars as the main plots and plantain densities as subplots; a gap of 2m was allowed between the blocks and adjacent subplots. The vegetation on the experimental sites was manually cleared and plantain suckers were planted 16 months before the establishment of tea. Tea clonal materials comprising cultivars 143 and 318 that were raised in CRIN Substation, Mambilla, Taraba State were transported to the experimental sites. Planting holes were dug at a dimension of 20x20x30cmand planting distance of 100x60cm. The tea cuttings were transplanted at 8-11 leaf stage in the avenue of the rows of plantain stands. Weeding was done with hoe and cutlass four times per annum. The subplots were weeded with hoe while the gaps between the subplots and the blocks were slashed with cutlass. In the dry season water was artificially applied to the base of the tea plants: 2L of water was applied per tea stand 3 times per week and the watering was done between November 2017 and April 2018 while the dry season lasted. On monthly basis, starting from 3 MAT (Months after transplanting), two tea plants per treatment per replication were randomly tagged for the following morphological parameters: number of leaves, leaf area and number of branches. At 9 MAT, data on survival count was taken. All data collected from the experiment were analyzed with ANOVA using STAR (Statistical Tools for Agricultural Research) (2013) statistical software package and the significant means were separated with Fishers Least Significant Difference (P=0.05).

Results and Discussion

Table 1 and 2 shows the effect of the different tea cultivars and plantain densities in the trial in Idi- Ayunre and Owena respectively. Cultivar 143 enhanced significantly higher number of leaves, number of branches and leaf area (P=0.05) than C318 across the two locations. The different plantain densities under which the tea plants were grown enhanced the vegetative growth of the tea plants. Plantain at 2222 plants ha^{-1} engendered the highest number of leaves, number of branches and leaf area of tea except in

Owena where 1111 plantain enhanced the highest number of branches; while the least vegetative performance was obtained zero shade in both Idi-Ayunre and Owena. At Idi-Ayunre, while plantain at 1111 and 2222 plants ha^{-1} were significantly (P=0.05) better than zero shade in number of leaves; plantain at 2222 plants ha^{-1} was significantly superior to both 1111 plants ha^{-1} and zero shade in number of branches and leaf area (Table 1). At Owena, although 2222 plantain ha^{-1} and 1111 plantain ha^{-1} were not significantly different (P=0.05) for number of leaves and number of branches; 2222 plants was significantly better than 1111 plantain ha^{-1} in number of branches of the tea plants (Table 2). The enhancement of better vegetative growth of tea by 2222 and 1111 plantain ha^{-1}could be due to the moderate light quantum incident on the plants occasioned by different levels the plantain canopy. Subdued light intensities have beneficial effect on both tea plant and the soil in which the plant grows. The subdued light must have precipitated optimal condition for photosynthesis by regulating leaf and canopy temperature (Jannedra, 2007). This result corroborates the report of Hajiboland *et al*. (2011) that tea growth was enhanced under intermediate light intensities. Besides, the shade imposed on the tea plants and their expanded canopies (as a result of moderate light intensities) had ameliorating effect on the soil in which the plants grew. Generally, the tea plants performed better in Owena than in Idi- ayunre. Moreover, cultivar 143 performed better than 318 in vegetative growth under all the plantain shade regimes. For instance, at Owena, under 2222 plantain ha^{-1} density, number of leaves, number of branches and leaf area of 51.41, 8.77 and 1529.33cm^2, respectively produced by C143 tea was significantly (P=0.05) higher than that of C318 (11.63, 2.88 and 287.78cm^2, respectively). Also, C143 tea performed better under zero plantain shade environment than C318. Under zero plantain shade, C143 plants were significantly superior to C318 plants in number of leaves, number of branches and leaf area in both locations. The better growth performance of C143 in comparison with C318 under both plantain and zero shade corroborates CRIN (1983) that the former was more drought tolerant than the later. There were significant differences in the effect of different cultivars and plantain densities on survival count of tea plants at the two locations (Table 3). At both Idi- Ayunre and Owena, C143 was significantly (P=0.05) superior to C318 in the survival count.

At Idi-Ayunre, the survival of tea under 2222 plantain ha^{-1} was significantly higher than those under 1111 plantain ha^{-1} and zero plantain in the following order: 79.43% > 32.24% > 25.74% for 2222, 1111 and zero plantain ha^{-1} respectively; while at Owena, 2222 plantain ha^{-1} was better than 1111 plantain ha^{-1}, though not significantly but was significantly better than zero shade. This implies that plantain shade reduced the scorching effect of adverse weather condition resulting from high ambient temperature (Obatolu and Ipinmoroti, 2000). This underscores the fact that tea survival was grossly endangered under full light intensity especially during cloudless dry season when light intensity is at its brightest with the accompanying excessive rise in ambient temperature. Cultivar 143 survived better than C318 under 1111, 2222 and zero plantain shade conditions; its survival was significantly (P=0.05) different at Idi-Ayunre, especially under 1111 and zero plantain as against the situation at Owena where the two cultivars were not significantly different under each plantain shade environment. The result of the interaction of cultivars with the varying light intensities shows that under all the light intensities, C143 was better than C318 in enhancing field establishment. This was as a result of better ability of C143 to withstand wide range of ambient temperature (CRIN, 1985). Generally, tea plants survived the first dry season better at Owena than at Idi-Ayunre

Table 1: Effect of Plantain Densities and Fertilizebr Types on Vegetative Growth of C143 and C318 Tea Plants 9 MAT on the Field at Idi-Ayunre

Cultivars		Number of leaves	Number of branches	Leaf area (cm
C143		12.97a	3.09a	216.76a
C318		6.96b	0.87b	162.35b
Mean		9.97	2.98	189.55
Plantain densities (Plants ha^{-1})				
1111		11.81a	2.05b	209.31b
2222		13.91a	3.31a	333.20a
Zero shade		4.17b	0.58c	26.16c
Mean		9.97	1.98	189.55
Plantain densities x Cultivars				
1111	C143	14.89a	3.78a	328.17a
	C318	12.94b	0.31b	338.21a
Mean		13.92	2.05	333.19
2222	C143	16.63a	4.45a	284.72a
	C318	7.00a	2.17b	133.89b
Mean		11.82	3.31	209.31
Zero shade	C143	7.41a	1.03a	37.37a
	C318	0.93b	0.13b	14.95a
Mean		4.18	0.58	26.16

Means followed by the same letters in a column under a treatment are not significantly different by LSD (P=0.05)

Table 2: Effect of cultivars and plantain density on vegetative growth of tea plants 9 MAT on the field at

Cultivars		Number of leaves	Number of branches	Leaf area (cm^2)
C143		40.52a	8.35a	1056.06a
C318		11.71b	3.94b	320.24b
Mean		26.12	6.15	688.15
Plantain densities (Plants ha^{-1})				
1111		28.36a	7.46a	690.78ab
2222		31.52a	5.82b	908.55a
Zero shade		18.87b	5.16b	465.12b
Mean		26.12	6.15	688.15
Plantain densities x Cultivars				
1111	C143	41.80a	9.63a	917.62a
	C318	14.93b	5.30b	463.94a
Mean		28.37	7.47	690.78
2222	C143	51.41a	8.77a	1529.33a
	C318	11.63b	2.88b	287.78b
Mean		31.52	5.83	908.56
Zero shade	C143	28.36a	6.66a	721.24a
	C318	8.58b	3.60b	209.01b
Mean		18.47	5.13	465.13

Means followed by the same letters in a column under a treatment are not significantly different by LSD

Table 3: Effect of cultivars and plantain densities on survival count (%) of tea plants at 9 MAT at Ibadan and

Cultivars		Idi-Ayunre	Owena
C143		58.62a	82.64a
C318		32.99b	53.99b
Mean		45.80	68.32
Plantain densities (Plants ha^{-1})			
1111		32.24b	70.83ab
2222		79.43a	79.69a
Zero shade		25.74b	54.43b
Mean		45.80	68.32
Plantain densities x Cultivars			
1111	C143	51.98a	83.33a
	C318	12.50b	58.33a
Mean		32.74	70.83
2222	C143	82.81a	92.71a
	C318	76.04a	66.67a
Mean			79.69
Zero shade	C143	41.07a	71.88a
	C318	10.42b	36.98a
Mean		25.75	54.43

Means followed by the same letters in a column under a treatment are not significantly different by LSD (P=0.05)

Conclusion

Growing tea under plantain shade enhanced its growth and field establishment at Idi-Ayunre and Owena. The growth and field establishment of cultivar 143 was better than that of 318 under all the plantain shade regimes, but its optimum was attained under 2222 plantain density ha^{-1}. Tea growth performance was enhanced at Owena than at Idi-Ayunre. It is therefore recommended to prospective tea farmers in the South West of Nigeria that C143 should be preferred to C318 and that growing it under 2222 plantain ha^{-1} density would enhance its growth and early field establishment.

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Title: Eucalyptus Agroforestry in Tea Plantation on the Mambilla Plateau: Influence on Carbon Sequestration and Soil Organic Carbon

Investigator: Aikpokpodion Paul E.

Introduction

Since industrial revolution, there has been a dramatic increase in the atmospheric concentration of carbon dioxide (CO_2) and other greenhouse gases. The atmospheric concentration of CO_2 has risen from 285 ppmv in 1750 to 379 ppmv in 2005 and is increasing at a rate of 1.4 ppmv per year (Forster *et al.* 2007). Similarly, the atmospheric concentration of nitrous oxide (N_2O) has increased from about 270 ppmv in 1750 to 319 ppmv in 2005 and is increasing at the rate of 0.84 ppmv per year (Forster *et al.* 2007), this enrichment of green house gases in the atmosphere is anthropogenically driven with fossil fuel usage and land-use change being the principal agents for CO_2 emissions, while agriculture is the principal source of CH_4 and N_2O.Carbon sequestration is a natural method for the removal of carbon from the atmosphere by storing it in the biosphere (Chavan and Rasal, 2010). A carbon sink absorbs CO_2 from the atmosphere and stores it as carbon. Trees serve as sink for CO_2 by fixing carbon during photosynthesis and storing excess carbon as biomass. As the rate of photosynthesis increases, more CO_2 is converted into biomass, reducing carbon in the atmosphere and sequestering it in plant tissues above and below ground (IPCC 2003). Eucalyptus spp are a group of trees native to Australia, with small number of species also indigenous to Indonesia, the Philippines and New Guinea (Stanturf *et al,* 2013) Eucalyptus dominates most of the natural forests in their habitat, growing in range of diverse climates and soil types (Pohjonen, 1989). Eucalyptus was introduced to the Mambilla plateau in the late 1950s. The tree species outperform other tree species in terms of production and farmers' income generation. This can be attributed to a number of biological and physiological characteristics including fecundity, rapid growth rates (Leicach *et al.* 2012) and tolerance for a wide range of soil and climate niches (Zegeye, 2010) . It is also tolerant to severe periodic moisture stress and low soil fertility (Davidson, 1989). Eucalyptus is the main source of fuel wood, timber and wood works on the Mambilla plateau. Due to its adaptability in the semi temperate climate, it is the most popular economic tree species on the plateau. Timber from Eucalyptus is virtually used for most furniture works on the plateau. Consequently, most farmers who abandoned *Coffee arabica* cultivation due to fall in price several years back, went into mass cultivation of eucalyptus which now serves as major source of income for its growers. Eucalyptus being a hardwood and good for charcoal coppices readily and rejuvenates almost immediately after tree felling. In addition to wood products, Eucalyptus plantations are also used for honey production on the Mambilla plateau. Collectively, the multipurpose nature of eucalyptus contributes to its efficacy as a major tree species grown by smallholder farmers on deteriorated soils with low fertility status. Currently, timbers from Eucalyptus on Mambilla plateau are transported to various parts of Nigeria for various categories of wood works by timber merchants. The economic value ascribed to Eucalyptus has made many tea farmers adopt a farming system where tea is intercropped with Eucalyptus for the purpose of maximizing land utilization and enhanced financial income. Information on carbon sequestration as influenced by intercropping tea with Eucalyptus in Nigeria is limiting. In view of this, the study evaluated the impact of agroforestation of tea plantation with Eucalyptus on carbon sequestration and soil fertility.

Materials and Methods

Study location

Mambilla Plateau is a plateau in Taraba State of Nigeria. The plateau has an average elevation of 1,600 meters above sea level making it the highest altitude in Nigeria. Some of the villages on the plateau are situated on hills higher than 1,700 meters above sea level. Among the villages is Nguroje which is more than 1,800 meters above sea level. There are other locations on the plateau that are approximately 2,000 meters above sea level. The plateau

covers an area of over 9,389 square kilometers (Leva, 2007). Mambilla Plateau receives an average annual rainfall of over 2,800mm. In 2018, it received a total rainfall of 3,157.73 millimeters from 111 rainy days of the year (CRIN, 2018). The climate of the plateau is semi temperate in nature. Outdoor temperature taken by 7.00 am hardly exceeds 19°C. It can be as low as 13°C during winter. At noon, temperature ranges between 14 and 30°C depending on the period of the year. The increase in day time temperature on the plateau in recent time is due to climate change. The study was carried out at the Cocoa Research Institute of Nigeria, Mambilla substation located in Kusuku village (N 6.8777; E 11.1322) Taraba State, Nigeria. The experiment was carried out in an existing tea-eucalyptus intercropped plot and monocropped tea plantation adjacent to the intercropped plot. Ten core soil samples (0-20cm depth) were taken from both plantations separately with soil auger. The samples from each plot were thoroughly mixed together to obtain two separate composite samples. Tea leaves were also obtained from the two experimental sites. Soil and plant samples were processed according to standard procedures.

Soil analysis

Sub-samples meant for major cations analysis were leached with 1N ammonium acetate. The leachate was analyzed for exchangeable cations (Ca^{2+}, Mg^{2+}, K^{+} and Na^{+}) determination (Schollenberger and Simeon 1945). Soils were analyzed for particle size by the Boyocous hydrometer method. Soil pH was measured with glass electrodes in 1:1 soil-water suspension. The organic carbon was determined according to Walkley and Black (1934). Total Nitrogen was determined by the Macro Kjedahlmethod (Bremner,1996).Available Phosphorus was determined using Mehlich 3 method (Mehlich, 1984). Mehlich 3 extracting solution was preferred to Bray 1 solution (Bray and Kurtz, 1949) owing to the inability of Bray 1 solution to extract available phosphorus from the soil samples at detectable level.

Carbon sequestration determination

The non destructive method of carbon sequestration (Saral *et al,* 2017)was used to quantify carbon sequestered in the tea-eucalyptus plantation.

The biomass of tree was estimated on the basis of Diameter at breast height (DBH) and tree height. DBH was determined by measuring tree Girth at Breast Height (GBH), approximately 1.3 meter above the ground. The GBH of trees having diameter greater than 10cm were measured directly using measuring tape.

Above ground Biomass (AGB) of Tree

The above ground biomass of tree includes the whole shoot, branches, leaves, flowers and fruits. It was calculated using the formula:

AGB (kg) = Volume of tree (m^3) x wood density kg/m^3. V = $\pi r^2 H$

Where V = volume of the cylindrical shaped tree in m3

R = radius of the tree in meters

H = Height of tree in meter

Radius of tree was calculated from GBH of the tree while the value of wood density was obtained from Global density database. The standard average density is 0.6gm/cm

Below ground Biomass (BGB)

The below ground biomass includes all biomass of live roots excluding fine roots. The BGB has been calculated by multiplying AGB X 0.26 factors as the root: shoot ratio,

BGB (kg/tree) = AGB (kg/tree) X 0.26

Total biomass was calculated by the summation of Above Ground Biomass (AGB) and Below ground biomass (BGB) i.e TB = AGB (kg/tree) + BGB (kg/tree)

Carbon stored in each tree was calculated by multiplying the total biomass by 50%

Determination of the weight of CO_2 sequestered in the tree

The weight of CO_2 is C + 2 X O = 43.99915

Hence, the ratio of CO_2 to C was calculated as 43.99915/12.001118 = 3.6663

Hence, in order to determine the weight of CO_2 sequestered in the tree, the weight of carbon in the tree was multiplied by 3.6663

Result and Discussion

Carbon sequestration in Eucalyptus trees

Calculated above ground biomass was 8.44 kg per tree, while the below ground biomass was 2.194 kg per tree on the average. Result of carbon sequestration in eucalyptus trees within tea-eucalyptus intercrop plot in Mambilla substation showed that on the average, 19.48 kg of CO_2 was sequestered in each eucalyptus tree. Saral *et al*. (2017) reported CO2 sequestration of 35.681, 8.70, 52.58, 25.67 and 23.90 kg per tree for Sausage tree, Neem tree, Cork tree, Silver tree fern and Yellow flame tree respectively. On the overall, approximately 10 tonnes of CO_2 was

sequestered in all the available eucalyptus trees within the tea-eucalyptus intercrop. The outcome of the study implies that; eucalyptus tree has economic potential to be used in carbon trading which involves the use of forest in cleaning up the environmental hazards. Estimation of carbon content in forest woody biomass is important with regard to Greenhouse effect mitigation. Wooden perennials during their growth absorb CO_2 from the air during photosynthesis in such a manner to sequestrate carbon in biomass thereby, decreasing the concentration of the greenhouse gas in the air. For this reason, forest trees are regarded as Carbon pools or Carbon sinks.

Table 1: Chemical properties of soils under eucalyptus and outside eucalyptus

Parameters	Soil outside Eucalyptus	Soil under Eucalyptus
pH	4.82	5.00
P (ppm)	9.55	9.96
Na ($cmolkg^{-1}$)	0.31	0.28
K($cmolkg^{-1}$)	0.32	0.34
Ca ($cmolkg^{-1}$)	1.31	1.47
Mg ($cmolkg^{-1}$)	1.28	1.39
Al+H	0.27	0.13
N (%)	0.27	0.48
Org C (%)	4.42	5.13
Cu ($mgkg^{-1}$)	0.90	1.45
Zn ($mgkg^{-1}$)	2.89	3.73
Mn ($mgkg^{-1}$)	13.50	15.65
Fe ($mgkg^{-1}$)	13.95	13.53

Note: values are means of three replicates.

Soil sample obtained under tea- eucalyptus intercrop had higher concentration of exchangeable K, Ca, Mg, Zn, Mn, total N, organic carbon, available P and pH compared with soil samples under mono-cropped tea plantation (Table 1). The higher organic carbon in soil under tea-eucalyptus intercrop compared with soil under mono-cropped tea plantation was due to leaf litter fall from the eucalyptus trees. The effect of leaf litter on soil chemical properties obtained in this work is in agreement with the report of Sarkar *et al.,* (2010) in which leaf litter increased soil pH, organic matter, total N, available P, exchangeable K, Ca and Mg. Leaf litters are rich in organic matter after decomposition and mineralization which increases the total organic matter content of the soil. Decomposition of leaf litter is an integral and significant part of biochemical nutrient cycling. Decomposition refers to both the physical and chemical breakdown of litter and the mineralization of nutrients (Boulton and Boon, 1991). Through decomposition of plant materials, nutrients locked up within leaf litter are converted into bio-available form for plant uptake. This was evident in the result of chemical analysis of tea leaves obtained from both experimental sites. Result of the analysis (Data not shown) showed that, tea leaves obtained under tea-eucalyptus intercrop were higher in N, P, K, Ca, Mg, Zn, and Mn compared with tea leaves obtained from the mono-cropped tea plantation. Litter plays a fundamental role in the turnover and in the transfer of energy between plants and soil. Higher organic matter occasioned by eucalyptus leaf litter fall in sample obtained from eucalyptus-tea plantation might also have been responsible for higher nitrogen content of soil under eucalyptus-tea intercrop compared with mono-cropped tea. This can occur through the activities of humus in soil organic matter. Organic matter decomposition produces humus which is a valuable reservoir of nitrogen. Humus contains 10% nitrogen. Aside being a source of soil nitrogen, chemical properties of humus also contributes to the retainability of nitrogen in soil via enhanced anion exchange capacity. Loss of soil nitrogen via leaching and runoff is high on the Mambilla plateau due to high annual rainfall (2,800-3,400mm) and land steepness. Owing to the fact that nitrate is negatively charged (anion), it is not attracted to the negatively charged edge of clay in the soil. Rather, the spongy soil humus with high anion exchange capacity provides means of attraction for nitrate thereby reducing its proneness to leaching and runoff. In agroforestry, there are both ecological and economical interactions between the different components (Nair, 1989). In contrast to temperate ecosystem, where soils are more fertile and a greater part of the nutrients is supplied by the weathering of parent materials, conditions of high temperatures and rainfall in the tropics accelerate soil processes, including loss of nutrients, so that the greater stock of nutrients is found stored in the biomass and made available through decomposition (Ricklefs, 1996; Primavesi, 2001). The high temperature and humidity of tropical climates are conducive to the decomposition of organic matter, so that there is not only the release of nutrients but also the formation of negatively charged particles, which help to retain cations such as Ca, Mg and K and maintain them in constant interface with the soil solution where they can be taken by plants. In tropical soils, the cover of organic matter helps in creating a conducive environment for microflora and fauna that carry out nutrient cycling. Consequently, many of the studies on the effects of trees on tropical soil concentrate on the importance of organic matter from litterfall. Litter production can be a very important contribution in systems where perennial crops are grown under shade of trees. Souza *et al* (2004)

observed that litter production in a coffee plantation shaded with diverse tree species was similar to that of native forests in the same region. Jaramillo-Botero *et al,* (2006) reported that the quantity of accumulated litter and level of K in the soil was positively influenced by the number of trees present in a distance of 0-3 meters from the coffee bushes. Since K is highly mobile in soil, its enrichment may be partly due to throughfall and stem flow, as observed by Pinho *et al* (2002) in coffee agroforestry systems. Also in coffee systems, Jesus *et al* (2006) found higher pH and base saturation in areas intercropped with rubber *(Hevea brasiliensis*) than in monocultures. The studies suggest that roots of trees occupy deeper soil layers that may not be accessible to other crops or that they are more efficient in extracting nutrients, due to their greater size and possibly through association with mycorrhizal. As such, comparison with other agricultural systems in tropical conditions implies that, agroforestry can accumulate greater amounts of carbon and help maintain soil fertility through a more efficient cycling of nutrients and a reduction of losses through leaching and erosion (Pinho *et al* 2012)

Conclusion

Eucalyptus trees planted in tea plantation have the potential to sequester carbon in their biomass by the absorption of CO_2 from the atmosphere thereby reducing the greenhouse effect of the gas in the atmosphere. Intercropping tea with Eucalyptus increased soil organic carbon which is a good index for soil health. Concentrations of soil macronutrients and micronutrients were enhanced in soil as a result of Tea-Eucalyptus intercropping. Massive cultivation of eucalyptus on the Mambilla plateau could be a source of carbon trading in the nearest future. Hence, increased Eucalyptus planting on the plateau should be encouraged for environmental benefits in addition to the benefits accrued to its existence on the plateau.

Fig 1: Agroforestry system at kusuku village on the Mambilla Plateau with Tea plant (*Camellia sinensis*) as principal cash crop intercropped with Eucalyptus.

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Experimental Title: Authentication and Validation of Tea Seed Oil as Edible Oil in Nigeria

Investigators: Yahaya L.E and Jayeola C.O

Introduction

Fats and oils are important part of human diet and they serve as rich source of dietary fibre. They contain certain fatty acid components that are essential nutrient and their functional and textural characteristics contribute to the flavour and palatability of many natural foods. Advances in fats and oil technology have led to increased awareness of the composition and structure of dietary fibre. Majority of the trees and plants do produce natural oils and fats, but these oils are not usually suitable for use without further physical and chemical treatment; for example, the oil expressed from the seed is first refined, then subjected to hardening either by glyceride separation or by hydrogenation. There are varieties of oil bearing plants, but only few are of commercial value. Examples include coconut oil, palm kernel oil and cocoa butter. Tea seed oil is one of such oils that have not been fully harnessed as vegetable oil in Nigeria. The study therefore seeks to authenticate and validate its edibility as this adds value to the crop and generate income for stakeholders.

Objectives

Authenticate and validate the edibility of Tea seed oil as vegetable oil in Nigeria

Materials and Methods

Standard procedure of analysis shall be employed to achieve the desired result of this study. Mice feeding trials shall also be carried out to ascertain any trace of toxicity according to standard methods giving consideration to ethics.

Conclusion: Not yet

Challenges: Inadequate funding

Status: On-going

Future plan: To complete and start new one.

Experimental Title: Enhancing Establishment of Tea (*Camelia Sinensis*) Through Integrated Application of Organic and Urea Fertilizers at Ibadan, Nigeria

Investigators:

Introduction

Tea adaptation and cultivation at Ibadan state have been ongoing for the past years with the sole aim of establishing adaptable commercial clones in these areas. Based on the results of a survey conducted at Cocoa Research Institute of Nigeria Ibadan in 2014 (result unpublished) by the team of experts in Tea Program Research, it was found that, Tea (*Camellia sinensis*) can grow well at Ikom, Uhonmora CRIN Substations and at the Headquarters (Ibadan). In

view of this observation, this present trial was proposed to examine the effect of some selected agricultural wastes on the establishment of Tea in lowland area (Ibadan). The study also sought to confirm the suitability of Ibadan ecology to Tea cultivation and the effects of the selected materials on the soil properties.

Materials and Methods

Treatments combinations: The treatments shall include:
(1): Control (no application), (2): CPHA (sole application), (3): CPHA+ Urea (50:50); (4): CPHA+ Urea (75:25) and (5): Urea (sole application)

Layout and Treatments administration
The treatments were split applied at 150kgNha^{-1} in a randomized complete block design (RCBD) in three replications. Agronomic data will be collected at monthly interval and tea harvest per plant be weighed (fresh and dry). The economic analysis of the fertilizer materials will be assessed. Also, genotypic evaluation of the performances of the various tea clones used and the economic analysis will be carried out. All data generated will be subjected to analysis of variance and significant means separated by LSD.

Preliminary Result
The work is still on – going. The initial soil sample collection has been carried out and pre- processed and sent to the laboratory for analysis. Secondly, the plot has been laid out and tea plants had been tagged, fertilizer treatment had equally been applied, data collection will commence in the month of August for the next 24 months.

Constraints
1: Late release of fund to start the project as schedule
2: In adequate fund release for the execution of the project.

Future Plan: The project continues in 2019

Location: Ibadan

Expected Output: - It is expected that establishment of Tea (*Camellia sinesis*) in the lowland area will be improved by 20%

Experimental Title: Comparative Analysis of the Demand for Different Brands of Tea in South Western Nigeria

Investigators: Oluyole, K.A. and Yahaya, A.T.

Introduction
Tea (Camellia sinensis (L) Kuntze) belongs to the family of theacea. It is an evergreen bush which is processed as beverage. Tea is one of the most popular and lowest cost beverages in the world and consumed by a large number of people (Oluyole *et al*, 2015). A lot of tea is consumed in European countries as well as countries where it is produced. In Nigeria, consumption of tea is common among different categories of people (Sowunmi *et al,* 2009). Tea increases alertness and also speeds up heartbeat and breathing rate thus reduces the incidence of hypotension (Aroyeun, *et al,* 2013). However, there are different brands of tea and it is disheartening that there is an information gap as regards the comparative demand among the brands. Therefore, the objective of this study is to compare the demand among the brands of tea in the study area.

Methodology
The study was carried out in the Southwestern Nigeria. Random sampling technique was used to select two states from the study area. The selected states were Ondo and Ekiti. Two Local Government Areas (LGAs) were selected from Ondo state while three LGAs were selected from Ekiti States. The LGAs selected were Akoko Northwest and Akoko Northeast from Ondo states while Ekiti Southwest, Ekiti West and Gbonyin from Ekiti state. One community was selected from each LGAs thus making a total of five communities used for the study. The communities were Ogbagi (Akoko Northwest), Ikare (Akoko Northeast), Ilawe-Ekiti (Ekiti Southwest), Aramoko-Ekiti (Ekiti West) and Imesi-Ekiti (Gbonyin). A total of 280 respondents (tea consumers) were randomly selected from the communities. Information was collected from the respondents with the aid of structured questionnaire and the data retrieved from the questionnaire were analysed using descriptive statistics such as frequencies, percentages, means and so on.

Results and Discussion
Table 1 shows the socio-economic variables for the consumers. The table shows that the highest consumers fell within the age range 21-30 years while the lowest consumers were those with above 60 years of age. This shows that tea is consumed more among the youths than

the old people. The low consumption among the old people in the study area might be due to the lack of awareness of the health benefits of tea. The result is in consonance with Oluyole *et al* (2017) who found out that only low proportion of the old people in Ogun and Oyo states consumed tea. Table 1 also shows that tea is more consumed among the females than the males as the result shows that 57.14% of the total consumers were females against 42.86% that were males. As regards the level of education, most (64.29%) consumers had secondary school education while only few (7.14%) consumers had tertiary education. Majority (74.29%) of the consumers were married. This is quite obvious as tea is more consumed at household level and household is mostly made up of married people. The table also revealed that the primary occupation of most of the consumers are trading as 60.00% of the total consumers were traders.

Table 2 describes the consumers' demand for different brands of tea. The table shows that most (68.57%) of the total consumers had more preference for Lipton tea. This is followed by Top tea (18.57%), Highland tea (5.71%) and lastly by Homecup tea (7.14%). The analysis shows that Lipton tea is mostly demanded for in the study area. This might be due to the fact that Lipton tea is more relatively available and popular than other brands of tea in the study area. It could also be observed in the table that both the Highland and Homecup tea are poorly demanded for in the study area. This shows that these two brands of tea are not so popular in the study area, hence, the producers of the brands would need to organize enlightenment programme in order to popularize the products in the study area.

Table 1. Socio-economic characteristics of tea consumers

Variables	Frequency	Percentage
Age		
≤ 20	40	14.29
21-30	92	32.85
31-40	44	15.72
41-50	60	21.43
51-60	32	11.42
> 60	12	4.29
Total	**280**	**100.00**
Gender		
Male	120	42.86
Female	160	57.14
Total	**280**	**100.00**
Educational Status		
No formal education	32	11.43
Primary education	48	17.14
Secondary education	180	64.29
Tertiary education	20	7.14
Total	**280**	**100.00**
Marital status		
Single	60	21.43
Married	208	74.29
Widow/widower	12	4.29
Total	**280**	**100.00**
Primary occupation		
Artisan	68	24.29
Trading	168	60.00
Civil service	8	2.86
Farming	16	5.71
Schooling	16	5.71
Retiree	4	1.43
Total	**280**	**100.00**

Source: Field survey,

Table 2. Consumers' Demand for Different Brands of Tea

Brands of Tea	Frequency	Percentage
Lipton Tea	192	68.57
Highland Tea	16	5.71
Top Tea	52	18.57
Homecup Tea	20	7.14
Total	**280**	**100.00**

Source: Field survey, 2018

Table 3 shows the quantity of different brands of tea consumed per person per week. The table shows that 6.54 gramme of Lipton tea is consumed per person per week. This is followed by Top tea with 1.26 gramme per person per week while the least consumed is Highland tea with 0.12 gramme per person per week. Therefore, the brand of tea with the highest consumption per person was Lipton tea.

Table 3: Quantity of per capita consumption of different brands of tea per week

S/N	Brands of Tea	Per capita consumption per week (gramme)
1	Lipton tea	6.54
2	Highland Tea	0.12
3	Top Tea	1.26
4	Homecup Tea	1.20

Source: Field survey, 2018

Table 4 shows the consumption pattern of tea in the study area. It was revealed in the table that majority (85.71%) of the respondents buy tea beverage and 97.14% of the people that bought tea consume it showing that the substantial proportion of the respondents consume tea. It

is quite pleasing that tea beverage is available everywhere in the study area as majority (72.86%) of the tea buyers asserted that they get the products buy around their homes. This claim is quite corroborated with the fact that majority (87.14%) of the respondents submitted that they do nothave problem in buying tea beverage and the few that do not buy it claimed that they do not have money to do so

Table 4: Status of tea demand among the respondents

Variables	Frequency	Percentage
Do you buy tea beverage?		
Yes	240	85.71
No	40	14.29
Total	280	100.00
If no, why are you not buying it?		
No response	240	85.71
I don't like it	32	11.43
I don't have money to buy it	4	1.43
I don't know where to buy it	4	1.43
Total	280	100.00
Why do you buy tea?		
For personal consumption	272	97.14
To give out as gift	8	2.86
Total	280	100.00
Where do you buy tea?		
Around my home	204	72.86
Market	64	22.86
Other places	12	4.29
Total	280	100.00
Do you have problem in buying tea?		
Yes	36	12.00
No	244	87.14
Total	280	100.00
If yes, what problem?		
No response	240	85.71
No money to buy it	32	11.43
Not always available in my area	8	2.86
Total	280	100.00

Source: Field survey, 2018

Conclusion and recommendation

Tea is consumed by all the categories of people in the study area and the brand of tea that is mostly demanded for is Lipton tea. This was followed by Top tea while Homecup and Highland tea were sparingly demanded for in the study area. Apart from this, Lipton tea has the highest per capita consumption among all the brands of tea consumed by the respondents, thus further confirming that Lipton tea has the highest demand. In a nut shell, tea was generally consumed in the study area. The study hereby recommends that the producers of the brands that are rarely demanded for in the study area (such as highland or homecup tea) would need to organize enlightenment programme in order to popularize their products. Also, the old people in the study area should be enlightened on the health benefits of tea in order to encourage them to increase their tea consumption.

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Experimental Title: Evaluation of Nutrient Dynamics in Tea Plantation as a Result of Continuous Harvest in Two Ecological Zones of Nigeria

Investigators: Adebowale L.A and Ipinmoroti R.R

Introduction

Tea grows under a great variety of climatic conditions ranging from equatorial to the humid temperate climates. The major factor to be considered in the production of any crop is the fertility status of the soil. Thus, soil fertility decline after cropping should be a major consideration in order to prevent reduction in soil fertility due to uptake during crop production; this would lead to subsequent reduced crop yields. Making feeding the even growing population difficult (Lai 2000). Every harvest of 1500kg tea; a total of 68.2kgN/ha; 18.0kgK/ha and 7.2kgP/ha are being extracted from the soil (Ogunmoyela and Obatolu, 1987). Non-replacement of these nutrients would render the soils unsuitable for adequate steps are not taken to replenish the nutrients.

Objective

To evaluate nutrient dynamics in tea plantation as a result of continuous harvest.

Materials and Method
Soil sample will be taken from tea plantation across important tea producing communities covering two states-: Cross River and Taraba states. Soil samples would be collected by using soil auger at 0-20 and 20-40cm depth. Eight core samples will be taken randomly from different point of tea plantation and be bulked into composite samples. Soils samples collected will be air-dried thoroughly mixed, crushed and sieve to pass through 2mm sieve for laboratory analysis. Tea leaf shall be sample from each location. The soil samples will be analyzed for texture, N,P, K,Ca, organic matter, Mg, Cu, Fe, Mn and Zn as described by IITA (1979). Representative tea sample shall be collected and analysed for their nutrient content.

Status: On-going

Experimental Title: Upgrading Tea Value Chain in Nigeria

Investigators: A T, Ipinmoroti, R.R, Adedeji, A.R, Oluyole K.A, Famuyiwa B.S, Olaniyi, Adeosun, Mokwuoye, I.D and Obatolu, B.O

Introduction
Tea farming in Nigeria has lost its share potential owing to problems in Production, processing and marketing. The cultivation and processing of tea in Mambilla plateau is characterized by: crude cultivation methods, lack of technological know-how, poor agronomic practices, smallholderfarmers, illiteracy of farmers, there are problems with poor quality tea leaves, low productivity, poor access to wider market, low pricing, and poor farmer income.

There are poor linkages among the stakeholders and the value chain is underdeveloped. There are tea packaging companies which import their raw materials from other tea suppliers around the world while tea leaves are wasting in Mambila plateau. Private sector has insufficient quality tea leaves, leading to inability to meet local market demands and importation of tea leaves.

The project aims to improve the productivity and profitability of tea through upgrade of tea value chain in Taraba State, Nigeria. The study is to be implemented in phases; the first phase concentrate on problem with production while the second phase will address problem with processing along with M&E of GAP training on production and the last phase considers the problem with marketing.

Objectives
The goal of the project is to improve the agricultural practices of tea farmers to enhance tea yield and competiveness.

Methodology
Training on ethical practices in tea production and training of farmers on good agricultural practices.

Challenges – Bandit

Status - compilation and editing of training manual

Future Plan
Training commences immediately manual and others logistic are ready

END USE RESEARCH

Experimental Title: Simulated Cashew Apple Meat as a Substitute for the Vegetarians

Investigators: Jayeola, C.O. and Yahaya, L.E.

Introduction:
The utilization of cashew apple is mostly for the production of juice and wine. The residue is made of the skin and the husk called baggasse and is frequently used for animal feed or even allowed to waste away. The residue has a dark yellow colour, a fibrous aspect, and a typical astringent aroma due to the presence of tannins which could be a limiting factor for the acceptability of the cashew apple and the juice, especially in foreign countries. Various products have previously been developed from cashew apple such as juice, wine, syrup and jam. Regarding to the use of cashew apple for meat, there are not many researches mentioned. This study therefore focused on the production of a meat - like substance from cashew apples as an alternative source of meat for the vegetarians. The essence of the study is to simulate cashew apple to make a meat-like product, analyse the physicochemical and Microbiological Quality of the cashew apple meat and furthermore determine the organoleptic acceptability of the meat through sensory evaluation

Materials and Methods
Cashew apple were collected during peak season from different locations and simulated into meat production, the processing was done through the use of different drying techniques to produce cashew apple meat. The products were subjected to organoleptic appraisal, physico chemical and Microbiological analysis.

Results
The results obtained for organoleptic appraisal is still undergoing statistical analysis. The comment from the panelist indicated that they could not differentiate from normal dry meat and that of simulated cashew apple. The Physicochemical and microbiological analysis are under analysis. shelf life study is also ongoing

Conclusion
Simulated cashew apple has come to become an alternative to meat. This has come to add to our satiety value while eating when meat becomes too expensive to buy, moreover good news to the vegetarians who can as well enjoy their meals with meat from plant origin.

Status: ongoing

Experimental Title: Production of Home Made Coffee

Investigators: Okunade, A., Jayeola, C.O., Ogunjobi, MAK and Williams, O

Introduction:
Nigeria is one of the coffee producing countries in the world but unfortunately not a consuming nation. The potential health benefits associated with drinking coffee are many and these include protecting against type 2 diabetes, Parkinson's disease, liver disease, liver cancer, and promoting a healthy heart. Therefore, there it is important to encourage ourselves to consume coffee not only because of aroma but for its health benefits

Material and Methods
Coffee berries were purchased and processed to well ground light, medium and dark roast coffee. The biochemical and cup quality of the products were carried out and are still ongoing. The cup quality of coffee produced in CRIN compared favourably with the commercially sold coffee except that of particles which will soon be taken cared of because it was compared with instant coffee.

Results
The biochemical and cup quality of coffee powders are presently undergoing statistical analysis

Conclusion
Homemade CRIN coffee was successfully developed and this will soon be made available in large quantities in CRIN

Status: ongoing

Challenges: Early request for report

Experimental Title: Setting Standards for Kolanut Grading in Nigeria

Investigators: Jayeola, C.O., Mofolasayo, A.S.

Introduction
Kola is a tropical genus of the family *Sterculiaceae*. It is native to coastal regions of West Africa. It comprises of about 125 species. In nigeria, *Cola acuminata and Cola*

nitida are the most commonly planted. *Cola nitida* has two cotyledons while *C. Acumminata and C. Anomala* have between three and seven. However, colour is used to differentiate between three subspecies of *Cola nitida* red, white or intermediates shades of pink. The white though sold in large quantitiesin Northern Cameron is imported from Nigeria and is not reported been grown in Cameroon. Kola is comparatively richer in caffeine than cocoa and coffee. Kola nuts are widely consumed in West and Central Africa as a masticated to counter fatigue, surprise thirst and Hunger and are believed to enhance intellectual capacity. It is for this reason that kolanut chewing has become very popular among students, drivers and many other consumers who need to remain active for unusually long periods. In some develop countries, kolanut extract is used industrially for the manufacturing of many cola types of drinks flavours, as a source of caffeine used used for manufacture of Pharmaceutical products and essential oils and as a main ingredient in production of heat tolerant chocolate bars. In addition, caffeine is known to be a fat burner and therefore beneficial in assisting weight loss. Most crops are graded in Nigeria but there is no legalise standard for kola nuts in Nigeria. Retailers inspect the nuts by setting aside anyone showing insect damage and then grade them according to colour and size. The most careful and repeated examination is for weevil infestation. The quality of the product is very important for the value and determination of market price. This objective of this work was to carried out physicochemical properties of kola nut in order to develop standard for kola nuts as regards grading in order to produce an exportable products of equal consistency and also to construct sieve for grading of kola nut for export. This is to ensure that high quality produce are able to attract premium prizes. The essence was to standardized kola nut grading system for adoption nationally by kola nut marketers.

Materials and method

Material sourcing

Fresh kolanuts used for this study C. nitida were sourced from Ogunmakin market in Ogun state. Kola nut purchased are of both dry and wet with varying colour shades ranging from red, pink to white.

Physical Grading

The grading started with sorting into different colours and the followed by sizing them according to weight. Weighing scale was used to grade from 1 gram -10 gram, 11gram-20gram and 21 gram and above >. Weeviled or diseased nuts were sorted out.

Construction of Grading Sieves

One hundred nuts were randomly picked from each lots of Kola nuts of varying colours ranging from red, pink and white of big, medium and small sizes. The size of each nuts was determined by measuring g the major, intermediate and minor diameter. The arithmetic and geometric mean diameter of each nut were computed as a measure of size (Mofolasayo, 2013). The surface area of the nuts were determined by measuring the shape of each nuts with digital plarimeter. The true and bulk density were determined on five structural surfaces, stainless steel, mild steel, ply wood, perspex sheet and glass.

Chemical Analysis

This was carried out using AOAC, 2010 for crude protein, fat, crude fibre, ash, moisture carbohydrate and dry matter. Moreover the mineral analysis

Results and Discussions

The results of proximate compositions, Mineral analysis and phytochemical components of the samples based on sizes and colour are undergoing statistical analysis.The mean values of the parameters obtained will be computed using descriptive statistics. The parameters obtained will be used in the design considerations of the sieves which are under Construction.

Conclusion

The grading of kola nuts into colour and sizes have been done. The availability of sieve that is been constructed will ease the grading by kola nuts farmers. The project is still ongoing to enhance construction of the grading sieves to be given to the kolanut stakeholders for onward adoption during grading.

Status: ongoing

Experimental Title: Cocoa Powder Mediated Diet in Combating Salt - Induced Hypertension in Rats

Investigators: Jayeola, C.O. and Olubamiwa, O

Introduction

It should be noted that although sodium is an important nutrient in the maintenance of good health as it is required for nerve conduction, cell signaling, maintenance of plasma volume and some other biochemical processes.[4] Excess sodium intake is associated with increase in blood

pressure levels and subsequent risk of cardiovascular and renal diseases. Different approaches have been taken to control sodium consumption, including regulating salt content in commercial foods, establishing policy goals, education and extension services and sanctioning defaulters. This study aims to ascertain if cocoa feed can ameliorate hypertension and oxidative stress damage induced by high salt diet

Materials and methods

Rats for this experiment were purchased and cocoa powder from CRIN was used to compound rat feeds. Male rats were randomly divided into five groups: Group A was the control group which was fed with normal feed alone, Group B was the cocoa control fed with cocoa feed alone, Group C was fed with normal feed compounded with 8% salt. Group D was fed with cocoa feed compounded with 8% salt for 4 week, Group E was fed with the normal feed alone

Result and discussion

We observed that cocoa control group exhibited the lowest levels of oxidative stress markers thus justifying the decreased oxidative stress seen in the treated group. However, the high flavanol content of cocoa is thought to be responsible for its anti-hypertensive effect.

Conclusion

Our findings lend credence to the involvement of renal and cardiac oxidative stress in high salt diet and induced pathogenesis of hypertension and that cocoa mitigates the pathology. It also justifies the regular consumption of cocoa and its products as cocoa acts by ameliorating the generation of oxidative stress in the renal and cardiac mitochondria. The findings of this study suggest an important role for cocoa in the management of hypertension and its complications.

Experimental Title: Extraction of Caffeine from Wholesome and Weevilled Kola Nut

Investigators: Mokwunye, F.C, Okunade, A.F; Jayeola C.O; Yahaya, L.E.

Introduction

Kola nut is widely known, especially in Western and Northern part of Nigeria, as an economic crop and it has a major active ingredient known as caffeine (soluble substance). Many Africans consume kola nuts regularly, even daily, for the medicinal, stimulating and sustaining properties. Kola nut has very high caffeine content, smaller amounts of Theobromine and Kolanin, which dispel sleep, thirst and hunger and act as a stimulant and anti-depressant. They also reduce Fatigue, aid digestion and work as an aphrodisiac. Kola nuts are best known outside Africa as an ingredient in Cola beverages. Commercially produced Cola drinks were developed in the late 1800s. Then Kola nuts were used as ingredients in (Beverage and Tonics). Coca Cola, the most famous beverage in the World was formulated from kola in 1886 by Atlanta druggist, Dr JOHN PEMBERTON and marketed as BRAIN and NERVE tonic. (Prevention's Healthy Ideas, 2002). Presently, the bulk of kola nuts being produced in Nigeria are either consumed fresh locally or exported as sun-dried nuts to drier areas of Africa where they are used as Masticants or as a source of Colourant for cloth dyeing with little or no industrial use in Nigeria. Globally, caffeine is widely consumed as psychoactive drug, because it's a central nervous system stimulant of the methyl xanthine class and it gives most people a temporary energy boost and elevates mood, but despite its importance caffeine is still underutilized. Therefore, the objectives of this work are to extract caffeine from hitherto discarded weevilled kola nut and to purify the extracted caffeine for commercial use as CRIN Caffeine.

Materials and Methods

Wholesome Kola nut (*Cola nitida*) was purchased from Ogunmakin Market in Ogun State. The kola nuts were separated into two batches, while one batch was sorted into the white, red and pink varieties

Kola Nut Powder Production

A modification of the method used by Ogunwolu and Akinwale (2003) was adopted. Cured healthy Kola nuts *(Cola nitida),* sorted into three different varieties, were washed and soaked in warm water (about 50^{o}C) and diced to 5mm^{2} separately. The Kola nut dices were then dried in ahot air oven at 90^{o}C for 3 hours and cooled. Each of these samples was milled with a Panasonic multipurpose blender and stored in tightly covered plastic jars and subsequently labelled as WKN for white coloured kola nut, RKN for red coloured kola nut and PKN for pink coloured kola nut. The 2nd batch of kola nut was not sorted into varieties but simply divided into two parts. One part was milled fresh and labeled MFK while the other part was diced in hot water, dried at 90^{o}C for 3 hours and milled

with a blender and labeled as MDK. Both samples were separately stored in tightly covered plastic jars.

Chemical Composition of the Fresh Kola Nut

Proximate analysis for moisture, crude protein, ether extract, total ash, crude fiber and carbohydrate were determined using the fresh kola nut sample according to the methods of the Association of official Analytical chemist (AOAC) (2014). Estimation of caffeine was done by the method of Luigi (1968) as modified by Ogutuga (1975).

Caffeine Extraction

Two methods were used for the extraction of caffeine from the kola nut samples.

1) 400g 0f each of the kola nut samples was put into a 4 litre plastic bottle, into which 1600 ml of ethanol was added. The setup was shaken periodically for 2 hours and allowed to stand for 24 hours, then filtered using cheese cloth. The residue was further washed with 400ml of ethanol. 400g of magnesium oxide was later weighed out into another 4 litre bottle and acidified with 50 ml of 10% concentrated sulfuric acid. The filtrate was transferred into the 4 litre bottle containing the acidified magnesium oxide and shaken periodically for one hour and allowed to stand for 3 – 4 hours during which caffeine was adsorbed by magnesium oxide. The mixture was again shaken after 4 hours and then filtered using a vacuum pump. The filtrate was then transferred into a 4 litre bottle, into which 100 ml of chloroform was added, mixed thoroughly and allowed to stand for 2 hours. The supernatant was decanted while the fluid concentrate or sediment was centrifuged at 350xg for 5 min. The supernatant was decanted, and caffeine was to be removed as silky residue, allowed to dry at room temperature. (Obidike et al, 2011)

2) Place 150g of kola nut sample into a separating funnel, add 150 ml of water and shake for 5min. then add 40 ml of Dichloromathane and place the stopper on the top of the funnel. Shake the funnel further for 2 minutes. Allow the two layers of liquid to separate and drain the lower Dichloromathane layer into a flask. Add a fresh 40 ml portion of Dichloromathane to the kola nut sample in the funnel, shaking the funnel for two min. Allow the two layers to separate again then drain the lower layer into the flask that already contains the first portion of dichloromethane. Repeat this process the third time draining the solvent layer into the flask. Add 2g anhydrous sodium sulfate to the flask containing the dichloromethane, swirl the flask gently and allow to stand for 10 minutes. This will dry any water left in the funnel. Recover the caffeine by distillation using the apparatus. (Okoli et al 2012)

Purification of Crude Caffeine

The crude caffeine was transferred to a clean 50 ml beaker, followed by the addition of 5 ml of Toluene, and heated on a steam bath (or hot plate) to dissolve the caffeine. The beaker was then removed from the heating source, followed by the addition of 10 ml of petroleum ether (boiling point 60 – 90^{o}C), and the caffeine was allowed to crystallize. The product was collected byvacuum filtration, washed with 1 ml of petroleum ether, allowed to dry and weighed. The melting point was determined, to confirm purity.

Results and Discussion

Chemical Composition

The chemical characteristics of the kola nut powder samples (WKN, RKN, PKN, MDK, MFK) are shown in table 1. There were insignificant differences in the moisture contents of the four powder samples except for the fresh kola nut, MFK, which is significantly different. Results also showed no significant variations in the values obtained for fibre, ash, fat, protein and carbohydrate contents. Sample WKN was significantly different from the other samples in the caffeine content. The fibre and ash contents ranged from 2.480 to 2.580% and 3.460 to 3.680% respectively. Protein and caffeine content of the powders were 8.600 to 8.680% and 1.560 to 1.860%, except for the MFN which has significantly low levels.

Table 1: Chemical Analysis of Kola nut Samples

	WKN	RKN	PKN	MFK	MDK
MC	3.080^{b}	3.160^{b}	3.150^{b}	56.030^{a}	3.160^{b}
Fibre	2.560^{a}	2.480^{a}	2.520^{a}	0.240^{b}	2.490^{a}
Ash	3.680^{a}	3.660^{a}	3.543^{a}	0.750^{b}	3.460^{a}
Fat	1.010^{a}	1.010^{a}	0.990^{a}	0.070^{b}	0.940^{a}
Protein	8.680^{a}	8.660^{a}	8.650^{a}	2.730^{b}	8.600^{a}
Caffeine	1.860^{a}	1.570^{c}	1.750^{b}	0.320^{d}	1.760^{b}
Carbohydrate	79.27^{a}	79.27^{a}	79.58^{a}	42.37^{b}	79.79^{a}

Note: Means along horizontal rows with the same superscripts are not significantly different at $p < 0.05$. WKN = White, RKN = Red, PKN = Pink kola varieties, MFK = Fresh and MDK = Dried kola samples.

Caffeine Extraction

Though White kola nut sample (WKN) yielded more during the estimation of caffeine, (table 1) mixed dried kola nut sample was utilized for caffeine extraction. First it came second in yield, also it be more readily available in the market. The method used by Obidike et al, 2011 for which many devices were procured, when employed yielded no caffeine. This method was adopted because it was meant to yield 8g of caffeine from 160g of dried kola powder which is quite high compared to the other methods in literature.

Many workers found dichloromethane as the best solvent for the extraction of caffeine from most products. (Okoli et al, 2012;). This method yielded only 5.4g of caffeine from 400g of dried kola sample.

Conclusion: No conclusion yet as the work is on-going

Challenges: The challenges had been lack of funds and fake chemicals being delivered for the original.

Future Plan: The plan is to extract caffeine from weevilled kola nut which is less expensive than wholesome kola, purify and identify the caffeine obtained by standard means.

Experiment Title: Development Utilization and Evaluation of Cashew Apple-Wheat Composite Flour for Confectionery Production

Investigators: Ogunwolu, S. O, Yahaya, L. E., Ogunjobi, M. A. K. Oluyole, A O, and Olalekan- Adeniran, M. A.

Introduction

Nigeria is one of the top ten cashew producers in the world. The production of cashew is estimated to about 160,000 tons of raw nuts per annum. About 60 to 70% of the local production is commercialized, of which about 90% is exported in the form of raw nuts. Nigeria is considered as one of the cheapest sources of raw cashew nuts supply to the Asian market. Only about 5 to 10% of total production are processed locally for local and export market consumption by handful of Nigerian entrepreneurs with various capacities ranging from 500 to 1,000 MT/year. Also, Cashew farmers lose the opportunity for enhanced income generation by selling raw nut cheaply to traders and left the apple wasting in the farm. Bread and flour confectioneries are popular staple foods of all ages in Nigeria. Bread and Confectionery products vary widely around the world, as do their production techniques. Basic ingredients are Cereal flour, water, yeast and salt. Optional ingredients can be added to improve processing or to produce speciality and novelty breads and confectioneries which often have an increased nutritional and organoleptic values. The formulation of cashew nut-wheat and cashew apple-wheat composite flour for bread and Confectioneries production in Nigerian will increase the local utilization and consumption of Cashew. This will reduce the tendency of selling raw cashew nuts to importers at cheaper rate and provide a new use for cashew apple which hitherto wasted in cashew plantations across Nigeria.

Objective

To utilize the Cashew apple powder in the formulation of composite flour for bread and other flour confectioneries production, so as to increase the local utilization and consumption of Cashew.

Materials and Methods

Materials

Fresh matured ripped cashew apple, polyethene sheet, knives, stainless trays, preservatives

Method

Cashew apple powder processing

Cashew apple powder was produced from fresh apple at CRIN Ochaja Substation. Matured cashew apple were harvested and the nuts detached from the apple manually. The apples were then sorted, weighed and washed with Sodium metabisulphite solution (350 ppm) to remove any contaminants from the farm. Cashew apples were cut into small pieces of approximately 1.0 x 1.0 cm with sterilized stainless steel knife and spread on stainless trays for drying. The samples were oven dried at 65^0C for 12 hrs, until final moisture content of 7%. Another set of diced cashew apples were also dried under the Sun until 7% moisture content was attained. Dried cashew apple slices were allowed to cool and then ground in domestic blender (Phillips) at low velocity for 5 mins, sieved to obtain a powder with an average particle size of 6µm. The weight of cashew powder obtained was recorded, sealed immediately in polyethene bags and stored at room temperature (about 28^0C).

Physicochemical analysis of Cashew apple powder

Cashew apple powder samples were analysed for moisture, ash, crude protein, crude fat, crude fibre, carbohydrate (by difference) and vitamin C content according to the methods of Kirk and Sawyer (1991).

Table 1: Physicochemical components of Sun- and oven-dried Cashew powder

Parameters	Sun-dried Cashew apple powder	Oven-dried Cashew apple powder
Moisture (%)	7.05[a]	6.50[b]
Crude protein (%)	12.75[a]	10.25[b]
Crude fibre (%)	4.08[b]	5.19[a]
Crude fat (%)	4.85[a]	5.21[a]
Ash (%)	2.70[a]	3.10[a]
Carbohydrate (%)	68.60[a]	69.00[a]
pH	4.72[a]	4.65[a]
Vitamin C (mg/100g)	52.60[a]	47.53[b]

Values are means of three replicates; sample means with the same alphabets along the rows are not significantly different at $p<0.05$

The physicochemical components of sun and oven dried cashew apple powder are as shown on Table 1. There were significant different between sun dried and oven dried cashew powder apple in moisture crude protein, crude fibre and vitamin C, while there were no significant different in crude fat, ash, carbohydrate and pH of the two samples. Sun drying resulted into higher crude protein and vitamin C content of the cashew apple powder compared with that of oven drying, this may be as a result of decomposition of vitamin C during oven drying of the powder. Also, oven drying method resulted to higher fibre content of the cashew apple compared with sun drying method.

Conclusion

It could be concluded that, both sun drying and oven drying methods are suitable for the production of cashew apple powder. However, for high crude protein and vitamin C, sun drying is recommended, while for high fibre cashew apple, oven drying method is recommended.

Status: On-going

Future plans

1. Formulation of cashew apple Powder-Wheat flour composite flour
2. Formulation and production of confectioneries from cashew apple powder-wheat flour composite flour.
3. Evaluation of the cashew apple powder- wheat flour confectioneries
4. Feasibility studies of Composite flour and Confectioneries produced

Experiment Title: Authentication and Validation of Tea Seed Oil as Edible Oil in Nigeria

Investigators: Yahaya L.E and Jayeola C.O

Introduction

Fats and oils are important part of human diet and they serve as rich source of dietary fibre. They contain certain fatty acid components that are essential nutrients and their functional and textural characteristics contribute to the flavour and palatability of many natural foods. Advances in fats and oil technology have led to increased awareness of the composition and structure of dietary fibre. Majority of the trees and plants do produce natural oils and fats but these oils are not usually suitable for use without further physical and chemical treatment; for example, the oil

expressed from the seed is first refined, then subjected to hardening either by glyceride separation or by hydrogenation. There are varieties of oil bearing plants, but very few are of commercial value. Examples include coconut oil, palm kernel oil and cocoa butter. Tea seed oil is one of such oils that have not been fully harnessed as vegetable oil in Nigeria. The study therefore seeks to authenticate and validate its edibility as this adds value to the crop and generate income for stakeholders.

Objectives
Authenticate and validate the edibility of Tea seed oil as vegetable oil in Nigeria

Materials and Methods
Standard procedure of analysis would be employed to achieve the desired result of this study. Mice feeding trials shall also be carried out to ascertain any trace of toxicity according to standard methods with much consideration to ethics.

Conclusion: Not yet

Challenges: Inadequate funding

Status: On-going

Future plan: To complete and start new one.

Experimental Title: Occurrence and Diversity of Thermo-Resistant Organisms Associated with Post-Harvest Technology of Cocoa Powder Production

Investigators: Igbinadolor. R.O and Jayeola, C.O.

Introduction and Justification
Cocoa beans the seed from the fruit (*Theobroma cacao L*) cultivated in tropical region are the principal raw material for chocolate production. The commercial importance of the beans depends on its use in the manufacture of chocolate products to which it contributes the characteristic flavour. However before being traded the beans must undergo post-harvest processing at the farm comprising pod opening, fermentation and drying. After these processes the beans are taken to the processing plant inorder to obtain the final product like cocoa butter, cocoa powder, chocolate etc. However, during the fermentation of cocoa beans, various microbiological activities of different groups of organisms usually come into play. Inspite of the intervention of different organisms during fermentation, the subsequent steps of post-harvesting and industrial processing lead to the survival of thermo-tolerant organisms. These spores can persist in commercial cocoa powder. Therefore, their occurrence in cocoa powder needs to be taken into account to ensure the stability of downstream heat-preserved products, such as chocolate drinks etc. The ability of these organisms to produce resistant spores means that they may survive the production process in the food industry and can pose spoilage or safety problem in cocoa products. The information about the presence of thermo-resistant organisms in cocoa derived products is still very much limited.

Aims and objectives
a. Determine the microbial ecology of cocoa fermentation
b. Isolate, quantify and characterize the occurrence of heat resistant organisms along the cocoa chain
c. Molecular characterization of the thermo-resistant spore formers

Expected output: It is expected that the research work will help to assess the risk of the bacteria and fungi surviving industrial processes and will result for intervention.

Status: On going but need additional fund for completion

FARMING SYSTEM RESEARCH

Experimental Title: Effect of Different Geometry of Cocoa Intercropping with Coconuts in Ideal and Marginal Cocoa Environments of Nigeria

Investigators: Famaye, A.O., Orisajo, S.B., Ayegboyin, K.O., Oloyede, A.A., Agbonghioarhuyi, E. A. & Oluyole, K. A.

Introduction

Field establishment of cocoa largely depends on the presence of other plants which must be adequately combined either when intercropped permanently or are used as shade/nurse crops. One of such permanent crops that provide suitable shade for young and mature cocoa is the coconuts palm (Wood and Lass, 2000). Inter planting cocoa with coconuts is a long established practice in Papua New Guinea, Malaysia, Philippines and even in Akwa Ibom State of Nigeria. However, inter planting cocoa and coconuts should only be adopted where soil conditions are suitable for cocoa (Wood and Lass, 2000). This is so because in many cases, coconuts are grown on sandy soils which are quite unsuitable for cocoa. For instance, in Papua New Guinea, coconuts are grown on volcanic soils and in Malaysia on coastal clay soils. These soils are suitable for cocoa once there is well distributed rainfall on the free-draining volcanic soils as well as good drainage on the coastal soils. The effect of inter planting mature coconuts with cocoa is attractive because the cost of establishing cocoa is relatively low, the income per hectare is increased and the cost of maintaining the coconut area is usually reduced. It has also been established that cocoa and coconuts are compatible with a lot of data showing that inter planting these two crops neither reduce the yield of cocoa beans nor the yield of copra (i.e. the dried meat of the coconut from which oil is extracted). Furthermore, there are impeccable evidence that after fully established the growth of both cocoa and coconuts are improved drastically due to less competition from weed. In Malaysia, Philippines and Papua New Guinea, optimum planting distances for these two crops had been determined. While coconuts are planted at a spacing of 9.0m or 120 palms per Ha, cocoa is sowed at 4.5m interval between and within row (i.e. 360 cocoa trees per Ha). Meanwhile, in Nigeria, specifically in Akwa Ibom State, where the practice is well practiced, farmers intercropped cocoa with coconuts haphazardly with no particular adopted planting distances or geometries.

Objectives

The aim of this project is to determine the optimum spacing and geometry for cocoa and coconut intercrop as well as evaluating the resultant effect of this farming system approach on the emerging weed and soil. The project will also determine the overall economic benefits of such intercrops.

Materials and Methods

The experiment made use of 2 major popular varieties of cocoa (F3-Amazon and TC series) raised for at least 6-month before they were transplanted to the field. It was be a factorial experiment combining 2 different spacing (2.5m x 2.5m as well as 3.0m x 3.0m) of cocoa with improved (dwarf) variety of coconuts from NIFOR, Benin City. Each plot size was about 0.2Ha (i.e. 20m x 20m = 400m^2) laid out in a Completely Randomized Block Design with 3 replications in different cocoa climates i.e. ideal and marginal cocoa climates. Plantain is being used as shade crop on cocoa during the early establishment. However, prior to field establishment of cocoa/coconuts intercrops, some questionnaires had been administered on about 150 cocoa stakeholders (i.e. 50 questionnaires per location) to extract information on the local knowledge of the enterprise in their environments. Experimental areas are CRIN Headquarters, Ibadan (Oyo State), Uhonmora (Edo State) and Ajassor (Cross River State).

The following arrangements were adopted:

1. Cocoa @ 2.5m x 2.5m intercrops at Hollow Square of Coconuts @ 9m x 9m
2. Cocoa @ 3.0m x 3.0m intercrops at Hollow Square of Coconuts @ 9m x 9m
4. Cocoa @ 2.5m x 2.5m intercrops at Avenue of Coconuts @ 9m x 9m
5. Cocoa @ 3.0m x 3.0m intercrops at Avenue of Coconuts @ 9m x 9m
7. Cocoa @ 2.5m x 2.5m intercrops alongside Coconuts @ 9m x 9m
8. Cocoa @ 3.0m x 3.0m intercrops alongside Coconuts @ 9m x 9m

Results and Discussion

The questionnaire had been administered and field establishment of the experiments had been established in Ibadan, Uhonmora and Ajassor. The collection of first set of data will begin around October 2019

Status: On-going

Future plans

1. Completion of nursery work in Ibadan and Ajassor to raised cocoa and coconut seedling for gap up of the field in 2020.
2. Transplanting of more materials to the field
3. Maintenance of the field
4. Regular collection of data
5. Budget of ₦1,300,000 still needed to cover expenses in the completion of the work.

Experimental Title: Evaluation of Cocoa Intercrop with Plantain, Cassava and Melon at Early Years of Establishment in Nigeria

Investigators: Famaye, A.O., Orisajo, S.B, Ayegboyin, K.O., Adeyemi, E.A., Oloyede, A.A., Adeosun, S.A., Idrisu, M., Nduka, B.N. and Ugioro, O.

Introduction

Cocoa is an under storey tree species native to the lowland rainforest of the Amazon basin (Bartley, 2005) but currently with the largest area of production in West Africa. Nigeria is currently ranked 4th in Africa and 6th globally while more than 90% of cocoa production is carried out by the smallholder farmers who intercrop cocoa with annuals, biennials as well as other permanent crops. More often, farmers also combine plantain/banana with other intercrops on their cocoa farms because CRIN recommended that plantain (not banana) should be used as a 'nurse crop' for cocoa. Meanwhile, the climate change scenario is making it imperative to provide more sustainable shade crops than plantain. This will shield cocoa during any long spell of dry season, especially during the first 3 years of establishment when cocoa fragile system needs to be protected from excess heat and dehydration. To ameliorate adverse weather conditions, cocoa farmers often use 'local knowledge' and age-long practice of mixed cropping. An example of such mixed cropping is intercropping cocoa with plantain, banana, cassava and melon. While plantain and banana provide shade for cocoa, melon is a leguminous crop which acts as both cover crop and source of native nitrogen, and some other essential plant nutrients to the soil. Cassava provides more sustainable shade on young cocoa and while preparations of ridges for this root-tuber crop helps in pulverising and improve the aeration of soil. More importantly, these smallholder farmers also heavily rely on the proceeds from sales of the produce of such intercropping system to sustain themselves and their families before cocoa starts to bear.

Objective

To evaluate the growth and yield production of two-commercially grown cocoa varieties with the aim of recommending such for both small-scale farmers and larger-scale commercial crop growers that depend on the adequate combination of such crops for optimal growth performance.

Materials and Methods

The experiment made use of Cocoa seedlings of 2 different varieties (F3-Amazon and TC1-TC8 series) raised for at least 6-month in the nursery before the actual transplanting to the field. It was a factorial experiment combining different cocoa varieties with two varieties of Cassava (Texaco and any Local variety) with melon. Plantain was used as a nurse crop (control) while the experiment was laid out in Completely Randomized Block Design with 3 replications in Ibadan (Oyo State), Ajassor (Cross River State) and Owena (Ondo State). Meanwhile, before the field establishment began, some questionnaires were administered on the farmers/stakeholders to extract some information on the practice and economic benefits of the intercropping enterprise in their different zones. The following 6 treatments shall be considered:

1. Cocoa variety TC series intercrops with Plantain, Cassava (Texaco variety) and Melon **(A1)**
2. Cocoa variety TC series intercrops with Plantain, Cassava (Local variety) and Melon **(A2)**
3. Cocoa variety F3 Amazon intercrops with Cassava (Texaco variety) and Melon **(B1)**
4. Cocoa variety F3 Amazon intercrops with Cassava (Local variety) and Melon **(B2)**
5. Cocoa variety Amelonado intercrops with Plantain and Cassava (Texaco variety) **(C1)**
6. Cocoa variety Amelonado intercrops with Plantain and Cassava (local variety) **(C2)**

Results and Discussion

The questionnaires were administered and field establishment of the experiments had been established in Ibadan, Owena and Ajassor had begun. Weeding of plot will start in August while collection of first set of data will begin in September 2019.

Status: On-going

Future plans

1. Completion of nursery work in Ibadan and Ajassor to raised cocoa and coconut seedling for gap up of the field in 2020.
2. Transplanting of more materials to the field
3. Maintenance of the field
4. Regular collection of data
5. Budget of ₦1,000,000 needed to cover expenses in the completion of the work

Experimental Title: Field Performance and Nutrient Uptake of Upland and Lowland Coffee Seedlings and Cuttings Raised in Contrasting Nursery Soils

Investigators: Ayegboyin, K.O., Famaye, A.O., Ugioro, O, Idrisu, M. and Adeosun, O.

Introduction

Cultivation of coffee, like most other tree crops in Nigeria, is mainly through raising of their seedlings and/or cuttings in the nursery. Apart from the other conditions to be met, nursery preparation of coffee involves filling of the pots with topsoil (0-15cm) from Virgin Forest Soil (Obatolu *et al*., 2000). However, the pressure on land as a result of increased population density as well as other human activities has made Virgin Forest Soils not readily available and if available at all, it is usually highly expensive. In Cocoa Research Institute of Nigeria, the usual practice is to buy these so-called top soils whenever coffee is to be raised. The method is too laborious, time consuming and without any tangible proof of the authenticity of such top soils.

Objective

This study was designed to evaluate the propagation of coffee seedlings and cuttings on soils collected at different levels (top and sub soil) and proffer a possible replacement to virgin forest top soils.

Material and Methods

The study was a factorial experiment with 4 soil types and 3 fertilizer factors to make 12 experimental treatments scheduled carried out in three coffee production areas of Nigeria (Ibadan, Mambilla and Ajassor). Experimental soils of different histories i.e. from uncultivated Virgin Forest (VF) as well as already Cultivated Land (CL) were collected from two different levels at 0-15cm (top-soil) and 15cm - 30 cm depths (sub-soil). The soils were amended with two types of fertilizers called Organic Fertilizer Pacesetter Grade B and Inorganic Fertilizer NPK 2:1:1 at the rate of 60Kg N Ha-1, 30Kg P2O5 Ha-1, and K2O Ha-1 respectively as a basal dressing. There would be twelve treatments as follows:

1. Topsoil of VF with organic fertilizer amendment
2. Topsoil of VF with inorganic fertilizer amendment
3. Topsoil of VF with no amendment
4. Topsoil of CL with organic fertilizer amendment
5. Topsoil of CL with inorganic fertilizer amendment
6. Topsoil of VF with no amendment
7. Subsoil of VF with organic fertilizer amendment
8. Subsoil of VF with inorganic fertilizer amendment
9. Subsoil of VF with no amendment
10. Subsoil of CL with organic fertilizer amendment
11. Subsoil of CL with inorganic fertilizer amendment
12. Topsoil of VF with no amendment

The seedlings and cuttings of both *Coffea arabica* and C. *canephora* after nursery evaluation for would be transplanted to the fields at Ibadan, Mambilla and Ajassor to evaluate their physiological performance, nutrients uptake as well as their agronomic and economic yields.

Duration: 4 years (48 months)

Results and discussion

The pre-nursery work on the seedlings and cuttings of *Coffea canophera* has begun both in Ibadan and Ajassor. The materials would soon be transplanted into the polythene bags in nursery. However, collection of data on the experiment is yet to begin.

Challenges

Money released for the project was too meagre and the little fund was released rather too late.

Status of the work: On-going

Future plans

1. Completion of nursery work in Ibadan and Ajassor
2. Expanding the nursery work to Mambilla
3. Transplanting of the materials to the field
4. Regular collection of data
5. Budget of ₦1,700,000 still needed to cover expenses to complete the work

Experimental Title: Establishment Ability of Some Drought Tolerance Assertions of Cocoa in the Marginal Environments of Nigeria

Investigators: Ayegboyin, K.O., Famaye, A.O., Idirisu, M, Adeosun, O, Osasogie, O and Nduka, B.

Introduction

Survival of cocoa under conditions of drought is dependent on a number of factors which include ability to source water (i.e. the size and spread of the root system), protection against water loss (thickness of cuticle, size and number of stomata) and the ability of the plant to continue to function and recover after water loss which largely dependent upon the age of the plant but also sometimes vary with genotypes. Ayegboyin, 2012, established genetic variation in the response to changes in vapour pressure deficit, stomatal conductance among cocoa genotypes in Nigeria. His work led to identification of cocoa varieties being most tolerant to water stress. Again, it was also revealed the importance of taking cognisance of soil structure and nutrient availability to plants as part of enhancing factors in the expression of their tolerance to water and heat stress (Ayegboyin, 2012).

Materials and Methods

This work involves pollination of targeted cocoa varieties to raise cocoa pods for both nursery and field establishment. The seedlings raised will eventually be used for field establishment across 5 sites of different cocoa climates in Nigeria.

Area of coverage

1. On-station at 2 CRIN substations (Ajassor and Mambilla substations)
2. On farmer's fields at 2 locations in Cocoa marginal areas (Ibadan, Oyo State and Kabba, Kogi State) and one location in Owena, Ondo State (Tropical Rain Forest Belt)

Duration: 4 years (48 months)

Results and discussion

The pollination of targeted cocoa genotypes started in Ibadan and Ajassor. The sites for field establishment of the materials have been selected and pre-nursery work on the first set of cocoa seedlings to be raised will begin both in Ibadan and Ajassor by October 2019. These materials will be transplanted into the field around May 2020. Meanwhile, collection of data on the experiment is yet to begin.

Challenges: Money released for the project was too meagre to fund the experiment and the little fund was released rather too late.

Status of the work: On-going

Future plans

1. Completion of nursery work in Ibadan and Ajassor
2. Expanding the nursery work to Mambilla
3. Transplanting of the materials to the field
4. Regular collection of data
5. Budget of ₦4,526,500 is still needed to cover expenses for the actualisation of all targeted objectives and completion of the work. The details and breakdown of the proposed budget is well spelt out in the new proposal on the work

Title: Economics of Cocoa-Based Sweetpotato Farming Systems in CRIN, Nigeria

Investigators: Akinpelu, A.O., Orisasona, T.M., Oluyole, K.A., and Agbebaku, E.E.O.

Introduction

Nigeria is the World's fourth largest cocoa producer after Ivory Coast, Ghana and Indonesia, producing about 12 percent of the total world production and Nigeria is the third producer in Africa (World Cocoa Foundation, 2014). Cocoa is the most prominent export crop in Nigeria in terms of her production and export capacities (Nwachukwu *et al*., 2012). According to Adebile and Amusan (2011) cocoa contributes about 15 percent to the total Nigerian export in 1970 and also contributes $900 million to Nigeria's economy in 2012 (*The Sun*, 2013). Sweetpotato (*Ipomoea batatas* L.) is an important crop in many countries and has been cultivated for food, animal feed and industrial raw material. It belongs to the Convolvulaceae family and it is grown for both human and animal consumption (Nwadili *et al.,* 2007). It originated from Central Africa (Nwauzor and Afuape 2005) and is the only member of the genus *Ipomoea* whose roots are edible, and is one of the world's most important food crops due to its high yield and nutritive value (Data and Eronico, 1987). Meanwhile, farming systems are defined as ecological systems or practices which are modified by human to produce food, fibre or other agricultural products. It entails nutrient balances in the soil as individual crops or

integrated animals return nutrients to the soil and the environment in form of biomass and animal wastes. There are inflows and outflows of materials in farming system. Inflows include among other things; organic and inorganic fertilizers, atmospheric deposition while outflows include farm and produce from animals, gaseous losses. Furthermore, the introduction of sweetpotato in cocoa based farms is expected to serve as a means by which a farmer can prevent food insecurity and also be able to withstand shocks in a situation of crop failure. However, there is a dearth of information on economics of cocoa-based sweetpotato farming systems for small holders who depend on it for livelihood. The general objective of this study is to economics of this farming system in Nigeria.

Specific objectives are to:

1. profile cost items in the enterprise
2. analyse the profitability of the enterprise
3. assess constraints to cocoa-based farming system study area

Methodology

The first year trial of the study was established in zone 1 within CRIN headquarter. The land was cleared and heaps were made according to the farming systems among farmers in the study area. Ex-Igbariam variety of sweetpotato was planted on 0.25ha. The sweetpotato vines were planted at a spacing of 1m x 0.3m. Planting of vines was done as soon as the rains established. Data would be collected on planting materials (N/bundle), labour requirements land preparation (N/manday), planting (N/manday), weeding (N/manday), fertilizer application application (N/manday), cost of fertilizer (N/kg). Data would be analyzed using simple descriptive statistics such as means, frequencies and percentages, gross margin (GM), and benefit cost (BC) analysis.

Status of the Work: On-Going (To be repeated for confirmation in 2020)

Title: Soil Nutrient Dynamics and Sustainable Capacity of Cocoa and Tea Intercrop in Nigeria

Investigators: Asowata. F.E, Daniel, M.A, Adeosun.O and Akinpelu, A.O

Introduction

Over the years various faming system practices have been reported among cocoa farmers in the Southwest and Tea farmers in the Northeast. These practices involve various crop combinations which have different nutrient demand being exerted on the soil. These crops as well have different rooting system and nutrient uptake. The fertility of the soil to a large extent has direct influence on the expected yield of the crop combinations, therefore the study was to evaluate and determine the nutrient status and requirement of various crop combinations with cocoa and tea in Ibadan and Owena.

Objectives

1. To evaluate the soil nutrient status of cocoa/sweet potatoe in Ibadan and Tea/plantain intercrop in Owena.
2. Determine the nutrient requirement of each of the intercrop and
3. Recommend adequate ameliorate for optimum yield of the intercrop.

Material and Method

Soil and plant samples were collected from the two plots at Ibadan and Owena at 0-15cm,15-30cm, 30-45cm and 45-60cm respectively. These samples will bring to the laboratory, air-dried and processed for analysis. The soil result obtained will form the base line for the study. Subsequent sample collection will be analyzed to determine the intercrop nutrient uptake and correlate with individual plant nutrient requirement. Two set of samples will be collected annually for analysis.

Location

Cocoa/sweet potatoes at Ibadan; Tea/plantain at Owena.

Project status: Work in progress.

Project Title: Determination of Appropriate Geometry in Cashew/Oil Palm Intercrop

Investigators: Adeyemi, E.A., Famaye, A.O., Orisajo, S.B., Oloyede, A.A. Ayegboyin, K.O. and Ibiremo, O.S.

Introduction

Cashew is a commodity crop that is commonly cultivated in about 32 countries within the Tropics and Nigeria is one of the major producers of the palm oil and palm kernel in the world. In Nigeria, Cashew is intercropped with some annuals, biennial and permanent crops, especially during its early years of establishment. These crops are either deliberately planted or retained as volunteer crops within the Cashew plantations. However, such intercrops are mostly haphazardly arranged and without any recommended spacing from CRIN. In a good crop

mixture, the component crops must be comparable suitable, practically feasible, socially acceptable, ecologically sound and economically viable. Management strategy in a cropping system must also consider the canopy architecture, light interception, moisture, nutrition, pests, insects, diseases, weeds etc. and their interactions on the farm. These factors were never considered by Nigerian farmers in their Cashew intercropping system practices. In some States like Kogi and Enugu, Oil Palm is one of the prominent mixture in Cashew plantation. Although, previous research efforts established intercropping of Cashew with food crops (Adeyemi, 1986, Aliyu et al. 2008), no definite recommendation had been developed on this farming system techniques, hence the need for the current scientific investigation of how Cashew could be intercropped with other crops mixture, especially Cashew/Oil palm intercrop.

Objective

Just like similar successfully work already perfected for Cocoa (Cocoa/Oil palm intercrop), this study was set up to investigate the effects of spacing and tree geometry on the Cashew/Oil palm intercrop in Nigeria.

Materials and Methods

Although, this cropping system (Cashew/Oil Palm) had earlier been observed in some parts of Kogi State, questionnaires were still administered on farmers and other stake holder in Kogi, Oyo and Enugu State to determine the spread of this intercropping system in all these major Cashew grown States. Three (3) Local Government Areas were chosen from each selected State. Theinformation gathered with questionnaires are being collated for analysis as at the time of writing this progress report. After the non-farm investigation, field experiment will be conducted at CRIN Headquarters and Ochaja substation. It will consist of the following 4 treatments:

1. Cashew sole @ 9m x 9m
2. Oil palm sole @ 9m x 9m
3. Cashew/Oil palm intercrop each @ 9m x 9m
4. Oil palm in hollow square of Cashew @ 9m x 9m

Unit Plot size will be $27m^2$ and treatments will be set up with Randomized Complete Block Design and replicated thrice.

Land area per replicate will be 27m x 27m x 4 = $2916m^2$. Total land be 2916 x 3 = $8748m^2$.

Project status: On-going

ECONOMICS & EXTENSION RESEARCH

Experimental Title: By-Product Utilization in Poultry Production Among Cocoa Farmers in Abagbo: CRIN Adopted Village

Investigators: Adebiyi,S., Uwagboe, E.O., Agbongiarhuoyi, A.E., Famuyiwa, B.S., Abdul- Karim., I.F., Williams, O.A., Agbebaku, E.E.O., Orimogunje, A,Awodumila,D.J. and Oduwole, O.O.

Introduction

CRIN has created awareness on the inclusion of cocoa pod husk in both broiler and layers feeds which is one the technologies developed in the institute. Olubamiwa and Hamzat (2001) opined that inclusion of cocoa pod husk in layer mash will replace 40% energy in maize. Invariably the by-product has been converted to useful product. Abagbo is one of the Agricultural Research Outreach Centre (AROC) formed by CRIN in Collaboration with Agricultural Research Council of Nigeria (ARCN) in 2010 with the aim of transferring technologies developed by CRIN to farmers in rural areas. As part of the method to solve problem of fund for their farming activities, the community was formed into various groups this was latter metamorphosed to a formidable cooperative society operated under the Oyo State Ministry of Commerce, Trade and Investment. In 2013, fund was released by WAAPP to build a small pen but the fund released was not enough to stock it. The non-stocking of the pen has reduced the interest of cocoa farmers who have interest CRIN technology. In 2018, fund was released to stock the pen with layers (60 point of lay) this will serve as morale booster for farmers who have already lost hope in the project.

Objective of the study

1. To encourage utilization of cocoa pod husk in poultry production.
2. To serve as capacity building for farmers.
3. To serve as income generation potential for their cooperative society.

Methodology

The existing pen built with fund released by WAAPP was renovated and stocked with 60 layers. Layer mashes were purchased, routine and occasional management such as feeding and general sanitation of the pen were carried out by an attendant as agreed by the farmers. Top feed layer

mash was used to feed the bird in the first two months to acclimatize them with the environment after which the inclusion cocoa beans shell follows. Records of eggs laid were taken on daily basis and percentage difference as egg production increases were calculated in order to know the performances of the bird.

Results and Discussion

Results in the table below showed the number of bird stocked, period of egg collection, eggs laid, egg laid difference and percentage difference. The table revealed that the percentage difference in egg production in the second weeks of egg production was 74.3%, while the percentage difference in the third weeks was 41.7%. Also, the percentage difference in the fourth weeks was 13.0%, this was increased to 22.5% in the fifth weeks of egg production. The reduction in percentage difference of egg produced in the fourth weeks was compensated for in the fifth weeks. The result showed that there is an appreciable increase in egg production as bird increase in age.

Week	Nos of bird	Egg laid	Egg laid difference	% difference
First Week	60	27	-	
Second Weeks	60	105	78	74.3
Third Weeks	60	180	75	41.7
Fourth Week	60	207	27	13.0
Fifth Weeks	60	267	60	22.5
Sixth Weeks	60	283	16	5.7

Table 1: Egg records and production performance.

Conclusion

Poultry production is an opportunity for the farmers to get additional income; this will improve their socio-economic standard. The approach was participatory; thus knowledge gain from the activities is sufficient for the farmers to manage their own poultry farm.

Challenges: Fund released is grossly inadequate.

Status: On-going

Situation of the pen before renovation and stocking

Crin Staff and Cocoa Farmers Displaing Eggs Laid by the Bird

Experimental Title: CRIN *Igioro* Live Phone-in Radio Programme with Radio Nigeria Premier Fm 93.5 Ibadan

Investigators: Agbongiarhuoyi, A.E., Uwagboe, E.O., Adebiyi, S., Famuyiwa, B.S., Abdul-Karim, I.F., Williams, O.A., Agbebaku, E.E.O., Orimogunje A. and Oduwole, O.O.

Introduction

The Cocoa Research Institute of Nigeria CRIN has national mandated to conduct research on five crops: Cocoa, Kola, Coffee, Cashew and Tea. The achievements made in research and development efforts of these crops are extended to the public through different methodologies. One of them is Radio agricultural programme which was adopted by Extension Section of the Institute. The concept of Radio programme in CRIN started in 2017 with Amuludun FM titled *Agbe Onigioro*. In 2018, the first edition of ***Igioro*** (Tree of Wealth) programme took place in Radio Nigeria Premier FM 93.5,

Ibadan. It was a 30 minutes live, phone-in weekly programme every Wednesday. It lasted for 13 weeks and was aired from 6:30 to 7:00 pm farmers' time. The programme was communicated mostly in Yoruba with few cases of English Language. This was due to majority of the target audience been Yoruba farmers in rural farming communities in the Southwest. The programme was flagged off by the Executive Director, Dr O. Olubamiwa on the 21st November, 2018 in Premier FM studio Dugbe, Ibadan. Historically in 1933, Radio broadcast started in Nigeria with the introduction of the Radio Distribution in Lagos by the British colonial government. The Ibadan station was commissioned in 1939, followed by the Kano station in 1944. The Federal Radio Corporation of Nigeria (FRCN) which is currently operational was established in 1978 (Familusi and Owoeye 2014). Radio has many advantages which include low cost, easy access and the fact that it can easily speak to marginalized cultural groups in their own language. Radio ranked as the most popular means of disseminating information to a larger audience. It is very appealing because of some distinguishing features of interactivity, its capacity to provoke dialogue and to solicit the participation of local population with extreme versatility. Over the years, CRIN made tremendous achievements and contributes significantly towards the Nigeria economy. These are in the areas of Technological advancement, value addition, training and capacity building of farmers, screening of pesticides recommended to farmers and publications. Some of the developed technologies are CRIN TC1-TC8 cocoa hybrids planting materials, cocoa bread, wines, cashew kernel and soap. These research information needs to be communicated to the general public to enhance adoption, productivity, income, food security and job creation.

Objectives

The objectives of the project were to:

i Create more awareness and disseminate CRIN developed technologies to farmers and other stakeholders.

ii Educate the public on the various aspects of Good Agricultural Practices (GAP) with respect to cocoa, kola, coffee, cashew and tea crops.

Materials and methods

The programme was conducted in Radio Nigeria Premier FM 93.5 Ibadan Oyo State. Premier FM was chosen due to its wide coverage reaching out to farmers and other stakeholders in theSouthwest. These include Oyo, Osun, Ogun, Ondo, Ekiti and Lagos States. The programme was designed to hold every Wednesday, which lasted 13 weeks. It is renewable after the duration for another edition. A 13-week work plan was designed by Subject Matter Specialist (SMS) from different disciplines. Each SMS goes with extension facilitator on a weekly basis to the Radio Studio and talk on specific subject for 30 minutes. It was a live phone-in discussion programme involving outside listeners from 6:30 to 7:00 pm. The programme was communicated mostly in Yoruba with few cases of English Language. During every episode, listeners call the CRIN SMS live in the studio for questions and comments. The target audiences were farmers and other stakeholders along the value chains of cocoa, kola, coffee, cashew and tea crop farmers. The Igioro programme was anchored by Mrs Olaitan Adeitan and presented by Mrs Afolasade Osigwe and Mr Babatunde Tiamiu. From the work plan, the following subject areas were outline and used throughout the programme. These include: CRIN Overview with the Executive Director, Nursery Management, Know your soil, Land Preparation, Planting and farm practices. Others were Know your enemies-Diseases Management, Know your enemies/friends-Insects Pest Management, Harvesting/ Primary Processing, Value addition and utilization, Record Keeping and Know your market, Certification, Climate change adaptation and Power in group dynamics.

Result and Discussion

Feedback

The feedback from callers showed that a total of 35 listeners called the Subject Matter Specialists during the phone-in live programme with more request for cocoa pods, products, training workshops/seminar on CRIN developed technologies and their availability in the market (Table1). In week one, the executive Director of CRIN gave an overview about the programme and welcome all listeners. Some callers commended the ED for the programme and while some asked questions which were answered. Similarly, other subject areas presenters received calls from the public were Nursery and soil Management (2 callers), Land Preparation (5 callers), Planting and farm practices (3 callers), Insect pest (3 callers) and disease management (2 callers). Others include value addition and utilization (4), Record keeping and know your market (2), Certification (2), Climate change adaptation and Power in group dynamics 2 callers each. Land Preparation and value addition however,

received the highest telephone calls from listeners. It implies that listeners always stay tuned to the programme. They obtained information on Good Agricultural Practices (GAP) in relation to CRIN mandate crops. Listeners called from Oyo, Osun, Ogun and Abia States of Nigeria.

Table 1: Distribution of 13-week Radio Phone-in feedback programme from listeners

Weeks	Subject presented and CRIN presenter	No of callers	Questions raised	Opinion remarks
1	CRIN Overview with the Executive Director Dr Olayinwola Olubamiwa 21/11/2018	3	*How can we have access to cocoa powder? *How can the new cocoa hybrid be accessed? *Is there seminar/workshop for planting cocoa and kola?	Products, cocoa hybrids and GAP training should be made available. *Igioro* programme should be sustained
2	Nursery Management Dr Festus Olasupo 28/11/2018	2	*How can I get CRIN cashew seedlings? *Is nursery necessary for cashew?	GAP training should be enhanced
3	Know your soil Dr Olufemi Ibiremo 05/12/2018	2	*Is soil testing necessary before cocoa planting? *How can fertilizer be applied to cocoa?	GAP training should be enhanced
4	Land Preparation Amos Oloyede 12/12/2018	5	*How can cocoa thrive in dry season *What is the best time to cultivate cocoa? *What is the maturity period for cashew? *Can oil palm be planted along side with cocoa? *What is the spacing for the cocoa and oil palm?	Irrigation support & intercropping recommendations advocated
5	Planting and farm practices Dr Kayode Ayegboyin 19/12/2018	3	*How can I get the new cocoa for planting? *How much is it? *Which crop can be intercropped with cocoa?	GAP training should be enhanced
6	Know your enemies – Diseases Management Dr Rasheed Adedeji 26/12/2018	2	*What can be done to an orange tree that is not yielding fruit? *How do I control mistotoe on cocoa tree?	Disease management practices advocated
7	Know your enemies/friends Insects Pest Management Indogesit Monkwuye and Rosemary Olorunmota 02/01/2019	3	*Can the fresh cashew nuts be sold in the open market? *Is seminar and workshop free? *Can CRIN Extension officers reach out to give farmers seminar in their communities?	Continuous enlightenment of farmers

8	Harvesting/Primary Processing Dr Shamsudeem Aroyeun 09/01/2019	2	Can the use of cutlass spoil the cocoa beans? *Where can I get cocoa dryer To dry cocoa during raining season?	GAP training should be enhanced
9	Value addition and utilization MAK Ogunjobi 16/01/2019	4	*Are the CRIN products available? *Which market can we buy CRIN products? *Can you train somebody on how to make soap? *How can green tea be recognised from other tea?	Need for products availability and training
10	Record Keeping and Know your market Dr Justina Lawal 23/01/2019	2	*Is there any effect on cocoa beans spread by the road side? *What are the benefits of joining farmers association in marketing?	Continuous enlightenment of farmers
11	Certification Dr Busayo Famuyiwa 30/01/2019	2	*Is the pric e of certified cocoa beans better than others? *What i benefit from certification?	Continuous enlightenment of farmers on certification
12	Climate change adaptation Anthony Agbongiarhuoyi Solomon Adebiyi 06/02/2019	2	Can afford irrigation facilities for farming during dry season? *Where can farmers get climate information?	Climate change information advocated
13	Power in group dynamics Solomon Adebiyi 20/02/2019	3	How can information be gathered about cocoa before venturing into the business? *How can CRIN Extension officers reach out to farmers facing challenges in cocoa farming? *How can we register a cooperative society?	Extension outreaches needs to be intensified to solve farmers' problems.
Total		**35**		

Conclusion

The dissemination of CRIN technologies through Radio channel is creating more awareness for developed products and making desired impact. Feedback from farmers' phone calls shows that listeners actively participated in the programme. This suggests improvements on their farm practices, food security and productivity.

Challenges

(1) The time allotted for the programme is inadequate
(2) Late release of fund to continue the programme after expiration at the due time
(3) Lost of calls from callers due to poor network connectivity during the live programme.

Status: On-going

Future plans

1. We have plans to extend the programme to other States where CRIN Sub-station is located.
2. We would like to have a similar programme in *Pigin* English and Yoruba for listeners on Television such as Channels or others. The idea is to promote CRIN technologies to processors, investors, marketers and other stakeholders in the value chains of CRIN mandate crops across Nigeria and beyond.

Reference

Familusi, E.B. and Owoeye, P.O. (2014). An Assessment of the Use of Radio and other Means of Information Dissemination by the Residents of Ado- Ekiti, Ekiti-State, Nigeria." (2014). *Library Philosophy and Practice (e-journal)*. P.1-29. Available online @ http://digitalcommons.unl.edu/libphilprac/1088. Accessed 28th June, 2019.

Cross section of Pictures taken during the Radio programme in Premier FM






ED fagging off the programme

Experimental Title: Organisation of Farmers' Field Day in CRIN Headquarters Ibadan

Investigators: Agbongiarhuoyi, A.E., Uwagboe, E.O., Adebiyi, S., Famuyiwa, B.S., Abdul- Karim, I.F., Williams, O.A., Agbebaku, E.E.O., Orimogunje A. and Oduwole, O.O.

Introduction

The second edition of Farmers' Field Day event took place in CRIN headquarters on 5th of May, 2019 at about 10:35 am. The theme of the event was "Improving farmers' practices through information dissemination." The programme was held in an open field closed to the administrative block of the Institute.

Objective

The essence of this programme was to create awareness, adoption, increase consumption, attract investors and highlight the importance of CRIN developed technologies to Nigerians. The technologies have been identified to create job opportunities, generate income, improve livelihood and solve some health challenges of end-users. Some of the technologies exhibited were CRIN TC1-TC8 cocoa hybrid, cocoa powder, cocoa bread, edible cashew nuts, chocolate, liquid and black soap. Others include the demonstration of soil testing kits to farmers, farmers' groups and other interested persons.

Invited guests

Major and minor stakeholders (140) from the cocoa, kola, coffee, cashew and tea value chains attended the programme. They were the Governor of Oyo State Senator Abiola Ajimobi represented by the head of Tree Crop Unit in the Ministry of Agriculture-Pastor Akinyinka, farmers, farmers' cooperative societies from the Institute's adopted villages and schools, input dealers, representatives of Cocoa Association of Nigeria, Kola Association of Nigeria, JusticeDevelopment and peace commission, commissioner of Agriculture Oyo State, micro-finance and bank of Agriculture, research institutes amongst others.

Goodwill messages

The Executive Director (ED) of CRIN, Dr. O. Olubamiwa welcomed all guests and CRIN staff for honouring the invitation to attend the programme. He told participants that CRIN has mandate to conduct research on cocoa, kola, coffee, cashew and tea crops. From these crops, many technologies were developed as exhibited before us. The cocoa hybrid planting materials that produce pods in two years are gradually spreading fast to all cocoa producing communities in Nigeria. Cocoa bread and powder for example have good health benefits and provide livelihood for processors and consumers. The ED enjoined investors, farmers' groups and the private sector to adopt CRIN technologies in order to ensure food and nutrition security. The Governor commended CRIN for the technologies developed and her contributions to the Nigerian economy through the release of the 2-year cocoa to farmers. He appealed to CRIN to reduce the price of cocoa pods so that the State Government can supply more of the materials to farmers at minimal rate. There were goodwill messages from representatives of Kolanut Association of Nigeria; Cocoa Association of Nigeria Bank of Agriculture, Micro-finance Bank, Research Institutes, input dealers and CRIN adopted villages and schools.

Training of farmers on soil testing kits

Participants were taken round the exhibition stands to see all the products and interacted with scientists. Some farmers were trained by Dr. M.O. Ogunlade on how to test the soil with kits before planting. There was cultural display and fun fair to entertain the audience who were thrilled to the solo performance of the troop from CRIN. During the ceremony, some farmers were awarded certificates and gifts as motivation in their production practices. Radio Nigeria Premier FM, News Agency of Nigeria, Agro Magazine and CRIN photographer covered the occasion which was well reported in the media.

Pictures Speak

Exhibition of CRIN technologies in the event

Group photograph with CRIN ED

Cultural display

Cross section of participants

Chemical display during the event

Experimental Title: Business Incubation Platform for Youth

Investigators: Oduwole, O. O, Oluyole O, Adebiyi, S, Ogunwolu.S. O

Introduction

Nigeria is a critical juncture; the economy is growing but the estimated elasticity of employment with respect to GDP is less than 0.5. In other words, 1% GDP growth generates less than 0.5% in job creation. Agriculture has accounted for a significant contribution to employment

since 1960 to the present day but the percentage contribution has decline from 78.2 % in 1962 to 59% in 2010, while service sector has increased within the same period from 16.5% to 34.2% (ISGPP 2018). The manufacturing sector has remained below 4%, the youth in employment has drastically reduced and youth unemployment continues to increase. Many of the youth instead of looking for opportunities within the agricultural value chain have gone to become tricycle "Okada and Maruwa" drivers, there is therefore the need to bring youth into the productive sector away from the unsecured service sector. The international labor Organization (ILO) convened in May 2018 the first global conference on "Innovation for decent jobs for youth". It is against this background that a business incubation platform for youth in the cocoa value chain is being proposed. Thecentral objective is delivering a job creation machine to the youth in all the cocoa growing locations of Nigeria.

Objectives

1. Show case the profitability of CRIN developed products in a prepared business plans
2. Establishment of Incubators at CRIN Sub-stations for the training and skill acquisition on some of the developed products
3. Creating entrepreneurship among the unemployed youth in the country
4. Scaling the business projects in CRIN mandate crops producing areas of the country

Justification

CRIN has been in existence since 1964 and has developed products with long thrust at improving the revenue generating mechanism within the institute as well as strengthening its relevance in the area of knowledge dissemination through the establishment of training school. This platform will provide CRIN that opportunity and also create employment for some unemployed youth in the country

Methodology

Equipment and training materials to kick start the platform will be purchased

Bids will be requested from interested youth from the different geopolitical zones / CRIN substations in Nigeria**.** 10 youth will be selected from areas of CRIN substations in 5 geopolitical locations of the country. Youth selected will be in the range of 18-40years old. Memorandum of understanding and appropriate contract will be signed and registration of the business will be made.

1. Information sessions will be organized to brief rural youth on the incubation platform where there will be training / mentorship with financial support.
2. The selected youth are assisted in developing business plan incorporating technical, financial and monitoring needs.

Result

Second year activities

Only 10 percent of the initial requirement was achieved because of the low released of fund. Some of the achievements include:

1. Establishment of the incubators at 2 substations namely Owena and Ajassor. Ovens were constructed for Cocoa bread and Lister engines for the practical training of the youth at the Substations
2. Interaction was made with the National Youth Council of Nigeria (NYCN) for inclusion of members on the platform and possible selection of beneficiaries.
3. Visit was made to banks for collaboration and support for loans to assist the youth. Discussion is on-going with Central banks for loans to meet the requirements of other assets for the business.
4. Upgrading of Master's trainer room.
5. Launch the platform at CRIN headquarters for public awareness

Constraints

Late and inadequate fund affected the project execution. Many things were done in a hurry to avoid mopping up of the fund.

ECONOMICS AND EXTENSION DEPARTMENT

Introduction

It is a research and service department consisting of Economics, extension, statistics and marketing with 45 staff, 14 in Economics section, 13 in Extension, 10 in statistics and 6 in marketing'

Main activities in the last one-year Extension Research activities

1. Assessment of Farmers Adherence to Safety Practices in Cocoa Production in Ondo State.
2. Assessment of Farmers Knowledge in Nursery Practices in Ondo State
3. Effect of Coppicing on Yield of Cocoa Pods in CRIN Demonstration Plot.
4. Assessment of Intercropping Arable Crops with Cashew among Farmers in Kogi State
5. Farmers use of Banana Instead of Plantain as Shade Crop in Cocoa Establishment: A case of Cross Rivers State of Nigeria
6. Challenges of Agro-input Supply to Farmers. Prerequisite for improved Cocoa Production in Nigeria
7. Implications of Sprayer Types used by Farmers for Controlling Insect Pests and Diseases of Cocoa in South West Nigeria
8. Farmer's field day event in `May 2018

Economic research activities

9. Efficiency of cocoa marketing among cocoa farmers in Nigeria
10. Youth involvement in coffee production panacea for poverty eradication in Ogun State
11. Kola nut grading in Southwestern Nigeria
12. Diagnostic survey of cherelle wilts in Cocoa farms in Nigeria: Its Economic implication.
13. Comparative analysis of the demand for different types of Tea in Southwestern Nigeria
14. Cocoa Soil Survey with socio economic data collected in 10 states in Nigeria 1DH/ CRIN/IITA project
15. Development of Data bank for Cocoa and Cashew
16. Business Incubation Platform for youth.

Statistics

17. Collection, collation and analysis of data field to primary processing on CRIN mandate crops from CRIN HQ.
18. Sales of CRIN mandate crops and developed products at CRIN and other end users in the country.

Achievements in the last one year

1. Development of Data Bank System: The department conducted a cocoa Survey in 2005 and the report is being used as a baseline or reference data for planning in Nigeria and other international organization. There is the need to update the information. The department is currently developing a data bank System for all CRIN mandate crops and updates of all information are ongoing. 2 Computers and some accessories have been acquired to kick start the project
2. Establishment of Business Incubation Platform for youth. Acquisition of equipment for soap and bakery and other training materials for training of youth in various incubator centres. Possible collaboration with National Youth Council is ongoing.
3. Improvement in the Geographic Information System equipment for mapping of CRIN mandate crops farms, stores, input centers and other works. 2 additional computers and soft wares have been acquired.
4. Improvement in the weather information data through the installation of an improved automatic weather station at the Headquarters. We are proposing to acquire more for each of the substations with possible network with other African countries for a weather smart agriculture.
5. N12, 15 million generated at the marketing unit in the year 2017 mostly from sale of Cocoa pod hybrids, cocoa beans and seedlings of CRIN mandate crops. This is expected to increase by the end of 2018.
6. Facilitation of 13 weeks Radio Program in Amuludun FM Station 99.1 Ibadan in 2017 to enhance information dissemination of improving productivity of CRIN mandate crops among stakeholders
7. Construction of Phase 1- Community Radio Station for broadcast of CRIN activities to the general public. The project that started in 2017 is still ongoing.
8. Training of farmers on Good Agricultural Practices (GAP) in Cashew Production in Edo,

Ekiti and Ondo State in 2017

9. Training of Farmers on GAP on Cocoa Production in Mokore Farm Settlement, Osun State 2017.
10. Organization of the first edition of Farmers Field Day Event in CRIN Ibadan in May 2018.
11. Cocoa Soil Survey with socio economic data collected in 10 states in Nigeria 1DH/ CRIN/IITA project
12. Constraint to Youth involvement in cocoa production in Nigeria: presented at International Cocoa Conference, Peru, 2017
13. Video documentation on cashew with P-CUBE on collaborative work
14. Setting up of innovation platform on Coffee with stakeholders

In general, the levels of achievement on the research projects have been low about 20-30 percent due to late release and inadequacy of the fund. Projects have to be merged, compressed or scope reduced.

Uncommon Challenges facing the department

1. Frequent change in the nomenclature and portfolio of the department head
2. Difficulty of aligning Statistical staff with Research staff on experimental design and analysis of data
3. Poor timing and inadequacy of research funds resulting in delay on execution of project and reduction of scope of project
4. Leaking office roof
5. Lack of research equipment and materials

Plan for 2018/19

1. Strengthening Extension Capabilities for research product dissemination and training of young school leavers and graduates
2. Establishment of college (Crop and Business Training school.) for all stakeholders
3. Establishment of more platforms (Technology & Innovations) for CRIN mandate crops
4. Establish collaboration for improved extension delivery system on new CRIN technologies
5. Completion of CRIN Community Radio
6. Acquisition of Open broadcasting Van (OB Van)
7. Production of Flyers, Manuals and Banners
8. Purchase of Graphics Design Equipment
9. Establishment of Demonstration farms
10. Purchase of Digital Editing Equipment
11. Rehabilitation and Equipping of Extension hall, offices and training rooms
12. Establishment of Improved Methods of Data Collection, Collation and Utilization on CRIN mandate crops
13. Establishment of Data Bank of all CRIN mandate crops.
14. Establishment of more Business Incubators for youth with new ideas on setting up ICT companies along the crop value chain: "Technologies for Skill Development in Businesses"
15. Establish collaboration for Climate Smart Agriculture on CRIN Mandate crops using modern agro metrological equipment and remote sensing.
16. Monitoring and Evaluation of farm evolution, forest changes and soil index using GIS and satellite imagery with collaboration with AfSIS, Google maps etc.

Library Information and Documentation Department
(HOD: Fagbami O. O)

(Head Library Division: Dr Taiwo E Ogunjobi)

Introduction

Library, Information and Documentation (LID) Department acquires, develops, generates,stores and disseminates information on CRIN mandate crops through prints and electronic media.

The Department comprises of 3 divisions namely: Library, ICT, and Documentation.

Achievements

- Provides up-to date resources in both prints and electronic media.
- Provides Internet services to all users.
- Provides a conducive reading environment
- Enhances the Institute' ICT new Technologies
- Enhances the Institute's local and International visibility electronically
- Produces print reports and technical publications

- Develops Nigerian Cocoa, Coffee, Cashew, Kola and Tea Information Center
- Enhances research development through the use of ICT facilities in the Institute

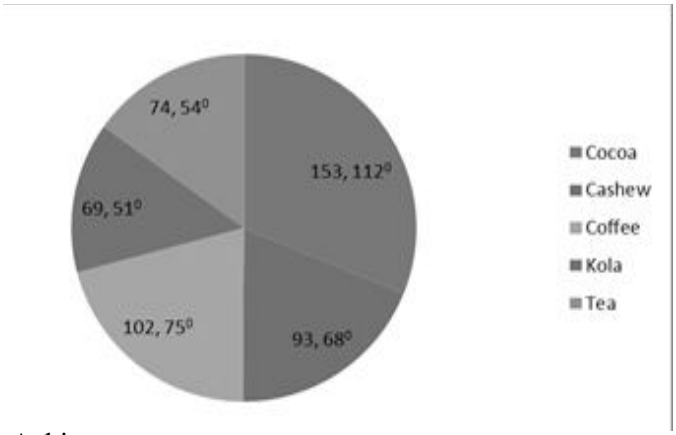
Challenges

- Linkage of Headquarters Library to substations electronically
- Insufficient Broadbandwidth
- Inability to acquire up-to date e-books, journals and other information resources
- Inadequate staff and funding for documentation work
- Overflooding and leaking roofs of library building
- Insufficient facilities for internet distribution
- Poor level of acquisition of print materials on CRIN mandate crops
- To acquire more electronic devices.

Library Automation

CRIN Library Automation systems comprises of electronic devices (computers) which transforms CRIN Library materials (Journals, theses, Reports, etc.) to full-fledged electronic library. It comprises of Four (4) severs; TEEAL (Microsoft windows Server 2003), File (Linux Server) and KOHA (Linux Server), CRIN DSpace Servers respectively.

Achievements and Challenges



Achievements

-TEEAL Drive was procured to provide up-to date e-library materials to Library Patrons (Research Scientists)

-Drive was procured to provide up-to date e-library materials to Library Patrons (Research Scientists)

-Downloads of Journals on CRIN mandate crops (Cocoa, Coffee, Cashew, Kola, and Tea) to be uploaded into CRIN DSpace. Below is the breakdown of the uploaded journals:- Cocoa –153, Coffee -102, Cashew –93, Tea – 74, Kola – 69, making 491 journals in total.

Pie Chart of Downloaded Journals on CRIN Mandate Crops in the year 2018

Challenges

The Library Automation File server had developed faults and the vendor (Projektlink) was contacted for repairs.

Crin Monthly Bulletin

This is a monthly News Bulletin that showcase CRIN-related events and news (within and outside the Institute) that occurred on monthly basis.

Achievements

CRIN monthly Bulletin was designed and circulated to heads of departments for necessary perusal, from the month of April to December, 2018.

CRIN Crop Book

CRIN Crop Books are collated journals written by Research scientists of different programmes.

Achievements

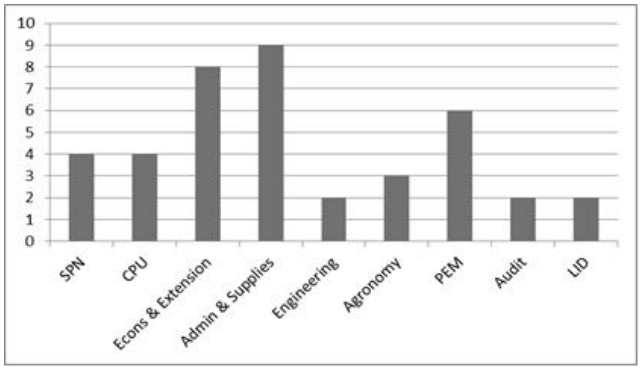
All CRIN Crop Books except Cocoa book were collated and submitted by head of the Crop programs

CRIN ID Card Production

This section deals with collation of staff details for ID card reproduction.

ID card Production Patronage

The following is the collation summary of ID card reproduction for the year 2018:
LID – 2, CPU – 4, AUDIT –2, SPN – 4, Econs & Extension – 8, Admin & Supplies – 9, Engineering – 2, Agronomy – 3, PEM – 6, making 40 patrons in total.



Bar Chart of CRIN ID card Production Patronage for the year 2018

Areas of Intervention

- Linkage of Headquarters Library to substations electronically
- Full transformation of CRIN library to electronic library
- To acquire more electronic devices.

ENGINEERING DEPARTMENT

Preamble

During the year under review, 2016 till date, the Engineering /Works Division operated as hitherto into three s(3) technical sections and fourteen (14) operational units. This help to effectively utilize the available manpower and to deliver maximally in all fronts of the official responsibility of the division tom support and service the Research mandated goal of the Institute.

Sections:

The three technical sections are arranged below:

(1) Civil Engineering
(2) Electrical Engineering
(3) Mechanical Engineering

Units

We have fourteen operational units, which are listed below

(1) Civil
  * Carpentry
  * Mansory and Bricklaying
  * Roads

(2) Electrical
  * Generation & Protection
  * Networks & Installations
  * Billing & Metering

(3) Mechanical
  * Agricultural & Equipment
  * Fabrication & Welding
  * Plumbing & Water supply
  * Generation, Refrigeration & Air-condition
  * Machine shop
  * Motor vehicles
  * Special Duties (Maintenances, Planning & Monitoring)
  * Transport

Personnel

Names of all Staff in Engineering Division

`S/N	NAME	DESIGNATION
1	Engr. Bakare Taiwo	Chief Maintenance Engineer/HEW
2	Engr. Ikpefan Patrick	Principal Maintenance Engr. l
3	Mr. Titiloye Isaac	Senior Maintenance Engr.
4	Mr. Olutola Ola	Chief Tech. Officer
5	Mr. Agwimah Emmanuel	Chief Tech. Officer
6	Mr. Ajiboye Gbenga	Asst. Chief Tech. Officer
7	Mr. Yinusa Sakiru Adedoyin	Principal Tech. Officer l
8	Mr. Awe Jacob	Principal Tech. Officer l
9	Mr. Ogunsuyi Busuyi	Principal Tech. Officer l
10	Mr. Gold Ahmed	Principal Tech. Officer l
11	Mr. Oduntan Samson	Principal Tech. Officer l
12	Mr Oyawale Muniru	Higher Tech. Officer
13	Mr. Ogunwumi Oluseye	Higher Tech. Officer
14	Mr. Ajayeoba Babatunde	Higher Tech. Officer
15	Mr. Ogbechie Micheal	Higher Tech. Officer
16	Mr. Mathews Dare	Senior Works Superintendent
17	Mr Akintoroye Ambrose	Senior Works Superintendent
18	Mr Ogbechie Christopher	Senior Works Superintendent
19	Mr. A deyanju Stephen	Higher Works Superintendent
20	Mr. Balongun Roland	Higher Tech. Officer
21	Mr. Adedoyin Nkanlola	Higher Works Superintendent
22	Mrs. Togun Olubukola	Higher Tech. Officer
23	Mr. Oyeniran Sunday	Works Superintendent
24	Mr. Oyebanjo Toyos i	Works Superintendent
25	Mr. Ironua Samuel	Senior Foreman
26	Mr. Ibiyemi Adewale	Senior Foreman
27	Mr. Oke Babatunde	Works Superintendent
28	Mr. Ojo L. Idowu	Senior Foreman
29	Mr. Adeogun Morufu	Senior Foreman
30	Mr. Uwaifo l. Andrew	Senior Foreman
31	Mr. Adekanbi Aderemi	Asst. Tech. Officer
32	Mr. Ismaila Salami	Senior Craftsman
33	Mr. Ojo Moses	Senior Craftsman
34	Mr. Adesida Adewumi	Senior Craftsman
35	Mr. Adeboye Kehinde	Foreman
36	Mr. Oladimeji Taofeek	Craftsman
37	Mr. Boluwade Sunday	Senior Craftsman
38	Mr. Faniyi Jimoh Abiola	Senior Craftsman
39	Osun Micheal	Senior Craftsman
40	Mr. Adio Dare	Asst. Technical Officer
41	Mr. Alade Gboyega	Senior Craftsman
42	Mr Adedayo Salaudeen	Senior Craftsman
43	Mr Adekanbi Segun	Senior Craftsman
44	Mrs. Ajekigbe Femi	Secretarial Asst. l
45	Mr. Ajayi Olalekan	Agric. Field Attendant l
46	Mr. Gabriel Ibhazakor	Agric. Field Attendant ll
47	Mr Rotimi Ipinmoroti	Motor Driver Mech.
48	Mr. Oladipupo Kayode	Senior Work Superintendent
49	Mr. Ajiro ba Taiwo	Senior Work Superintendent
50	Mr. Enodumwenben Anthony	Senior Work Superintendent
51	Mr. Kpeleye Friday	Work Superintendent
52	Mr. Odeku Olufemi	Work Superintendent
53	Mr. Tijani Fatai	Chief Motor Driver Mechanic l
54	Mr. Muraina Lukman	Chief Motor Driver Mechanic l
55	Mr Osungbade Ayoade	Higher Technical Officer
56	Mr. Ogunkunle Gbadebo	Senior Motor Driver Mechanic
57	Mr. Arumemi Christian	Senior Motor Driver Mechanic
58	Mr. Arowobusoye Akinrinsola	Senior Motor Driver Mechanic
59	Mr. Oluwole Segun	Senior Motor Driver Mechanic
60	Mr. Adesuyi Busuyi	Senior Motor Driver Mechanic
61	Mr. Oyedele Bolaji	Senior Motor Driver Mechanic
62	Mr. Iyeh Moses	Senior Motor Driver Mechanic
63	Mr. Nome Peter	Motor Driver Mechanic
64	Mr. Rabiu Ak eem	Motor Driver Mechanic
65	Mr. Ajewole	Motor Driver Mechanic
66	Ismaila Tajudeen	Motor Driver Mechanic

Achievement of the division

1. General maintenance of buildings, equipment, vehicles and road network within the Institute
2. Erection of fencing Poles and wires along the Institute outside Lawn
3. Supervision of all Contract works like road construction, the Laboratory complex, installation of solar/inverter system in the Institute and so on.
4. Re-roofing of the Event Centre.
5. Redd-roofing of the Engineering workshop.
6. General transport activities.

Functions and Responsibilities of Engineering Division

1. Initialize and develop a process plan to service the research mandate goal.
2. To design, construct, install and maintain any engineering related equipment to support the research mandate goal.
3. Daily Maintenance of vehicle fleets, building, machinery, and equipment's that drives the research mandate goals.
4. Prepare tender document to facilitate excursion of capital projects.
5. To advice the Executive Director and CRIN management on the tenets of the ethnics of the engineering profession.

Challenges (major & minor):

Major challenges faced by the Division:

- Lack of readily available working fund to solve immediate maintenance needs.
- Also, poor or rather no imprest reimbursement.
- Lack of an upgrade of equipment and tools in commensurate with available manpower.
- Insufficient training and re-training of staff to meet up with the global trends in maintenance techniques

Minor challenge faced by the division:

- Lack of an engineering inventory store which will enable closeness to maintenance spare items thereby eradicating long down time delay.
- Also, the Engineering Division lack daily logistics like availability of vehicle to move materials finished work to the site, a direct projection of poor funding.

Scope for Future Recommendation

1. Provision of upgrade equipment /tools for the day to day running of the division
2. Training of staff to meet with the recent global technology
3. Provision of daily needed maintenance items in the inventory store to eradicate delays in the execution of maintenance plans.
4. The farm machineries could be used for hiring in-order to generate IGR
5. Construction of a 33KV transmission line or a dedicated line to solve the problem of light in the Institute which could also be a source of IGR.

INTERNALAUDIT

The Internal Audit Division was set up to provide a complete and continuous audit of the accounts and records of revenue and expenditure, assets, allocated and unallocated stores of the Institute. In line with section **1702** of the financial regulations, the Division is structured responsible to the Executive Director.

Personnel

Our staffs are qualified professionals with knowledge and expertise in the field of auditing and investigation; and financial reporting. As at 31st of December, 2018 the Division had fifteen (15) staff. This comprised six accountants, eight Executive Officers and one

Secretarial staff.

One of the Executive Officers was on approved study leave.

Responsibilities

In addition to exercising its core mandates of providing a complete and continuous audit of the accounts and records of revenue and expenditures, assets, allocated and unallocated stores of the Institute which are in tandem with section **1701** sub section **(i)** and **(ii)** of the Financial Regulations, the Division perform amongst others the following duties:-

- Maintenance of adequate checks against fraud and misappropriation; verification of assets and liabilities at regular intervals;
- Examination and constant scrutiny of all system of authorization of payment to ensure adequate control of expenditure;
- Ensuring that various policies as put in place by the Management are strictly adhered to as well as reviewing accounting system and related internal controls;
- Ensuring that information required by the Management for effective performance is reliable, complete and timely;
- Conducting special investigations and periodic examination of internal checks to ensure accuracy and efficiency;
- Examination of financial and operational information for management, including detailed testing of transactions and balances;
- Reviewing the economy, efficiency and effectiveness (Value for Money Audit) of operations and functioning of both financial and non-financial controls;

Achievements

The following are some of the heights we have attained during the year:-

- Review, monitor and ascertain accounting and internal control systems put in place by the management.
- We have been able to keep cost of items/materials requested within reasonable and acceptable limits without impairing the quality and quantity of its intended use.
- We have ensured that expenditures incurred are wholly, reasonably, exclusively and necessarily incurred in the interest of the institute.

- In many ways we have ensured compliance with extant rules and regulations vis-à-vis financial regulations, public service rule, government official gazettes and circulars, and management policies.
- We have safeguarded the institute's property by confirming their existence, rights & obligations, completeness, valuation and allocation.
- Our audit has also provided feedbacks to the management on the effectiveness of the internal controls put in place.
- We have also served as a moral check on those entrusted with the management of government resources (financial and non-financial).

Challenges

Our major challenge is inadequate funding. Auditing is a continuous exercise that requires gathering of sufficient, appropriate, relevant and reliable evidences on which our findings and recommendations would be based. This cannot be achieved without proper and adequate funding. Though we realise that delay in the release of funds by the government warrant this at times, we encourage the management to prioritise audit assignment in the institute.

Conclusion

We look forward to seeing an Institute where majority of the staff if not all would understand the nitty-gritty of audit rather than seeing it as a witch hunt exercise. We also look forward to seeing an Institute where audit assignment would be given priority in terms of funding.

SUBSTATIONS

OWENA

Head of Station: Dr. K.A. Oluyole

Staff Disposition: The staff list at the station during the year 2018 is as shown below

S/N	Designation	Owena	Alade	Onisere
1	Chief Research Officer	1		
2	Principal Agric. Superintendent 1	2		
3	Principal Agric. Superintendent 2	1		
4	Principal Executive Officer II	1		
5	Chief Motor Mechanic	1		
6	Principal Health Assistant	1		
7	Chief Agric. Field Overseer	1		1
8	Assistant Executive Officer	1		
9	Assistant Chief Agric. Field Overseer	3		
10	Clerical Officer 1	1		
11	Assistant Executive Officer	1		
12	Senior Agric. Field Overseer	2		
13	Motor Driver	1		
14	Field Attendant1	6	1	
	Total	**23**	**1**	**1**

Land Area

At Owena main Substation, the size of all the plantations is 17.95ha but the effective hectarage is 10.4ha; at Alade Outstation, the total hectarage is 0.5ha and the effective hectarare is 0.3ha while at Onisere Outstation, the total hectarage is 2.5ha and the effective hectarage is 1.0ha.

Activities

On-going research experimental plots were maintained in collaboration with the scientists involved. Some of the experiments under the station's supervision include:

1. Evaluation of fertilizer use efficiency on cocoa varieties (Dr. Ogunlade, M.O.)
2. Evaluation of field establishment of tea under shade plant and organic manure and low cocoa ecology of Nigeria (Mr. Adeosun)
3. Life mulch weed control system on the development and growth of seedling of cocoa (Mr. Idrisu Muhammed)
4. Effect of varying light intensities and organic manure on the growth of Tea (Mr. Adeosun)
5. Genetic diversity studies on Robusta coffee (Coffea canephora) assisted by molecular markers (Mr. Muhammed Baba-Nitsa)
6. Effect of deforestation on the survival of young cocoa on the field (Dr. Ogunlade *et al*.)

7. Fungicide screening activities were carried out to determine the efficacy of fungicides Tandem, Overgo, Jorkemil and Michorhiza (Lens and Plus).

Achievements:

1. Efforts were made to maintain our plantations at Owena main-station and outstations with the little resources and available labour.
2. Establishment and maintenance of 2 hectares cocoa plantation planted with TC1-8
3. Revenue: A total sum of One million, three hundred and thirty-two thousand, seven hundred and ninety-five Naira Only (N1,332,795.00) was realized from the sales of farm produce and other services. This is an improvement over the previous year's own.

Challenges/Constraints:

1. There is paucity of fund and this affects the station negatively. Station's overhead which cares for the expenses of the day to day running of the station is not forthcoming and this makes the running of the station difficult.
2. Considering the enormity of the work in our plantation, the present field staff is grossly inadequate to take care of the work.
3. The present number of security staff is inadequate for effective guarding of the office, staff quarters and plantations.
4. The road linking the staff quarters with the office is totally spoilt and this makes it difficult to be plied by vehicles.

Suggestions for improvement

1. The overhead should be revived so that it will be regular. This will make it easy for the station to be taking care of her day to day expenses.
2. The Substation's guest house needs a light renovation in order to make it a more habitable for our researchers that are coming from the headquarters to carry out research work at the substation.
3. Considering the enormity of the work in our plantation, there is a need for more farm workers to complement the few number on ground. The additional staff request by cadre is as follows:

Field Attendant 1	10
Field Attendant II	10
Security Guards	4

However, if the above categories of workers are not available, it will be highly appreciated if we can be allowed to recruit contract workers to replace them.

APPENDIX

2018 INTERNALLY GENERATED REVENUE

Cocoa Beans	N651, 590
Cocoa Pods	N66, 450
Cocoa Seedlings	N60, 000
Plantain	N14, 000
Palm Oil	N18, 000
Rent	N219, 755
Rest house	N2, 000
Fire wood	N13, 000
Access Fees	N288, 000
	N1, 332,795

IKOM, CROSS RIVER STATE

Dr Eghosa Osas Uwagboe (Head of Station) Ikom, Cross River State

Introduction

Cocoa Research Institute of Nigeria (CRIN), Ajassor substation, was founded in the year 1965 as a Research Substation and Extension Centre to CRIN, Ibadan. CRIN Ajassor is located along Ikom –Ajassor Border Road near Cameroun Border in Etung Local Government Area of Cross River State of Nigeria. It is bounded in the West by Ikom township, South by Effraya town, North by Ajassor plantations (Etigefe) and East by Ajassor Mission town. CRIN Ajassor substation is predominantly cultivated with Cocoa but because of its soil fertility and ability to sustain most tree crops, some handful of plantations of Kola, Coffee and Tea are also located at the station. In fact, it is well established that Cashew can also thrive in CRIN Ajassor. Consequently, all the five mandate crops of CRIN can be grown on CRIN Ajassor soil.

CRIN Ajassor substation is the largest Substation with a landmark of about 768 hectares. However, only about 88Ha of these lands had ever been cultivated with CRIN mandate crops. There are 56.86Ha of effective cultivated plots while about 23.7Ha and 7.5Ha are categorized as non-effective and abandoned plots, respectively. These figures are exclusive of the ground cover of approximately 113,436m^2 of land area that accommodates the Administrative and Planation Management Blocks, Staff Residential Quarters, Crop Nursery and Post-Harvest Unit, Mechanical Workshop, Rest House, Fermentary Building, Cocoa Dryer Compartment, a Staff Clinic as well as a Primary School (now under the control of Cross River State Government). In addition to the main substation in Ajassor, there are two other experimental outposts (Rantimankonor and Okundi) Rantimankonor in Enoghi community near Kalime, along Ikom –Ajassor Border Road and mainly cultivated with T.38 clone of Cocoa while Okundi the second outpost is located at Ikom-Okundi-Etome Road and predominantly cultivated with Cocoa and Coffee.

Cocoa Research Institute of Nigeria, Ajassor Substation, engage in exclusive training programme and extension services by disseminating research findings and many relevant information to the farmers, cooperative societies, corporate organizations, local and state governments in her immediate neighborhoods, and other surrounding States.

Staff Disposition

As at 31 December 2018, the staff strength across different sections were 34 including the Head of Station who is a Research Officer, 2 Agricultural Superintendents, 2 Clerical Officer (Administration), 1 Executive Officer (Account), 1 Store Keeper, 1 Nursing and Midwifery Superintendent, 1 Health Asst, 1 Typist, 2 Foremen, 5 Security men, 15 Field officers and 2 contract staff. It is pertinent to inform CRIN Management that most staff of CRIN Ajassor, especially those on the field and in the Security Section are very few and mostly old people. There is an urgent need to recruit more young and vibrant persons into the system.

Table 1: Names, PF Nos., CONRAISS & steps, Designations as well as the Dates of First and Current Appointments of all staff at CRIN Ajassor as at December 2018:

S/N	Name	PF No.	CONRAISS and step as at 31/12/2018	Designation	Date of 1st appointment	Date of current appointment
1.	Dr. Eghosa Osas Uwagboe	251	13/01	Chief Research Officer (Head ofStation)	11/12/2001	01/01/2018
2.	Mr. Samson O. Odedele	314	11/01	Principal Agric Superintendent I	08/04/2008	01/01/2018
3.	Mr. Kehinde Oyeledun	351	09/05	Principal Agric Superintendent II	05/02/2009	01/10/2015
4.	Mrs. Joy Awunghe Takim	390	08/05	Senior Nursing Sister	01/04/2010	01/01/2016
5.	Mrs. Eunice O. Ojua	1143	07/01	Higher Executive Officer (Acct.)	17/07/1986	01/01/2017
6.	Mrs. Blessing Ekama Isong	1288	06/09	Chief Clerical Officer	01/12/1997	01/10/2009
7.	Mr. Effiong Nathaniel Udoh	1142	06/05	Senior Foreman	16/07/1986	01/10/2014
8	Mrs. Esther Ntomo Echi	1293	07/02	Chief Health Asst.	01/12/1997	01/01/2017
9.	Mr. James Ibiang Okoi	1543	06/01	Snr Foreman	10/06/2003	01/01/2017
10	Mr. Ezekiel Asuquo Effiong	1289	06/02	Chief Agric Overseer	01/12/1997	01/01/2017
11.	Mr. Edet Akpan Robson	1541	06/02	Chief Agric. Overseer	02/06/2003	01/10/2016
12.	Mr. Okpokam Ozong Edim	1556	06/02	Chief Store Keeper	10/04/2008	01/10/2015
13.	Ms. Pauline Ukpeukiema Ugi	1566	06/01	Senior Secretariat Asst. II	23/12/2008	01/01/2018
14..	Mr. Augustine Akwagiobe Uzichu	1699	03/09	Head Watchman	02/01/2009	01/10/2013
15.	Mr. Azogor Isong Echeng	1707	04/06	Senior Agric Field Overseer	02/01/2009	01/01/2018
16.	Mr. Iwara Eteng Okoi	1760	05/02	Asst. Chief Field Overseer	02/01/2009	01/10/2018
17.	Mr. Samuel James Udoh	1702	05/02	Asst. Chief Field Overseer	02/01/2009	01/10/2018
18.	Mr. Sunday Ime Asua	1705	04/05	Senior Agric Field Overseer	02/01/2009	01/10/2016
19.	Mr. Onah Peter Ogar	1704	05/02	Asst. Chief Field Overseer	02/01/2009	01/10/2018
20.	Mr. Emeng Ele Eleng	1708	04/07	Senior Agric Field Overseer	02/01/2009	01/10/2018
21.	Mr. Idagu Godwin Echa	1703	05/02	Asst. Chief Field Overseer	02/01/2009	01/10/2018
22.	Mr. Igbang Bassey Igbang	1709	04/06	Senior Agric Field Overseer	02/01/2009	01/012018
23.	Mr. Abraham Samuel Inyang	1701	05/02	Asst. Chief Field Overseer	02/01/2009	01/01/2018
24.	Mr Augustine Eteng Ubi	1698	03/08	Senior Agric Field Overseer	02/01/2009	01/01/2018
25.	Mr. Sunday Nkanta Ekereobong	1700	05/02	Asst. Chief Field Overseer	02/01/2009	01/01/2018
26.	Mr. Adariku Patrick Iyaji	1706	04/06	Asst. Chief Field Overseer	02/01/2009	01/01/2018
27.	Mr. Anthony David	1816	03/08	Agric Field Attendant 1	29/04/2011	01/10/2015
28.	Ms. Mercy Umontia	1814	04/04	Senior Agric Field Overseer	29/04/2011	01/01/2018
29.	Mr. Peter Godwin	1815	03/05	Agric Field Attendant I	29/04/2011	01/10/2015
30.	Mr. Idorenyin Okpo	1950	03/05	Agric Field Attendant 1	26/04/2012	01/10/2015
31.	Mr. Udoh Akpan Johnny	1951	03/05	Agric Field Attendant 1	26/04/2012	01/10/2015
32.	Miss Precious Magagi	1820	05/03	Senior Clerical Officer	06/07/2011	01/10/2015
33.	Miss Patience Takum Ayiba		01/02	Agric. Field Officer III	01/07/2018	01/07/2018
34.	Mr Emmanuel Takum Ayiba		01/02	Agric. Field Officer III	01/07/2018	01/07/2018

Table 2: Staff who joined CRIN Ajassor in 2018

S/N	Name	Designation	Date of Resumption	Mode
1.	Dr. Eghosa Osas Uwagboe	Chief Research Officer (Head of station)	02/07/2018	Staff transfer from Ibadan
2.	Mr. Samson O. Odedele	PAS I	02/07/2018	,,
3.	Mr. Kehinde Oyeledun	PAS II	02/07/2018	,,
4.	Mr Emmanuel Ayiba	AFA III	01/07/2018	Staff employment
5.	Miss Patience Ayiba	AFA III	01/07/2018	Staff employment

Table 3: Staff who left CRIN Ajassor in 2018

S/N	Name	Designation	Date of Exit	Cause of Exit
1.	Dr. Kayode Ayegboyi	Chief Research Officer	24/05/2018	Staff transfer back to CRIN headquarters
2.	Mr. Maroof Adekunle Olayiwola	Asst. Chief Agric Superintendent	20/07/2018	,,
3.	Mr. Mohammed BabaNitsa	Principal Agric Superintendent 2	13/07/2018	,,

Plantation Management

There were various challenges such as inadequate labour force (field workers) as well as unavailability of enough agro-chemicals for field and ground maintenance. Adequate cultural maintenance of all the Cocoa, Coffee, Kola and Tea plots under CRIN Ajassor were done throughout the period under review.

Table 4: Plantations/ Research plots with their hectares and maintenance status in Ajassor as at 31 December 2018

Cocoa Research Plots	Hectares	Status
Cocoa plots		
1967 Trinidad	2.9	Maintained
1975 F_3 Amazon	1.6	Maintained
CRIN/NIFOR 1	6.0	Maintained
CRIN Elite Seed Multiplication	2.2	Maintained
T38 Kalime	2.8	Maintained
Commercial	2.0	Maintained
Cocoa Cuttings	1.0	Maintained
15 Acres Extension	2.0	Maintained
Amelonado	2.0	Maintained
1973 F_3 Amazon	2.0	Maintained
Seed Garden Multiplication	2.2	Maintained
Okondi	10.69	Maintained
Planting at stake	1.6	Maintained
Farming System Experiment	2.0	Maintained
Adaptability/Tolerant Trial	2.1	Maintained
65 Lines Experiments	1.0	Maintained
CRIN Elite Seed Multiplication	2.2	Maintained
Cocoa Research Plot	1.32	Maintained
Ornamental Cocoa Plot	0.5	Maintained
Okundi (Cocoa) Plot	0.4	Maintained
Kola Research Plots		
Kola Progeny	1.6	Moribund
Kola Cuttings	0.65	Maintained
Kola Germplasm	2.92	Maintained
Kola Fertilizer Trials	2.0	Moribund
Coffee Research Plots		
Okundi	1.46	Moribund
1989 Ajassor	1.57	Moribund
Tea Research Plots		
Tea Ajassor	0.28	Maintained

Research Experiments

A pocket of research experiments was on-going at CRIN Ajassor Substation as at 31 December, 2018 as indicated in Table 5 below

Table 5: Research experimental work on-going at Ajassor Sub-station

S/N	Description	Crop	Researcher	Remark
1.	Effect of varying temperature on black pod incidence	Cocoa	Dr. A. R. Adedeji	Terminated as at 31 December, 2018
2.	Shade effect of Banana/Plantain/Cocoa intercrop	Cocoa	Dr. O. A. Famaye	On-going
3.	Screening of fungicides to control black pod disease	Cocoa	Dr. M. O. Okeniyi and Dr. D. O. Adeniyi	Terminated as at 31 December, 2018
4.	Cocoa soil evaluation on yield performance	Cocoa	Dr. Ogunlade, M. O.	On-going
5.	Tea Agroforestry experiment	Tea	Mr A. A. Oloyede and others	Started 25/10/2018
6.	Cocoa/Cassava shade intercrop	Cocoa	Dr. O. A. Famaye	At nursery stage

Vehicles/Motorcycles/Generators at CRIN Ajassor Sub-station

The list of the vehicles/motorcycles/generators/other equipment (and their conditions) are as below:

I. Toyota Hilux Van with registration number FG 09 V03 (Not functioning. Recommended for auction).

ii. Peugeot 404 Pick-Up with registration number FG 2326 B034 (not functioning; recommended for auction).

iii. Mercedes 911 Water Tanker with registration number FG 237 B02 (functioning but below optimal level; should be overhauled as soon as possible).

iv. The Eicher Truck with no registration number FG 740 B03 (Recommended for repairs).

v. Mitsubishi L200 Van with registration number FG 741 B03 (not functioning but could be repaired for the use of CRIN Ajassor Substation).

vi. Bedford with registration number FG 238 BO3 (already a scrap; recommended for auction)

vii. Tractor 1 (serviceable) with registration number FG 239 B03 MF 265 (functioning but its tires and few parts needed replacement).

viii. Tractor 2 (unserviceable) already a scrap; recommended for auction.

ix. Motor-cycles 3: We have 1 Daylong Wolf150 is functioning but need servicing but the 2 Suzuki 185 motor bikes with registration numbers FG 334 B03 and FG 335 B03 are old and not functioning, and are recommended for auction

x. 1 Tricycle Bazuki 200 TRC (functioning)

xi. Generators: 50 KVA Generator plant 1 (functioning but some of its parts needed replacement), 1 Elepaq 10KVA Petrol generator functional, 1 Tiger 2700 (functioning), 1 Sumec SPG 2500 (functioning) and 1 Tiger T 950 (functioning)

xii. Farm/Field equipment: 1 Hand driven mower, 1 Hand mower, 1 Water pump, 1 Harrow, 1 Plough, 1 Ridger

xiii. Audio visual equipment: 1 Overhead projector DLP LG,

xiv. Laboratory Equipment: 1 Autoclave, 1 Micrscope

xv. Electronic machines: 1 HP Scanner G4010 (functioning), 1 HP Printer P1006 (Faulty), 2 HP Laptops, 3 HP Laserjet printer (2 faulty, 1 functioning), 1 Desktop computer (Samsung) (Faulty).

Infrastructure/Capital Projects

CRIN Ajassor received the sum of Five Hundred Thousand Naira (N500,000) for capital project in 2018. This fund was to be used in the roofing of fermentation house and repairs of one of the nursery shade nets. However, I am using this medium to plead with the CRIN Management to help complete the 2013 Electrification of CRIN Ajassor project which the request and quotation has been submitted and awaiting approval. This will positively change the living standards of staff and all other residents of CRIN Ajassor quarters in no small measure. The drying slab is obsolete and non-presentable. We recommend its replacement with more recent and highly acceptable raised platforms. Meanwhile, only one of the 3 shade nets for raising seedlings was fairly in good working condition during the period under review. So, the repair of the two other shade nets is urgently needed.

Environmental Sanitation

At CRIN Ajassor, we know that 'health is wealth' and so we placed a high premium on the cleanliness of our offices and the residential quarters. Against this backdrop, a Monthly Environmental Sanitation on every last Saturday of the month was observed throughout the year under review. We also implore CRIN management to provide more public toilets for the staff in their residential quarters in 2019.

Visitors to the Substation in 2018

More than 200 visitors came to CRIN Ajassor sub-station in 2018 but only 22 of them were sampled for this report. The names, addresses, phone numbers and purposes of visit of the sampled visitors are reflected in Table 6.

Table 6: Name, address, purpose of visitation and phone number of some sampled visitors to CRIN Ajassor

	Names	Address	Phone number	Purpose of visit	Date of arrival
1.	Mr Ibiang Obetem	Ugep LGA	07030296404	Official	19/01/2018
2..	Edet Bassey Kings	Effraya	08107323615	official	24/01/2018
3.	Barr, Takom	Ikom	08063840527	official	6/02/018
4.	Nene Akwefeg K.	W.C.F.	+23324438919	official	14/2/018
5.	Peter Ogar	Ikom	07035571078	Business	4/3/018
6.	Clement Arikpo	Ugep	08182218999	personal	3/3/018
7.	Gimba A.D.	Ibadan	08035009456	Store taken	5/4/018
8.	Akomaye Festus	Calabar	08178792003	Official	11/5/018
9.	Kingsly Ikulen	Calabar	07033616670	Official	11/5/018
10.	Dr. A.R. Adedeji	CRIN Hq Ibadan	08055607561	Research	24/5/018
11.	Dr. A.O. Famaye	,,	08034742072	,,	,,
12.	Solifu Gabriel	Ikom	0805262452	Official	01/6/018
13.	Bisong Monica	etung	07064466689	Official	04/6/018
14.	Gab Odu Oji	Etung	08064496589	Enquiries	06/7/018
15.	Dr. Okenini M.O.	Ibadan	08059227840	Official	09/8/018
16.	Peter A. Bisong	I.R.S Etung	08122774171	Official	11/8/018
17.	Achima Praise	Ikom	07033333412	Official	04/9/018
18.	Hon. Bassey Agbor N.	Ajassor	08059242729	Official	09/9/018
19.	Cletus a, Okafa	Ogba-Osotom	07066795967	Official	08/10/018
20.	Mrs. Abiodun	Ikom	08104314940	Official	06/11/018
21.	Odu Richard	Boki	08166693835	Official	09/11/018
22.	Ayuk O.Ayuk	Boki/Ekim	07036249761	Official	17/12/018.

Internally Generated Revenue:

A total amount of Three Million, Three hundred Thousand and One Hundred and Twenty Naira (**₦3,300,120**) only was generated by CRIN Ajassor Sub station 2018. The breakdown of the revenue generated is in Table 7 below:

Table 7: Internally Generated Revenue Analysis (January-December)

	ITEMS	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT	OCT.	NOV.	DEC.	TOTAL
							Farm produce (A)							
1	Cocoa pods	-	-	1,059,000		210,000	804,000	-	30,000	120,000	600,000	30,000	-	2,853,000
2	Kola nuts	5,145	-	-	6,825	6,650	-	-	-	-	-	-	7,500	26,120
3	Dry Cocoa beans	-	-	-	-	20,000	76,000	-		76,000	-	-	80,000	252,000
4	Palm oil	-	-	-			18,000	-	-	-	-	-	-	18,000
	SUB TOTAL (A)	5,145	-	1,059,000	6,825	236,650	898,000	-	30,000	196,000	600,000	30,000	87,500	3,149,120
							Services (B)							
1	Staff rent	-	5,000	-	2,000	-	-	-	4,000	-	-	-	-	11,000
2	Tenant rent	3,000	4,000	15,000	13,000	2,000	3,000	33,500	-	-	38,500	24,000	4,000	140,000
	SUB TOTAL (B)	3,000	9,000	15,000	15,000	2000	3000	33,500	4000	-	38,500	24,000	4,000	151,000
	Total (A + B)	**8,145**	**9,000**	**1,074,000**	**21,825**	**238,650**	**901,000**	**33,500**	**34,000**	**196,000**	**638,500**	**54,000**	**91,500**	**3,300,120**

Challenges and Prospects

Some of the challenges and prospects in CRIN Ajassor Substation are as follows:

1. **Inadequate workforce:** We are the largest substation in CRIN yet with just a few staff. Our staff strength is just 34, but we need more staff to adequately maintain all our plots and watch over them. The substation has the capacity for expansion and increased productivity if more staff is engaged. This problem has resulted into the situation where most of our productive plantations are abandoned' which, of course, gives room for pilfering of our farm produce, more encroachment and much lower productivity. We urgently need to salvage the situation and produce at our optimal level. To this end, CRIN Ajassor requires nothing less than 60 field staff to cope with the weeding, spraying, harvesting, pruning and other cultural practices on our 56.86 ha of cocoa, kola, coffee and tea plots. Therefore, there is a need to employ additional 47 Field Attendants to complement the existing 15 Field Staff. Besides, in order to effectively secure lives, properties and forestall against theft of our farm produce, we need additional 20 Watchmen to complement our 5 current Watchmen at the moment.
2. **Funds:** I thank the Director/Chief Executive for the ₦100,000.00 sent to the substation in September 2018 and the submission of application for ₦500,000 from this year's capital vote which has been paid, we also use this medium to appeal for Overheads and more Capital Votes to CRIN Ajassor Station as soon as possible. It is extremely difficult to run a Substation with 34 Staff without overheads. We need to repair and fuel our tractor, tanker as well as Bazuki, machines, equipment and generators especially as we mobilize our field men to go into our 3 outposts at Okundi, Rantimankonor near Kalime, NIFOR etc. We are already struggling to meet our target of higher revenue next year but it is already becoming extremely difficult without enough funds.

Other pressing needs of CRIN Ajassor Substation:

1. Vehicles: One new Hilux Pick-up Van and one 18-Seater Staff Bus

2. Motorbikes: Based on the volume of the field work and the need for constant patrol of our plots by the security, there is a need to have 5 functioning motorbikes at our substation.

3. Surveying and fencing of the station: Surveying of our lands is the only way CRIN can permanently stop the encroachment problem presently being faced by the station. Wire or Perimeter fencing with Oil-palm will also be an added advantage.

4. Construction of concrete and metallic sign posts in all plots for easy identification of name of plants, year of establishment, varieties of plant used, size of each plot, location and general history of all our plots and plants.

5. An internet connection: This could be a broadband internet facility that will facilitate speedy surfing of the web and transfer of research related information to the headquarters. This will help the station to key into the present policy of internet administration strategy in CRIN.

6. Renovation of residential quarters: The buildings at CRIN Ajassor are all dilapidated while toilet facilities are becoming a mirage. Although, government quarters had been monetized, an urgent rescue mission on our Residential buildings to avoid total collapse of these 'farm houses'. Once collapsed, the tenants and staff will move out of the quarters and that will spell doom for the safety of all farm produce at the station.

7. Construction of farm houses in the zones for the field workers to serve as coverage during rainy season.

8. Renovation of seedling shade nets.

9. Installation of inverter at the station to bring down the running cost on gasoline/diesel operated generators.

10. Connection to National electricity grid which quotation has been submitted and awaiting approval

11. Repairs of meteorological station which quotation has been submitted and awaiting approval

12. Re-printing and painting of the CRIN Ajassor Sub-station sign post at the entrance of the station

13. Construction of farm houses in the zones for the field workers to serve as coverage during rainy season.

14. Renovation of the fermentary house, drying oven shed and construction of raised platforms for drying cocoa.

15. Renovation of worn-out seedling shade nets at CRIN Ajassor.

16. Provision of a modern and better equipped laboratory for CRIN Ajassor.

Once again, on behalf of the entire members of staff of CRIN Ajassor Substation, I thank the Director/Chief Executive and the entire CRIN IMC for their kind gesture to CRIN Ajassor Substation in 2018. We appeal that the D/CE should consider most of our requests, especially in the area of employment of more staff at the substation as soon as possible.

CRIN UHOMORA SUB-STATION
Head Of Station: DR. Adejobi, Kayode Babatunde

S/N	NAMES	DESIG NATION	CONR AISS
1	DR ADEJOBI KAYODE	PRO	11/4
2	OGIUGO PHILIP	PAS 1	11/1
3	EDIBO GABRIEL	PAS 1	11/1
4	ASEIN OYAKHIRE	HEO	7/2
5	0AIKHENA LYDIA	AEO	6/11
6	MUSA SAMUEL	WS	6/9
7	ALABA UMAHOIN	CAFO	6/3
8	OKPAISE IDOWU	CAFO	6/3
9	IRUOBE ELIZABETH	SCO	5/6
10	ANIJESE FUNMILAYO	SAFO	5/2
11	ONOJA JOSEPH	SMD/M	5/3
12	IFIDON IKHUOSIO TEDDY	HA	5/5
13	ISOKPEHI DANIEL	AFA I	3/10
14	KOKORI PAUL	AFA 1	3/7
15	IMUMOLEN JEFFREY	AFA 1	3/7
16	EDEH SIMON TOCHUKWU	AFA 1	4/2
17	EBIALE BENJAMEN	AFA 1	4/2
18	NWAGALA CHARLES	AFA 1	4/2
19	AMEDU ACHONU	AFA 1	3/5
20	EVBODAGHE MONDAY	AFA 1	3/7
21	EJIMAH DENISS	AFA 1	4/2
22	EHIDIAMEN JOSEPH	AFA 1	3/6
23	JAMGBADI IMOUDU	AFA 1	3/6
24	AMAIZE AUGUSTINE	AFA1	4/2

(1) Staff work force

The staff strength was twenty-four (24) as at 31st December 2018, which was made up of eight (8) senior staff, sixteen (16) Junior staff, consisting of 4 in Security unit (**Deployed from the field**), 1 in dispensary unit, 1 in Admin Office, 2 drivers and 8 field staff.

(2) Land area: The total land area of Uhonmora substation is 268.4 hectares. The total hectarage put into use is 16 hectares. Out of these 16.5 hectares, 5 for cacao, there are hectares, for Cashew 4.5 while 3 hectares for oil palm and 4 hectares.

(3) Field and Research Activities

(A) Nursery and Field Activities

(1) The nursery activities for the fiscal year were increased. About 10,000 cocoa, 1,000 Oil palm and 1,000 coffee

seedlings were raised against the 2019 planting season.

(2) Establishment of 1.5 hectares of cashew plantation for research and internal generated revenue purposes.

(3) Establishment of 1 hectare of land with plantain suckers in preparation for coffee establishment in 2019 planting season.

(4) Supply of missing gaps was done on cocoa plantations to obtain optimum plant population.

(5) Fire tracing was done round our plantations to prevent fire outbreak.

(6) The old and new cocoa plantations were regularly weeded harvested as at when due.

(B) Research Activities

1. Cocoa coppicing research was established.
2. Organic cocoa research was established awaiting treatment application.

(4) Achievements

Revenue

Staff List

Analysis of IGR For the Month of January To December 2018

PRODUCE	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	TOTAL
COCOA SEEDLINGS				56,200	20,000	15,000		120,000					**441,200**
PLANTAIN		10,000						70,000		70,000			**150,000**
PLANTAIN SUCKERS							40,000		180.000				**220,000**
PALM FRUIT			10,500	36,000									**46,500**
ORANGE							10,000						**10,000**
LAND RENTAGE								30,000	10,000	133,000	103,300	33,000	**309,300**
COCOA BEAN										30,240			**30,240**
ACCESS FEE												14,000	**14,000**
COCOA PODS												50,000	**50,000**
TOTAL	200,000	10,000	10,500	92,200	20,000	15,,000	50,000	220,000	190,000	233,240	103,300	97,000	**1,241,240.**

Infrastructural Development

Constant light supply to ensure security of lives and properties was sustained.

Employment: Ten (6) Project Contract Workers were employed to work on the field from the month of October to December, 2018

Promotion: Total number of 10 staff were promoted in the year 2018 fiscal year, namely: Mr Oguigo Philips and mr. Edibo Gabriel from Principal Agric. Sup. 11 to Principal Agric Sup. 1 Mrs. Oaikhena Lydia Itowa from Asst. Executive Officer to Executive Officer (Senior Staff). Also, Mrs Funmilayo Victoria Anijese from senior Agric. Field Overseer to Asst. Chief Agric. Field Overseer. Also, Mr Tochukkwu Edeh, Benjamin Ebiale, Amaize Augustine., Amedu Achonu, Ojimah Dennis and Nwagala Charles were promoted from Agric. Field Attendant 1 to Senior Agric. Field Overseer respectively (Junior Staff).

Health: No Drug was supplied to the station dispensary throughout the fiscal year 2018 by the Institute's Management. Notwithstanding, 80 pieces Measles Vaccines were received from Edo State Ministry of Health and administered to 120 children between age 0-5 in CRIN Estate and " One Man

Camp". A total of 1,000 Mectizan drug was given by the same state government to prevent and cure River Blindness Disease among 40 house holds. Not only that, as well as distribution of Membendazole (worm expeller) for children between the age of 5 to 14 years. Also vacillation of yellow fiver was carried out on people between the age of 15 to 49 years. Anti tetanus injection was also administered to females of age 15 to 49 years.

Staff Relationship: Inter-personal relationship amongst staffers was very cordial throughout the fiscal year 2018compared to 2017.

Sanitation: Regular monthly environmental sanitation was observed by all staffers of the Station, to keep the streets, building and Quarters of the Station clean and neat all the time for healthy living. The flowers were well trimed to maintain the aesthetic beauty of the station.

Socials: The staffers of the station organized their end of the year Co-operative Society party in honour of all members.

Students on Industrial Training: A total of 5 students from the College of Agriculture, Iguoriakhi were at the station for Industrial Training in 2016. The students were impressed at the standard of imformation and knowledge impacted on them during their short stay at the station.

(5) Challenges and Constraints

(I) Lack of funding, plans and ideas will decay if there is no fund to execute them.

(ii) No security staff, this poses threat to life and properties in the institute.

(iii) Inadequate staff for field works. This makes it very difficult to maintain the plantations and other new plots regularly.

(iv) The problem of annual fire outbreak around the plantations. (v) Inadequate farm inputs and tools like Agrochemicals (Herbicides, Insecticides and fungicides) cutlasses, field coats, Rain boats, Hoes, Wheel barrows, Poly-bags, Sensitive weighing balance scale, spade, Digital veneer calliper, Ranging poles, Watering Cans, Sprayers, Long sickles .

(vi) Inadequate vehicles/lack of tractor

(vii) Illegal felling of economic trees

(viii) Land encroachment

(ix) Dilapidating buildings (Both rest house, offices and quarters)

(6) **Additional staff request by level**

(i) 1 typist or computer operator. (ii) 5 Security officers
(iii) 25 field attendants

(7) **Suggestion and way forward**

(I) Adequate funding of Substation: There is need for proper funding of the substation to enable it achieve its set objectives.

(ii) More field attendants (25) should be employed. Employment of 5 security officers is very germane

(iii) There is need to supply the station with another vehicle, preferably a bus, to complement the Hilux to enhance transportation of staff and produce to the market.

(iv) Office, rest house and HOS house need to be rehabilitated.

ECONOMICS AND EXTENSION RESEARCH

Experimental Title: Cocoa Women Farmers' Agricultural Information Need and Search Behaviour in Ondo state Nigeria

Investigators: Williams OA, Adedeji RA, Adebiyi S, Oluyole KA. Abdulkarim IF

Introduction

Women farmers play immeasurable role in Nigerian food production, although motivation for participating in agriculture is first to contribute to household food security and income. The 2006 census puts women at fifty-two percent out of which about forty-five percent (45%) live in the Nigerian rural areas. In agriculture, a United Nation's estimate puts women's domestic food production at 80% in Africa, 60% in Asia and the Pacific and 40% in Latin America (FAO, 1998); thus revealing their high level of participation in agriculture especially in food production in African countries like Nigeria. In essence, women can be regarded as driving force for agricultural productivity. To sustain this productivity, it is necessary to understand their information need and searching behavior as this will help close the resource access gap between male and female farmers. The 2006 census puts women at fifty-two percent out of which about forty-five percent (45%) live in the Nigerian rural areas. In. agriculture, a United Nation's estimate puts women's domestic food production at 80% in Africa, 60% in Asia and the Pacific and 40% in Latin America (FAO, 1998); thus revealing their high level of participation in agriculture especially in food production in African countries like Nigeria. In essence, women can be regarded as driving force for agricultural productivity. In agriculture, new information and knowledge fuel innovation and increase productivity and competitiveness. It is then necessary for farmers to access information as this will contribute to both food security and economic growth. Agricultural information enhances farming decisions to sustain growth of agricultural activities. According to Mudukuti and Miller (2002), in the information age, dissemination of information and applying this information in the process of agricultural production will play a significant role in the development of farm settlements.

According to Agbamu (2006) they can be placed in the following categories: technical, commercial, socio-cultural and legal. In Nigeria Ozowa (1995) noted that farmers seldom feel the impact agricultural innovations either due to lack of access or poor dissemination of such vital information. This has become a key constraint or limitation to agricultural development. Nevertheless, for this approach to work, Nigerian government must first understand what women farmer's information needs are and then grow a dissemination and management strategy. Information needs can be diverse in nature but many times linked with individual's work activities; therefore, agricultural information needs of farm women is closely connected with their farming activities which is mainly cocoa production.

This cut across information on production, post planting, marketing and sales as well as policy oriented information. Nonetheless, it is insufficient to limit development effort to just understanding farmers' information needs; researchers need to explore women farmers' searching behavior as this will further enhance the development of better intervention programs. Paying more attention to the differences in how men and women farmers currently need and seek information may provide insight into how agricultural information can be disseminated more efficiently. This study will examine the information need and sourcing of women farmers

Statements of the Problem

The role of women farmers in food production is immeasurable and their motivation for participating in agriculture is first to contribute to household food security and income. Unfortunately, minimal or non-provision of agricultural information is a key factor that has greatly limited agricultural development in Nigeria. Especially with women farmers who experience gender gap in accessing information which is a key productivity resource. Gullen (1994), opined that African women farmers labour without crucial support, that could raise their agricultural productivity. Scarce inputs like credit, improved seeds, among others rarely flow to women in the African country side. Generally, it is a known fact that male farmers have more access to agricultural extension services than women in Nigeria. Osuman (1997) observed, that agricultural extension services are mostly staffed by men and are inclined to helping men folk. According to Morna (1989), in Malawi, when agricultural extension workers visit rural areas to explain improved technologies or other access to inputs they usually interact with Men not women. To overcome these limitation, program designers and the government need to understand

the information need and seeking pattern of these women farmers. It is in the light of this that this study investigated Information need and searching behavior of cocoa women farmers in Ondo state Nigeria.

Objectives

The following specific objectives guided the study to:

1. Describe the agricultural information needs of cocoa women farmers
2. Determine the extent to which agricultural information sources are accessible to the cocoa women farmers
3. Determines the sources cocoa women farmers in Ondo state consult for agricultural information.

Materials and Methods

The population for the study consisted of women farmers in Ondo State.

A questionnaire made up of 42 items was designed and used as instrument for primary data collection. Some copies of the questionnaire were given to literate respondents to complete while enumerators were used to assist the illiterate respondents in completing the questionnaire. The women farmers' Socio-economic characteristics considered for the purpose of this study include age, marital status, religion, educational level, income level and farm size. They were measured using the conventional methods. Both descriptive and inferential statistics were used for the analysis of data collected. Chi-square was used to test the stated hypothesis. Multistage sampling techniques was employed two local governments (Idanre and Ondo East) areas were puposively selected and in each local government two communities (Owena, Orisunbare,) and (Paadi, Ilutuntun) were randomly selected for the interview respectively. In each community ten farmers were interviewed; giving rise to 40 cocoa women farmers in Ondo state. The Data entry has been carried out and data will be analyzed using both descriptive and inferential statistics. The analysis will be carried out using the Statistical Package for Social Science 22.

Table 1, states the pattern of rural women's agricultural information needs found in the study locale. A considerably high number of farm women expressed need for information on farm implements (2.57), improved seeds (2.43) closely followed by land management (2.38). On the other hand, they seem to have less need for information on cropping system. This may reveal the participation pattern of women in agriculture which is more of planting, processing and marketing of farm sales.

Findings here imply that women still lack adequate supply of agricultural information that are pertinent to improving their level of productivity. As women experience insufficient agricultural information supply, they might be forced to stick to traditional or old agricultural practices.

Table 2 reveals that women farmers have access to agricultural information sources. Their access to these sources although can be relatively described as average with just few sources being well accessed by the women. Specifically, women had greater access to extension agents/services (4.90), family members (3.60), radio (3.60) and other farmers (3.38). On the other hand, the least accessed sources by the women is the library (1.92) closely followed by the internet (2.02), film/slide projection (2.14) and Agricultural institutes/university (2.29).

This may imply that women had higher access to interpersonal and old Information and Communication Technology (ICT) based sources as compared to the little access to institutional and recent ICT based sources.

Discussion of Findings

From the analysis of the study, findings of (Okwu and Umoru, 2009; Zaid and Popoola, 2010; Saleh and Lasisi 2011). They identified various areas where rural women require information for the purpose of improving their productivity. They include: income generation, best farming practices, methods of fertilizer application, agricultural inputs, market prices, transportation, food processing and preservation and new agricultural technologies. It is also evident that various sources are relatively accessible to the women for obtaining agricultural information.

This is in agreement with past studies such as (Demiryurok 2000, Boz 2002; Ajayi, 2003; Yakin and Boz 2007 and Zaid and Popoola, 2010) where husbands, fellow women, mass media (radio, television), agricultural extension officers, friends and neighbours, agricultural faculties, farmers' union and input dealers were major agricultural information sources consulted.

Unfortunately, few expressed their use of recent ICT-based sources like the internet and institutional sources

such as the library and agricultural institute. These sources unfortunately should have served as major sources for communicating agricultural information to these women farmers. This supports the challenge given by (Ofuoku, Emah and Itedjere, (2008) that research institutes and universities are not giving enough attention to carry out their responsibilities of information generation and delivery to farmers.

It is also worthy to note the relative use of the mobile phone for obtaining agricultural information.

This commensurate with the submission of Banmeke and Ajayi (2007) who note that some of the women farmers in developing countries still depend on traditional sources of information.

In conclusion, information remains a key component in ensuring agricultural development and productivity in Nigeria. Since women are seen as major player in this sector it is important to understand their information need and seeking pattern as this is expected to influence the sector's productivity level as well as inform information service providers on what strategies to adopt for agricultural disseminating information. Also, in spite of the wide range of sources available to these women to consult and the observed average access to these sources, farm women still expressed relatively high need for agricultural information especially those that will enhance income generation and productivity. Similarly, they still consult more of interpersonal and media sources with little or no significant exploit of the modern Information and Communication Technologies with the exception of mobile phones. Finally, it contributes to a growing body of literature that aims to understand to close gender gaps in agriculture and lead to more equitable opportunities for farmers.

Recommendation

Based on the findings of this study, the following recommendations were proposed:

i. Provision of productivity related information that takes into consideration farm women's agricultural information need including information on pricing, loan and resource acquisition, marketing and competition.

ii. Information service providers need to explore modern sources such as use of Information and communication Technologies for disseminating agricultural information. Although this might imply the establishment of Information Technology Centers in the communities.

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