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COCOA PROGRAMME

Title 1: Diagnostic assay, identification and incidence of causal organism(s) of cherelle wilt disease in three major cocoa producing States (Ondo, Osun and Abia) of Nigeria.

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Introduction

The cocoa tree, an understory tree crop that belongs to the *Malvaceae*, is of considerable economic importance to the producing countries and chocolate and cocoa product based companies of the western nations or Europe. 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. Further, obtained from the commercial bean seed are melted cocoa-intended for various food industries for sweetening products, cocoa butter used in making sweets, perfume, pharmaceuticals and finished products that include, cocoa cake and various chocolate-based products, among others. Although 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 prevailing in the humid tropics that the perennial tree crop is grown, 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, and fauna and plant nutrients in the tropics are variable due to the variable weather conditions of the tropics that could be hot with low relative humidity and suddenly changes becoming cloudy with accompanying heavy rainfall that 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 0.5-5% of cacao flowers set fruit that become young *Theobromacacao* 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). Other possible causes have also been adduced to diseases causing organisms such as *Phytophthora* species, *Moniliophythorararoreri*, *Lasiodiplodia theobromae*, *Fusarium* species among others (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 treehoppers have been shown to cause 40% cherelle wilt (Bartolome, 1954).Other factors such as hormonal influence and deficiency of certain essential nutrient elements such as potassium, nitrogen, calcium, magnesium, copper, manganese, zinc and boron coincide 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:

A. Pathology

As a result of the complaint of cacao farmers that reached the Institute in 2017, were the farmers reported continuous heavy losses to cherelle wilt since 2014 year with the year of report of incidence witnessing the highest, a team of scientists from the Institute from various disciplines was setup and assigned with the responsibility of ascertaining possible remote causesand management options available to proffer to the farmers.

In carrying out the task, the team decided to survey the cocoa producing areas of Nigeria. In conducting the survey,stratify sampling method was used to divided the cocoa-producing states in the country into 3 cacao producing agro-ecological zones and from each zone, a state(s) with high cherelle wilt mortality according to previous reports and findings of preliminary study conducted was randomly selected. This resulted in the selection of Ondo state in the West, Abia state in the South East, Cross River state in the South-South. Other states such as Oyo and Osun state from the West and Akwa Ibom from the South-South were later added due to further complain and pressure from these states. However, due to limiting fund, the South-South states and Oyo could not be covered.

In the states covered, three local government areas (LGAs) were selected starting with the local government with the highest production, the one following and the third one with marginal

production. Within these LGAs, three cocoa farming communities per LGA and a cocoa farmer's farm per community were randomly selected and surveyed.

Furthermore, per farm visited, three cacao trees were selected. Soil samples were collected at different depths around the rhizosphere of the cacao stand and three spots farther from the stand but within the canopy. Leaves and diseased sample cherelle were also collected from the cacao plant and put in Ziploc plastic bags and labelled properly. Insect's pest was 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 selected (disease severity index), status of farm (clean, 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 insects pest and disease problems.

Questionnaires were further distributed to 20-25 farmers per community to obtained further information on type, period and method of pesticides, herbicides and fertilizer application. How and where chemicals use by the farmers was acquired were other information obtained.

Analysis of diseased cherelle samples from the states surveyed:

The diseased cherelle 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 litre: 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 were 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 the total number of pods (both healthy and disease) then multiply by 100

B. Entomology

Diagnostic survey of insect pests on cherelles was conducted in different locations. In each farm, ten trees with healthy cherelles and cherelle wilt were randomly sampled. The sampling period was for 3 hours on each farm and records spanned from morning to evening. The plants on each plot were searched visually and the insects on the plants were counted. A representative sample of each insect species was collected and taken to the insect museum, CRIN, Ibadan for proper identification. Materials used for collecting insect samples included sweep nets for flying insects, pair of forceps and hand picking for larvae and slow moving insects. They were deposited into glass vials labelled with the following information. Damage symptoms were also noted. Meteorological parameters (temperature, humidity and rainfall) were collected.

C. Soil

(a): Study Area:

The study areas covers three farms (Mokore in Orile – Owu LGA, Ita Apa in Atakunmosa LGA and Orisumbare in Obokun LGA of Osun state; Ondo East, Ago store in Akure South and Alade - Idanre in Idanre LGA of Ondo state and three cocoa producing local governments areas (Umuohia North, Ikwano and Bende) in Abia state respectively.

(b): Soil and Leaf Samples collection:

Cocoa Farms were demarcated into three plots. From each of the plot, three augering points were located where soils samples were collected at 0 – 15; 15 – 30 and 30 – 45cm, the samples collected were labelled accordingly. These procedures were repeated throughout the selected farms. Altogether, twenty- seven soil samples were collected per plot, these were later bulked into nine (9) samples per location, the same procedure were repeated across three farms per local government.

Leaf samples were collected from the fourth leaf round the cocoa tree where soil samples were collected, the number of leaf samples collected were the same as the number of soil samples respectively.

(c): Pre soil and Laboratory Analysis:

Soil samples collected were air dried, sieved using 2mm sieve and subjected to physical and chemical analysis. Mechanical analysis was done using hydrometer method as described by Bouyoucos (1951), pH was determined in water (1:2 Soil : Water ratio) using a pH meter with glass electrode as described by Jackson (1965).Total Nitrogen (N) using Micro Kjedahl procedure as described by AOAC, (1990). Organic carbon content was determined using the Walkley – Black method (Nelson and Somers, 1982), available Phosphorus determination was done by the Bray method described by Bray and Kurtz (1945). Exchangeable K, Ca, Mg and Na were determined by extraction with 1N ammonium acetate and the amount of K, Ca, Na in the filtrate were determined using a Perkin Elmer Atomic Absorption Spectrophotometer (AAS).

Micro – nutrients – Cu, Fe, Zn and Mn were determined after extraction of the soil samples with 0.1 NH_4Cl and the filtrate read on AAS. Exchangeable acidity was determined by soil extraction with 1N KCl and titration with 0.05N NaOH using phenolphthalein indicator as outlined in IITA laboratory manual, (1979).The effective cation exchange capacity (ECEC) of the soil samples was determined by summation of exchangeable bases (Ca, Mg, K, Na) and the total exchangeable acidity. All the sampling points are geo referenced. Leaf Samples were equally prepared for laboratory analysis following standard method as outlined in the IITA Laboratory manual of 1979.

Data Analysis

Data were analyzed with the SPSS Version 18. The parameter analyzed include: Mean and SEM. Means were separated with Duncan Multiple Range Test (DMRT). The incidence of cherelle wilt was correlated with insect pests using multiple regression analyses.

Results

A. Pathology:

Table 1, shows percentage disease severity index obtained per state surveyed and frequency of occurrence of organisms as shown by the percentage colony count.

The percentage disease severity index indicates that Ondo state has 94.23% followed by Abia with 73.35%, Table 1. Frequency of isolation showed that *Lasiodiplodia* spp had the highest percentage occurrence of 64.4%, 56.0% and 49.6% in Ondo, Abia and Osun state respectively, while *Fusarium* spp with 51.8, 50.3 and 46.3 respectively, followed, Table 1.

Pathogenicity test conducted of the fungal isolates implicated *Lasiodiplodia* spp and *Fusarium* spp.

Results of molecular identification from CABI, identified, *Lasiodiplodia* spp, *Fusarium* spp-(*Fusarium solani* species complex, *Fusarium decemcellulare*), *Aspergillus* section *nigiri*,*Colletotrichumgloeosporioides*,*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 hosts.

B. Entomology

The insect pests observed on the wilted cherelles were sucking insect pests, termites, psyllid and pod miner. A positive and significant correlation coefficient (r= 0.743) was observed between sucking insect pests and the incidence of cherelle wilt. The correlation between the cherelle wilt and termite (r = 0.260) and psyllids (r= 0.146) were positive but not significant. There was a negative and non-significant relationship with pod miner (Table 2). The regression model was significant (R^2= 0.557, F (4,29) = 9.122), implying that all the insect pests observed which

constituted the predictor variable together contributed to the cherelle wilt condition. However, based on individual contribution towards the cherelle wilt condition, it was only the sucking insect pests that contributed significantly to the cherelle wilt compared to other insect pests encountered. The predictor variables also accounted for 55.7 % of the incidence of the cocoa cherelle wilt. A significant regression equation obtained for the sucking insect pests was b= 0.742, t=5.510, p<0.01.

C. Soils

Table 1 presents the results of soil samples collected from farmer's farm at Mokore in Orile – Owu Local government area, Osun state. The result indicated that the soils in these areas are loamy in nature, the soil pH in these areas are slightly acidic with the values ranging from 6.5 to 6.7 at the 0 – 15cm depths; 6.52 to 6.70 at 15 to 30cm depths and 6.2 to 6.75 at 30 to 45cm depths respectively. This observation agrees with earlier result of Akanbi, *et al.,* (2012). Generally, the acidic nature of the soil could be attributed to high rainfall of the two zones which may have leached out the basic cations from the soil surface in the study areas. However, the values fall within the range of 4.5 – 6.5 considered suitable for sustainable Cocoa production in Nigeria (Egbe *et al.,* 1989)**.** The organic carbon contents of the various sites selected at Mokore, Osun state were found to be soil inadequate compared to the critical level required for cocoa production. The organic matter ranged from 10.22 – 11.60gkg^{-1} soil; 10.77 – 11.77 and 10.22 – 1.70gkg^{-1} soil at 0 – 15, 15 - 30 and 30 – 45cm depths respectively. Similar trends were observed Atakumosa East and Orisunbare, Obokun Local Government area of Osun state with organic matter found at the top layer ranging from 10.02 – 11.06 at Atakumosa and from 10.80 – 12.70gkg^{-1} soil respectively. The OC at the deeper depths were equally found to be low, an indication that the sites require good agricultural practises that can enhanced the organic matter accumulation of the fields (Table 2 and 3). This on the other hand, might be the cause for the yellowing of both cocoa leaves and dropping of the young cherrelles in the plantations under study. The values of total N (0.08; 0.07 & 0.08mgkg^{-1}) at 0 – 15cm depths; (0.08; 0.07 & 0.06gkg^{-1}) recorded at the depths of between 15 and 30cm and OC values of (0.09; 0.07 & 0.08gkg^{-1}) found at 30 – 45cm depths (Tables 1, 2 and 3) fall below the critical value of 30gkg^{-1} soil recommended for optimum cocoa production in Nigeria. Apart from the Magnesium (Mg) contents which are adequate in all the sites visited in Osun state compared to the critical Mg value of 0.8cmolkg^{-1} soil, exchangeable cations (Ca^{2+} K^{+} and Na^{+}) and available P (Tables 1, 2 & 3) however, are grossly inadequate since they contained lower value with respects to the critical levels (50 and 0.30cmolkg^{-1} soil) calculated for sustainable cocoa production.

Tables 4, 5 and 6 present the results of analysis of soil samples collected from farmer's farm at Akure south, Ondo East and Idanre Local government area of Ondo state. The results indicated that the soils in these areas are loamy in nature with underlying clay content, good enough to support sustainable cocoa production.

The soil pH in these areas are generally slightly acidic with the average values ranging from 6.00 to 6.3.00; 6.00 to 6.40 and 5.90 to 6.45 at the 0 –15, 15 – 30 and 30 - 45cm depths in the three farm locations visited in Ondo - East Local government area of Ondo state respectively. This range is ideal for sustainable cocoa production and agrees with earlier observation result of Akanbi, *et al.,* (2012). Generally, the slightly acidic nature of the soil could be attributed to high rainfall of these zones which may have leached out the basic cations from the soil surface in the study areas. However, these values fall within the range of 4.5 – 6.5 considered suitable for sustainable Cocoa production in Nigeria (Egbe *et al.,* 1989). Similar observations were recorded at Idanre and Akure South Local government areas of the state. The pH ranged from 6.2 – 6.4; 6.20 – 6.60 and 6.50 – 7.00 across the three selected farms in the local government areas.

The OC on the other hand, ranged from 7.9 – 8.96; 7.90 9.68 and 9.50 – 10.50g/kg soil respectively while the pH values range from 6.30 – 6.50; 6.10 – 6.40 and 6.30 – 6.50 and OC are found to range from 8.70 – 9.75g/kg soil in the first farm, 8.70 – 8.75 and 9.68 – 9.84g/kg soil in second and third farms at Akure South local government area of the state.The organic carbon contents of the various sites selected in Ondo - East were equally found to be grossly inadequate compared to the critical level required for cocoa production. The organic matter ranged between 7.10 - 7.18; 8.75 – 9.68 and 7.72 – 9.07gkg^{-1} soil at 0 – 15, 15 - 30 and 30 – 45cm depths respectively. The OC across the depths were generally low, a condition which may influence the performance of the plantations to full capacity (Table 4). This trend was the same in all the farms visited in other two local government areas (Tables 5 and 6). The OC were far below the critical level of 30.00g/kg soil required for optimal growth performance of cocoa. The low OC contents might be the one of the reasons for the yellowing of cocoa leaves and dropping of the young cocoa pods (cherrelles) in the plantations under study.

The total N varied from 0.01 – 0.06%; 0.05 – 0.08%% and 0.04 – 0.07% at the three farmers' farms visited in Ondo East while the values of soil N varied from 0.07 – 0.09% at the first location; 0.06 – 0.08 at the second farmer's farm and 0.17 – 0.20% on the third farm (Table 4) selected in Idanre local government areas. Generally, N is deficient in all the farms selected in Idanre local government area, this might be as a result of ageing farms and continuous mining of nutrients through harvesting of cocoa pods year in year out without returning same back into plantations either through mineral or organic fertilizer. Although, there are heap layers of dry cocoa leaf litter falls found everywhere in the plantations which are still under process of decomposition. Nitrogen is responsible for the green colouration in plants, the lack of it leads to yellowness of leaves in flowering plants. Therefore, its short supply in these farms may perhaps be the reason for the yellowish nature of Cherelles and consequently premature abortion of the Cherelles.

Similarly, the Magnesium (Mg); Calcium (Ca) and Potassium (K) contents found in all the farmer's farm visited in Idanre, Akure East and Akure South (Tables 4, 5 and 6) Local

government areas of Ondo state were low compared to the critical levels of 0.8; 50.0 and 0.30cmolkg^{-1} soil calculated for sustainable cocoa production in Nigeria (Egbe *et al.,* 1989). Summarily, the soils in these areas were generally low in native nutrients; this might be due to years of usage coupled with continued mining of nutrients through pod harvesting without necessarily applying fertilizer to replace the mined nutrient elements. This on the other hand might not be unconnected to the cherrelles wilt (Yellow Okro) experienced in these areas.

Micronutrient Contents:

The micro nutrients are those nutrients that are needed in a small quantity by the crop. At the selected farmer's farms in Idanre (Table 4), the micronutrients (Fe and Zn) contents of the site varied between 0.14 and 0.16g/kg soil Fe in the first farm visited, the value recorded at the second locations ranged between 0.14 and 0.17g/kg soil Fe while that of the third farm varied from 0.12 to 0 0.1glkg soil Fe respectively within the site. The values of Zn recorded from all the locations ranged from 0.17 - 0.19; 0.20 – 0.23 and 0.06 – 0.10g/kg soil Zn. The farms at Akure East (Table 5) recorded a similar results of 0.14 0.16; 0.16 – 0.18 and 0.15 – 0.20g/kg soil Fe, 0.19 – 0.21; 0.18 0.19 and 0.18 – 0.21g/kg soil Zn respectively. Similarly, the values recorded at Akure South (Table 6) ranged between 0.16 – 0.18; 0.16 – 0.17 and 0.16 – 0.19g//kg soil Fe, 0.09 – 0.20; 0.18 – 0.22 and 0.21 – 0.22g/kg soil Zn at 0 – 15cm; 15 – 30 cm and 30 – 45 cm respectively.

Abia State

The results from Abia State are presented on Tables 7, 8 and 9 below. The results of Soil samples collected at various farm locations at Umuoha, Bende and Ikwano Local Government areas revealed that the soils are slightly acidic with the pH values within the ideal recommended for cocoa cultivation in Nigeria.

The Soil N recorded in all the farm locations at Umuoha. Ikwano and Bende Local Government areas are moderately adequate for the good growth of cocoa but the values are much lower in some locations. The total N varied from 0.01 – 0.09%; 0.10 – 0.12%% and 0.07 – 0.10% at Umuoha, the values decreased with depths (Table 7). At Ikwano, the values of soil N varied from 0.09 – 0.14%; 0.10 – 0.13 and 0.06 - 0.07% at 0 – 15, 15 – 30 and 30 – 45cm depths respectively (Table 8). Similar trend was recorded at farm locations at Bende Local Government areas (Table 9).

The organic carbons (OC) across the depths in all the farm locations were generally low and below the critical value of 30%. The organic carbon recorded across the farms at Umuoha Local Government areas ranged from 12. 60 – 12.64; 11.40 – 11.86 and 10.60 – 10.64gkg^{-1} soil at 0 – 15, 15 - 30 and 30 – 45cm depths (Table 7), at Ikwano Local Government Area, the organic carbon varied from 10.00 – 10.92; 12.00 – 12.40 and 8.05 – 8.16g/kg soil (Table 8). Also the farmer's farms selected across Bende Local Government areas recorded OC values which ranged

from 7.80g/kg soil; 8.50 – 9.12g/kg soil and 11.82 12.00g/kg soil (Table 9). These values fall below the required amount for optimum cocoa production.

The Magnesium (Mg) contents was low in Umuoha, adequate Ikwano and Bende Local Government areas (Tables 7,8 and 9); Calcium (Ca) contents were found to be limiting in all the farms visited in the three local government areas. Potassium (K) contents on the other hand were adequate in the entire farmer's farm visited in Umuoha, Ikwan and Bende Local Government areas (Tables 7, 8 and 9) of Abia State. The short supply of these major and essential nutrients elements on the other hand might be the main cause of yellow Okro (Cherrelles wilt) which cause dropping young cocoa pods Cherrelles experienced in these areas.

Observations:

The following are the general observations in the course of our visit to the various locations selected in the three states for sample collections.

1: Many of the Cocoa plantations visited were old,

2: The plantations were planted without following recommended spacing; most of the cocoa plots were over populated with touching or inter locking branches.

3: Poor shade regime of most of the farms visited were also noticed, this may enhance the build-up high humidity

4: There was no history of fertilizer usage in all the farm location visited across the states.

Conclusion/Recommendations

The high disease severity index from the states surveyed shows that cherelle wilt could be exacerbated by pathogenic organisms aided by some soil factor, management practices and prevailing climatic condition of the area involved. Sucking insect pests of cocoa include mirid, tea mosquito bug, shield bug among others. The study has demonstrated that these sucking insect pests are significant predictors of cherelle wilt. These sucking insect pests which feed extensively on cocoa pods might contribute to the wilting condition through the toxic effect of their saliva or by lowering resistance of pods to wilting. In order to address the wilt condition of young pods, an in-depth study on the role of these pests is be conducted.

The low level of major soil nutrients required by the cocoa plant to perform optimally might trigger the physiological disorder in the plant thereby leading to the physical expression of cherelles wilt expressed by the cocoa plants across the study areas. This disorder may be expressed in the leaves and even on the young forming pods inform of yellowness of the leaves or the young cocoa pods which might result to premature abortion.

Based on the preliminary results of the soil analysis and the general observations of the farmer's farms in these locations, it is therefore recommended that fund be made available to run the Laboratory analysis of the leaf samples collected from the various farm locations for a more and better understanding of the scenario.
Also, training on good agricultural practices, most especially in the area of soil nutrient management, Disease and Pest management be organized across study areas.
Challenges: Fund limitation and difficult terrain of areas surveyed

Status: On-going

Future Plans: Conclusion of survey of listed states and field trials of fungicides on fungal isolates in three cocoa agro ecological zones to proffer management options for the control of cherelle wilt disease. The final stage will be book publication and teaching farmers and stakeholder's best and cost effective management options available

Table 1. Percentage Disease severity index and frequency of isolation of fungal isolates

State Surveyed	% Disease severity index	% frequency of fungi isolated from infected cherelle pods														
		Lasiodiplodia spp	*Aspergillus niger*	*Fusarium* species	*Rhizopus nigricans*	*Trichoderma* spp	*Colletotrichum*	*Botrytis* spp	*Aspergillus* spp	*Pythium* spp	*Curvularia* spp	*Penicillium* spp	Yeast	Streptomyces	*FusariumOxysporium*	*Neurospora* spp
Abia	72.35	26.10	2.90	10.14	-	-	-	-	-	5.80	-	4.35	31.88	10.14	-	2.90
Osun	68.16	29.41	22.05	14.70	2.10	7.11	9.01	-	2.34	14.70	-	1.47	7.35	-	1.47	-
Ondo	94.23	19.4	4.47	0.05	20.63	1.58	11.11	25.9	3.17	1.58	9.52	1.58	-	-	26.98	-

Table 2: Relationship between the Incidence of Cherelle wilt and Insect Pests of Cocoa

Insect Pests	Correlation coefficient (r)	Regression equation
Sucking insect pests	0.743*	Y= 0.271+0.742x
Termites	0.260	Y= 0.271 - 0.013x
Psyllids	0.146	Y= 0.271 - 0.013x
Pod miner	-0.045	Y= 0.271 - 0.142x

*Correlation is significant at $p<0.05$

Table 1: Results of soil samples collected from farmer's farm at Mokore in Orile – Owu Local government area, Osun state.

	Farm 1			Farm 2			Farm 3		
Soil Properties	**0 -15cm**	**15 – 30cm**	**30 – 45cm**	**0 – 15cm**	**15 – 30cm**	**30 – 45cm**	**0 – 15cm**	**15 – 30cm**	**30 – 45cm**
pH	6.70	6.60	6.75	6.70	6.60	6.20	6.50	6.52	6.72
Na $cmolkg^{-1}$	0.58	0.56	0.64	0.64	0.62	0.62	0.60	0.63	0.68
K $cmolkg^{-1}$	0.12	0.26	0.08	0.17	0.05	0.27	0.21	0.16	0.09
Ca $cmolkg^{-1}$	0.27	0.25	0.38	0.37	0.31	0.30	0.33	0.32	0.35
mg $cmolkg^{-1}$	1.24	1.26	1.37	1.35	1.41	1.46	1.51	1.50	1.70
H^+	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.084	0.07
Av. P($mgkg^{-1}$)	8.70	8.74	9.40	9.46	8.96	8.94	8.86	8.88	9.12
OC(gkg^{-1})	10.7	10.77	11.24	11.32	11.5	11.7	11.6	11.72	10.22
TN($mgkg^{-1}$)	0.08	0.07	0.06	0.08	0.07	0.06	0.09	0.07	0.08
Fe ($mgkg^{-1}$)	1.64	1.62	1.58	1`.56	1.7	1.72	1.88	1.86	1.84
Zn ($mgkg^{-1}$)	1.82	1.8	1.72	1.7	1.94	1.96	1.97	1.94	1.96
CEC	2.91	2.87	3.40	3.39	3.29	3.35	3.36	3.36	4.14
% Base Saturation	97.43	93.39	97.85	97.79	97.57	97.61	97.47	97.5	98.21
% Silt	86.4	8.6.42	80.2	80.32	82.6	82.7	78.4	78.6	88.4
% sand	10.1	10.14	14.2	14.25	12.6	12.8	20.1	20.14	10.4
% clay	3.5	3.44	5.6	5.43	4.8	4.5	1.5	1.26	1.2

Table 2: Results of soil samples collected from farmer's farm at Atakunmosa Local government East, Ita Apa in Osun state

	Farm 1			Farm 2			Farm 3		
Soil Properties	0 -15cm	15 – 30cm	30 – 45cm	0 – 15cm	15 – 30cm	30 – 45cm	0 – 15cm	15 – 30cm	30 – 45cm
pH	6.1	6.3	6.26	6.3	6.2	6.1	6.4	6.12	6.02
Na $cmolkg^{-1}$	0.46	0.42	0.50	0.44	0.32	0.51	0.6	0.5	0.48
K $cmolkg^{-1}$	0.55	0.62	0.88	0.75	0.77	0.76	0.80	0.78	0.94
Ca $cmolkg^{-1}$	0.22	0.20	0.33	0.32	0.29	0.20	0.21	0.28	0.29
mg $cmolkg^{-1}$	1.00	0.76	1.00	1.11	1.03	0.96	0.81	0.9	0.8
H^+	0.06	0.05	0.07	0.06	0.07	0.07	0.07	0.08	0.07
Av. P($mgkg^{-1}$)	7.36	8.00	7.60	7.65	7.80	7.17	7.20	7.78	7.21
OC(gkg^{-1})	11.02	11.00	10.01	10.02	10.23	10.61	10.13	10.32	12.50
%TN	0.07	0.03	0.94	0.09	0.08	0.09	0.08	0.08	0.04
Fe ($mgkg^{-1}$)	0.44	0.92	1.01	0`.96	0.82	1.60	1.21	1.06	0.24
Zn ($mgkg^{-1}$)	1.11	0.90	1.00	1.11	1.21	1.00	1.17	1.31	1.01
% Silt	85.6	81.46	81.3	85.35	83.5	81.9	76.4	79.4	87.4
% sand	11.1	15.10	14.0	10.25	11.7	12.5	21.1	19.34	11.4
% clay	3.3	3.44	6.7	4.40	4.8	5.6	2.5	1.26	1.2

Table 3: Results of soil samples collected from farmer's farm at Orisunbare in Obokun Local government area, in Osun state

	Farm 1			Farm 2			Farm 3		
Soil Properties	0 -15cm	15 – 30cm	30 – 45cm	0 – 15cm	15 – 30cm	30 – 45cm	0 – 15cm	15 – 30cm	30 – 45cm
pH	6.01	5.90	6.45	6.23	6.56	6.26	6.45	6.62	6.52
Na $cmolkg^{-1}$	0.50	0.51	0.54	0.60	0.52	0.72	0.70	0.66	0.61
K $cmolkg^{-1}$	0.68	0.65	0.80	0.75	0.83	0.91	0.74	0.86	0.69
Ca $cmolkg^{-1}$	0.12	0.21	0.34	0.33	0.31	0.3	0.32	0.29	0.30
mg $cmolkg^{-1}$	0.64	0.96	0.87	1.00	0.92	0.60	0.81	0.90	1.10
H^+	0.08	0.06	0.05	0.08	0.06	0.05	0.07	0.06	0.08
Av. P($mgkg^{-1}$)	7.6	7.84	8.80	8.56	8.46	8.07	8.74	7.68	8.12
OC(gkg^{-1})	12.7	11.57	14.14	10.80	14.53	10.87	12.63	13.72	20.85
TN(gkg^{-1})	0.08	0.76	0.08	0.10	0.05	0.07	0.80	0.06	0.04
Fe ($mgkg^{-1}$)	0.64	0.52	0.51	0`.57	0.78	0.92	1.53	1.25	1.04
Zn ($mgkg^{-1}$)	0.62	0.90	0.61	0.97	0.86	0.97	0.99	0.90	1.05
% Silt	83.4	80.32	82.4	83.42	83.6	81.4	75.4	80.6	86.5
% sand	12.1	16.24	12.2	11.15	10.4	13.8	22.1	18.15	12.3
% clay	4.5	3.44	5.4	5.43	7.0	4.8	2.5	1.25	1.2

Table 4: Results of soil samples collected from farmer's farm at Ondo East Local Govern Area of Ondo State.

	Farm 1			Farm 2			Farm 3		
Soil Properties	**0 -15cm**	**15 – 30cm**	**30 – 45cm**	**0 – 15cm**	**15 – 30cm**	**30 – 45cm**	**0 – 15cm**	**15 – 30cm**	**30 – 45cm**
pH	6.30	6.20	6.00	6.40	6.10	6.00	6.01	5.90	6.45
Na $cmolkg^{-1}$	0.37	0.36	0.30	0.38	0.37	0.35	0.29	0.27	0.26
K $cmolkg^{-1}$	0.41	0.50	0.49	0.56	0.50	0.49	0.51	0.45	0.41
Ca $cmolkg^{-1}$	0.28	0.27	0.25	0.28	0.27	0.23	0.30	0.28	0.29
Mg $cmolkg^{-1}$	0.18	0.18	0.09	0.21	0.20	0.18	0.06	0.04	0.01
H^+	0.09	0.10	0.07	0.09	0.08	0.07	0.07	0.05	0.06
Av. P($mgkg^{-1}$)	6.64	6.62	6.00	6.94	6.91	5.90	7.07	6.74	6.08
OC(gkg^{-1})	7.80	7.81	7.10	9.68	8.75	8.50	9.07	8.03	7.72
TN (%)	0.06	0.03	0.01	0.08	0.07	0.05	0.07	0.05	0.04
Fe ($mgkg^{-1}$)	0.14	0.16	0.15	0.16	0.17	0.14	0.12	1.10	1.00
Zn ($mgkg^{-1}$)	0.18	0.19	0.17	0.23	0.20	0.20	0.11	0.09	0.06
CEC	1.42	1.40	1.38	1.52	1.50	1.49	1.46	1.40	1.60
% Base Saturation	**93.29**	**92.91**	**90.68**	**94.08**	**94.00**	93.06	96.05	94.20	93.60
% Silt	62.20	70.20	64.20	75.20	65.20	61.80	81.9	75.4	89.40
% sand	36.20	28.20	25.20	13.20	33.20	36.20	12.5	11.1	19.34
% clay	1.60	1.60	10.60	2.60	1.60	2.00	5.6	2.5	1.26

Table 5: Results of soil samples collected from farmer's farm at Idanre Local Government Area of Ondo State.

	Farm 1			Farm 2			Farm 3		
Soil Properties	**0 -15cm**	**15 – 30cm**	**30 – 45cm**	**0 – 15cm**	**15 – 30cm**	**30 – 45cm**	**0 – 15cm**	**15 – 30cm**	**30 – 45cm**
pH (H_2O)	6.45	6.40	6.20	6.60	6.50	6.20	7.00	6.90	6.50
Na cmolkg^{-1}	0.41	0.40	0.40	0.46	0.45	0.42	0.52	0.50	0.47
K cmolkg^{-1}	0.60	0.58	0.54	0.62	0.60	0.59	0.71	0.65	0.60
Ca cmolkg^{-1}	0.32	0.31	0.30	0.32	0.31	0.30	0.45	0.41	0.40
Mg cmolkg^{-1}	0.19	0.18	0.16	0.26	0.24	0.22	0.46	0.40	0.50
H^+	0.09	0.85	0.80	0.08	0.75	0.70	0.06	0.05	0.04
Av. P(mgkg^{-1})	7.86	7.82	7.50	8.00	7.82	7.80	7.50	7.20	7.00
OC(%)	8.96	8.94	7.90	9.68	9.67	8.80	10.50	10.50	9.60
TN%)	0.09	0.08	0.07	0.08	0.07	0.06	0.06	0.05	0.04
Fe (mgkg^{-1})	0.16	0.16	0.14	0.18	0.16	0.17	0.20	0.18	0.15
Zn (mgkg^{-1})	0.21	0.20	0.19	0.19	0.18	0.17	0.21	0.20	0.18
CEC	1.60	1.58	1.54	1.75	1.65	1.60	1.80	1.70	1.65
% Base Saturation	94.38	94.30	93.80	95.24	94.80	93.46	97.24	96.50	94.70
% Silt	60.00	61.80	70.20	77.20	76.20	80.90	80.20	72.20	85.90
% sand	31.00	28.20	25.00	21.40	21.10	20.10	18.40	25.40	10.10
% clay	9.00	10.00	4.80	1.40	2.70	9.00	1.40	2.40	4.00

Table 6: Results of soil samples collected from farmer's farm at Akure South Local Government Area of Ondo State

	Farm 1			Farm 2			Farm 3		
Soil Properties	**0 -15cm**	**15 – 30cm**	**30 – 45cm**	**0 – 15cm**	**15 – 30cm**	**30 – 45cm**	**0 – 15cm**	**15 – 30cm**	**30 – 45cm**
pH	6.50	6.40	6.30	6.20	6.10	6.40	6.50	6.40	6.30
Na cmolkg^{-1}	0.45	0.44	0.39	0.38	0.37	0.35	0.48	0.46	0.44
K cmolkg^{-1}	0.63	0.61	0.60	0.52	0.50	0.51	0.61	0.60	0.60
Ca cmolkg^{-1}	0.32	0.31	0.30	0.27	0.25	0.23	0.33	0.32	0.30
Mg cmolkg^{-1}	0.21	0.20	0.19	0.17	0.16	0.15	0.24	0.23	0.21
H^+	0.08	0.08	0.08	0.10	0.10	0.08	0.10	0.08	0.09
Av. P(mgkg^{-1})	6.96	6.94	6.75	6.78	6.75	6.72	7.90	7.48	7.30
OC (%)	9.75	9.72	8.70	8.75	8.72	8.70	9.84	9.80	9.68
TN (%)	0.09	0.08	0.07	0.07	0.06	0.06	0.10	0.09	0.07
Fe (mgkg^{-1})	0.18	0.18	0.16	0.17	0.16	0.16	0.19	0.17	0.16
Zn (mgkg^{-1})	0.20	0.09	0.17	0.19	0.18	0.22	0.22	0.22	0.21
CEC	1.68	1.44	1.39	1.44	1.39	1.30	1.74	1.72	1.70
% Base Saturation	96.93	94.93	92.82	93.06	92.10	92.00	96.10	95.46	93.60
% Silt	62.20	69.40	70.80	63.20	62.80	61.00	69.40	69.20	69.00
% sand	27.20	29.40	29.20	21.60	27.20	27.69	26.60	27.20	20.20
% clay	1.60	11.20	10.00	15.20	10.00	11.31	15.00	13.60	10.80

Table 7: Results of soil samples collected from farmer's farm at Umuoha North Local Government Area of Abia State

	Farm 1			**Farm 2**			**Farm 3**		
Soil Properties	**0 -15cm**	**15 – 30cm**	**30 – 45cm**	**0 – 15cm**	**15 – 30cm**	**30 – 45cm**	**0 – 15cm**	**15 – 30cm**	**30 – 45cm**
pH	6.60	6.20	6.00	6.50	6.10	6.00	6.65	6.60	6.45
Na $cmolkg^{-1}$	0.51	0.50	0.48	0.49	0.48	0.46	0.47	0.46	0.42
K $cmolkg^{-1}$	0.73	0.72	0.64	0.68	0.63	0.60	0.64	0.62	0.60
Ca $cmolkg^{-1}$	0.35	0.34	0.32	0.32	0.30	0.29	0.35	0.34	0.32
Mg $cmolkg^{-1}$	1.22	1.20	1.15	0.24	0.22	0.20	0.26	0.22	0.24
H^+	0.08	0.08	0.07	0.85	0.83	0.80	0.08	0.07	0.65
Av. P($mgkg^{-1}$)	8.46	8.44	8.40	8.94	8.74	8.68	7.52	7.50	7.50
OC (%)	12.64	12.62	12.60	11.86	11.40	10.90	10.64	10.62	10.60
TN (%)	0.14	0.12	0.09	0.12	0.11	0.10	0.10	0.08	0.07
Fe ($mgkg^{-1}$)	0.25	0.20	0.20	0.19	0.16	0.13	0.16	0.15	0.13
Zn ($mgkg^{-1}$)	2.89	2.80	2.50	0.26	0.24	0.22	0.22	0.20	0.19
CEC	1.80	1.78	1.70	1.80	1.79	1.68	1.79	1.75	1.70
% Base Saturation	95.53	95.48	93.90	95.26	95.24	95.00	97.00	95.50	93.56
% Silt	73.20	71.20	68.80	69.00	68.20	68.00	76.40	71.40	68.80
% sand	25.20	27.40	29.00	20.00	20.20	21.40	20.00	21.00	20.10
% clay	1.60	1.40	2.20	11.00	11.60	1.60	3.60	7.60	11.10

Table 8: Results of soil samples collected from farmer's farm at Ikwano Local Government Area of Abia State.

	Farm 1			Farm 2			Farm 3		
Soil Properties	**0 -15cm**	**15 – 30cm**	**30 – 45cm**	**0 – 15cm**	**15 – 30cm**	**30 – 45cm**	**0 – 15cm**	**15 – 30cm**	**30 – 45cm**
pH	6.62	6.60	6.00	6.60	6.20	6.00	6.50	6.20	6.00
Na $cmolkg^{-1}$	0.48	0.46	0.42	0.52	0.50	0.49	0.54	0.50	0.48
K $cmolkg^{-1}$	0.68	0.66	0.60	0.64	0.62	0.60	0.71	0.70	0.68
Ca $cmolkg^{-1}$	0.33	0.32	0.30	0.34	0.30	0.29	0.38	0.36	0.32
Mg $cmolkg^{-1}$	1.14	1.11	1.10	1.12	1.10	1.10	1.10	1.01	1.00
H^+	0.78	0.70	0.67	0.08	0.07	0.06	0.14	0.13	0.11
Av. P($mgkg^{-1}$)	7.88	7.86	7.40	8.60	8.40	8.20	6.55	6.37	6.25
OC(gkg^{-1})	10.92	10.90	10.80	12.40	12.20	12.00	8.16	8.12	8.05
TN($mgkg^{-1}$)	0.12	0.10	0.09	0.13	0.12	0.10	0.07	0.07	0.06
Fe ($mgkg^{-1}$)	0.18	0.15	0.13	0.21	0.20	0.18	0.24	0.22	0.21
Zn ($mgkg^{-1}$)	0.24	0.22	0.20	0.23	0.20	0.19	0.28	0.25	0.22
CEC	2.70	2.69	2.52	2.74	2.68	2.65	2.87	2.77	2.68
% Base Saturation	98.04	97.02	93.52	97.08	95.00	93.03	95.67	95.26	92.70
% Silt	68.21	68.10	63.24	71.20	68.60	67.70	73.20	72.60	71.20
% sand	31.20	21.50	33.56	28.20	28.20	30.00	26.40	27.10	28.20
% clay	1.60	1.40	3.20	0.60	3.20	2.30	0.40	0.30	0.60

Table 9: Results of soil samples collected from farmer's farm at Bende Local Government Area of Abia State.

	Farm 1			Farm 2			Farm 3		
Soil Properties	**0 -15cm**	**15 – 30cm**	**30 – 45cm**	**0 – 15cm**	**15 – 30cm**	**30 – 45cm**	**0 – 15cm**	**15 – 30cm**	**30 – 45cm**
pH	6.20	5.8	5.9	5.70	5.60	5.20	6.75	6.70	6.20
Na $cmolkg^{-1}$	0.51	0.50	0.49	0.56	0.52	0.51	0.47	0.49	0.51
K $cmolkg^{-1}$	0.35	0.33	0.32	0.38	0.34	0.30	0.61	0.61	0.59
Ca $cmolkg^{-1}$	0.38	0.28	0.33	0.31	0.25	0.21	0.38	0.35	0.32
Mg $cmolkg^{-1}$	1.11	1.10	1.05	1.14	1.12	1.09	0.40	0.50	0.24
H^+	0.14	0.13	0.12	0.14	0.08	0.08	0.07	0.06	0.08
Av. P($mgkg^{-1}$)	6.52	6.50	6.50	6.40	8.00	7.60	9.10	9.00	8.89
OC (%)	8.26	8.16	7.80	11.30	8.50	9.12	12.00	11.82	11.96
TN (%)	0.10	0.08	0.07	0.10	0.09	0.08	0.09	0.07	0.05
Fe ($mgkg^{-1}$)	0.20	0.18	0.14	0.16	0.09	0.20	0.19	0.18	0.17
Zn ($mgkg^{-1}$)	0.27	0.25	0.22	0.24	0.23	0.20	0.20	0.21	0.23
CEC	2.98	2.85	2.81	2.65	2.61	2.58	1.80	1.74	1.50
% Base Saturation	97.20	98.08	96.03	95.60	93.80	92.80	96.00	94.85	95.10
% Silt	73.10	68.40	70.00	76.20	71.10	70.00	67.35	68.30	64.80
% sand	26.60	20.30	27.60	10.60	26.50	29.20	30.00	31.40	35.10
% clay	0.30	11.30	3.40	13.20	3.40	0.80	2.65	0.30	0.10

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Title 2: Growth and Establishment of Cocoa Seedlings under intercrop with plantain at different transplanting positions

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INTRODUCTION

Cocoa (*Theobroma cacao* L.) is a tropical woody species which belongs to the family Malvaceace (Alverson *et al*., 1999). Under natural condition, the tree can attain a height of 20 - 25 m (Lachenaud *et al*., 1997), whereas under cultivation, plant height varies from 3 to 5 m. The geographical origin of cacao is South America (Oluwalade, 2018). It is considered as one of the most important perennial crops with an estimated world output of 4.2 million tonnes in 2018 (ICCO, 2007), while FAO (2011) reported an estimated annual yield of 3.2 million tonnes in 2009. It is cultivated in the Humid tropics of the world (Yanelis *et al.,* 2012) with more than 70% production coming from Africa as source of income for producing countries (Simo *et al*., 2018).Cocoa production is dominated by small-scale farmers who live and work in the cocoa belt providing them employment and income (Minimol *et al*., 2015; Ngoh *et al.,* 2015) Cocoa is the most prominent export crop in Nigeria in terms of its production and export capacities.

Traditionally, cacao farmers in Nigeria established their farms with plantains or other food crops, either sown directly at stake or seedlings are transplanted from the nursery in to the field (La Anyane, 1963; Benneh, 1987; Opeke, 2005). Conventionally, cacao seedlings are planted or transplanted in between the plantain suckers (Owusu-Benpah, 1988). The temporary shade provided by plantain provides direct shade to the cacao seedlings for 2 to 3 years after transplanting. Moreover, despite the provision of shade by plantain for transplanted young cacao seedlings, it is a known fact that the highest percentage of these seedlings die between the first and second dry seasons as a result of soil moisture deficit during the peak of dry seasons (Babadele, 2018). It is also established that plantains that are planted to provide shade during the dry period do shed most of their leaves as a result of limited soil moisture in order to survive (Babadele, 2018). In Nigeria, cocoa production is limited to the rainforest and savanna transition zones. Presently, the level of cocoa production stands at 350,000 tonnes per annum (ICCO, 2015), in spite of the fact that Nigeria is endowed with vast land areas suitable for its cultivation. Adoption of good management practices can bring about increased bean production of up to 100-300% (Famuagun, 2016). According to Famuagun and Agele (2010), the major reason attributed to low productivity despite the huge effort of the government were limited access to modern production technology, limited access to input and credit facilities, low percentage of survival (less than 35%) of transplanted seedlings at the end of the second dry season due to soil moisture stress and poor field management. There are also concerns that the projected global temperature rise and subsequent increase in potential evapo-transpiration and demand for plant water may lead to further drought stress during the dry season and deterioration of cocoa climate condition

(Laderach *et al*, 2013; Schroch *et al.,* 2016). To solve the above mentioned problems, more robust farm management strategies are therefore needed.

Effective management of cacao seedlings on the field using agronomic practices like dry season irrigation and optimum shading regime to enhance root development could improve plantation establishment and cacao productivity. However, research efforts that would ensure cocoa sustainable production at the early stage of establishment are seen as steps in the right direction which remains sacrosanct for the survival of young cocoa in the field and the improvement of farmers' income (Agbongiarhuoyi *et al.,* 2016). Moreover, it is a known fact that cacao cultivation in Nigeria is predominantly in the hand of peasant farmers who cannot afford irrigation facilities. Due to climate change, rainfall and humidity have been on a decline progressively since mid-1970s (Omotosho *et al.*, 2000), while global warming has been on steady increase. Given the increasing global demand for cocoa and quest for obtaining sustainable production systems, it is imperative to understand the effects of some agronomic practices on the responses of cacao seedlings to dry season environmental conditions especially the hydrothermal stresses (Daymond and Hardley,2004). Improved insights would be valuable towards the attainment of optimum seedlings establishment and vigor on the field (Famuagun and Agele, 2019). Much of success of intercrops in cacao establishment depends on understanding the role each component plays in the system: cacao/plantain farming system has been recommended (Manu and Tettel, 1988) but the transplanting arrangement in the face of global warming and climate change is a gap in research.

Objective of the study: To evaluate effect of different planting positions of cacao and plantain on survival and morphological growth of cacao on the field.

MATERIALS AND METHODS

Study area

Field experiment was carried out at the experimental farm of Cocoa Research Institute of Nigeria (CRIN), Uhonmora Station in Edo State between 2018 and 2020 covering two consecutive rainy seasons and two dry seasons. The location, a derived savanna zone of Nigeria, lies on latitude 6'5N and longitude 5'50'E. The rain fall is between 1000 – 1500 mm per annum. The maximum temperature ranges between 26 to 35 ^{0}C with an average of about 30 ^{0}C while minimum temperature ranges from 15 to 25^{0}C with an average of 20 ^{0}C. Relative humidity is high during the raining season, ranges from 50 to 85 % with an average of 75%. There are seasonal variations in the values of relative humidity, which varies from 65 to 89% during the rainy season and 46 – 70 % during the dry season. The rainy season which runs from April to October is characterized by heavy rains, low ambient temperature and high humidity; while the dry season runs from November to March and is characterized by little or no rain, high ambient temperature and very low humidity.

Acquisition and preparation of experimental materials

Seedlings of hybrid CRIN TC genotype were collected from CRIN, Uhonmora nursery, while plantain suckers were collected from experimental plots in the station. Experimental plot of 50 by 30 m was mapped out and the experiment was laid out in rows of 3 x 3 m.

Treatments and experimental design.

The field experiment comprised four treatments (four different transplanting positions of cacao seedlings and plantain suckers):Plantain suckers on top of cacao seedlings at transplanting (PTCT), Cacao seedlings on top of plantain suckers at transplanting (CTPT), and Cacao seedlings transplanted 30 cm (between 2 plantain stands) apart from plantain suckers at transplanting (CT30cmP) and Cacao seedlings transplanted 150 cm (between 2 plantain stands) apart from plantain suckers at transplanting (CT150cmP) as control. The experimentwas laid in Randomized Complete Block Design (RCBD) with three replications. Layout of the experimental site (Measurement, pegging, and holing) was carried out. One hundred and forty-four (144) plantain suckers were planted at 3 x 3m spacing as shade crop. The same number of five months old cacao seedlings (Hybrid) of average height of 50 cm (raised in the nursery) was transplanted on treatment basis. The experiment was monitored for 22 months after transplanting (MAT).

Data collection

Data collected included growth parameters of cacao seedlings (Plant height, Number of leaves, Stem diameter, Leaf area, Number of branches) and their Survival counts. The growth parameters were taken on monthly basis for 22 months commencing from 3 months after transplanting (3MAT).Plant height (cm)was measured using a meter rule from the ground surface to the tip of the main stem. Stem diameter (cm) was measured with Vernier Caliper 30 cm above the ground level. Number of leaves, Number of branches and Survival count were determined by visual count. Leaf area was also measured. The growth parameters were taken monthly for 22 months commencing from 3 MAT. Survival counts were carried out at 10 and 22 MAT

Data collected were subjected to statistical analysis using analysis of variance (ANOVA) as well as descriptive statistics, and significant means were separated by Duncan Multiple Range Test (DMRT) ($P<0.05$)

RESULTS AND DISCUSSION

Effects of transplanting positions of cacao seedlings on survival count are represented in Figure 1.Cacao seedlings on top of plantain suckers at transplanting (CTPT) and Plantain suckers on top of cacao seedlings at transplanting (PTCT) significantly ($P<0.05$) enhanced the survival count of cacao seedlings relative to other treatments at 10 and 22 MAT, while cacao seedlings on top of plantain at transplanting gave the highest survival count in both 10 and 22 MAT (Figure 1). The

highest seedlings survival count recorded in 10 and 22 MAT under Cacao seedlings on top of plantain suckers at transplanting (CTPT) could be as a result of commensalism relationship between the transplanted cacao seedlings on top of the plantain suckers in which both shared the same environment and the cacao benefitted from the water and cooler weather around the biosphere especially during the dry season, yet the plantain was not adversely affected. The relationship is called table fellowship. This result also confirmed that the survival of transplanted cacao seedlings did not depend on the spacing adopted but the arrangement of cacao with the plantain. This result was corroborated by Ayegboyin *et al*.(2020), Famuagun and Agele (2019) who reported that the reduction in stand mortality under moderate and dense shaded plots was traced to improved microclimate conditions occasioned by shade plants that aided reduced air and soil temperature, reduced moisture loss through evaporation and increased activities of microbial organism under shaded microclimate. It was also observed that the same CTPT treatment had the lowest percentage mortality rate of 18% after the end of the first dry season; this was closely followed by PTCT (19%) (Figure 1).

Effect of transplanting position of cacao seedlings on growth parameters of cacao seedlings is presented in tables 1 -5. The CTPT also gave the highest plant height, number of leaves, stem diameter, number of branches and leaf area at 4 MAT, at 15 MAT, at 13, 14, 15 MAT, at 15 MAT and 15 MAT, respectively. When compared with the conventional transplanting of cacao seedlings in between the plantains (CT150cmP), CTPT increased the plant height, number of leaves, stem diameter, number of branches and leaf area at 4 MAT, at15 MAT, at 3, 13, 14, 15 MAT, at 3, 15 MAT and at 13, 14,15 MAT respectively by 1%, 10%, 61%, 2%, 3%, 8%,46%, 11%, 5%, 3% and 13% respectively; while CT150cmP treatment significantly enhanced cacao seedlings, number of leaves, number of branches and leaf area at 4 MAT, 4 and 13 MAT, 3, 4,5 MAT, respectively, when compared with the other treatments. This finding could be due to the fact that the cacao seedlings which could have been suppressed by plantain shade were not directly positioned under the plantain suckers but in between which is 150cm apart. This discovery is in agreement with the reports of Famaye *et al*. (2003) that, due to the competition that exists among them, closely spaced cacao seedlings produced smaller morphological parameters than well-spaced ones. Shipat (2001) as well as Famuagun and Agele (2016) also established that the leaves and circumference of plants are among the main factors that determine the vigour needed for the growth of cacao seedlings after transplanting.

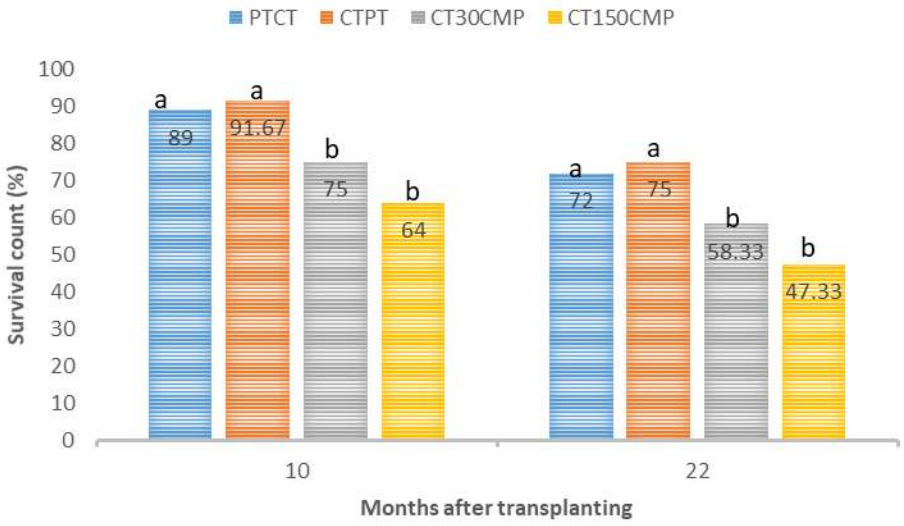

Figure 1: Effect of transplanting positions on survival count (%) of cocoa seedlings

Means followed by the same letters in each composite bars are not significantly different by DMRT (P<0.05)
PTCT: Plantain on top of cacao seedlings at transplanting; CTPT: Cacao on top of plantain at transplanting; CT30cmP: Cacao transplanted 30 cm apart from plantain; CT150cmP;Cacao transplanted 150 cm apart from plantain

Table 1: Effect of transplanting positions on plant height (cm) of cocoa seedlings

Treatments	3 MAT	4 MAT	5 MAT	12 MAT	13 MAT	14 MAT	15 MAT
PTCT	74.33b	98.33c	124.00c	175.67a	179.67a	182.67a	187.00a
CTPT	94.33ab	147.00a	157.67ab	159.33a	173.00a	178.67a	195.33a
CT30cmP	92.00ab	134.00b	146.33b	162.33a	169.67a	182.00a	191.33a
CT150cmP	112.67a	145.67a	164.67a	177.00a	179.67a	186.67a	200.67a
Mean	93.33	131.25	148.17	168.58	175.50	182.50	193.58

Means followed by the same letters along each column are not significantly different by DMRT (P<0.05)
PTCT: Plantain on top of cacao seedlings at transplanting; CTPT: Cacao on top of plantain at transplanting; CT30cmP: Cacao transplanted 30 cm apart from plantain; CT150cmP; Cacao transplanted 150 cm apart from plantain

Table 2: Effect of transplanting positions on number of leavesof cocoa seedlings

Treatments	3 MAT	4 MAT	5 MAT	12 MAT	13 MAT	14 MAT	15 MAT
PTCT	23.00a	45.67b	64.33ab	92.33a	111.00a	114.33a	132.33a
CTPT	9.00c	48.00b	83.33a	91.33a	110.67a	112.67a	137.67a
CT30cmP	13.33b	31.00c	55.67b	90.00a	109.00a	109.00a	121.33a
CT150cmP	11.33bc	87.33a	87.33a	92.33a	127.00a	116.00a	123.67a
Mean	14.17	53.00	72.67	92.00	114.42	113.00	128.75

Means followed by the same letters along each column are not significantly different by DMRT (P<0.05)
PTCT: Plantain on top of cacao seedlings at transplanting; CTPT: Cacao on top of plantain at transplanting; CT30cmP: Cacao transplanted 30 cm apart from plantain; CT150cmP; Cacao transplanted 150 cm apart from plantain

Table 3: Effect of transplanting positions on stem diameter(cm) of cocoa seedlings

Treatments	3 MAT	4 MAT	5 MAT	12 MAT	13 MAT	14 MAT	15 MAT
PTCT	0.63a	1.57ab	1.83b	3.27a	3.33a	3.70a	3.67b
CTPT	0.43ab	1.60ab	2.23ab	3.03a	3.73a	3.83a	4.07a
CT30cmP	0.73a	1.20b	2.30ab	3.20a	3.47a	3.43a	3.77ab
CT150cmP	0.17b	1.83a	2.67a	3.37a	3.67a	3.73a	3.73b
Mean	0.49	1.55	2.26	3.22	3.55	3.81	3.68

Means followed by the same letters along each column are not significantly different by DMRT (P<0.05)

PTCT: Plantain on top of cacao seedlings at transplanting; CTPT: Cacao on top of plantain at transplanting; CT30cmP: Cacao transplanted 30 cm apart from plantain; CT150cmP; Cacao transplanted 150 cm apart from plantain

Table 4: Effect of transplanting positions on number of branches of cocoa seedlings

Treatments	3 MAT	4 MAT	5 MAT	12 MAT	13 MAT	14 MAT	15 MAT
PTCT	0.47a	2.00b	5.67ab	3.50b	4.17b	5.67ab	5.33a
CTPT	0.37a	3.33b	5.00bc	3.60ab	4.20b	5.00bc	6.00a
CT30cmP	0.57a	1.33b	4.00c	4.37a	4.17b	4.00c	4.33b
CT150cmP	0.20b	6.67a	6.67a	4.00ab	6.67a	6.67a	5.33a
Mean	0.40	3.33	5.33	3.89	4.80	5.33	5.25

Means followed by the same letters along each column are not significantly different by DMRT (P<0.05)

PTCT: Plantain on top of cacao seedlings at transplanting; CTPT: Cacao on top of plantain at transplanting; CT30cmP: Cacao transplanted 30 cm apart from plantain; CT150cmP; Cacao transplanted 150 cm apart from plantain

Table 5: Effect of transplanting positions on leaf area (cm^2)of cocoa seedlings

Treatments	3 MAT	4 MAT	5 MAT	12 MAT	13 MAT	14 MAT	15 MAT
PTCT	70.33bc	84.00b	95.33b	308.33a	306.33a	308.67a	327.00b
CTPT	76.33c	74.33c	86.67b	164.67b	292.33a	302.67a	362.67a
CT30cmP	77.33b	82.00b	93.00b	153.33b	165.00b	206.33b	232.00a
CT150cmP	101.33a	110.33a	119.67a	241.33a	279.00a	292.67a	316.67b
Mean	79.08	87.67	98.67	215.12	260.27	277.58	309.58

Means followed by the same letters along each column are not significantly different by DMRT (P<0.05)

PTCT: Plantain on top of cacao seedlings at transplanting; CTPT: Cacao on top of plantain at transplanting; CT30cmP: Cacao transplanted 30 cm apart from plantain; CT150cmP; Cacao transplanted 150 cm apart from plantain.

CONCLUSION AND RECOMMENDATION

Much of success of intercrops in cacao establishment depends on understanding the role each component plays in the system, cacao/plantain farming system has been recommended, but the transplanting arrangement in the face of global warming and climate change is a gap in research which this work has filled. Furthermore, the long dry season and the wind – storms early March to April in the study area usually devastate the plantains so that effective shade is not actually provided for the cacao in the later part of the dry season when the shade is needed most. According to this work, Cacao transplanting on top of plantain (CTPT) enhanced the best performance of cacao seedlings when compared to other treatments because cacao seedlings would have benefited from the soil moisture available at the base of plantain for survival and morphological growth.

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Title 3: On-Station and on-Farm Evaluation of 4 New Cocoa Varieties for Nigeria

Investigators: Muyiwa, A.A., Adeigbe, O.O., Adenuga, O.O., Olaniyi, O.O; Adepoju F.; Mapayi, A.E., Olasupo,; Anagbogu C. and Keji Dada (Plant Breeders)

Collaborators: Oyedokun, A.V (Entomologist), Adedeji, A. A., Otuonye, H. (Pathologists), Ibiremo, O.S., Ogunlade. M.O. (Soil Fertility Scientists), Nduka, B. A. (Crop Physiologist), Aikpokpodion, P. (Soil Chemist), Ogunwolu, (Food Nutritionist) Adejobi, K.B. (Agronomist), Okeniyi, M. (Nematologist), Lawal (Agricultural Economist), Famuyiwa, S. B (Agricultural Extensionist).

Introduction: In 2011, twelve cocoa hybrids which had consistently outperformed the popular F3 Amazon cocoa variety in yield and earliness were presented to the National Committee on Naming, Registration and Release of Crop Varieties for evaluation and for release. However due to some reasons, only eight of these hybrids were accepted for release by the Committee. As such this proposal is put forward to further evaluate the remaining 4 varieties in order to collate recent and up to date necessary data and information on them; needed for putting them forward for release by the National Committee on Naming Registration and Release of Crop Varieties. This is necessary considering the fact that these four hybrids are equally good as the other eight previously accepted (Dr. Peter Aikpokpodion, pers. Comm.).

Pods of the four hybrids were generated by crossing of the parental trees at the institutes' headquarters. The 4 hybrids will be evaluated along with 3 check varieties including F3 amazon, WACRI and farmer's variety at the CRIN headquarters and on nine farmer's fields in seven states in the cocoa agro-ecologies of Nigeria including Ideal climate, Ideal soil and Marginal climate. These include Cross river (2 locations) Abia (1 location), Akwa-ibom (1 location), Ogun (1 location), Edo (1 location), Osun (1 location), and Ondo (2 location).

The project activities to be carried out is as listed below:

1. Hybrid pod generation
2. Nursery activity
3. Farm site selection, farmers' consent visit, and soil sample collection and analysis
4. Supply of farmers with planting materials
5. Field trial at CRIN HQ.
6. On-farm trial in nine locations (Cross rivers-2 locations, Abia-1 location, Akwa-ibom-1 location, Ogun-1 location, Edo-1 location, Osun-1 location, and Ondo-2 locations).
7. Data collection
8. Data analysis, interpretation, collation and presentation to National Variety release committee for evaluation and subsequent release.

Activities 1-6 have carried out as at the date of this report and described below.

Progress Report: The project commenced in February/March 2019 immediately after fund release, with pollination process, which produced pods of the four hybrids. Selection of farm sites, visit to obtain farmers' consents, and soil sample collection and analysis were made in March 2019.

The farmers selected after visitation and inspection of the suitability of their farms were:

1. Mr Etok (08060940588) at Oborokara, Uyo, Akwa-Ibom state
2. Mr Ibe Williams (08059587576) at Bendegeh-Ekim, Cross River State
3. Mr Kirian Banjo (08101382173) at Boki East of Cross River State **replaced** by Mr. Richard Etim, Effraya, Cross-River state (07034376770, 07051126991) **
4. Mr Francis Ohilebo (08038905024) at Uhonmora (Edo state),
5. Kabiyesi (08067538218) at Ikoromaja in Oshun state
6. Gabriel Abiodun (08033076186) at Idanre, Apomu area, Ondo state
7. Mr Ade Fagite (08038129701) at Wasimi village in Ondo state
8. Chief Manure (08077017838) at Mamu in Ogun state
9. Chief Chijioke Nwosu (08068156361) at Bende **replaced** by Dr. Onukwo Joseph at Kwomu orie village, Bende, in Abia state**

** Note: 2 farmers had to be replaced because of their lack of cooperation to ensure the success of the project. Chief Chijioke Nwosu (08068156361) of Bende, in Abia state did not comply to secure the allotted farm land for us and was replaced by Dr. Onukwo Joseph of Kwomu orie village, Bende. Mr Kirian Banjo (08101382173) of Boki East, Cross River State failed to raise the nursery and also cut off communications and was replaced by Mr. Richard Etim, of Effraya, Cross-River state (07034376770, 07051126991).

Pods generated were distributed to farmers in June/July 2019 and seedlings raised in nursery beds.

Seedling of the four new cocoa varieties were raised in the CRIN HQs., nursery to support the pods given to farmers for nursery in June/July 2019. These seedling were taken to the farmers for planting from Tuesday 23rd June to Tuesday 30th June 2020 upon the ease of Corona pandemic lockdown by the Federal Government. Clones were also raised from TC material and included with the materials given to farmers for clonal evaluation.

Upon visit to the farmers' plots, their nursery seedlings performance was inspected and more hybrid seedling were given to augment for losses and new clonal generated seedlings were given to be included in the trial. Farmers (e.g at Wasimi) with enough seedling raised from the pods were not given additional seedlings. Plantain were observed to be already established on the plots. Field plan of planting the cocoa seedlings was made and demonstrated on their farm. The seedlings were established on 4 blocks, with minimum of 6 tree replications per block.

Table 1. List of seedlings distributed to farmers

	T12/11 x N38	T53/5 x N38	T65/7 x T101/15	T86/2 x T57/22	F3	WACRI	TC1	TC2	TC3	TC5	TC7	TC8
Ikoromaja	15	26	-	10	-	14	40	15	20	8	14	13
Idanre	30	30	-	30	30	30	40	15	20	8	14	13
Wasimi	-	-	10	-	-	10	40	15	20	-	14	13
Uhonmora	24	20	10	12	12	20	40	15	20	8	14	13
Ibeku	30	25	-	16	18	30	40	15	20	8	14	13
Akwa Ibom	40	30	10	20	22	30	40	15	20	8	14	13
Cross River 1	33	25	10	19	21	25	40	15	20	8	14	13
Cross River 2	30	30	-	30	30	30	40	20	24	16	14	13
Mamu	30	30	10	20	22	30	40	15	20	8	14	13



Title 4: **on-Station Rial of New Cocoa Cultivar Development**

Investigators: Muyiwa, A.A., Adeigbe, O.O., Adenuga, O.O., Olaniyi, O.O; Adepoju F.; Mapayi, A.E., Olasupo,; Anagbogu C. and Keji Dada (Plant Breeders)

Collaborators: Oyedokun, A.V (Entomologist), Adedeji, A. A., Otuonye, H. (Pathologists), Ibiremo, O.S., Ogunlade. M.O. (Soil Fertility Scientists), Nduka, B. A. (Crop Physiologist), Aikpokpodion, P. (Soil Chemist), Ogunwolu, (Food Nutritionist) Adejobi, K.B. (Agronomist), Okeniyi, M. (Nematologist), Lawal (Agricultural Economist), Famuyiwa, S. B (Agricultural Extensionist).

Introduction: Cocoa breeding is a continuous process of creating more variation to meet present demands of farmers for sustainable production. Continuity of the breeding process to advance new genotypes or varieties is majorly due to the usual challenges of the declining genetic potential of available genotypes (over the years). The dynamics of biotic (pest, diseases etc.) and abiotic (soil, climate etc.) factors leading to the generation of new variants and strains of pests, pathogens and degradation of soil fertility among others have over the years kept crop breeding an active discipline of problem solving in agriculture. Further breeding leads to improvement of economic or other traits of interest, advances the genetic potential of the species, improves livelihood of users (farmers) through reduction of inputs, increase in yield and quality etc. Moreover, higher cocoa productivity promotes and stabilizes the cocoa business for every player in the cocoa value chain. The ever increasing demand for cocoa by the world growing population and market, coupled with changes in the environment, makes breeding for higher cocoa yield and quality a usual and primary objective of most breeding programmes. The present proposal is with the following objectives:

1. To raise new varieties of cocoa with higher yield
2. To raise new varieties of cocoa with advanced tolerance/resistance to major pests and diseases of cocoa
3. To raise new genotypes of cocoa with better adaptability to various ecologies of Nigeria and low uptake potential for heavy metals
4. To raise new genotypes of cocoa with higher quality

Methodology: Selection shall be made from the existing hybrid progenies and some parents for some economic traits (yield, resistance to Phytophtora pod rot, resistance to Mirids, and improvement of quality). Pods of progenies shall be generated by hand pollination in a backcross breeding programme. A total of ten progenies are targeted to be generated. Seedlings shall be raised from the pods for eventual on-station and off-station multi-locational evaluation with at least three checks (F3 Amazon and CRIN Tc-2 and CRIN Tc-3) on the field. On-station sites would be CRIN head quarter at Ibadan and four sub-stations (Ajassor, Ibeku, Owena, Unhomora). The off-stations sites will be at least ten specific locations across the notable cocoa

ecologies of Nigeria in the farmer's plot. States of choice for the trial will include: Oyo, Ondo, Ekiti, Osun, Edo, Cross River, Delta and Abia states.
The plant breeder will generate agro morphological data for at least five years on the genotypes in the different locations (on and off farm), moreover, the diversity of the progenies will be studied at the genomic level using the single nucleotide polymorphism (SNP). The response of the genotypes to soil nutrition will be studied; the pathologist and the entomologists will screen the progenies for resistance to Phytophtora pod rot and Mirid respectively and the quality profile of the genotypes will be assessed by the food nutritionist.

Progress Report: 3 sub-station trials (CRIN HQ., Ajassor and Owena) have been attempted. Pods of progenies of the selected parents were generated by hand pollination in a backcross breeding programme in 2018/2019. Seedlings of the hybrid progenies were raised from the pods in the nursery along with three checks (F3 Amazon and CRIN Tc-2 and CRIN Tc-3). The seedlings were planted on the field after clearing and plantain establishment at the zone 8 of CRIN HQ, and at Ajassor and Owena sub-station in 2020.

However, some challenges were faced in the process of generating the hybrids; Six crosses were successful out of ten and some of the successful crosses did not develop to maturity probably due to old age of the mother tree. Therefore, resupplying needs to be done in the next season.

Materials planted in On-station trials at Ibadan HQ, Ajassor and Owena on June/July 2020.

Material	Ibadan HQ (Zone 8)	Owena	Ajassor
NV1	30	30	30
NV2	30	30	30
NV3	8	9	9
NV5	30	30	30
NV8	12	_	_
NV10	30	30	30

Status: The Corona stay at home order of staff under grade level 12 which started from March 2020 spreading to 2021, was a major setback for the plots.

Title 5: Fertilizer Application Enhances Establishment of Cacao Seedlings in Plant-Parasitic Nematodes Infected Soil

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INTRODUCTION: Cocoa (*Theobroma cacao*) is grown in the humid tropics of the world (Yanelis et al., 2012) with more than 70% production coming from Africa as a source of income for producing countries (Simo et al., 2018). The crop production is dominated by small-scale farmers who live and work in the cocoa belt providing them employment and income (Minimol et al., 2015; Ngoh Dooh et al., 2015). However, cocoa production has witnessed a downward trend because of ageing trees and small farms that do not provide an attractive income to current and future cocoa farmers, low farm gate prices making it difficult to afford costly inputs such as mineral fertilizers, climate change (Läderach et al., 2013; Schroth et al., 2016)pests and diseasesandfalling soil fertility. The production increases by new plantings and rehabilitation of moribund farms, but a build-up of plant-parasitic nematodes causing dieback with chlorotic symptoms, sudden death and retardation of cacao seedlings' growth in nurseries and young plantations and deteriorating soil fertility has caused many farmers to lose heart and abandon the crop (Orisajo et al., 2012; Orisajo, 2018).The need to pay attention to soil fertilization is now almost as important as the control of pests and diseases in cocoa. Tropical soils are inherently low in soil organic matter and fertility status; hence external fertilizer supply is a key factor in raising crop production.

Fertilization is an indispensable agricultural practicein which organic and inorganic fertilizers are used primarily to improve plant nutrition and hence crop productivity (Tian et al., 2015;Francioli et al., 2016).Inorganic fertilizers perform a decisive role in improving crop productivity, but are wildly applied. The production andapplication of these fertilizers cause serious environmental damage like greenhouse gas emissions,eutrophication (Copetti et al., 2016), pollution (De Notaris et al., 2018), leaching and contamination of groundwater thereby posing risk to human health(Huang et al., 2018;Jalali & Latifi, 2018). The continuous application of NPK leads to increase in the soil compactness, decrease in thesoil pH (Adamtey et al., 2016), soil fertility, soil porosity, and organic carbon level (Chaudhary et al*.,* 2017) as well as soil beneficial microorganism populations (Wei et al*.,* 2017).Continuous excessive applications of inorganic

fertilizercan also lead to nutrient accumulation in soil, and eventual P and N lossfrom soil to aquatic ecosystems (Qiao et al., 2012; Yanet al., 2013). Excessive N and P applications will also deteriorate the soilquality and reduce the soil's production levels (Zhang et al., 2015).With rising costs of chemical fertilizer and the aforementioned growing concernsover the environmental impact of excessive fertilizer application, there has been an increasing scrutiny on how nutrients aremanaged on farms (Chen et al., 2014).

Organic fertilizers (manures)are gaining attention as the alternative to inorganic fertilizers. Organic manureproduced from biomass and animal conventionallyplays an important role in recycling of nutrients (Hasler et al., 2015).When added to soils, organic manure enhances soil fertilityby increasingnutrient availability(Cavagnaro, 2014), soil organic carbons(Xie et al.,2014),available N and P, micronutrients, soilaggregation, andwater holding capacity, as well as leading to a highsoil buffering capacity against external disturbances (Yuet al., 2012;Liang et al., 2012;Chaudhary et al., 2012;Sogn et al., 2018). Though, the benefits associated with organicamendments majorly depend upon the type and application rate of organic fertilizers (Jones & Healey, 2010).

The application of organic material, though a traditional practice to improvesoil fertility and structure, is also known as a control method for soil-borne diseases, including plant parasitic nematodes (Hassan et al., 2010; Houx et al., 2014).In recent years, a variety of organic materials, such as animal and greenmanures, compost, and proteinous wastes, are used for this purpose(Summers, 2011; Stirling et al.,2011;Renco & Kovacik, 2012; Olabiyi & Oladeji, 2014; Abolusoro et al., 2015;Rudolph & DeVetter, 2015; Tiyagi et al., 2015; Briar et al., 2016; Forge et al., 2016;Atandi et al., 2017;Shiferaw et al., 2017). Incorporation of organic amendments has been shown to be detrimental to plant parasitic nematodes (Wang et al*.,* 2004) due to release of NH4, formaldehyde, phenol, volatile fatty acids and toxic compounds (Oka, 2010; McSorley, 2011; Briar et al., 2016). It was generally postulated that the adverse influence oforganic amendment on plant-parasitic nematode is referred to increasing host resistance to nematode infection and enhancement of growth performance (Country & Millon, 2008).

This work aims toexamine the effects of organic and organo-mineral fertilizers on plant-parasitic nematodes, cacao seedlings growth and establishment on the field. This will possibly ameliorate the current frustration faced by small-scale farmers on poor establishment of cacao seedlings and thereby increasing the crop production and income.

MATERIALS AND METHODS:

2.1 Study Area

Field experiments were carried out at the Cocoa Research Institute of Nigeria (CRIN) experimental farms in Ibadan, Oyo State and Owena, a CRIN Substation in Ondo State, Nigeria. Ibadan lies between the latitude 7^0 30' N and longitude 3^0 54' E at an altitude of 1222 m above sea level. It is located in the tropical rain forest ecosystem with mean solar radiation of 18mj/m^2/day and an annual average rainfall of 2000 mm with a bimodal pattern.Owena lies between the latitude $7^0$15' N and longitude $5^0$12' E at an altitude of 367 m above sea level. It is located in the tropical rain forest ecosystem with mean solar radiation of 30mj/m^2/day and an annual average rainfall of 1500 mm with a bimodal pattern.

The experiment was conducted over three years on the False horn plantain (*Musa* spp. L., AAB – group cv. Agbagba) as shade crop planted with cacao (*Theobroma cacao* cv. F3 Amazon) in Ibadan and Owena. The experiment was set as a randomized complete block design involving four fertilizer types [Goat Dung (GD), Organic (OF), Organo-Mineral Fertilizer (OMF) and NPK 15:15:15] which were separately applied at 200, 400, 600kg/ha and unfertilized served as control. Each treatment had 3 replications. Healthy sword suckers of plantain of approximately uniform size (50-60cm tall, 30-40cm pseudostem girth) pared to remove lesions were planted at a spacing of 3x3m. Cocoa seedlings of 5 months old were planted four weeks later at the same spacing.

2.2 Soil Samples Collection and Analysis

Soil samples were collected randomly from each of the experimental sites at both locations (Ibadan and Owena) with the aid of soil auger at 30cm depth. For the pre-cropping analysis, the samples were bulked together and mixed thoroughly, air dried at room temperature and analysed for various elements. Particle analysis was determined using the hydrometer method (Kettler et al, 2001). Organic carbon determination wasby the potassium dichromate oxidation method (Zhang et al., 2001).The total nitrogen (N) was determined byKjeldahl method; available P by ammonium-vanadomolybdate colorimetric method; exchangeable K and Na by flame

photometer; and exchangeable Mg, Ca and Mn were determined using atomic absorption spectrophotometer (Ryan et al., 2001). Soil pH was read on pH meter (1:1 water).Soil was assayed to confirm the presence and the initial population density of the nematodes (Coyne et al., 2007). Two grammes (2g) each of the organic fertilizers used were also analyzed for nutrient composition.

2.3 Fertilizer Application and Data Collection

The fertilizers were applied to treatment plots one month after transplanting using ring method of application at 5cm away from the base of cacao. Monthly Data collection on growth parameters (plant height, stem girth, number of leaf, and leaf area and number of branches) commenced 3 months after transplanting. Leaf samples (4^{th} leaf) were collected from 4 tagged cocoa seedlings at 12 months after transplanting and were analysed in the laboratory for chemical composition. The experiments were monitored for 36 months (144 weeks after planting). Survival count was carried out 12 months after transplanting. At 15 months after transplanting, soil samples were collected from treatment plots and were processed and analysed for physical properties (sand silt, loam, clay, soil moisture content and soil bulk density), chemical properties (soil organic matter, soil pH, N, P, K, Mg, Ca, and Na), and plant-parasitic nematodes population densitiesusing aforementioned standard procedures.

2.4 Data Analysis

Nematode population densities were $\log_{10}(x + 1)$ transformed and percentage data were square-root-transformed prior to analysis to stabilize variances (Gomez & Gomez, 1984), while the other data collected were not transformed. Only the predominant nematode species were included in the data analysis. Analyses of variance (ANOVA) were carried out to test for main effects and interactions. Pre-planned comparisons between treatment combinations were tested with linear contrasts. All analyses were performed using GENSTAT.

RESULTS AND DISCUSSIONS:

3.1 Nutrient Composition of the Organic Materials

The nutrient composition of the organic materials applied to the soil is presented in Table 1. The C: N ratio of the organic fertilizers used are8.2, 9.4, 9.8 for Goat dung, Organo-mineral fertilizer and Organic fertilizer, respectively. Changes in the C:N ratio of aggregates may reflect the

degree of organic materials decomposition within aggregate fractions (Baldock et al., 1992). Higher C:N ratios of aggregates suggest that soil organic C is relatively fresh or little altered, whereas, soil organic C is more decomposed and relative aged when the C:N ratio of aggregates is low (Chen et al., 2010).Difference in soil organic matter quality within aggregate fractions will result in difference in the types of nutritional substrates available, which may directly affect the natural of microbial communities(Bending et al., 2002).In general, amending the soil with organic materials having low C: N ratio (less than 20) resulted inrapid mineralization of N in the form of NH4+ or NO3 – for absorption and uptake by plant roots (Powers & McSorley, 2000).The fertilizers used in these experiments have low C: N and this appeared to have positive effects on the survival of the cacao seedlings.

Table 1. The nutrient composition of the organic materials

Properties	Goat dung (GD)	Organo-mineral fertilizer (OMF)	Organic fertilizer (OF)
pH (water)	8.17	7.00	7.30
Organic carbon (%)	40.1	40.5	36.4
Organic matter (%)	69.1	69.8	62.8
Total nitrogen (%)	4.9	4.3	3.7
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	8.2	9.4	9.8

3.2 Survival and Growth of Cacao Seedlings as Affected by Fertilizer Application

Fertilizers applied significantly ($p < 0.05$) enhanced the survival of cocoa seedlings12 months after transplanting on the field. The percentage survival of cacao seedlings under organic fertilizers at Ibadan and Owena increased significantly compared to NPK and control even at the

lowest rate of 200kg/ha used in the experiment (Table 2). However, application of 600 and 400kg/ha of NPK enhanced the survival of the cacao seedlings than the control. In the same vein, growth of cacao seedlings was consistently improved by the fertilizer application comparedwith the control at both locations (Table 3). Application of Goat dung, Organo-mineral fertilizer and Organic fertilizer at 200, 400 and 600kg/ha led to a significant increase in the height of cacao compared with NPK and control (Table 3). Similar pattern was observed for other growth parameters measured. In contrast, there was a significant reduction in plant height, stem girth, number of leaves, leaf area and number of branches of cacao in unfertilizedplots. The increase in growth parameters could be attributed to theenhanced nitrogen and phosphorus uptake by the plant using organicamendments (Pandit et al., 2018). Organic manures have been shown to supplyrequired plant nutrients, improve soil structure and promote plant growth (Agbede et al.,2014, 2017).The addition of organicmanure in soil may encourage the immobilization of bio-available nitrogenand phosphorus, which may otherwise be lost through leachingor emissions in the environment (Sun et al., 2018). The inclusion oforganic manure may also generate higher transpiration rates leading tohigher water retention in the soil. Hence, more availability of watersolublenutrients may cause the crop yield improvement (Doan et al.,2015).

Application of inorganic fertilizer, NPK, even at the lowest 200kg/ha also improved cacao growth significantly compared with the control (Table 3). This is in agreementwith the earlier study that the use of appropriatelevels of NPK fertilizers have good effects on plantgrowth factors (Irshad et al.,2006).NPK application enriched the availability of macro nutrients, nitrogen, phosphate, and potassium in the soil. These nutrients therefore, were readily absorbed by the crops. In crop metabolism, these nutrients are utilized in carbohydrate synthesis, cellulose, proteins, hormones, and enzymes. All these processes triggered the growth of plant organs such as plant height, stem diameter, number of leaves, leaf area and number of branches as reported in this present study. This result was in line with the previous studies conducted by Mandal et al.(2009) and Bandyopadhyay et al.(2010). In their studies, applications of NPK also triggered the growth of vegetative crops.

3.3 Relationships between Plant-Parasitic Nematodes and Cacao Growth

Relationships between the predominant plant-parasitic nematode population densities recovered and vegetative growth of young cacao revealed various statistically significant interactions (Table 4). *Meloidogyne incognita*, *Pratylenchuscoffeae* and *Radopholussimilis* population densities were negatively correlated with the survival percentage of the cacao seedlings ($r = -0.69$, $p < 0.01$; $r = -0.58$, $p < 0.05$ and $r = -0.46$, $p < 0.05$, respectively). Furthermore, *M. incognita* was negatively correlated with the plant height ($r = 0.91$, $p < 0.01$), leaf area ($r = -0.61$, $p < 0.01$) and number of branches ($r = -0.51$, $p < 0.05$). This confirmed the previous reports that root-knot nematodes,*M. incognita*, damage on cacao seedlings led to stunted growth of the plants (Afolami & Caveness, 1983; Afolami & Ojo, 1984) Similarly, *H. multicinctus*, *P. coffeae* and *R. similis* population densities were negatively correlated with plant height ($r = -0.46$, $p < 0.05$; $r = -0.51$, $p < 0.05$; $r = -0.43$, $p < 0.05$, respectively), while they have no significant correlation with leaf area and number of branches (Table 4). However, plant height was positively correlated with survival percentage ($r = 0.89$, $p < 0.01$), leaf area ($r = 0.71$, $p < 0.01$) and number of branches ($r = 0.53$, $p < 0.05$).

Table 2. ***Survival of cacao seedlings as affected by fertilizer application at Ibadan and Owena (12 months after transplanting)***

Treatments		Ibadan experiments	Owena experiments
Fertilizers	Rates (kg/ha)		
Goat dung	600	94.44a	94.44ab
	400	94.44a	94.44ab
	200	94.44a	88.33abc
Organo-mineral fertilizer	600	90.44a	83.33abc
	400	88.88a	83.33abc
	200	77.77ab	83.33abc
Organic fertilizer	600	94.44a	100.00a
	400	90.44a	83.33abc
	200	83.33ab	83.33abc
NPK 15: 15: 15	600	66.66b	72.22bc
	400	77.77ab	72.21bc
	200	72.21ab	66.88cd
Control		66.66b	49.89d

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 4. Linear correlation matrix (half) of mean values for plant-parasitic nematode population densities / 100g soil, percentage survival, plant height, leaf area and branches of young cacao

Hm	Pc	Rs	Survival (%)	Plant height (cm)	Leaf Area (cm^2)	Branches (no)		
M. incognita (J2)		0.96**	0.41*	0.67**	-0.69**	-0.91**	-0.61**	-0.51*
H. multicinctus-		0.46*	0.72**	0.24	-0.46*	-0.12	-0.24	
P. coffeae-		0.84**	-0.58*	-0.51*	-0.15	-0.18		
R. similis-		-0.46*	-0.43*	-0.15	-0.17			
Survival (%)					-	0.89**	0.63**	0.51*
Plant height (cm)						-	0.71**	0.53*
Leaf Area (cm^2)							-	0.28

Mi*: Meloidogyne incognita;* Hm: *Helicotylenchus multicinctus;* Pc: *Pratylenchus coffeae;* Rs: *Radopholus similis*
Correlation coefficient significant at *p< 0.05, **p <0.01.

3.4 Effects of Organic Fertilizers on Population Densities of Plant-Parasitic Nematodes

The incorporation of Goat dung, Organo-mineral fertilizer and Organic fertilizer at 200, 400 and 600kg/ha led to a significant reduction in the population densities of these plant-parasitic nematodes compared with NPK fertilizer and control (Table 5). This is in agreement with earlier studies that soil amendments with different types of organicmanures are effective in reducing the populationdensities of many soil-borne plant pathogens including plant-parasitic nematodes (Hassan et al., 2010;Shiferaw et al., 2017).Organic manure has beenreported to be rich in several compounds especially nitrogen and phenolics (Hassan et al., 2010; Renco & Kovacik, 2012). Nitrogen in the organic manure after conversion into ammonia (Thoden et al., 2011) has been reported to killseveral plant parasitic nematodes (Lazarovits et al., 2001).Phenols and nematostatic chemicals released from organic matters into amended soil significantly decreased the nematodes population (Oka 2010; Briaret al., 2016). Several workers using organic soil amendments have reported satisfactory results on the plant growth and yield in avariety of crops with marked reduction in the population of plant-parasitic nematodes (Orisajo et al., 2008; Pakeerathan et al., 2009; Iqbal et al., 2012; Chaudhary &Kaul, 2013; Abolusoro et al., 2015; Adepoju et al., 2017). All the treated plants showed significant and satisfactory results when compared to untreated control. Our findings in this study are similar with theaforementioned earlier reports.In the same vein, application of NPK at 200, 400 and 600kg/ha 600 also had a significant lower population densities of *M.incognita*,*H.multicinctus*, *P.coffeae* and *R.similis*.Our findings were consistent with earlier studies that the use of appropriatelevels of NPK fertilizers have good effects on plantgrowth factors with resultant reductions in plant-parasitic nematode populations(Irshad et al.,2006; Ameen et al., 2013; Osman et al.,2015; Kolawole et al., 2018).

CONCLUSION

Improving the agronomic conditions for plant growth is an important factor for increasing the plant tolerance to plant-parasitic nematodes (Charegani *etal.*, 2010). Results from this

study have shown that the addition of fertilizers to the soil will improve the survival and growth of cacao seedlings. With rising costs of chemical fertilizer and the growing concernsover the environmental impact of excessive fertilizer application, Goat dung, Organo-mineral fertilizer and Organic fertilizer at 200kg/ha are recommended for soil application. These have been shown to enhance the field establishment of cacao seedlings in the soil infected with plant-parasitic nematodes.

Table 5. Effects of fertilizer types and rates on population dynamics of nematodes in Ibadan and Owena

Treatments	Ibadan				Owena			
	Meloidogyne incognita (000)	*Helicotylenchus multicinctus* (000)	*Pratylenchus coffeae* (000)	*Radopholus similis* (000)	*Meloidogyne incognita* (000)	*Helicotylenchus multicinctus* (000)	*Pratylenchus coffeae* (000)	*Radopholus similis* (000)
GD 600	0.28e	0.01c	0.36c	0.01c	0.33e	0.01c	0.37c	0.01c
GD 400	0.28e	0.02c	0.37c	0.01c	0.33e	0.01c	0.37c	0.01c
GD 200	0.27e	0.02c	0.35c	0.02c	0.33e	0.01c	0.38c	0.01c
OMF 600	0.35d	0.01c	0.33c	0.02c	0.44d	0.01c	0.37c	0.01c
OMF 400	0.34d	0.02c	0.33c	0.02c	0.44d	0.01c	0.38c	0.01c
OMF 200	0.34d	0.01c	0.36c	0.02c	0.43d	0.01c	0.38c	0.01c
OF 600	0.16f	0.01c	0.33c	0.03c	0.19f	0.01c	0.40c	0.01c
OF 400	0.16f	0.01c	0.35c	0.02c	0.19f	0.01c	0.40c	0.01c
OF 200	0.17f	0.01c	0.37c	0.02c	0.19f	0.01c	0.41c	0.02c
NPK 600	1.67c	0.22b	2.02b	0.14b	1.81c	0.21b	3.01b	0.14b
NPK 400	1.63b	0.23b	1.97b	0.14b	1.77b	0.21b	3.01b	0.14b
NPK 200	1.61b	0.23b	2.01b	0.14b	1.76b	0.22b	3.02b	0.15b
Control	7.63a	2.12a	8.36a	3.53a	7.01a	1.25a	7.84a	3.41a

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

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Title 6: National Survey of Cocoa growing Agro-Ecologies to update Epidemiological Data on *Phytophthora Megakarya* in Nigeria.

Adedeji, A. R., Orisajo, S. B., Okeniyi, M., Otuonye, H., Kolawole, O. O. and Ogundeji, B. A.

Introduction

Worldwide, about 3.5 million tons of cocoa is produced annually (WCF, 2010a). Notwithstanding, cocoa demand has been increasing by an average of 3% a year for the past 100 years. Industry representatives estimated that the cocoa sector will need to achieve annual production of at least 4.5 million tonnes of cocoa by 2020 to satisfy demand (WCF, 2010b). Cocoa production is one of Africa's greatest industries and 70% of cocoa produced is contributed by Africa (WCF, 2010a). In Nigeria today, the amount of cocoa produced is not commensurate to the large area of land used for cocoa cultivation. This is due to several factors, most importantly pest and disease outbreaks (PAN, 2001). Black pod disease of cocoa caused by *Phytophthora megakarya* is the most devastating disease of cocoa in West Africa, frequently causing total loss of pods (Opuku *et al*., 2000). Copper and metalaxyl-based fungicides are the most common methods of disease control used by farmers for the disease control, but do not prevent regular outbreaks of black bod disease every cropping season. Unfortunately, indiscriminate use of fungicides by growers may cause the emergence of resistant pathogens and deleterious effects on non-targets and the environment. To circumvent this situation, breeding for resistant cultivars has been a top priority. However, to breed durable resistance to *P. megakarya*, there must be a good understanding of its population biology (McDonald and Linde, 2002). It is surprising that the population structure of a pathogen of such magnitude has been so little studied and available data on its population is very old. There is a need to investigate the population structure and genetic variation of *P. megakarya* using molecular tools. Specifically, the studies will simultaneously examine population structure and genetic variation in virulence-related genes. Obtaining these data is a prerequisite to further understand the epidemiology of the disease and for selecting disease resistance sources for cocoa breeding.

Objectives

To examine the population structure and genetic variation of *P. megakarya* in Nigeria, including the phylogenetic relationships among populations or clonal lineages.

Materials and Methods

Diseased cocoa pod samples were collected from Akure South, Idanre and Ondo West Local Government Areas of Ondo State, and Atakumosa East and Irewole Local Government Areas of Osun State as well as from Ikom, Boki East and West, Etung and Obubra Local Government Areas of Cross River State. The infected pods were surface-sterilized and inoculated under aseptic condition into freshly prepared potato dextrose agar and carrot agar plates. Associated *P. megakarya* isolates were sub-cultured and characterized morphologically. The isolates were thereafter taken to the laboratory for molecular characterization and phylogenetic analysis.

Results and Discussion

About 145 different strains of *P. megakarya* were isolated and characterized from across the five cocoa growing Local Government Areas in Ondo, Osun and Cross River States (Table 1).

Table 1: Number of isolates recovered

	State/Local Government					
	Ondo			**Osun**		**Cross River**
	Akure South	Idanre	Ondo West	Atakumosa East	Irewole	Boki E/W (8), Etung(7), Ikom (3), Obubra (7)
No. of *P. megakarya* isolates	23	21	24	27	25	25

Sequences of some of the strains characterized are as shown below:

Nucleotide sequences of fungi isolates from Cocoa samples

>PHYTOPH 1

GATTGgCTTCGGCTGAACAGAAGCTTATTGGGCGTTTTTCCTgCTATGGCGGTATG
AAGTAGTGAACCGTAGTTATGtGGGCTTGGCTTTTGAATGTGCTCGCTGTGCGAAG
TAGAGTGGCGACTTTGGTTGTCGAGGGTCGATCCATTtGGGAAATTGTGTGTACTT
CGGTAtGCATCTCCAATtGGaCCTGATATCctGGGC

>PHYTOPH 2
AGGTCCATTGAGATGCATACCGAAGTACACACAATTTCCCAAATGGATCGACCCT
CGACAACCAAAGTCGCCACTCTACTTCGCACAGCGAGCACATTCAAAAGCCAAG
CCCACATAACTACGGTTCACTACTTCATACCGCCATAGCAGGAAAAACGCCCAAT
AAGCTTCTGTTCAGCCGAAGCCAATCATACCGCGAATCGAACACTCCTCCATTAA
CGCCACAGCAGACAAACTAGTCGCCGACTGGTTACACAAGCAGCCTCCACAACA
AGCAAGCTTTACTTTTCGAGCAAAGAGAAGTACAGTTCAGTACATTTCAAGGGAC
TCACAGCCGACCCGAAGGCCAGCCGCAAGACACCTCACATCTGGCATATCCTCCA
CCGACTACACGGAAGGAAGAAAACCAAGTTTGATGTACGGACACTGATACAGGC
ATACTTCCAGGACTAACCCGGAAGTGCAATATGCGTTCAAAATTTCGATGACTCA
CTGAATCCTGCAATTCGCATTACGTATCGCAGTTCGCAGCGTTCTTCATCGAGGTG
CGAGCCTAGACATCCACTGCTGAAAGTTGCTATCTAGTTAAAAGCAGAGACTTTC
GTCCCCACAGTATAATCAGTAATAATGAATGGGTTTAAAAAAGCTACTAGTTCAG
ACCGAAGCCCAAACGCTCGCCATGATAGGGCTCTCCCAGCAGCAACCgCCAGTAA
TTAAACCAGCAGCCGCCGCCGAAAAAGACCCCCAACTAAAGGTTGATACGGTTC
ACGTGGAAAGTTTTTAGGTGTGGTAATGATCCTTCCGCAGGTTC

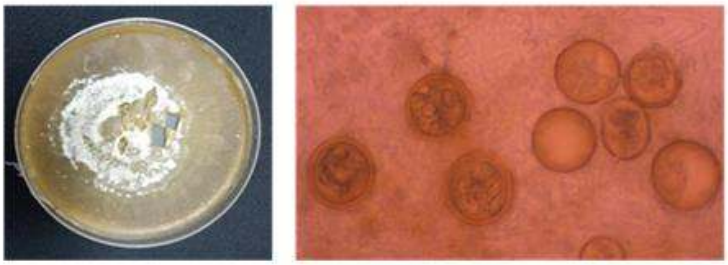
> PHYTOPH 3

TCAACCTTTAGTTGGGGGGTCTTTTTCGGCGGCGGCTGCTGGTTTAATTACTGGCG
GTTGCTGCTGGGGAGAGCCCTATCATGGCGAGCGTTTGGGGCTTCGGTCTGAACT
AGTAGCTTTTTTAAACCCATTCATTATTACTGATTATACTGTGGGGGACGAAAGTC
TCTGCTTTTAACTAGATAGCAACTTTCAGCAGTGGATGTCTAGGCTCGCACCTCG
ATGAAGAACGCTGCGAACTGCGATACGTAATGCGAATTGCAGGATTCAGTGAGT
CATCGAAATTTTGAACGCATATTGCACTTCCGGGTTAGTCCTGGAAGTATGCCtGT
ATCAGTGTCCGTACATCAAACTTGGTTTTCTTCCTTCCGTGTAGTCGGTGGAGGAT
ATGCCAGATGTGAGGTGTCTTGCGGCTGGCCTTCGGGTCGGCTGTGAGTCCCTTG
AAATGTACTGAACTGTACTTCTCTTTGCTCGAAAAGTAAAGCTTGCTTGTTGTGGA
GGCTGCTTGTGTAACCAGTCGGCGACTAGTTTGTCTGCTGTGGCGTTAATGGAGG
AGTGTTCGATTCGCGGTATGATTGGCTTCGGCTGAACAGAAGCTTATTGGGCGTT

TTTCCTGCTATGGCGGTATGAAGTAGTGAACCGTAGTTATGTGGGCTTGGCTTTTG
AATGTGCTCGCTGTGCGAAGTAGAGTGGCGACTTTGGTTGTCGAgGGtGcGATCCA
TTTGGGAAATTGTGTGTACTTCGGTATGC

>PHYTOPH 4

TTCCCGTAGGTGAACCTGCGGAAGGATCcTaACCACACCTAAAAACTTTCCACGTG
AACCGTATCAACCTTTAGTTGGGGGTCTTTTTTCGGCGGCGGCTGCTGGTTTTAAT
TACTGGGCGGTTGCTGCTGGGAGAGCCCTATCATGGCGAGCGTTTGGGCTTCGGT
CTGAACTAGTAGCTTTTTTAAACCCATTCATTATTaCTGATTATACTGTGGGGACG
AAAGTCTCTGCTTTTAACTAGATAGCAACTTTCAGCAGTGGATGTCTAGGCTCGC
ACCTCGATGAAGAACGCTGCGAACTGCGATACGTAATGCGAATTGCAGGATTCA
GtGAGTCATCGAAATTTTGAACGCATATTGCACTTCCGGGTTAGTCCTGGAAGTAT
tCCTGTATCAGTGTCCGTACATCAAACTTGGTTTTCTTCCTTCCGTGTAGTCGGTGG
AGGATATGCCAGATGTGAGGTGTCTTGCGGCTGRCCTTCGGGTCGGCTGTGAGTC
CCTTGAAATGTACTGAACTGTACTTCTCTTTGCTCGAAAAGTAAAGCTTGCTTGTT
GTGGAGGCTGCTaGTGTAACCAGTCGcCGACTAGTTTGTCTcCTGTGGCGTTAATG
GAGGAGTGTTCGATTCcCGGTATGATTGGgTTCGGCTGAACAGAAGCTTATTGGGC
GTTTTTCgTGCTATGGCGGTATGAAGTAGTGAgCCGTAGTTATGTGGGCTTGGCTT
TTGAATGTgCTCgCTGTGCGAAGTAGAGTGGCGACTTTGGTTGTCGAGGGTcGATC
CATTTGGGAAATTGtGTGTACTTCGGTATGCATC



Sample Name: BE2.3
Organism Name: *Phytophthora megakaya*

Morphological Characteristics.
Dense rosette or homothallic felt-like colony and stoloniferous mycelia growth on PDA at Maximum temperature of 27°C

Microscopic Characteristics.
Phytophthora megakaya produced the following: semi-papillate sporangium with sometime short pedicels, with some caducous, ovoid, semi-papillate sporangium with long pedicel, Oogonium with aplerotic oospore and amphigynous antheridium.

Summary: About 120 different strains of *P. megakarya* were isolated and characterized from across the cocoa growing Local Government Areas of Ondo, Osun and Cross River States. The research work is still on-going as more States are still to be covered.

Challenges faced

Unavailability of cooled incubation facility for the *Phytophthora* strains especially during off-season.

Status: Ongoing

Title 7: On-farm demonstration of CRIN Liquid soap in Abia State.
Investigators: Yahaya L.E, Adedeji A.R and Agbonghiaryiu A.

Introduction: Nigeria is endowed with huge natural resources which include cocoa. Cocoa is planted across the cocoa ecological zone. There is need to diversify the Nigerian e economy because of overdependence on crude oil which finite in nature. The cocoa production generates high volume of pod husk which has been source of host to pathogens in most farms. This has been harnessed in soap production as one of CRIN perfected technologies. Farmers need income to supplement whatever they can get from cocoa farming and thus sustain them as the engage in cocoa business. Soap production using pod husks from cocoa prove to be one of such sources of income. This project seeks to train farmers on this perfected technology of CRIN.

The Eastern cocoa producing regions of Nigeria have been marginalized in terms of funding and resource distribution. Umuahia north and Bende are two out of the major cocoa producing areas in the East and report has it that they have not been enjoying the training programme CRIN has been extending to other cocoa producing areas in other regions of the country. It is for this reason the work is focusing on this part of the country.

Materials and Methods: Farmers were trained on soap production using cocoa pod husk. This was done using the participatory approach method. The saponification process as modified by Yahaya *et al*, 2004 for soap production was employed while involving the farmers in the production process. Farmers were made to participate in the training so that they can have mastery over the process of production and were able to take up the skill at the end of the training.

Results and Discussion: Over sixty farmers and stakeholders participated and were favorably disposed to the training programme as they were all excited and enthused about the training. They aslo looked forward to having similar training from CRIN.

Conclusion and Recommendations: It is therefore recommended that such training be replicated in other cocoa producing states so that they can all benefit from the potentials available to them in terms of cocoa value addition.

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CASHEW PROGRAMME

2020 RESEARCH REPORT

CASHEW RESEARCH PROGRAMME

BEHAVIORAL BIOASSAY OF STEM GIRDLER TO HOST PLANT VOLATILES

Investigator: Mokwunye, I.U

Abstract

Analeptes trifasciata, cashew stem girdler damages cashew by its girdling activities on the stem thereby causing huge economic loss. Little is known about the cues mediating attraction to the host plant, cashew, hence the role of olfaction in the girdling behavior of *A. trifasciata* was studied. Y-tube olfactometer was used to study the behavioural responses of stem girdler to cashew stem and leaf volatiles separately. Crude volatile extracts of these plant parts were also subjected to coupled gas chromatography-mass spectrometry (GC-MS) analysis. Male and female spent significantly greater time, 448.25 secs and 299.0 secs, respectively, in the olfactometer arm containing the stem volatiles, compared to 121.5 secs and 30.22 secs spent, respectively, in the control arm of the olfactometer. Y-tube olfactometric assays demonstrated that the stem volatiles were more attractive to both sexes compared to those from the leaves. A combination of fatty acids, amino acids and carbohydrates were detected in cashew stems. Some of these fatty acids have been reported as attractants on other insect pests. Therefore it is suspected that these fatty acid blends may be responsible for facilitating host plant location by both sexes of the stem girdler. In conclusion, this study opens the possibility of utilizing cashew stem volatiles as surveillance and control tools for the management of cashew stem girdler.

Key words: cashew stem girdler, behavior, olfactometer, volatiles, cashew stem

Introduction

Cashew is an important economic crop in Nigeria. It is cultivated in almost all agro-ecological zones in Nigeria. The major products of cashew traded on the International market are kernels and CNSL while the pseudo-apples are locally consumed. Besides, the cashew tree is also used to control erosion and serves as wind break. Damage by insect pests has contributed to decline in productivity of the crop. Despite the huge

losses attributed to stem girdler infestation, farmers hardly apply pesticides due to several limiting factors. This should be encouraged by exploring other safer alternatives such as the utilization of semiochemicals. It is known that most insects use volatile cues to identify and locate appropriate requirements such as host, oviposition sites, mates etc. An improved understanding of pest olfaction could lead to the development of a novel protection of cashew, based on semiochemical. The objective of this study was to determine the semiochemical interactions between cashew and *A. trifasciata*, which can be exploited for monitoring the pest population, mass trapping and to alter the behaviour of *A. trifasciata*.

Materials and methods

Behavioral bioassays

Insect behavioural assays were carried out using a glass Y-tube olfactometer following the description by Ginzel and Hanks (2005). This was to determine the responses of sexually matured male and female stem girlder to cut cashew stems and young leaves volatiles. Static air was allowed through the two glass chambers measuring 14 cm ID x 55 cm high, one glass chamber contained five 5 cm long cashew stem or leaf as the odour source and the other served as a blank control. Individual test females and males were gently released into base of the main tube of the olfactometer and observed for 15 min. The time spent in each zone was recorded using a stop watch. Each trial was replicated with 30 female and 30 male respondents. Data on the mean time spent in, and number of entries (visits) into, odour and control arms of the olfactometer were the parameters chosen for assessment of the differences between odour source and control.

Extraction of Volatiles from Cashew Plant Parts

The plant materials, cashew stems and leaves were air-dried for 5 days under laboratory conditions. Thereafter solvent-assisted extraction method according to Cañas-Hoyos *et al.* (2017) with slight modification was applied. The extract was stored in the freezer for subsequent analysis.

Gas Chromatography-Mass spectrometry (GC-MS)

Coupled gas chromatography-mass spectrometric (GC-MS) analysis of the cashew plant part extracts were carried out at the Central Laboratory, University of Lagos, Lagos, Nigeria. The plant part extracts were analysed using an Agilent HP 7890 Gas chromatograply coupled to an HP 5975 mass spectrometer (EI, 70 eV, Agilent, Palo Alto, California, USA) equipped with an HP-5MS column (30 mm x 0.320 mm ID x 0.25 um, Agilent, Palo Alto, California, USA) in the spitless mode. The oven temperature was programmed at 80 °C for 2 min and then increased by 12 °C min^{-1} to 240 °C, and held at this temperature for 6 min. The interface temperature between GC injector and MS was 250 °C. The carrier gas was helium. GC-MS identifications were made by comparison of retention time and spectra with mass spectral databases (NIST, 2005), and confirmed by peak enhancement on GC using authentic compounds. Quantification of the components were based on external calibration curve prepared from standard solution of the parameter.

Statistical analysis

Data on the mean time spent in either arm of the olfactometer was analysed using t-test while the data on the number of entries (visits) into odour and control arms of the olfactometer was analysed using χ^2 test.

Results and Discussion

In the Y-tube olfactometer bioassays, both male (male: t = 2.228, d.f = 11, p = 0.040) and female (t = 2.341, d.f =11, p = 0.040), *A. trifasciata* spent significantly greater proportion of time in the arm with intact cashew stems compared to the control (Figure 1). For most cerambycid species, plant volatiles are attractive to both sexes, thus playing a role in mate location. The result of this study has provided support for this assertion. There was no significant difference between proportion of time spent by either male (t = 1.477, d.f =11, p = 0.178) or female (t = 1.697. d.f =11, p = 0.165) *A. trifasciata* in the olfactometer arm containing the intact cashew leaves and control arm (Figure 2). The number of times male and female *A. trifasciata* entered the odour zones (cashew stems and leaves) were not significantly different from the control (Figures 3 and 4).

The GC-MS analysis of the cashew stem bark extract detected fourteen (14) compounds that represented 94.76% of the extract (Figure 5). The most abundant

copounds were 5-hydroxymethyl furfural (60.87%), Alanyl-β-alanine (10.63%), n-Hexadecanoic acid (5.25%) and 2,3-dihydro-3,5-dihydroxy-6-methyl 4H-pyran-4-one (4.70%). Trace amount of carbohydrates such as D- mannoheptulose (0.78%), D-allose (0.51%), 4-O-methylmannose (0.10%) and amino acids namely cycloserine (0.59%, L-asparagine (0.55%) were identified in the cashew stem bark extract. Documented evidence shows that fatty acids such as Hexadecanoic acid (palmitic acid), cis, cis-9,12-Octadecadienoic acid (linoleic acid), Octadecenoic acid and Octadecanoic acid (stearic acid) are useful as whitefly attractants (Hamilton, 2010).

A total of twenty four (24) compounds were identified in the cashew leaf extract and they belonged to classes such as hydrocarbons, fatty acids, esters and terpenes. Terpenes were predominantly present. Earlier studies have established that hydrocarbons such as sesquiterpenes, monoterpenes, alkanes and fatty acids function as olfactory cues for host finding among insect species (Harborne, 2003; Schoonhoven et al., 2005). The major compounds present were 3β, 17β-dihydroxyestr-4-ene (10.89%), Hexadecanoic acid, ethyl ester (7.49%), I-Methylbicyclo[3.2.1] octane (7.28%) and 3α, 17β-dihydroxysterene (7.06%). The least abundant compounds were Methyl (Z)-5,11,14,17-eicosatetranoate (0.31%), Aromandendrene (1.42%) and 2,2,6-trimethyl-1-(2-methyl-cyclobut-2-enyl)-hepta-4,6-dien-3-one (1.60%) (Figure 6).

Conclusion and Recommendation:

In conclusion, both sexes were independently attracted to cashew stems, they did not show significant attraction to cashew leaves. Thus signifying that the cashew stem volatiles play a role in host location and maybe mate location as well. Synthetic version of the identified compounds can be developed and utilized for field monitoring pest population or/and mass trapping of the stem girdler, particularly since they are low–density pest.

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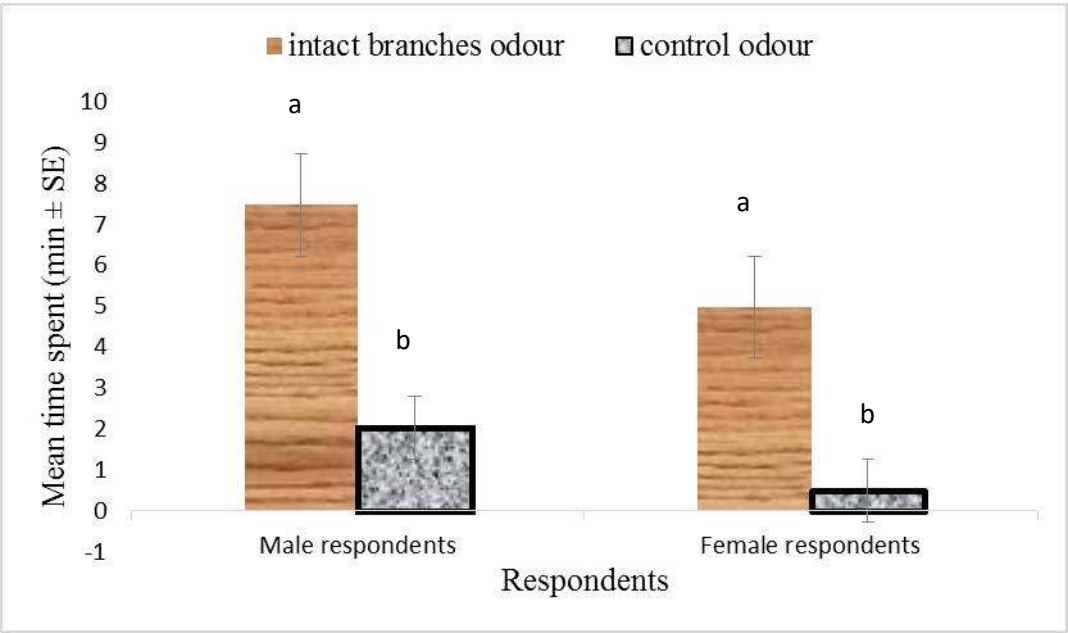

Figure 1: Responses of male and female *Analeptes trifasciata* with

in an olfactometer as expressed as mean time spent (minutes) in intact stem odour arm and control arm

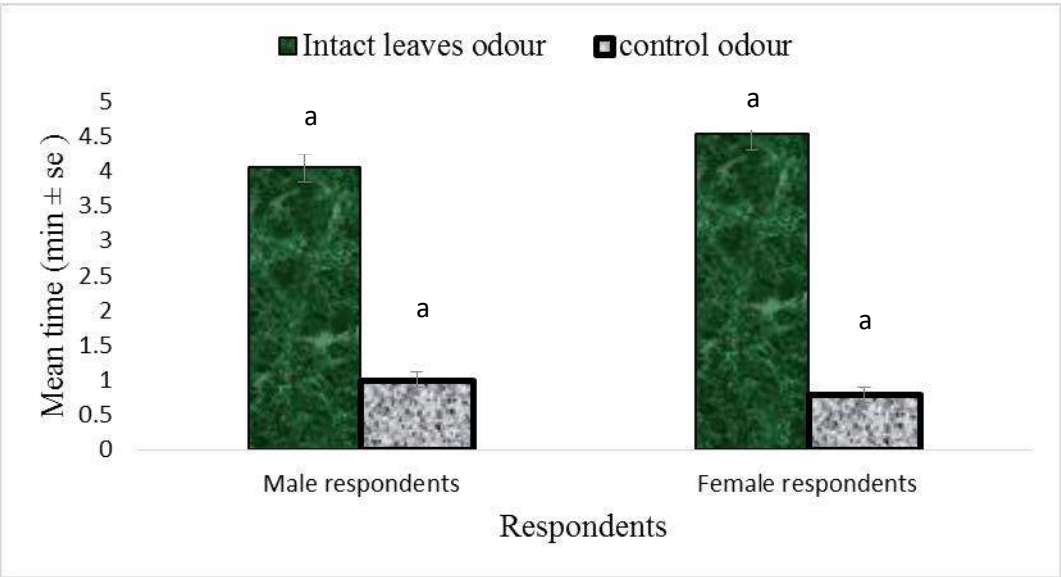

Figure 2: Responses of male and female *Analeptes trifasciata* within an olfactometer on mean time spent in intact leaves odour arm and control arm

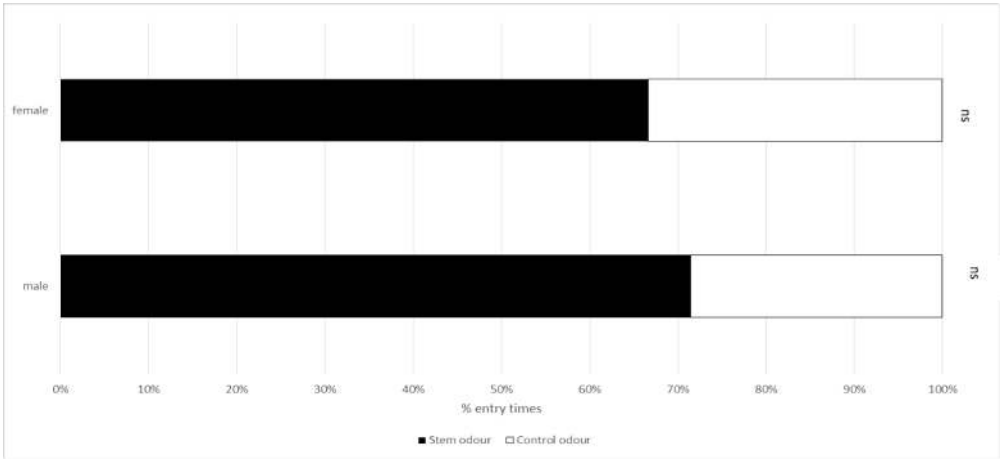

Figure 3: Responses of male and female *Analeptes trifasciata* within an olfactomete to cashew stems as expressed as mean number of entries into cashew stem and control odour arms

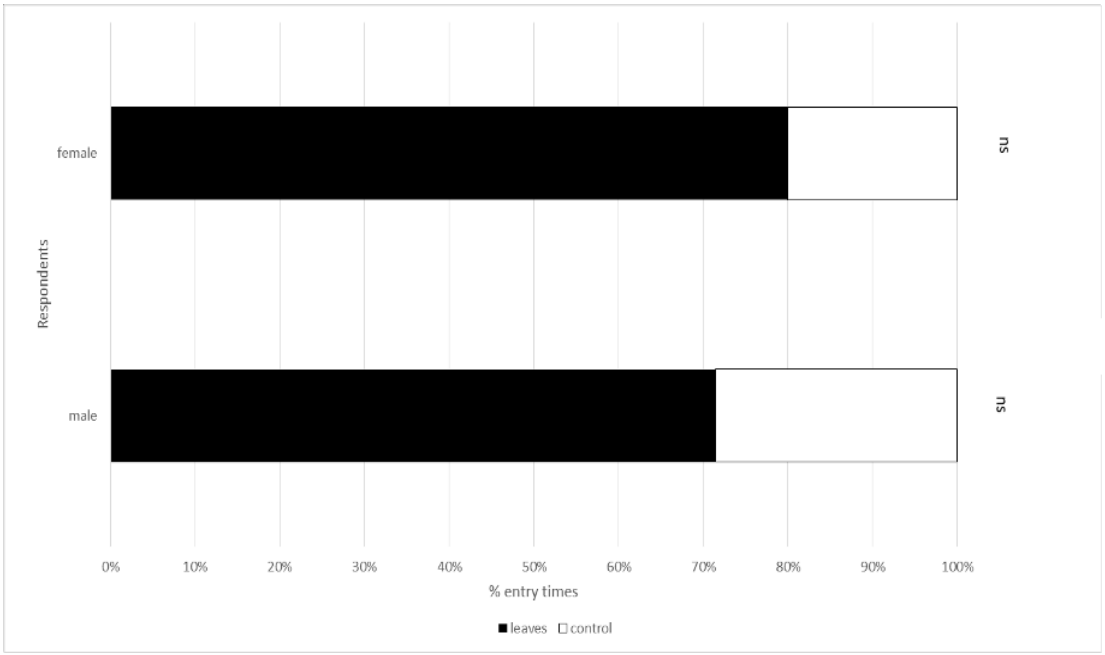

Figure 4: Responses of male and female *Analeptes trifasciata* within an olfactometer to cashew leaves as expressed as mean number of entries into cashew leaves and control odour arms

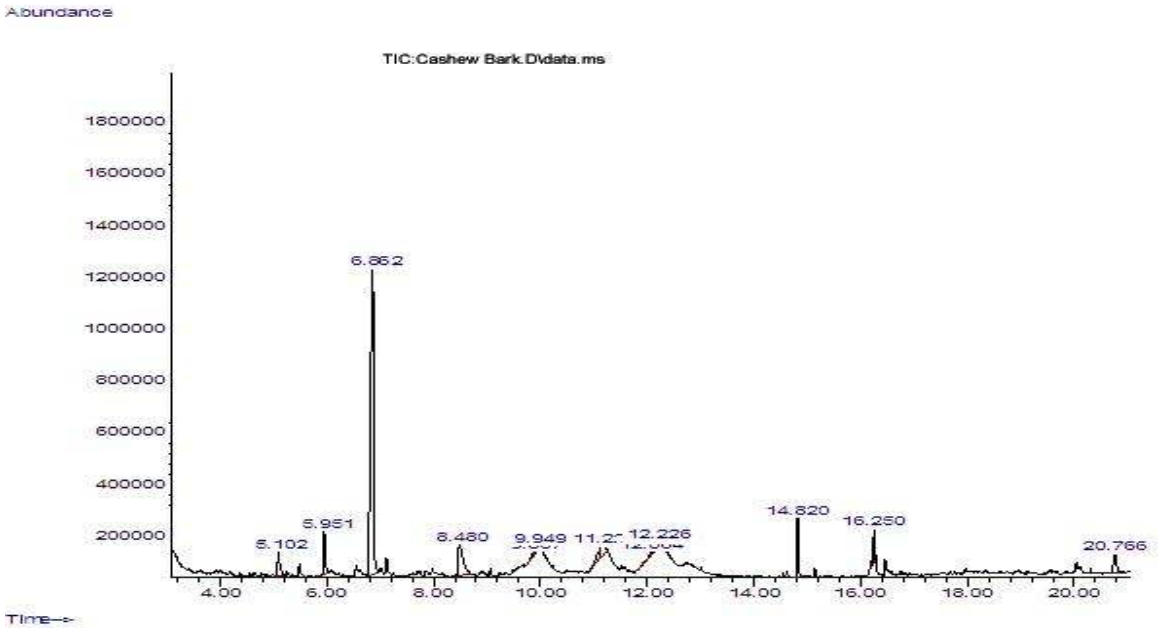

Figure 5: Chromatogram of intact cashew stems extract

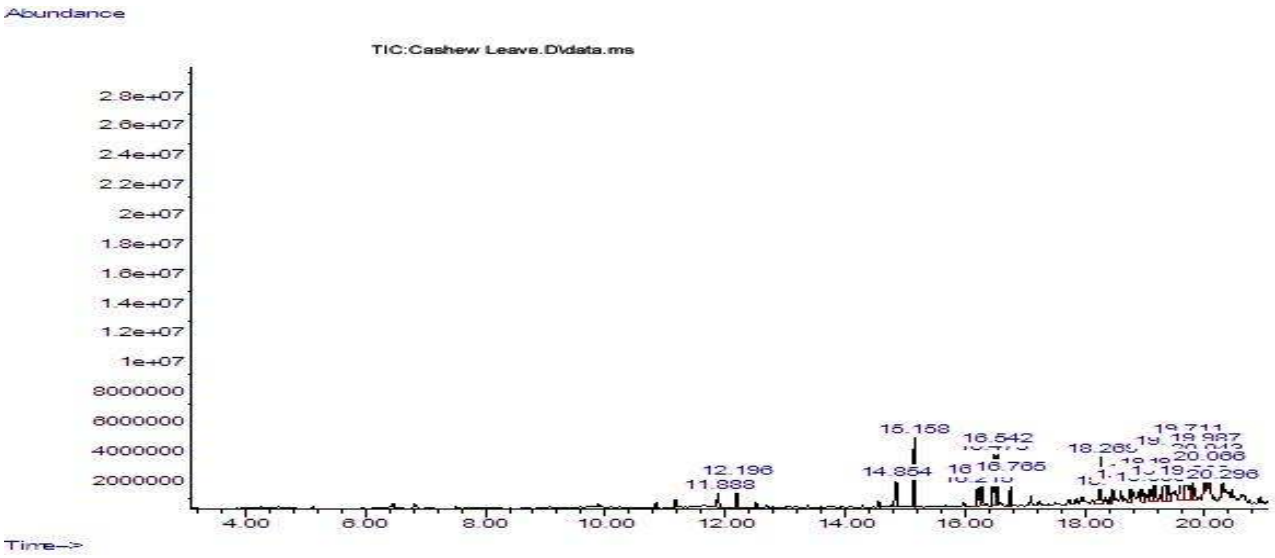

Figure 6: Chromatogram of intact cashew leaf extract

COFFEE PROGRAMME

Title 1: Mycotoxins production in variedly processed *Robusta* and *Arabica* coffee in storage

Adeniyi, D. O., Mofolasayo, A. S. and Adeji, A. O.

Introduction

Interaction between environmental stress factors such as water activity and temperature, may have an influence on expression of the biosynthetic regulatory genes, growth and mycotoxin production by mycotoxigenic species of fungi. The risk of spoilage is a function of factors including: the variety of crop, time and method of harvest and storage, storage temperature, moisture content and drying method prior to storage. Storage is a critical stage where infection and mycotoxin accumulation occur. The potential sources for contamination of products are mostly environmentally based and include air, dust, soil, water, insects, rodents, birds, animals, microbes, humans, storage, shipping containers, handling and processing equipment. Infection of agricultural produce in the field by fungi could have resulted in production of mycotoxins during cultivation, harvesting, storage, transport and processing, most contamination is of a microbiological nature.

The adverse economic effects attributed to mycotoxin contamination and losses are widely felt in all sectors of food production and particularly in agricultural commodities. Mycotoxin contamination of agricultural commodities has considerable economic implications. Two important groups of fungi: field fungi and storage fungi. The previous invades the seeds while the latter still in the field and require high moisture conditions of 20 – 21%. (CAST, 2003). The growth of toxigenic fungi can adversely affect produce quality and produce mycotoxins. The fungal genera, *Fusarium* and *Alternaria* are considered most important because of their toxigenic ability to produce mycotoxins, they are classified as field fungi, while *Aspergillus* and *Penicillium* species are often considered storage fungi (Roige *et al*., 2009).

Fumonisin, aflatoxin, ochratoxin, zearalenone and trichothecenes such as deoxynivalenol, T-2 toxin and nivalenol are appreciate as most important mycotoxins. The important mycotoxins produced by *Aspergillus* species include aflatoxin B1, B2, G1 and G2, ochratoxin A, sterigmatocystin and cyclopiazonic acid. Aflatoxins are produced mainly by *A. flavus, A. parasiticus* and *A. nominus*. Zearalenone is a phenolic resorcyclic acid lactone mycotoxin produced by several *Fusarium* species, particularly *Fusarium graminearum*. The proliferation of these fungi is stimulated with higher moisture content, higher temperature during storage, long storage period, intensive infection by fungi before storage and by higher activity of insects and mites. Therefore, it is important to identify the species of fungi in coffee beans with special emphasis on mycotoxigenic species, which pose a potential risk to human and animal health. The occurrence and the formation of ochratoxin in processed coffee beans have been studied by many authors, it was present before storage, indicating the possibility that harvesting and post – harvest handling of coffee berries could be critical steps leading to contamination. There is currently little information available on the presence of ochratoxin – producing moulds in coffee beans that undergo wet and mechanical processes and the impact of these processes on the production or presence of ochratoxin among other mycotoxins.

Materials and Methods

Different types of coffee beans were sourced from stores in Cocoa Research Institute of Nigeria (CRIN). The coffee beans were of dry processed *Arabica* highland coffee, wet processed *Robusta* lowland coffee, husked dry processed *Robusta* lowland coffee and dry processed dehusked *Robusta* lowland coffee. The pH of the coffee beans of varied sources was determined using a pH meter following standard procedures. Effect of post-harvest handlings and storage were assayed on the associated mycotoxins in the categorized coffee beans.

Results and Discussion

The pH values of coffee beans varied with sources, the acidity of the beans was highest in husked dry processed *Robusta* lowland coffee with 4.5 while the dry processed *Arabica* highland coffee was near neutral with pH of 6.0. All categories of coffee beans used in this study had acidic medium condition.

Table 1: pH of stored coffee beans

Code	Coffee bean source	pH
AHD	dry processed *Arabica* highland coffee	6.0
RLW	wet processed *Robusta* lowland coffee	5.6
RLDH	husked dry processed *Robusta* lowland coffee	4.5
RLDD	dry processed dehusked *Robusta* lowland coffee	5.5

The dry processed *Arabica* highland coffee recorded five mycotoxins comprising of aflatoxins and ochratoxin-A. four other mycotoxins were detected whose identity were unknown. The concentration of ochratoxin-A was highest (8.6881ppb) followed by 8.2028ppb recorded for aflatoxin B2, while the least concentration of 3.1186ppb was recorded in aflatoxin G2 (table 2).

Table 2: Mycotoxins associated with dry processed *Arabica* highland coffee

Peak ID	Ret Time	Height	Area	Conc ppb
Aflatoxin B2	1.248	497921.000	5266799.000	8.2028
Aflatoxin B1	1.473	390751.188	4735150.500	6.9522
Aflatoxin G1	1.682	206823.641	3716628.750	4.7246
Aflatoxin G2	2.432	98751.609	2636212.500	3.1186
Unidentified	4.540	125.113	297.460	0.0018
Ochratoxin A	1.315	10153.037	205958.609	8.6881
Unidentified	1.773	9817.846	137223.656	4.4465
Unidentified	1.923	9410.674	206092.469	6.7081
Unidentified	2.498	5066.014	121860.164	4.1573

Aflatoxins B2, B1, Ochratoxins-A were detected in the wet processed *Robusta* lowland coffee with 10.9478ppb of aflatoxin B2 as the highest but aflatoxin B1 recorded the least concentration (3.0522ppb) while three other mycotoxins were not identified (table 3).

Table 3: Mycotoxins associated with wet processed *Robusta* lowland coffee

Peak ID	Ret Time	Height	Area	Conc ppb
Aflatoxin B2	1.298	748490.813	12600794.000	10.9478
Aflatoxin B1	1.765	186730.234	3774966.750	3.0522
Unidentified	0.115	51.658	295.867	0.0354
Ochratoxin A	1.307	10434.562	207410.438	4.7972
Unidentified	1.715	10529.284	420708.406	8.2983
Unidentified	2.557	6887.426	208012.031	2.8691

The dry processed dehusked *Robusta* lowland coffee also recorded eight mycotoxins but identity of three were not known. The identified toxins were Aflatoxins B2, B1, G1, G2 and Ochratoxins-A. Concentration of aflatoxin B1 (9.7053ppb) was highest but 0.0122ppb was the least recorded in aflatoxin G2 (table 4).

Table 4: Mycotoxins associated with dry processed dehusked *Robusta* lowland coffee

Peak ID	Ret Time	Height	Area	Conc ppb
Aflatoxin B2	1.315	218185.672	1444442.000	5.5544
Aflatoxin B1	1.490	324264.031	6658855.000	9.7053
Aflatoxin G1	2.340	58988.348	1181982.250	2.7281
Aflatoxin G2	2.973	705.000	1135.800	0.0122
Ochratoxin A	1.348	13182.044	247627.719	7.7454
Unidentified	1.815	11515.943	167668.438	2.1719
Unidentified	1.973	10747.178	214948.813	3.4241
Unidentified	2.548	5319.500	125975.227	1.6585

The concentration of mycotoxins varied with coffee bean types used in this study. The detected concentrations of aflatoxin B2 was most in wet processed *Robusta* lowland coffee, aflatoxin B1 highest in dry processed dehusked *Robusta* lowland coffee and ochratoxin-A was highest in dry processed *Arabica* highland coffee. Aflatoxin G2 recorded the least concentrations in dry processed *Arabica* highland coffee and dry processed dehusked *Robusta* lowland coffee while aflatoxin B1 was smallest in wet processed *Robusta* lowland coffee.

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KOLA PROGRAMME

Background

The Theme of Kola Research Programme is to Improve Kola Productivity and Promote Safe Consumption of the Produce in Nigeria. To achieve this theme, Kola Research Programme has set out the objectives to: a) improve the genetic potentials, agronomic and husbandry practices of Kola, b) identify effective control methods of pests and diseases of Kola, c) develop safe methods of Kola storage for human consumption and d) investigate effective utilization of Kola and its by-products. Against this background, in spite of the COVID-19 pandemic, the programme was able to achieve some of her set out objectives highlighted below:

1. Clonal propagation and development of high yielding Kola varieties

Introduction: The programme saw the urgent need for CRIN to assemble new kola germplasm and properly characterize its germplasm for optimum utilization. This is very important because the existing germplasm has a very narrow genetic base and is largely uncharacterized. Also, the existing germplasm consists of old and unfruitful trees. 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. The gestation of the crop also needs to be reduced. Proffering solutions to 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 needed to be improved upon and perfected by the Institute in her attempts to solve the aforementioned problems. This study therefore aims to identify good performing kola genotypes from farmer's plots and propagate them through cutting and grafting.

Methodology

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 fourteen accessions were used in the study. Stem cuttings were collected from the apical regions of the trees selected as mother trees which have diverse genetic origin. They are noted to fruit early and 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: Though 29.2% of the grafted materials remained green after two weeks of grafting, only 2% of the original population were successfully established into the germplasm plot. 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 29.2% that were green after two weeks remained green even beyond six weeks, and some sprouts were eventually recorded beyond eight weeks after grafting. A similar result was reported in 2018. These inconsistencies may be attributed to the timing of the grafting which lied between March and August. 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.

Callus formation and eventually, root development occurred in some of the accessions used in the setting of cuttings. Three months after setting of cuttings, 36.84% of the original population of the cuttings set remained green after 12 weeks of setting (Figure 2a). Ten percent (10%) of these green produced new

sprouts (Figure 2b), which are already developing through the juvenile stage at 12 weeks after setting (Figure 2c and 2d).

Figure 1: Successful grafting in Cola accessions

Figure 2: Sprouting, Leaf formation and development of juveniles in Cola cuttings

Achievement

Many cuttings and grafted materials from this experiment were successfully established in a new Cola germplasm plot at CRIN Headquarters, Ibadan. The success obtained in the setting of the kola cuttings is significantly different from all the previous results obtained from cuttings of the various *Cola* spp set. This result indicates that with further efforts, CRIN will be able to successfully establish clones of better performing kola genotypes in its germplasm collection, thereby paving way for the development of improved kola varieties for distribution to farmers.

2. Evaluation of antimicrobial potentials of selected botanicals against kola nut storage rot pathogen (*Lasiodiplodia theobromae*)

Introduction: Cola species (Family: Sterculiaceae) are native to the tropical rainforests of Africa, West Indies, and Brazil. The kola tree reaches heights of between 40-60 feet. Out of the twenty-five species known to exist, *Cola nitida* and *C. acuminata* are the two most commonly cultivated and suitable for human consumption. Nuts of these two *Cola* spp. are commercial export commodities for the production of kola-chocolate, liquors, laxatives and caffeine for pharmaceutical purposes. Maturity of kola fruits usually takes place 4-5 months after pollination, with characteristic change in colour from deep green to a paler tint (at a time the fruit should be harvested), as the follicles will start to dehisce thereafter. Exposed seeds are more prone to insect attack and subsequently predispose the nuts to fungal infection. Numerous toxic metabolites are produced in mould-infected stored kola nuts as can be found in other mould-contaminated foods. When such nuts are consumed, they pose a huge health risk to the consumers. Due to the warm, humid rainforest zone in which cultivation, processing and storage of the kola nuts take place, there is high risk of mould infection. Most traders as a result, labour assiduously to maintain the freshness of the nuts, prevent fungi growth and insect attack that predisposes Cola to rot infection in storage. This requires removal of infested nuts at intervals during the storage period, but this does not control fungi which spread rapidly in the nuts. Most traders and consumers do not discard fairly mouldy nuts during storage, leading to infection of more hitherto healthy nuts and a huge loss in the long-run.

Diseases associated with stored kola nuts include dry rot, grey mould and black rot. Storage rot caused by *Lasiodiplodia theobromae* is a serious post-harvest disease of kola nut. This fungus, with some other storage moulds, causes discolouration, shrinking, rottening and physiological alterations in kolanut. These subsequently cause defects which seriously depreciate the commercial value of the nuts. In a bid to control the incidence of storage-induced kola nut rot/spoilage, most of the individuals trading in the commodity have resorted to the use of synthetic chemicals, which though very effective, is costlier and

constitute some high level health hazards to both the handlers and consumers of the commodity. There is therefore, the need to shop for much safer, ecologically friendly and cheaper alternatives for the management of kola nut storage disease.

Methodology: The effectiveness of leaf extracts of *Azadirachta indica, Piper guineense, Eucalyptus camaldulensis*, *Lantana camara* and *Citrus sinensis* peel against mycelia (vegetative) growth and pycnidia production of kola nut rot pathogen, *L. theobromae*, was determined using poisoned food technique. Ten (10), 20, 30 and 40% concentrations of each of the five extracts were prepared from their stock solutions and pour-plated with freshly sterilized but cooled (45oC) potato dextrose agar (PDA). Synthetic fungicide (mancozeb 80WP) solution was prepared at the manufacturer's recommended rate of 0.5g/100ml and separately pour-plated with PDA to serve as standard check/positive control. The freshly prepared PDA was also poured into another set of sterile Petri dishes containing neither extracts nor chemicals to serve as untreated/negative control.

The poisoned as well as control plates were inoculated with agar discs (8mm diameter) of the kola rot pathogen cut with the aid of a sterile cork borer. All the plates were incubated at 28-32oC and the mycelia growth diameter of the inoculated fungus in each of the plates was measured every 24hours using transparent ruler until the negative control plates were completely covered. Percentage inhibitions of the pathogen's mycelia growth were calculated using the formula:

Percentage inhibition (%) =

Where: Dc = Mycelia growth diameter in control

Dt = Mycelia growth diameter in treatment

Each of the treatments was replicated thrice in a completely randomized design. At the tenth day of incubation, pycnidia structures produced on each of the treated plates and their controls were counted and recorded. Data obtained were subjected to analysis of variance using Statistical Analysis Software (SAS) 9.1 package.

Results: Percentage mycelia growth inhibitions produced by extracts of *A. indica, P. guineense, L. camara*, Eucalyptus and Citrus peels within 24 hours of incubation ranged between 26.09-33.05%, 33.05-51.31%, 45.22-60.87%, 55.65-64.35%, and 52.18-67.83% respectively (Table 1). At 24 hours after incubation, the four extract concentrations of Eucalyptus as well as 20-40% concentrations of Citrus extract and 10% Lantana gave significantly highest mycelia inhibitions ($P \leq 0.05$) against *L. theobromae* and better than the standard check (mancozeb). These were closely followed by 20% Lantana, Mancozeb,

10% Citrus and 40% *P. guineense* which produced 53.74, 53.48, 52.18, and 51.31% mycelia growth inhibitions, respectively, while the four extract concentrations of Azadirachta and 10% *P. guineense* gave the least inhibitions (Table 1). The situation was more or less the same at 48 hours after incubation, but with the standard check (Mancozeb) producing the highest inhibition at this instance. The chemical also gave the significantly highest mycelia inhibition, 53.69% ($P \leq 0.05$) at 72 hours of incubation, followed by 20-40% Citrus extracts, 30 and 40% Eucalyptus, 10 and 30% Lantana and 40% *P. guineense*. The four extract concentrations of Azadirachta as well as 10-30% *P. guineense*, 20% Lantana, 10 and 20% Eucalypus and 10% Citrus produced significantly lowest inhibition values ($P \leq 0.05$) (Table 1).

Virtually all the extract concentrations with the exemption of 10 and 20% Azadirachta, 10-40% P. guineense, 30% Lantana and 30 and 40% Eucalyptus, showed noticeable reductions in the mycelia growth inhibitions at 48 hours after incubation when compared with their respective values, 24 hours earlier. A similar trend was noticed in the positive control plates (Table 1).

Average number of pycnidia induced by Azadirachta, *P. guineense*, Lantana, Eucalyptus and Citrus ranged between 10-24, 3-28, 9-34, 8-51, and 8-48, respectively, while an average of 36 pycnidia were observed in the negative control plates (Table 1). The number of pycnidia produced by the pathogen decreased as the concentration of each of the extracts increased. Eucalyptus at 10% concentration induced the highest average number of pynidia (51), followed by 20% concentration of the extract (48), and 10% Citrus (48). The positive control plates showed no pycnidia growth, while *P. guineense* at 40% concentration closely followed with an average number of 3 pycnidia (Table 1).

Highest overall inhibitions (58%) were produced by mancozeb, and closely followed by Citrus (49.17%), Eucalyptus (49.13%) and Lantana (42%), while Azadirachta (26.6%) gave the least inhibition against the pathogen (Figure 3).

Table1: Inhibitory effects of plant extracts on mycelia growth and sporulation of *L. theobromae*

Extract	**Conc. (%)**	**Mycelia growth inhibition (%) at:**			
		24HAI	**48HAI**	**72HAI**	**Average no. of pycnidia**
NL					

10	29.59fg	34.93f-h	23.93c	24.00
20	26.09g	26.83h	21.57c	21.00
30	33.05e-g	28.60gh	22.94c	17.00
40	26.96g	23.54h	21.18c	10.00
IY				
10	33.05e-g	38.98fg	24.71c	28.00
20	40.87d-f	47.34c-f	26.28c	23.00
30	37.39e-g	44.81d-f	23.34c	20.00
40	51.31b-d	58.23a-c	29.23b-c	3.00
LT				
10	45.22c-e	40.00e-g	24.71c	34.00
20	46.09c-e	41.52ef	25.69c	31.00
30	53.74b-d	46.83c-f	30.80bc	21.00
40	60.87ab	56.96a-d	31.59bc	9.00
EU				
10	55.65a-c	44.81d-f	24.32c	51.00
20	64.35ab	52.40b-e	23.34c	48.00
30	62.61ab	64.05ab	38.07b	36.00

40	64.35ab	64.05ab	31.59bc	8.00
OR				
10	52.18b-d	43.29ef	23.93c	48.00
20	57.39a-c	51.90b-e	30.41bc	24.00
30	62.61ab	61.77ab	38.66b	16.00
40	67.83a	60.00ab	40.04b	8.00
MCB	53.48b-d	66.83a	53.69a	0.00
CTR	-	-	-	36.00

Means with same letters in the same column are not significantly different at P≤0.05 using Fisher's LSD Test

Key: NL- *Azadirachta indica* IY- *Piper guineense* LT- *Lantana camara*

EU- *Eucalyptus camaldulensis* OR- *Citrus sinensis* (peel) MCB- Mancozeb

HAI- Hours after incubation

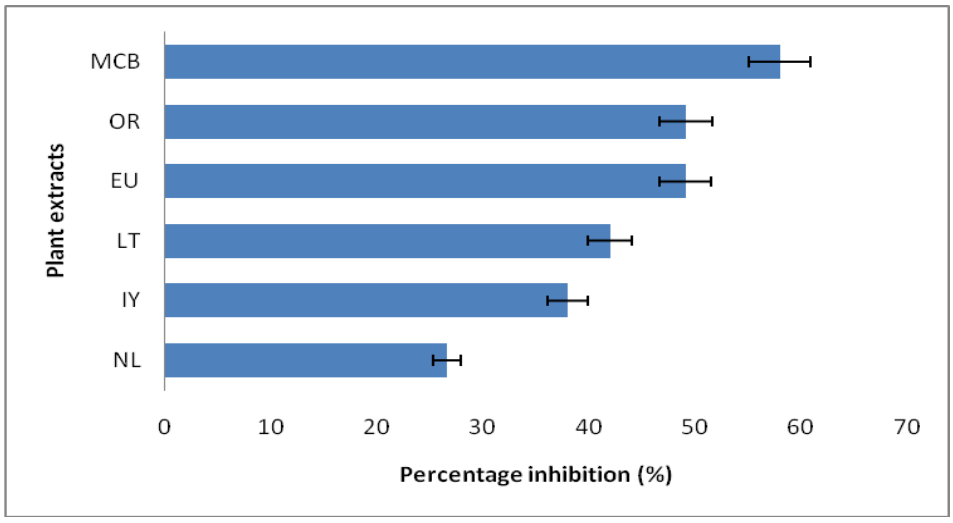

Figure 3: Overall effects of plant extracts on the mycelia growth of kola rot fungus, *L. theobromae*

Key: NL- *Azadirachta indica* IY- *Piper guineense* LT- *Lantana camara*

EU- *Eucalyptus camaldulensis* OR- *Citrus sinensis* (peel) MCB- Mancozeb

Findings from this research showed a decrease in the number of pycnidia produced by the kola pathogen as extract concentrations of all the botanicals used in this study increased, indicating an increase in extract inhibitory effects on the pathogen's sporulation. The inhibitory effects of the plant extracts used in this study against the kola nut storage pathogen, *L. theobromae* was due to the presence of some phytochemicals, which are secondary metabolites synthesized by plants and often sequestered in tissues to protect them against microbial attacks.

Achievement

The use of extracts of *P. guineense* (aqueous) and *L. camara* (ethanolic) at 20-40% and 10-20% concentrations, respectively, having shown some potential against the kola pathogen, is therefore recommended for an effective control of kola storage rot disease.

3. Partnership with Bissy Inc. USA for the production of Kola Powder

The Institute partnered with Bissy Inc. USA geared towards promoting production, processing and healthy consumption of kola nuts locally and internationally. We were able to source kola nuts free of diseases and chemical residue from farms that are observing Good Agricultural Practices (GAP). These were delivered to the AACE Processing Factory, Sango, Otta, Ogun State.

Achievement

Kola energy powder, with three (3) times natural caffeine more than Coffee, was produced from the processed kola nuts. The powder is rich with antioxidants, boosts metabolism and improves performance, more effective than coffee and tea.

Figure 4. Kola nut Energy Powder

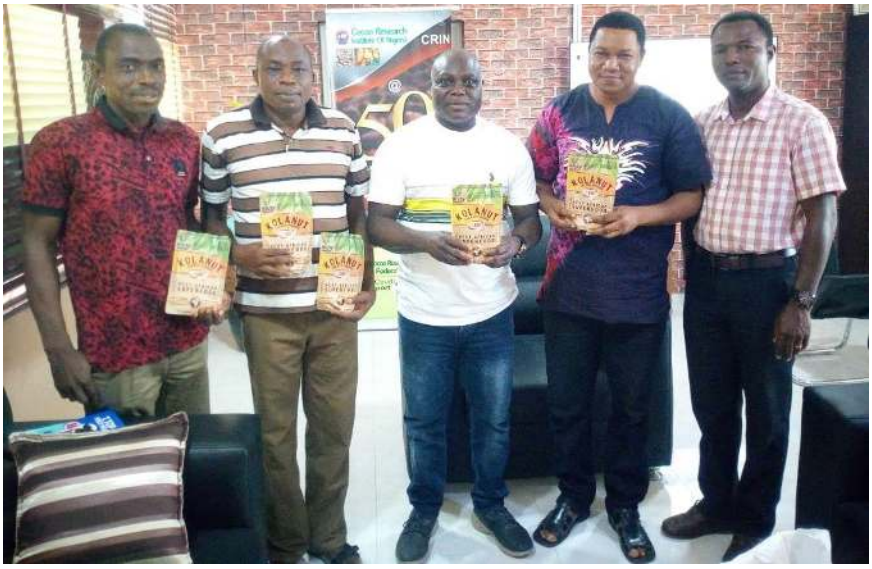

Figure 5. Presentation of Kolanut Energy Powder by CRIN Scientists to the ED, Dr. Patrick Adebola (middle)

ANNUAL REPORT 2020

Title: Evaluation of antimicrobial potentials of selected botanicals against kola nut storage rot pathogen (*Lasiodiplodia theobromae)* in Nigeria (Ogundeji, B. A., Orisajo, S. B., Olorunmota, R. T., Oyedokun, A. V. and Agbeniyi, S. O.)

Introduction

Cola species (Family: *Sterculiaceae*) are native to the tropical rainforests of Africa, West Indies, and Brazil. The kola tree reaches heights of between 40-60 feet. Out of the twenty-five species known to exist, *Cola nitida* and *C. acuminata* are the two most commonly cultivated and suitable for human consumption (Opeke, 1992). Nuts of these two *Cola* spp. are commercial export commodities for the production of kola-chocolate, liquors and laxatives. The presence of alkaloids such as caffeine, kolanin and theobromine make kolanuts useful for pharmaceutical purposes (Atanda *et al*., 2011). The caffeine containing nut is used also as a flavouring ingredient in beverages and that is the origin of the term *cola* (Greenwood, 2016). Maturity of kola fruits usually takes place 4-5 months after pollination, with characteristic change in colour from deep green to a paler tint (at a time the fruit should be harvested), as the follicles will start to dehisce thereafter. Exposed seeds are more prone to insect attack and subsequently predispose the nuts to fungal infection. Numerous toxic metabolites are produced in mould-infected stored kola nuts as can be found in other mould-contaminated foods. When such nuts are consumed, they pose a huge health risk to the consumers (Opeke, 1992; Ndubuaku, 2015; Jimenez, 1991). Due to the warm, humid rainforest zone in which cultivation, processing and storage of the kola nuts take place, there is high risk of mould infection. Most traders as a result, labour assiduously to maintain the freshness of the nuts, prevent fungi growth and insect attack that predisposes *Cola* to rot infection in storage. This requires removal of infested nuts at intervals during the storage period, but

this does not control fungi which spread rapidly in the nuts. Most traders and consumers do not discard fairly mouldy nuts during storage, leading to infection of more hitherto healthy nuts and a huge loss in the long-run (Atanda *et al*., 2011).

Diseases associated with stored kolanuts include dry rot, grey mould and black rot. Storage rot caused by *Lasiodiplodia theobromae* is a serious post-harvest disease of kolanut (Agbeniyi 1998). This fungus, with some other storage moulds, causes discolouration, shrinking, rottening and physiological alterations in kolanut. These subsequently cause defects which seriously depreciate the commercial value of the nuts (Agbeniyi, 2014). In a bid to control the incidence of storage-induced kolanut rot/spoilage, most of the individuals trading in the commodity have resorted to the use of synthetic chemicals, which though very effective, is costlier and constitute some high level health hazards to both the handlers and consumers of the commodity (Mokwunye and Oluyole, 2017). There is therefore, the need to shop for much safer, ecologically friendly and cheaper alternatives for the management of kola nut storage disease.

Materials and Methods

The effectiveness of leaf extracts of *Azadirachta indica*, *Piper guineense*, *Eucalyptus camaldulensis*), *Lantana camara* and *Citrus sinensis* peel against mycelia (vegetative) growth and pycnidia production of kolanut rot pathogen, *L. theobromae,* was determined using poisoned food technique. Ten (10), 20, 30 and 40% concentrations of each of the five extracts were prepared from their stock solutions and pour-plated with freshly sterilized but cooled (45^{o}C) potato dextrose agar (PDA). Synthetic fungicide (mancozeb 80WP) solution was prepared at the manufacturer's recommended rate of 0.5g/100ml and separately pour-plated with PDA to serve as standard check/positive control. The freshly prepared PDA

was also poured into another set of sterile Petri dishes containing neither extracts nor chemicals to serve as untreated/negative control.

The poisoned as well as control plates were inoculated with agar discs (8mm diameter) of the kola rot pathogen cut with the aid of a sterile cork borer. All the plates were incubated at 28-32^{o}C and the mycelia growth diameter of the inoculated fungus in each of the plates was measured every 24hours using transparent ruler until the negative control plates were completely covered. Percentage inhibitions of the pathogen's mycelia growth were calculated using the formula:

Percentage inhibition (%) = $\frac{Dc-Dt}{Dt} x100$

Where: D_c = Mycelia growth diameter in control

D_t = Mycelia growth diameter in treatment

Each of the treatments was replicated thrice in a completely randomized design. At the tenth day of incubation, pycnidia structures produced on each of the treated plates and their controls were counted and recorded. Data obtained were subjected to analysis of variance using Statistical Analysis Software (SAS) 9.1 package.

Results and Discussion

Percentage mycelia growth inhibitions produced by extracts of *A. indica, P. guineense, L. camara, Eucalyptus* and *Citrus* peels within 24 hours of incubation ranged between 26.09-33.05%, 33.05-51.31%, 45.22-60.87%, 55.65-64.35%, and 52.18-67.83% respectively (Table 1). At 24 hours after incubation, the four extract concentrations of *Eucalyptus* as well as 20-40% concentrations of *Citrus* extract and 10% *Lantana* gave significantly highest mycelia inhibitions (P≤0.05) against *L. theobromae*and better than the standard check (mancozeb).These were closely followed by 20% *Lantana,* Mancozeb*,* 10% *Citrus* and

40% *P. guineense* which produced 53.74, 53.48, 52.18, and 51.31% mycelia growth inhibitions, respectively, while the four extract concentrations of *Azadirachta* and 10% *P. guineense* gave the least inhibitions (Table 1). The situation was more or less the same at 48 hours after incubation, but with the standard check (Mancozeb) producing the highest inhibition at this instance. The chemical also gave the significantly highest mycelia inhibition, 53.69% (P≤0.05) at 72 hours of incubation, followed by 20-40% *Citrus* extracts, 30 and 40% *Eucalyptus*, 10 and 30% *Lantana* and 40% *P. guineense.* The four extract concentrations of *Azadirachta* as well as 10-30% *P. guineense,* 20% *Lantana*, 10 and 20% *Eucalypus* and 10% *Citrus* produced significantly lowest inhibition values (P≤0.05) (Table 1).

Virtually all the extract concentrations with the exemption of 10 and 20% *Azadirachta*, 10-40% *P. guineense,* 30% *Lantana* and 30 and 40% *Eucalyptus* showed noticeable reductions in the mycelia growth inhibitions at 48 hours after incubation when compared with their respective values, 24 hours earlier. A similar trend was noticed in the positive control plates (Table 1).

Average number of pycnidia induced by *Azadirachta, P. guineense, Lantana, Eucalyptus* and *Citrus* ranged between 10-24, 3-28, 9-34, 8-51, and 8-48, respectively, while an average of 36 pycnidia were observed in the negative control plates (Table 1). The number of pycnidia produced by the pathogen decreased as the concentration of each of the extracts increased. *Eucalyptus* at 10%concentrationinduced the highest average number of pynidia (51), followed by 20% concentration of the extract (48), and 10% *Citrus* (48). The positive control plates showed no pycnidia growth, while *P. guineense* at 40% concentration closely followed with an average number of 3 pycnidia (Table 1).

Highest overall inhibitions (58%) were produced by mancozeb, and closely followed by *Citrus* (49.17%)*, Eucalyptus* (49.13%) and *Lantana* (42%), while *Azadirachta* (26.6%) gave the least inhibition against the pathogen (Figure 1).

Table1: Inhibitory effects of plant extracts on mycelia growth and sporulation of *L. theobromae*

Extract	Conc. (%)	Mycelia growth inhibition (%) at:			
		24HAI	48HAI	72HAI	Average no. of pycnidia
NL					
	10	29.59fg	34.93f-h	23.93c	24.00
	20	26.09g	26.83h	21.57c	21.00
	30	33.05e-g	28.60gh	22.94c	17.00
	40	26.96g	23.54h	21.18c	10.00
IY					
	10	33.05e-g	38.98fg	24.71c	28.00
	20	40.87d-f	47.34c-f	26.28c	23.00
	30	37.39e-g	44.81d-f	23.34c	20.00
	40	51.31b-d	58.23a-c	29.23b-c	3.00
LT					

10	45.22c-e	40.00e-g	24.71c	34.00
20	46.09c-e	41.52ef	25.69c	31.00
30	53.74b-d	46.83c-f	30.80bc	21.00
40	60.87ab	56.96a-d	31.59bc	9.00
EU				
10	55.65a-c	44.81d-f	24.32c	51.00
20	64.35ab	52.40b-e	23.34c	48.00
30	62.61ab	64.05ab	38.07b	36.00
40	64.35ab	64.05ab	31.59bc	8.00
OR				
10	52.18b-d	43.29ef	23.93c	48.00
20	57.39a-c	51.90b-e	30.41bc	24.00
30	62.61ab	61.77ab	38.66b	16.00
40	67.83a	60.00ab	40.04b	8.00

MCB	53.48b-d	66.83a	53.69a	0.00
CTR	-	-	-	36.00

Means with same letters in the same column are not significantly different at P≤0.05 using Fisher's LSD Test

Key: NL- *Azadirachta indica* IY- *Piper guineense* LT- *Lantana camara*

EU- *Eucalyptus camaldulensis* OR- *Citrus sinensis* (peel) MCB- Mancozeb

HAI- Hours after incubation

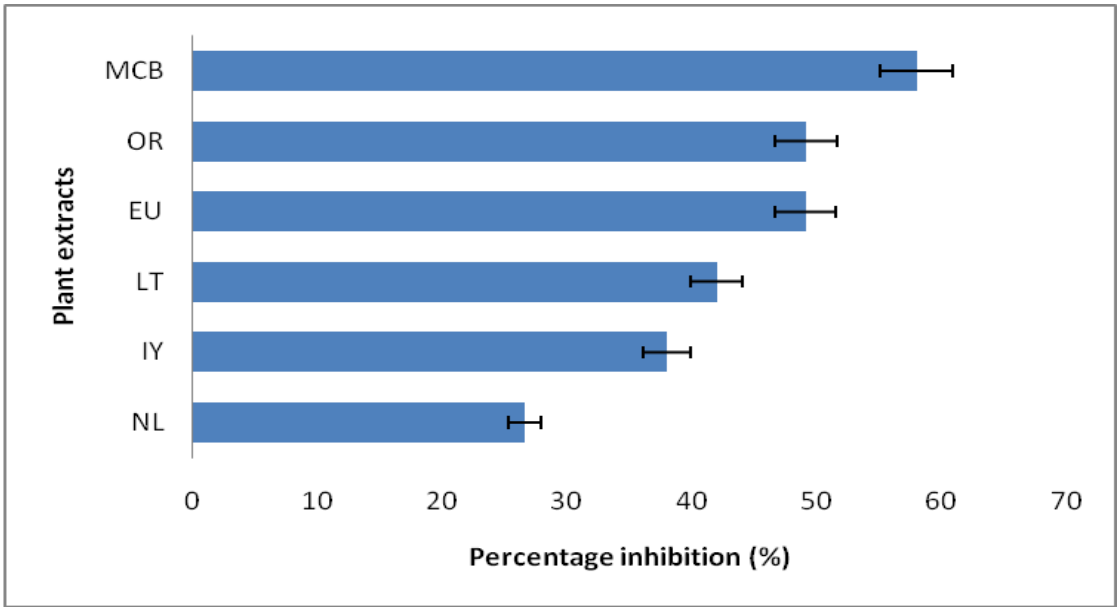

Figure 1: Overall effects of plant extracts on the mycelia growth of kola rot fungus, *L. theobromae*

Key: NL- *Azadirachta indica* IY- *Piper guineense* LT- *Lantana camara*

EU- *Eucalyptus camaldulensis* OR- *Citrus sinensis* (peel) MCB- Mancozeb

The inhibitory effects of the plant extracts used in this study against the kolanut storage pathogen, *L. theobromae* was due to the presence of some phytochemicals, which are secondary metabolites synthesized by plants and often sequestered in tissues to protect them against microbial attacks (Nweke, 2015). Findings from this research showed a decrease in the number of pycnidia produced by the kola pathogen as extract concentrations of all the botanicals used in this study increased, indicating an increase in extract inhibitory effects on the pathogen's sporulation. All the extracts used in this study (with the exception *A. indica* and *P. guineense*) also clearly produced increasing inhibitory effects against the pathogen's mycelia growth with increasing concentrations all through the incubation periods. These findings clearly agree with the discovery of Nweke (2015) who reported that the inhibitory effect of the extract of *C. aurantifolia* on the mycelia growth and spore germination of some plant pathogens increased with increasing concentration of the extracts. The findings of Ogundeji *et al.* (2018) which indicated that the percentage inhibition exhibited by freshly prepared aqueous extract of *P. guineense* against *P. megakarya* consistently increased with extract concentration also partly agrees with the results of this study. Mycelia inhibitions produced by the *P. guineense*in this study however does not agree with the findings of the authors.

Noticeable reductions in the effectiveness of the extracts at 48 to 72 hours after incubation agrees with the findings of Babalola *et al.* (2017) which opined that the antimicrobial potencies of some plant extracts including *P. guineense* decreased as incubation period increased. This discovery also seems to agree with the findings of Ogundeji *et al.* (2018) which indicated a reduction in the

effectiveness of some selected botanicals against cocoa black pod disease pathogen, *Phytophthora megakarya* with storage time. The increase noticed in the pathogen's mycelia inhibition between 24-48 hours of incubation however disagrees with these facts.

The very low average percentages of inhibition produced by *Azadirachta* extracts against the kola rot pathogen disagrees with the findings of Adeniyi and Joseph (2014) which explained that the botanical, among a few others, could be used to effectively control strains of *L. theobromae* affecting cashew. Findings from this study also partly disagree with Sahi *et al.* (2012), who in an *in vitro* evaluation discovered that *Eucalyptus camaldulensis* and *A. indica* were effective against mycelia growth of *L. theobromae* strain causing quick decline of mango. These disparities may be an indication to a stronger aggressive nature on the part of the strain of *L. theobromae* affecting kola, when compared to others isolated from both cashew and mango. The differences may most likely be brought about by inherent and/or acquired genetic variations among the different strains. Further research however need to be carried-out to substantiate this possibility.

Differences in the number of pycnidia induced by the various extracts used in this study would most likely be due to differences in the type and/or concentrations of anti-sporulation ingredients naturally present within each of the plant extracts. Also, the production of lesser number of pycnidia as the concentrations of each of the extracts increased is an indication of the proportional presence of compounds capable of inhibiting sporulation in the botanicals.

Conclusion

Lantana, *Eucalyptus* and *Citrus* peel extracts used in this study, having shown reasonable efficacy, particularly within the first 48 hours of incubation, competed favourably with the positive control in the inhibition of kola rot pathogen, *L. theobromae.* Higher concentration (40%) of *P.*

guineense, having shown some promise in inhibiting the pathogen's pycnidia production, could also be used in the suppression of the pathogen's sporulation. The use of extracts of *P. guineense* (aqueous) and *L. camara* (ethanolic) at 20-40% and 10-20% concentrations respectively, having shown some potential against the kola pathogen, is therefore recommended for an effective control of kola storage rot disease.

Status: Completed

Title: Development of Bio-Pesticides for the Preservation of Stored Kola Nuts (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. 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*, *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). This project attempts to explore and develop safe alternatives, such as bio-pesticides, for the control of storage pests and diseases 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. 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.

Aqueous extract formulations: The plant parts of all the collected plant samples (leaves, seeds and bulbs) were chopped into bits and air dried for two weeks before being pulverized with a high-speed mill into fine powder. A range of serial dilutions was made with water to obtain solutions of three doses of 1,000g/L (100% w/v), 500g/L (50% w/v) and 250g/L (25% w/v) by soaking the samples in 1 litre of water. The solutions were left for 24 hours and then filtered to obtain the aqueous extracts in accordance with methods used by Ndubuaku, (2014).

Bioassay screening of the candidate plant materials in the laboratory: The efficacy of the aqueous extracts of the five (5) test plant samples were carried out at a concentration 100% w/v of the extract. The plant used were *Tectonia grandis, Musa paradisiaca, Carica papaya, Chromolaena odorata, Nicotiana tabacum, Jatropha spp* and *Vernonia amygdalina*. Twenty (20) cured kolanuts were randomly sorted out into three transparent plastic bowls of 1 litre volume each, containing 100% w/v of the extracts. The kolanuts were soaked in these various concentrations for 12 hours. A reference standard insecticide (Cypermethrin 10 EC) was used for comparison (Positive control), while distilled water was

used as the control treatment (Negative control). The negative control treatment (0% w/v) kolanuts were soaked in distilled water for the same period of time, while the reference standard treated nuts were soaked in Cypermethrin for ten (10) minutes. Each of the treatments was replicated four times in a completely randomized design (CRD). The nuts were removed after the soaking period and placed in small flat baskets for excess water to drain off. The nuts in the baskets were aerated in the laboratory for a period of 72 hours to reduce the moisture content to a minimal level. The kolanuts treated with the various aqueous plant extracts were each placed in black light gauge polythene bag of dimension 42.5cm x 21.0cm and tied up. All the treatments were stored at the Entomology laboratory for subsequent record taking.

Post storage assessments: The various treatment levels in separate polythene bags were sieved every fortnight to determine the progress of adult *Balanogastris kolae* and *Sophrorhinus* spp emergence by direct counting of newly emerged adult weevil. Data obtained will be subjected to the analysis of variance and significant means were separated at 5% level using the Tukey's Honestly Significance Difference (HSD) Test.

Status: On-going.

2020 RESEARCH REPORT

Kola Research Programme

Development of Bio-pesticides for the Preservation of stored kola nuts (Entomology aspect)

Investigators:

Entomology Team: Mokwunye, I. U., Asogwa, E.U. and Olorunmota, R. T.

External Collaborators: Prof. O.O. Oyesiku and Dr. (Mrs.) E.O. Adesanya

Department of Biological Sciences,Olabisi Onabanjo University (OOU), Ogun State

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, Acoruscalamus, Hyptisspicigera*, *Cassia nigricans* and *Menthaspicala* which have been shown to be effective against bruchids, curulionids and the tenebrionid*Triboliumcastaneum* (Mishra *et al.*, 1984; Stoll, 1988). Seeds and fruits of *Azadirachtaindica* and *Dennettiatripetala* and*Piper guineese* have pesticidal and behaviour modifying properties against various pests of stored products including kola (Asogwa*et al*., 2015; Ndubuaku, 2014; Lale, 1992; Ugwu and Mokwunye, 2019). This main objective of the project was to develop biopesticides as safe alternative for control of storage pests of kola that can be easily administered and adopted by farmers.

Materials and methods

Collection and Preparation of Plant extracts

The plant materials were obtained from the CRIN forest and environs. The plant materials were *Nicotianatabacum, Tectonagrandis, Jatrophacurcas, Musa paradisiaca, Carica papaya, Chromolaenaodorata* and Pepper. 200g of each plant material was measured and rinsed in 10% Sodium hypocloride solution. These were air-dried for 30 minutes in the laboratory. Then the dry sample of individual plant material was pulverised by pounding in a mortar. Thereafter, the powdery sample was soaked in 100 ml of water for 24 hours. The solutions were left for 24 hours and then filtered to obtain the aqueous extracts. The aqueous extracts were sterilized in the water bath. A range of serial dilutions was made with water to obtain solutions of three doses of 1,000g/L (100% w/v), 750g/L (75% w/v), 500g/L (50% w/v), 250g/L (25% w/v) and 100g/L (10% w/v) by soaking the samples in 1 litre of water. These extracts were used subsequently for the laboratory residual contact bioassays and storage trials.

Sources of kolanuts and other materials

Unskinned kola nuts for these experiments were purchased from local farmers and traders at Ogunmakin and Mamu markets, both inOgun State, Nigeria.

Residual toxicity of the candidate plant materials in the laboratory

The plants used were *Tectonagrandis, Musa paradisiaca, Carica papaya, Chromolaenaodorata, Nicotianatabacum*and *Jatrophacurcas*. The residual contact toxicity of the candidate plant materials was conducted in the laboratory using aqueous extracts of the seven (7) test plant samples at a concentration of 100% w/v. This was done by introducing 1ml of each plant aqueous extract into the filter paper placed in a petridish with perforated lids. Then five weevils were placed in the petridish. Distilled water was used as the control treatment (Negative control). Each of the treatment was replicated four (4) times. The weevil mortality was confirmed by gently probing each with a Camel's hairbrush and those that did not show any sign of movement were recorded as dead. Mortality count was taken at 20 minutes intervals for 300 minutes and continued daily for 3 days.The percentage (%) mortalities were recorded to determine the relative toxicity of the aqueous plant materials applied. This was compared with percentage mortality in untreated petridishes.

Kola nut storage trials with the candidate plant materials

Forty (40) cured kolanuts were randomly sorted out into three transparent plastic bowls of 1 litre volume each, containing the various concentrations (25% w/v, 50% w/v and 100% w/v) of the extracts. The kolanuts were soaked in these various concentrations for 18 hours. A reference standard insecticide (Cypermethrin 10 EC) was used for comparison (Positive control), while distilled water was used as the control treatment (Negative control). The negative control treatment (0% w/v) kolanuts were soaked in distilled water for the same period of time, while the reference standard treated nuts were soaked in Cypermethrin for ten (10) minutes. Each of the treatments was replicated four times in a completely randomized design (CRD). The nuts were removed after the soaking period and placed in small flat baskets for excess water to drain off. The nuts in the baskets were aerated in the laboratory for 6 days to reduce the moisture content to a minimal level. The kolanuts treated with the various concentrations of the aqueous extracts were each placed in black light gauge polythene bag of dimension 42.5cm x 21.0cm and tied up. All the treatments were stored at the Entomology laboratory for three (3) months.

Post storage assessments

The various treatment levels in separate polythene bags were sieved every week to determine the progress of adult *Balanogastriskolae* and *Sophrorhinus*spp emergence by direct counting of newly emerged adult weevil until 98 days post treatment period (DPTP).

Extraction of bioactive components of the plant samples

The extraction and isolation of bioactive components of the plant samples were conducted at the Biology Laboratory, OlabisiOnabanjo University, Ago-Iwoye, Ogun State. Plant samples used included *Tetrapleuratetraptera, Jatrophacurcas, Lantana camara, Vernoniaamygdalina, Nicotianatabacum, Eucalyptus camaldulensis*and*Cymbogoncitratus*. The leaves of collected plant samples were chopped into bits and air dried in the laboratory for two weeks. Solvent-Assisted Extraction (SAE) according to Cañas-Hoyos*etal*., (2017) with slight modification was adopted. The dry samples were pulverized with an electric blender into coarse powder which were weighed and then macerated in three different solvents – Hexane, DCM and methanol representing non-polar, medium polar and high polar environment for 120 hr. The solution was concentrated in a rotary evaporator to remove the solvent and obtain the concentrates. The concentrates have been stored for subsequent use.

Statistics

Data obtained were subjected to the analysis of variance and significant means were separated at 5% level using the DMRT.

Results and Discussion:

There was no significant difference between the mortality caused by aqueous extracts of the plant samplesand control from 20 min to 280 mins after exposure. Though, *N.tabacum* was quick-acting as mortality of 15%, was observed at 40 minutes after exposure, this was not significantly different from others (Table 1). While *M. paradisiaca* extract recorded the earliest mortality at 100 min of exposure. Aqueous extracts of *Jatrophacurcas* and *Caricapapaya* did not record any mortality until 24 hr after exposure. At 300 minutes, only*N.tabacum*extract caused significant mortality (30%) which was different from the other treatments except *T. grandis*. At 24 hr, 48 hr and 72 hr, mortalities recorded for *N.tabacum* were 65%, 70% and 70%, respectively, these were significantly higher thanother treatments (Table 1). In previous studies, *N. tabacum*has alsobeen reported to possess insecticidal property.

The storage trial lasted for fourteen weeks when the weevils stopped emerging. Weevil emergence was observed in all the treatments at varying levels. There was no distinctive difference in terms of number of weevil that emerged amongst the different plant materials. The aqueous extracts of the tested plant materials neither suppressed development and emergence of the kola nut weevil in treated stored nuts nor sufficiently cause mortality of weevils. However, plant materials can be exploited for their pesticidal activity in either of the three major formulation types: aqueous, oil and powder. In addition, the efficacy of the formulation can also

depend on the plant part used, for instance ,Ugwu and Mokwunye (2019) reported that ethanol extract of seeds of *Jatropha*spp recorded up to 100 % mortality within 24 hr.

Consequently, we approached the OlabisiOnabanjo University (OOU) for collaboration in order to access its facilities such as equipment and Laboratory use, which was gladly granted. The bioactive components for each plant sample have been obtained and stored for subsequent use.

Conclusion and Recommendations

Out of all the plant samples tested*, N. tabacum*showed good prospects for use for kola nut protection against weevil in storage. However the drawback with its use is that the concentration that can effect mortality is 100% which is not feasible for economic reasons.

The collaboration with the Research team from OOU should be nurtured and strengthened.In addition, the following activities are proposed for the full delivery of the project objectives.

- Determination of pesticidal properties of the bioactive components
- Formulation of most active extracts in pellets
- Determination of the pesticidal property of the pellets
- GCMS identification of the pesticidal compounds

Challenges

- Sourcing for weevil was very challenging largely because it was off season at the time of fund release and this delayed the work very much.
- Lack of conducive laboratory facilities for the maintenance of stock culture for continuous and regular supply of weevil.
- The lockdown of the institute as a result of the covid-19 pandemic and on-going strike action constitute major constraints.

Table 1: Mortality of adult *Balanogastris kolae*treated with aqueous of selected plant materialsin the laboratory

Treatments	% Mortality/Time of exposure (minutes and hours)

	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	24hr	48hr	72hr
Nicotianatabacum	0a	15a	15a	15a	15a	15a	15a	15a	15a	15a	25a	25a	25a	30b	65b	70b	70cd	
Tectoniagrandis	0a	0a	0a	0a	0a	0a	15a	15	15a	20a	20a	20a	20a	25a	25ab	30a	30a	65c
Jatrophacurcas	0a	0a	0a	0a	0a	0a	0a	0a	0a	0a	0a	0a	0a	15a	30a	50bc		
Musa paradisiaca	0a	0a	0a	0a	5a	5a	5a	5a	5a	5a	5a	5a	5a	5a	10a	25a	35ab	
Caricapapaya	0a	0a	0a	0a	0a	0a	0a	0a	0a	0a	0a	0a	0a	15a	20a	35ab		
Chromolaenaodorata	0a	0a	0a	0a	0a	0a	0a	0a	0a	0a	0a	0a	0a	10a	15a	20a		
Control	0a	0a	0a	0a	0a	0a	0a	0a	0a	0a	0a	0a	0a	0a	0a			

Means followed by different letters within the column are significantly different using DMRT at $p<0.05$

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2020 ANNUAL REPORT

KOLA PROGRAMME

SOIL FERTILITY EVALUATION OF SOME KOLA PLANTATION IN KWARA AND KOGI STATES, NIGERIA

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

Introduction

Kola is an important economic cash crop with about forty kolanut species but two must cultivated species in Nigeria are *C. nitida* and *C. acuminate*(Ndagi et al., 2012). Apart from their industrial uses (wine, liquor, drug etc); the nut when chewed serves as energizer and stimulant (Adejoke et al., 2020). Kola production level over the years has been reported to decline due to old age and decline in soil nutrient. Soil nutrient of most kola plantations gradually decline below required level with continuous pod harvesting without maintenance program (Asogwa et al., 2012). Nutrient availability potential of soil depends on the quantity of nutrient the farmer could provide because plant nutrition is an important component of in kola production. Soil nutrient maintenance of most kola farm is constrained by the limited use of inorganic fertilizer due to high cos(Ndagi et al., 2012) and limited understanding of benefit of organic amendments to soil. To ensure proper growth and profitable yield, nutrient management is one important part that must be focused on by farmer. Many experiments have been conducted which show decline in soil and leaf nutrient level of kola plantation below requirement after many years of pods removal(Asogwa et al., 2012). There is need for further information on soil type and fertility status of various kola plantations across Nigeria. Research on soil nutrient level of these

plantations is highly essential to recommend appropriate soil fertility management that will enhance kola yield on sustainable basis. Kwara and Kogi are among the states where kolanut is produced in Nigeria(Ndagi et al., 2012). This study was conducted by collecting soil samples from two farms per Local Government Area in each state to determine the soil fertility and leaf nutrient content as a means to measure the capacity of the soil to support profitable production. It was observed that the farms visited were inherited and a decline in yield was generally reported by most of the farmers. This could be linked to old age and soil nutrient depletion as it has been reported. This investigation sought to confirm this claim by the farmers as well as to establish the need for replacement of soil nutrients removed through fertilizer application for sustainable kola production. Increasing the supply of nutrients has been reported to play major role in increasing yield of crop plant while observation showed that fertilizer is seldom used in kola plantation in Nigeria despite continuous nutrient removal from soil yearly. Therefore, evaluation and knowledge of the soil nutrient status of the kola plantations is necessary. The knowledge of nutrient status of soil and leaf is very much essential for the judicious application of fertilizer and soil amendment for higher crop production. Hence,the objectives of the studies were:

(I) To evaluate the physico- chemical properties of the soil,

(II) To determine nutrient status of the leaf

(III)To recommend adequate

Materials and Methods

The study was carried out in two Local Government Areas of Kwara State (Oyun and Irepodun) and Kogi State (Ijumu and Yagba East). Soil and leaf samples were collected from plantation for analysis. Two farms were selected for study per local government area. A distance of 25 m by 25 m quadrat was given between point of sampling and leaves were randomly picked from closer kola tree to the point of sampling. Soil samples were randomly taken with soil auger from soil depths of 0-20cm and 20-40cm considered as topsoil and subsoil, respectively. Eight (8) samples from each depth were bulked together to form a composite sample. Composite samples were taken to the laboratory for physico-chemical analyses. Soil particles were air-dried, mixed up together, sieved with a 2.0mm sieve and analyzed using routine laboratory techniques. Soil samples were analyzed for particle sizes and compositions using the hydrometer method (Bouyoucos 1926). Soil pH was determined colorimetrically in water solution ratio of 1:1 according to (*Udo et al.,* 2009).The soil organic carbon content was derived through wet digestion dichromate acid-oxidation method (walkley and Black,1934) as modified by Nelson and sommers (1982).Total N was determined using Kjeldahl digestion method and available P by Bray P1 method. This

involved the addition of 15ml of 0.03 NHFand 25ml of 0.5 N HCl to 460ml of water solution. Exchangeable cations (Ca , Mg , K and Na) were extracted by leaching 5g soil with 50ml of 1N NH4OAc buffered at pH 7.0. Exchangeable K and Na in the extracts were read on the flame photometer while Ca and Mg were read on Atomic Absorption Spectrophotometer (AAS). Exchangeable acidity was extracted with I N KCl and determined by titration with 0.05 N NaOH using phenolphthalein indicators. Soil effective cation exchange capacity (ECEC) was determined by summation method while percent base saturation was analysed. Extractable Zn was determined using 0.04M EDTA and concentration measured after extraction withthe aid of Atomic Absorption Spectrophotometer (FAO 2007).Leaf samples were bulked together to form a composite sample, air-dried and pulverized for chemical analysis.Plant samples were ashed with Murphy furnace at 500 °C for 5 hours, cooled, dissolved with 5 mL of 0.4 N HCl and leached to 100 mL with distilled water. The filtrates were used to determine Na+ and K+ by flame photometry, Ca2+ and Mg2+and Zn contents by AAS, P by colorimetry and N by theKjeldahl distillation method (Udoetal 2009).

Table 1: Soil pH, textural class and organic carbon content of the plantation soil at Kwara and Kogi States

Soil Sample	pH(water) (1:1)	Particle size (g/kg) Sand	Clay	Silt	Textural class	Organic C (g/kg)
Irepodun 1						
0-20	6.05	83.80	4.80	11.40	loamy sand	17.0
20-40	5.95	81.80	4.80	13.40	loamy sand	14.4
Irepodun 2						
0-20	5.75	87.80	4.80	7.40	sandy soil	9.0
20-40	5.75	91.80	4.80	3.40	sandy soil	7.3
Oyun 1						
0-20	5.80	86.60	6.00	7.40	sandy soil	13.2
20-40	5.55	82.60	14.00	3.40	loamy sand	6.1
Oyun 2						
0-20	6.30	88.60	6.00	5.40	sandy soil	20.2
20-40	6.00	80.60	12.00	7.40	loamy sand	9.7
Ijumu1						
0-20	5.90	87.80	4.80	7.40	sandy soil	28.4

20-40	5.85	85.80	4.80	9.40	loamy sand	23.0
Ijumu 2						
0-20	5.90	91.80	4.80	3.40	sandy soil	24.6
20-40	5.25	75.80	4.80	19.40	loamy sand	12.2
Yagba East 1						
0-20	6.45	83.80	4.80	11.40	loamy sand	24.1
20-40	6.50	77.80	8.80	13.40	sandy loam	8.3
Yagba East 2						
0-20	6.50	81.80	6.80	11.40	loamy sand	19.7
20-40	6.20	83.80	6.80	9.40	loamy sand	8.2

Table 2: Major Nutrient Content of Soils in Kwara and Kogi States

Soil	Exchangeable cation (cmol/kg)				Total N	Avail.P	Al+H	ECEC	Base	Zn
	Ca	Mg	Na	K	g/kg	(mg/kg)			Sat	
Irepodun 1										
0-20	4.58	0.839	0.16	0.40	1.0	2.35	0.08	6.06	98.68	16.70
20-40	3.90	1.110	0.21	0.34	1.1	4.85	0.06	5.62	98.93	15.50
Irepodun 2										
0-20	3.23	0.780	0.20	0.18	0.7	2.25	0.09	4.48	92.99	8.92
20-40	2.60	0.512	0.12	0.09	0.9	1.23	0.07	3.39	97.94	9.11
Oyun 1										
0-20	6.38	1.517	0.18	0.16	0.8	9.51	0.06	8.30	99.28	16.15
20-40	4.21	1.050	0.18	0.18	0.7	13.49	0.11	5.73	98.08	6.02
Oyun 2										
0-20	6.66	1.330	0.28	0.70	1.3	8.94	0.07	9.04	99.23	20.72
20-40	2.60	0.512	0.12	0.09	1.1	1.23	0.07	3.39	97.94	9.11
Ijumu 1										

0-20	6.82	1.41	0.39	0.57	1.7	11.86	0.08	9.27	99.14	29.18
20-40	5.78	1.09	0.36	0.48	1.9	11.50	0.07	7.78	99.10	27.27
Ijumu 2										
0-20	6.54	1.16	0.34	0.51	1.5	11.70	0.06	8.61	99.30	30.00
20-40	2.12	0.81	0.28	0.35	1.6	3.63	0.10	3.66	97.27	16.64
Yagba East 1										
0-20	6.12	1.92	0.46	0.70	2.1	8.64	0.05	9.25	99.46	31.39
20-40	5.17	1.51	0.26	0.38	1.1	5.01	0.08	7.40	98.92	19.70
Yagba East 2										
0-20	5.91	1.59	0.27	0.43	1.3	5.11	0.09	8.29	98.91	22.92
20-40	3.71	1.22	0.25	0.45	1.2	2.20	0.05	5.68	99.12	

Table 3: Leaf nutrient content for kola plantation in Kwara and Kogi States

Leaf Sample	Total N %	Avail.P mg/kg	K %	Ca %	Mg %	Organic C %	Zn mg/kg
Irepodun 1	1.057	857.18	1.284	1.204	0.141	14.07	72.13
Irepodun 2	0.562	789.95	1.086	0.944	0.109	15.31	57.74
Oyun 1	0.826	700.31	0.869	0.598	0.125	13.59	67.33
Oyun 2	0.1453	868.39	1.126	0.886	0.131	12.14	59.35
Ijumu1	1.09	638.08	1.07	1.03	0.11	14.48	68.76
Ijumu2	0.80	862.79	1.15	0.62	0.12	12.41	65.41
Yagba East	11.01	778.75	1.34	0.60	0.12	12.55	74..75
Yagba East	20.60	599.47	0.93	0.72	0.12	14.76	59.21

Table 4: Critical nutrient level required for kola production

	Total N	Avail.P	K	Ca	Mg	Organic C	Zn
	%	mg/kg		%	%	%	% mg/kg
Soil sample	0.1	3.7ppm	0.12	0.8	0.08	1.05	
Leaf sample	1.09	0.08		1.2	0.47	0.34	-

Results and Discussion

The pH of the soils in for Irepodun and Oyun local government areas(Kwara state) ranged between 5.75-6.05 and 5.55–6.30 respectively (Table 1). Kwara state could be said to be slightly acidic with ranges of 5.55 to 6.30. Kogi state was also slightly acidic with ranges of 5.25 to 6.50 , Ijumu LGA in particular was more acidic and the pH values fall below 6.0–6.5 reported to be normal for tree crops like cocoa, coffee, cashew and kola (Opeke, 1987, Wood and Lass 1985). Any activities that will further acidify the soil should be avoided in both states. These plantations will require a soil fertility improvement program that include application of liming materials to increase the pH to optimum values (6.0 –6.5) required to enhance availability and uptake of nutrients and to improve microbial activities.

The result showed that soil texture of Kwara and Kogi States were either loamy sand or sandy soils. Soil organic carbon contents in both states were lower than the critical value of 30.00g/kg considered optimum and ideal for tree crop plantation (Egbe et al., 1989). This result indicates that there has been a great loss of organic content from the soil reflecting the sandy texture of the plantations. Also the organic carbon in the topsoil (0-20cm depth) at both Kwara and Kogi States were higher than the organic carbon content in the subsoil (20 -40cm depth). This may be attributed to the accumulation and decomposition of large amounts of leaf litter falls over the years. This result is in agreement with the findings of Iloyanomon and Ogunlade(2011).

Nitrogen (N) contents were adequate except for Irepodun II and Oyun I in Kwara state, which were below the critical level 1.0 g/kg for the cultivation of kola. Therefore, application of N on the plantation is needed for sustainable and profitable yield. Available Phosphorus for the plots in Kogi state were above the critical required value of 3.7mg/kg except at the sub soil in Ijumu2 and yagba east 2. Exchangeable Potassium for Kwara and Kogi States were above the critical value of 0.12cmol/kg recommended for kola cultivation (Egbe et al., 1989) The Magnesium, Mg contents of the soils in Kwara state were found to be adequate for kola cultivation except for Irepodun II which was totally deficient while top soil of Irepodun I (0.839cmol/kg) and sub soil of Oyun II were below the critical level of 9.00cmol/kg recommended for kola cultivation (Egbe et al., 1989). Also, Ca content were generally higher than the critical levels of 3.00cmol/kg established for kola (Egbe et al., 1989) in Kogi and Kwara states except for Irepodun II and Oyun 2 (Kwara state) sub soil which were lower (2.60 cmol/kg).

The kola leaf N contents were below critical levels of 1.09% recommended for kola (Egbe et al., 1989). P content of Irepodun II and Oyun I in Kwara state were lower than the critical value of 8000mg/kg (Egbe et al., 1989) while Irepodun I and Oyun II were above this value. Leaf K contents of kola plant were below 1.2% recommended for kola (Egbe et al., 1989) in all locations except for Irepodun I which is 1.284% and adequate compare to the critical value. The plant Mg contents were lower than the critical value of 0.34% in al the locations. The Ca contents were higher than the critical value of 0.47% recommended for kola in all locations. Organic carbon contents of the

leaves ranged from 12.14 -15.31%. Zinc leaves contents were above 2.5% recommended for tree crop cultivation (McKenzie, 2001).

Conclusion

The low organic matter content and slight acidity of the soil could affect major nutrients availability and may result to nutrient imbalance. The low N content of some of the plantation soil is not surprising as sandy soil especially under high rainfall are prone to N deficiency which must have affected N leaves content, this makes N fertilizer application necessary because N is needed for vegetative growth and profitable yields (Snoeck et al., 2016). Available P and exchangeable cation (Mg and Ca) were found adequate for most of the plantations. Variation in soil nutrient content of top soil and sub soil of some of the plantation shows that fertilizer management system that is specifically directed to address the need of the soil is required. Despite the low level of leaf nutrient (such as N, P, K and Mg) none of these plantation shows deficiency symptoms.

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RESEARCH REPORT

Year: 2020

Research Programm: Kola

Title: Evaluation of Kola Nut Supply Chain in Nigeria

List of Investigators: Yahaya, A.T, Adebiyi,S; Oluyole, K.A and Obatolu, B.

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 this 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.

i. 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

ii. analyze the competitiveness and the effects of policies on competitiveness at each stage of Kola value chain
iii. determine the comparative advantage of the nodes of Kola value chain in Southwestern Nigeria
iv. estimate the effects of price distortions on consumers' and producers' welfare in the study areas

Methodology

The study was carried out in two Kola producing states namely (Ondo, Ekiti) of Southwestern state of Nigeria. Multistage sampling techniques were be used to select three (3) local governments from each from the state namely Akoko North East,Owo, and Odigbo andEkiti West, Ado andEmure/Ise/Orun. Second stage involved selection of one hundred and fifty (150) respondents from each state in the proportion of fifty (50) from each LGA. Information was elicited through the use of structured questionnaire and focus group discussion. Returned questionnaire was sorted and analyzed.

Results and Discussion

Table 1 show the socio-economic characteristics of the respondent in Ondo and Ekiti states respectively. It shows that majority of the respondent are in their active years 46% and 52% respectively. The table also shows that majority of them are females 73.33% and 100% respectively. Majority 50% of the marketers in Ondo had basic education with only 26.67% Ekiti state. This informed their efficiency in trade.

Table1. Social Economic Characteristic of the respondents

Variable	Ondo		Ekiti	
Age	Freq.	percent	Freq.	Percent
≤ 40	12	8	2214.67	
40-50	42	28	2013.33	
51-60	69	46	7852	
>60	27	18	30	20
Total	150	100.00	150	100.00
Gender				

Male	40	26.66	0	0
Female	110	73.33	150	100
Total	150	100.00	150	100.00
Educational Status				
No Education	138.67	2	1.33	
Primary Education	75	50	20	13.33
Secondary Education	62	41.33	125	83.33
Total	150	100.00	150	100.00

Source: Field Survey 2020

Table 2 show the supply chain of kola-nut in Ondo and Ekiti respectively. The table shows that most 54.86% and 64% kola traders buy kola for trade from middle men/women. This help in facilitating volume needed to trade in. The table also shows that all 150% of the traders deals in both wet and dry kola-nuts. Majority of the traders in Ondo sell their products to cities like Maiduguri, Zamfara Kebbi, Zaria, Sokoto, Kano and trade as far as Saudi- Arabia Dubai, Central Africa. Ondo kola nut marketers cover a wider scope in their business activities. While marketers in Ekiti trade within the northern states such asKebbi, Zaria, Sokoto, Kano, Maiduguri, Zamfara Also, majorityof the marketers used funds family and friends in their business. This is shows the easy at which such funds can be access. However, 28.67% marketers in Ondo used externalfunds, not minding the stressinvolved in accessing such fund as well as the high interest rate charged. This could be as a result of their scope of operation in kola trade. They need huge capital base to operate at such a wider range in their business dealings.

Table 2 Marketing and Sales

Variables	Ondo		Ekiti	
	Freq.	percent	Freq.	Percent
Who are your suppliers?				
Farmers	40	26.67	13	8.67
Processor	28	18.67	41	27.33
Retailers	82	54.66	96	64
Total	150	100	150	100
Where do you sell to?				
Gombe	10	6.67	5	8.67
Sokoto	15	10	70	20
Kano	20	13.33	41	18
Zaria	15	10	2	12
Maiduguri	18	12	32	13.33
Yola	12	8	-	-
Saudi-Arabia	10	6.67	-	-

Sudan	10	6.67	-	-
Cameroon	10	6.67	-	-
Central Africa	10	6.67	-	
Niger Republic	10	6.67	-	
Chana	10	6.67	-	
Total	150	100	150	100
Which type of kola nut do you sell?				
Dried			-	-
Wet			-	-
Processed			-	-
Unprocessed			-	-
Both	150	100	150	100

Source: Field Survey 2020

Table 2 Sources of Finance

Variables	Ondo		Ekiti	
	Freq.	percent	Freq.	Percent
Loan	43	28.67	15	10
Family	60	40	100	66.67
Friend	47	31.33	35	23.33
Total	150	100	150	100

Source: Field Survey 2020

Conclusion and Recommendations

Marketers in the study areas are in their active working year. They are mostly women and are lettered. The marketers used mostly family funds and deals in both processed and fresh nuts. They sourced their produces mostly form middle men/women and they have a very wide scope in their business activities. It is recommended that government annex Kola business in Nigeria to enhance the trade.

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2020 KOLA RESEARCH PROGRESS REPORT

Experimental Title: Introduction, Clonal propagation and development of high yielding Kola varieties (Adenuga, O. O. and Adebiyi, S)

INTRODUCTION:

There is an urgent need for CRIN to assemble new kola germplasm and properly characterise its germplasm for optimum utilization. This is very important because the existing germplasm has a very narrow genetic base and is largely uncharacterised. Also, the existing germplasm consists of old and unfruitful trees. 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. The gestation of the crop also needs to be reduced. Profering solutions to 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. Furthermore, activities are being initiated to commence the molecular characterization of the existing kola germplasm in CRIN for a more precise improvement procedure of the crop.

Existing kola germplasm has a very narrow genetic base and is largely composed of old, unfruitful and uncharacterized trees.

OBJECTIVES: The eperiment was initiated to collect superior kola accessions from farmers' plots at contrasting locations in Osun State in Nigeria, establish at least 150 clones of such accessions and determine the success of clonal establishment of these 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, Saga and Iyemogun (Osun State) State. These included two farms in each Location. Stem cuttings were collected from two accessions from each farm. This implies four accessions from each farm per location. A total of twelve accessions were used in the study. Stem cuttings were collected from the apical regions of the trees selected as mother trees which have diverse genetic origin. They are noted to fruit early and 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:

Though 35% of the grafted materials remained green after two weeks of grafting, only 6% of the original population were successfully establishes into the germplasm plot. This inconsistency may be attributed to the timing of the grafting which June. 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.

Callus formation and eventually, root development did not occur occurred all of the accessions used in the setting of cuttings. All eventually dried up.

Further ongoing field activities include periodic field maintenance (weeding, dry season irrigation and shade management).

CONCLUSION AND RECOMMENDATION

Some grafted materials from this experiment were successfully established in a new *Cola* germplasm plot at CRIN Headquarters, Ibadan. A better level of success was obtained in the setting of the kola cuttings in the previous year. This result indicates that with further efforts need be employed, and aided by improved availability of research materials, to enable CRIN to successfully establish clones of better performing kola genotypes in its germplasm collection, thereby paving way for the development of improved kola varieties for distribution to farmers.

Timely release of research fund and adequate funding of research activities are hereby solicited for.

CHALLENGE

The primary challenge in the execution of this research project was the late provision of fund, which 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, whereas it was carried out in June in this instance.

Status

On-going

TEA PROGRAMME

1. Training on Good processing practices for tea: In Nigeria, Tea has not really commanded much premium due to poor processing methods among the farmers. This has led to poor earnings amongst tea stakeholders and the nation at large. To improve good earnings for tea via good price for the commodity, a training programme was organized on Good processing practices for tea. Participants cut across tea farmers, local processors of tea and tea marketers in Taraba state.

Plate 1. Cross section of participants during the training

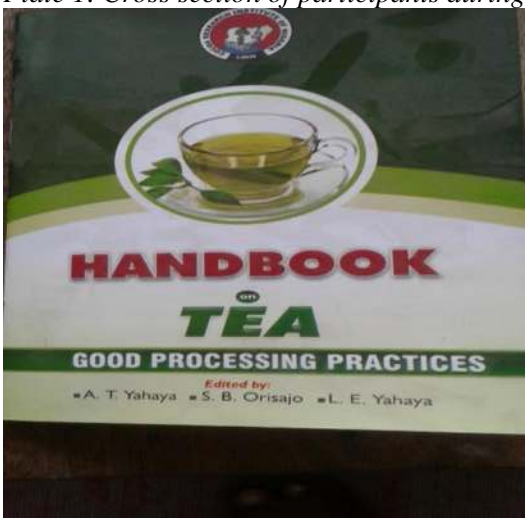

Plate 2. Copy of Training manual used during programme

Plate 3. Women participants during the training section

Plate 4. The PI of the project during her opening remark

2. **Authentication and validation of Tea seed oil as edible oil and for other industrial applications**.

Oil has been successfully expressed from Tea seed, a byproduct of tea. Chemical characterization and toxicity studies revealed its richness in polyunsaturated fatty acid and free of toxin, thus making it health friendly oil. Effort is underway to harness it in other areas of applications.

Plate 5. Tea seed oil

3. **Development of Green Tea**

The different types of Tea in the market involves different processing method in their production. Green Tea have been developed locally and characterized to ensure quality requirement is met. In order to go into large scale production, some equipments are required, one of which have been procured (Tea fixing machine). With funds available, the programme intend procuring the remaining (Tea dryer, roller and tea bag machine). We also intend improving the packaging of this product.

Plate 6. Pack of Green Tea

RESEARCH REPORT
Year: 2020
Research Programme: Tea
Title: Good Processing Practices on Tea in Nigeria
List of Investigators: Yahaya, A.T, Aroyeun, S.O; Yahaya, L.E; Jayeola, C.O, Oluyole, K.A; Igbinnadolor, R, and Agbebaku, E.O,
Introduction:
Food chains are greatly affected by consumers concerns regarding food quality and safety and the sustainability of food production and handling methods. Societal concerns regarding chemical residues and environmental impact have to be met in a competitive, increasingly global environment. Increasing consumer's demands regarding the quality, traceably and environmental friendliness of products and processes call for fundamentally new ways of developing, producing and marketing products (Hawkes and Ruel, 2011). This brings about the development of grades, standards and agreements regarding good production and management's practices as well as adequate monitoring systems to ensure quality compliance.
Tea industry in Nigeria has lost its share potential owing to problem in processing among others. The post harvest handling and processing of tea in Mambilla plateau is characterized by crude and unhygienic methods, lack of technological know-how, poor post harvest and unsafe processing practices. There are problems with poor quality tea leaves, poor processing methods, and resulting into lack of access to wider market, low pricing, and poor farmer income. There are poor linkages among the stakeholders and the value chain is underdeveloped. Private sector has insufficient quality tea leaves; there are tea packaging companies which import their raw materials from other tea suppliers around the world.
Attempt at improving the post harvest and processing practices comes with opportunities to increase nutrition sensitivity and food safety, improve rural income, reduce poverty, increase livelihood, and improve management of natural resources in a sustainable manner, and increase rural employment.
Objectives

Improve the ethical standards of tea small scale processors
Improve post-harvest handling and processing methods of the small-scale processors
Upgrade tea value chains through quality post-harvest handling and processing
Enhance the competitiveness of Nigeria Tea subsector.

Beneficiaries: Small scale processor and Farmers

Material & Methods
The project involved a training programm on post-harvest handling and standard processing methods for green and black tea on Mambilla, Taraba, state. It was a training of trainer's (TOT) methodology that is participatory in approach. Random sampling was used in selection of processors and farmers which include men, women and youths from the 6 tea producing wards in Sarduana local government areas. Three hundred (300) processors and farmers were trained in a batch of thirty (30) each to have ten (10) batches. Also, a post training assessment was carried out through administration of questionnaire.
Results and Discussion
All the 300 participants expressed their gratitude for the training as they all learned better methods of processing tea. They equally promised to adjust their former method of processing tea. And a feedback assessment was carried out with collection of samples processed from the trainees for analysis a year after the training. The report showed that more than 65% actually adopted the new skill acquired as the analysis of their samples conformed to standard. This has also improved tea

pricing, enhance demand and access to wider market and boost income accruable from tea business and prevent exploitation.

Conclusion & Recommendations

The ethical standard for handling and processing green and Black tea was demonstrated to the stakeholders. Small scale processors and farmers were trained on how to upgrade tea business through proper and safe post-harvest handling and processing. A year field evaluation of the trainers shows a good adoption rate among the trainees. These small holders' trainees' livelihoods can be improved with their access to wider market for increase pricing for the products and also, to prevent exploitation. This study thereby recommends the link of these small holders to higher marketing opportunities.

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2020 Report

EXTENSION RESEARCH ACTIVITIES

YEAR OF REPORT: 2020

PROGRAMME: DATABANK

TITLE: Report of Cashew Data Bank for Oyo State, Nigeria

LIST OF INVESTIGATORS: Oduwole, O.O., Lawal, J.O., Obatolu, B.O., Taiwo, O and A.T. Yahaya

Introduction: The dearth of data on Cashew as it relates to production and the farming households has affected planning and policy decisions at different levels.. 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. It requires careful data collection and management for the needs of the various users of information.

Justification

There is no existing reliable data platform for CRIN mandate crops and the available ones are not adequate and not reliable and timely, hence, there is a need to complement it to make it more robust. Various agencies and private sectors have different information on cashew and the available ones are limited to just production and price. However, there is need for information on socio-cultural variables, biological variables, soil and spatial information (GIS).

Objectives:

1. Collection and management of baseline information on cashew;
2. To provide the network with other local and international bodies.

Methodology: This will involve desk research, field survey and interactions' with various stakeholders and scientists. Data bank is a continuous and dynamic process involving modeling techniques for the management of information. It involves a lot of rules for the coding system . Personal interviews and the use of questionnaires to collect data and the data set requirement will include the following:

- Socio-economic and physiological data, Weather data, Soil nutrients and water balances,- Phenolic and growth data (variety, acceptability, cultural);- Agronomic data
- Disease and pest data- level of infection and damage;- Pesticides and their products
- Risk or uncertainty data; production, processing and consumption patterns

RESULTS AND DISCUSSION: This report is subdivided into the following major heading:

I. Socio- economic characteristics of the cashew farmers
II. Planting history of the cashew farmers
III. Cashew agricultural practices and rehabilitation methods
IV. Major constraints faced by farmers
V. Awareness of cashew production factors
VI. Proffered solutions by the farmers

SOCIO-ECONOMIC CHARACTERISTICS OF THE CASHEW FARMERS

The socio-economics of the cashew farmers are germane as this contributes positively or negatively to the production of the cashew in the study area. Such demographic characteristics like age, gender, educational levels, membership of associations, mode of land acquisition, sizes of farm among others were considered and analyzed.

The result shows that majority (87%) of the cashew farmers in Oyo state are male indicating that cashew plots are mainly owned by the male. Most of them (81%) are primarily farmers with few engaging in artisanship or business. They are relatively educated 30% had secondary education, 38.37% has no formal education and 25% had primary leaving certificates. This relatively shows that the farmers have the capacity to adopt new innovations /technologies on cashew production if such is extended to them.

Table 1: Distribution of Cashew farmers by Gender, Primary Occupation& Educational Status

Variables	Frequency	Percentages	Cumulative
Gender			
Female	10	12.82	12. 82
Male	68	87.18	100
Primary occupation			
Carpentry	1.32	1.32	
Civil servant	1	1.32	2.63
Driver	1	1.32	3.95
Farmer	62	81.58	85.53
None	6	7.89	93.42
Supply	1	1.32	94.74
Trader	4	5.62	

Total	76	100	
No formal education	28	38.36	63.01
Primary	18	24.66	93.15
Secondary	22	30.14	6.85
Tertiary	5	6.85	
Total	73	100	

Source: Field survey, 2021

Close to 96% of the cashew farmers in Oyo state belongs to one farmer's association or the other with 80% belonging to cashew growers' association. This gives a good sense of belonging to the farmers and could be channels where government reaches out to the cashew farmers in terms of credit/ input facilities, as well as training of farmers in good agricultural practices. The result further shows that majority of the farmers (85%) inherited their cashew farms thus indicating that cashew is more or less a generational farm business that's been passed on from one generation to the other., only 8% purchased their cashew farm land while 1% was a gift.

Table 2: Distribution of farmers by Membership of Socio-Economic Association &Farms Ownership

Variables	Frequency	Percentages	Cumulative
Association Membership			
No	3	4.05	4.05
Yes	71	95.95	95.95
Total |	74	100	
Name of Association			
Afan	6	8.45	8.45
Agfam	1	1.41	9.86
Ncan	3	4.23	14.08
Cashew Growers Association	57	80.28	94.37
National association of cashew	1	1.41	95.77
None	2	2.82	98.59
Society	1	1.41	
Total	71	100	
Mode of Land Acquisition			

Gift	1	1.54	1.54
Inheritance	55	84.62	86.15
Lease	2	3.08	92.31
Purchase	5	7.69	100
Total	63	100	

Source: Field Survey, 2021

Further demographic analysis shows the average age of the cashew farmers as 56 years indicating that they are relatively young farmers hence posses some strength to do farm work and coordinate farm activities to boost production. The average cashew farmer in the study area has 16 years of cashew farming experience and with an average house hold size of 10 and 6 persons assisting in the cashew farm. This shows that the farmers have relatively long years of experience in cashew farming with a relatively high household size indicating some high level of social responsibility on the farmers. Furthermore, majority of the famers has between 2-4 ha of land and on the average 164 bags of 90kg is been produced in the study area.

PLANTING HISTORY OF THE CASHEW FARMERS

Data on planting history were collected particularly on planting methods, varieties of cashew planted, sources of materials planted, as well as survival rate of cashew planted. This data was collected for the cashew's trees between 5-25 years of age.

The result shows that majority (96%) of the cashew farmers planted their cashew at stake while very few (1-2%) planted the seedlings to establish their cashew plantation. Further result analysis shows that 80-95% planted small- medium variety of cashew very few (2%) planted the jumbo variety. According to the farmers, the small and medium yielded more fruits and therefore increased in income and livelihood. As regards source of planting materials for cashew plantation establishment, most farmers (90%) source their materials from an existing farm nonetheless, they have over 80% survival rate of the cashew. This however has been an age long practice which needs to be avoided and a paradigm shift

needed to enhance productivity by accessing improved materials from research institutes or other relevant agencies.

Table 3: Distribution of farmers by planting History

Planting methodology	Frequency.	Percentages	Cumulative
Planting at stake	32	96.97	96.97
Seedlings	1	3.03	3.03
Total	33	100	
Variety planted			
Jumbo	2	6.67	6.67
Medium	6	20	26.67
Small	13	70	43.33
Small and medium	4	13.33	83.33
Small, medium and jumbo	1	3.33	86.67
Small,medium and jumbo	4	13.33	100
Total	30	100	
Source of materials			
Existing farm	15	83.33	83.33
Fellow farmer	2	16.67	100
Total	18	100	
Do you			
Keep nursery			
No	61	87.14	87.14
Yes	9	12.86	100
Total	70	100	
Intercrop planted			
Banana	3	6.12	6.12
Cashew	3	6.12	6.12
Cassava	18	36.73	48.98
Guinea corn	1	2.04	51.02
Maize	19	38.78	89.8
Okro	1	2.04	91.84
Pineapple	2	4.08	95.92
Yam	2	4.08	100
Total	49	100	
Types of weeds			
Akintola	37	66.07	66.07
Akintola and carpet grass	4	7.14	73.21
Akintola and lemon grass	1	1.79	75
Akintola and spear grass	4	7.14	82.14
Akintola and sturborn grass	1	1.79	83.93

Akintola and sunflower	2	3.57	87.5
Carpet grass and akintola	1	1.79	89.29
Gbegiete	1	1.79	91.07

Source: Field survey, 2021

CASHEW AGRICULTURAL PRACTICES AND REHABILITATION METHODS

Furthermore, over 90% of the farmers do not keep nursery. Good agricultural practice (GAP) is germane to enhancing the productivity, income and livelihood of the cashew farmers. The type of intercrop, weeding, soil testing, rehabilitation and type, planting distance among others were considered important in this regard. The result analysis shows that over 90% of the farmers planted cassava and maize as annual intercrop on their cashew plots. Other intercrops include vegetables, watermelon and groundnut (2-10% of the farmers). This indicates that maize and cassava are the main staple intercrops and source of income for the farmers. This corroborates the findings of Lawal and Uwagboe (2017). Other tree crops intercropped with cashew includes Mangoes, Palm and Orange.

The most prevalent weed on their cashew farm is the “akintola weed”. Most of the farmers (45%) weed their farms manually while only 14% uses herbicides to such as Paraforce Force-up as means for controlling weed. They mostly use one cup per 15 liter of water in spraying their farms. Similarly, over 59% uses pesticides to control pest. These are applied twice in a year by majority of the farmers. According to the farmers, the pesticides are very effective in controlling the pest.

On fertilizer application, majority of the farmers (94%) do not use fertilizer on their cashew farms. Fertilizer is not taken as important to cashew and it is perceived that cashew is rugged and can do well on their soil without applying fertilizer. Major diseases /pest experienced by the farmers are the cashew stem borers (40%) Soldier ant and “salamo” (local name). Majority of the farmers (38%) do not take action on the disease infestation, 33% of them uses pesticides in tackling the pest and diseases while 6% uses cultural means for control.

The analysis further shows that 62% constituting both hired and family labour was used in cashew farm operation. Virtually all the farmers (94%) do not keep records of their farming

activities. This is mainly because they have not received any training on how to keep such nor do they see it as of any relevance.

Seventy-seven percent of the farmers (77%) carry out one form of rehabilitation or the other of which coppicing is mostly practiced as well as pruning 93%. In some cases, total replanting was done. Some other farm practice they do includes use of chemicals, weeding pruning which virtually (93%) all the farmers do,

Furthermore, result shows that over (98%) of the cashew farmers experienced change in cashew production due to climate change especially changes in temperature and rainfall as well as cloud cover.

Table 4: Distribution of farmers by Agricultural Practices

Do you do soil test?	Frequency	Percentages	Cumulative
No	69	98.57	98.57
Yes	1	1.43	100
Total	70	100	
Do you carry out rehabilitation			
No	13	22.81	22.81
Yes	44	77.19	100
Total	57	100	
What methods of rehabilitation			
Coppicing	13	27.66	27.66
Partial Replanting	3	6.38	34.04
Selected Spacing	2	4.26	38.3
Selection Replanting	3	6.38	44.68
Selective Replacement	1	2.13	46.81
Spraying	1	2.13	48.94
Total Replanting	22	46.81	95.74
Total Replanting& Coppicing	1	2.13	97.87
Total replanting	1	2.13	100
Total	47	100	
Types of mgt practice			
Chemical Use	3	7.14	7.14
Regular Cutting of Grass	3	7.14	14.29
Regular Spraying	1	2.38	16.67
Routine Management	20	47.62	64.29
Spraying	7	16.67	80.95
Spraying And Weeding	3	7.14	88.1

Weeding	5	11.9	100
Total	42	100	
Do you prune			
No	4	6.9	6.9
Yes	54	93.1	100
Total	58	100	
Number Of Times for Pruning			
1	21	38.18	38.18
2	29	52.73	90.91
3	2	3.64	94.55
4	3	5.45	100
Total	55	100	
Other mgt practice undertaken			
Chemical	15	34.09	34.09
Chemical Spraying	3	6.82	40.91
Clearing	1	2.27	43.18
Cutting Of Grasses	1	2.27	45.45
Field Maintenance	1	2.27	47.73
General	1	2.27	50
Local One	1	2.27	52.27
Regular Hygiene	6	13.64	65.91
Regular Maintenance	4	9.09	75
Routine Management	3	6.82	81.82
Spraying	1	2.27	84.09
Spraying And Weeding	4	9.09	93.18
Spraying Of Chemicals	2	4.55	97.73
Weeding	1	2.27	100
Total	44	100	
Planting distance			
1.5-2m	1	1.75	1.75
10feet	18	31.58	33.33
12feet	1	1.75	35.09
15-20feet	1	1.75	36.84
2.5m	4	7.02	43.86
2m	14	24.56	68.42
5m	1	1.75	70.18
7m	1	1.75	71.93
Free Planting	8	14.04	85.96
Regular	8	14.04	100
Total	57	100	
Mode of harvesting			
Use Of Family	8	14.55	14.55
Use Of Family &Labour	5	9.09	23.64

Use Of Friends	2	3.64	27.27
Use Of Labour	22	40	67.27
Use Of Labour& Family	16	29.09	96.36
Use Of Labour& Friend	1	1.82	98.18
Use Of Labour& Friends	1	1.82	100
Total	55	100	
Method of weeding			
Chemical	8	14.55	14.55
Manual	25	45.45	60
Manual And Chemical	22	40	100
Total	55	100	
Herbicide use			
No	17	29.82	29.82
Yes	40	70.18	100
Total	57	100	
Firefox And Force-Up	1	2.7	2.7
Force Up	1	2.7	5.41
Force-Up	6	16.22	21.62
Forceup Glyphosphate	1	2.7	24.32
Glyphoshate	7	18.92	43.24
Glyphosphate	13	35.14	78.38
Paraforce	7	18.92	97.3
Sulphate	1	2.7	100
Total	37	100	
Dosage used			
1 Cup	1	4.35	4.35
1cup	21	91.3	95.65
4liter	1	4.35	100
Total	23	100	
Do you use pesticide			
No	19	40.43	40.43
Yes	28	59.57	100
Total	47	100	
Frequency of application /yr			
2times	30	100	100
Total	30	100	
Is the pesticide effective			
No	2	6.67	6.67
Yes	28	93.33	`100
Total	30	100	
Do you apply fertilizer			
No	46	93.88	93.88
Yes	3	6.12	100

Total	49	100	

Source: Field survey, 2021

Data on major constraints faced by the cashew farmers were collected and result analysis shows that : inadequate information on cashew production, high taxes and unfavorable government policy towards cashew, climate change, inability to access government assistance on production are rarely of importance to farmers as this are major constrains which they face in their cashew production. While; inability to access government assistance on production and marketing, high risk and uncertainty in agriculture, poor access road to farmers plots and poor credit facilities are constrains considered to be highly important to the farmers and therefore needs urgent intervention.

Data on the awareness of basic information on cashew production were collected and analyzed. results shows that majority of the cashew farmers (91%) are not aware of proper use and types of agrochemicals used in cashew production, proper cashew plot sanitation, various cashew varieties research advancement on cashew, the various marketing channels, processing problems as well as cashew stakeholder value chain. this indicates that the farmers are not well informed on basic rudiments of cashew production hence the possibility of not attaining maximum yield in cashew.

Further analysis on the perceived solution on cashew production from the farmers side shows that: information on improved cashew production technology, better government policy towards farm practice, information on how to mitigate against adverse climate change, training , setting up of marketing board to control price and quality as well as the provision of good infrastructure like good road to farmers plots , electricity to avoid youth migration and portable water are major desirable solutions proffered by the farmers.

Table 5: Distribution of farmers by Major Constrains, Awareness of Cashew Production &
Proffered Solutions by the Farmers

Constraints of Inadequate Information on Cashew	**Frequency**	**%**	
Highly Important	12	21.82	21.82
Important	3	5.45	27.27
Less Important	21	38.18	65.45
Very Important	19	34.55	100

Total	55	100	
Unstable Government Policy on Farm Practice			
Highly Important	13	23.64	23.64
Important	5	9.09	32.73
Less Important	30	54.55	87.27
Very Important	7	12.73	100
Total	55	100	
Climate Change Affect Cashew Production			
Highly Important	34	56.67	56.67
Highly Important	9	15	71.67
Important	1	73.33	73.33
Less Important	10	16.67	90
Very Important	6	10	100
Total	60	100	
Inability To Access Government Assistance on Production			
Highly Important	1	1.72	1.72
Highly Important	28	48.28	50
Highly Important	8	13.79	63.79
Important	3	5.17	68.97
Less Important	7	12.07	100
Total	58	100	
Inability To Access Government Assistance in Marketing			
Highly Important	34	59.65	59.65
Highly Important	9	15.79	75.44
Important	2	3.51	78.95
Less Important	9	15.79	94.74
Very Important	3	5.26	100
Total	57	100	
High Risk & Uncertainty in Agriculture			
Highly Important	31	54.39	54.39
Highly Important	7	12.8	66.67
Important	8	14.04	80.7
Less Important	6	10.53	91.23
Very Important	5	8.77	100
Total	57	100	
Highly Important	57	65.52	65.52
Highly Important	7	12.07	77.59
Important	4	6.9	84.48
Less Important	7	12.07	96.55
Very Important	2	3.45	100
Total	58	100	

Poor Credit Facilities			
Highly Important	47	81.03	81.03
Important	4	6.9	87.93
Less Important	5	8.62	96.55
Very Important	2	3.45	100
Total	58	100	
Awareness On Use of Agrochemicals			
Aware	7	12.28	12.28
Not Aware	1	1.75	14.04
Not Aware	36	63.16	77.19
Rarely Aware	3	5.26	82.46
Very Much Aware	10	17.54	100
Total	57	100	
Awareness On Cashew Farm Sanitation Practice			
Aware	7	12.5	12.5
Not Aware	30	53.57	66.07
Rarely Aware	5	8.93	75
Very Much Aware	14	25	100
Total	56	100	
Varieties Of Cashew			
Aware	8	14.29	14.29
Not Aware	29	51.79	66.07
Rarely Aware	6	10.71	76.79
Very Much Aware	13	23.21	100
Total	56	100	
Planting Population			
Aware	5	9.26	9.26
Not Aware	30	55.56	64.81
Rarely Aware	12	22.22	87.04
Very Much Aware	7	12.96	100
Total	54	100	
Research Advances in Cashew Production			
Aware	6	11.32	11.32
Not Aware	30	56.6	67.92
Rarely Aware	12	22.64	90.57
Very Much Aware	5	9.43	100
Total	53	100	
Marketing Chanels			
Aware	6	11.32	11.32
Not Aware	38	71.7	83.02
Rarely Aware	4	7.55	90.57

Very Much Aware	5	9.43	
Total	53	100	
Processing Problem			
Aware	7	13.46	13.46
Not Aware	36	69.23	82.69
Rarely Aware	5	9.62	92.31
Very Much Aware	4	7.69	
Total	52	100	

Conclusion and Recommendation

The survey showed that most cashew farmers in Oyo State are male and of an average age of 56years with cashew farming experience of 16 years. They are primarily farmers who are fairly educated and almost all belonging to cashew farmers association. Majority acquired their cashew farms through inheritance.

Most of the farmers planted small and medium cashew seeds at stake. They rarely keep nurseries. They planted other crops for livelihood sustainability. Quite a number of them use herbicide as well as pesticides/insecticides for insect however, some use indigenous methods for affected trees.

The farmers carry out some form of rehabilitation or the other on their cashew farm such as coppicing, replanting and pruning. They mostly made use of family and hired labour for their cashew farm operations especially harvesting. Most of them do not keep farm records. They all experience one form of cashew production changes due to climate change which are mostly adverse to cashew production.

Majority of the farmers considered constraints on inadequate information,unstable government policies, changes in climate, access to government assistance, access to government assistance in marketing and other constraints considered for the survey were found to be highly important constraints for the cashew farmers.

The cashew farmers are mostly not aware of some of the important variables considered to enhance cashew production such as: cashew farm sanitation practices, research advance in

cashew production, the various marketing channels and processing problems among others. These are germane in the enhancement of cashew production in Nigeria.

RECOMMENDATIONS

In view of the survey carried out and the result of analysis from the work, it is recommended that:

1. The farmers in Oyo State be properly trained in the area of good practices for cashew production this includes planting distances and population, weeding, pruning, chemical application and dosage, processing of cashew nuts and cashew juice among others;
2. Educate the farmers on proper record keeping and create awareness on the important variable that enhances cashew production;
3. Stakeholders be sensitized (policymakers, research institute and the cashew farmers etc) on way forward for cashew production and improvements along the value chain.

References

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Knowledge Acquisition through by-product utilization among cocoa farmers in Abagbo: A CRIN Adopted village

Adebiyi, S., Uwagboe, E.O., Agbongiarhuoyi, A.E., Famuyiwa, B.S., Abdul-Karim., I.F., Williams, O.A., Agbebaku, E.E.O., Orimogunje, O. A, Awodumila, D.J. and Oduwole, O.O.

INTRODUCTION

The inclusion of cocoa pod husk in both broiler and layers feeds which is one the technologies developed in the institute is a paradigm shift in turning waste to wealth in the present age of agricultural development. According to Olubamiwa and Hamzat (2001), the inclusion of cocoa pod husk in layer mash will reduce quantity of maize from 60% to 40%. Invariably, 20% saved will be used will reduce cost of feed production and by so doing, the waste 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 West Africa Agricultural Productivity Programme (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 2019, the pen was stocked with layers (80 point of lay) which serves as morale booster for farmers who have already lost hope in the project.

Objectives of the study

1. Encourage the utilization of cocoa pod husk (CPH) in poultry production by farmers.
2. Serve as capacity building for farmers.
3. Serve as income generation potential for farmers' cooperative society.

Methodology

The existing poultry pen was renovated and stocked with 80 layers purchased at point-of-lay in 2019. Automated drinker was installed and this was used to replace manure drinkers

which are more laborious in poultry management. 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 three months to acclimatize them with the environment after which feed formulated with cocoa pod husk was used to feed them. Records of the available birds, eggs laid and percentage egg production was calculated in order to know the performances of the birds on a daily basis.

Results and Discussion

Results in the table 1 below showed the number of bird, expected number of egg in line with the birds available, eggs laid and percentage egg laid on a monthly basis. The table revealed that the percentage eggs laid between January and September is greater than 50% which is an indication that it was still economical to keep the birds. The table also revealed that there was a sharp reduction below 50% in the egg production between the month of September and December 2020, which is an indication that owing to the reduction in the number of birds and their age, it is no longer productive to keep the birds.

Table 1: Egg lay according to number of birds.

Month	Number of bird	Expected egg laid	Egg Laid	% Egg laid
January	80	2400	1450	60.4
February	80	2400	1465	61.0
March	78	2340	1480	63.2
April	76	2280	1300	57.0
May	73	2190	1260	57.5
June	73	2190	1220	55.7
July	69	2070	1195	57.7

August	68	2040	1125	55.1
September	67	2010	1102	54.8
October	66	1980	976	49.3
November	58	1740	835	48.0
December	52	1560	712	45.6

Conclusion

Poultry production is an opportunity for the farmers to get additional income. The technology improved their socio-economic standard of participants. The approach was participatory; thus knowledge gain from the activities was sufficient for the farmers to manage their own poultry farms.

Activities in pictures

Fig.1: Situation of the pen before renovation and stocking

Fig.2: CRIN staff and cocoa farmers displaying eggs laid by birds

2020 Report

CRIN *Igioro* Live Phone-in Radio Programme with Radio Nigeria Premier FM 93.5 Ibadan

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 4th edition of CRIN *Igioro* Live Phone-in Radio Programme with Radio Nigeria Premier FM 93.5 Ibadan continued in 2020. The achievements made in research and development efforts of CRIN mandate crops: Cocoa, Kola, Coffee, Cashew and Tea are extended to the public through Radio, Television, Newspaper, exhibition, training, internet and other methodologies. Agricultural Radio programme has popularized CRIN technologies to larger number of farmers and other stakeholders along the value chains. The Extension Section of the Institute has adopted the use of Radio programme to reach out to our clientele with feedback to solve their problems and update knowledge where necessary.

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 was 13 week programme 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 2020 edition was flagged off by the current Executive Director/Chief Executive Officer, Dr. Patrick Olu Adebola CRIN on the Wednesday 25th November, 2020 at 6:30-7:00pm 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, Choco gari, cashew kernel, soap and cream. 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.

Methodology

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 the Southwest. 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. From the work plan, the following subject areas were outline and used during the programme. These include: Cocoa and cashew value chains as source of livelihood to farmers and other stakeholders in Nigeria, improving productivity among farmers of CRIN mandate crops and nursery management, Others were diseases and insects' pest management, value addition and utilization.

Result and Discussion

In the first week, the Executive director (ED) was the special guest. He made a presentation on cocoa and cashew value chains as source of livelihood to farmers and other stakeholders in Nigeria. The highlights of his presentation were: CRIN cocoa hybrid planting materials, CRIN developed products, training, screening and recommendation of pesticides for cocoa production.

CRIN Executive Director Dr P.O. Adebola kickstarting the Programme

The presenter and Dr S. Adebiyi at the Studio

Feedback: A total of four farmers called during the programme on how to access the hybrid materials and uptake CRIN developed technologies. They were encouraged to visit CRIN and request for them and they will be given. The ED advised farmers to get their planting materials from CRIN in order to ensure maximum yield.

The next presenter in the second week was Dr Adebiyi, S. His presentation was on improving productivity among farmers of CRIN mandate crops: Intervention through extension methods. The highlights were planning, farmers' need and outcome, group association, farming system approach and skills' acquisition. At the end of the presentation, three persons called and we lost two calls due to network issues. They complained that even with their cooperative societies, they cannot access loans from bank and government. They said farm inputs are becoming expensive and they needed support. The presenter advised them to source money from their personal savings of the group as alternative means.

Suspension of the Radio programme: The *Igioro* Radio programme was however suspended due to the on-going strike by Research Institutes in Nigeria. We hope to continue it when the Subject Matter Specialists will be available.

TRAINING DEPARTMENT

Dr. S. O. Agbeniyi
DIRECTOR (TRAINING)

CRIN/FMARD TRAINING WORKSHOP – SKILLS ACQUISITION BY COCOA FARMERS

Cocoa Research Institute of Nigeria (CRIN) in collaboration with the Federal Ministry of Agriculture (FMARD) organised a training workshop for cocoa farmers in the south-west region of Nigeria themed: *Skills Acquisition by Cocoa Farmers* on 9th and 10th December, 2020.

The training workshop was held at the Event Centre of the Cocoa Research Institute of Nigeria, Idi-Ayunre, Ibadan. It was well attended by cocoa farmers in the south west region of Nigeria.

The Executive Director of the Institute, Dr P.O. Adebola, ably represented by Director (FSR) Dr A.O. Famaye and the Director (Training)/Workshop Coordinator, in person of Dr S.O. Agbeniyi welcomed the Permanent Secretary (FMARD), Director (FDA) and all the participants to the training workshop.

Many erudite scientists of the Institute took cocoa farmers in different sessions at the workshop, amongst which are Dr A.O. Famaye, Dr M.O. Ogunlade, Dr(Mrs) A.A. Muyiwa and Dr (Mrs) C.O. Jayeola. The following sessions were taken extensively; Cocoa Nursery Management, Integrated Soil Fertility Management, Field Establishment and Demonstration and Harvesting Fermentation and Processing.

There was field visit to the Nursery session of the Institute where participants were shown how grafting, propagation and so on were being carried out.

The feedback from the participants showed that the training workshop was well appreciated and they prayed that such training could be done more frequently to keep farmers abreast of latest development of handling cocoa.

A tour of the nursery unit

Cocoa seedlings at the Nursery unit

CRIN/FMARD TRAINING WORKSHOP FOR COCOA FARMERS ON KNOWLEDGE TRANSFER ON GRAFTING

Cocoa Research Institute of Nigeria (CRIN) in collaboration with the Federal Ministry of Agriculture (FMARD organised a training workshop for cocoa farmers in the south-west region of Nigeria 25th – 26th March, 2021. The training workshop was on Knowledge Transfer on Grafting for Cocoa Farmers.

The Executive Director, Dr P. O. Adebola, welcomed the Director(FDA), Dr Tobaba Ajayi, and cocoa farmers to the training workshop.

Dr (Mrs) Anna Muyiwa spoke on **Cocoa Nursery establishment** where she emphasized that any individual farmer who plans to establish a nursery for production of cocoa planting materials must think about the certified varieties. They must also think about the commercial viability of their business. Climate and weather condition in nursery location must be suitable for the variety planned. Water is important and poor water supply affects quality of planting materials. The nursery operator must understand the market requirements for cocoa planting materials.

She also told cocoa farmers about the Cocoa Nursery layout should be: have adequate structures including fencing to keep out domestic and other animals, provision should be made for the hardening area, propagation area, should be organised to make daily operations easy, and enable easy movement of plants.

Cocoa farmers were also taken to the Nursery Unit of CRIN where they were shown practical and the nitty gritty of grafting by Dr (Mrs) Muyiwa, assisted by Mrs E. A. Babalola of the Nursery Unit.

Cross section of cocoa farmers at the nursery

Dr (Mrs) A. Muyiwa with the nursery staff

The nitty gritty of cocoa grafting at the nursery section

Mrs Babalola listed the process of budding and grafting as follows:

STEPS IN BUDDING AND GRAFTING

A. BUDDING PROCESS

- 1.Collection of budwood
- Preservation of collected budwood (serviette paper, was, ice block)
- Disinfection of budwood and other budding materials with fungicide (e.g. Ultimax plus)
- Selection of Healthy rootstocks
- Detachment of a bud from the budwood
- Making a patch below the cotyledon level of the root stock
- Insertion of the bud (scion) into the patch made on the rootstock
- Tying up the union point with budding tape
- Careful arrangement of the budded materials into vegetative propagation shed
- Removal of the budding tape after 14 days

NOTE: Do not pour water directly to the point of budding rather, watering should be done with the use of kettle.

B. GRAFTING PROCESS

- Collection of Scion (Budwood)
- Preservation of Scion (Serviette paper, wax, ice block)
- Disinfection of scion and other grafting materials with fungicide
- Selection of healthy rootstock
- Cutting of scion to contain about 2 or more budeyes
- Careful slicing of the Scion at opposite end
- Horizontal dissection of the root stock
- Insertion of the Scion into the dissected rootstock leaving 3 -4 leaves below
- Tying up of the union point for firmness
- Cover the inserted scion with grafting cap
- Carefully arrange the grafted materials into vegetative propagation shed
- Untie the cap at 21 days

NOTE: If sprouting occurs before 21 says, the cap should be removed.

Materials needed for budding and grafting

- Secateur
- Budding knife
- Paraffing waz
- Grafting cap
- Fungicide
- Buddwood rack
- Budding tape
- Serviette paper
- Label
- Recording book

FMARD Cocoa Desk Officer, Rep. of Minister of Agric., ED CRIN & Director (Training) at the High Table

A cross section of participants with the Executive Director CRIN at the Events Centre, CRIN

FMARD Cocoa Desk Officer and his team with Director (Training) CRIN at the Nursery Section

Dr S.B. Orisajo

Dr S. B. Orisajo spoke on Responsible use of Pesticide in Cocoa where he explained that

1. Prevention.....better than cure! Keeping the pest populations below action threshold, create unfavorable conditions for pest development and inoculums production

2. Protection.....action oriented measures; targeting a particular pest population with a bid to manage them and are never intended to 'stand - alone', but are rather integrated into ''preparation and prevention'' He gave farmers the list of pesticides currently approved for use on cocoa farms as shown below:

s/n	Trade name	Formulation	Active Ingredient	Recommended dosage	Distribution Company in Nigeria	Target pest
1	Funguran OH	Wettable powder (WP)	Copper Hydroxide (50% or 500g/kg)	60g/15 Litres of Water	INSIS	Black pod
2	Champ DP	Wettable powder (WP)	Copper hydroxide (37.5% of 375g/kg)	50g/15 Litres of Water	SARO	Black pod
3	Ridomil Gold	Wettable powder (WP)	Copper (1) Oxide 600g/kg + Metalaxyl-M 60g/kg	50g/15 Litres of Water	SYNGENTA	Black pod
4	Copper Nordox 75 WP	Wettable powder (WP)	Copper Hydroxide (75% or 750g/Kg)	50g/15 Litres of Water	DIZZEN GOFF	Black pod
5	Ultimax plus	Wettable powder (WP)	Metalaxyl 12% + Copper (1) Oxide 60%	50g/15 Litres of Water	HARVESTFIELD	Black pod
6	Kocide 2000	Wettable powder (WP)	Copper hydroxide (53.8% or 538g/kg)	50g/15 Litres of Water	VANCOL	Black pod
7	Red Force/Jorkemil Plus	Wettable powder (WP)	Copper-1-Oxide 60% + Metalaxyl 6%	50g/15 Litres of Water	JUBAILI/JORKEMIL	Black pod
8	Pergado	Granule (G)	Mandipropamid 125g + Mefenoxam 100g	30g/15 Litres of Water	SYNGENTA	Black pod

9	**Carbrio Duo**	**Emulcifiable concentrate (EC)**	**Pyraclostrobin 40g/L + Dimethomorph 72g/L**	**50/65 mls in 10 Litres of Water**	**BASF**	**Black pod**
INSECTICIDES						
10	**Actara 25 WG**	**Wettable Granule (WG)**	**Thiamethoxam 98%**	**6g/10 Litres of Water**	**SYNGENTA**	**Mirid**
11	**Esiom 150 SL**	**Soluble liquid (SL)**	**Acetamiprid 100g/L + Cypermethrin 50g/L**	**8.33mls/10 Litres of water**	**INSIS**	**Mirid**
12	**Proteus 170 O Tec**	**Oil Technology (O-Teq)**	**Thiacloprid 150g/L + Deltamethrin 20g/L**	**27 mls/10 Litres of Water**	**SARO**	**Mirid**
13	**Confidor 200 O Tec**	**Oil Technology (O-Teq)**	**Imidacloprid 200g/L**	**36.4 mls/10 Litres of Water**	**HARVESTFIELD**	**Mirid**
HERBICIDES						
14	**Touch down**	**Soluble liquid (SL)**	**Glyphostate (36.8% or 368g/IW/V)**	**200 mls/15 Litres of water**	**SYNGENTA**	**Weed**
15	**Clear weed**	**Soluble liquid (SL)**	**Glyphostate (36% or 360g/IW/V)**	**200 mls/15 Litres of water**	**HARVESTFIELD**	**Weed**
16	**Round up**	**Soluble liquid (SL)**	**Glyphostate (49% or 490g/IW/V)**	**200 mls/15 Litres of water**	**CANDEL**	**Weed**
FUMIGANTS						
17	**Phostoxin**	**Tabletized (T) or Pelletized (P)**	**Aluminium phosphide 500g/kg**	**3-4 tablets/ton of well stacked cocoa bags**	**GONGONI**	**Storage pests**

He concluded that pesticides should be used responsibly only if the preventive practices fail

and there will be less concern about residue in soil and contamination of cocoa beans and there will be access to safe and quality cocoa for the production of chocolate.

The feedback from the participants showed that the training workshop was well appreciated and they prayed that such training could be done more frequently to keep farmers abreast of latest development of handling cashew. They were all given certificate of attendance and participation.

CRIN/FMARD TRAINING WORKSHOP ON PROPER HANDLING OF SOLAR COLLAPSIBLE COCOA DRYER FOR COCOA FARMERS.

The Cocoa Research Institute of Nigeria (CRIN) in collaboration with the Federal Ministry of Agriculture (FMARD) organized a training workshop for cocoa farmers in the south-west region of Nigeria 25th – 26th March, 2021. The training workshop was on Proper Handling of Solar Collapsible Cocoa Dryer for Cocoa Farmers.

ED CRIN, Dr O. Adebola welcomed participants to the Training Workshop

Cocoa Desk officer, Abuja, Rep. of Minister of Agric., ED CRIN, D(T) (L-R) at the Events Centre CRIN

Cross section of participants at the Events centre, CRIN

Dr (Mrs) Lawal talked on Certification and Traceability

Dr (Mrs) Lawal talked on Certification and Traceability: the means to achieving Sustainable Cocoa Production in Nigeria

She said an enterprise is sustainable when it that has low negative impact and high positive economic **viability**, environment and social equity on the people.

Sustainable production trains the farmers to grow cocoa responsibly, increase their yields, improve farmer's livelihood and increase their income so that farmers **can** invest in their farms and communities.

She also said Certification is one of the available tools in the market to ensure the application of principles for sustainable production of commodities, like cocoa.

Which comprises a set of principles addressing social and economic concerns of farmers, farmer groups and communities including environmental requirements.

Dr Lawal went further to say The farmers need to comply with the determined requirements, and compliance is verified by independent auditors, through regular audits (frequency varying per scheme).

The key changes to adapt to certification happen at farm level, however responsibilities for and costs of certification are distributed through the value chain.

Certification schemes operate in similar ways and have as key objective to promote sustainable practices in the cocoa supply chain and improve the livelihoods of farmers.

She said sustainability could be achieved through Farmers in groups
Good Agricultural practices, Adoption of new hybrid planting materials

- responsible use of chemicals (pesticide/insecticides); appropriate use of fertilizer and crop protection
- avoidance of child labour in all shades
- Resource-use efficiency
- proper record keeping on farm activities
- Timely operations on the farms: gapping-up, ideal spacing, weeding, pruning, spraying
- Proper post-harvest handling of beans: stick breaking, box fermentation (5days), drying
- Proper storage of cocoa beans: good ventilation
- Regular trainings
- Ban on child labour on cocoa farm
- Improved agro-forestry/afforestation
- Increased productivity and access to markets
- Increased income and improved livelihood
- improve food security, access to clean water, education, women empowerment

She also explained traceability as a step beyond the certification process;

- The scope for traceability is from production up until retail level of certified product;
- Certification helps traceability and help farmers earn more;
- It helps to identify farmers producing the beans at all location;
- help to collaborate on curbing deforestation, child labour and extreme poverty;
- Consumers' increase in concern about food safety and concerns of the processes in food supply chain triggered it.

She emphasized on child labour as the menace to certification and traceability

- Children younger than 15 are not employed in any form.
- Children younger than 18 do not conduct heavy or hazardous work, or any that could jeopardize their physical, mental or moral well-being.
- No forced, bonded or trafficked labor is allowed in any shape or form if certification is a standard.
- On small scale/family run farms, children are allowed to help their families, but only if: the work does not interfere with schooling; it's not physically demanding or hazardous; an adult relative always accompanies the child.

Dr (Mrs) Jayeola spoke on Cocoa Harvesting, Fermentation and Processing. She talked extensively on Proper harvesting techniques, Damage to beans during opening of fruit, Proper fermentation and curing, Proper drying of beans (Moisture content) and Insect and animal infestation of stored beans


Dr (Mrs) Jayeola went further to highlight the technique of pre-harvesting and the tools needed as itemised: Healthy crops lead to good products.Environmental hygiene in harvesting areas and Harvesting tools must be ready and it includes:

- Sharp cutlass,
- A sharp knife with short handle
- A sharp knife attached to a long pole (go-to-hell)
- A clean basket
- Harvest time
- When its ripe
- Crop protection protocols
- Safe pesticide "window"

She also talked about pre-fermentation stage and said cocoa farmers should ensure the following important steps are taken into recognition; Allow the pods to rest for at least two days, ensure correct nib acidification, enhance pre- fermentation activity inside beans, facilitate rapid rise in temperature and Impart stronger chocolate flavor. They should make sure that when they are breaking pods, ensure the use of club or wooden object, pods are broken without causing damaged to beans, only good beans are collected, diseased, germinated and caked beans are discarded.

On pre-fermentation, she said they should ensure that after splitting, they remove wet beans from the pods, any defective or damaged beans are removed, fermentation to be done 12 to 24hrs after pod breaking, wet beans are fermented for 5 to 6 days (until strong odour develops) , beans should be turned every 48 hours which is responsible for chocolate flavour and external browning

On drying of cocoa beans, they should use sun to dry cocoa on a raised platform, slow but progressive loss of moisture, loss of a stringency and bitter taste, loosening of the shell from the beans, moisture content reduced to 6%.

She said during drying, the beans must be turned every 2 to 3 hours to ensure beans uniformly dried as well as preventing overheated beans

They should protect cocoa beans during drying from rain and dew. The cocoa beans should be heaped and covered at night or during rainy weather to avoid re-wetting.
She said when packaging, flat beans slaty beans, shrivelled beans, black beans, mouldy beans, small and/or fused beans, germinated beans, beans with insect damage should be removed before bagging and packaged in clean hydrocarbon-free jute bags securely sealed.
She also talked about labeling; bagged cocoa beans must be placed in storage sheds that are weatherproof, well aerated, cleaned, free from dampness and insect pests and away from smoke.

Only non-toxic ink or paint should be used for marking and should not be allowed to come in contact with the beans.
A Field visit to the drying and fermentation unit of CRIN was made where cocoa farmers were shown different types of drying methods and Engr. Mofolasayo displayed solar collapsible cocoa dryer for the farmers, showed the intricacy of using the machine.

Engr. Mofolasayo talking on solar collapsible cocoa dryer

ED, CRIN with Directors at the solar collapsible cocoa dryer stand

Cocoa Farmers at the solar collapsible dryer

Presentation of Certificate to participants



A cross section of participants at the Workshop

Cocoa Sun dryer

Cocoa farmers at the classroom

Mr Tobaba Ajayi, cocoa desk officer, FMARD gave the closing remark

CRIN/FMARD TRAINING WORKSHOP ON SKILL ACQUISITION ON AGROCHEMICALS APPLICATION AND SAFE HANDLING FOR CASHEW FARMERS.

The Cocoa Research Institute of Nigeria (CRIN) in collaboration with the Federal Ministry of Agriculture (FMARD) organised a training workshop for cashew farmers in the south-west region of Nigeria on 15th – 16th March 2021. The training workshop was on Skill Acquisition on Agrochemicals Application and Safe handling for Cashew Farmers.

The Executive Director, CRIN, Dr. P. O. Adebola, welcomed cashew farmers in the presence of Director (Tree crops), Abuja, in person of Mr. B.C. Ukattah, and Director (Cashew Value chain), Mr. T.T. Usman and Tree crops officer, Mr. Ohinoyi Christopher to the training workshop.

ED, CRIN welcomed participants to the training workshop

A cross section of participants with the ED, CRIN at the Events Centre, CRIN

Director Tree Crops, Abuja, Director Cashew Value Chain, Abuja and Director (Training) CRIN

The first training was taken by Dr Ibiremo who talked on Management of Cashew Soils for Improved Yield. He mentioned that in selecting site for cashew the following should be put into cognizance: Visual observation, which involves presence and types of trees, types of weeds and presence of worm cast. He also mentioned Soil characteristics as; Soil depth 1-1.5m, Gentle slope, grows on a wide range of soil, Ideal, slight sandy to sandy loam soil with not less than 60% sand Well drained soil, no water logging, Soil pH 5-7.5 and Steady and continuous supply of nutrients.

Cashew farmers should take note of these; Proper site selection, Soil testing before fertilizer recommendation and application and integrated nutrient management.

Dr Ibiremo talking on Management of Cashew soils for improved yield

Mrs E. Adeyemi also talked on *Nursery & Field Establishment of Cashew***.** She said cashew is a tropical crop, native to Brazil, introduced into Nigeria in1950s and its grown primarily for its nut. She said in establishment of cashew farm, they must take note of the Topographically suitable & accessible site, Fell trees, cross cut & remove logs, Establishment by seeds or seedlings, Sow / Plant at 9.0 x 9.0 m (123 plants / ha) or 6.0 x 6.0 m (278 plants / ha).

She emphasized steps to take on harvesting of cashew as;

- Pick nut on dropping or pick with apple from tree
- Harvest spans from Dec. to May; peak in Feb/Mar
- Pick nuts before rains
- Fruiting starts 2 - 3 years old; mature yield in the 7th year

She gave the acronyms of CASHEW as;

- C Come
- A And
- S See
- H How
- E Easy
- W Wise, Work, Wine & Win

So: PET (Plant, Eat & Trade) Cashew

Good plantation ▫ Good Yield ₌ Great cash

A field visit was made to cashew plantations in the estate.

Dr Aroyeun talking on Value Addition In The Cashew Industry

The other session was taken by Dr Aroyeun who talked on Value Addition in the Cashew Industry. He said that cashew is an example of perishable fruits, it consists of a kidney shaped NUTS and a fleshy, juicy and sweet apple attached to the NUT, it is rich in Vitamin C and has been considered to be richer in vitamin C when compared to some other tropical fruits.

Cashew is ready for harvest when it has soft skin, yellow or red colour of the skin, contains more water, Sweet taste and less acidic.
He explained home based cashew nut processing as follows: In this process, raw cashew nuts are boiled in a large drum or open pan (25min), Sun drying 24hrs, Mechanical deshelling to remove the kernels, kernel drying 7hrs.

He said cashew can be made into cashew chocolate, cashew kernel biscuit, cashew ice cream, cashew kernel yogurt, cashew nut protein concentrate, cashew kernel butter.

The next session was on **Pests and Diseases of Cashew in Nigeria and their Control Measures** which Dr Adedeji done justice to by defining pest, major pest and minor pest as; pest is generally used to mean insects, other invertebrates and vertebrates that cause damage to our crops and livestock. **Major pests:** These are pests that cause serious damage to crops irrespective of their population. **Minor pests:** These pests are known not to cause economic damage to the crops even when their populations are large. They cohabit with the crops without much problem.

From his teaching insect pest of cashew are;

- Cashew stem girdler *(Analeptes trifasciata)* – Causes 53% - 75% loss
- Cashew Pseudo-Apple scrapper *(Pachnoda cordata)*
- Termites *(Nasutitermes spp*
- Grasshopper *(Zonocerous variegatus)*
- Leaf miners *(Acrecercops synagramma)*
- Tailor ant (*Oecophylla longinoda)*
- Cashew giant bug (*Anoplocnemis curvipes)*

The following can be used as controlled Cultural measures ;Pruning,Weeding, Timely harvesting of ripe apples, Phytosanitary harvesting, Destruction of termite mounds, Removal of King/Queen
While the approved Insecticides are: ***Actara, Proteus***, ***Esiom*** *and* ***Confidor***
Other diseases of cashew are: Kernel rot of cashew:
Symptoms: deep brown, grey intense yellow as compared with light yellow kernel of normal cashew kernel
Control: Cleaning of the cashew nuts during harvest (Picking) and before processing
Rot of immature cashew nuts*:*
Symptoms: Dry rot of the nuts, Nuts shrivels and becomes dark in colour
Control: spraying systemic or contact fungicide and insecticides, Rot of peusdoapple in the plantation.

Complex of fungi associated with fruit flies
Symptoms: From the area of bruise white fungi mycelia is seen sporulating followed by putrefying odour
Control: Timely harvest of cashew apples.

Cashew farmers at the field

Dr. Orisajo talked on Responsible Pesticide Use in Cashew. He explained the AESA - **Agro Eco-System Analysis**

- The health of a plant is determined by its environment.
- Includes abiotic factors (i.e. sun, rain, wind and soil nutrients) and biotic factors (i.e. pests, diseases and weeds).
- All these factors can play a role in the balance, which exists between pests and their natural enemies.
- If we understand the whole system of interactions, we can use this knowledge to reduce the negative impact of pests and diseases.

He gave the threshold action on Cashew pests damage level at which it makes sense to control it.

Threshold key	***Decision***
0 - 5% damage	***Do not spray***
6 – 25% damage	***Do spot application***
Above 25% damage	***Do blanket spraying***
If 70 – 75 % of the apples will be ready for harvest in 2 weeks	***Do not spray***
If 85% of cashew nuts are already harvested	***Do not spray***

Pesticide Use on Cashew

PRESENTATION OF CERTIFICATE TO PARTICIPANTS





Vote of thanks from the Secretary Cashew farmers Association

Alhaja, secretary of the group on behalf of all the cashew farmers, appreciated the Federal Ministry of Agriculture and Rural Development and CRIN for the thoughtful training workshop for farmers and prayed for continuous training and empowerment to reach unto others in the community and the country at large.

Capacity Building on Cashew Value Addition through processing cashew apples into cashew juice on 16th of April, 2021

Introduction

Training on cashew juice processing to salvage wastage of cashew apple which are seldom consumed during its peak season was organized by Nigerian Export Promotion Council In collaboration with our Institute Cocoa Research Institute of Nigeria in an attempt to add value to cashew, CRIN was engaged as facilitator to train the farmers on how to produce cashew juice from the wasting cashew apple. CRIN was ably represented by myself and Mr Tayo Bamgbose from the engineer section to operate the cashew juice extractor

Training Objectives

To create awareness and enlightenment on the utilization of cashew apple which will provide more employment opportunities and increase in profit margin from the same Cashew tree

Training

The training took place in Joga Orile village in Yewa North, Ogun state. The capacity building involved training of 70 cashew farmers from Yewa North; using on- farm demonstration techniques and participatory approach.

The practical training was facilitated by the Cocoa Research Institute CRIN.

Over the years, farmers are only interested in the sale of raw cashew nut while the fruits rots away. Invariably cashew juice contains five times of vitamin C than that of oranges which can help eliminate various disease conditions such as scurvy. The juice is made from pure cashew apple without addition of water and sugar.

The processes involved the farmers plucking only mature and ripe apples. I engaged the farmers in sorting, cleaning, blanching, extraction of the juice and bottling into cashew juice. The participatory training was a demonstration of the different Cashew value chain processes, requirements for labelling and Packaging, how to obtain NAFDAC, Barcode and NEPC registration.

Observation

The farmers were very happy for the training and expressed their joy and promised to start instantly as this will boost their revenue from cashew. Cashew farmers were advised to group themselves and form cooperatives so as to enable them have access to loans. The farmers were encouraged to go into mass processing of Cashew apple into juice for sale at this season at affordable price all over the local government that produces cashew in Ogun State and all cashew producing states in Nigeria for local consumption and for export

Recommendations

I recommend that this type of training be repeated in cashew producing states in Nigeria in order to showcase CRIN, create job opportunity for unemployed youths and also increase the nations multiple streams of income

Administrative charges

A sum of twenty thousand Naira (#20,000) was paid by Nigerian Exports Promotion Council to the cover of the Institute as administrative charges. The receipt of payment is hereby attached with this report.

Appreciation

My appreciation foremost goes to the representatives of Nigerian Exports Promotion Council, Ibadan Office under the leadership of Mr. Idowu for sponsoring this capacity building on cashew value addition, moreover, I want to sincerely thank the Executive Director of Cocoa Research Institute of Nigeria Dr. P.O. Adebola for the opportunity granted me to be the facilitator of this training.

Dr. Jayeola at the training venue

ECONOMICS AND STATISTICS

2020 Research Report

Cocoa Data Bank in Ogun State, Nigeria

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

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. In Africa, Nigeria is the third producer (World Cocoa Foundation, 2014). Cote d'voire which was placed at a distant third position in Africa with 143,000 tonnes behind Nigeria's 196,000 tonnes in 1970 is now the largest producer of cocoa in the whole world with 12, 824, 717 tonnes while Nigeria with 298,029 tonnes is currently the fourth largest producer (FAO, 2019; ICCO, 2015). Nwachukwu *et al*. (2012) stated that cocoa is the most prominent export crop in Nigeria in terms of production and export capabilities. 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). Nigeria's cocoa production in 2011/12 was put at 300,000 MT, up from 280,000 MT in 2011. The increase is based on a favourable weather conditions in addition to considerably higher grower prices, which encouraged farmers to increase their farm holdings (David and Nzeka, 2011). Cocoa and its products exported from Nigeria include cocoa beans (whole or broken, raw or roasted), chocolate and other food preparations containing cocoa, cocoa paste (whether or not defatted) cocoa powder and cake and cocoa butter (World Cocoa Foundation, 2014). United States of America, Spain, France, Germany and Netherlands are the main importers of Nigerian cocoa. It was reported that Nigerian cocoa output declined from 399, 200 tonnes in 2010 to about 298, 029 tonnes in 2016 with a growth rate declining from 16.2% to about 12.2% during the period (FAO, 2019).

Objectives

The specific objectives of the study were to:

i. profile the socio economic characteristics of the farmers in the study area
ii. identify cropping patterns and agronomic practices among the farmers
iii. identify marketing channels in the study area
iv. identify constraints in cocoa production in the study area

Methodology

The study was carried out in Ogun State, Nigeria in 2019. The study employed a multistage random sampling technique to select cocoa farmers. The first stage was a purposive selection of the state.

This is because of the volume of cocoa production recorded in the state. The second stage was a purposive selection of Ijebu North Local Government Areas (LGA). The third stage was a random selection of forty four (44) cocoa farmers within the selected LGA. Primary and secondary data were used for the study. Well-structured questionnaire was used for the primary data. Data were collected on age of the farmers, marital status of farmers, household size, farming experience, educational level, and membership of farmers' association. Data was analyzed using simple descriptive statistics (means, frequencies, percentages).

Results and Discussion

Socioeconomic characteristics of the respondents (cocoa farmers)

Table 1 shows the socio-economic characteristics of cocoa farmers in Ijebu North Local Government Area (LGA) of Ogun State. The table reveals that a little above half (56.82%) of the farmers were male. The implication of this is that cocoa farming in the study area is largely dominated by male gender. Girei *et al* (2013) reported that in Africa, men are more in a crop that is perceived to have commercial value. In addition, the result conforms to the findings by Taiwo *et al* (2015) who reported that about 68.7% of farmers that practiced cocoa rehabilitation techniques (CRTs) in Southwest and South-South agro-ecological zones of Nigeria are male. In addition, the table reveals that majority (90.90%) of the farmers were married. Moreover, the mean age of the farmers is 49 years with a Standard Deviation (SD) of ± 9.71. The implication of this is that cocoa farmers in the LGA are still in their productive years and thus cocoa production in the study area is expected to be on the increase. However, this is not in consonance with the findings by Adeogun *et al* (2010) and Adebiyi and Okunlola (2013) who reported that cocoa farmers in selected states of Nigeria were old and that most of the cocoa farmers in Oyo State have passed there productive age. Similarly, the table reveals that 45.00 percent of the farmers had access to secondary education. The implication of this is that the farmers may perhaps not have access to information on good agricultural practices (GAP) with respect to cocoa production. However, the result showed that majority of the respondents can read and write. Furthermore, the table reveals an average household size of 6 persons with ± 2.6 as SD. This implies that the farmers may perhaps utilize members of the household as labour for some operations relating to cocoa production and probably rehabilitation of farms. This may reduce some production costs expected to be incurred on the crop. Furthermore, the table shows that about 59.1% of the cocoa farmers had between 1-5 hectares of cocoa farms. This implies that cocoa production in the study area is still in the hands of smallholder farmers who probably may not have access to farm inputs to enhance their production activities.

Table 2 below shows the cropping patterns, varieties of cocoa grown and sources of planting materials by the farmers. The table reveals that majority of the farmers (81.80%) were involved in sole cocoa cultivation; about 54.50 percent practiced cocoa/tree crops while 29.60 percent of the farmers cultivated cocoa/arable combination. The implication of this is that sole cocoa cultivation is the most predominant cropping pattern in the study area. However, the result of cocoa/arable

combination implies that the farmers maximized the use of available land that was not shaded to cultivate short duration crops. This conforms to a priori expectation. In addition, majority of the farmers (86.40%) planted F3 Amazon variety of cocoa while 11.40 percent, 6.80 percent planted Amelonado and Hybrid (CRIN) varieties, respectively. This implies that distribution of CRIN varieties of cocoa has not spread enough to the farmers, hence the cultivation of the old and low yielding varieties. Furthermore, it was revealed that 36.40 percent, 6.80 percent and 2.30 percent of the farmers got their planting materials from friends, CRIN and Ministry of Agriculture, respectively. This implies that the old habit of getting planting materials from neighbours by cocoa farmers is still in existence. This may perhaps lead to recycling of pests and diseases on the farms.

Moreover, the table revealed that majority of the farmers (93.20%) carried out clearing operation on the farms while planting, weeding and spraying were carried out by 86.40 percent, 90.90 percent and 77.30 percent, respectively. Similarly, prunning and harvesting were both carried out by 79.50 percent of the farmers. The implication of these results is that the farmers are knowledgeable in all these agronomic practices in cocoa farming.

Table 3 below shows distribution according to the marketing channels among the farmers. The result shows that 75.00 percent of the farmers chose local buying agents as channels through which their product gets into the market while about 9.10 percent sell to exporters. The implication of this is that majority of the farmers are smallholders who see the local buying agents as a faster means of getting cash from the sale of their produce. In addition, it was revealed that about 47.73 percent of the farmers produced between 500-1000kg of cocoa from their farms while 22.72 percent produced above 1000kg. This justifies that the farmers farm on small hectarage of land. Furthermore, majority of the farmers sold their cocoa beans between 500-1000 naira/kg. The implication of this is that almost all the farmers had information on the prevailing market prices for their produce. However, the remaining farmers in the study area may perhaps be those in need of quick cash and thus sell at any amount without recourse to the quality of the cocoa beans. Moreover, about 56.80 percent of the farmers agreed they pay taxes to the government while taxes paid by majority (84.10) of the farmers are less than 500 naira per annum.

Table 4 below reveals the distribution of the farmers according to common insect pests and diseases on cocoa farms in the study area. The result shows that termite was seen as most common insect pest by about 45.50 percent of the farmers while 2 percent of the farmers saw locust as common pest and about 15.90 percent of the farmers showed indifference on the insect pests. This implies that the insects have not reached economic injury levels or perhaps they are still at the levels that the farmers can easily control or manage. Similarly, black pod disease and fungi were seen as the most common diseases by about 59.10 percent and 6.80 percent of the farmers respectively while 34.10 percent of the respondents showed indifference to the diseases. This implies that blacpod disease still remains a disease of cocoa in the humid region of Nigeria.

Table 5 below shows the distribution of farmers according to constraints and intention to increase cocoa production. It was revealed that about 65.90 percent of the farmers identified non-availability of improved varieties of cocoa as a constraint. Similarly, credit accessibility and high cost of agrochemicals were seen as constraints to cocoa production by 93.20 percent and 90.09 percent,

respectively. However, contrary to a priori expectations, almost all the farmers (90.09%) had intentions to increase their production despite the identified constraints.

Conclusion and Recommendations

The study was carried out to have a data bank of the operations of cocoa farmers in the study area. The study showed that majority of the farmers is still producing at a small scale. Farmers should be encouraged to increase their farm holdings through the provision of enabling policies such as liberalization of cocoa markets, accessibility of improved varieties of cocoa and the removal or mitigation of identified constraints to cocoa production in the study area. However, there is need for adequate and up to date information on the need for the farmers to put these insects population at minimal levels.

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Table 1: Socio economic characteristics of Cocoa Farmers in Ijebu North Local Government Area, Ogun State

Variables	Frequency	Percentage (%)	Mean	Std. Deviation
Gender				
Male	25	56.82		
Female	19	43.20		
Age (Years)				
31-40	13	29.55		
41-50	13	29.55		
40-49	29	33.34		
Above 50	18	40.90	**49**	**9.71**
Marital Status				
Married	40	90.90		
Single	2	4.55		
Widowed	2	4.55		
Educational Level				
No Formal Education	6	15.00		
Primary	16	36.00		
Secondary	20	45.00		
Tertiary	2	4.55	**2.4**	**0.81**
Membership of Farmers'Group				
Yes	43	97.70		
No	1	2.30		
Household Size				

1-5	13	29.60		
6-10	28	63.60		
Above 10	3	6.80	**6.0**	**2.6**
Farm Size (Hectares)				
< 1	7	15.90		
1-5	26	59.10		
6-10	8	18.20		
Above 10	3	6.80	**6.1**	**6.3**

Source: Field Survey, 2019 Std. Dev: Standard Deviation

Table 2: Cropping patterns and agronomic practices among the respondent farmers

Variable	Frequency	Percentage
Sole Cocoa		
Yes	36	81.80
No	8	18.20
Cocoa-Arable		
Yes	13	29.60
No	31	70.40
Cocoa/Tree Crops		
Yes	24	54.50
No	20	45.50
Amelonado		
Yes	3	6.80
No	41	93.20
F3 Amazon		

Yes	38	86.40
No	6	13.60
Hybrid (CRIN Varieties)		
Yes	5	11.40
No	39	88.60
Source of Planting Material		
Self/Own Farm	9	20.50
Inherited	11	25.00
Friends	16	36.40
CRIN	3	6.80
Agrodealers	2	4.50
Ministry of Agriculture	1	2.30
Clearing		
Yes	41	93.20
No	3	6.80
Planting		
Yes	38	86.40
No	6	13.60
Weeding		
Yes	40	90.90
No	4	9.10
Spraying		
Yes	34	77.30
No	10	22.70
Prunning		

Yes	35	79.50
No	9	20.50
Harvesting		
Yes	35	79.50
No	9	20.50

Source: Field Survey, 2019

Table 3: Distribution according to the Marketing Channels among the farmers

Variable	Frequency	Percentage
Quantity Produced (Kg)		
<500	13	29.55
500-1000	21	47.73
Above1000	10	22.72
Price of Cocoa beans (₦ /Kg)		
<500	1	2.30
500-1000	43	97.70
Marketing and Sales		
Local buying agents	33	75.00
Licensed buying agents	7	15.90
Exporters	4	9.10
Tax/Levy		
Yes	25	56.80
No	19	43.20
Amount of Tax (₦/Yr)		
<500	37	84.10

500-1000	3	6.80
Above 1000	4	9.10

Source: Field Survey, 2019

Table 4: Common insect pests and diseases on cocoa farms

Insects	Frequency	Percentage
Termite	20	45.50
Black Ant	12	27.30
Mirid	3	6.80
Locust	2	4.60
Indifference	7	15.90
Diseases		
Blackpod Disease	26	59.10
Fungi Disease	3	6.80
Indifference	15	34.10

Source: Field Survey, 2019

Table 5: Distribution according to constraints and intention to increase cocoa production

Variable	**Frequency**	**Percentage**
Improved Cocoa Varieties		
Yes	29	65.90
No	15	34.10
Land Availability		
Yes	17	38.60

No	27	61.40
Credit Accessibility		
Yes	41	93.20
No	3	6.80
High Cost of Agrochemicals		
Yes	40	90.90
No	4	9.10
Inadequate Marketing Channels		
Yes	14	31.80
No	30	68.20
Storage Facilities		
Yes	19	43.20
No	25	56.80
Fire Incidents		
Yes	8	18.20
No	36	81.80
Intention to increase production		
Yes	40	90.90
No	4	9.10

Source: Field Survey, 2019

ECONOMICS AND STATISTICS

Economics Section Achievements

1. The section carried out data collection on cocoa. The main objective was to have a data bank for the Institute's mandate crops. While data were collected for cocoa in Ogun and Oyo States, data were collected for cashew in Enugu State. These are as shown in the pictures below.

2. The section was also involved in Market Survey and Data collection on Kolanut and Cashew Marketing in both Ogun and Oyo States, respectively. The broad objective of these studies was to assess the market participation among different actors in the value chains of these crops.

Scientist from Economics Section during data collections

3. The section was involved in training cocoa farmers in Ondo State on Record Keeping and Resource Use. The objective of the study was to enlighten the farmers on the importance of record keeping in cocoa production and efficient use of farm resources with a view to improve the livelihood of the farmers.
4. The section was also involved in CRIN Igioro live phone-in Radio programme in Radio Nigeria Premier FM 93.5 Ibadan. Presentations were made on Farm Record Keeping of CRIN Mandate crops and Impact of Low Pricing on Cocoa, Cashew and Coffee, respectively.

Dr (Mrs) Lawal at the studio of Premier FM 93.5, Ibadan

Statistics Section Achievements

The section was involved in the construction and installation of new meteorological station at the headquarters. The main objective of this was to make available reliable weather data to scientists interested members of the public in order to provide guidance on production of our mandate crops. The equipment was given by the Nigerian Meteorological Agency (NIMET), Abuja.

Extension Section Achievements

1. Continuation of CRIN Igioro live phone-in Radio programme in Radio Nigeria premier FM 93.5 Ibadan. Scientists across all disciplines in CRIN were involved in educating farmers, processors, marketers, consumers and the general public on CRIN mandates crops and technologies. It was a medium to promote the image of CRIN.
   See pictures of presentations:

CRIN Executive Director Dr P.O. Adebola kickstarting the Programme


Other prersenters at Premier FM Ibadan

2. Establishment of CRIN model demonstration farm for planting of cocoa hybrids (TC1-TC8) and improved seedlings of cashew, coffee and kola. The size of the plot is 2 acres and is located close to Engineering section, zone one. The plants are doing well and is currently maintained by Extension. This plot serves as model demonstration farm for farmers, visitors on excursion, Industrial Training students (IT), Youth corps members, and other stakeholders. It is a good plot to facilitate adoption of our mandate crops.
   Pictures of activities:



Cross section of new CRIN model demonstration farm

3. Stocking of poultry pen with 200 birds in the Institute adopted village at Aba-Agbo Community Oyo State and adopted school at Mamu Community Comprehensive High School, Mamu Ogun State. The adopted village and School's concept are outreach centers for the transfer of CRIN technologies to farmers, 15km outside the Institute for awareness creation and adoption on-farm. Cocoa pod husk (CPH) was used to replace 20% maize in layers' mash. The birds layed eggs and performed well which implies that there was reduction in the production cost of feed with CPH fortified feed compared with birds fed with conventional feed. The essence of adopting a school is to encourage students in Agriculture (Catch them young) especially with respect to our mandate crops. This approach has been very helpful to the host communities. Extension established a cooperative society for farmers in Aba-Agbo community. The organization is known as Agbeloba Multi-Purpose Cooperative Society and the society operates a revolving loan scheme among themselves which is still sustainable till now. The project is a source of income and promote cooperation among beneficiaries. This project is very much in place and sustainable.

Pictures of the poultry activities:

Poultry at Mamu and Aba-Agbo with birds

Poultry birds at Mamu and Aba-Agbo

4. Extension staff attended to One thousand and Twelve (1012) visitors (students from secondary and tertiary institutions) on excursion to CRIN. They were exposed to the institute developed technologies to promote uptake and encourage commercialization.

5. CRIN partnership and collaboration with foreign investor: Extension facilitated the partnership with foreign investor to develop a supply chain for global demand for Nigerian produced kolanuts. This partnership helped in sourcing healthy and chemical free kolanuts and processed into kola energy powder by AACE Food Processing factory in Sango Otta, Ogun State, 2020

ED and other staff with the processed product Kolanut Energy drink

6. Attendance and presentation of paper in the 38th Horticultural Science Society of Nigeria (Hortson) conference at University of Nigeria, Nsukka, Enugu State by some scientists from Extension. The title is Assessment of farmers' awareness and practices of coffee wet processing method in Kogi State from 25-31 October, 2020 presented by Awodumila, D.A.

7. Publication of research papers in reputable scientific international journals showcasing CRIN research outputs in the year under review. These are:

Authors	Title	Year
1. Agbongiarhuoyi Anthony Eghe and Fawole Ogbaraeno Pippy	Determinants of Compliance with Standard Practices of Pesticides use Among Cocoa Farmers in Southwestern Nigeria. *Pelita Perkebunan, Coffee and Cocoa Research Journal,* 36(3) 2020:290-300.	2020*
2. Agbongiarhuoyi A. E., Uwagboe E. O., Agbeniyi S. O., Famuyiwa B. S., Shittu T. R.	Analysis of Farmers' Cashew Nuts Marketing Channels and Information Frequency: Implications for Cashew Sustainability in Nigeria. *World Rural Observations* 2020:12(3):23-30.	2020*
3. Agbongiarhuoyi, A. E., Thomas, K.A., Uwagboe, E.O. and Famuyiwa, B.S.	Utilization of ICTs in accessing cocoa beans market information by Cross River State Farmers. *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development.* Vol. 20, Issue 3. Pp. 45-52.	2020*
4. Uwagboe, E. O. and Agbongiarhuoyi, A. E.	Adoption Challenges of Integrated Pest Management (IPM) Technology and Cocoa Production in Cross River State, Nigeria: The Elucidation and Way Forward. *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development Vol. 20, (4) pp. 575-582.*	2020*

5. Abdul-karim, I. F., Ajagbe, J. A., Famuyiwa, B. S., Adebiyi, S., Uwagboe, E. O. and Agbongiarhuoyi, A. E.	Appraisal of Leadership Styles among Cashew Co-operative Farmers in Ilorin West Local Government Area of Kwara State, Nigeria. *International Journal of Applied Research and Technology.* Vol. 9, No. 10, Pp. 20–27.	2020*
6. Alex O. Orimogunje, Babatunde A. Ogundeji, Tolulope I. Ademola, Shamsudeen T. Balogun, David J. Awodumila, Rosemary T. Olorunmota and Kehinde O. Oyeledun	Cocoa Farmers' Coping Strategies for Climate Adaptation in Ogun State, Nigeria Journal of Scientific Research & Reports Vol. 26, No.2, Pp 44-51.	2020*
7. M.A. Alli, K.A. Adesanya, M.O. Agboola-Adedoja, Adejoke, A.A., Q.A. Ogunwolu, C.A. Ugwu, and A.O. Akinpelu.	Review on coffee research and production in Nigeria in the last one decade (2009-2018). *World Journal of Advanced Research and Reviews 09(01):031-036. e-ISSS: 2581-9615, Cross Ref Doi:10.30574/wjarr*.	2020*
8. C.A. Ugwu, M.A. Alli, K.A. Adesanya, M.O. Agboola-Adedoja, Adejoke, A.A., Q.A. Ogunwolu, and A.O. Akinpelu 2020**.** Q.A.	Health implications of Kolanut production and consumption. *World Journal of Advanced Research and Reviews 08(03):312-316. e-ISSS: 2581-9615, Cross Ref Doi:10.30574/wjarr.*	2020*
9. Ogunwolu, C.A.Ugwu, M.A. Alli, K.A. Adesanya, M.O. Agboola-Adedoja, Adejoke, A.A., and A.O. Akinpelu.	Prospects and challenges of cash crop production in Nigeria: The case of cashew (*Anacardium Occidentale*, Linn). *World Journal of Advanced Research and Reviews 08(03):439-445. e-ISSS: 2581-9615, Cross Ref Doi:10.30574/wjarr.*	2020*
10. Adejoke, A.A., Q.A. Ogunwolu, C.A.Ugwu,	Kolanut Consumption, its benefits and side	2020*

M.A. Alli, K.A. Adesanya, M.O. Agboola-Adedoja and A.O. Akinpelu.	effects. *World Journal of Advanced Research and Reviews 08(03):356-362. e-ISSS:2581-9615, Cross Ref Doi:10.30574/wjarr.*	
11. Akinpelu, A.O., Oluyole, K.A.	Farm Level Characteristic Factors Influencing Tea in Sadauna Local Government Area of Taraba State, Nigeria. *Journal of Business and Economic Management 3(3): 001-004, January 2020.DOI.10.15413/jbem.2020.0117*	2020*
12. Akinpelu, A.O., and Oluyole, K.A.	Socio-economic Variables of Coffee Producers in Kogi State State, Nigeria. *Journal of Business and Economic Management 3(3): 066-069, January 2019:DOI:10.15413/JBEM.2020.* *0118 ISSN 2315-7755.*	2020*

PLANTATION AND ESTATE MANAGEMENT DEPARTMENT

Akande, M. A. (Mrs.)

Plantation Manager

A. STAFF STRENGHT / DISPOSITION.

S/N	Unit	Effective Hectare	No of Senior & Admin Officer	No of Supervisor	Field / Junior Staff & Admin	Total Work Forces	No of PCW
1	PEM	-	5	-	1	6	
2	ZONE 1	34.79	6	2	12	18	
3	ZONE 2	15.14	7	3	6	13	
4	ZONE 3 & 4	15.19	4	2	6	10	
5	ZONE 5	27. 63	6	2	10	16	
6	ZONE 6	26.00	4	2	15	19	20
7	ZONE 7	23.85	3	2	8	11	
8	ZONE 8	41. 05	6	2	13	19	
9	ZONE 9	22.89	5	3	9	14	
10	BCOO	6.00	2	-	1	3	
11	Fermentary	-	4	2	5	9	
12	Ground Maintenance	-	10	3	26	36	2
13	Palm Oil Milling	-	1	1	4	15	
14	**Total**	**-**	**63**	**24**	**116**	**179**	

During the period under review PEM was given fifteen new staff, comprising of three (3) Higher Agric superintendents, one (1) clerical staff, and 11 field staff. Messer's Kunle Akande, Godwin Mufutau and Olayemi Oyebanjo, were transferred to BCOO Moor Plantation, Engineering Department and ED's office. In addition, Mr Ojo Moshod retired from active service, while Mr kasali Adeleke was announced dead.

ACHIEVEMENTS:

Plantation Activities: The plantation activities were effectively carried out in all the existing zones in the zones and BCOO plot at Moor- plantation.

During the year under review, the covid- 19 pandemic affected our normal cultural farm practices between March and mid- October, 2020. Nevertheless, skeletal activities which include harvesting of cocoa pods, and clearing of CRIN frontage, were carried out. After resumption, all farm activities such as harvesting, and processing of cocoa, and oil palm, weeding, pruning of old plots, clearing of access roads, removal of mistletoes, and chupons resumed back to normal in various zones and plots while the ground maintenance section took care of the clearing of all open grounds, which include the office complex, residential environment, lawn and pruning of hedges.

Detailed analysis of the harvested farm produce within the year under review is itemized below:

A. COCOA

ZONES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1	2548	-	336	-	4928	-	-	-	-	-	3526	1017	12409
2	1976	200	-	-	2109	-	-	-	-	-	1752	510	6547
3 & 4	677	-	-	-	2042	-	-	-	-	-	1674	2000	6393
5	3939	-	-	-	7732	-	-	-	-	-	2903	2144	16,718
6	2887	824	-	-	5197	-	-	-	-	-	1686	1619	12,213
8	11800	1548	716	-	6380	-	-	-	-	-	7113	9896	37,453
9	2295	1142	-	-	5963	-	-	-	-	-	7219	2922	19,541
BCOO	2413	430	-	-	-	-	-	-	-	-	7686	1400	11,929
DEMO	-	-	-	-	195	-	-	-	-	-	294	-	489
CFC	-	-	-	-	8055	-	-	-	-	-	-	-	8055

TOTAL	**28,535**	**4,144**	**1,052**	**-**	**42,601**	**-**	**-**	**-**	**-**	**-**	**33,853**	**21,562**	**131,747**

B. OIL PALM

OIL PALM	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1	116	65	71	-	-	-	-	-	-	-	52	72	376

C. RECORD OF OTHER HARVESTED FARM PRODUCE.

ZONE	KOLA PODS	CASHEW NUGTS (kg)	BANANA BUNCHES	PLANTAIN BUNCHES	COFFEE (kg)	AFRICAN STAR APPLE
3 & 4	-	99.5	-	7	-	-
7	1, 809	-	8	-	-	-

D. FERMENTARY UNIT

COCOA

During the period under review

i. The total dried cocoa beans produced was 2 tonnes, 289.2kg.
ii. The dried cocoa beans brought forward from the previous year (i.e. 2019) was 2 tonnes, 367.6kg.
iii. The total dried beans sold was 3 tonnes, 655kg
iv. The total beans issued out for research work was 50kg.
v. The remaining dried cocoa beans in the store was 951.8kg.

CASHEW NUT:

Medium size of cashew nut sold was 6kg while 115.6kg and 50.8kg of Jumbo size were issued out respectively.

CHALLENGES AND CONSTRAINTS:

- Shortage / inadequate supply of manpower greatly affects our production and maintenance activities.

- There is the need to revisit old and abandoned cocoa plots the way it was done the previous year.
- Porosity of zonal / unit office complex gives room for pilfering of farm produce.
- Delay in release of fund for the running of PEM.
- Late and inadequate supply of agro- chemicals allow over growing of weeds which compete with crops.
- Inadequate supply of farm tools and protective clothing materials.
- Monitoring / supervising exercise is difficult because of unavailability of functional motocycle or utility vehicle.
- All the bazuki's tricycles attached to PEM are grounded.
- The zonal and unit leaders have no personal and conducive office to retire to after each day work from the farm

CONCLUSION:

We thank God for being merciful to us and for seen us through the COVID -19 pandemic period. Also we deeply appreciate the Executive Director and the entire management for their support and encouragement from time to time. We say thank you sir. More power to your elbow.

PRODUCTION AND SUBSTATIONS DEPARTMENT

ANNUAL REPORT, 2020

HOD: DR M.O. OGUNLADE

PRODUCTION AND SUBSTATIONS DEPARTMENT

The advent of total lockdown occasioned by covid-19 pandemic had a great devastation on the productivity of the Department in year 2020

- Cocoa hybrid pods were produced through hand pollination and distributed during the year 2020. A total of twenty thousand seven hundred and sixty-two hybrid pods (20,762) were distributed.

- Raising and distribution of seedlings of CRIN mandate crops:

- Seventy thousand hybrid cocoa seedlings were propagated for sales and distribution

- Twelve thousand cashew seedlings were raised for commercial purposes

- Five thousand of Kola seedlings were also produced.

- Five hundred coffee seedlings were produced.

- Periodic maintenance of the plantations and the premises

- Harvesting and processing of a total of one hundred and twenty three thousand two hundred and three (123,203) cocoa pods from the Cocoa plantations at the Headquarters.

- Two thousand, two hundred and eighty nine kilogram (2,289kg) of dried cocoa beans was produced during the year.

SUBSTATIONS ACHIEVEMENTS

AJASSOR

- A training/workshop was organized for more than 50 cocoa farmers on Best Global Practices for Sustainable Development in Cocoa Production at Ikom, Cross River State on the 27th November, 2020.
- CRIN Ajassor Sub-station 50 KVA transformer was connected to PHED National Grid on the 20th February, 2020. However the Substation is still awaiting electricity to be supplied.
- Internally generated revenue for the year 2020 was two million, one hundred and thirty four thousand, nine hundred and seventy five naira only (N2,134,975)
- Periodic maintenance of the plantations.

OWENA

- Proper maintenance and supplying of the missed stands at the newly established 2Ha Cocoa Varieties (TC1-TC8) plantation.
- Establishment of bakery infrastructure (Courtesy of incubation platform project anchored by Dr. O.O. Oduwole). The objective of the project was to train young school leavers on how to produce cocoa bread vis-a-vis to boost internally generated revenue for the Institute.
- Erection of muti-functioning meteorological equipment at Owena Substation by Cocoa Soils core trial site at Owena and for others who might need the weather data.
- Training of four incubatees under the IFAD/FGN/ONDO-LIVEND program. The incubatees who were youths were trained on the establishment of a good cocoa plantation.
- Provision of 2.5KVA Elepaq generator and water pump by IFAD/FGN/ONDO LIVEND program as seed capital for the trainees of the four incubatees on cocoa production
- Renovation of Head of Station's residential quarters.

OCHAJA

- Fire tracing of about 60 hectares of total land areas cropped with cashew
- Periodic maintenance of research and commercial plots

MAMBILLA

- Regular field maintenance

IBEKU

- Resuscitation of abandoned five hectares of cocoa plantation established in 1987
- Establishment of 0-5 hectares cocoa germplasm
- Maintenance of peace between the station and the host communities.

UHONMORA

- Internally generated revenue was five hundred and seven thousand, eight hundred and thirty one naira only (N507,831) for year 2021.
- Five thousand cocoa seedlings worth N500,000 were freely supplied to Cocoa Association of Nigeria as directed by the Headquarters.

Renovation of Account Apartment building Regular plot maintenance

PLANTATION AND ESTATE MANAGEMENT

The detailed analysis of the activities for the year under review are itemized below:

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CONCLUSION:

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Thanks.

Akande, M. A. (Mrs.)
Plantation Manager

NURSERY DEVELOPMENT AND MANAGEMENT SECTION.

The Nursery section comprises of two units; Sexual propagation unit and Vegetative propagation unit. The activities of each unit in the year reported upon are as follows:

1. Sexual propagation unit (SPU): The following activities were carried out in this unit:

-Propagation of all mandate crops through sexual means

-Maintenance of seedlings of all mandate crops

-Maintenance of plantain orchard

-Supply of seedlings all mandate crops to farmers for commercial and research purposes

-Training of Students on industrial attachment, farmers on field trips, Students on excursion and other visitors

-General cleaning of Nursery and its environment

-Maintenance of WCF plot.

2. Vegetative propagation unit (VPU): The activities performed by this unit are as listed below:

-Vegetative propagation of all mandate crops through grafting, budding and stem cutting.

--Maintenance of all bud wood gardens.

-Maintenance of old cocoa clonal and seed gardens

-Establishment of new cocoa clonal garden for bud wood collection and seed collection purposes

-Supply of budded and grafted cocoa, cashew and kola to farmers and CRIN garden

-Training of visitors, students and farmers

-General maintenance of Nursery

3. Others activities carried out include:

-Rehabilitation of one number of shades net by the Management

-Successful vegetative propagation of kola and coffee stem cuttings for research purposes

-Successful grafting of cashew for field research purpose by cashew programme

-Provision of technical assistance on research activities as demanded by Research Scientists

4. Tools and Equipment: The following tools and equipment were given to the section for effective service delivery:

a. Chemicals: 1. Herbicide (clear weed and weed crusher)

2. Insecticides (termex)

b. Spraying pump

c. Spraying coat

d. Nose mask

e. Hand gloves

f. Wheel barrow

5. Training: All Nursery were trained except those who were not regular during the period

6. Staff strength: The staff strength of the section is 32 (5 supervisors and 28 Staff)

7. Achievement: The following achievement were recorded within the period reported upon:

-Sales of 70,000 hybrid cocoa seedlings to farmers

-Sales of 12,000 cashew seedlings

-Sales of 5,000 Kola seedlings

-Sales of 500 coffee seedlings

8. Challenges: The nursery section is being faced with some challenges in spite of the aforementioned achievement which include:

-Dilapidation of some shade nets

-Irregular transportation of staff to and fro Nursery

-Lack of security personnel

-Lack of farm tools and office equipment/facilities

Recommendation: More attention should be given to Nursery section in order to improve the production of healthy seedlings and clones.

Babalola E. A. (NDM*)*

AJASSOR SUBSTATION

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

Table 1: UPDATED LIST OF AJASSOR SUB-STATION STAFF IN ORDER OF SENIORITY AS AT 31st December, 2020

cultivated with Cocoa and Coffee.

Ajassor Substation, engaged 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 2020 the staff strength across different sections were 33 including the Head of Station who is a Research Officer, 1 Agricultural Superintendents, 2 Chief Clerical Officer (Administration), 2 Accountants II, 1 Executive Officer (Account), 1 Store Keeper, 1 Principal Nursing Sister I, 1 Health Asst, 1 Senior Secretariat Asst. I, 2 Foremen, 4 Security men, 15 Field officers, 1 Mechanic/Driver. 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.

S/N	Name	PF No.	CONRAISS and step as at 29/12/2020	Designation	Date of 1st appointment
1.	Dr. Eghosa Osas Uwagboe	251	13/03	Chief Research Officer (Head of Station)	11/12/2001
2.	Mr. Samson O. Odedele	314	12/02	Asst. Chief Agric Superintendent	08/04/2008
3.	Mrs. Joy Awunghe Takim	390	09/03	Principal Nursing Sister I	01/04/2010
4.	Mr. Nmeregini Uwadiaru	1206	08/03	Accountant II	17/07/1995
5.	Mrs. Eunice O. Ojua	1143	08/01	Senior Executive Officer (Acct.)	17/07/1986
6.	Mrs. Esther Ntomo Echi	1293	07/03	Chief Health Asst.	01/12/1997
7.	Mrs. Maureen Duruaku	1897	07/01	Acct. II	05/12/2011
8.	Ms. Pauline Ukpeukiema Ugi	1566	07/01	Senior Secretariat Asst. I	23/12/2008
9.	Mrs. Blessing Ekama Isong	1288	06/11	Chief Clerical Officer	01/12/1997
10.	Mr. Effiong Nathaniel Udoh	1142	06/05	Senior Foreman	16/07/1986
11.	Mr. Ezekiel Asuquo Effiong	1289	06/04	Chief Agric Overseer	01/12/1997
12.	Mr. Edet Akpan Robson	1541	06/04	Chief Agric. Overseer	02/06/2003
13.	Mr. James Ibiang Okoi	1543	06/04	Snr Foreman	10/06/2003
14.	Mr. Okpokam Ozong Edim	1556	06/04	Chief Store Keeper	10/04/2008
15.	Miss Precious Magagi	1820	06/02	Chief Clerical Officer	06/07/2011
16.	Mr. Sunday Nkanta Ekereobong	1700	06/01	Chief Field Overseer (Security)	02/01/2009
17.	Mr. Abraham Samuel Inyang	1701	06/01	Chief Field Overseer	02/01/2009

18.	Mr. Samuel James Udoh	1702	06/01	Chief Field Overseer	02/01/2009
19.	Mr. Idagu Godwin Echa	1703	06/01	Chief Field Overseer	02/01/2009
20.	Mr. Onah Peter Ogar	1704	06/01	Chief Field Overseer	02/01/2009
21.	Mr. Iwara Eteng Okoi	1706	06/01	Chief Field Overseer	02/01/2009
22.	Mr. Sunday Ime Asua	1705	05/02	Asst. Chief Agric Field Overseer	02/01/2009
23.	Mr. Azogor Isong Echeng	1707	05/02	Asst. Chief Agric Field Overseer	02/01/2009
24.	Mr Augustine Eteng Ubi	1698	05/02	Asst. Chief Agric Field Overseer	02/01/2009
25.	Mr. Emeng Ele Eleng	1708	05/02	Asst. Chief Agric Field Overseer (Security)	02/01/2009
26.	Ms. Mercy Umontia	1814	05/02	Asst. Chief Agric Field Overseer	29/04/2011
27.	Mr. Peter Godwin	1815	05/02	Asst. Chief Agric Field Overseer (Security)	29/04/2011
28.	Mr. Idorenyin Okpo	1950	04/05	Senior Agric Field Overseer	26/04/2012
29.	Mr. Udoh Akpan Johnny	1951	04/05	Senior Agric Field Overseer (Security)	26/04/2012
30.	Mr. Anthony David	1816	03/09	Agric Field Attendant 1	29/04/2011
31.	Mr Monday Echi Enya	1974	02/02	Driver/Mechanic II	5/3/2020
32.	Mr Emmanuel Takon Ayiba	1979	01/02	Agric. Field Attendant III	5/3/2020
33.	Miss Patience Takon Ayiba		01/02	Agric. Field Attendant III	5/3/2020

Table 3: Staff who left CRIN Ajassor in 2020

S/N	Name	Designation	Date of Exit	Cause of Exit
1.	Oyeledun Kehinde	Principal Agric. Superintendent II Asst. Chief Field Overseer PF 1706	2/1/2020	Transfer to Headquarters
2.	Mr Adariku Patrick Iyaji		2/1/2020	Retirement
3	Mr Augustine Akwagiobe Uzichu	Senior watchman PF 1699		Retirement

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. Inadequate cultural maintenance of all the Cocoa, Coffee, Kola and Tea plots under CRIN Ajassor were done throughout the period under review due to the covid-19 pandemic.

Table 4: Plantations/ Research plots with their hectares and maintenance status in Ajassor as at 31 December 2020

Cocoa Research Plots	Hectares	Status
Cocoa plots		
1967 Trinidad	2.9	Abadoned
1975 F_3 Amazon	1.6	Abandoned
CRIN/NIFOR 1	6.0	Abandoned
CRIN Elite Seed Multiplication	2.2	Maintained
T38 Kalime	2.8	Maintained
Commercial 1	2.0	Abandoned
Cocoa Cuttings	1.0	Maintained
15 Acres Extension	2.0	Maintained
Amelonado	2.0	Maintained
1973 F_3 Amazon	2.0	Abandoned
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	Abandoned
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	Abandoned
Coffee Research Plots		
Okundi	1.46	Moribund
1989 Ajassor	1.57	Moribund
Tea Research Plots		
Tea Ajassor	0.28	Abadoned

Research Experiments

A pocket of research experiments were on-going at CRIN Ajassor Substation as at 31 December, 2020 as indicated in Table 5 below

Table 5: Research experimental work on-going at Ajassor Sub-station in 2019

S/N	Description	Crop	Researcher	Remark
1.	Coconut/Cocoa experiment	Cocoa	Dr. O. A. Famaye	Established 2019
2.	Screening of fungicides to control black pod disease	Cocoa	Dr. Kolawole and others	Carried out in 2019
3.	Cocoa germplasm experiment	Cocoa	Dr. (Mrs) Muyiwa and others	On-going
4.	Tea Agroforestry experiment	Tea	Mr A. A. Oloyede and others	Started 25/10/2018
5.	Kola experiment	Kola	Dr. Ugioro	Established 2019
6.	Coffee nursery experiment	Coffee	Dr. K. O. Ayegboyin	,,
7.	Cocoa Bread Bakery	Cocoa	Dr. O. O. Oduwole	On-going

Vehicles/Motorcycles/Generators at CRIN Ajassor Sub-station

The list of the vehicles/motorcycles/generators/other equipment (and their conditions) are as below:

1. Toyota Hilux Van with registration number FG 09 V03 (Not functioning. Recommended for auction).

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

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 FG 740 B03 (Not functioning. Recommended for auction).

5.Mitsubishi L200 Van with registration number FG 741 B03 (not functioning but could be repaired for the use of CRIN Ajassor Substation).

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

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 auction.

9. 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

10. 1 Tricycle Bazuki 200 TRC (functioning. Needs servicing)

11. 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)

12. Farm/Field equipment: 1 Hand driven mower, 1 Hand mower, 1 Water pump, 1 Harrow, 1 Plough, 1 Ridger

13. visual equipment: 1 Overhead projector DLP LG,

14. Laboratory Equipment: 1 Autoclave, 1 Micrscope

15. 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 didn't receive any capital fund for project in the period (2020) under review. The slab and tarpaulin are obsolete and non-presentable. We recommend their replacement with more recent and highly acceptable raised platforms and durable tarpaulin. The 3 shade nets for raising seedlings need urgent replacement as they are in bad condition.

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 2021.

Visitors to the Substation in 2020.

More than 150 visitors came to CRIN Ajassor sub-station in 2020 but only 26 of them were sampled for this report. The names, addresses and purpose of visit of the sampled visitors are reflected in Table 6.

Table 6: Name, address and purpose of visitation of some sampled visitors to CRIN Ajassor sub-station in 2020

	Date	Names	Address	Purpose	
1.	9/1/2020	Maria Eju	Ajassor	Official	
2.	12/01/2020	Odo Joshua	Ikom	Official	
3.	15/2/2020	Gertrude Osadim	PHC	Official	
4.	21/2/2020	Olouyole, K. A.	CRIN hqtrs, Ibadan	Official	
5.	16/3/2020	Taiwo, O. A.	,,	Official	
6.	26/3/2020	Borjor Obi	Ekimaya	Cocoa pods	
7.	24/4/2020	Loe Ati	Ikom	Cocoa pods	
8.	28/4/2020	Ogar Oscar	Ikom	Cocoa pods	

9.	10/5/2020	Osang Lawrence	WCS	Cocoa seedlings	
10.	18/5/2020	Patrick Isong	Water falls	Cocoa pods	
11.	18/6/2020	Sunday Ova	WCS	Cocoa seedlings	
12.	23/6/2020	Abua Jonas	Police Etung	Official	
13.	27/6/2020	Okozi Jude	Boki	Test	
14.	02/7/2020	Joseph K	Hqtrs	Official	
15.	17/7/202	Accoyin K.N	Nde Ikom	Personal	
16.	14/8/2020	Sunday Okpikan	Ikom	Cocoa seedlings	
17.	18/8/2020	Mbang **Oboyi**	Obubura	Cocoa seedlings	
18.	6/9/2020	Faith Echeng	Ikom	Personal	
19.	25/9/2020	John Ojang Agbor	Bashua	Personal	
20.	13/10/2020	Sam Eko	Ekori	Cocoa seedlings	
21.	13/10/2020	OK Nyam	Yala	Cocoa pods	
22.	7/11/2020	George Arrume	Edor	Cocoa pods	
23.	20/11/2020	Agbor Edotri	Mfum border	Cocoa pods	
24.	2/12/2020	Dr. Adebiyi S	CRIN Hqtrs	Official	
25.	4/12/2020	Dr. Abua K. B.	Calabar	Official	
26.	18/12/2020	Mr Etuk Ntim	Ikom	Cocoa pods	

Internally Generated Revenue for 2020

A total amount of Two Million, One Hundred and Thirty FourThousand and Nine Hundred and Seventy Five Naira (**₦2, 134,975**) only was generated by CRIN Ajassor Sub station in 2020. The breakdown of the revenue generated is in Table 7 below:

Table 7: Internally Generated Revenue Analysis for 2020 (January-December)

	ITEMS	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT	OCT.	NOV.	DEC.	TOTAL
Farm produce (A)														
1	Cocoa pods	129,9000	-	-	-		-	-	-	-			150,000	279,900
2	Dry Cocoa beans	-	-	-	-	-	-	-		-		248,000		248,000
3	Cocoa Seedlings						1,500,000							1,500,000
4	Kola nuts	-	-	-	-			-	-	-		-	3,975	3,975
5	Palm oil	-	-	-	25,000	-		-	-	-	-	-	-	25,000
	SUB TOTAL (A)	129,900	-	-	25,000		1,500,000			-				2,056,875
Services (B)														
1	Rents	12,200		55,100	-	-	-		-	-	10,800	-	-	78,100
2					-	-	-	-	-	-	-	-	-	
	SUB TOTAL (B)	12,200		55,100	-	-	-		-	-	10,800	-	-	78,100
	Total (A + B)	142,100		55,100	25,000		1,500,000			-	10,800	**248,000**	153,975	**2,134,975**

Challenges and Prospects

Some of the challenges and prospects in CRIN Ajassor Substation are as follows:

Internally Generated Revenue (IGR): It was observed that revenue reduced this period (2020) due to Covid-19 pandemic, (the state/interstate lockdown and field workers stay at home due to the pandemic) and intensive heat resulting from climate change. Hired labour was used to open up some of the abandoned plots for share cropping in late 2020 in order to increase IGR for the station in subsequent years.

Inadequate workforce: We are the largest substation in CRIN yet with only 15 Field staff. 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 45 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 4 current Watchmen at the moment.

Funds: There was no capital fund released to the station in 2020. We use this medium to appeal for Overheads and Capital Votes to CRIN Ajassor Sub-Station as soon as possible. It is extremely difficult to run a Substation with 33 Staff without overheads. We need to repair and fuel our Toyota Hilux, Tractor, Water Tanker as well as Bazuki, machines, equipment and generators especially as we mobilize our field men to go into our 3 outposts at Assena-sen (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 and the Covid-19 pandemic.

Training/Workshop: A training/Workshop was organized for Cocoa farmers on Best Global Practices for Sustainable Development in Cocoa Production in Cross River State on 27th November, 2020 at Cocoa Association of Nigeria Secretariat Hall, Ikom. Some issues that needed to be attended to which generated from the workshop include; seeking for a space in CAN Secretariat complex to exhibit and sell CRIN products, extension of the training to cocoa growing communities, more extension services required in the cocoa growing areas etc.

Other pressing needs of CRIN Ajassor Substation:

Vehicles: One new Hilux Pick-up Van and one 18-Seater Staff Bus

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.

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.

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.

Tarring or grading of road from Border road to CRIN Ajassor main gate which is becoming unmotorable.

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.

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.

Construction of farm houses in the zones for the field workers to serve as coverage during rainy season.

Renovation of nursery seedling shade nets which are in very bad state.

Installation of inverter at the station to bring down the running cost on gasoline/diesel operated generator.

Repairs of meteorological station which quotation has been submitted and awaiting approval

Re-printing and painting of the CRIN Ajassor Sub-station sign post at the entrance of the station

Renovation of the fermentation house, purchase of tarpaulin for drying of cocoa beans, drying oven shed and construction of raised platforms for drying cocoa.

Provision of a modern and better equipped laboratory for CRIN Ajassor.

Completion of Cocoa bread bakery in the station

OWENA SUBSTATION

Head of Station: Dr. K.A. Oluyole

Staff Disposition: The staff list at the station during the year 2020 is as shown below

S/N	Designation	Owena	Alade	Onisere
1	Chief Research Officer	1		
2	Principal Agric. Superintendent 1	3		

3	Principal Executive Officer II	1		
4	Chief Health Assistant	1		
5	Higher Executive Officer	2		
6	Executive Officer	1		
7	Work Superintendent	1		
8	Chief Agric. Field Overseer (CAFO)	2		1
9	Asst. Chief Agric. Field Overseer (ACAFO)	4		
10	Senior Motor Driver Mechanic Grade 1	1		
11	Senior Agric. Field Overseer	3		
12	Agric. Field Attendant 1	3	1	
13	Agric. Field Attendant II	2		
	Total	**25**	**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. CocoaSoils core trial experimental plot (Dr. Ogunlade *et al.*)
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. Fungicide screening activities were carried out to determine the efficacy of fungicides Tandem, Overgo, Jorkemil and Michorhiza (Lens and Plus).
7. Establishment of Breeder's plot (New Cultivar) (Dr. Muyiwa et al).
8. Establishment of Breeder's plot (WCF replanting) (Dr. Muyiwa et al).

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 hectare 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 (N1,466,225.00) 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 advent of pandemic Covid 19 actually restricted the operation during the year.
5. 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. The ongoing renovation of the office building should be fast-tracked for early completion so as to put it on use on time.
4. Considering the enormity of the work in our plantations, 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

2020 INTERNALLY GENERATED REVENUE

Items	N
Cocoa Beans	1,048,850
Cocoa Pods	330, 400
Palm Oil	21, 000
Rent	66,375
	_____
	N1, 466,225

MAMBILLA SUBSTATION KUSUKU

Report on the activities carried out during the year January – December 2020.

1. PLANTATION: General plantation maintenance of the two (2) mandate crops (Tea and Coffee Arabica) plots using both methods of weed control. A total of 39 litres of herbicides (27 litre of force up weed herbicides and 11 litre of clear weed herbicides) were used during the year 2020 in spraying the weeds on the field. Furthermore, other methods of weed control implore was slashing using cutlasses and hand hoeing. In addition, contract weeding of the plantation which the CRIN management sent some money from CRIN-Headquarters Ibadan to engaged outside labour for the weeding was also carried out.
   All these methods were used aim at reducing weed density on the field since the issue of corona virus (convid 19) pandemic lock down and many months during the year were mostly essential duties carried out on the station.

2. Pruning: Selected portions of tea plot with overgrown tea bushes were pruned from time to time during the period under review. The tea germplasm was pruned in order to preserve tea cuttings planting materials.

   Dr. Olaniyi O. O. experimental tea plot was also pruned all aim at reducing plucking height and maintaining good plucking table, furthermore, it will re-juvenate the tea plants for more fresh tea leaves shoots and increase tea yield for IGR for the station.

3. COPPICING: The commercial coffee Arabica plantation that was established since 1968 and the coffee plants were old and cannot longer produce well in terms of yield. There was high need to do coppicing as advised by the Director Head of coffee programme. During the year about 95% coffee Arabica plot was coppiced, aim at enhancing normal plucking height of coffee berries and yield.

4. FIRE TRACING: Cutting of fire traces round the plantation was one of the activities carried out during the end of the year as the commencement of dry season at the last (4th) quarter of the year 2020. This is aim at checking out fire encroachment into the plantation.

5. HARVESTING: The following crops were harvested for internal generated Revenue (IGR) for the station during the year 2020.

1.	Plantain	-	one (1) Bunch
2.	Avocado Pear	-	2 bags
3.	Tea Leaves	-	1,300 kgs
4.	Banana	-	14 Bunches

5. Coffee berries - 70KG

6. PLANTING: A total of 131 eucalyptus seedlings were transplanted to the field during the year 2020. Aim at revenue generation in the near future.

7. NURSERY: A new nursery shade was constructed near the office premises by Dr. Olaniyi O.O, Director Dr. Impimoroti and others research scientist from CRIN-Headquarters during the period under review.

A total of 1,816 tea cuttings were set in the tents in the nursery for the research work of the scientist who sponsored the nursery activities.

-3-

A total of 131 eucalyptus seedlings were raised in the nursery and later issued out to field when the seedlings were ready for transplanting.

8. GREEN TEA TRAINING WORKSHOP: A team of 7 Research scientists led by Dr. S.O. Aroyeun / Mrs. Yahaya Susan from CRIN-Headquarters Ibadan came to Mambilla Substation and organized a training workshop for small scale tea processing farmers on green tea processing which is far better in high income and easier to produce manually or using few machines.

This training was carried out during the last quarter of the year 2020 and the training was successful as many invited tea farmers turned out was encouraging. The trained tea farmers/ processors were advised to go home and train others in their villages on how to process Green tea.

9. STAFF STRENGTH: CRIN-management employed 2 field staff during the year of report bringing the total number of staff from 24 at the beginning of the year to 26 staff in the station.

10. SECURITY: The security unit of the station has 5 securities instead of normal 8 numbers and that makes the securities in Mambilla station to work for 12 hours daily against official 8 hours shift because of inadequate manpower in the security unit.

11. LIBRARY: A total of 2 numbers of Hand book on tea processing practical were donated by the team of scientist who visited the station from CRIN- Headquarters during the Green tea processing farmers training programme.

MAYO-SELBE EXPERIMENTAL STATION:

The following activities were carried out during the year 2020 at Mayo-selbe.

1. WEED CONTROL: Weeding was the major field activities on the plantation of cocoa and tea plot of the station. A total of 18 litre of glyphosate herbicides chemicals were used in spraying on the 2 mandate crops plots during the period of report to control weeds on the field.

2. WATERING/MULCHING: Wetting of cocoa and young tea on the plantation during draught was carried out. Aim at supplementing water to the young plants which are yet to be well established. Mulching was also carried out on young cocoa on the field during the dry period of the year 2020.

3. GAPPING UP: A total of 520 healthy cocoa seedlings were used in gapping up vacant spaces caused by termites damaged to the young plants on the field.

   During the period, a total of 360 tea seedlings were transplanted onto the tea plot as infillings for the season.

4. COCOA PLOT MAINTENANCE: Light pruning of cocoa branches, removal of mistletoes/climbers and chupons were among the activities performed during the period.

5. COCOA HARVEST: Ripped cocoa pods were harvested and processed during the year under review. A total of 150.8 kgs of dry beans were recovered for the year 2020 and this would go a long way in Generating Revenue for the station (Institute).

6. CONTRACT FIELD CLEARING: Outside labours were engaged in field weed clearing on the plantation which was a welcome idea by CRIN-Management to reduce weed density on the plantation since we have inadequate field workers in the station.

7. PEST/DISEASE CONTROL: during the period of the year 2020, ten (10) sachets of ultimax Gold plus (fungicide) was sprayed on cocoa pods And trees to control black pod disease and 250 mls of perfect killer was sprayed on stems of young plants of cocoa/tea on the field against termites and other pests of the mandate crops.

8. NURSERY: The nursery unit was kept tidy during the period under review. A total of 340 polythene pots were filled with soil and coffee Robusta seedlings were pricked into pots preparing for next year season gapping up field program on coffee plot.

9. FIRE TRACING: Making of fire tracing round the plantation against fire outbreak was done during the 4th quarter of the year.

10. STAFF STRENGTH: A total of six (6) staff were on the station Mayo- selbe during the period of this report and all performed their duties well.

11. SECURITY: The securities performed their duties well as there was no theft report.

WEATHER RECORD: the amount of rainfall and temperature recorded within the year (January – December) 2020. The records are shown below appendix 1 A&B.

RAIN FALL APPENDIX (1) A

MONTH	RAINFALL (MM)	RAIN DAYS	MEAN RAINFALL(MM)
January	Nil	Nil	Nil
February	Nil	Nil	Nil
March	50.8	3	16.9
April	209	12	17.4
May	478.9	24	19.5
June	223.2	19	11.7
July	630.3	21	30
August	79.9	11	7.2
September	436.3	24	18.1
October	219.2	15	14.6
November	Nil	Nil	Nil
December	Nil	Nil	Nil
Total			

AVERAGE MEAN TEMPERATURE JANUARY – DECEMBER 2019 APPENDIX (i) B

	8am mean Temp. (°C)	1pm mean Temp (°C)	4pm mean Temp(°C)
JANUARY	19.27	31.18	28.36
FEBRUARY	19.02	32.17	30.35
MARCH	23.32	29.09	28.76
APRIL	22.24	28.92	27.06
MAY	22.87	26.83	23.85
JUNE	23.22	25.69	21.67
JULY	20.84	25.05	22.49
AUGUST	18.97	25.88	23.40
SEPTEMBER	20.80	28.18	24.91
OCTOBER	22.85	26.33	22.73
NOVEMBER	23.86	28.30	23.82
DECEMBER	21.82	30.69	27.72

LIST OF 8 EXPERIMENTS SITED ON THE STATION ARE ALL SHOWN BELOW ON APPENDIX (II)

S/N0	TITLE OF EXPERIMENT	SIZE	YEAR	RESEARCHER	REMARKS
1	Setting of 75 Nigerian China (NGL) 1-5 tea clone (15-cuttings each)		2012	Mr. Olaniyi O.O.	In progress
2	Simultaneous selection and genotype x environment interaction of tea in Nigeria (1) Kusuku	0.048	2014	Mr. Olaniyi O.O.	In progress
3	Effect of Neem fortified fertilizers on tea yield.	-	2015	Dr. Ipinmoroti	In progress
4	Effect of tea yield in the open and under the eucalyptus	-	2015	Dr. Ipinmoroti	In progress
5	Simultaneous selection and genotype environment interaction of tea in Nigeria (11) Mayo-selbe	0.048	2016	Mr. Olaniyi O.O.	In progress

INTERNALLY GENERATED REVENUE (IGR): The sum of one hundred and sixty seven thousand, nine hundred and fifty naira (N167,950) was generated as Revenue for the year 2020 and the summary of the breakdown of the IGR is stated below on appendix (iii) below.

SUMMARY OF (IGR) FOR JANUARY – DECEMBER 2020 APPENDIX (iii)

S/N	ITEMS	JAN 2020	FEB 2020	MAR 2020	APRIL 2020	MAY 2020	JUNE 2020	JULY 2020	AUG 2020	SEPT 2020	OCT 2020	NOV 2020	DEC 2020	TOTAL
1	Rented Quarters	-	-	7,375	-	2,500	-	6,125	10,000	13,750	3,000	-	13,750	**56,500**
2	Plantain	600	-	-	-	-	-	-	-	-	-	-	-	**600**
3	Pear Avocado	2,500	-	-	-	-	-	2,000	-	-	-	-	-	**4,500**
4	Tea Leaves Sales	-	-	6,000	-	-	-	8,000	15,000	-	-	-	10,000	**39,000**
5	Banana Sales	-	-	2,700	-	-	-	950	-	-	-	-	1,700	**5,350**
6	Land Loan Recovered	-	-	-	-	-	-	-	2,000	3,000	-	-	-	**5,000**
7	Cocoa Beans Sales	-	-	-	-	-	-	-	-	-	-	50,000	-	**50,000**
8	Coffee Berry	-	-	-	-	-	-	-	-	-	-	7,000	-	**7,000**
	Total	**3,100**	**-**	**16,075**	**-**	2,500	**-**	**17,075**	**27,000**	**16,750**	**3,000**	**57,000**	**25,450**	**167,950**

THE SUBSTATION'S DISPENSARY: APPENDIX (IV) below shows the ailment record for January to December 2020 in the station:

DISPENSARY REPORT JANUARY – DECEMBER 2020 APPEINDIX (iv)

DISEASES	JAN	FEB	MARCH	APRIL	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
Malaria	28	17	30	11	18	6	4	2	-	7	-	-	121
Backpain	16	-	9	-	14	-	-	10	12	-	-	11	99
Cough	23	8	-	14	-	9	1	-	-	12	5	-	78
Catarrh	16	-	18	-	11	-	-	7	2	-	7	10	71
Heart burn	19	7	-	1	-	12	14	4	-	9	11	-	72
Body pain	11	6	17	-	-	11	-	-	12	-	-	19	76
Loss of appt.	12	14	-	13	7	-	9	8	-	-	13	-	76
Sore mouth	-	-	16	-	-	19	-	13	-	-	-	17	65
Diarrhoeq	6	10	-	-	11	-	19	-	16	-	1	-	63
Accident	-	-	-	1	3	2	-	-	1	-	-	-	7

Sleepless night	12	-	11	-	-	14	-	-	1	-	-	-	38
Side pain	9	-	-	1	6	-	-	-	7	-	8	7	38
Vomiting	-	14	-	7	15	-	9	-	7	10	-	-	62
Typhoid fever	16	-	12	-	-	10	-	13	-	9	-	14	74
Cold	-	9	-	-	16	17	-	11	-	-	9	11	73
Chill	7	-	3	-	-	-	1	-	-	1	-	-	11
Stomach pain	8	8	-	-	11	-	12	-	14	-	19	-	59
Oedema	1	-	3	-	2	-	1	-	-	6	-	-	13
Neck pain	-	1	-	4	-	-	-	-	7	-	9	-	21
Hypetion	10	-	2	11	-	11	-	13	-	2	6	16	71
Headaches	21	17	22	1	-	-	14	-	15	-	1	-	91
Total	206	704	143	64	114	111	75	81	787	56	89	105	1,335

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VISITORS TO CRIN MAMBILLA SUBSTATION

A total of visitors visited the station within the year January – December 2020 appendix (v)

DATE	NAME	ADDRESS	REMARKS
9/01/2020	Adeyemi A. R.	CRIN – Headquarters Ibadan	
" " "	Akinwande O. O.	" " " "	
" " "	Adukoya Olawlu	" " " "	
20/02/2020	Olaniyi O.O.	" " " "	
" " "	Oloyede A. A.	" " " "	
" " "	Thomas Bukam	Local Government Area Gembu	
" " "	Mohammed Ali	" " " "	
14/8/2020	Ibrahim Bako	Patu Kamino Kurmi L. G. A.	
" " "	Bako Yakubo	" " "	
18/4/2020	Prof. Vincent Ado Tenebe	VC Taraba State University , Jalingo	

" " "	James DSS BOSS	Local Government Area Gembu	
" " "	Mr. Thomas Tentishe Luka PhD Student	University of Calabar	
2/9/2020	Giidiga Johnson O.	Internal Auditor CRIN Ibadan	
" " "	Bakare Adeyemi	" " " "	
22/10/20	Sajoh F. Endince	National Identity Management Commission Gembu	
25/11/2020	Dr. S. O. Aroyeun	CRIN – Headquarters Ibadan	
" " "	Dr. C. O. Jayeola	" " " "	
" " "	Dr. K. A. Oluyole	" " " "	
" " "	Dr L. E. Yahaya	" " " "	
" " "	Dr. R. O. Igbinadoler	" " " "	
" " "	Yahaya A. T.	" " " "	
" " "	Agbebaku Edurance	" " " "	
" " "	Mr. Segun Oluwole	" " " "	
	Mr. Malande Caluraojule	" " " "	
7/12/2020	ALH. Sani Bakusi	Furmi Village	
10/12/2020	Mohammed Abubakar	Gembu	
15/12/2020	Kahya S. Shuaibu	NRCRI KURU JOS	
" " """"	Daniel A.	" " "	
18/12/2020	Haji Abubakar	Taraba State university	

MAMBILLA SUBSTATION'S NEEDS:

1. Four number of wheel barrows for field work

2. Ten thousand poly pots and 4 rolls of poly sheets for raising tea cuttings in the nursery for gapping up and to increase tea holdings.

3. Ten (10) litre of pesticides/insecticides for the control of termites and other insect pest attacks on the field of the mandate crops.

4. Farm House for field workers

5. Mayo-selbe experimental station office building is at the verge of collapsing due to termites damage to roof. There is need for renovation to arrest the situation.

6. Renovation of Rest House/HOS quarters and other staff quarters that are in deplorable condition.

7. NAFDAC Registration number on green tea.

Dr. Aikpokpodion P. E.
Head of Station,
CRIN – Mambilla Substation – Kusuku.

IBEKU SUBSTATION UMUAHIA

A. STAFF DISPOSITION:

The staff strength as at December 31, 2020 stood at nineteen (19). This comprises of eight senior staff, that is, the HOS, Station Accountant, three (3) Agric Superintendents, one (1) Secretariat Assistant and two (2) Chief Clerical Officers – one in store and the other in account, and eleven junior staff, that is, two (2) motor mechanic/driver, 1 watchman, 1 other watchman on borrow from the field, 6 field staff in Ibeku and only 1 field staff in Ugbenu Outstation.

Table 1. Staff list of CRIN Ibeku Substation as at 31st December, 2020

S/N	Name	GL	PF	Design.	Date of Birth	Date of 1st Appoint.
1	Dr. Okeniyi Michael O.	13/4	254	HOS/Chief Research Officer	10/12/70	02/01/2002
2	Mrs. U.N. Nmeregini	13/4	281	ACAS	21/10/68	25/09/2002
3	Mr. Borokini Olufisayo	11/4	367	PAS 1	27/03/79	08/02/09
4	Mr. Agbor Charles	8/6	432	PAS II	27/05/78	13/10/2010
5	Mr Ayoade Oluwole P				Deseased	
6	Mrs Nya Emem	7/3	534	HAS	17/12/90	03/03/2020
7	Mr. Onwubiko Michael	7/2	1521	CD	17/08/64	01/06/2003
8	Mr. Onyemuwa J.C.	5/2	1736	SMD/MI	15/05/66	17/03/2010
9	Mr. Eze Joseph	5/3	1680	ACAFO	13/06/67	02/01/2009
10	Mr. Animba Michael	5/3	1686	ACAFO	28/01/65	02/01/2009
11	Mr. Nwachukwu Benedict	3/12	1678	HW	10/06/67	02/01/2009
12	Mrs. Chibuo Oluchi	4/2	1679	AFA I	02/01/70	02/01/2009
13	Mrs. Ihueze Chinedu	3/12	1681	AFA I	15/08/68	02/01/2009

14	Mr. Chimaobi E. I	4/3	1683	AFA I	15/03/68	02/01/2009
15	Mr. Ani Cyril	3/6	1684	AFA I	18/11/63	02/01/2009
16	Mr. Nwachukwu Anthony	4/2	1890	AFA I	12/12/75	14/12/2011
17	Mr, Uwakwe Innocent	2/10	1892	AFA I	14/03/65	14/12/2011
18	Mr. John Muo	1/3	1976	FA	06/11/76	05/03/2020
19	Mr. Uwakwe Christopher	2/2	1976	FA	06/11/76	05/03/2020

B. LAND AREA:

Please find below the landmark of CRIN Ibeku Substation:

Total land area: 80.0 hectares.

Effective hectares: 43.36 hectares

Ugbenu Cashew Experimental Outstation

Total land area: 19.33 hectares

Effective hectares: 11.20 hectares

Total Effective hectares: (43.36 + 11.20) hectares = 54.56 hectares

C. 2020 ACTIVITIES:

FIELD ACTIVITIES: General maintenance of research and commercial plots - slashing, pruning, spraying, pollination, removal of mistletoes, fire tracing, harvesting and processing of pods and ground maintenance of both office blocks at Ibeku and Ugbenu were taken care of.

Grass Cutting Using the Mower

Slashing of bushy arrears

D. 2020 ACHIEVEMENTS:

1. Internally Generated Revenue: A total sum of Four Hundred and Eighty Nine Thousand and Ninety Naira only (₦489,090) was realized in the year 2020.

Below is the breakdown.

SN	ITEM	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total
1	Cocoa Beans	97,350	57,750	81840	-	-		-	-	-	-	65860	67340	370,140
2	Cocoa Pods	-	30,000	-	-		-	-	-	-	-	5000		35000
3	Agbalumo	-	-		-	-	-	-	-	-	-	-	-	
4	Ogbono	-	-		-	-	-	-	-	-	-	-	-	
5	Plantain	5300	19000	17,840	-	-	-	-	-	-	-	7600	-	49740
6	Banana	-	-		-	-	-	-	-	-	-	-	-	
7	Cashew Nut	-	-	30000	-	-	-	-	-	-	-	-	-	30000
8	Firewood	-	-	-	-	-	-	-	-	-	-	-	-	
9	Cocoa Seedlings	-	-	-	-	-		-	-	-	-	4200	-	4200
10	Palm Fruit	-	-	-	-	-		-	-	-	-	-	-	
	TOTAL							**-**	**-**	**-**	**-**	**-**		
		102,650	106,750	129680								82660	67340	**489,080**

CRIN IBEKU SUBSTATION IGR SUMMARY FOR YEAR 2020

2. Erection of New Signpost at the Station boundary: the signpost was erected to prevent land encroachment in Ibeku sub-station

3. Peace: We were able to maintain peace in the station and communities.

4. Office and Ground Maintenance: Regular maintenance of the office premises, cutting flowers/lawn thereby maintaining neatness of the office as commended by all visitors of the station in spite of the few labour we have.

Admin Block Frontage

Cutting of Grass With Hand Mower

5. FIELD ACTIVITIES: General maintenance of research and commercial plots - slashing, pruning, spraying, pollination, removal of mistletoes, fire tracing, harvesting and processing of pods and ground maintenance of both office blocks at Ibeku and Ugbenu were taken care of.

6. Cocoa Seedlings: Seedlings were raised to boost our IGR and for replacing dead cocoa trees in some of our plots.

7. Erosion and Slippery Floor Control: The station over the years have been suffering from erosion and slippery floor. We were able to control this by sand-filling the affected areas.

From the Gate to the Carpenter Shed **Pathway to Admin Block**

E. VISITORS: The following persons visited our office in the course of the year, Dr. Mrs Adeigbe, Dr. Adenuga, Dr. Olaniyi, Dr Olasupo and Mr Ajiroba

F. CHALLENGES/CONSTRAINTS:

1. Lack of Adequate Work Force: Both Ibeku and Ugbenu lack adequate work force.

2. Chemical Spraying: The substation is in need of fungicides, herbicides and insecticides without which the crop productivity will be grossly reduced. Considering the humid weather at the substation, black pod disease is ravaging the pods coupled with high density of weeds due to shortage of labour and pesticides

3. Overhead: There is high dependency on fuel to keep the substation running effectively. Due to the fact that, out of the 6 substations CRIN Ibeku Substation is the only substation without residential quarters and electricity. The imprest is drastically too small and does not even come on monthly bases.

4. Vehicle Maintenance: The tyres of the station's utility Hilux Project vehicles need replacement. The NCSGP Hilux is currently faulty and needs a total overhauling.

5. Clinic: We urgently need a nurse and health attendants to administer drugs and first aid services in case of emergency like snake bite or accidental cutlass cut injury. There is neither Nurse nor Health attendants in an isolated place like CRIN Ibeku Substation since 2012.

6. Ugbenu Experimental Station: The outstation has only a staff since 2013 and supported by two Project Contract Workers engaged in 2016. No security staff in the outstation. No office in the outstation.

7. Furniture: Lack of good furniture. All furniture in the station are those that were in the office since inception of the station.

8. Road: Lack of good road from the station entrance to Admin Block to combat the serious erosion that has taken up CRIN Ibeku office.

G. ADDITIONAL STAFF REQUEST BY CADRE:

Security	10	(8 in Ibeku and 2 in Ugbenu).
Field Staff	48	(Following the standard set at the headquarters, CRIN Ibeku Substation will require nothing less than 55 field staff to cope with the current 54.56 effective hectares. Therefore, an additional 48 staff at the moment is needed to complement the existing 7 field staff.)
Nurse	1	
Health Attendant	2	
Secretarial Assistant	2	(The only Secretarial Assistant we have will retire this year.)
Clerk	2	
Driver	1	
Total	66	

H. SUGGESTIONS/WAY FORWARD:

1. Imprest: The imprest is drastically too small and doesn't even come monthly. An increase in the imprest will be highly appreciated and receiving it monthly will help us a lot.

2. Furniture: We are in need of furniture in all offices of the station. The furniture we have are mostly bad and obsolete, they have been the ones there since inception of the station.

3. Equipment and Stationery: A brand new laptop and toner based HP printers are needed in the station. The secretarial staff has nothing to work with since the PC in her office is totally bad and beyond repair. For over two years all typing is done in the accountant's office. We are in need of reams of A4 printing papers, toners, staplers and other stationeries for the smooth administrative running of the substation.

UHONMORA SUBSTATION

UHONMORA SUBSTATION

Head of Station: Dr. Adejobi K.

S/N	NAME	DESIGNATION	PHONE NUMBER
1	DR. FAMUYIWA BUSAYO .SOLOMON	HOS	08033978146
2	EDIBO GABRIEL	ACAS	08066545507
3	PHILIP OGUIGO	ACAS	07033181107
4	ASEIN OYAKHIRE	SEO	08036657855
5	OAIHENA LYDIA (MRS)	HEO	07031888644
6	ALABA UMAHOIN	CAFO	08062399335
7	OKPÅISE IDOWU (MRS)	CAFO	07060701641
8	ONOJA JOSEPH	CD/M	07068129566
9	IRUOBE ELIZABETH	CCO	08067179194
10	IFIDON IKHUOSHIO	PHA	07085713536
11	ANIJESE FUNMILAYO (MRS)	CAFO	08065709602
12	DANNIS OJIMAH	ACAFO	08075154789
13	AMEDU ACHONU	ACAFO	08106290329
14	EBALE BENJAMIN	ACAFO	07083647934
15	EDEH SIM0N TOCHUKWU	ACAFO	07032472593
16	NWAGALA CHARLES	ACAFO	08067179166
17	AMAZE AUGUSTINE	ACAFO	08139184020
19	JOSEPH EHIDIAMEN	ACAFO	07037138092
20	KOKORI PAUL	AFA 1	08071310591
21	IMUMOLEN JEFFERY	FAF 1	08134881918
22	OKEDION FRIDAY	AFA 11	08135924292

23	EHIMIKA KETU	AFA 11	09066749259
24	JAMGBADI IMOUDU	AFA 111	09030653041
	Total	23	

Staff List and Disposition: The staff list at the station during the year 2020 is as shown below

Staff Disposition

STAFF	SENIOR STAFF	JUNIOR STAFF	TOTALSTAFF
HOS	1		1
AGRIC SUP	2		2
ACCOUNT	2		2
TRANSPORT	1		1
HEALTH OFFICER	1		1
FIELD		9	12
SECURITY		4	4
TOTAL	10	13	23

Land Area:
The Substation was established in 1967and situated along Uhonmora/Ekpoma road,

Crops planted

1. Cocoa
2. Cashew
3. Oil palm
4. Plantain

Research 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. Establishment of 1.2 hectares of budded and grafted cacao clones in D1 plot, in collaboration with World Cocoa Foundation (WFC) and African Cocoa Initiative (ACI)
2. Establishment of 0.5 hectares of Cocoa germplasm with plantain for distribution to cocoa farmers
3. Establishment of a research plot to determine the appropriate time and height of coppicing in a rehabilitated cacao plantation
4. Establishment of research plot to evaluate the effect of planting pattern of cacao seedlings intercropped with plantain on cacao establishment in the face of prevailing climate change
5. Field evaluation of cocoa pod husk biochar fortified with fertilizer on cocoa yield and soil pshysiochemical properties

6. Field establishment of Tea (*Camellia sinensis*) under varying watering regimes and different plantain shade levels
7. Effect of different geometry cacao intercropping with cocoanut in ideal and marginal cacao environments of Nigeria
8. Pesticides residue assessment across some cacao ecologies in Edo

Structural Development

Renovation of Account Apartment building that was started in 2020.

Achievements:

1. Efforts were made to maintain our plantations with the little resources and available labour.
2. Nursery irrigation system
3. Production of 5,000 cocoa seedlings
4. Purchase of farm inputs
5. Revenue: A total sum of five hundred and seven thousand, eight hundred and thirty one Naira Only (N507,831) was realized from the sales of farm produce and other services.

Potentials

1. The Substation is at an advantage of land mass if well-funded could have generated more IGR
2. Availability of stable electricity to power investment such as bakery
3. The Guest House can be furnished for use to generate more IGR
4. Establishment of germplasm materials in Cocoa to augment for Headquarters supply to farmers

Challenges/Constraints:

1. There was paucity of fund and this affected 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 field officer were not equipped with enough equipment such as cutlasses, files, safety boots and farm wears to work with
4. The Health Centre is moribund short of and health facilities to take care of the staff
5. The present number of security staff is inadequate for effective guarding of the office, staff quarters and plantations.
6. The effect of pandemic Covid 19 and the consequent sit at home by the Federal Government, culminated by the staff strike actually restricted the operation during the year.
7. No drinkable water to service the station
8. Serious fire out break

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. Provision of working inputs such as herbicides, pesticides, cutlasses, files, safety boots and farm coats
3. Provision of drinkable water either by borehole or well
4. The Substation's guest house needs to be furnished for our researchers that are coming from the headquarters to carry out research work at the substation.
5. Considering the enormity of the work in our plantations, 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
Security Guards 4

APPENDIX

2020 INTERNALLY GENERATED REVENUE

S/N	ITEM	AMOUNT
1	Land Rent	99,500
2	Cocoa seedlings	200,000
3.	Palm oil	60,000
5	Plantain	40,000
6	Cocoa Pods	10,231
7	Access fee	8,100
	Total	**507,831**

OCHAJA SUBSTATION

Table 1: The number of staff, their names, cadres/designation and levels in the order of hierarchy in the Substation as at the time of this report:

S/N	NAMES	CONRAISS	DESIGNATION
1	DR. A.V. OYEDOKUN	13	CRO/HOS
2	MR. ULOKO B.A.	13	CAS
3	MR. ELUGBE M.O.	12	ACAS
4	MR. OKONTA PATRICK	11	PAS 1
5	MR. MAGAJI MUHAMMED	11	PAS 1
6	MR. IBRAHIM WASIU ADEWALE	8	HEO, ACCT.& AUDIT
7	MR. MUSA IBRAHIM YAHAYA	7	HEO, ACCT.& AUDIT
8	MRS. SAMUEL LADI E.	7	SSA 1
9	MR. OGUCHE NATHANIEL	6	CAFO
10	MR. IBRAHIM NOAH	6	CD/MECH.
11	MR. OPALUWA PIUS	6	CAFO
12	MRS. AYE FATIMA	5	SAS
13	MRS. ABAH JANET	5	SHHA
14	MR. MUSA ABDULLAHI	5	ACAFO
15	MRS. YAHAYA MUSA ADISHETU	5	ACAFO
16	MR. NDA OKPANACHI	5	ACAFO
17	MR. ALFA NDAH	5	ACAFO
18	MR. ALIH MUHAMMED	5	ACAFO
19	MR. ATTAH OJONE	3	AFA 1
20	MR. UNUBI ATTAH	3	AFA 1

21	MR. ALU FRIDAY	3	AFA 1
22	MR. ATAWODI JIBRIN	3	AFA 1
23	MR. OTANWA JOHN	3	AFA 1
24	MR. NIFU YAHAYA	3	AFA 1
25	MR. HUSSENI YAHAYA	3	AFA 1
26	MR. ABUBAKAR YAHAYA	3	AFA 1
27	MR. SIMON SUNDAY	2	AFA II
28	MR. UMORU JAMES	2	AFA II

LAND RESOURCE OF THE SUBSTATION AND UTILISATION

Total land coverage of the Substation - 351 Hectares
Total land area already cropped with cashew - 59.2 Hectares
Total land area encroached upon by Indigenes - 17 Hectares
Newly cultivated Cashew Plot in 2018 & 2019 - 12 Hectares
Total land area under permanent crops cultivation - 71.2 Hectares:

Table 2: Details of the established plots in CRIN Ochaja Substation, Kogi State

NAME	SPACING	PEDIGREE	YEAR PLANTED	PURPOSE	HECTARGE
1.Demonstration Plot	9M X 9M	Oro Selection Cashew	1997	Commercial	2.0
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	1.5

				Spacing Expt.	
18. CRIN Acharu	9M X 9M	Kola	2011/2012	Demonstration Plot	2.5
19. Newly Planted		Improved Cashew variety	2018 & 2019	Commercial	12.0
Total Hectarage					**71.2**

RESEARCH PLOTS

Table 3: Research Plots and the corresponding Scientists

S/N	Project/Experiment Title	Scientist (Experimenter)
1.	Physical effects of intercropping cashew with some arable crops (completed her PhD work on the plot)	Dr.Mrs. Nduka B.A.
2.	Growth and yield of cashew as influenced by leguminous cover crops	Mrs. Iloyanomon C.J.
3.	Preliminary studies on yield differential and soil nutrient status of cashew plantations of different nut sizes in Ochaja Substation, Kogi State.	Mrs. Iloyanomon C.J,
4.	Leaf litter fall and soil nutrient dynamics of cashew plantations of different ages in Ochaja Substation, Kogi State	Mrs. Iloyanomon C.J.
5.	Field establishment of cashew as influenced by shade plants and phosphate fertilizers	Dr. Ibiremo O.S.
6.	Effect of coppicing period and height on cashew rehabilitation	Mrs. Adeyemi E.
7.	Cashew hybrid trials	Dr. Festus Olasupo
8.	Setting up of beehives to enhance cashew productivity project	Dr. Ibiremo O.S. *et al*.

INFRASTRUCTURE

Table 4: Details of the Substation Infrastructure

S/N	TYPE	QUANTITY	DESCRIPTION	REMARK

1.	Office complex	7 Office Rooms, 1 Waiting Room, 1 Store, 1 Laboratory space	The Office Complex is the Administrative Block of the Substation.	The offices and the rest rooms require some levels of renovation. All the tables and chairs in the offices are obsolete and dilapidated, hence due for replacement. Periodical termite control is required to keep in check the economic damage effects of termites on the building complex. General ground maintenance around the office complex is being carried out as and when due.
2.	A	1	4 Bedroom Flat	Some facelifts and repairs were done in 2019 and the roof was completely removed and replaced. The building was renovated and termites eaten woods were changed. The facility was re-netted and painted. However, periodical termite control, replacement of all doors eaten by termites, buying of beds for the rooms and adequate plumbing work/installation to be done
3.	B	3	3 Bedroom Flat	Requires some levels of facelifts and periodical termite control
4.	C	1	3 Bedroom Flat	Ditto
5.	D	7	2 Bedroom Flat	In very bad state and requires serious renovations. One of the quarters (Quarter D4) was renovated by a contactor sent from the Headquarters.
6.	E	5	4 Units of 1Bedroom	All in very bad state and require serious renovation to improve the state of the facilities
7.	Rest House	1	2 Bedroom Flat	Renovated in 2019 to give it some facelifts especially the uncovered

				and leaking ceilings. The beds, mattress and bed sheets have to be replaced.

Other facilities include:

a. Central Toilet: 4 room central toilet for staff quarters' general use. Requires facelifts.
b. The Store: The Produce Store has no Raw Cashew Nuts as at the time of filing this report. The Cashew Nut Processing Factory gets its raw materials from this stock. Other Store materials (Technical and Stationeries).
c. The Cashew Juice Processing Factory has manually operated equipment that is not in too good conditions and thereby requires renovation and/or automation.
d. Cashew Nut Processing Factory also has manually operated equipment that requires automation in order to make profit from the business. Similarly, the Cashew Nut Processing Factory needs serious renovation, ceiling fixing and floor tiling in order to meet the standard of regulatory bodies like NAFDAC and SON.
e. The Substation Dispensary needs to be upgraded to provide Primary Health Care needs of the staff of the Substation as well as the host community (Ochaja). However, some drugs, materials and mini equipment are not available in the dispensary.
f. Water Borehole: A functional borehole is within the premise of the Substation with 8000 Liters Capacity Storage Tanks installed. This can be improved upon to ease the period of incessant pumping of water.
g. Power Generating Sets:
    i. A 50 KVA Electricity Generating Plant (Functional, no battery to start and no fund to power the set- 5liter/hour consumption rate of Diesel)
    ii. 2.5 KVA Electricity Generating Set for Office Complex Use – very old, tattered and needs replacement with a new one.
    iii. Sumec 3800 Electricity Generator- for borehole use- functional
    iv. Portable Generator for Rest House Use – functional

k. Mini Weather Station – Non-functional except the obsolete Rain gauge. It requires overhauling and installation of digital weather station that is holistic in its functions.

l. Poultry House: It is within the Power Generating Set axis. This requires general renovation and overhauling as it had been seriously damaged by termite attack and the roof leaks seriously whenever rain falls.

m. The Security Post at the main entrance of the Substation needs urgent renovation and total change of the seriously leaking roof.

n. All the roads leading to and within the Substation require urgent attention. Many wooden electricity poles had been eaten up by the termites and are fallen on the road and this necessitates changing of the poles to concrete type before general grading of the roads.

VEHICLES

Table 5: Details of the vehicles in the Substation

VEHICLE	CONDITION	REMARKS
Toyota Hilux (Petrol Engine)	Functional	Roadworthy but requires serious maintenance, servicing and running cost of the vehicle
Toyota Hilux (Diesel Engine)	Not functional	Engine needs overhauling, tyres and upholstery are to be replaced with new ones, to complement the only working Hilux Vehicle. However, it has been listed for boarding.
Bedford Lorry (Water Tanker)	Grounded for years	Already listed for boarding by the team of Auditors from Headquarters
Pegeout 504 Station Wagon	Grounded for years	Ditto
Pegeout Pick-up Van	Ditto	Ditto
MF Tractor with Trailer	Ditto	Ditto
Motorcycle TX 185	Not functional	Total overhauling required or new one should be bought. Listed for boarding.
Bazuki Tricycle	Functional	New Tyres and general servicing required
Motorcycle CG 125	Functional	Use for field work and minor runs of the Substation. **New one required**

The main crop and only viable source of revenue in Ochaja Substation is Cashew, which the station head (H.O.S) and subordinate (co-staff) had been working very hard to protect and make sure revenue were generated and subsequently remitted to the purse of CRIN through the account department of Ochaja Substation.

The work force had already cleared the bush and are waiting for cashew fruiting and subsequently harvest, when the pandemic (COVID 19) struck around March 2020.

Year 2020 was engulf with by pandemic at a time we were expecting the cashew fruiting and harvest of cashew produce.

At this time federal government gave a directive for all workers below CONRAISS 12 to stay at home and there was no staff to call upon thereafter.

Cashew season (fruiting and harvesting) comes in between March and May or June sometimes, the fruiting and production period fell into the period of this stay at home ordered by the government due to the pandemic and there was no staff on ground to pick cashew produce from farm or prevent the villagers from stealing from the farm.

This gave the villagers a huge opportunity to invade the farmland and took away all the available farm produce and we were left with nothing, therefore the substation was unable to generate any revenue for the year ending 2020.

FUND RECEIVED FROM HEADQUARTERS DURING THE YEAR ENDING 2020

One Hundred and Ninety-Nine Thousand, Seven Hundred Naira only. (N199,700) was sent from CRIN Headquarters to Ochaja Substation twice, for the clearing and weeding of Ochaja Substation productive farm and quarters.

The return for the said amount have been rendered and submitted to the headquarters through the office of the Director, Production and Substations.

OFFICE MAINTENANCE AND UPKEEP GRANT (IMPREST)

Office maintenance and upkeep grants were not sent to Ochaja Substation in the year 2020, this maade it difficult for the station to maintain the available office and farm equipment, Bazuki Tricycle and other equipment that will be needed for the coming season.

Submitted for your information and further directives sir,

Yours faithfully

- **Capital Project**

No capital project was carried out in the Substation within the year but a sum of ₦199,700.00(One Hundred and Ninety-Nine Thousand, Seven Hundred Naira Only) was given twice from the Headquarters to weed the plots and quarters in Substation making a

total of ₦ 399,400.00 (Three Hundred and Ninety-Nine Thousand, Four Hundred Naira Only)

- **Cash Received and Spent**

No money or fund was sent to the Substation as overhead during the 2020.

- **Cashew Nut Kernel Production**.

Presently, the Cashew Processing Factory had some of the damaged equipment (Manual Nut Deshelling Machines and Roasting Chamber) due to persistent usage in the past and they are no more functional. A lot of requests had been made to refurbish the factory and give it a facelift renovation so as to become economically viable but all efforts are to no avail.

- **Cashew Juice Production**

In the year under review, there was no Cashew Juice production due to some materials challenges, coupled with COVID-19 pandemic lockdown.

- **Ground Maintenance**

The ground maintenance of the quarters and office complex of the station was carried out promptly in the year 2020 to enhance cleanliness and proper sanitation of the environment. 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 before the COVID-19 Lockdown was declared by the Federal Government on 26th March, 2020.

2020 Achievements

- The only achievement in 2020 was the clearing of plots and the staff quarters with the fund provided by the headquarters and fire tracing exercise to prevent fire from entering our plots.
- Inspection, renovation and management of Kenyan Top Bar Bee Hives set up in the Substation. Unfortunately, Fulani Herdsmen harvested the honey and other by-products at about a week before we could harvest the honey and other by-products and they (Fulanis) burnt down many of the hives in the process of harvesting the honey

Internally Generated Revenue (IGR)

The IGR of the station is mainly dependent on raw cashew nuts harvested from the Substation cashew plots. However, other sources of IGR in the Station include cashew nuts as planting materials, revolving loans, rent, processed cashew kernels and arable crops produced in the Substation. It is noteworthy that Cashew production this year could not be harvested due to COVID-19 Pandemic Lockdown declared by the Federal Government as it fell within the Cashew harvest period in Ochaja. No staff was on ground to work since the lockdown had been declared. This gave high rate of theft of the produce on the field by surrounding communities like Efikpo, Efekpe, Ijoji, Egume and Ochaja. These incidents have left the station with no harvest of cashew nuts for IGR in 2020.

GENERAL OBSERVATIONS:

- It was generally observed that the Substation had been neglected in terms of funding and the paucity of fund is thereby making Substation to function far below its capacity as an outreach center of the CRIN Headquarters.
- The Substation can contribute immensely into the IGR of the Institute if properly funded to function as required as and when due.
- Paucity of fund allocation to the Substations should be adequately addressed, in which capital projects like periodical road maintenance, power generation, processing facilities, plantation expansion, and boundary demarcation should be funded.
- Manpower base of the Substation has to be expanded in the Security Unit of the Institute (presently, there are 2 Security Officers remaining b and also in the Field Production Unit to maintain the plots adequately as well as expanding the plantations. This can be made effective by employing Casual Workers (Special Project Staff) on a regular basis as Security Officers and also to see to plot maintenance and plantation expansion.

ADDITIONAL STAFF NEED & REQUEST BY CADRE

(i)	Agricultural Field Attendants	-	15
(ii)	Watchmen	-	8
(iii)	Foremen	-	2
(iv)	Health Attendants	-	2
(v)	Rest House Attendant	-	1

CHALLENGES AND SUGGETED REMEDIES

- The Substation is poorly funded for maintenance of the Station and vehicle, motorcycle and tricycle available being used in Station.
- The Substation faces a lot of challenges in the area of theft of farm produce and other personal properties from neighboring communities like Ijoji, Efikpo, Egume, Efikpe and even Ochaja. Fund should be made available for constant patrol by the police especially at nights within the Substation's Residential Quarters and Farm.
- It is therefore noteworthy that the Substation is short-staffed especially in the Security Unit that used to have 12 Officers which has now been reduced to 2 Officers, most of whom are aged and are not even sufficient for the job. The Station has no Foreman again who can do some repairs and other minor jobs that are highly essential within the Substation. The Substation also needs more Field Officers for maintenance of the old and new plantations as well as other plots. This can be made effective by employing Casual Workers (Special Project Staff) on a regular basis to see to plot maintenance and plantation expansion.as well as Casual Security Officers for patrol and vigilance both at the Residential Quarters and the field.
- It was generally observed that the Substation had been neglected and thereby made to function far below its capacity as an outreach center of the CRIN Headquarters. The Substation can contribute immensely into the IGR of the Institute if properly funded to function as required.
- Paucity of periodic and adequate fund allocation to the Substations should be promptly addressed, in which capital projects like road maintenance, power generation; automated processing facilities, plantation expansion, and boundary demarcation with economic trees like oil palm, juggernaut and castor plant should be funded by the Headquarters.
- Recruitment of new staff should be done at the Substation level especially where we have gap through retirement, shortage of manpower and even unfortunate situation like death.
- Approval should be given Substation to involve Nigerian Security apparatus to curb the rate of theft of farm produce and other farm products in the Substation.
- Capital projects that will enhance output from the Substation as well as enhancing the sustainable livelihood of Staff and the host community should be provided for.

- The Headquarters have to be prompt in responding to the needs of the Substation before things go out of hand.
- Establishment of functional Digital Weather Station in the Substation is essential and needful.
- Renovation of the laboratory space within the office complex and acquisition of handheld equipment like GPS, USB Microscope, Environ-meter and other small laboratory equipment that could be powered by small generator to run some experimental procedures have to be provided to the Substation as this will help any resident and/or visiting scientists in their work at the Substation .
- Renovation and Stocking of the station's Library with books, periodicals and journals for the extension of CRIN findings to student and other stakeholders that will be visiting the Substation is germane and needful.
- Also, indigenes encroach on the Institute's land for farming activities without the consent or approval of the Institute and every attempt to curb those people usually results in some friction between the perpetrators and Institute's staff. Similarly, the indigenes engage in wood felling activities on our plots and other Institute's land mass along Ochenwa Road and the Rivers Okura and Ideli Banks. Every move to stop them had not been fruitful in spite of reporting to the Area Command of Nigeria Police in Anyigba and termination letter served to one Mr. Zaccheus Ubolo who was given permission by the Headquarters prior to my resumption as HOS in 2016 to enter our plot for such activity. If we can bring in the service of Security apparatus like SARS and/or Civil Defence Officers, I believe it will curb their activities. If this act of deforestation is not curbed, it will eventually affect the Substation in the long run.
- Fulani Herdsmen are invading our quarters, arable farm by the Institute and staff as well as newly established plots, burning bush, vandalizing beehives and setting them on fire.

CONCLUSION

We deeply appreciate the Almighty God, for making it possible for us to have served the Institute in the year 2020, we trust in His grace and mercy for a more fruitful 2021.

ANNEXURE

Figure 1: Renovated Rest House at the Substation

Figure 2: Quarters D4 at the Substation after renovation

Figure 3: Quarters D4 at the Substation before renovation

Figure 4: Burnt plot where Beehives were set up after Fulanis had harvested the honey and set the hives on fire.

LIBRARY, INFORMATION AND DOCUMENTATION DEPARTMENT

Library Information and Documentation Department (Head: Fagbami, O.O.)

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.

Personnel: There were thirteen (13) staff working at LID department. These were; three (3) Librarians, two(2) Programme Analyst , four(4) Library Officers, one(1) Chief Printer, one(1) Data Processing Officer, one(1) Chief Typist and one(1) Clerical Officer

Library Division (Aboderin A.K – Acting Head, Library Division)

The library division is saddled with the responsibility of providing information resources to its users through printed or electronic format. The library division performed the duty by ensuring that the institutes' staff both researchers and non-researchers got the needed information to carry out their day to day activities.
The Users query both printed and electronic forms were also attended to.
Current Awareness Services (CAS) and Selective Dissemination of Information (SDI) were done for profiled Researchers.
The division Trained six students who were on Industrial Attachment.

The library division has four sections: Acquisition, Reference, Circulation, Cataloguing and Classification.

Personnel
There were eight (8) staff in the library division, while Dr (Mrs) Ogunjobi T.E. is on Sabbatical leave at University of Ibadan.

Activities and Achievement
In the year under review (January to June 2020), the records shown that 316 researchers used the information resources of the library, 265 non-research staff also used the library, 202 visitors were received and 404 industrial training student and crops members visited the library.
The highest used library resource was Annual report total 297. This could be attributed to the increased in numbers of researcher in the institute due to the recruitment of staff. Copies of 2000 to 2012 annual reports were distributed to the newly employed scientist.

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 and Library Automation have four (4) personnel.

Functions

The division is saddled with the following functions:

- Provision of Internet access to the staff of the Institute
- Troubleshooting and fixing of all Internet equipment
- Provision of computer related services in offices
- Administration/maintenance of the Institute's website
- Provision of computers and peripherals solutions to staff
- Training of Interns

Activities and Achievement

1 Update of Institute's website with value chain products.
2 Creation of Information Technology (IT) closed Whatsapp group to address the IT needs of staff remotely.
3 Troubleshooting and repair of Internet connection defects
4 Handling of official correspondences
5 Organised training for staff on online meeting using zoom
6 Ogranised zoom meeting between the Executive Director and the Institute Board Members
7 Training of interns
8 Procurement of switches for the Indoor and Outdoor signal distribution.

DOCUMENTATION DIVISION: (Fagbami, O.O. and Babafemi Ibitope B. Acting Head, Documentation Division)

Activities and Achievement

1. Cocoa Research Institute Database on Nigeria (CRIDAN), collection continued.
2. Work continues on processing of reprints.
3. Crop book on cocoa was still outstanding and this has delayed its printing.
4. Staff Identity card data were collated and printed on request as approved.
5. Compilation of bibliographies is on-going
6. A designated computer for CRIDAN, photographs of events was put in place.
7. The Username and Password of Research 4life was made available for use of Scientists.

ENGINEERING DEPARTMENT

FINANCE AND ACCOUNTS DEPARTMENT

Sorinolu Oluwatoyin
Ag Head Finance and Accounts Dept

The department has four (4) divisions based on new Finance and Accounts restructuring method by the Federal Government of Nigeria.

i. **Final Accounts Division**
   a. Pension Section
   b. Budget and Monitoring Section

ii. **Cash / E-Payment Division**

iii. **Payroll / IPPIS Division**

FINAL ACCOUNTS:
The Final Accounts Division is responsible for the preparation of end of year trial balance and statement of affairs for the Institute. The duties of Final Accounts capture all summary of financial events/transactions that occurred during the year.
Final Accounts has ten (10) energetic staff saddled with different schedule of duties. It is sole responsibility of final accounts to work hand in hand with the federal auditors and the institute external auditors.

SECTIONS UNDER FINAL ACCOUNT:
PENSION:
The section is saddled with the responsibility of computation, preparation and payment of exited and retired staff of the institute plus updating NHF record of all serving staff and retirees.

BUDGET AND MONITORING:
The section deals with submission of each department yearly budget and saddled with the responsibility of monitoring the on-going and completed capital project both at the headquarters and substations.

CASH/E-PAYMENT
The division deals with receipts of all monies to the Institute and payment of approved claims and bills. The department also covers maintenance of relevant books of account in respect of income received or payment made.

PAYROLL DIVISION

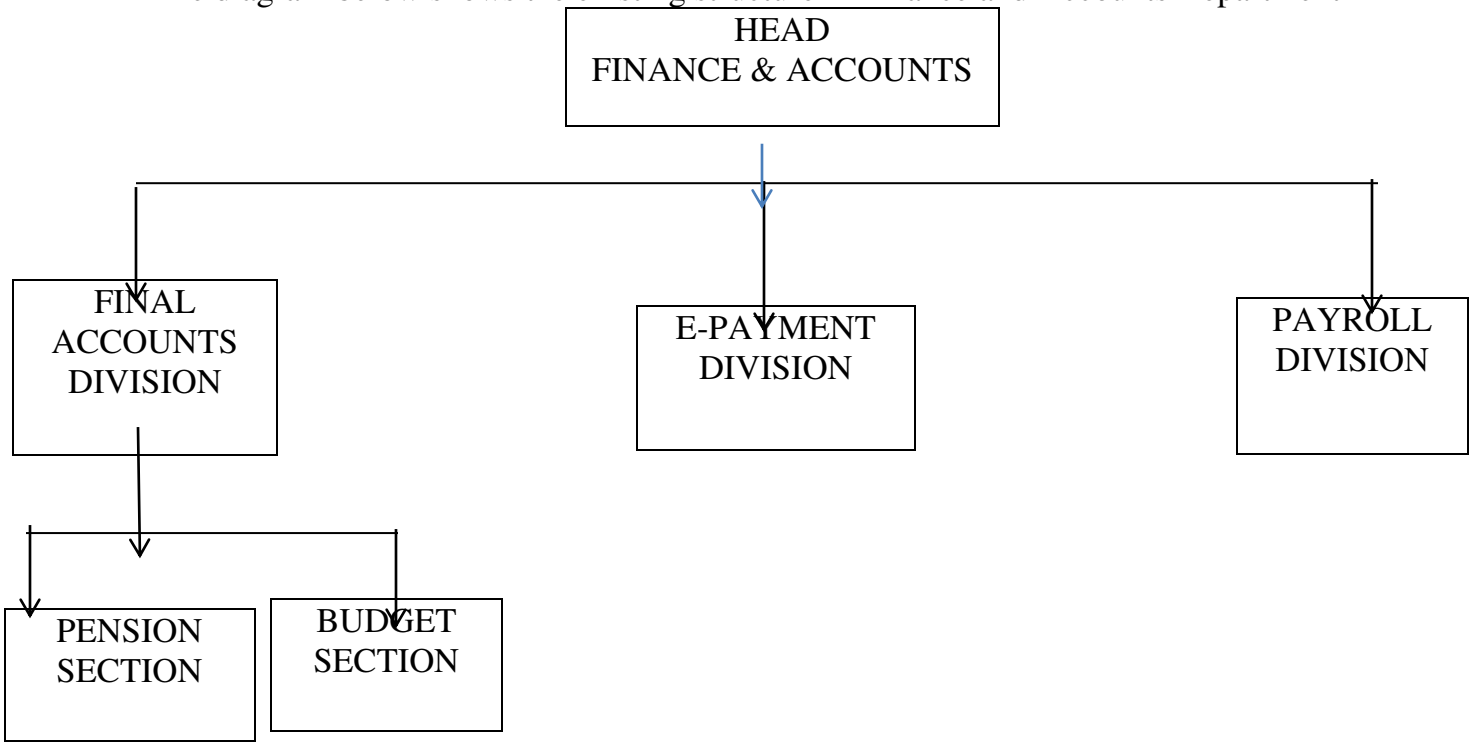
This is the division saddled with the responsibility of preparation and payment of personnel emolument. It also includes payment of all sort of personal allowances and other issues relating to staff emolument.

PAYMENT CYCLE

For any payment to be made, it must have passed through all due process and got the Executive Director's approval. Also for payment to be effected on any approved request, the following procedures are follows;

- The request is forwarded to Executive Director's office
- The request is sent to audit section for Auditor's recommendation for Executive Director's approval
- After ED's approval, it will be directed to Head finance and accounts department for further action
- The voucher will be raised, checked and controlled by relevant senior officers
- The voucher together with the request will be taken to audit for prepayment checking
- The then voucher, attached with the request is sent to e-payment division
- The payment is then made base on the **availability of fund** as the moment or wait till allocation(s) is/are received from the Federal Government.

The diagram below shows the existing structure in Finance and Accounts Department



Presently, the staff of F&A for both Hqtrs and Six (6) Substations as at 31 December, 2020 are as follow;

S/N	PARTICULAR	HOD	Final Accts	E/Pmt	Payroll	Pension	Budget	S/S	TOTAL
1	Ag. HFA	1	-	-	-	-	-	-	1
2	Chief Accountant	-	2	-	-	-	-	-	2
3	Assist Chief Accountant	-	1	1	1	1	-	-	4
4	Principal Accountant	-	-	-	-	-	2	-	2
5	Senior Accountant	-	2	2	2	-	-	-	6
6	Accountant 1	-	-	-	-	-	-	-	-
7	Accountant 11	-	-	-	-	-	-	1	1
8	C.E.O.	-	-	1	-	-	-	-	1
9	A.C.E. O.	-	-	1	1	-	1	-	3
10	P.E.O.1	-	-	-	-	-	-	1	1
11	P.E.O.11	-	1	-	-	-	-	-	1
12	S.E.O.	-	3	2	-	-	-	1	6
13	H.E.O.	-	-	-	-	-	-	2	2
14	E.O.	-	-	-	-	-	-	-	-
15	A.E.O.	-	1	-	1	-	-	-	2
16	Secretarial	1	-	-	1	-	-	-	2
17	Clerical	1	1	-	-	-	-	-	2
18	Driver	1	-	-	-	-	-	-	1
	Total	**4**	**11**	**7**	**6**	**1**	**3**	**5**	**37**

Note: Mr Abodunrin Peterkin, a Principal Accountant attached to Budget section is currently on leave of absence from the Institute.

INTERNAL AUDIT ANNUAL REPORT FOR YEAR 2020

The Internal Audit Division was set up to monitor and evaluate the internal control system put in place by the management; and to ascertain the level of compliance or otherwise with these procedures, policies, rules and regulations. We also provide reasonable assurance about the achievement of Institutes objectives with regards to the economic, effective and efficient use of resources allocated to the Institute. We provide complete and continuous audit of the accounts and records of revenue and expenditure, assets, allocated and unallocated stores **(FR 1701).** Where the need arises, we investigate specially into suspected cases of fraud in the Institute. We also attend to issues relating to TSA, IPPIS, GIFMIS and other platforms to the level of access granted. The division is directly responsible to the Executive Director.

DIVISIONAL STAFF STRENGHT

The staff are highly qualified and show professionalism in the discharge of their duties. As at 31st of December, 2020, the division had thirteen (13) staff. five (5) of these are accountants; Six (6) are Executive officers; and two (2) are secretarial officers. One of the executive officer is on approved study leave.

WHAT WE DO (RESPONSIBILITIES)

As part of our responsibilities as stipulated in the Financial Regulation (FR 1701), the division ensures that:-

- Transactions are valid and properly recorded.
- Transactions are properly approved and authorized for payment.
- Valuations in the books were complete and reasonably stated.
- Assets and Transactions are properly classified.
- Transactions are recorded to time.
- Value for money is achieved.

ACHIEVEMENTS

In the year under review, the division has been able to achieve the following feats:

- Proper monitoring and evaluation of the internal control mechanisms put in place by the management of the Institute.
- Ensure compliance with government rules and regulations; and other official gazettes and circulars.
- Increase in the level of compliance with the different control measures (preventive, detective, corrective, directive and compensating) put in place.
- Cost reduction and controls have improved drastically, as we have been able to manage these by ensuring the best quality of items or material is bought for the institutes use.

- The rate of retirement of advances by staff have improved compared with the previous years as the rule of no retirement of previous advances before getting another was strictly enforced.
- No extra budgetary spending; expenditures were wholly, reasonably, exclusively and necessarily incurred.
- On a regular basis, physical inspection of the Institutes assets were carried out for update on existence, current value, completeness, rights & obligations and allocation of these assets.

CONSTRIANTS

Funding is a major challenge facing the division. Audit is continuous and it is evidenced based. Getting sufficient, appropriate, relevant and reliable evidences to back up our opinion on a particular phenomenon require funds. Another challenge of the division is the perspective of staff as to what audit stands for. Many see our job as a witch hunt exercise rather than for the good of the institute; there is need for reorientation.

CONCLUSION

Our role is to add credence and value to the realization of the institutes mandate by ensuring that resources are allocated and used economically, efficiently and effectively. We therefore enjoin you to join in the crusade of value addition so as to take the institute to greater height.

ADMINISTRATION AND SUPPLIES DEPARTMENT

The administrative and Supplies Department of the Institute applied itself meritorious 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 statement.

A. STRUCTURE OF THE DEPARTMENT

To facilitate the activities of the Department, the Department is structured into four (4) Division, Supplies Division and Health Services Division.

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

Human Resources Management Division	-	Personnel Registry, Confidential Registry & Pension
Legal and Corporate Matters Division	-	Legal, Corporate, Catering Services & Open Registry
Supplies Division	_	Supply Section and Stores Section
Health Services Division	_	Dispensary and Maternity

B. STAFF STRENGHT

The Department has a total number of 100 staff.

They are summarized as follows:

26 professional in Administration, 26 Executive Officers, 1 Confidential Secretary, 1 Data Processing Officer, 8 Secretarial Assistant, 6 Clerical Officers, 8 Nurses, 1 Higher Environmental Health Officer, 1 Health Information Record Officer, 1 Health Assistant, 2 Health Attendants, 1 Data Processing Assistant, 2 Catering Officers, 3 Catering Assistants, 5 Store Officers, 1 Store Keeper and 7 Field Assistants.

C. FUNCTIONS/ACTIVITIES OF THE DEPARTMENT

Detailed reports of the functions of the Department are as follows:

(i) Cost-effective management of a;; the administrative activities of the Institute, including all elements of personnel function, Legal and Corporate Matters, incorporating Governing Board affairs and Public Relations.
(ii) 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.
(iii) Identifying, articulating, formulating and reviewing from time to time and administrative activities of the Institute in compliance with 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.
(iv) 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:

D. ACHIEVEMENT/PROGRESS OF THE DEPARTMENT

Total staff strength

Year 20202 the total strength of the Institute's staff is 910 i.e Male: 595 AND Female: 315

PROMOTIONS

Junior staff promotions done in year 2020, 78 junior staffs were promoted while 4 were given inter-cadre/conversion.

Senior staff promotions done in year 2020, 96 senior staff was promoted.

TRAINING

As at 31 December, 2020, no training due to COVID-19.

2020 LEFT THE SERVICE

Total number of seventeen (17) staffs left the service based on length of service/age/death/resignation/transfer.

LEAVE MATTERS

All staff that requested for annual leave and casual leave got approval in year 2020, while five (5) staffs on maternity leave one (1) staff on leave of absence, one (1) sabbatical leave, four (4) staff on study leave without pay, four (4) staffs on compassionate leave and ten (10) staffs on exam leave.

INTERNAL MANAGEMENT COMMITTEE MEETINGS

In year 2020, the Internal |Management held meetings seven times.

GOVERNING BOARD MEETINGS

Governing Board had one physical meeting and two visual meetings in year 2020.

CORPORATE VISITS

Four (4) corporate organization pay courtesy visit to the Institute.

INSTITUTE'S REST HOUSE

Activities of Institute's Rest House

1. Provision of menu refreshments for Governing Board members and other staff recruitment exercise facilitators.
2. Accommodation of staffs from CRIN substations on redeployment to CRIN Headquarters, Ibadan for the first 28 days.
3. Accommodation of guest during Senior and Junior Staff recruitment exercise for a week.
4. Accommodation of sixteen newly recruitment staff for the first 28 days.
5. Accommodation and provision of refreshment for IPPIS Officials for staff data capturing exercise.
6. Accommodation of a corper on national assignment at CRIN Headquarters, Ibadan.
7. Accommodation of auditors from Auditor general office, Abuja.
8. Accommodation of SSA Sectorial delegates for a week at CRIN Rest Houses.
9. Accommodation of NIMET officials from Abuja on Metrological assignment.
10. Accommodation and feeding of farmers delegates from Southwest State on Training at CRIN Headquarters, Ibadan (FMARD Training).
11. Generation of reasonable revenue from accommodation sales at CRIN Rest house.
12. General cleaning and maintenance of clean guests rooms and surroundings couples with other Ad-hoc assignments.

Challenges/Constraints

1. Lack of regular electricity for guest usage and provision of wholesome water(lack of solar power).
2. Inadequate bedding materials and window curtains
3. Inadequate/old guest's towels and foot mats.
4. Renovation and refurbishing of the chalet buildings.
5. Inadequate staff as a result of staff statutory retirement.
6. Poor plumbing system.
7. Lack and poor wiring TV system.
8. Termite and bat invasion of the institute rest house as result of non-regular fumigation exercise.
9. Non-regular release of provisional approval sectional monthly imprest.
10. Lack of cooperate revolving imprest for the occasional provision of large refreshment during any CRIN official functions.
11. Non-regular payment of approved cash request and reimbursement.

ACHIEVEMENT /SCOPE OF THE FUTURE

The guest house has been generating reasonable revenue for the institute and immediately the guest house was given face-lift through renovation works, good image maker for the Institute because of warm reception tactics and good maintenance of CRIN mandate crops planted at the frontage of the Rest House.

HEALTH SERVICE

DISPENSARY

Between January – December, 2020, total number of 3,990 patients were seen.

MATERNITY

From January-December, 2020 total number of 1,090 patients were seen.

DELIVERY

Fourteen (14) babies delivered normally by Spontaneous vaginal delivery without any complication.

FAMILY PLANNING

Sixty-six (66) clients attended the clinic.

DEATH

No death was recorded

SICK OFF

Sick off were given to staff and casual depending on the medical condition presented at the clinic.

REFERRALS

Staff/non staff were referred to hospital for better management.

IMPREST

Nil imprest received during the reporting year.

IMMUNIZATION

Seven hundred and seventy-four (774) children were immunized against preventable disease, while the pregnant mothers too were immunized against Tetanus infection.

STAFF EDUCATION

None of the staff Nurses or subordinates staff was sponsored for any seminars/workshop in the reporting year.

BABIES PARTY

This annual events does not hold due to COVID-19.

ACHIEVEMENTS WITHIN THE YEAR

1. Presently the Division has an Environmental Health Officer
2. Both junior and senior staffs in the Division due for promotion were promoted to their next level in January, 2020 and of course for the first time in the history of the Division, a position of Assistant Director in Nursing was obtained as due in NARIS and other Federal Government establishment. To God be the Glory.
3. Some of the nurses are now B.Sc. holders due to their quest for more knowledge.
4. Two (2) Nurses were sent for workshop at Centre for Management and Development (CCM), Lagos. Theme **"Efficiency and performance improvement workshop"** between 18-21 June, 2019.

CHALLENGES

1. Shortage of water especially during dry season at the Health Centre.
2. Epileptic power supply making some procedures difficult especially during night shift.
3. Failure to implement the NHIS programme since accreditation.
4. Nonpayment of uniform allowances to Nurses.
5. Nil payment of imprest.
6. Lack of seminar/refresher course for staff.
7. Staff of internet facility.

8. The low-turn out of patronage from April to July, 2020 was as a result of Global Pandemic of COVID-19 necessitating rendering of skeletal services by the Medical and Paramedical staff.

SUPPLIES DIVISION

Year 2020 annual report of Supplies Division from 02 January – 31 December, 2020. Some of the activities performed during the period under review are as follows:

1. End of the year physical counting exercise was successfully carried out.
2. All items delivered into Institute Store are properly checked and certified to ensure the conformity of the materials to the quantity and quality required.
3. Receiving material into store and arranged them on the rack accordingly.
4. Tally cards were balance and always intact on the rack with the materials.
5. Sore ledger book were checked and balanced at the end of every month.
6. Taking materials uncharged accordingly.
7. Materials issued and releasing of fuel and lubricant were done without delay.
8. General cleaning of store houses and rearranging of stock were carried out.
9. Keeping vigilant of Store houses and stock.
10. Report writing
11. Internal and External Auditors were well attended to during their visit to the Division.
12. Obsolete materials were fished out for disposal.

Notes: Details and relevant documents of all the above listed activities are available in the Store.

CONTRACT

Apart from purchased made by Procurement or individual, materials were also delivered into the Store through contractors or supplies. They are as follows:

1. Supply of Laboratory equipment by Ashfords Scientist Ltd., vide PD2.
2. Supply of Rotary Evaporator by Moses Adewuyi Nig. Ltd., vide PD270/Vol.ll/33.
3. Supply of Laboratory Chemical by JC Richard Interbiz Service Ltd., vide PD270/Vol.ll/13
4. Supply of chemical and glass wear by JC Richard Interbiz Service Ltd vide PD270/Vol.ll/13.
5. Supply of Laboratory equipment by Moses Adewuyi Nig. Ltd vide PD270/Vol.ll/33
6. Supply of field tools by JC Richard Interbiz Service Ltd vide PD270/Vol.ll
7. Supply of CRIN community Radio studio materials by Mikkyway Multi Ventures Ltd., vide PD270/Vol.ll/29.
8. Supply of Steel grid & Co for Somatic Embryo Genesis by Ashford Scientific Ltd.
9. Supply of Air-condition & kit Reakyem Opa Consulting Ltd.
10. Supply of Television & DSTV by Halow-sway Consulting Ltd.
11. Supply of office materials & Furniture by Larry-well Mao & Co., Ltd. Vide PD270/Vol.ll/32.
12. Supply of working tools by Boboy Investments Ltd. Vide PD270/Vol.ll/235

CHALLENGES OF THE DIVISION

1. Harmful and obsolete chemicals are yet to be disposed.
2. Protective and preventive materials are needed for safety of store personnel.
3. Computerization of store is required to enhance our performance of duties
4. Building of toilets at technical store.
5. Provision of working materials e.g. stationery, furniture, computer and office equipment.
6. Store personnel training are highly required for more effective productive productivity in store activities.
7. Electricity connection at Research Store yet to be corrected.
8. More staffs are needed in the Division
9. Fumigation of store is required to stop the snakes, rats and vamps disturbance.
10. Hazard allowance is required to motivate staff performance.
11. Strong doors and burglary proof for security purpose is yet to be attended to.
12. Protective nylon for tally cards.
13. Construction of net at medical store.
14. Imprest account to maintain the division is required.

THE FUTURE EXPECTATION

- Computerization of the functions of Admin. & Supplies Department.
- Upgrading of inverter for the Department.
- Provision of good file cabinet.
- Provision of office equipment i.e. complete sets of computers, laptops, refrigerators and air conditioners.
- Provision of impress regularly.