ANNUAL REPORT

OF THE

COCOA RESEARCH INSTITUTE
OF NIGERIA, IBADAN

2012

COCOA PROGRAMME

Experimental Title: Status of organic cocoa production in Nigeria (Adedeji A. R. and Oluyole K. O)

Introduction

Evidence abound that mineral fertilizers, herbicides and pesticides are extremely harmful to human health. Conventional agriculture relies heavily on these toxic agro-chemicals which are harmful to human health, penetrate water sources, harm livestock, deplete soil, kill pollinators like bees and butterflies, devastate natural eco-systems and contaminate farm produce(TOFA, 1995). Furthermore, several other disadvantages are possible under agrochemical-based farming.

Eating habits are changing particularly in the US and Europe as people are more aware of environmental and ecological issues making them prefers organic products even in chocolates. The use of organic substances for health and body care has become the in thing these days. People are shying away, at all cost, from using those products that are presumed to contain many chemicals. Organic cocoa butter and other cocoa products are part of such resource being exploited to new levels. Cocoa products are used as a remedy for many conditions including burns, snake bites and healing wounds. Cocoa butter (CB) has been proved to contain natural antioxidants that prolong its shelf life, making it a suitable material for manufacturing long lasting products (Wisegeek, 2012; Articlebase, 2012). To cash in on this trend, major chocolate companies are hooking to the organic bandwagon (Krishnakumar, 2011). However, only 15 – 20% of world cocoa is of the organic variety i.e. production is inadequate but the premium price is an incentive for farmers to increase cultivation (Krishnakumar, 2011). Whereas other major (world) cocoa producers, including African countries, are producing organic cocoa, organically grown cocoa in Nigeria is virtually none existent.

Objective of the study

To determine the status of organic cocoa production in Nigeria.

Materials and Methods

The study was carried out among cocoa farmers in Nigeria. Three states were selected for the work; these are Oyo, Ondo and Cross-River. One Local Government Area (LGA) was chosen in each of the state. In Oyo State, Ido LGA was chosen, in Ondo State, Ondo East LGA was chosen while in Cross-River State, Etung LGA was chosen. From the three states, 102 cocoa farmers were randomly selected for the study. Structured questionnaire was used to collect information from the respondents and the data from the information supplied were analyzed using descriptive statistics.

Results and Discussion

Socio-economic variables of the farmers show that 76.47% of the farmers were aged 50 years and below indicating that the substantial proportion of the respondents were still in the active age and this improves cocoa production efficiency among the respondents. The result also shows that 85.29% of the respondents were males and 70.59% of the respondents had formal education. Majority (78.43%) of the respondents were married. This is a good pointer towards family labour supply thus easing the problem of labour scarcity in the area. 75.49% of the respondents were having farm size of five hectares and below. This shows that majority of the farmers in the study area were small scale farmers.

As regards the awareness about organic cocoa production, 80.39% of the respondents claimed that they did not know about organic cocoa production while 19.61% claimed to have known about it. Regarding the control of pests, the study revealed that 90.10% of the respondents used chemical to control diseases while 1.98% used bio-control. Majority (92.08%) of the respondents used chemicals to control insects while 1.98% used bio-control. As for the control of weed, 52.94% of the respondents used cultural method while 4.90% used bio-control.

Table 1. Socio-economic characteristics of the farmers

Variables	Frequency	Percentage
Age (years)		
≤ 25	7	6.86
26-50	71	69.61
>50	24	23.53
Total	102	100.00
Gender		
Male	87	85.29
Female	15	14.71
Total	102	100.00
Educational level		
No formal education	28	27.45
Primary education	25	24.51
Secondary education	39	38.24
Tertiary education	10	9.80
Total	102	100.00
Marital status		
Single	14	13.73
Married	80	78.43
Widow/widower	5	4.90
Divorced	3	2.94
Total	102	100.00
Farm size (hectares)		
≤ 5	58	75.49
5.1-10	15	14.79
>10	29	9.72
Total	102	100.00

Source: Field survey, 2013.

Table 2. Analysis of pest control methods

Pest	Chemicals	Bio-control	Cultural method	No response
Disease	90.10	1.98	-	7.92
Insects	92.08	-	1.98	5.94
Animals	56.44	1.98	31.68	7.92
Weeds	52.94	4.90	42.16	-

Source: Field survey, 2013

Conclusion
It could be deduced from this study that majority of cocoa farmers in the study areas were not aware of organic cocoa production. The study also found out that chemical is still predominantly being used to control pests in cocoa farms and this has both immediate and long term effects on the environment and the health of the farmers. Efforts should therefore be put in place to encourage cocoa farmers to use integrated pest management (IPM) and biological control as safe strategies to both the environment and farmers.

Constraints
This is 2012 project, but the fund was released in 2013, however 2013 project could not be executed because the approved fund was not released.

Experimental Title: Breeding for early maturing or precocious cocoa hybrids (Adenuga O.O. Adewale B.D. Adeigbe O.O)
Introduction
Cocoa is a crop with long gestation period. In most cases, it bears fruit about four years or even more after establishment in the field. An evaluation of some hybrids at CRIN Headquarters led to the identififation of some 27 genotypes which attained fruitng between 18 and 24 months after field establishment. Pod production among these 27 genotypes ranged between 1 and 18 pods per individual tree at about 30 months of field establishment. Improvement on these findings will make early maturing materials available for farmers.
Objectives: the objectives of the study were:

i. To obtain cocoa hybrids with reasonably short gestation period; and
ii. To estimate the combining abilitites [general combining ability (gca) and specific combining ability (sca)] in the parents for precocity and black pod disease tolerance.

Methodology
Seven promising genotypes among the 27 highlighted above were crossed in a 7x7 half diallel design in which each of the 7 was mated to everyone else including itself. The progenies thus generated were raised in the nursery and transfered to the field at CRIN Headquarters in Ibadan in June 2011. The experimental layout is RCBD with 3 replications.

Results and Discussion
The collection of juvenile data on the field commenced at 3 months after field establishment. The survival of the hybrids in the first month of field establishment was above 90%. However, fund was not available for the irrigation of the field during the dry season between December 2011 and April 2012. Hence a loss of above 55% was recorded on the plants in the field as a result of the harsh and dry weather.
Conclusion and Recommendation
The plant population that survived the dry season was not sufficient to generate adequate data for analysis to provide a meaningful scientific result.

Experimental Title: Increasing cocoa bean yield of small holder farms through cocoa pod husk (CPH) based compost and NPK fertilizers in Cross River State, Nigeria(Ogunlade M.O, Agbeniyi S.O. and Oluyole K.A.)

Introduction
Low soil fertility has been identified as one of the major causes of low yield of cocoa in Nigeria. Nutrients are being removed from the soil through pod harvest without replacement in the form of fertilizer application. Omotoso (1975) reported that harvest of 1000kg dry cocoa beans removed 20kg N, 4kg P and 10kg K from the soil. Inspite of the soil nutrient depletion more than 85% of cocoa farmers in Nigeria (Ogunlade et. al 2009) and about 98% in Cross River state (Agbeniyi et.al. 2010) do not use fertilizer on cocoa.

Enhancing soil fertility status is a sustainable option to increase cocoa production. The use of readily available sources of organic fertilizer like cocoa pod husk being generated annually in large quantity on cocoa farms(Ogunlade et.al 2011) provide a suitable means of soil fertility management. Crop residues are not a “waste” (Lal, 2008a). They are valuable assets when returned to soil (Wilhelm et al., 2007). Therefore the aim of this study is to sensitize cocoa farmers in the study area on the need to use CPH based organic fertilizer to raise fertility status of the nutrient depleted cocoa soils in order to boost cocoa production and raise income of farmers.

Materials and Methods

The study was carried out with farmers’ participation in Cross River state, Nigeria. Two adjacent cocoa plantations of different ages in Effraya cocoa farming community, in Etung Local Government area of Cross River State were selected through the consensus of the participating farmers. Cocoa trees in one of the plantations were planted in 1983(referred to as young cocoa in this paper), while the cocoa trees in the second plantation were planted in 1969(referred to as old cocoa). The area falls within longitude 8.8878 and latitude 5.8878 in the rainforest region of the south eastern Nigeria. The annual rainfall ranges between 2000 and 2300mm per annum. The cocoa farmers were involved in the collection of organic materials, composting, application of compost and data collection. Cocoa pod husks generated in the cocoa plantations selected were used. Leaves of *Chromolaenaodorata* were also collected in the adjacent farms and chopped into smaller pieces. Cowdung was collected from the Abattoir at Ikom, about 10km away from the site of the experiment. Cocoa pod husks were cut into smaller sizes (about 1-2cm in length). CPH, *Chromolaenaodorata* and cowdung were thoroughly mixed together in ratio 2:1:1 respectively by weight before packing into composting box. The content of the compost box was watered and turned once a week for the first two weeks and fortnightly for the last ten weeks. At maturity, the compost was evacuated from the box, air dried and bagged for use in the selected cocoa plantation.

The samples of the individual organic materials used and the resulting compost were analysed for their nutrient contents.

The experimental design was randomized complete block with three treatments replicated three times.The treatments were:(1) Compost (2) NPK 20:10:10 (3) Control (No fertilizer application). The treatments were administered separately to both the younger and older cocoa trees.

Each of the plantations was divided into three blocks. The three treatments were randomized in each block. Each treatment was applied to ten trees to give 30 cocoa trees per block thus given 90 labeled trees for younger cocoa plantation, and 90cocoa trees for older cocoa plantation. The plantations were manually weeded before fertilizer application. The compost and NPK 20:10:10 were applied at the rate of 100kgN/ha.The yield data were taken with the active participation of the farmers for two years.

Results and Discussion

The initial soil chemical properties indicated that available phosphorus and exchangeable potassium contents of the soil were of low values (Table1) and below the critical levels required for cocoa (Egbe et.al 1989). The soil pH is slightly acidic with values ranging from 6.2 to 6.3 (Table 1). The higher N, P, K and Ca contents of soil in older cocoa plantation (Table1) might be due to higher leaf litter normally generated under old cocoa plantation as reported by Ogunlade and Iloyanomon, 2009 who assessed leaf litter fall under cocoa plantation of different ages.

Table 1: Some chemical and physical properties of soils before fertilizer application

Soil properties	Old cocoa plantation	Young cocoa plantation
pH	6.2	6.3
O.C(g/kg)	8.1	7.6
N(g/kg	1.8	1.2
P(mg/kg)	6.2	3.9
K(cmol/kg)	0.24	0.19
Ca(cmol/kg)	6.92	5.12

Mg(cmol/kg)	1.30	1.42
Zn(mg/kg)	10.4	10.3
Fe(mg/kg)	108.4	102.3
Mn(mg/kg)	80.3	75.4
Cu(mg/kg)	5.2	4.4
Sand(g/kg)	660	640
Silt(g/kg)	140	150
Clay(g/kg)	200	210

The N, P and Mg contents of compost were higher than that of cocoa pod husk which was the major component of the compost (Table2). The heavy metal contents of the compost were very low and ranged between 0.009mg/kg for Arsenic and 0.136 for vanadium (Table 2) which implied that the compost was of good quality as similarly reported by Mullet, 1992 and Walid et.al 2009.

Table 2: Some nutrient and heavy metal contents of compost materials and matured compost

Properties	**Cocoa pod husk**	**Chromolaena**	**Cowdung**	**Mature compost**
Total N (%)	1.140	2.340	3.080	2.610
P (%)	0.510	0.620	0.740	0.530
K (%)	0.820	0.830	0.850	0.560
Ca (%)	2.580	4.440	2.860	2.070
Mg(%)	0.410	0.390	0.390	0.940
Fe (mg/kg)	100	98	112	58
Zn (mg/kg)	20	17	23	12
Cu (mg/kg)	5	4	6.120	3.950
Pb (mg/kg)	0.014	0.013	0.016	0.021
Se (mg/kg)	0.011	0.010	0.013	0.074
Cd (mg/kg)	0.005	0.006	0.007	0.013
As(mg/kg)	0.003	0.002	0.004	0.009
V(mg/kg)	0.106	0.104	0.117	0.136
Cr(mg/kg)	0.073	0.068	0.030	0.026
Ni (mg/kg)	0.028	0.030	0.030	0.018

Compost amendments increased the soil pH, available P and exchangeable Ca and Mg one year after application compared with their soil contents before compost application. Compost raised the pH of the soil to 6.5 one year after compost application in cocoa plantation planted in 1983 (Table3). The value of soil pH under compost treatment was higher than value obtained in NPK treated soil one year after compost application (Table3). This agreed with the work done by Duruigbo et al., (2007), who reported that poultry manure increased pH of the soil. The pH is a good indicator of the quality and productivity of soils (Schoeneau, 2005). It should be considered as one of the most important factors in the control of the absorption, mobility and bioavailability of metallic elements in the soil solution (Ramos, 2005). Nitrogen contents of the soil under NPK treated plots were higher than compost treated plots one year after fertilizer application (Table 3).Under control plots, P, K, Ca and Mg contents of the soils were reduced one year after treatment application (Table3).

Table 3: Some soil chemical properties of old and young cocoa plantations after one year of fertilizer application

Chemical properties	**Treatments in old cocoa plantation**			**Treatments in young cocoa plantation**		
	CPT	NPK	CTR	CPT	NPK	CTR
pH	6.40	5.60	5.50	6.50	5.70	5.60
O.C (%)	7.97	5.30	4.01	6.95	4.66	3.03

N(g/kg)	1.90	1.69	0.96	1.5	1.2	0.84
P (mg/kg)	7.18	7.27	6.74	4.69	5.98	4.05
K(cmol/kg)	0.18	0.24	0.31	0.21	0.18	0.12
Ca(cmol/kg)	7.05	5.23	6.25	6.18	7.21	4.96
Mg(cmol/kg)	1.70	1.40	1.27	1.77	1.80	1.54

CPT= Compost, NPK=NPK20:10:10, CTR= Control without fertilizer

Under young cocoa plantation, compost application gave significantly higher dry cocoa bean yield than NPK and control plots in the first and second year of application (Table 4). Dry cocoa bean yield obtained in compost treated plot was 1640kg/ha in 2009 and increased to 1773kg/ha in 2010. The increase in dry cocoa bean yield obtained in the two plantations treated with compost was consistent during the two years of application and this might be due to slow and steady release of nutrients from the compost. NPK fertilizer also significantly enhanced dry cocoa bean yield than the control plots in the first and second year of fertilizer application. In the first year (2009), it gave dry cocoa bean yield of 1043kg/ha which reduced to 757kg/ha in the second year (27% reduction). Dry cocoa beans obtained in the control plots were 657 and 620kg/ha in the first and second year respectively. The dry bean yield under control plot was higher than the average yield obtainable in farmers' cocoa farm. The higher yield in the control plots compared to average yield of about 300-400kg/ha in most cocoa farms in Nigeria might be due to proper farm sanitation; timely weeding and pruning carried out both in the fertilized and control plots of the trial. Traditionally, most of the cocoa farmers pay little or no attention to good agricultural practice. Many of the cocoa plantations are bushy and the number of cocoa stands per hectare are grossly below the expectation (1040trees/ha). This, in no small measure contributes to reduction in dry bean yield obtainable on farmers' farms.

Table 4: Effects of Compost and NPK Fertilizer on dry cocoa bean yield in Cross River State, Nigeria

Treatments	**Young Cocoa (Planted 1983)**		**Old cocoa (Planted 1969)**	
	2009	**2010**	**2009**	**2010**
CPT	1640a	1773a	1283a	1827a
NPK	1043b	757b	1193a	943a
CTR	657c	620c	660b	690c

Conclusion

Compost and NPK fertilizers significantly enhanced dry cocoa bean yield than control in the first year of application under the old cocoa plantation. In the second year, dry cocoa bean yield in compost treated plots (1827kg/ha) was significantly higher than yield obtained in NPK treated plot (943kg/ha) and yield got under control plot (690kg/ha). Cocoa farmers can realize higher cocoa bean yield than what they presently obtain if proper attention is given to good agricultural practices on their cocoa farms.

Acknowledgement

The authors appreciate the financial support of World Cocoa Foundation through Challenge Grant to undertake the study. The Executive Director and the Management of Cocoa Research Institute of Nigeria are also acknowledged for the permission to conduct the trial.

References

Agbeniyi S.O, Ogunlade M.O and Oluyole K.A (2010): Fertilizer use and cocoa production in Cross River state, Nigeria. *ARPN Journal of Agricultural and Biological Science* 5(3):10-13.

Duruigbo, C.I.,Obiefuna, J.C. and Onweremadu, E.U (2007): Effect of poutry manure rates on soil acidity in an ultisol. *International Journal of Soil Science* 2(2): p 154-158.2007, ISSN 1816-4978. Published by Academic Journals Inc. U.S.A.

Egbe, N.E; Ayodele E.A. and Obatolu, C.R.(1989). Soils and nutrition of Cacao, Coffee, Kola, Cashew and Tea.*Progress in Tree Crop Research* pp.28-38.

Lal R. (2008a): Crop Residues as soil amendments and feedstock for bioethanol production. *Waste Management* 28:747-758

Mullet,J.(1992): A review of European Compost Standards. In: Jackson, Merillot, L' Hermite, (eds). Composting and compost quality assurance criteria.*Commission of the European Communities*331-5

Ogunlade, M.O**.,** Oluyole, K.A., Dada,A and Adeyemi, E.A.(2011). Determination of the Quantity of cocoa pod husk being generated in cocoa plantations in Nigeria. *ObecheJournal*29(1) 246-249.

Ogunlade M.O., Aikpokpodion P.O. and OluyoleK..A (2009) :An evaluation of the level of fertilizer utilization for cocoa production in Nigeria.*Journal of Human Ecology*, Vol.135 issue 3 pp175-178

Ogunlade, M.O**.**andIloyanomon,C.I.(2009);Leaf litter fall and soil nutrient status under cocoa plantation of different ages in Ibadan, Nigeria..*Nigeria Journal of Soil Science* VOl.19 (1) pp 25-28.

Omotoso, T.I. (1975). Amounts of nutrients removed from the soil in harvested Amelonado and F3 Amazon Cacao during a year. *Turrialba*25: 425-8

Ramos, M.C.(2005): Metals in vineyard soils of the penedes area(NE Spain) after compost application *J. Environ. Manage.* 72, 1-7.

Schoeneau, J. (2005). Impacts of repeated manure additions on soil fertility. In*: Proceedings of soil and crops*. University of Saskatchewan Extension Press, Saskatoon, S.K; (on CD), pp.95- 100

Walid, B.A; Noureddine G., Abdelbasset L., Gijs Du Laind, Marc,V., Naceur, J. and Tahar, G. (2009): Effects of 5-year application of municipal solid wast compost on the distribution and mobility of heavy metals in a Tunisian calcareous soil. *Agriculture, Ecosystem and Environment* 130:156-163

Wilhelm, W.W; Johnson J.M.F; Karlen, D and Lightle, D. (2007).Corn stover to sustain soil organic carbon further constraints biomass supply.*Agron. J.* 99: 1665-1667

Experimental Title : Comparative effects of NPK fertilizer, cowpea pod husk and some tree crops wastes on soil, leaf chemical properties and growth performance of cocoa (Theobroma cacao L(Adejobi, K. B and Akanbi, O.S.O)

Introduction

Cocoa is one of the most important tropical crops (FAOSTAT, 2006). West Africa contributes about 70% of the world's cocoa production. The crop significantly contributed to the economies of countries in this sub-region, as well as economics of many other countries in Central America and South East Asia. Nigeria is the fourth largest producer of cocoa in the world with an estimated production of 485,000 metric tons in 2006 (FAOSTAT, 2006). Cocoa is therefore a major commodity crop cultivated in Nigeria and is a major raw material used in the production of cocoa powder (for beverage drink), various chocolate based products, biscuits and confectioneries. Processed cocoa bean is also used to make sweets, sweetening products, cocoa butter (used in making chocolate), perfume, and in pharmaceuticals. Locally, cocoa bean is used in cooking soup that has resemblance of okra and in treating various abdominal problems or ailments (Opeke, 2005). The production of cocoa in Nigeria has witnessed a downward trend since the early 1970s due to numerous factors like ageing trees, ageing farmers, wrong application of recommended agronomic techniques by farmers, effects of pests and diseases and deficiencies in macro and micro nutrients in the soils (Adejobi et al., 2011a). Previous studies have attributed this yield decline essentially to soil nutrients imbalance (Ojeniyi et al., 1981). One way of combating this problem is the use of fertilizer. However, African farmers use very little fertilizer (8kg/ha) compared to their counterparts in other parts of the agrarian world, hence, Africa's soils are increasingly depleted of nutrients (IFDC, 2008/2009). This is particularly true with cocoa farmers in

Nigeria. Ogunlade et al. (2009) reported that more than 85% of cocoa farmers in Nigeria do not use fertilizers on cocoa. Reasons for this low usage of fertilizers vary from lack of farmers' knowledge of the nutrients status of their soils to scarcity and high cost of fertilizers where available. The need to pay attention to soil fertilization is now almost as important as the control of capsids and black-pod disease in cocoa. Ayanlaja (2002),Adejobi et al(2011 a, b, c), d and Moyin-Jesu (2008) reported the use of organic residues such as animal manures, urban refuse, agro-industrial processing wastes ,animal dungs, refuse dump compost, pit latrine compost, foot of the hill compost, mulching, passive refuse dump in home gardens and alley cropping with appropriate nitrogen fixing shrubs, have been found capable of increasing and balancing soil nutrients with consequential increase in yield and crop performance.

Objective : To examine the influence of different organic wastes on soil, leaf chemical composition and growth performance of cocoa seedlings.

Methodology

The experiment was carried out at Federal college of Agriculture, Akure between 2010 and 2011. Akure is located in the sub-humid region with distinct dry and wet seasons.

The annual rainfall ranges from 1100 to 1300mm per annum, temperature ranges between 24^0C and 30^0C, and relative humidity is about 85%.

Soil Sampling and Analysis before planting

Soil samples were randomly collected from 0-15cm depth on the site. The soils were bulked, air dried and made to pass through a 2mm sieve for chemical analysis. The soil pH (1:1 soil/water) was measured using pH meter. Organic matter was determined by the Murphy blue coloration and determined on a spectronic 20 at 882um (Murphy and Riley, 1962). Soil potassium (K), calcium (Ca) and Magnesium (Mg) were extracted with $lMNH_4$ OAC, PH_7 and were determined with flame photometer; Mg was determined with an atomic absorption spectrophotometer. The total nitrogen (N) was determined by the Microkjedahl method (AOAC, 1990).

Processing of the Organic Residues used for the Experiment

Cocoa pod husk ash (CPHA) and kola pod husk (KPH) were both obtained from cocoa and kola processing departments of Cocoa Research Institute of Nigeria (CRIN), Ibadan. Cowpea pod husk (CPH) was obtained from near-by farm in Ibadan, Oyo State while NPK15-15-15 fertilizer was obtained from Mikky Farm Limited, Akure, Ondo State. Cocoa pod husk, cowpea pod husk and kola pod husk were sun dried for 32 hours. Only cocoa pod husk was bunt to ash and allowed to cool for another 32 hours, bagged and kept in a dry place. Kola pod husk and cowpea pod husk were ground with heavy mortal, bagged and kept in a dry place.

Chemical analysis of the organic material used

Two (2) grams each of the processed forms of the organic material used were analysed for nutrient composition using the standard procedure as described by Udo and Ogunwale (1986).

Nursery experiment

Mature, disease-free and ripe cocoa pods were harvested from cacao plantation of the Cocoa Research Institute of Nigeria (CRIN). The pods were broken and the beans were hand- scooped for planting. The bulked soil taken from the site (0-15cm depth) of the experiment was sieved to remove stones and plant debris and 2.5kg of the sieved soil was placed into a polythene bag (25x13cm)

There were 5 treatments: 2.5t/ha cowpea pod husk (CPH), 2.5t/ha cocoa pod husk ash (CPHA), 2.5t/ha kola pod husk (KPH), 2.5t/ha NPK 15-15-15 and the control (no fertilizer application). Two cocoa beans were sown per polythene bag arranged in Completely Randomized Design (CRD) and later thinned to one seedling per polythene bag. The amount of the treatments were applied using spot method a month after sowing, the parameters such as plant height, number of leaves, leaf area, stem girth, and number of branches were recorded from 8 weeks to 32 weeks after planting.

At 32 weeks after planting in the nursery, the seedlings were carefully removed from the polythene bags for the measurement of shoot and root lengths, fresh shoot and root weights; then oven dried and both dry shoot and root weights were taken before they were finally analysed for N, P, K, Ca and Mg contents.

At the time of taking the shoot weight , soil samples were taken from each of the polythene bag, air dried and sieved for analysis of major elements (soil N, P, K, Ca, Mg, pH and OM) as described earlier.

Table 1: Soil physiochemical composition before planting cocoa

Soil Properties	**Values**
Physical Properties	
Sand	76.02%
Silt	16.25%
Clay	7.73%
Textural Class	Sandy loam
Chemical Properties	
Soil pH (H_2O)	5.40
Organic Matter	0.52%
Organic Carbon	0.25%
Nitrogen	0.11%
Available P	6.05mg/kg
Exchangeable Bases	
K^+	1.20cmol/kg
Ca^{2+}	1.42cmol/kg
Mg^{2+}	0.95cmol/kg
Mn^{2+}	0.89cmol/kg
Exchangeable Acidity	
Al^{3+}	1.39cmol/kg
H^+	0.12cmol/kg
ECEC	6.97

Table 2: Chemical analysis of the organic manures used for the experiment

Treatments	pH H_2O	C/N Ratio	OM %	N %	P mg/kg	K mg/kg	Mg mg/kg	Ca mg/kg	Na mg/kg
CPH	7.02	6.00	4.02	2.63	22.93	3.89	8.25	4.98	4.19
CPHA	7.20	9.50	2.00	1.02	40.21	5.31	1.08	3.60	3.06
KPH	6.99	5.60	3.21	2.68	6.51	3.29	1.09	2.66	2.61

CPH: Cowpea Pod Husk; CPHA: Cocoa Pod Husk Ash; KPH: Kola Pod Husk

Table 3: The growth parameters of cocoa seedlings between 4-24 weeks after planting under different organic fertilizer application

Treatments	Plant Height (cm)	Number of Leaves	Stem Girth (cm)	Leaf Area (cm^2)
CPH	27.81b	9.55b	2.24a	47.09b
CPHA	27.82b	10.46a	2.19a	45.91b
KPH	30.56a	11.38a	2.19a	53.64a
NPK15-15-15	27.87b	11.27a	2.16a	52.26a
Control	19.96c	6.86c	1.13b	28.96c

CPH: Cowpea Pod Husk; CPHA: Cocoa Pod Husk Ash; KPH: Kola Pod Husk

Treatment means within each column followed by the same letter are not significantly different from each other using Duncan Multiple Range Test at 5% level

Table 4: The yield parameters of cocoa seedlings under different organic fertilizer application

Treatments	Fresh Root Weight(g)	Dry Root Weight(g)	Fresh Shoot weight(g)	Dry Shoot Weight(g)
CPH	6.30a	5.60a	12.86c	10.00b
CPHA	7.30a	3.80b	14.3ab	9.00b
KPH	7.53a	3.95b	18.66a	13.13a
NPK15-15-15	6.86a	2.85b	15.90b	12.83a
Control	3.37b	2.88b	10.00c	6.33c

CPH: Cowpea Pod Husk; CPHA: Cocoa Pod Husk Ash; KPH: Kola Pod Husk

Treatment means within each column followed by the same letters are not significantly different from each other using Duncan Multiple Range Test at 5%level.

Table 5: Soil chemical analysis after the experiment under different organic fertilizer application

Treatments	SoilpH (H_2O) 1:1	Organic Carbon (g/kg)	Organic Matter (%)	N (%)	Pmg/ kg	Kmg/ kg	M mg/ kg	Ca mg/ kg	Na mg/ kg
CPH	7.05a	2.05a	3.59a	0.20b	12.66c	1.11a	2.21a	4.10a	1.13c
CPHA	7.38a	1.53b	2.15b	0.27b	40.00a	1.88a	1.98b	3.19b	1.09a
KPH	7.28a	2.78a	2.46b	0.62a	16.00c	1.31a	2.01a	3.11a	0.66b
NPK15-15-15	5.03b	1.79b	0.85d	0.99a	20.00b	1.40a	1.10b	2.93b	0.60b
Control	5.95b	1.00b	0.56d	0.11c	12.00d	1.20a	0.58c	1.42c	0.50b

CPH: Cowpea Pod Husk; CPHA: Cocoa Pod Husk Ash; KPH: Kola Pod Husk

Treatment means within each column followed by the same letters are not significantly different from each other using Duncan Multiple Range Test at 5% level

Table 6: The leaf chemical composition under different organic manure application

Treatments	N (%)	P (mg/kg)	K (mg/kg)	Ca (mg/kg)	Mg (mg/kg)	Na (mg/kg)
CPH	1.98a	1.44a	5.94b	2.08a	2.11a	2.40a
CPHA	1.48b	1.24b	7.08a	1.08b	1.91b	1.99b
KPH	1.49b	1.31b	6.01a	0.73c	2.06a	1.99b
NPK 15-15-15	1.93a	1.20b	5.48b	2.06a	1.88b	1.08b
Control	1.00c	0.27c	0.81c	0.83c	0.92c	1.00b

CPH: Cowpea Pod Husk; CPHA: Cocoa Pod Husk Ash; KPH: Kola Pod Husk

Treatment means within each column followed by the same letter are not significantly different from each other using Duncan Multiple Range Test at 5% level.

Results and Discusion

The result of the initial physico-chemical properties of the soil used for the experiment is presented in Table 1. The soil which was classified as an Affisol belonging to Akure series (Soil Survey Staff, 1999) had pH (H_2O) of 5.40, Organic matter (0.52%), Total N (0.11%), Available P (6.05mg/kg) , exchangeable K, Ca, and Mg being 1.20, 1.42 and 0.95 mole/kg respectively. The values for Organic matter, N, P, and Mg were generally low and fell below the critical level required for optimal performance of most tree crops in Nigeria (Egbe et al., 1989). With low N, P, K, Ca, Mg and Organic Matter, it is quite obvious that the soil is inherently low in fertility and therefore expected to show positive response to soil amendment. The insufficient levels of the major nutrients in the soil showed that the soil is depleted and would not be able to meet the nutritional needs of the cocoa plants unless external nutrients supply is made for the soil to be able to support optimum growth of cocoa plants.

The soil particle size distribution indicated that the overall mean sand, silt and clay contents of the soil were 76.02, 16.25 and 7.73% respectively. The clay + silt values were generally below 32% estimated to be adequate for soils considered to be ideal for tree crop production especially cocoa plant (Egbe et al., 1989)

Table 2 presented data on the nutrient composition of the organic materials used for raising the cocoa seedlings, cowpea pod husk (CPH) contained 4.02% OM, 22.93mg/kg P, 8.25mg/kg Mg, 4.91mg//kg Ca and 4.19mg/kg Na. Kola pod husk (KPH) on the other hand had 2.6%N, 3.21% OM, 6.51mg/kg P, 1.09mg/kg Mg, 2.66mg/kg Ca and 2.61mg/kg Na. On the contrary, cocoa pod husk ash (CPHA) contained 2.0% OM, 1.02% N, 4.02 mg/kg P, 5.31mg/kg K, 1.08mg/kg Mg. 3.60mg/kg Ca and 3.06mg/kg Na. Cocoa pod husk ash had high K with low N, and P. The low value of N in CPHA might be as a result of volatilization during the burning process since the carbon present in the material has been partially destroyed by burning. This is consistent with the findings of Ajayi et al. (2007a, 2007b.) Odedina et al. (2003) and Ajayi et al. (2008b) that cocoa pod ash contained N, P, K, Ca and Mg. The high pH of the organic materials especially the CPHA, is an indication that the soil used for the conduct of the experiment which is confirmed to be acidic will benefit positively from their addition, and hence moderate the acidity of the soil. This finding is in agreement with the earlier results of Ayeni et al. (2008a, 2008b) and Ajayi et al. (2007a, 2007b) that CPHA increased soil pH due to its liming effects on the soil.

The growth parameters of cocoa seedlings as influenced by different organic fertilizers application are presented in Table 3. The organic fertilizer materials positively and significantly affected the growth parameters of cocoa seedlings such as plant height, stem diameter, number of leaves per plant and leaf area relative to control. Kola pod husk produced the highest plant height , number of leaves per plant and leaf area respectively relative to control and other fertilizer materials; this was closely followed in descending order by NPK15-15-15, cocoa pod husk ash, cowpea pod husk and control (KPH > NPK15-15-15 > CPHA >CPA> control). Generally, the values of KPH with respect to these parameters were either higher or comparable to the in-organic fertilizer (NPK15-15-15) and other organic material.

Fresh and dry root weight of cocoa seedlings (Table 4) showed that NPK fertilizer and Organic materials of plant origin were comparable in their values.

However, values due to organic fertilizers of plant origin were higher compared to that of inorganic origin (NPK15-15-15 fertilizer). This might be due to presence of other vital nutrient elements presence in the organic fertilizer materials (Ca, Mg, organic carbon and other micronutrients) that are required for good seedling growth which are absent in the NPK15-15-15 fertilizer. () Similar results were obtained for both fresh and dry shoot weight of cocoa seedlings with kola pod husk having the highest shoot weight (13.13g) relative to control (6.33g). The mean weight differences recorded for KPH and NPK15-15-15 were not significantly ($p=0.05$) different from each other although the highest response was recorded with KPH. CPH and CPHA recorded similar mean values of 10.00 and 9.00g respectively for dry shoot weight while KPH was significantly ($p\geq0.05$) higher relative to other materials and control.

The effects of the treatments on the chemical properties of the soil as presented in Table 5 showed that all the organic materials and most importantly the cocoa pod husk ash increased the soil pH significantly ($p\leq0.05$) compared to NPK and control respectively. This findings is in agreement with the result of Nottidge et al. (2007) that affirmed the role of ash as a liming material and effective source of nutrients for crops such as vegetables, maize and cocoa (Ojeniyi and Adejobi, 2002; Odedina et al.,2003; Ayeni et al., 2008)

The soil N contents ranged between 0.11-0.99g/kg soil. NPK15-15-15 significantly increased soil nitrogen content relative to control. The effect of the treatments on soil N status shows the soil was significantly ($p\leq0.05$) and positively affected by all the treatments. The effect of kola pod husk on soil N was more pronounced followed by CPHA and CPH respectively. The difference between NPK15-15-15 and KPH in respect to soil was not significant (Table5). The effects of the applied organic material on soil P revealed that

CPHA gave significantly higher mean values relative to control and NPK15-15-15. This might not be unconnected to the higher P present in the material as revealed by the analysis of the materials (Table2).

Similarly, all the organic materials improved soil K, Mg, Ca, and Na respectively relative to the control. CPHA recorded the highest value of 1.88mg/kg K followed by NPK15-15-15 (1.40mg/kg). CPH recorded the least soil K value. There is no significant difference among all the treatments applied. The amount of Mg, Ca and Na were also positively influenced with organic fertilizers addition irrespective of sources. This result is consistent with the findings of Odedina et al. (2003) who reported that cocoa pod husk ash significantly increased soil OM, N, P, K, Ca and Mg respectively. Adejobi, et al. (2011) in their work on the effects of organo-mineral fertilizer and cocoa pod husk ash in the soil, leaf chemical composition and growth of coffee concluded that combined application of organo-mineral fertilizer and cocoa pod husk ash increased soil N, P, K, Ca, Mg and soil pH.

The nutrients element composition of the cocoa leaf as affected by different organic manure application is shown in Table 6. The leaf N and P composition of cocoa seedlings was either comparable or higher than the NPK15-15-15 in leaf nutrient composition. The mean values in the fertilizer treated seedlings were significantly higher compared with that of control. Similar trend as obtained in leaf N and P compositions was recorded with Ca. CPH gave a significantly higher value relative to control. The difference in values recorded for CPH and NPK15-15-15 were comparable, though CPH produced a higher value, the difference was not significant. The leaf Mg contents was higher in CPH relative to control and other applied fertilizer material. The low leaf chemical composition value noticeable with the control is a clear indication that the soil is inherently low in soil fertility and basic nutrients for cocoa seedlings. Hence, application of organic fertilizer amendments is quite necessary for enhanced production.

Conclusion and Recommendation

The use of both chemical and organic fertilisers significantly enhanced cocoa growth parameters, fresh and dry matter yield and leaf and soil chemical composition. However, addition of organic materials such as CPH, CPHA, and KPH as nutrient sources produced a promising effects on cocoa seedlings comparable to inorganic fertilizer hence, they are advised for the purpose of cocoa seedlings establishment.

References

Adejobi, K.B., Famaye, A.O., Adeniyi, D.O., Orisajo, S.B., and Adeyemi, E.A. (2011a). Effect of cocoa pod husk and goat dung on nutrient content and growth performance of cashew (*Anacardium occidentale*). *Advances in Environmental Biology. 5(7); 1536-1542*

Adejobi, K.B., Famaye, A.O., Adeniyi, D.O., Akanbi, O.S. and Orisajo, S.B. (2011b). Comparative effect of organo-mineral fertilizer and cocoa pod husk ash on the soil, leaf chemical composition and growth performance of cacao (*Theobroma cacao* L.) in South-western Nigeria. *Obeche Journal 29(1): 212-217.*

Adejobi, K. B., Famaye, A. O., Oloyede, A. A., Oyedokun, A. V., Adeniyi, D. O. and Adeosun, S. A. (2011c). Effects of organo-mineral fertilizer and cocoa pod husk ash on the soil, leaf chemical composition and growth performance of coffee in Nigeria. *Nigeria Journal of Soil Science, 21(2): 45-51pp.*

Adejobi, K. B., Adeniyi, D. O., Famaye, A. O., Adenuga, O. O. and Ayegboyin, K. O. (2011d). Evaluation of the effectiveness of goat dung manure and kola pod husk ash on nutrient composition and growth performance of coffee (*Coffea Arabica*) in Nigeria. *Journal of Applied Biosciences, 44: 2987-2993pp.*

Ajayi, C.A., M.A. awodun and S.O. Ojeniyi (2007b). Comparative effect of cocoa pod husk ash and NPK fertilizer on soil and nutrient content and growth of kola seedlings. International Journal of Soil science, 2(2): 148-153

Ajayi, C.A., M.A. Awodun and S,O. Ojeniyi (2007b). Effect of cocoa pod husk ash on growth and stem nutrient uptake of kola seedlings. Asian Journal of Agricultural Research, 1: 27-30

Ayanlaja, S.A. (2002). Soil nutrient management research on the humid forest zone of Nigeria for cocoa production between 1940 and 2000 missing gaps. 17th WCSS. Thailand Symposium No.16 paper, No.1503.

A.O.A.C. (1990) Official methods of Analysis 12th ed. Association of Official Analytical Chemistry, Washington, D.C., USA.

Ayeni, L.S., Adetunji, M.T. and Ojeniyi, S.O. (2008). Comparative Nutrient Release from cocoa pod ash, poultry manure and NPK 20:10:10 fertilizer and their combinations. Incubation Study. *Nigeria Journal of Soil Science 18, 114-123.*

Ayeni, L.S., Adetunji, M.T. and Ojeniyi, S.O.(2009). Integrated application of NPK fertilizer, cocoa pod ash and poultry manure effect on maize performance, plant and soil nutrient content. *International Journal of Pure and Applied Science 2(2), 34-41.*

FAOSTAT (2006). Food and Agricultural Organization. World Food Balance sheet. www.faostat. fao.org.

Moyin-Jesu E.I. (2008). Comparative evaluation of different organic fertilizers on the soil fertility, leaf mineral composition and growth of dike nut (*Irvingia gabonensis*). *Emirate Journal of Food and Agriculture. 20(2) 1-9.*

Murphy, J. and Riley J.P. (1962). A modified single solution method for the determination of phosphate in waters. Analytical Chemistry Act a 9: 69-82.

Ogunlade, M.O. and Iloyanomon, C. I. (2009). Leaf litter fall and soil nutrient status under cocoa plantation of different ages in Ibadan, Nigeria. *Nigeria Journal of Soil Science. Volume 19(1), pp 25- 28.*

Ojeniyi, S.O. (1981). Effect of long term NPK application on secondary and micronutrient contents of *Coffea canephora* Pierre. Plant and Soil 60:477-480

Udo, E. J. And Ogunwale, J. A. (1986). Laboratory Manual for the analysis of Soil, Plant and Water samples. 2nd edition.

Experimental Title: Efficacy of *Trichoderma asperellum* against *Phytophthora megakarya*

(Agbeniyi, S. O., Adedeji, A. R. and Adeniyi, D. O.)

Introduction

Theobroma cacao L. is one of the most important cash crops grown by farmers in Central and West Africa representing more than 59.9% of the world production. Cacao, the source of cocoa beans used to make chocolate, is a tropical, low–input, perennial tree crop grown by small scale farmers. Unfortunately, the crop suffers from a number of devastating diseases, among the most important is black pod disease caused by various species of *Phytophthora*.

Small holder production in Central and Northern South America has been devastated by frosty pod rot, and production in West Africa is threatened by the highly virulent black pod pathogen, *Phytophthora megakarya*. Diseases of cacao can account for losses of more than 30% of the potential crop and this, along with old, less productive trees has caused a steady decline in global production. Black pod, caused by various *Phytophthora* spp. is the most widely spread and destructive disease of cacao causing losses that have been estimated in recent years at 30% of pod production and up to 95% in cacao farms even in Nigeria. *Phytophthora* spp. pathogenic to cacao pods are arguably some of the most important cacao pathogen in Africa because of the annual crop losses inflicted and the costs associated with its management. Due to various reasons, black pod is difficult to control, chemical control of black pod by spraying with copper fungicide is a well established control method but not completely effective in wetter areas. In addition, fungicidal control can be expensive and polluting. So, an urgent need exists for an effective biologically based integrated approach to the management of such plant diseases. A renewed interest in biological control of plant diseases in agriculture has evolved partly as a response to public concern about the use of hazardous agrochemicals. Attempts have been made to use biocontrol agents against *Phytophthora* species, effective biocontrol microorganisms are expected to contribute to reduction in the use of chemical fungicides, and increasing farmer’s profit margins.

Until disease-tolerant cultivars are readily available and adequate extension services are provided, a low-input IPM strategy disseminated through farmer field school training is seen as a short-to-medium-term solution to the current challenges in pest management.

Objectives:

Application of *Trichoderma asperellum* in disease management, rational use of fungicides.

Inclusion of biocontrol agents (BCA) as part of the IPM strategies.

Methodology

Biocontrol agents: The biocontrol agents used was isolated from the leaves of cacao tree and natural forest reserve soils in Ibadan, Nigeria and stored in sterile distilled water on small plugs of modified potato dextrose agar. Isolate of *Trichoderma* were cultured and maintained on potato dextrose agar. Eight day old cultures of *Trichoderma* were flooded with sterile distilled water harvested by scrapping the plates gently. The obtained suspensions 50ml were then adjusted to 10^8 conidial/ml and mixed to get a 300ml solution of a 1.5% sterile cassava flour liquid suspension. The biocontrol isolate suspension was stored in a refrigerator and transported to the field.

Field Trial: The field trials were carried out at three locations (Iloro-Idanre, Owode, Khalime and Bendeghe). The experimental plots were set up in a completely randomized block experimental design with 3 replicates, in cacao fields left untreated with chemical fungicides for 5 years due abandonment but was newly re-opened, on which the pathogen pressure was well established. Five treatments (F, Tr, Tr+F, Tr+F_1 and C) where F is Funguran OH; Tr = *Trichoderma*; Tr+F = Funguran OH sprayed only once +*Trichoderma* 5 times; Tr+F1 = Funguran OH sprayed twice +*Trichoderma* 4 times; C = Sprayed with sterile water. Six applications of each treatment were made during this field trial. All treatments were applied in liquid suspension using a hand – operated sprayer and 150ml/tree was appliedin one pass over each plot.

Disease incidence ratings were taken for each tree in each plot every week after the first application till the end of the trial. Data were taken on number of pod and cherelles production, while number of damaged and *Phytophthora* pod rot were taken as total pod loss on each tree in each plot. All data collected were subjected to analysis of variance (ANOVA) while the means were separated with Duncan’s Multiple Range Test (DMRT).

Results

The output of the different treatments application of *Trichoderma* and chemical fungicide (funguran OH) in Iloro-ldanre are as shown in table 1.

Table 1: Pod production and incidence of *Phytophthora* Pod rot in Iloro-Idanre

Treatment	Pod Production	Cherelles Production	*Phytophthora* Pod rot	
			No. of Pod	% Pod rot
F	215.0b	100.0b	12	5.6
Tr	224.0a	172.0a	11	4.9
Tr+F	122.0e	51.0e	20	16.4
Tr+F1	160.0c	72.0d	22	13.8
C	153.0d	91.0c	28	18.3

Each value is the mean of 3 replicates. Means followed by the same letter in the same column are not significantly different according to DMRT (5%)

The highest pod and cherelle production of 224 and 172 respectively were observed in *Trichoderma* treatment while the least (122 and 51 respectively) was observed in a combination of *Trichoderma* and funguran treatment. However the lowest percent of *Phytophthora* pod rot incidence (4.9%) was observed in *Trichoderma* treatment whereas it was higher(16.4%) in the combination of *Trichoderma* and funguran, both of which differ significantly (P=0.05) compared to 18.3% in the untreated control (table 1). The pod productions in all the treatments differ significantly from the untreated control, likewise are the number of cherelles production in the treatments as well as the percent of *Phytophthora* pod rot incidence obtained from Iloro-Idanre (table1).

The effects of the different treatments on the control of *P. megakarya* was the primary target of this research work, which could be seen from the result in the tables of this but significant effect of *Trichoderma* could be seen in Iloro-Idanre as it influenced the pod production of the cacao tree.

In table 2, both the number of pod production and cherelles production differ significantly in all the treatments and compare to the control. However, the pod production was highest (328) in trees treated with funguran application and the least percent (6.9%) of *Phytophthora* pod incidence was recorded in the same followed by that of *Trichoderma* and funguran combination and *Trichoderma* alone respectively in Khalime. The untreated control has 473 numbers of cherelles produced and the highest percent (14.8%) of *Phytophthora* incidence in this community.

This study shows that the treatments *Trichoderma* and funguran when applied alone improved the number of pod production in Iloro-Idanre and Khalime which differ significantly from the untreated control. *Trichoderma* treatment applied in Iloro-Idanre has the highest number of pod and cherelles production with the least occurrence of *Phytophthora* spp. after applications. This shows *Trichoderma* to be effective as a bio-control agent of *P. megakarya*.

Table 2: Pod production and incidence of *Phytophthora* Pod rot in Khalime

Treatment	Pod Production	Cherelles Production	*Phytophthora* Pod rot	
			No. of Pod	% Pod rot
F	328.0a	391.0c	22	6.7
Tr	297.0b	394.0b	35	11.7
Tr+F	192.0d	333.0d	20	10.4
Tr+F1	176.0e	324.0e	24	13.6
C	256.0c	473.0a	38	14.8

Each value is the mean of 3 replicates. Means followed by the same letter in the same column are not significantly different according to DMRT (5%)

The untreated control in Bendeghe community (table 3) has the highest number of pod production (129), while the number of cherelles produced is significantly high (151) following the highest of 154 in funguran application. The least percent incidence (9.8%) of *Phytophthora* pod rot was found in a combination of *Trichoderma* and funguran followed by that of funguran (12.9%) treatment. The untreated control in this community has the highest number of pod production of 129 pods but also recorded the highest percent (17.8%) of *Phytophthora* pod incidence (table 3).

The pod production in *Trichoderma* and untreated control do not differ significantly in Owode community (table 4), though both differ significantly from other treatments. However, cherelles production of 111 cherelles was also highest in the untreated control but least in funguran treatment (37.0).

The observation of highest pod production in funguran application in Khalime community, the highest cherelles production and the least percent of *Phytophthora* in the untreated control require further experimental studies.

It could be observed in this study that the efficiency of *Trichoderma* and funguran OH treatments when applied alone and in combinations differ significantly from one community to the other when compared to the untreated control. This however could be linked to the climatic and ecological diversity of the communities as the applications were done at the same period.

Table 3: Pod production and incidence of *Phytophthora* Pod rot in Bendeghe

Treatment	Pod Production	Cherelles Production	*Phytophthora* Pod rot	
			No. of Pod	% of Pod
F	77.0d	154.0a	10	12.9
Tr	72.0e	124.0d	12	16.7
Tr+F	102.0b	52.0e	10	9.8

Tr+F1	98.0c	128.0c	14	14.3
C	129.0a	151.0b	23	17.8

Each value is the mean of 3 replicates. Means followed by the same letter in the same column are not significantly different according to DMRT (5%)

Whereas, the percents incidence of *Phytophthora* (23.8%) was least in the funguran treatment which differ significantly from the untreated control which has (72.1%) the highest *Phytophthora* incidence (table 4).

Table 4: Pod production and incidence of *Phytophthora* Pod rot in Owode

Treatment	Pod Production	Cherelles Production	*Phytophthora* Pod rot No. of Pod	% of Pod
F	63.0b	37.0d	15	23.8
Tr	68.0a	99.0b	26	38.2
Tr+F	43.0d	41.0c	13	30.2
Tr+F1	55.0c	44.0c	20	36.4
C	68.0a	111.0a	49	72.1

Each value is the mean of 3 replicates. Means followed by the same letter in the same column are not significantly different according to DMRT (5%)

The results also show diversity in the pod production and reduction of *Phytophthora* pod rot under different treatments. Except in Iloro-Idanre, the treatment with the highest number of pod production does not have the least incidence of *Phytophthora* pod rot.

Conclusion and Recommendation

There is need to investigate the integrated pest management (IPM) strategies including biocontrol, rational use of chemicals and technology transfer. Also, the integration of botanicals into the IPM for black pod disease needs to be investigated.

Experimental Title: Evaluation of plant residue ash fortified with NPK on the growth and dry matter yield of Cocoa seedlings.(Akanbi, O. S. **O**.; Ipinmoroti, R. R.; Ibiremo,S. O.; Ojeniyi, S.O and Adejobi, K. B).

Introduction:

The production of cocoa in Nigeria has been bedeviled by years of neglect due to crude oil discovery and exploration, ageing cocoa plantations, nonuse of fertilizer, and to a larger extent, soil fertility depletion due to years of continuous nutrients removal through harvesting without replenishment.

Organic amendments such as compost, farm yard manure, ash of plant residues have been identified to contain both micro and macro nutrients (Ayeni *et al*., 2008a and Odedina, *et al.*, 2003) that could support optimal and sustainable cocoa production. Sobulo and Jayeola,(1977) reported that organic amendment incorporation greatly improved soil texture, structure and makes the soil more friable, warmer, more moisture retentive and more congenial to plants.

Studies showed that combined application of organic manure and mineral fertilizers resulted to superior effect in balanced plant nutrition and improved soil fertility (Ayeni, 2008). Study into use of Cocoa pod husk ash alone or in combination with mineral fertilizer is scarce. Cocoa pod husk ash has been found to increase growth and nutrient uptake of Kola seedlings and soil N, P, K, Ca, and Mg contents compared to NPK fertilizer (Ajayi *et al*.2007a and 2007b). Animal manure amended husk significantly increased the growth and yield of tomato by 397% (Ojeniyi *et al*.,2002).

Objective: The objective of this study is to evaluate effect of cocoa pod husk and oil palm bunch ash amended with NPK fertilizer on the growth and dry matter yield of cocoa seedlings.

Materials and Methods

Greenhouse Trial:

The study was carried out at Cocoa Research Institute of Nigeria, Ibadan (CRIN) during the seedling production season in 2011 to evaluate sole and combined effects of NPK fertilizer and ash from cocoa pod husk and oil palm bunch. Top soil (0 – 20cm depth) was collected at the old moribund cocoa plantations at Ibadan and was air dried, crushed and allowed to pass through a 2mm sieve. A representative sample was collected from the sieved soil for routine laboratory soil analysis.

Particles size distribution was determined by hydrometer method (Udo and Ogunwale, 1986) using sodium hexa-metaphosphate as the dispersing agent. Soil pH was determined potentiometrically in distilled water to soil ratio 1:1. Exchangeable bases (K, Na and Mg) were extracted with neutral normal NH_40Ac. Potassium and Na in the extract were determined by flame photometry while Ca and Mg were read by atomic absorption spectro photometer. Exchangeable acidity was determined by titration of normal Kcl extract against 0.05 Sodium -hydroxide to a pink end point using phenolphthalein as indicator. Available P was determined by using the Bray 1 method. Total N was determined by regular micro- kjedahl method while the organic matter was determined using the wet oxidation method. The cocoa pod husk (CPH) and oil palm bunch (OPB) used for the experiment were sourced from CRIN Cocoa and Oil palm processing units respectively. The CPH and OPB were dried in the sun, ashed and analyzed by the standard procedures for following characteristics: N, P, K, Ca, Mg, and Na respectively.

The experiment consisted of six treatments namely: Cocoa pod husk ash, Oil palm bunch ash (both applied sole), Cocoa pod husk ash plus NPK fertilizer (CPA+ NPK), Oil palm bunch ash plus NPK fertilizer (OPA+ NPK), NPK 20:10:10 (applied sole) and control (no application).Treatments were laid out in a completely randomized design (CRD) in three replications. Two healthy cocoa beans were sown per pot of 5kg soil and later thinned to one seedling three weeks after sprouting. Equivalent quantity of the fertilizer materials were introduced into each of the eight pots in a ring form four weeks after sowing. Agronomic parameters such as seedling height (cm), stem diameter (cm), number of leaves per plant and leaf area (cm^2) were monitored monthly for six months. Seedlings were carefully uprooted six months after treatments application; root washed and separated into leaf, stem and root respectively. The dry matter yield of each of the cocoa plant was determined after drying in the oven to a constant weight at 105^0C for 72 hours. Root to shoot ratio was also determined. Data were subjected to analysis of variance and means separated using Duncan Multiple Range Test (DMRT) at 5% level of significance.

Results and discussion

The properties of the soil used in the greenhouse are shown in Table1. The critical soil nutrients contents recommended for optimum production of cocoa in Nigeria are: Organic matter (OM) -30gkg-^{1} , total nitrogen (N) – 1.0gkg-^{1}, available phosphorus (P) - 5.5gkg^{-1}, exchangeable K – 1.2gkg^{-1}, Ca – 8.0cmolkg^{-1}, and Mg – 0.8cmolkg^{-1} respectively (Egbe et al., 1989).

Table 1: Pre – soil physico - chemical properties

Soil properties	Soil nutrient values		Soil critical values
pH (1:1 soil to water)	6.47		-
N (gkg^{-1})	0.8		1.0
P (gkg^{-1})	4.2		5.5
K (gkg^{-1})	0.2		1.2
Ca (cmolkg^{-1})	4.3		8.0
Mg (cmolkg^{-1})	0.7		0.8
Na (cmolkg^{-1})	0.1		-
OM (gkg^{-1})	10.3		30.0
Sand gkg^{-1}	650.0		
Silt gkg^{-1}	152.0	**TC =**	Sandy clay loam
Clay gkg^{-1}	166.0		

N: nitrogen; P = phosphorus; K = potassium; Ca = calcium; Mg = magnesium; Na = sodium; TC = textural class; C/ N = carbon to nitrogen ratio.

Comparison of the nutrients concentrations in the test with critical values, the test soil was low in OM (10.3gkg^{-1}), N (0.8gkg^{-1}), P (4.5gkg^{-1}), K (0.2gkg^{-1}), Ca (4.3cmolkg^{-1}) and Mg (0.7cmolkg^{-1}) respectively and generally low in fertility. However, the clay + silt content of 318gkg-1soil are sufficient to hold enough water for optimal cocoa growth and to guard against short duration of drought (Egbe et al., 1989). The low nutrient status of the soil is an indication that the soil could not be cropped for long without fertilizer application. The low organic matter, N, P, K and Mg is typical of upland soil in the tropics particularly Alfisols (Sanchez and Logan, 1992). The low organic matter may be due to the effect of high temperature and relative humidity which facilitate rapid mineralization of organic matter.

Table 2 presents data on nutrients composition of cocoa pod husk ash (CPA) and oil palm bunch ash (OPA). The CPA had pH (H_2O) of 7.51, 0.91gkg^{-1}N, 0.51gkg^{-1}P, 4.3gkg^{-1}K, 0.82cmol^{-1}Ca, 0.31cmolkg^{-1}Mg, 3.02cmol^{-1}Na and 2.0gkg^{-1}OC. The OPA on the other hand, had pH(H_2O) of 8.3, 0.23gkg^{-1} N, 0.17gkg^{-1} P, 26.3gkg^{-1}K, 6.93cmol^{-1} Ca, 3.11cmolkg^{-1} Mg, and 1.74gkg^{-1}OC respectively.

Table 2: Nutrients composition of the test organic materials

Organic materials	**pH(H_2O)**	**N (gkg^{-1})**	**P (gkg^{-1})**	**K (gkg^{-1})**	**Ca (cmolkg^{-1})**	**Mg (cmolkg^{-1})**	**Na (cmolkg^{-1})**	**OC (gkg^{-1})**
CPA	7.51	0.91	0.51	4.31	0.82	0.31	3.02	2 .03
OPA	8.30	0.23	0.17	26.3	6.93	3.11	2.27	1.74

CPA – cocoa pod husk ash; OPA – oil palm bunch ash

The OPA was higher in K, Ca and Mg relative to CPA while cocoa pod husk ash was found to be higher in N, P and OC contents. Addition of both OPA and CPA to the soil is expected to increase the pH of the soil and remediate its slightly acidic nature of the soil due to the alkaline nature of the ash materials.

The influence of the fertilizer materials on the growth parameters of cocoa seedlings at Six (6) months after treatment application is shown in Tables 3. The materials significantly ($p < 0.05$) increased all the growth parameters (plant height, stem diameter, number of leaves per plant and leaf area) considered. The cocoa seedlings amended with either CPA + NPK (50:50) or OPA + NPK (50:50) increased height by 59.3 and 48.3%, and stem diameter by 18 and 6% and number of leaves per plant by 28.8 and 23.4% respectively relative to sole application and control.

Table 3: Effects of sole and combined use of NPK, CPA and OPA on growth parameters of cocoa seedlings at 6 months after application

Treatments	**Plant-height (cm)**	**Stem-diameter (cm)**	**Number-of leaves**	**Leaf area (cm^2)**	**Root-length (cm)**
CPA (Sole application)	69.15d	1.39b	42.33c	304.89d	50.10b
OPA (Sole application)	66.25e	1.40b	41.67d	301.81e	43.78c
CPA + NPK 20:10: 10 (50: 50)	**85.67a**	**1.51a**	**45.33a**	**340.07a**	**58.68a**
OPA + NPK 20:10:10 (50:50)	80.23b	1.33d	44.33b	320.37b	43.68c
NPK 20:10:10 (Sole application)	73.60c	**1.57a**	39.67e	313.24c	38.67d
CONTROL	60.13f	1.36c	35.33f	257.24f	36.40e

CPA = cocoa pod husk ash; OPA = oil palm bunch ash; NPK = nitrogen, phosphorus, potassium.

Leaf area was increased by 45.3 and 39.5% relative to sole application of either CPA or OPA which recorded 34 and 23.8% increase on plant height, 5 and 4% on stem diameter, 20.6 and 23.4% on number of leaves per plant, 10.2 and 11.4% on leaf area respectively.

Combined application of the organic and inorganic fertilizer materials gave better effect than their sole application or sole application of mineral (NPK) fertilizer. This is attributable to the combined beneficial effects of organic materials (ash) and NPK fertilizer which enhanced mineralization of organic nutrients and availability of more nutrients. Ojeniyi, (2000), Ojeniyi and Adejobi, (2002) and Adeniyan and Ojeniyi,(2005) had reported higher crop performance due to integrated application of organic manure and mineral fertilizers. Similarly, in the present work combined application of CPA + NPK (50: 50) recorded the highest treatment effects on all the growth parameters of cocoa seedlings relative to the other treatments.
The dry matter yield and shoot to root ratio as influenced by sole and combined application of NPK, CPA and OPA at six (6) months after treatments addition are presented in Table 4. The organic materials and NPK significantly ($p< 0.05$) increased leaf, stem and dry matter yield. OPA+NPK (50: 50) gave the highest shoot to root ratio and dry matter yield unlike the case of growth parameters where CPA+NPK (50: 50) produced the highest growth variables.

Table 4: Dry matter yield (DMY) as influenced by sole and combined application of NPK, CPA and OPA at six (6) months after treatments application

Treatments	**Root to shoot ratio**	**Leaf-dry weight (g)**	**Stem-dry weight (g)**	**Root dry weight (g)**
CPA (Sole application)	3.75a	18.63c	12.30d	8.33d
OPA (Sole application)	3.81a	18.87b	12.37d	8.36c
CPA + NPK 20:10: 10 (50: 50)	3.70a	19.10b	13.37b	8.67b
OPA + NPK 20:10:10 (50:50)	**3.84a**	**21.40a**	**13.97a**	**9.57a**
NPK 20:10:10 (Sole application)	3.61a	18.17d	12.80c	8.65b
CONTROL	2.62b	12.51e	8.10e	7.87e

CPA = cocoa pod husk ash; OPA = oil palm bunch ash; NPK = nitrogen, phosphorus, potassium.

The increases experienced in shoot to root ratio were not significant ($p< 0.05$) among the fertilizer materials but were significantly higher than the control. The increases observed in the dry matter yield of the cocoa plant could be attributed to slow but steady release of nutrients contained in the materials (OPA and CPA) over a longer period due to their relatively high C: N ratio compared to NPK with a faster rate of nutrients release. Generally, the influence of organic materials on the growth parameters and dry matter yield of cocoa seedlings were either higher or comparable to NPK fertilizer. This observation is consistent with the earlier results of Akanbi *et al.*, (2012) who reported an increase in coffee seedling growth and dry matter yield using CPHA and Urea fertilizer.

Conclusion: Ash of plant origin (such as those of cocoa pod husk and oil palm bunch ash contain varying concentration of Ca and Mg in addition to N, P and K which are the only major nutrients in the NPK fertilizers. In this work, the presence of major and secondary nutrients in the above named types of ash led to increased growth of cocoa seedlings. Combined application of CPA and OPA with reduced level of NPK 20:10:10 was found more effective than sole application of ash and NPK 20: 10: 10. This approach can be recommended to cocoa farmers.

References

1. Adeniyan, O. N. and S. O. Ojeniyi (2005). Effects of poultry manure, NPK 15: 15: 15 and combination of their reduced levels on maize growth and soil chemical properties. Nigerian Journal of Soil science society. 15: 34 – 41.
2. Akanbi, O. S. O., Ojeniyi, S. O., Ipinmoroti, R. R., Ibiremo, S. O., Famaye, A.O., Oloyede, A. A., Aderolu, I. A and Orisasona, T. M. (2012). Utilisation of ashed cocoa pod husk and Urea fertilizer on

the growth and dry matter yield on coffee on Alfisol in Ibadan. A paper presented at the 36th Annual conference of Soil society of Nigeria held at University of Nigeria, Nsukka, between 12th to 16th March, 2012

3. Ayeni, L. S. Ayeni, O. M., OSO, O. P and Ojeniyi, S. O. (2008a). Effects of Sawdust and wood ash applications in improving soil chemical properties and growth of cocoa (Theobroma cacao) seedlings in the nurseries. Medwell Agricultural Journal 3(5), 323-326.
4. Egbe, N. E.,Ayodele, E.A. and Obatolu, C. R. 1989: Soils and nutrition of Cocoa, Coffee, Cashew, Kola and Tea. Progress in Tree Crop Research. Pp 28- 38
5. Odedina, S. A., Odedina, J.N., Ayeni, S., Arowojolu, S.A.,Adeyeye, S.D and Ojeniyi, S. O.(2003). Effect of types of ash on soil fertility, nutrient availability and yield of tomato and pepper. Nigerian Journal of Soil Science. 13: 66 – 67.
6. Ojeniyi, S. O. and K.B. Adejobi (2002). Effect of ash and goat manure on Nutrient composition, growth and yield of Amaranthus. Nigeria Agricultural Journal 33. 46 -57.
7. Ojeniyi, S.O. (2000). Effects of goat manure on soil nutrients content and Okra yield in rain forest area of Nigeria. Applied Tropical Agriculture 50; 20-23.
8. Sanchez, PA and Logan, T. J. (1992). Myths and science about the chemistry and fertility of soils in the tropics. Soil sci. soc. of American society of Agronomy. 667. Sedge Rd. Maidson. Wis 5371, USA. SSA. Specia publication, No. 29, pp 35- 45.
9. Sobulo, R. A. and Jayeola, E. K. (1977). Influence of organic matter on plant Nutrition in Western Nigeria. Ecprint, 'Soil organic matter studies'. Intern. Atomic Energy. Vienna. Pp. 105 -115.
10. Udo, E. I. and Ogunwale, J.A. (1986). Laboratory Manual for the analysis of soil, plant and water samples. 2nd edition.

Experimental Title: Control of major field insect pest of cocoa, *Sahlbergella singularis* using crude botanical extracts.(Oyedokun, A.V., Otuonye, H.A, Aikpokpodion and Aderolu, I.A.)

Introduction

Over the years, the use of synthetic insecticides in control and management of insects especially mirids on cocoa plantations has been the most-readily available option that is very effective. However, the attendant aftermath effects of these synthetic insecticides on the crops produced and the environmental equilibrium being altered by these xenobiotics have created more problems than it solved. The nature itself has provided some controlling factors to regulate the population insurgence of insect pests but these natural controlling agents like predators, parasitoids have been extinct by incessant use of synthetic insecticides. The short and long term effects of pesticides on cocoa farmers, traders and consumers of cocoa products are enormous in terms of health risks and economic downturn. Hence, there is dire need to revisit nature in solving insect pests' problems via the use of secondary metabolites that abound in different species of higher plants. Production trend of cocoa, Theobroma cacao L. in Nigeria had been on decline since the mid 80s till 2002, due to the negative effects of some biotic and abiotic factors as well issues bothering round quality parameters. Mirids (especially *Sahlbergella singularis*) and other insect pests have been major limiting factor in cocoa production in terms of quantity and quality. The population build-up of insect pests over time and their control using insecticides have a multiplier effect on quality of cocoa beans in terms of pesticides residue. Hence, this study sought to evaluate the contact toxicity potency and repellent potentials of crude extracts of some selected bioactive plant materials against *Sahlbergella singularisin vitro* and *in vivo* as well as isolating the active insecticidal compounds in the plant extracts.

Objective:

i. To evaluate the contact toxicity potency of crude extracts of some selected bioactive plant materials against *Sahlbergella singularis*

Location of the study:

This study was carried out in the Entomology Laboratory of the Cocoa Research Institute of Nigeria, Ibadan at a temperature of 28 ± 3^0C and relative humidity of $75 \pm 5\%$. The field collection of mirid samples were carried out at

CFC Plot, CRIN and the culture was maintained in the laboratory at controlled temperature of 22-24°C during the day for 24hrs before use.

Collection of Materials

Fresh plant materials (*Distemonanthus benthamianus*- bark, *Newbouldia laevis*- leaves *and Zingiber officinale*- seeds) were collected from different locations (Ibadan, Osogbo and Ilorin) and were brought to the Entomology Laboratory at CRIN, Ibadan. The collected plant samples were rinsed in clean water and were allowed to drain separately on a 3mm diameter wire mesh except for Zingiber seeds that was ground directly. The samples were then spread on the sterilized laboratory tables where it was air-dried for 2 weeks. The air-dried samples were ground separately using mortar and pestle. The ground samples were divided into three equal parts and from one part. Aqueous extracts were prepared and from another part ethanolic extracts were prepared.

Extract preparation.

The plant extracts were prepared as described by Adedire and Akinneye, 2003 with some modifications (Oyedokun *et al*., 2012). Aqueous extracts were prepared by weighing 200g of ground plant parts of each plant material into 200ml of distilled water with which the stock solution of each extract was prepared. These mixtures were allowed to stay for 24 hours, heated at 60°C for 45 minutes in a water bath, later shaken thoroughly and sifted through a muslin cloth. The filtrates were the stock solution that were serially diluted (water: extract) into different concentrations 1-8v/v: 12.5%, 1-4v/v: 25%, 1-2v/v: 50%, and 3-4v/v: 75%. Another extract was prepared using 200ml of ethanol (96%) as the solvent for 200g each of the ground plant parts following the extraction and dilution methods of the aqueous extract described above. The ethanolic extract was serially-diluted with distilled water at the same rate as described above.

Bioassay of the extracts

The topical application test was carried out on the workers of *S. singularis* using different concentrations (12.5% v/v, 25% v/v, 50% v/v and 75% v/v) of the aqueous and ethanolic extracts to evaluate the contact action and toxicity ratings of the plant extracts used in this study. The control was water and 50% alcohol while the standard was Actara 4G WP (a.i. Thiamethoxam) at the rate of 4g insecticide/litre of water. The sterile Petri dishes (90mm diameter) were lined with white filter papers to fit and the lids of the Petri dishes were perforated to allow for aeration. Four mirids (4 nymphs and adults) were picked randomly into each Petri dish from the collection and/or culture cages with soft camel hair brush. There were four treatments, two controls and a standard (Thiamethoxam) at 4g insecticide/1itre of water. 1µL of each aqueous and ethanolic extract concentrations (12.5% v/v, 25% v/v, 50% v/v and 75% v/v) was applied on the dorsal surface of each mirid in each Petri dish using sterilized micro-syringe. Each treatment was replicated four times. Mortality counts were recorded after every 30 minutes for 150 minutes to determine the contact action of the extracts on *S. singularis* nymphs and adults. A mirid was considered dead when it was lying flat on its back and showing no sign of movement of its body after being touched with soft, moist camel hair brush.

Statistical Analysis

The data obtained from all the bioassays were converted to percentage and were subsequently subjected to analysis of variance and the means were separated using Tukey's Studentized Range (HSD) Test of SPSS 17.0 Version.

Results and discussion

The mean mortality rates (MMR) of aqueous extract of *D. benthamianus* on the nymph and adults of *S. singularis* following topical application test are shown in Table 1. The mortality trend during 150 minutes of exposure was progressive from 30 to 150 minutes exposure time. There were significant differences ($P < 0.05$) among the insecticidal activities of aqueous extracts of *D. benthamianus* at concentrations 12.5%v/v, 25%v/v, 50% v/v, and 75% v/v resulting in 36,56, 64 and 72 percent mean mortalities respectively, this followed a progressive trend with increase in concentration of the extract and this trend is similar in other extracts with varied concentrations resulting in percentage mean mortalities of S. singularis nymph and adults that were significantly different ($P < 0.05$) from each other, the control and the standard (Table 1). The standard insecticide (Thiamethoxam at 4g/L) significantly differed ($P < 0.05$) from all the treatments' percentage mean mortalities and the control resulting in 100% and 0% mean mortality of *S. singularis* afterthe maximum period of exposure (150 minutes) respectively. Percentage mean mortalities of *S. singularis* that resulted from the contact toxicity action of aqueous extract of *N. leavis* at 12.5% v/v concentration was significantly lower ($P<0.05$) than other aqueous extract of *D. benthamianus and Z. officinale* at the same concentration. Aqueous extract of *Z. officinale's* performance *at 12.5%v/v* was not significantly different *(P<0.05)* from the performance of *N. leavis* at 75% v/vconcentration. Likewise, percentage mean mortality of *S. singularis* exposed to 25%v/v aqueous extract of *Z. officinale* and 50%v/v aqueous extract of *D. benthamianus* were not significantly different (P<0.05) from each other. Of all aqueous extracts of the plant samples used, *Z .officinale* at 75%v/v concentration outperformed other extracts by causing 84% mortality of *S. singularis* at the maximum exposure period of 150 minutes, indicating that aqueous extract of *Z. officinale* contains more insecticidal compounds that can break the cuticle of the test insect sample to cause mortality of the insect may be through penetration into the parasympathetic gap in the nervous system of the test insect sample to cause knock down effects and eventually kill the insect. Table 2 shows the percentage mean mortality of *S. singularis* treated with different concentrations of *D. benthamianus, N. leavis,* and *Z. officinale* after the maximum period of contact exposure to the extracts. Ethanolic extract of *D. benthamianus* at concentrations 12.5% v/v, 25% v/v, 50% v/v, and 75% v/v resulted in mean mortalities of 56%, 64%, 84%, and 84% respectively while the ethanolic extracts of *N. leavis* resulted in 48%, 48%, 52% and 60% mortality of the adult and nymph of S. singularis after the maximum exposure period of 150 minutes at respective concentrations of 12.5% v/v, 25% v/v, 50% v/v, and 75% v/v. Ethanolic extract of *Z. officinale* at 75% concentrationgave an 100% kill of the test insect samples at 150 minutes after exposure and this out-performed other ethanolic extracts and it compared favourably with the standard insecticide that gave 100% kill of the test insect samples at the same exposure period. At varied concentrations (12.5%v/v, 25%v/v, 50%v/v and 75%v/v), all ethanolic extracts of *D. benthamianus, N. leavis and Z. officinale* had better kill of the test insect samples within the same exposure period to the extracts, indicating that ethanol either extracts the biocidal components of plant materials better or have some potentiation or synergistic effects in killing the killing insect sample. This was also demonstrated in the control for ethanolic extracts in which 50% ethanol was used which gave about 12% percentage mean mortality of the test insect samples after the maximum exposure period of 150 minutes. All the plant extracts at different concentrations were significantly different (P < 0.05) from control and the standard (Thiamethoxam) except 75%v/v concentration of *Z. officinale*. Table 3 showed that toxicity ratings of the extracts ranged between low in 12.5% v/v aqueous extract of *N. leavis* and very high in 75% v/v ethanolic extract of *Z. officinale*. Generally, aqueous extract of *N. leavis* rated moderately low while the ethanolic extract *Z. officinale* rated either high or very high. This study conclusively showed that ethanolic extracts of the *Z. officinale* and *D. benthamianus* have the potentials of being used as a bio-rational biopesticide on the test insect sample at higher concentrations in the field to have optimum result in control and management of the insect. This work needs to be furthered in the area of isolation and characterisation of the active compounds and/or ingredients in the used plant materials with a view to synthesize the prototyped analogues that will be readily available to farmers at cheaper cost.

Table 1: Percentage mean mortality rate of *S. singularis* after 150 minutes of exposure to aqueous extracts of different bioactive plant materials at different concentrations.

Plant Extract	Concentration %(v/v)	% Mean Mortality
D. benthamianus (aq.)	12.5	36.00±1.56^{bc}
N. leavis (aq.)	12.5	24.00 ±1.06^{b}
Z. officinale (aq.)	12.5	52.20 ±1.24^{cd}
D. benthamianus (aq.)	25.0	56.00 ±2.00^{cde}
N. leavis (aq.)	25.0	36.00 ±0.63^{bc}
Z. officinale (aq.)	25.0	64.00 ±0.89^{e}
D. benthamianus (aq.)	50.0	64.00 ±2.19^{e}
N. leavis (aq.)	50.0	40.00 ±0.69^{c}
Z. officinale (aq.)	50.0	72.00 ±1.57^{ef}
D. benthamianus (aq.)	75.0	72.00±2.04^{ef}

N. leavis (aq.)	75.0	52.00±1.94[cd]
Z. officinale (aq.)	75.0	84.00 ±2.80f[g]
Control (water)	Nil	0.00 ±0.00[a]
Standard (Thiamethoxam)	4g/L	100.00±1.04[g]

Mean values with the same letter in a column are not significantly different ($P<0.05$) following Tukey's Studentized HSD range

Table 2: Percentage mean mortality rate of *S. singularis* after 150 minutes of exposure to ethanolic extracts of different bioactive plant materials at different concentrations.

Plant Extract	Concentration %(v/v)	% Mean Mortality
D. benthamianus (aq.)	12.5	56.00±1.60[c]
N. leavis (aq.)	12.5	48.00 ±2.01[b]
Z. officinale (aq.)	12.5	64.00 ±0.16[cd]
D. benthamianus (aq.)	25.0	64.00 ±1.42[cd]
N. leavis (aq.)	25.0	48.00 ±1.50[b]
Z. officinale (aq.)	25.0	72.00 ±0.25[d]
D. benthamianus (aq.)	50.0	84.00 ±1.65[e]
N. leavis (aq.)	50.0	52.00 ±1.22[c]
Z. officinale (aq.)	50.0	94.00 ±1.90[ef]
D. benthamianus (aq.)	75.0	88.00±1.64[ef]
N. leavis (aq.)	75.0	58.00±1.42[c]
Z. officinale (aq.)	75.0	100.00 ±1.75[f]
Control (ethanol)	50.0	12.00 ±1.710[a]
Standard (Thiamethoxam)	4g/L	100.00±1.64[f]

Mean values with the same letter in a column are not significantly different ($P<0.05$) following Tukey's Studentized HSD range

Table 3: Toxicity rating of the plant extracts used based on percentage mortality after maximum exposure period (150minutes) of *S. singularis* to the extracts.

Plant	**Extract**	**% Mortality**	**Toxicity class**
Distemonanthus bethamianus	12.5% aqueous	36	moderately low
	25% aqueous	56	moderate
	50% aqueous	64	moderately high
	75% aqueous	72	high
	12.5% ethanolic	56	moderate
	25% ethanolic	64	moderately high

	50% ethanolic	84	very high
	75% ethanolic	88	very high
Newbouldia leavis	12.5% aqueous	24	low
	25% aqueous	36	moderately low
	50% aqueous	40	moderately low
	75% aqueous	52	moderate
	12.5% ethanolic	48	moderate
	25% ethanolic	48	moderate
	50% ethanolic	52	moderate
	75% ethanolic	60	moderate
Zingiber officinale	12.5% aqueous	52	moderate
	25% aqueous	64	moderately high
	50% aqueous	72	high
	75% aqueous	84	very high
	12.5% ethanolic	64	moderately high
	25% ethanolic	72	high
	50% ethanolic	94	very high
	75% ethanolic	100	very high

Toxicity rating was adapted from Areekul et al.,1987.

References

Adedire, C.O. and J.O .Akinneye. 2003. Biological activity of tree marigold, *Tithonia diversifolia* on cowpea seed bruchids, *Callosobruchus maculatus* (Coleoptera: Bruchidae). Annals of Applied Biology, 144: 185 – 189

Areekul, S., Sinchaisri, P. and Tigvatananon, S. 1987. Effects of Thai plant extracts on the oriental fruit fly-toxicity test. Kasetsart Journal of Natural Science, 21 (4), 395 - 407

Oyedokun, A.V., Anikwe, J.C., Okelana, F.A., Mokwunye, I.U. and O.M. Azeez. 2011. Pesticidal efficacy of three tropical herbal plants' leaf extracts against *Macrotermes bellicocus*, an emerging pest of cocoa, *Theobroma cacao*. Journal of Biopesticides, 4(2): 131 - 137

Experimental Title: Remediation potential of sokoto rock phosphate in heavy- metal contaminated cocoa soil in nigeria (Aikpokpodion Paul E)

Introduction

As human activity impacts the environment, metal contamination issues are becoming increasingly common (Fernandes and Herriques, 1991). Metals are a natural part of terrestrial system and occur in soil, rock, air, water and organisms. Afew metals inmcluding Cu, Mn and Zn are required by plants in trace amount. It is only when metals are present in bioavailable forms at excessive levels that they have the potential to become toxic to plants. Part of the sources of metals in agricultural soils is use of fertilizers, sewage sludge and animal wastes used as fertilizers, pesticides and irrigation water (Reddy *et al*., 1995). Many cocoa soils in Nigeria have accumulated copper in them due to long term application of Cu-based fungicide in the control of the black pod disease of cocoa (Aikpokpodion et al., 2010; Aikpokpodion, 2010). Copper being a metal is not biodegradable by soil microorganisms which is the main reason why it accumulates in soil. The build-up of copper in soil can lead to its undue absorption and translocation to various vegetative parts of the tree including the beans which is the economic part of the crop. In order to keep the level of copper residue in cocoa beans within the acceptable limit set by the European Union, it became necessary to apply in situ remediation technique which will not involve excavation of soil before treatment.

Objectives

The study was carried out to evaluate the potential of Sokoto rock phosphate in the remediation of heavy metal-contaminated soils.

Methodology

Surface soil (0-30cm in depth) contaminated with copper was collected with soil auger in a cocoa plantation in Owena, South-Western part of Nigerian. The farm has the history of twenty five years of continuous application of copper fungicide. The soil samples were air-dried and then ground and passed through 2mm sieve prior the introduction of Sokoto rock phosphate. Chemical analysis of the soil sample used for the study was also carried out.

Treatments

Sokoto rock phosphate (36% P) was purchased from Glamour Nigeria Limited, Ibadan, Nigeria. The pulverized rock phosphate was sieved through 266μm before application. The rock phosphate material contained 2.5mg/kg cadmium. For pot experiment, 20g, 40g and 60g rock phosphate were mixed with the soil sample. There were four treatments including the control pot in which no rock phosphate was added. Rock phosphate application rate was based on the specific P/total metal molar ratio. Total metals, for the purpose of the immobilization treatments in this study, were defined as the sum total of Cu, Pb, Zn and Cd which was determined by Atomic Absorption Spectrophotometer. This application rate was chosen with the intent to immobilize the total concentrations of the main four metal specie of interest in the studied soil. In related work, authors have used the ratio of 3/5 P/M total as the basis of hydroxyapatite and apatite treatments to Pb-contaminated soils (Laperche et al., 1997; Qiao et al., 2003; Ryan et al., 2001 and Zhang and Ryan, 1991). This ratio corresponds to the P/Pb ratio for chloropyromorphite [$Pb_5(PO_4)_3Cl$]. However, due to the solubility of rock phos[hate in soils, since the total P may not react with insoluble Pb, higher P/Pb molar ratios (up to 11.2) have been suggested by Zhang and Ryan, (1999); Basta and Gradwohl, (2001) and Hettiarachchi and Pierzynski (2002)

Pot Experiments

Two and half kilogram of the treated and untreated soil samples were packed into each polypropylene pot. Four treatments were: a control with no rock phosphate amendment, amendment with 20g RP, 40g RP and 60g RP. The treatments were kept moist and incubated for one month before the sowing of cocoa beans. This was done to allow the solubilization of rock phosphate in soil solution in order to make the phosphate active in the stabilization of the heavy metals in soil. The seedlings were allowed to grow for six months after which the experiment was terminated. At termination the plant was removed from the pot and washed with distilled water, sun-dried and kept in oven for 4 hours at 60^{o}C. The leaves, stem and roots were pulverized and digested with $HCl/HNO_3/HClO_4$(3:2:1, v/v/v) and the concentration of Cu, Pb, Zn and Cd were determined. But for this report Cd is not included.

Metal speciation

After the removal of cocoa seedlings from the rock phosphate treated soils, some portion of the remaining soil samples in the various pots were air-dried and sieved with 2mm sieve prior to sequential extraction of Cu, Pb, Zn and Cd. One gram of each of the samples including the control was weighed into 30ml sample bottles and the procedure of Tessler (1979) was used to separate the heavy metals into various fractions.

Statistical analysis

The data generated from the various chemical analysis were subjected to ANOVA analysis using SPSS Version 15 and differences ($P < 0.05$) between means were determined using Duncan test.

Results and Discussions

Result showed that, foliar bioaccumulation factor of Cu was 2.48 in the control cocoa seedlings while bioaccumulation factor of Cu was 0.5, 0.76 and 0.38 in seedlings from soils treated with 20, 40 and 60g kg^{-1} phosphate respectively (Table1). Bioaccumulation factor is the ratio of heavy metal in plant to the heavy metal in soil. This result is an indication of significant reduction in the absorption and accumulation of copper in plant tissue as a result of immobilization of soil copper by the applied rock phosphate. The bioaccumulation factor of Pb in the foliage of control cocoa seedlings was 24.94 while bioaccumulation factor of Pb was 3.12, 2.73 and 5.84 in seedlings from soils treated with treated with 20, 40 and 60g kg^{-1} phosphate respectively. Bioaccumulation factor of Zn in foliage of control seedlings without rock phosphate was 21.66 while bioaccumulation factor of Zn was 13.13, 5.20 and 5.00 in seedlings planted in 20, 40 and 60g kg^{-1} rock phosphate treated soils respectively. Result show that, Zn bioaccumulation factor in all the treated seedlings were significantly lower than that of the control. Result show that, bioaccumulated Cu, Pb and Zn in foliage of cocoa seedlings planted in soils treated with 20g, 40g and 60g were significantly ($P < 0.05$) lower than the control (Table 1). Translocation factor of Cu in foliage of the control seedlings was 0.49 while translocation factor of Cu was 0.10, 0.15 and 0.08 in seedlings planted in soil treated with 20, 40 and 60g kg^{-1} rock phosphate respectively. Translocation factor of metal in foliage of cocoa seedlings is the ratio of heavy metal in leaves and metal in the roots. There was significant reduction in translocated Cu in foliage of seedlings planted in soils treated with rock phosphate than the control which had no rock phosphate treatment. Translocation factor of Pb in foliage of the control experiment was 6.86 while factor of 0.86, 0.79 and 1.64 was obtained in foliage of seedlings planted in soil treated with 20, 40 and 60g kg^{-1} phosphate respectively. Translocation factor of Zn in the control seedlings (0.39) was significantly higher than the translocation factors (0.24, 0.09 and 0.09) of Zn in foliage of seedlings planted in soil treated with 20, 40 and 60g kg^{-1} rock phosphate respectively. Result showed that, the application of rock phosphate significantly ($P<0.05$) reduced the uptake of zinc from the soil treated of seedlings treated with rock phosphate. Figure 1show the reductive effect of rock phosphate on Cu, Pb and Zn mobility in Owena cocoa soil. Result showed that, the treatment of the contaminated soil with 20, 40 and 60g kg^{-1} rock phosphate reduced Cu mobility by 19%, 35% and 42% respectively while Pb mobility was reduced by 12%, 23% and 25% respectively zinc mobility was reduced by 38%, 54% and 54% by the application of 20, 40 and 60g kg^{-1} phosphate respectively to the contaminated soil.

The relationship between metals in cocoa foliage and heavy metal fractions in Owena cocoa soil is presented in Table 3. Linear regression of data generated from the determination of metals in cocoa seedlings' foliage and heavy metal fractions of rock phosphate-treated soil showed that, Pb in exchangeable fraction had the highest R^2 value with foliar Pb (0.85).

Relationship between water soluble Pb and foliar Pb had R^2 value of 0.37 while carbonate bound Pb had R^2 value of 0.15 with foliar Pb. Fe-Mn oxide bound Pb had R^2 value of 0.26 with foliar Pb. R^2 values between water soluble Cu, exchangeable Cu, carbonate bound Cu, Fe-Mn oxide Cu and foliar Cu was 0.83, 0.07, 0.43 and 0.02 respectively. Regression analysis between zinc in the various metal fractions in soils and foliar Zn had R^2 values of 0.61, 0.82, 0.71 and 0.26 for water soluble, exchangeable, carbonate bound and Fe-Mn oxide respectively.

Discussion

Metals remobilization

The effect of rock phosphate on heavy metals transformation from non residual fraction to residual fraction was shown by the reduction of mobility factor of the various metals in the treated soil samples (Figure 1). The reduction in mobility factor is an indication that, the metals have been stabilized in soil by being remobilized from available to non available fraction . Mobility factor was calculated by the formula MF=F1+F2+F3/F1+F2+F3+F4+F5+F6 X 100. The Fs are the various fractions of heavy metals in soil. When a particular heavy metal is in its labile state (soluble) it can easily be bioavailable. But when the metal is transformed or remobilized from available (non residual) state to unavailable state (residual). Such metal becomes inactive, stable and unavailable for plant uptake. By this, success would have been made in reducing the toxicity and contamination of such metal in soil environment. The non residual fractions include; water soluble fraction, exchangeable, carbonate, Fe-Mn oxide and organic fractions. Heavy metals bound or associated with the water soluble, exchangeable and carbonates are bioavailable to plants and the environment. The remaining two fractions in the non residual fraction (Fe-Mn oxide and organic) are not readily available except there are favorable chemical reactions in soils.

Effect of rock phosphate on heavy metal uptake in cocoa seedlings

The concentration of metals in foliage of cocoa seedlings planted in rock phosphate - treated soil were significantly ($P < 0.05$) lower than the concentration of metals in foliage of controlled cocoa seedlings which had no rock phosphate (Table 1). This implies that, the applied rock phosphate significantly immobilized Cu, Pb and Zn in the contaminated soil thereby, reducing the amount of metals taken by cocoa seedlings. Translocation factor was calculated as TF= metal in foliage/metal in root. On the other hand, Bioaccumulation factor was calculated as BF = metal in foliage/metal in soil. Two main different mechanisms have been proposed for the immobilization of Pb: first mechanism involves rock hydroxyapatite (rock phosphate) followed by phosphate reaction with dissolved Pb and precipitation of pure hydroxypyromorphite (Ma *et al*., 1993; Xu and Schwartz, 1994; Chen *et al*, 1997). At 60g rock phosphate treatment, it was observed that, translocated and bioaccumulated Pb was higher than those treated with 20 and 40g rock phosphate which appeared to be a deviation from the trend of Cu and Zn. This suggests a release of Pb from the rock phosphate which is a confirmation of the report of McLaughlin *et al*., (1996) and Mort ve dt, (1996) who stated that rock phosphate compounds contain a range of metals. According to McLaughlin *et al*., (1996), addition of phosphate compounds to soils does not only help to overcome the deficiency of some of the essential trace elements, but could also introduce toxic metals. However due to the fact that, rock phosphate slowly dissolves, its recommendation has been made for use by many authors without fear of soil contamination.
Result (Table 3) show that, among the various fractions of heavy metals studied, the water soluble and extractable fractions are well correlated with heavy metals in the foliage which suggest that, availability of Cu, Pb and Zn for cocoa seedlings in rock phosphate amended soil depend on available metal present in the water soluble and exchangeable fractions. This implies that, the bulk of these metals found in cocoa tissue are mainly mined from these two fractions. According to so many authors, metals in the water soluble and exchangeable fractions are the most available for plant uptake. Metals within the soil solution are the only soil fraction directly available for plant uptake (Fageria *et al*., 1991; Marschner, 1995; Whitehead, 2000).

Table 1: Effect of rock phosphate on soil pH

	Month1	% Inc	Month 2	% Inc	Month 4	% Inc	Month 6	% Inc
Control	5.72[b]	-	5.54[c]	-	5.59[b]	-	6.55[b]	-
20g/kg	6.57[a]	14.86	6.60[b]	19.13	6.68[a]	19.50	7.34[a]	12.06
40g/kg	6.79[a]	18.70	6.73[ab]	21.48	6.67[a]	19.32	7.35[a]	12.21
60g/kg	6.63[a]	15.91	6.79[a]	22.56	6.66[a]	19.14	7.34[a]	12.06

Key: % Inc = Percent Increment in soil pH

Same alphabets on the same column are not significant at $p<0.05$

Different alphabets on the same column are significant at $p<0.05$

Table 2: Effects of rock phosphate on heavy metal translocation and mobility factors

	Translocation factor			Bioaccumulation factor		
Treatments	Cu	Pb	Zn	Cu	Pb	Zn
Control	0.49±0.03a	6.86±0.05a	0.39±0.03a	2.48±0.06a	24.94±0.3a	21.66±1.5a
20gP/kg soil	0.10±0.02c	0.86±0.02c	0.24±0.02b	0.50±0.02b	3.12±0.14c	13.13±1.6b
40gP/kg soil	0.15±0.02b	0.79±0.02c	0.09±0.02c	0.76±0.04b	2.73±0.17c	5.20±0.41c
60gP/kg soil	0.08±0.01c	1.64±0.01b	0.09±0.03c	0.38±0.03c	5.84±0.21b	5.00±0.52c
	% reduction in Translocation factor			% reduction in Bioaccumulation factor		
	Cu	Pb	Zn	Cu	Pb	Zn
20gP/kg soil	69.39	87.46	38.46	80.00	87.50	39.42
40gP/kg soil	68.39	88.48	76.92	69.23	89.06	75.96
60gP/kg soil	83.67	76.09	77.00	81.0a	76.56	76.92

Key: Different alphabets on same column are significantly different ($P < 0.05$)

Table 3: Linear regression of metals in leaves and various metal fractions

Fractions	y	R^2
	Lead	
Water soluble	0.0037x + 0.886	0.371
Exchangeable	0.0157x + 13.747	0.850
Carbonate	-0.0014x + 3.84	0.150
Fe-Mn oxide	0.0124x + 2.169	0.266
	Copper	
Water soluble	0003x + 0.42	0.839
Exchangeable	-0.0017x + 1.924	0.079
Carbonate	0.0021x + 1065	0.432
Fe-Mn oxide	0.0063x + 6.415	0.027
	Zinc	
Water soluble	0.006x + 0.239	0.614
Exchangeable	0.0219x + 2.66	0.820
Carbonate	0.0157x + 18.42	0.717
Fe-Mn oxide	-0.0076x + 7.94	0.269

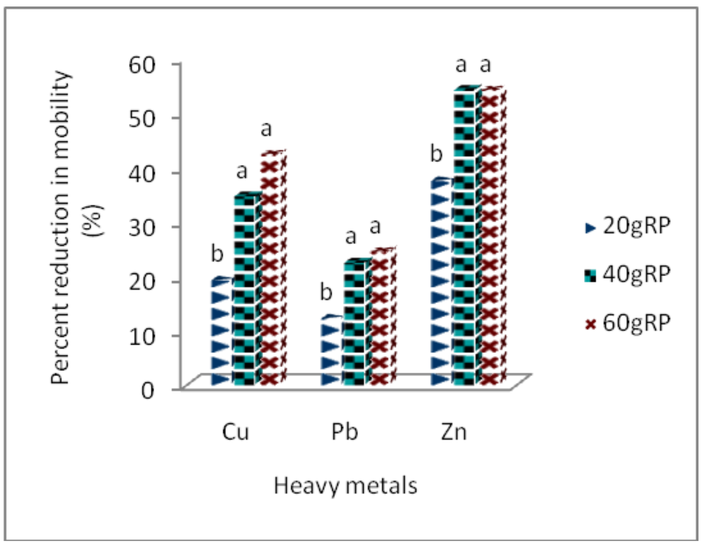


Figure 1: Reductive effects of rock phosphate on heavy metal mobility factor

Conclusions and Recommendation

This study has shown that, Sokoto rock phosphate is a potential remediation material for copper, Pb and Zn contaminated soil by significantly reducing bioaccumulated and translocated metals in cocoa seedlings tissue. This material has a double advantage in its application on agricultural soils. It increases soil fertility and at the same time reduces the mobility of heavy metals in soil. However, due to the presence of trace metals in rock phosphate, its application should be based on calculated total heavy metals in soils to be treated in order to avoid undue introduction of trace metals into the environment.

References

Aikpokpodion P.E (2010) Assessment of heavy metal pollution in fungicide treated cocoa plantations in Ondo State, *Nigeria. Journal of Biosciences* 33:2037-2046

Aikpokpodion P.E, Lajide L. and Aiyesanmi A.F (2010) heavy metal contamination in fungicide treated cocoa plantations in Cross River State, Nigeria. *American-Eurasian J. Agric & Environ Sci*. 8(3) 268-274

Basta N, Gradwohl R, Snethen K, Schroder J (2001) Chemical immobilization of lead, zinc and cadmium in smelter contaminated soils using biosolids and rock phosphate. *J Environ Qual*
Chen X., Wright J., Conca J., Perurrung L. (1997). Evaluation of heavy metal remediation using mineral apatite. *Water Air Soil pollution* 98:57-78
Fageria N.K., Baliger V. and Jones C.A (1991). Growth and Mineral Nutrition of Field Crops. Marcel Dekker, New York.
Fernandes, J.C and Henriques F.S (1991) Biochemical, physiological and structural effects of excess copper in plants. The Botanical Review 57: 246-273
Hettiarachchi G, Pierzynski G (2004) Soil Lead bioavailability and in situremediation of Lead-contaminated soils: a review. *Environ Prog*. 23: 78-93
Laperche V, Logan T.J., Gaddam P., Traina S.J. (1997) *Environmental Science Technol* 31: 2745
Ma QY, Traina SJ, Logan TJ (1993) In situ lead immobilization by apatite. *Environ Sci Technol* 27:1803–1810
Marschner H. (1995). Mineral Nutrition of Higher plants 2nd edn. Academic Press, London.
Mclaughlin M.J., Tiller KG, Naidu R., Stevens D.P (1996) Review: the behaviour and environmental impact of contaminants in fertilizers, *Australian Journal of Soil Research* 34:1-54
Mort Vedt J.J. (1996) heavy metal contaminants in organic and organic fertilizers. *Fertilizer Research* 43:55-61
Qiao X.L, Luo Y.M, Christie P., Wong M.H (2003) *Chemosphere* 50:823
Reddy J., Wang L. and Gloss S.P.(1995) Solubility and mobility of copper, Zinc and Lead in acidic environments. *Plant and Soil* 171: 53-58
Ryan J.A, Zhang G P. Hesterberg D., Chou J., Sayers D.E (2001) *Environmental science and Technology* 35:3798
Tessier A., Campbell P.G.C and Bisson M. (1979). Sequential extraction procedure for the speciation of particulate trace metals. *Anal. Chem*. 51:844-851
Whitehead D.C. (2000). Nutrients elements in Grasslands: Soil – plant – Animal Relationship: CABI Publishing Wallingford
Xu Y, Schwartz F (1994) Lead immobilization by hydroxyapatite in aqueous solution. *J Contam Hydrol* 15:187–206
Zhang P., and Ryan J.A (1999*) Environmwntal Science and Technology* 33:625
Zhang P., Ryan J. (1999). Formation of chlorophyromorphite from galena (Pbs) in the presence of hydioxyapatite. *Environ Sci. Technol* 33:618-624

CASHEW PROGRAMME

Experimental Title: Growth and Yield of Cashew as Influenced by Leguminous Cover Crops (Iloyanomon, C.I., Ibiremo, O.S., Adeyemi, E.)

Introduction

Cashew is an export crop and one of the most important tree nuts in international trade. However, soil nutrient management in cashew is a challenge. Cashew is often grown on poor soils due to it's adaptation to a wide range of soil and climatic conditions. This coupled with nutrient mining due to harvesting of cashew nuts without adequate nutrient replenshment has led to the need for nutrient supplementation. Through nutrients are returned through leaf litter, the amount returned is not sufficient to replace the lost nutrients. Low external input agriculture without fertilizer is a common place in Sub-Saharan Africa. Many cashew farmers in Nigeria do not use fertilizer. Reason ranges from lack of knowedge of the nutrient status of the soil, to scarcity of the conventional inorganic fertilizer and high cost where available, among other reasons. This coupled, with the detrimental effect of continuous use of inorganic fertilizers has necessitated the search for a sustainable and environmentally friendly alternative.

The use of leguminous cover crops is a viable and sustainable alternative. Leguminous cover crops have been extensively used in the tropics for plantation crops such as rubber and oil palm in countries like

Malasia. Apart from some of these cover crops being sources of food and fodder. Their nitrogen fixing potentials has made them an atractive alternative. Leguminous cover crops such as pigeon pea Peuraria phaseoloides, Mucuna prorren, Calopogonium mucuncides, Fix 46-122kgN/ha (Tian, 2007), increased soil available Phosphorous by 3-15% and also increase yield. Cover crops also increases soil organic matter which is also essential in soil fertility management. In addition to improving soil fertility, they smoother weeds, reducing the drudgery of hand weeding and the use of expensive herbicides and enviroemntal problems associated with use of these herbicides. Cover crops, also reduces soil degradation due to erosion and conserves soil moisture (Salako and Tian, 2003). It decreases nematode population (Osei *et al*, 2010). Beneficial effects of some cover crops in improving growth and yield of Cocoa has also been reported (Wilson, 1999).

Despite the benefit of cover cropping it has not been properly integrated into the farming system on Nigeria. Hence it is not a common practice in Nigeria. There is therefore need to study the impact of cover cropping on cashew with the aim of incorporating these leguminous cover crops in cashew plantaions to enhance their benefits.

Objectives

1. Evaluate the effect of leguminous cover crops on soil fertility status of cashew plantation;
2. Determine the effect of luguminous cover crops on early field establishment of cashew;
3. Evaluate the effects of leguminous cover crops on cashew nut yeild;
4. Study the effects of leguminous cover crops on weed suppression;
5. Evalaute the effect of leguminous cover crops on pest, diseases and soil micro fauna; economic analysis of the use of leguminous cover crops in cashew production.

Results

Work commenced in May 2013 after the strike. Cashew seedlings are presently being raised and clearing of the land for establishment is going on

Experimental Title: Dry matter yield and Nutrient uptake of Cashew Seedlings as influenced by Arbuscular Mychorrhizal inoculation, Organic and Inorganic Fertilizers in two soils in Nigeria.(Ibiremo O.S; Ogunlade, M.O, and Adewale D.A).

Introduction

Cashew (*Anacardiumoccidentale* Linn) is an export-earning crop and is cultivated in many agro – ecological zones in Nigeria. Cashew is grown in many soil types of the savanna zones of Nigeria. It is less selective and demanding in terms of soil types and fertility requirements compared with other plantation crops (Ohler, 1979). Cashew as a result of its wide adaptation is often grown in very poor soils and this has affected its survival and establishment in most fields. In many cashew plantations, the establishment could be as low as 45 %, while in acute situations it could be less. The use of N, P and K fertilizers for cashew nutrition had been established (Owaiye and Olunloyo, 1990). Phosphorus is the second most limiting nutrient after nitrogen in the nutrition of cashew. Phosphorus plays an indispensable role as a universal fuel for all biochemical work in living cell and in particular root development which is very important to crop establishment in the field (Agbede, 2009). NPK fertilizers and other inorganic sources. Application of most of these P-chemical fertilizers on a long term basis often leads to reduction in pH and exchangeable bases thus making them unavailable to crops and the productivity of crop declines (Zainol *et al*., 1993). The use of organic fertilizer to grow tree crops, especially cocoa, coffee and oil palm has been reported by various workers (Aisueni *etal.*, 2000). Application of compost improves the biological activity of the soil and has a direct impact on the sustainability of soil health (Nagaraj *et al*., 2000).

Arbuscular mycorrhizal fungi (AMF) are ubiquitous beneficial soil micro-organisms associated with roots of most plants (Howeler *et al.*, 1982). They penetrate the living cells of plants without harming them and their hyphae can range far into the bulk soil establishing equally intimate contact with the micro-biota of soil aggregates and micro-sites. The fungi link plant and soil transporting mineral nutrients to the plant and carbon compounds to the fungi (Reid, 1990). Therefore, the objectives of this study were to determine the effect of AM fungi inoculation, organic and phosphate fertilizers on the dry matter yield and nutrient uptake of cashew seedlings and to determine the effect of the fertilizer amendments on the chemical properties of the two soils.

Materials and Methods

The experiment was conducted in the greenhouse of Cocoa Research Institute of Nigeria in 2007/2008 seedling production. Soil samples (top soil) were collected randomly at the plantations of the stations at 0-30 cm depth. The soil was air-dried and sieved using 2mm sieve. Sub-samples were analyzed for physical and chemical parameters using standard laboratory procedures (IITA, 1982). The organic fertilizer (CPH) contained 0.95, 0.11, 4.30, 1.2, 0.24 % N, P, K, Ca and Mg respectively. SRP had 33.47, 44.23, 0.95 and 7.90% for P_2O_5, CaO, MgO and $CaCO_3$ respectively while SSP had 18.02, and 27.00% for P_2O_5 and CaO respectively. Five kilogrammes sieved soils were placed in 5 -litre plastic pots and watered to field capacity before the nuts were planted. All pots were planted with two large nuts of cashew but after a month, the seedlings were thinned to one seedling per bucket. Twelve treatment combinations were formed comprising two levels of CPH (0 and 2.5 t/ha), three sources of phosphorus (control, Single super phosphate and Sokoto rock phosphate) and two levels of mycorrhizal inoculations (with and without). The AM used for the study was *Glomusclarum*(Nicolson and Schenck). The phosphate fertilizers were applied at rate equivalent to 11kg P_20_5 ha^{-1} which was equivalent to 5kg Pha^{-1} while 20g of the AM fungi containing spore, hyphae and roots of the cultural plant was applied just below the nuts at planting .The treatments were replicated four times and then arranged in a completely randomized design (CRD). Watering was done regularly thrice a week. Data on height, stem diameter and number leaves were regularly taken on monthly basis. At four months after planting (MAP), the plants were destructively sampled and separated into leaves, stem and roots. The fresh plant samples were dried in an oven to constant weight to determine the dry matter yield and the samples must milled using in electric hammer and nutrient analysis was carried out for major nutrients in the leaves, stems and roots. The nutrient uptake as calculated as the product of the concentration and dry matter yield. Uptake = Nutrient concentration x dry matter yield (Osonubi *et al.* 1991). Analysis of variance was performed on all data to test the treatment effect on different parameters measured using a SAS analytical package of 9.20 version.

Results and Discussion

The soil of Ibadan is near neutral with a pH of 6.66 while that of Uhonmora was slightly acidic with pH of 5.83 (Table 1). The sand fraction of Uhonmora soil was 13.8% lower than that of Ibadan (Table 1). Conversely, the clay content of Uhonmora was 51.6% higher than Ibadan soil. Similarly, the water holding capacity (WHC) of Uhonmora was 40.4% higher than that of Ibadan. The total soil nitrogen of both sites was adequate for cashew production while the available P is moderate for Uhonmora and Ibadan Adeoye 1986). However, the exchangeable K^+, Ca^{2+}, and Mg^{2+} are adequate for cashew production. The exchangeable sites have enough basic cations and thus resulting in very high base saturation values. The soils of Ibadan and Uhonmora are quite ideal for cashew production (Obatolu 1996). The total dry matter yield (DMY) of cashew seedlings as influenced by phosphate fertilizers indicated that SSP significantly ($p < 0.05$) enhanced the accumulation of DMY in Uhonmora soil (Fig. 1a) compared to the control. Conversely, phosphate fertilizers did not significantly affect the DMY of cashew seedlings in Ibadan soil. In Ibadan, SSP and SRP application increased the DMY of cashew seedlings by 15.0 and 10.0 % respectively compared to the control (without P fertilizers). The performance of SSP in terms of dry matter accumulation and nutrient uptake in Uhonmora and Ibadan soils was significantly higher than that of SRP due to its higher solubility. This result is consistent with findings of Haugen and Smith, (1993) who reported that plants receiving SSP were significantly larger than plants receiving only basic nutrients after six weeks. Ghosh, (1999) found that application of finely ground rock phosphate was as effective as SSP, whereas in some other reports by Haugen and Smith, (1993), showed that rock phosphate performed less than SSP. Organic fertilizer application and AM inoculation have no significant effect on the total DMY of cashew seedlings in both

Ibadan and Uhonmora soils (Fig.1 b and c). Arbuscular mycorrhizal inoculated cashew seedlings had 20.0 % DMY increase compared to non-inoculated seedlings in Ibadan soil, whereas in Uhonmora soil, non-inoculated cashew seedlings had 10.0% increase in DMY compared to the inoculated ones. Organic fertilizer application significantly ($p < 0.05$) enhanced the root N, K and Ca uptake in Uhonmora soil (Table 2). However, root uptake of P and Mg were not significantly improved as a result of organic fertilizer application. It was observed that organic fertilizer improved root uptake of Mg by 26.7 % compared to the control. Similarly, the root P, K and Ca of cashew seedlings planted in Ibadan soil were significantly ($p < 0.05$) enhanced as a result of organic fertilizer application compared to the control. In Uhonmora soil in particular, organic fertilizer application improved shoot uptake of N, P and K by 9.9, 8.9 and 5.1 % respectively compared with the control but were not significant. At 4 MAP, the root nutrient uptake (N, K, Ca and Mg) were not significantly affected as a result of phosphate fertilizers applied to cashew seedlings in Uhonmora soil (Table 3). The root K and Ca uptake of cashew seedlings were positively enhanced by organic fertilizer application. This is consistent with the findings of Brunner *et al.,* (2004) in which wood ash application positively enhanced the root Ca and root Mg of spruce in Norway. The effect of organic fertilizer application on pH of Uhonmora soil was not significant at the end of the study (Table 3). However, organic fertilizer application significantly ($p < 0.05$) improved the pH of Ibadan soil. The available phosphorus of Uhonmora soil was significantly ($p < 0.05$) increased as a result of organic fertilizer application by 11.7% compared to the control. Conversely, organic fertilizer did not significantly affect the available P in Ibadan soil. Organic fertilizer application caused 4.7% reduction in the available P of Uhonmora soil. The influence of organic fertilizer application on exchangeable H^+ and Al^{3+} was not significant in both Uhonmora and Ibadan soils at the end of the study (Table 3). In particular, organic fertilizer reduced the amount of exchangeable hydrogen ions in Ibadan soil by 17.2% compared to the control. The inorganic P-fraction of Uhonmora soil was significantly ($p < 0.05$) improved by 16.2% compared to the control as a result of organic fertilizer application. However, organic fertilizer negatively affected the organic P of Uhonmora soil (Table 3). In contrast, the inorganic, organic and total P-fractions of Ibadan soil were not significantly affected by organic fertilizer application. Organic fertilizer application increased the inorganic P-fraction of Ibadan soil by 4.9% and decreased the organic P by 1.6%. The total P of Uhonmora and Ibadan soils decreased as a result of organic fertilizer application. The total organic carbon (TOC) particulate organic carbon (POC) and relative particulate organic carbon (RPOC) of Uhonmora soil were not significantly influenced by organic fertilizer application (Table 5).

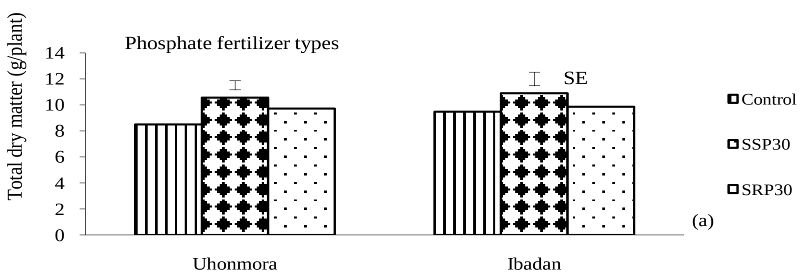
Conclusion

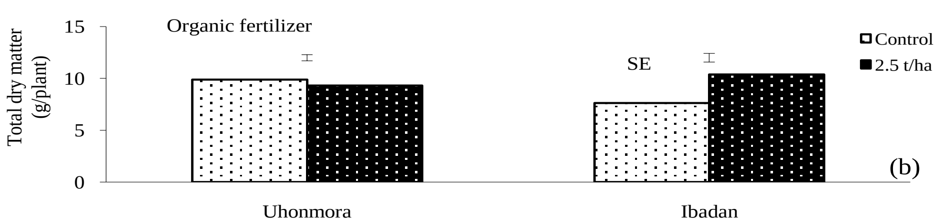
Sokoto rock phosphate had comparable influence with SSP on the growth of cashew seedlings. Hence, when SSP is not available, Nigerian Sokoto rock phosphate is a viable option for cashew production. Inoculation of cashew with exotic AM may not be necessary because cashew easily forms association with native mycorrhiza in the soil and thus making the external addition of AM to increase the cost of input to cashew production. Organic fertilizer amended with phosphate fertilizer and AM inoculation has positive influence on the growth of cashew and the chemical properties of the soil.

Table 1: Physical and chemical characteristics of the soils of Onigambari, Ibadan and Uhonmora at 0 – 30 cm

Soil Properties	Unit	Value	
Physical		Ibadan	Uhonmora
Sand	g kg^{-1}	694.00	610.00
Silt	"	149.55	152.85
Clay	"	156.45	237.15
Textural Class	-	Sandy loam	Sandy clay loam
WHC	%	38.60	65.06
Chemical			
pH (H_2O) 1:1	-	6.66	5.83
Organic Carbon	g kg^{-1}	1.81	2.95
Total Nitrogen	"	0.65	0.79
Available Phosphorus	mg kg^{-1}	8.87	9.81
Exch. Bases			
K^+	cmol kg^{-1}	0.67	0.57
Ca^{2+}	"	2.07	2.23
Mg^{2+}	"	2.01	2.95
Na^+	"	0.55	0.67
Mn^{2+}	"	0.03	0.06
Exch. Acidity			
Al^{3+}	"	0.13	0.10
H^+	"	0.04	0.27
ECEC	"	5.14	6.81
Base Saturation	%	96.76	94.47

ECEC - Effective Cation Exchange Capacity
WHC - Water Holding Capacity





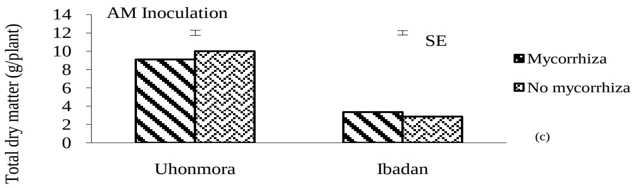


Fig.1: Dry matter accumulation of cashew as influenced by phosphate fertilizer types, organic fertilizer and AM inoculation in soils from two locations under greenhouse conditions

Table 2: Effect of organic fertilizer on the nutrient uptake by cashew seedlings grown in soils from two locations under greenhouse conditions at 4 MAP

Organic Fertilizer (t ha^{-1})	Nutrient Uptake mg/plant				
	N	P	K	Ca	Mg
			Uhomonra		
Root Nutrient Uptake					
0	19.92	3.08	11.25	8.79	5.39
2.5	25.69	2.43	15.08	12.10	6.83
LSD (0.05)	5.66	ns	3.43	2.66	ns
Total Nutrient Uptake					
0	176.69	12.40	80.72	43.41	23.82
2.5	197.69	12.58	87.46	44.11	24.82
LSD (0.05)	ns	ns	ns	ns	ns
			Ibadan		
Root Nutrient Uptake					
0	25.10	1.97	9.55	7.62	4.90
2.5	23.30	2.73	14.69	9.42	5.43
LSD (0.05)	ns	0.69	3.56	2.18	ns
Shoot Nutrient Uptake					
0	111.14	5.82	54.51	22.03	10.95
2.5	100.34	5.60	58.49	20.00	10.04
LSD (0.05)	ns	ns	ns	ns	ns
Total Nutrient Uptake					
0	140.10	7.59	62.96	29.43	15.74
2.5	123.50	8.25	73.31	29.51	15.54
LSD (0.05)	ns	ns	ns	ns	ns

LSD (0.05) = Least significant difference; ns = not significant

Table 3: Influence of organic fertilizer on some soil chemical properties of soils from two locations under greenhouse conditions at harvest (4MAP)

Variable	Unit	Organic Fertilizer Rate of Application		LSD (0.05)
		0	2.5	
		Uhonmora		
pH		5.84	5.84	ns
Avail. P	mgkg-1	10.73	11.99	0.86
Exch H	cmolkg-1	0.26	0.27	ns
Exch Al	cmolkg-1	0.05	0.05	ns
Organi P	gkg-1	102.79	119.47	6.84
Inorganic P	gkg-1	140.22	123.18	7.72
Total C	gkg-1	15.91	16.73	ns
Particulate Organic C	gkg-1	8.71	8.90	ns
Relative Particulate Organic C	gkg-1	0.55	0.53	ns
Total N	gkg-1	0.93	0.82	ns
Total Acidity	cmolkg-1	0.31	0.32	ns
		Ibadan		
pH		6.20	6.28	0.06
Avail. P	mgkg-1	5.51	5.26	ns
Exch Al	cmolkg-1	0.29	0.24	ns
Exch H	cmolkg-1	0.05	0.05	ns
Organi P	gkg-1	33.70	35.35	ns
Inorganic P	gkg-1	144.83	142.83	ns
Total C	gkg-1	9.43	9.41	ns
Particulate Organic C	gkg-1	3.90	2.67	1.19
Relative Particulate Organic C	gkg-1	0.41	0.27	0.12
Total N	gkg-1	0.76	0.70	ns
Total Acidity	cmolkg-1	0.34	0.29	ns

Table 4: Influence of P- fertilizer sources on some soil chemical properties of soils from two locations under greenhouse conditions at harvest (4MAP)

Variable	Unit	P Sources			LSD (0.05)
		Control	SSP	SRP	
		Uhonmora			
pH		5.86	5.85	5.82	ns
Avail. P	mgkg-1	11.38	11.32	11.38	ns
Exch H	cmolkg-1	0.26	0.32	0.21	0.07
Exch Al	cmolkg-1	0.06	0.05	0.04	ns
Organi P	gkg-1	104.03	113.81	115.53	8.38
Inorganic P	gkg-1	139.09	127.55	128.47	9.46
Total C	gkg-1	16.35	16.52	16.10	ns
Particulate Organic C	gkg-1	9.70	8.14	8.58	ns
Relative Particulate Organic C	gkg-1	0.60	0.50	0.53	ns
Total N	gkg-1	0.89	0.90	0.84	ns
Total Acidity	cmolkg-1	0.32	0.37	0.25	ns
		Ibadan			
pH		6.25	5.39	5.34	ns
Avail. P	mgkg-1	5.41	5.39	5.34	ns
Exch H	cmolkg-1	0.26	0.25	0.29	ns
Exch Al	cmolkg-1	0.05	0.05	0.05	ns
Organi P	gkg-1	32.62	33.18	37.77	4.84
Inorganic P	gkg-1	148.17	141.47	141.44	ns
Total C	gkg-1	9.92	9.10	9.24	ns
Parti Organic C	gkg-1	3.89	2.78	3.19	ns
Rel.Parti Organic C	gkg-1	0.40	0.30	0.34	ns
Total N	gkg-1	0.75	0.83	0.60	0.18
Total Acidity	cmolkg-1	0.31	0.30	0.34	ns

REFERENCES

Adeoye, G.O (1986). Comparative studies of ammonium bifluoride-chelate extractants and some conventional extractants for sedimentary soils of South Western Nigeria.
Ph.D. Thesis,University of Ibadan, Ibadan, Nigeria.

Agbede, O.O (2009). Understanding Soil and Plant Nutrition. Salman Press and Co. Nigeria Ltd Keffi, Nasarawa State. 147-159.

Aisueni, N.O.; Omoti, U.; Ekhator, F. and Oviasogie, P (2000). Effect of compost on soils supporting nursery seedling production of oil palm. *Nig. Journal of Tree CropResearch*, 4, 43-51.

Ananthakrishnan, G; Ravikumar, R; Girja, S Ganapathi, A (2004). Selection of efficient arbuscularmycorrhizal fungi in the rhizosphere of cashew and their application in thecashewnursery.*Scientia Horticulturae* 100, 1-4: 369-375.

Ghosh, P.C(1999). Chemistry and agronomic evaluation of Phosphate Fertilizers, Arotech Publishing Academy, Udaipar 234.

Haugen, L.M. and Smith, S.E. (1993). The effect of inoculation of cashew with Nutrilink on vesicular arbuscular mycorrhizal infection and plant growth. *Australian Journal ofAgricultural Research* 44: 1211-20.

Howeler, R. H. Cadavid, L. F. and Burchardt, E. (1982). Response of cassava to V.A mycorrhizae inoculation experiments *Plant and Soil* 69:327-339.

International Institute of TropicalAgriculture Ibadan(1982) *Laboratory Manual* 1982 edition 70.

Laska, R.K.; De, G.K.; G.K. Debnalth, N.C.; Basks, E.K. (1990). Phosphorus availability and transformation from Mussorie rockphosphate in arid soils. *Environment and Ecology* . 2, 612-616.

Nagaraj J. S.; Shanmukappa, D. R; Velmourougane, K; Selvam P.P. and Alwar R.P.A (2000): Production of compost from coffee pulp. In (Ed): *Recent Advances in plantation CropsResearch*,121-124.

Obatolu, C.R (1996). Soil Requirements of cashew: In National workshop on cashew production Technology CRIN/NAERLS 19-21.

Ohler J.G (1979). Cashew Koninklijk Instituut Voor de Tropen Armsterdam, 260.

Osonubi, O.; Mulongoy, K.; Awotoye, O.; Atayese, M.O. and Okali, D.U.U(1991). Effects of ecto-mycorrhizal and vesicular arbuscular mycorrhizal fungi on drought tolerance of four leguminous woody seedlings. *Plant and Soil* 136: 131-143.

Owaiye, A.R. and Olunloyo, O. A (1990): The effect of NPK fertilizer combinations on incidence of inflorescence blight disease of cashew at Ochaja. In: Annual Report of Cocoa Research Institute of Nigeria, 31.

Publication :Ibiremo O.S., Ogunlade, M.O., Oyetunji, O.J and Adewale, B.D (2012). Dry matter yield and Nutrient uptake of Cashew Seedlings as influenced by Arbuscular Mychorrhizal inoculation, Organic and Inorganic Fertilizers in two soils in Nigeria. *Journal of Agricultural and Biological Sciences*.7 (3): 196-205

TEA PROGRAMME

Experimental Title: Utilization of Green Tea in wine and Beverage Production (Aroyeun et al.)

Background

Epidemiologica; studies have been associated consumption of green tea beverage with prevention of several chronic and degenerative diseases including cancer, *Nichochamala, et al., 2006) cardiovascular disorders (Kariyama et al., 2006), obesity and diabetes *Iso et al., 2006). The production of beverage in the form of nin alcoholic infusion and the fermented, mildly alcoholic green tea wine is an example of functional foods which provide heath benefits to consumers beside nutritional benefits. This study involved the production of a beverage from green tea infusion obtained fro both loose tea and tea bags and also the application of 2 drying methods of fresh tea leaves (Sun Drying, SD and the oven drying OD) to dry the tea before infusion for analysis and evaluation of the Total phenols, tannins, caffeine and other chemical; elements in the infusions

Materials and Methods

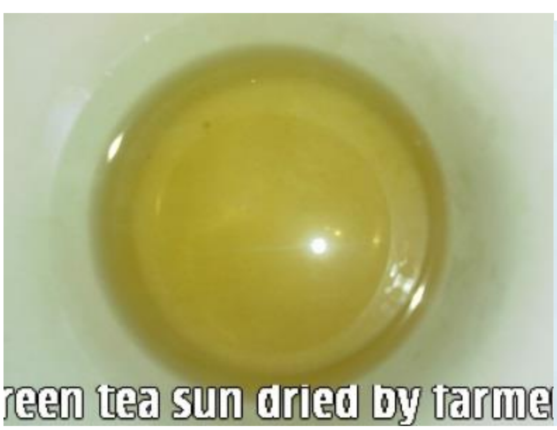
Green tea was produced on the Mambilla station after plucking the fresh tea leaves from the experimental plot of the Cocoa Research Institute of Nigeria using the popular Chinese method of pan fixing instead of the steaming method of the Japanese green tea production. The green tea used were initially analysed to obtain some chemical properties and thereafter 1 sample of loose tea was used to make both Loose and Tea bags respectively to demonstrate the effects of Loose or bagging on some quality characteristics of the different non alcoholic beverage produced.

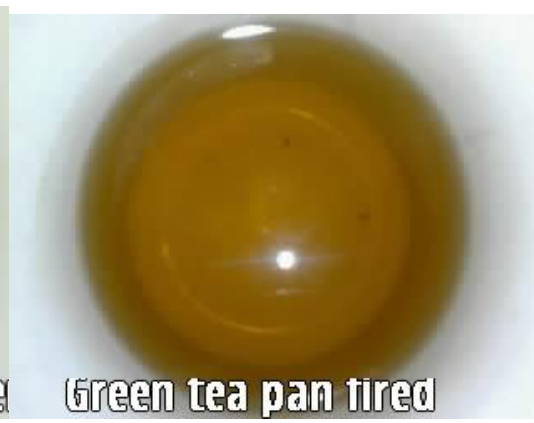
The Analysis of the Polyphenols, minerals, and proximate components of the various samples followed standard AOAC methods (2000). Colour analysis was done using Ceilab Hunter lad.

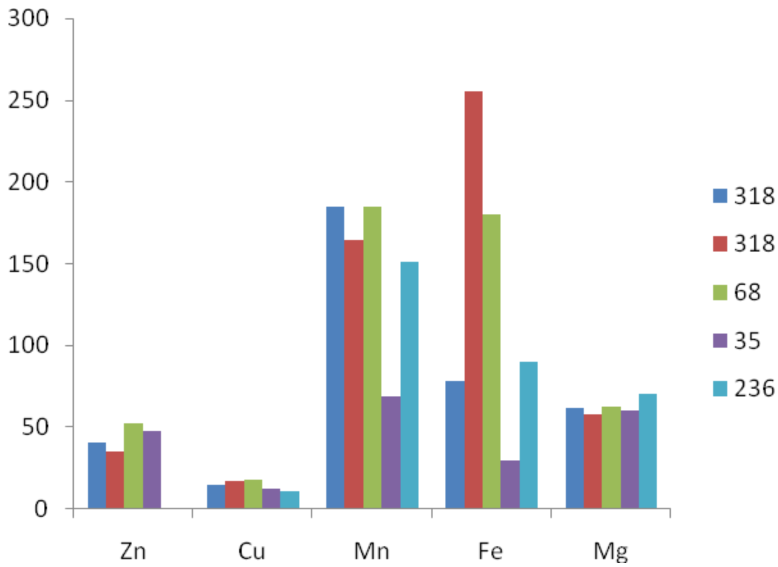
Visual colour analysis were also used to show the dullness or otherwise of samples of infusion made form sun dried green tea samples and oven dried green tea samples.

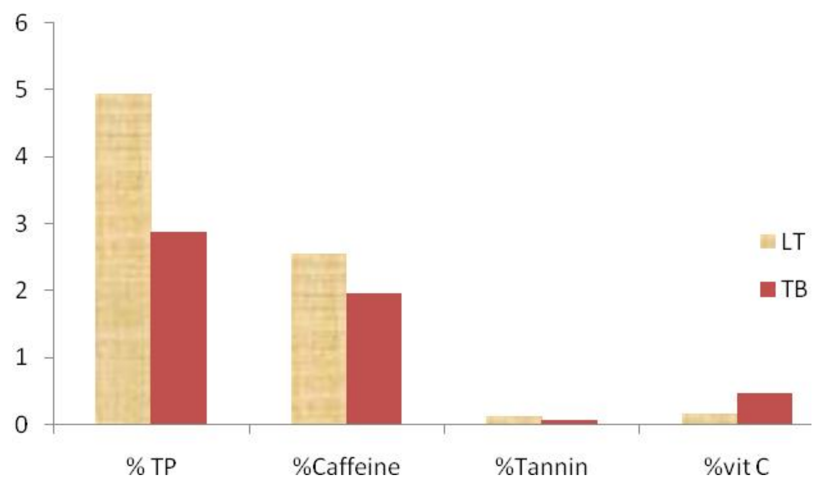
Results and Discussion

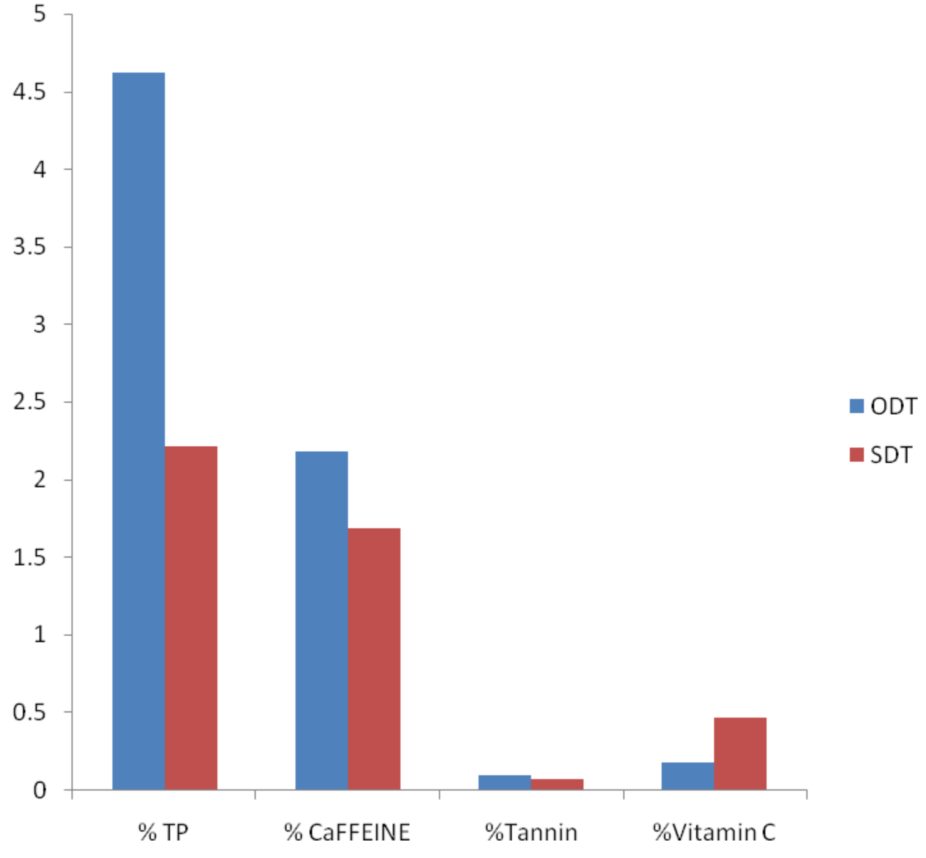
In this study, it was established that significant differences existed among the different green tea infusions due to the tea type and the method of drying the tea .The caffeine content of loose tea seemed to be prominently higher than the caffeine of tea bags (LP =……). This might be due to the permeable membrane between the tea and the extracting solvents (water) which restricted the complete release do all the soluble contents form the tea bags.. Caffeine is an example of methyl Xanthenes and is a Purina alkaloid with a lot of stimulating effects. Caffeine consumption need to be regulated as too much consumption of tea can react over activity and extra excitation .its addictive effects can also result in Alzheimer and vertigo. The difference in the caffeine contents between Loose tea and tea bags have different benefits for different categories of green tea beverage consumers. Low caffeine is necessary for children and the pregnant while high caffeine may be beneficial to consumers wanting to stay awake all the times and as such requires a stimulating beverage like loose green tea.






300
250
200
150
100
50
0
Zn
Cu
Mn
Fe
Mg
318
318
68
35
236


6
5
4
3
2
1
0
% TP
%Caffeine
%Tannin
%vit C
LT
TB



Experimental Title: Metallic salt of Tea (*Cammellia sinensis*) seed oil as modifier for polymer reinforcement. (Yahaya, L.E**)**

Introduction: The field of polymer-clay nanocomposites has experienced rapid growth in the past decades. This class of materials has assumed considerable importance and has been the focus of extensive investigation (Kojima *et al*., 1993., Gianelis, 1996).

Methodology: Sodium salt of Tea seed oil (TSO-Na) was prepared by reacting 2.8 g of TSO with approximately 10 ml of 20% NaOH in an ice bath with constant agitation for 24 h. The pH of the resulting solution was maintained at 8–9. TSO–Na was then introduced into a separating funnel and washed with water to remove excess base. This solution was then oven-dried to remove any moisture and powdered. 2 g of TSO–Na was reacted with 9.8 g kaolin, 7 ml of hydrazine and 50 ml water under vigorous agitation at 20 °C. The mixture was homogenized using an ultra Schallprozessor (HIELSCHER, GMbH, UP 100 H) and the sample was dried in a freeze drier (HetroTrap-CT600e, JOUAN) and powdered. The X-ray diffraction of the samples was determined using a Philips -1710 X-ray diffractometer using monochromatic Ni-filtered Cu K alpha radiation 1.5418Ao at 40Kv and 20mA. All the readings were taken at room temperatures. The d-spacing was calculated using Braggs equation, $n\lambda = 2d \sin\theta$, where λ is the wavelength of the monochromatic x-ray source, d is the spacing between two similar planes, θ is the angle at which x-ray falls on the sample, and n is the order of reflection.

Objective: To formulate tea seed based modifier for polymer reinforcement.

Results and Discussion: The XRD patterns of the neat kaolin and TSO-Na modified kaolin are shown in figures 1 and 2 respectively. The d- spacing was determined from the diffraction peak position in the XRD using the Braggs equation. The basal distance of the neat kaolin and the d- spacing of TSO-Na organokaolin are shown in the peaks corresponding to 7.15, and 14 Å respectively. Evidently the intercalation of organic modifier enlarges the distance of the kaolin layers thus suggesting the successful preparation of organokaolin using rubber seed oil derivative. The peak value of TSO-Na modified kaolin is greater than the d-spacing (13.89A^o) reported for caesium acetate- kaolinites intercalate (Frost *et al*, 1999) and sodium montmorillonite (12.5-12.6A^o) (Arroyo *et al*, 2003 and Wu *et al*, 2005).

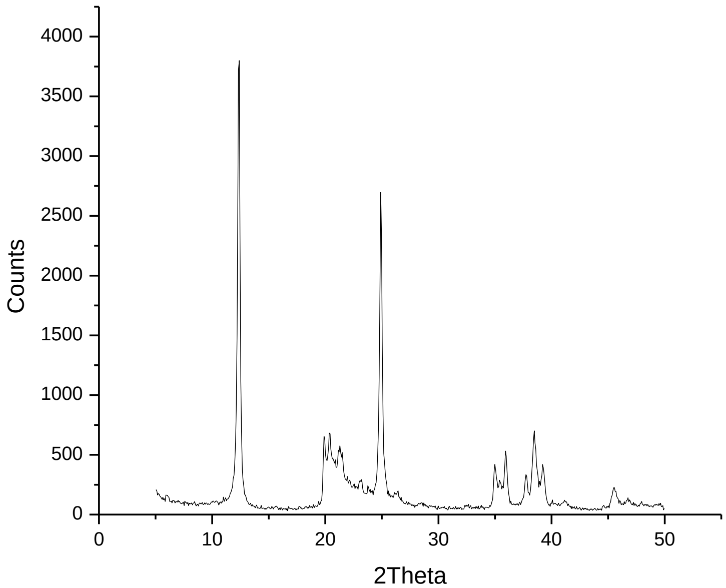


Figure 1. XRD Pattern of Unmodified Kaolin

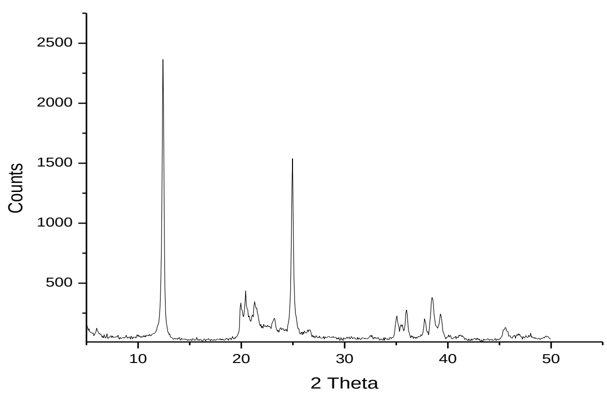


Figure 2. XRD Pattern of TSO modified Kaolin

References:

Arroyo, M; Lopez-Manchado;Herrero, B.(2003).*Polymer*.44,2447.

Gianelis, E.P;Krishnamoorti,R;Manias, E.(1999) *Advanced. Polymer science*

Hasegawa, N; Okomota, H;Kato M; Usuki, A (2000) *Journal of Applied Polymer Science*. 78, 1981

Frost, R.L;Kristof, J;Harvath, E;Kloprogge, J.T(1999). *Langmuir* 15, 26

Kojima, Y; Usuki,A;Kawasumi, M; Okada, A;Kurauchi,T;Lamigato,O.J (1993) *Journal of Polymer science. Part A.* Polymer Chem.31,938

Wu, Y.P; Wang, Y-Q; Zhang, Y-Z; Yu, Z-S;Zhang, L.Q;Yang (2005). *Journal of Composite Sciemce and Technol*. 65, 1195.

FARMING SYSTEM RESEARCH

Experimenta Title: Determination of Problems Associated with Cashew Production through Pair wise Ranking System in Surulere L.G.A of Oyo State. (Uwagboe, E.O Famaye. O.A, Adebiyi,S, Agbongiarhuoyi, A.E, Famuyiwa B.S,Abudkarim I.F and Williams ,A.O)

Low yield has been identified as the major limiting factor in cashew production as it is arise from the prevalence of pests and diseases in the cashew farms.

Olunloyo (1979) reported that 38.7% average loss per hectare in total cashew nut yield at two cashew plantations are due to the floral shoot disease of cashew caused by Lasiodiplodia theobromae fungus.

Adebiyi etal (2011) also reported that cashew stem girdlers, cashew stem borers, inflorescent die back and immature fruit drop are the major pests and diseases affecting cashew trees and apples in any cashew plantation.

Cashew is produced in twenty (20) states in Nigeria of which Oyo state particularly Ogbomoso zone is majorly known for cashew production.

However, determination of problems associated with cashew production in the area becomes necessary in order to proffer solution for to cashew production constraint.

Objectives of the Study

1. To identify problems in cashew farms in the study area.
2. To improve cashew production and productivity in the study area.

Methodology

Farmers were interviewed with the use of focus group discussion in order to determine problems encountered on their farms.

The pair wise ranking methods, which is a chart, contains problems associated with cashew production were arranged in both horizontal and vertical forms.

Questions on problems affecting cashew production were asked and responses were ticked and scored accordingly.

Questions on farmers' problems were asked by the facilitator

Farmers responding to questions during focus group discussion

Cross section of female participants during the exercise

Results and Discussions

Table 1 showed the results of pair wise ranking system among cashew farmers in the study area. It showed that cashew stem girdler is the most destructive pest of cashew in the area. Farmers also noted that cashew stem borer is also common in their cashew farms, while, squirrel and grasshopper are not posing a serious threat to cashew production in the area.

Table 1

S/N	PESTS/DISEASES	1	2	3	4	5	6	7	8	9	SCORE	POSITION
1.	Stem girdler	X	1	1	1	1	1	1	1	1	8	1st
2.	Stem borer		X	2	2	2	2	2	2	2	7	2nd
3.	Fret nut diseases			X	3	3	3	3	3	3	6	3rd
4.	Inflorescent diseases				X	4	4	4	4	4	5	4th
5.	Larva					X	5	5	5	5	4	5th
6.	Grasshopper						X	6	8	9	1	8th
7.	Squirrel							X	8	9	0	9th
8.	Termites								X	9	2	7th
9.	Leaf Roller									X	3	6th
	Judgment without bias											

Conclusion

Pests and diseases are the major problems militating against cashew production in the study area. Cashew production of the area will be increased if steps are taken to control them.

Reference

S, Adebiyi, E.O, Uwagboe, E.A, Agbongiorhuoyi, N, Idris and E.O, Aigbekaen (2011);
Assessment of Pest and Diseases Management Practices among Cashew Farmers in Kogi State,Nigeria: International Journal of Sustainable Agriculture 3(2) 49-53.
Idosu publication, 2011.
Olunloyo, O (1979) CRIN Annual report.

Experimental Title: On Farm Demonstration of Good Agricultural Practices (Gap) In Idi-Ogun Village In Ona- Ara Local Government of Oyo State (Famaye ,O.A. Adebiyi. S Oloyede, A.A, Adeyemi, E.A. Uwagboe, E.O.Ibiremo O.S Akanbi ,O.S.O and Adejobi .K.B)

Introduction

The vast majority of cocoa farms in Nigeria have low yield per hectare due to the problem of old age of individual cocoa trees and poor agronomic practices observed by peasant cocoa farmers in many cocoa producing communities (Adebiyi and Okunlola 2009). Olaiya et al 2003 observed that the highest cocoa yields are achieved between the ages of 15 and 25 years. They also opined that low yield in cocoa is associated with poor management or total neglect of cocoa farms.

Adenikinju (1999) observed that low in cocoa yield is associated with poor management or total neglect of cocoa farms, according to him rehabilitation of cocoa farms through gapping up and coppicing would increase yield of cocoa trees.

Obviously, many cocoa farms are not within optimum planting population, as many cocoa farms are left with few cocoa trees; this has consequently affected greatest economic return which is expected of an ideal cocoa plantation.

In order to increase cocoa yield per hectare, the Institute has recommended spacing of 3m x 3m for establishing cocoa plot which will give plant population of 1,111 cocoa trees per hectare.

Meanwhile, literature has shown that cocoa gives the yield of 1.5 tons to 3.5 tons per hectare when establishing at this geometry together with practices such as pruning, mistletoes removal, removal of chupon and diseased plants. In view of this above development a participatory on farm demonstration of GAP and rehabilitation of old and moribund cocoa trees were initiated in a farmer's farm in Idi-Ogun Community of Ona Ara LGA of Oyo State with the aims of increasing cocoa yield and improved farmers' livelihood.

Materials and methods

The experiment was carried out at Idi-Ogun village. A cocoa farm which was established in 1956 was randomly selected among other farms in the village. An hectare of land was measured out of the farm and this was divided into four blocks, after which a block was picked for the experiment. From the block chosen, a dimension of 30m x 45m was measured out for the demonstration of gapping up and coppicing.

The block was then divided into three replicates of which each replicate contains gapping up and coppicing. Nine hybrid cocoa seedlings from the Institute were planted in each replicate, also, two old cocoa trees were coppiced in each replicate in the month of November. Pruning, removal of chupon as well as mistletoes removal were carried out on the experimental plot.

Demonstration of coppicing at 30cm above the ground

Results and discussion

The nine (9) hybrid cocoa seedlings planted in each replicate gives better performance out of the thirty-six (36) seedlings established, twenty-five (25) survived the dried season, the six (6) coppiced cocoa trees in the three replicates produce chapon after four weeks of coppicing. The vigorous and the most basal chupon were returned after twelve (12) weeks of chupon formation. Pruning, removal of chupon and mistletoes carried out in the plot increased healthy pod production compare to the initial situation of the farm.

Summary and conclusion

Rehabilitation through coppicing and gapping up using/hybrid cocoa variety were acceptable to farmers as techniques of cocoa rehabilitation. Pruning, removal of mistletoes and disease plants have increased plot's performance through better flowering and production of disease free cocoa pods.

References

Adenikinju, S. A. (1999) – Evaluation of cocoa rehabilitation techniques, CRIN annual report (1999)

Adebiyi, S. and Okunlola, J. O. (2009) - Globalization and socio-political economy of Rural development: proceedings of the Eighteenth Annual Congress of the Nigerian Rural Sociological Association, held at Federal University of Tech., Akure Ondo State. 16th – 18th December, 2009

Olaiya, A. O., Hammed, L. A. and Famaye (2003) – Yield Evaluation of Cocoa

Rehabilitation through coppicing, a paper presented at 14th International Cocoa Research Conference. Accra,Ghana, 13 – 18 October, 2013.

Experimental Title: Youth involvement in cocoa production in Cross River state of Nigeria (Uwagboe, E. O., Ndagi, I., Abdulkarim, I.F., Williams, A. O., Famuyiwa, B. S., Asogwa, U. and Shittu, T. R. **)**

Introduction

Nigeria was among the leading cocoa producing nations until oil discovery in early 1970s. This trend changed and attention given to agricultural sector including cocoa industry in particular is grossly inadequate. Prior independence in 1960's cocoa export accounted mainly for agricultural export which made over 80% of gross national product of the Nigeria economy. It is still the most important agricultural export crop and accounted for about 37.9% of agricultural export in 1997 (Oduwole, 2001)

Uwagboe (2011) noted that among other factors responsible for the decline in production of cocoa in Nigeria is the vacuum created by the abolition of the Nigeria cocoa marketing board, old age of the farmers, massive migration of the youth from rural areas, high cost of agricultural labour, lack of credit facilities to cocoa farmers and indiscriminate bush burning that affect cocoa plantation. Amos (2007) found out that age of farmers and age of farms reduced the efficiency level of cocoa farmers. Adeogun (2011) found out that majority of cocoa farmers are already in their old age and youths need to be encouraged to engage in cocoa farming.

Objectives are to:

1. Describe socio-economic characteristics of the respondents
2. Determine attitude of the youth towards cocoa farming in the study area
3. Ascertain sources of information the respondents
4. Find out constraints of the youth in the stud area

Justification:

There are reports of massive drift from rural areas to urban centers by youth which reduced labour in the farms including cocoa plantations. There is need to ascertain the contribution of the youth towards cocoa production and their constraints. The result of this study will enable scientists and government to focus on the needs of the youths in order to strengthen the area of weakness for increase in cocoa yield.

Methodology

In Cross River state, three Local Government Areas; Boki, Etung and Ikom were randomly selected. Seventy Nine farmers were randomly selected from the LGAs and questionnaire was administered to elicit information from the youth farmers. Frequency and percentages were used for the descriptive statistics analysis.

RESULTS AND DISCUSSION

Table 1: Distribution of respondents according to personal characteristics

Sex of respondents	Frequency	Percentage
Males	64	81.0
Females	15	19.0

Total	79	100.0
Age range		
24-30	15	19.0
31-37	38	48.1
38-44	26	32.9
Total	79	100.0
Marital status		
Single	11	13.9
Married	64	81.0
Divorced	1	1.3
Widowed	3	3.8
Total	79	100.0
Educational status		
No formal Education	3	3.8
Primary	26	33.0
Secondary	25	31,6
Tertiary	25	31.6
Total	79	100.0
Years of farming experience		
5-20	60	75.9
21-30	19	24.1
Total	79	100.0

Source: Field survey, 2012

The result on Table 1 revealed that 81.0% of the respondents were males while 19.0% were females which indicate that more male youth farmers are into cocoa farming in the study area. This could be due to the limitations that women have in acquiring land for tree crops cultivation in Nigeria.

Age is a factor that affects adoption andalsoaprimarylatentcharacteristicinadoptiondecisions.The result revealed that 81.0% of the respondents were between the age range of 31 and 44 years which means that majority of the youth farmers are matured and experienced which could improve efficiency in cocoa farming. This is very favourable to cocoa farming in the study area (Table 1). Adeogun (2011) found out that majority of cocoa farmers are already in their old age and youths need to be encouraged to engage in cocoa farming.

Majority (81.0%) of the youth farmers were married while few (13.9%) were still single. This implies that the married among the farmers could be assisted by their wives and children which could reduce cost of labour in farm maintenance (Table 1).

The educational status result on Table 1 revealed that majority (96.2%) of the youth farmers were educated with 33.0% having primary school qualification and 31.6% having secondary and tertiary school qualification respectively. This indicates that the youth farmers are mostly educated which could enhance effective dissemination of developed technologies.

The result on Table 1 revealed that majority (75.9%) of the youth farmers had between 5 and 20 years of cocoa farming experience. This implies that the youth farmers in the study area possess enough experience to carry out cocoa farming.Amos (2007) that farming experience is important for day-to-day running of the farming activities including IPM practices, as cocoa cultivation is very tasking.

Table 2: Distribution of respondents based on farm size

Farm size (Acres)	Frequency	Percentages
1-5	34	43.0

6-10	31	39.2
11-15	10	12.7
>15	4	5.1
Total	79	100.0

Source: Field survey, 2012

The result on Table 2 revealed that 43.0% of the respondents have between 1 and 5 acres of cocoa farm and only 5.1% have above 15 acres which shows that the youth farmers are small scale farmers. Farm sizes were categorized by STCP Nigeria baseline survey in 2001 as small 0.4-6 acres, medium 6.1-12 acres and Large 12.1+. According to World cocoa foundation (2012) cocoa is typically produced in small individual farms (1-3 Ha), where it is the main source of revenue.

Table 3: Distribution of respondents according to land ownership

Land ownership	Frequency	Percentages
Purchase	1	1.3
Inherited	37	46.8
Rent	2	2.5
Cooperative	1	1.3
Legal right	11	13.9
Community	15	19.0

Source: Field survey, 2012

Based on the result on Table 3 majority (46.8%) of the respondents inherited the land used for cocoa farms. This implies that most of the cocoa farms are old as majority indicated that their land were inherited.

Table 4: Distribution of respondents according to farming activities performed

Source: Field survey, 2012

Farm activities	Frequency	Percentages
Nursery	48	60.8
Weeding	60	75.9
Pest and disease control	49	62.0
Harvesting	55	69.6
Post harvesting	51	64.6

The result on Table 4 revealed that all the respondents perform most of the various farming activities such as nursery (60.8%), weeding (75.9%), pest and disease control (62.0%), harvesting (69.6%) and post harvesting (64.6%). This indicates that youth farmers perform various farming activities in cocoa farming in the study area.

Table 5: Distribution of respondents based on their attitude towards cocoa farming

S/N	Attitudinal statements	SA %	A %	UD %	D %	SD %
1	Cocoa farming is mainly for old farmers	-	-	1.3	12.7	86.1
2	Cocoa farming can empower the youth	92.4	7.6	-	-	-
3	High income is generated from cocoa farm	70.9	26.6	1.3	-	-
4	Cocoa farming needs too much labour	64.6	29.1	2.5	3.8	-
5	Prices paid by buyers of cocoa is too low	88.6	10.1	-	-	1.3
6	Youths are not encouraged in cocoa farming	19.0	30.4	3.8	17.7	29.1
7	Cocoa is my primary farming	77.2	12.7	2.5	3.8	3.8
8	Income from cocoa farming takes care of my household	65.8	19.0	-	7.6	7.6
9	I prefer arable crops to cocoa farming	8.9	1.3	1.3	15.2	73.4
10	I will leave cocoa farming for other job	3.8	2.5	1.3	8.9	83.5

Source: Field survey, 2012

The attitude of respondents towards cocoa farming is positive. Most (86.1%) of the respondents strongly disagree that cocoa farming is mainly for old farmers and 92.4% strongly agree that youth can be empowered by cocoa farming. Majority (70.9%) of the respondents strongly agree that high income can be generated from cocoa farming while 77.2% strongly agree that cocoa farming is their primary farming occupation. Also, 73.4% strongly disagree that arable crops are preferred to cocoa farming while 83.5% strongly disagree that they will leave cocoa farming for other job. This implies that youth farmers in the study area are favourably disposed to cocoa farming and would need to be encouraged for its sustainability.

Table 6: Distribution of respondents based on constraints experience in cocoa farming

	Constraints	Not severe		Severe		Very severe	
		Freq	%	Freq	%	Freq	%
1	Land for farm expansion	55	69.6	2	2.5	22	27.8
2	Age of farms	42	53.2	17	21.5	20	25.3
3	Pest and diseases	1	1.3	15	19.0	63	79.7
4	High cost of inputs e.g. chemical	2	2.5	8	10.1	69	87.3
5	High cost of transportation to major market centres	12	15.2	11	13.9	56	70.9
6	Inaccessibility to capital	4	5.1	8	10.1	67	84.8
7	Problem of marketing information	4	5.1	23	29.1	52	65.8
8	Problem of storage facilities	33	41.8	13	16.5	33	41.8
9	Lack of improved varieties	11	13.9	18	22.8	50	63.3
10	Inadequate Labour	12	15.2	22	27.8	45	57.0
11	Farm maintenance	6	7.6	10	12.7	63	79.7
12	Processing of produce	46	58.2	16	20.3	17	21.5
13	Contact with Extension agents	15	19.0	10	12.7	54	68.4
14	Membership of farmers/ cooperative Association	18	22.8	10	12.7	51	64.6
15	Prices offered by local buyers	3	3.8	7	8.9	69	87.3

Source: Field survey, 2012

Table 6 revealed that 69.6% of the respondents indicated that land expansion is not a severe constraint while 87.3% indicated that cost of input is a very severe constraint. Also, capital is a very severe constraint as indicated by majority (84.8%) of the respondents. Farm maintenance is a very severe constraint as indicated by 79.7% of the respondents. Processing is not a severe constraints as indicated by few (21.5%) of the respondents. Youth cocoa farmers in the study area need empowerment to boost cocoa production in the study area.

Conclusion and recommendations

The youth farmers were mostly males that are still very young in age with much experience in cocoa farming and are educated. They are small scale farmers and are favourably disposed to cocoa farming. Their major constraints were capital, farm maintenance and high cost of inputs. The youth farmers need to be encouraged in order to sustain them in cocoa farming.

References

Adeogun, S. O., Uwagboe, E. O. and Aigbekaen, E. O. (2011) Awareness and Attitude of Cocoa Farmers Toward Activities Encouraging HumanImmunodeficiency Virus/ Acquired Immune Deficiency Syndrome in Ondo State Nigeria. Middle-East Journal of Scientific Research 8 (1): 16-22, 2011

Amos T. T. 2007. An Analysis of Productivity and Technical Efficiency of Smallholder Cocoa Farmers in Nigeria Journal of Social Science., 15(2): 127-133

Oduwole, O.O. (2001). Sustainable cocoa production in Nigeria: Farmers perception of technology characteristics and socio economic factors in adoption decision. Proc. 13th Int. Cocoa Res. Conf., pp. 1147 – 1152.

Uwagboe, E. O. (2011). Effect of Integrated Pest Management utilisation on cocoa farmers yield in selected states of Nigeria. Unpublished M.Phil Dissertation submitted in the Department of Agricultural Extension and Rural Development, University of Ibadan, Nigeria. 69-70.

World cocoa foundation (2012) World cocoa production http://worldcocoafoundation.org/world-cocoa-production/ 2012

CROP PROCESSING PROGRAMME

Experimental Title: Microbial Assessment of Cocoa Powder Circulating In South Western Nigeria(Jayeola, C.O and Oluwadun,)

Abstract

The consumption of cocoa powder (CP), which is the major ingredient of cocoa-based beverages, has been on the increasing trend in Nigeria without much concern for whether or not they meet the microbiological criteria for food safety. This study was, therefore, carried out to investigate the micro flora of twenty four brands of cocoa powder samples bought from different sources in South-West Nigeria with a view to determining their food safety. The viable bacteria counts were determined using standard plate count while the microbial isolates were identified using cultural, microscopic and biochemical methods. The pH, proximate, mineral and physical parameters were determined using recommended standard methods by Association of Official Analytical Chemists (AOAC). Student t-test and multiple linear regressions were employed in the statistical analysis of the data. The pH, proximate, mineral and physical parameters were determined using recommended standard methods by Association of Official Analytical Chemists (AOAC). Student t-test and multiple linear regressions were employed in the statistical analysis of the data. The result revealed that the microbial load were within the specified standard as recommended by FAO/WHO.

Introduction

The importance and influence of the diet on health is undisputed. Several chronic illness and death are as a result of consuming food contaminated by microbes and this is of major public health concern. Outbreak of food borne illnesses have been traced to undesirable harmful microbial contaminants and toxin by bacteria, yeasts or filamentous fungi, thus necessitating this experiment in cocoa powder.

Cocoa powder (CP) is the major ingredient of cocoa based beverages and confectioneries throughout the world. Cocoa powder contains carbohydrate in form of sugar and a high proportion of dietary fibre, up to 30% minerals and of which potassium and sodium are of primary importance (Knight, 1999).

CP is not an important source of vitamins as they occur in negligible quantities with exception of vitamin E which occurs in higher quantities due to the presence of cocoa butter. The calorific value of cocoa powder is intrinsically low and thus contributes little to a products total calorific value (ICCO, 1997)

CP contains polyphenols which are phytonutrients and are sometimes referred to as phytochemicals or nutraceuticals which are increasingly being used as dietary supplements or in fortified foods (Knight, 1999).

Polyphenols exhibit antioxidant activity, which has been reported to play a vital role in reducing the risk of some diseases in human by protecting cells in the body from damage during aerobic production of energy. Left unattended, free radicals attack DNA and eventually accelerate the ageing process and likelihood of cancer. Polyphenols are thought to reduce the risk cardiovascular diseases, inhibit Low Density Lipo protein (LDL), cholesterol and modulate immune functions (Zumbe, 1998)

CP contains flavonols which are natural compound in cocoa that may modulate platelet activities and may positively affect the balance between certain hormones. (ICCO, 1997)These actions play a role in maintaining cardiovascular health. This has been increasingly linked to promising circulatory benefits including improved blood flow and a reduced tendency to form damaging clots (Hackettstones, 2006)

Campaign for cocoa powder consumption is recently gaining ground in Nigeria. More importantly awareness is increasingly created on the health benefit derived from drinking cocoa powder especially in prevention / cure against high blood pressure, diabetics and malaria (Olubamiwa, 2007). This had resulted to packaging and sales of different cocoa powder by cocoa producing companies and some food packaging industries for sale

Therefore, there is need to protect the health of the consumer and this can be carried out by evaluating the presence of pathogenic bacteria present in cocoa powder circulating in south western Nigeria.

Materials and Methods

Samples are analyzed chemically according to the official methods of analysis described by the Association of Official Analytical Chemists (A.O.A.C., 1990). All analysis was carried out in triplicate.

Microbial analysis was carried out using plate count method

1g of Cocoa powder was dissolved in 9ml of 0.1% peptone water (i.e 1 /10 dilution) Ten-fold serial dilution was performed Pour plate on Nutrient Agar (NA)- For TBC Surface spread on MacConkey Agar (MA)- For presumptive CC and EC. All cultures are incubated at 37^0C for 24 hrs. Sub-culture 5-10 typical colonies of >0.5mm sizes from MA into pairs of Mac Broth; (1) at 37 ^{0}C & (2) at 44 ^{0}C, confirmation of CC and EC Speciation was done by Sub-culturing of bacterial colonies on Mackonkey Agar and Nutrient Agar for Gram and biochemical tests. Characterization of the organisms was based on two criteria; Cultural and Morphological characteristics of the colonies as well as the biochemical characteristics.

Results

Table 1: Isolation Rates of Microflora in Cocoa Powder

MICROFLORA	N	n	(%)
Gram positive rods	24	8	(35.5)
Gram positive cocci	24	4	(16.5)
Mould	24	9	(37.5)
Yeast	24	3	(12.5)

N=Number of cocoa powder brand cultured
n=number of samples with positive culture
%=Isolation rate

Figure 1: Effect of moisture on Bacteria count of cocoa powder

Relationship between moisture contents (%) of cocoa powder and total bacterial counts (log cfu/g) was determined in figure 4.1. A significant positive correlation ($r = + 0.362$, $P < 0.05$) was observed between the two parameters, with a linear equation of $y = 0.52 + 2.93x$. Regression determinant showed that moisture content is responsible for increase in total viable bacterial counts (R^2=0.13).

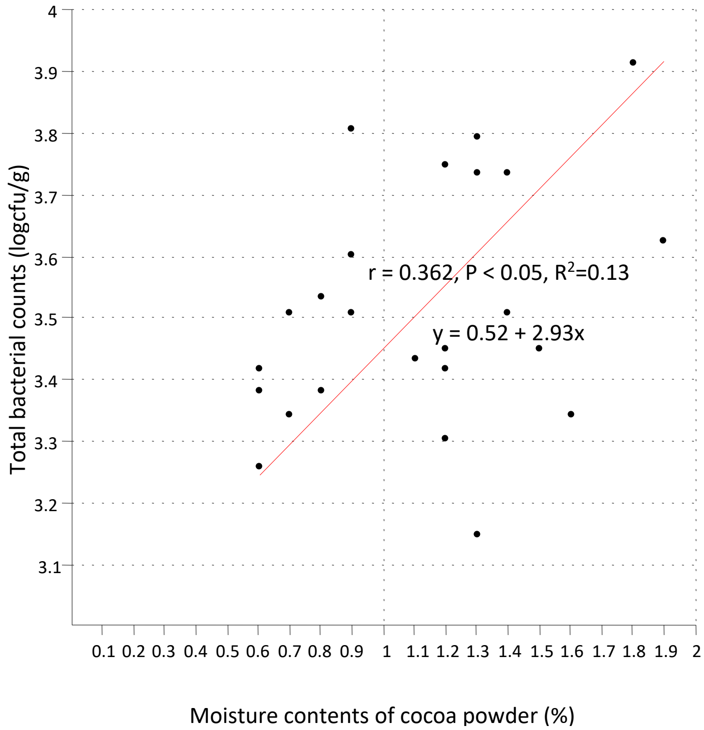


Figure 1: Effect of moisture on Bacteria count of cocoa powder

Discussion

The above table 1 showed that the cocoa powder brands consists of gram positive rods, gram positive cocci, mold and yeast with isolation percentages of 35.5%, 16.5%, 37.5% and 12.5% respectively. The highest occurrence of the microbes is recorded for mold.

Moreover, Relationship between moisture contents (%) of cocoa powder and total bacterial counts (log cfu/g) was determined in figure 1. A significant positive correlation ($r = + 0.362$, $P < 0.05$) was observed between the two parameters, with a linear equation of $y = 0.52 + 2.93x$. Regression determinant showed that moisture content is responsible for increase in total viable bacterial counts (R^2=0.13).

Conclusion

The mean microbial load cfu/g count of cocoa powder brands as indicated in table 1 showed that there are variations in some of the microbial load within the same company. This could be as a result of seasonal variation which might contribute to the quality of cocoa that was subjected to processing. However, most of the cocoa brands are within the NAFDAC specification of $1x10^3$. Most brands with higher microbial load are recorded for brands that were purchased locally in open market within the country.

Refrences

AOAC (2000): In Official Methods of Analysis of the AOAC International, 17th ed, vol. 11 Association of Official Analytical Chemist International, Washington, D.C.

Hackettstones, N.J. (2006): Flavonol-rich cocoa. Journal of Hypertension.vol 12 August 2006.

ICCO (1997): Flavonols. International Cocoa and Confectioneries Organisation. Quarterly bulletin on cocoa, 1997.

Knight,I. (1999): Chocolate and Cocoa. In Health and Nutrition, Black Well Science. 1999.
Olubamiwa, O. (2007): Have you had your cocoa today? Book published on behalf of National Cocoa Development Committee (NCDC), Nigeria.
Zumbe,A.(1998): Polyphenols in cocoa : Are there health benefits? BNF Nutrition Bulletin Volume 23, pp94-102, spring 1998.

Experimental Title: Adaptation and Evaluation of a Small Scale Solar Dryer in Some Cocoa Growing Ecologies in Nigeria (Mofolasayo A. S., Otuonye A. H., Igbinadolor R. O., Ojediran J. O., Mokwunye F. C., Yahaya A. T., Dr. Famuyiwa, B.S.)

Introduction

The effects of climate change is being felt by farmers during the drying of cocoa beans in recent times where less sunshine hours are experienced and humid conditions prevail. This has resulted in mould contaminationof dried beans up to toxic levels. High percentage of mould in cocoa beans lowers the premium placed on the commodity in both local and international trade hence reducing farmers' income. Moreover, erratic weather conditions increase drudgery during drying operations where labor is required to cover or unpack the beans to protect them from rain. The proposed small scale solar dryer removes these constraints and ensures a better utilization of the sunshine hours available during humid conditions to achieve a more even drying of the cocoa beans. The proposed capacity better suits the condition of the small holder farmers

Objective: i) To develop a 50 – 100 kg per batch wet cocoa bean solar dryer for small holder farmers
ii) to evaluate the dryer for performance in different cocoa growing ecology of Nigeria

Materials and Methods

Solar dryer was made of mild steel square pipe, angle iron, galvanized sheet, galvanized net, aluminium net, polyethylene sheets and fasteners. Two tons of 4 inch hard core material, coated black, was incorporated to trap solar radiation during day time and release heat to dry the beans in the cooler periods in the evening. The solar dryer was constructed in modules and thus easily dismantled into component parts for relocation and assembly. Two solar dryers were constructed- one each installed at CRIN headquarters, Ibadan and Owena substation respectively. Preliminary evaluation of done by spreading about 20 kg of wet cocoa beans on the dryer; an equal quantity was also spread on the conventional concrete platform to serve as control. Although under normal operation the solar dryer was supposed to be left open during the day – especially when the weather is favourable, but it was covered throughout the drying period partly owing to the small quantity of bean dried and also to simulate how the dryer would operate during unfavourable weather conditions.

Figure 1: The cocoa solar dryer

Results and Discussion

The research work is still ongoing but preliminary evaluation at the Cocoa Research Institute of Nigeria headquarters showed increased drying rate of cocoa beans and a better appearance over cocoa dried on conventional concrete platform. Further investigation is necessary to determine other quality parameters of cocoa dried using the solar dryer. The dryer shall also be evaluated in other cocoa producing areas.

EXTENSION PROGRAMME

Experimental Title: Transfer of CRIN Technologies through Participatory Approach-A Case Study of Aba-Agbo, CRIN/ARCN Adopted Village. (Adebiyi, S ,Adeyemi ,E.A, Uwagboe, E.O, Agbongiarhuoyi. A.E Famuyiwa, B.S, Ndagi, I, Abudkareem, I.F, Williams, A.O, , Aigbekaen, E.O, and Oduwole O.O)

Introduction:

Aba-Agbo is one of the Agricultural Research Outreach Centre (AROC) formed by CRIN in Collaboration with Agricultural Research Council of Nigeria (ARCN) with the aims of transferring technologies developed by CRIN to farmers in rural areas. The Institute has arrays of technologies which are meant to be transferred to farmers in order to improve their farm practices and income of which many of these technologies are still on shelf.

Objectives of The Study

1.) To transfer CRIN developed technologies
2.) To improve farmers' practice on their farm
3.) To increase farmers' income

Methodology

An advocacy visit was conducted to the village in 2009 to introduce the institute and its mandate to the community. Farmers were formed into various groups these are adult groups comprising of men and women, and the youth group without disrupting the structure and norm of the community. A centre was donated by the community with the approval of the village head. This centre was renovated and furnished by the Institute from the fund released by ARCIN.

A portion of an ideal land for cocoa of about 0.25 ha was donated by the community for planting of high yielding cocoa varieties developed by the Institute in line with cocoa Transformation Agenda (COCTA). The portion of land was cleared and farm layout was done at the geometry of 3m by 3m for the establishment of plantain Suckers. Pepper seeds were purchased and raised in the plot and these were transplanted at 1.5m by 1.5m in the month of September 2012. Weeding was done monthly and other agricultural practices were achieved. A nursery site was also selected near a stream in the community for an on –farm nursery demonstration practices.

Results and Discussion

Formation of Farmers into Groups

Fig 1 &2 showed the members of farmers in the adopted village formed in to group which has metamorphosed to cooperative society known as Agbeloba Farmers' Multipurpose Cooperative Society, Aba –Agbo. The members comprise of 18 men and 18 women This cooperative society will help the members to secure soft loan for their farming activities.

Fig 1: Members of Agbelogba farmers' multipurpose cooperative society

Fig. 2: Official presentation of certificate of registration to the society by the ministry of Trade, investment and cooperative, Oyo State

R-L: Mr. Babalola (representing Ministry of Trade, Investment and Cooperative, Oyo State); Mr. JimohAkanmu (President of the Society); Dr. O.O. Oduwole (representing the Director, FSR&E, CRIN); Mr. S. Adebiyi (CRIN Scientist).

Plantain suckers and pepper intercrop

Table 1 showed the planting distance, planting population and percentage survivor of the crops established on the plot. Plantain suckers were established at the geometry of 3m by 3m to give a total of 260 plantain suckers and the survivor count was 95.4% while pepper was also established as intercrop at the geometry of 1.5m by 1.5m to give a total of 800 pepper stands and survivor count is 77.75% Established plantain suckers as shade crop and pepper as intercrop have suppressed weeds and as serve as additional income for the farmers as shown in Fig 3

Fig 3 Plantain suckers and pepper as intercrop

Table 1: Plantain Suckers and Pepper Intercrop

Crops	Planting Distance	Planting population	Survivor Count	% Survivor	Land Area
Plantain Suckers	3mX3m	260	248	95.4	0.25ha
Pepper	1.5mX1.5m	800	620	77.5	0.25ha

Field Survey: 2012

On –Farm Nursery Practices

Table 2 showed the performance of the new high yielding Cocoa varieties in the nursery through participatory approach method. The table revealed that the 8 new hybrids TC1 – TC8 are better materials that farmers can raise in their nursery as all the 8 materials have good germinating potentials in the nursery as showed in Table 2 and fig 3 respectively.

Fig. 3: On-farm cocoa nursery practices

Table 2: on-farm nursery practices

Hybrids	Number of Pods	Number of Beans sown	Number Germinated	Percentage Germinate
TC 1 ………	10 …….	308 ……..	308 ………	100
TC 2 ……..	20 ……..	615 ……..	611 ………	99.3
TC 3 ……..	10 …….	311 ……..	309 ………..	99.4
TC 4 ……….	14 …………	442 ………	442 …………	100
TC 5 ………	6 ……..	198 …….	190	95.6
TC 6 ………	13 ……………	401 ………..	396 ………..	98.8
TC 7 ………	7 …………	216 ………..	209	96.7
TC 8 ……..	20 ………..	601	592	97.0

Source : Field Survey: 2012

Crisis Management and Conflict Resolution

In any community based project, the need to design strategy of managing crisis and conflicts resolution becomes necessary. Members of a group can not perceive issues in the same manner due to some factors that arise from individual difference. The situation in Aba- Agbo was not different as crises arise over where the demonstration plot and the nursery for raising cocoa seedlings would be sited. These issues were managed as farmers were made to understand that the project belongs to the group and that all members have equal right in the project. Finally it was resolved that a farm land be purchased in an acceptable area, this was done and the money was taken from their cooperative society. Long before now, there is an existing area near a stream used by the farmers to raise their seedlings and dried season vegetable, this site was choosing for the on-farm nursery practices and it was acceptable to the farmers.

Conclusion
The plot of land chosen as demonstration plot supported growth and development of plantains as well as the intercrop. Reasons for intercropping peppers with cocoa at early establishment are obvious as farmers have started noticing some produce from the peppers. On – farm Nursery practices Introduced to the farmers was successful and acceptable to the farmers as this will save them the high cost of transporting their seedlings to the field.
Finally, the registration of their group to a formidable cooperative Society has started solving the problems of fund for their farm practices. Hence, there exists mutual understanding and interpersonal relationship among the group within the community.

Experimental Title: Food Insecurity Status and Transition among Cashew Farming Households in Kogi State, Nigeria (Shittu, T. R)

Introduction
Food security is for individual and by extension households to be able to obtain its food requirement at all times, and to be able to utilize the food to meet the body's need. However, recent findings from the National Living Standard Survey (NLSS) in 2004 showed that about 37 percent Nigerians are food insecure (World Bank, 2004).

The constraints encountered in achieving an end to hunger which is the main goal (of the 1996 World Food Summit by Nigeria include the high incidence of farming and post-harvest losses due to pests and diseases, environmental degradation, debt burden and problems associated with these burdens. Food security being multifaceted in nature is pivoted on tripod stands of availability, accessibility and utilization aside production issue alone.

Cashew being a tree crop with large canopy formation its production require land expense of land for cultivation and once established reduce the amount of land available for growing food crops. Cashew production is seasonal in nature as flowing commences in September and fruiting takes place between December and March which makes cashew farming household vulnerable to food insecurity when income is not available to purchase food to meet immediate food need. The household is therefore thrown into a temporary dimension of food insecurity called Transitory or current food insecurity.

This phenomenon according to Obamiro et al (2005) whereby food consumption varies according to season is prominent among farming households in Nigeria. Transitory food insecurity. This (Transitory Food Insecurity) can lead to chronic food insecurity when a population has a long-term inability to acquire sufficient food.

This issue of food insecurity eradication is very important in Nigeria as it is a prerequisite for the creation of a stable socio-political environment for sustainable economic development.

Given the numerous negative outcomes associated with poverty and hunger, food insecurity is a serious threat to the well-being of our society. Okumadewa (2003) reported that Nigeria's appalling food insecurity situation was at a very low level that made her to be listed among the 42 countries tagged "Low income food deficit country and food insecurity disproportionately affects rural people particularly rural women, minorities and children who constituted the larger work place in Cashew subsector.

This problem of food insecurity especially during the hungry period among farming households especially cashew farming households because they are faced with high level of manure variability (access to food variability) due to factors such as poor harvesting and pest harvest handling infrastructural facilities, poor pricing of their produce couple with their poverty, that make them particularly vulnerable to shocks such as seasonal charges in food production.

Objectives of the study

This study is to assess the food insecurity transition among cashew farming households in Kogi State specifically.

1. Profile food insecurity status of cashew farming households.
2. Analyze the correlates of food insecurity status.
3. Investigate food insecurity transitions.
4. Examine the factors influencing food insecurity transitions.

Methodology

The study was carried out in Kogi State because it is high cashew growing State. Both primary and secondary data were used for the study. Data collections took place in two periods during the late rains of 2011 and early rains of 2012. The late rain is a period between September and December when harvesting is normally at peak and food crops are surplus and of low prices during the period while early rains is a period between March and May when farmers prepares their land for planting and planting of food crops normally takes place. This is a period of food security and higher food prices (Farmers period).

Data collections were done with the aid of structured questionnaires, administered on cashew farmers in the study area. Soliciting information on the socio-economics and demographic characteristics of the households, and their food consumption expenditure; while the secondary data was sourced from various publications of Central Bank of Nigeria (CBN) and National Bureau of Statistics (NBS). Information collected were on poverty, food insecurity and food prices.

Respondents were selected through multi stage random sampling technique. First stage was purposive selection of Kogi State while selection of two Local Government Areas (LGAs) was randomly done in the selected state. The third stage involved selection of villages (1 – 2) depending on the number of the villages in each LGA by adopting the delineation of National Population Commission (NPC) using proportionality factor $X_i – n/N * 4$

Where i = number of villages to be sampled

n = number of villages in a particular LGA

N = total number of villages in all the LGAs

The fourth stage involves selection of 4 villages using another proportionality factor stated below:

$X_j = p/P * 60$

Where j = number of households sampled in each village

p = number of households in each village

P = number of household in the 4 selected villages

Thus, two villages each were proportionately selected from each state to give a total of four villages and thirty respondents each from each of the selected villages.

Data analysis was done by adopting Foster Green Thorbecke (FGT) weighted poverty index for food security as used by Omonona (2001) and Agboola et al (2004) while the socio-economic and demographic characteristics and the food security status. Tobit and Probit models were used to examine the correlates of food insecurity status and the factors influencing food insecurity transitions respectively.

Food Insecurity Transition among Cashew Farming Households

This is done to investigate food insecurity transition matrix from food secure to food insecure and vice versa among population under consideration. Baulch et al (1998) approach of measuring the dynamics of poverty transitions in rural Pakistan was modified and adopted along works of Ribar and Hamrick (2003) and London and Scott (2005). The long term equilibrium (when the proportion of households entering food insecurity equals the proportion existing it) was obtained using

$$eP = e$$

$$\text{as } e_1, e_2 \begin{bmatrix} X_{11} & X_{12} \\ X_{21} & X_{22} \end{bmatrix} = [e_1, e_2]$$

Where e_1 = probability of households that will be food secure at equilibrium
e_2 = probability of households that will be food insecure at equilibrium

First – order Markov model of food insecurity transition

	Period 2 – early rain		
	Food secure	**Food insecure**	**Total**
Period 1 late rain			
Food secure	N_{11}	N_{12}	n_1
Food insecure	N_{21}	N_{22}	n_2
Total	$\mathbf{n_1}$	$\mathbf{n_2}$	

Results and Discussions

The estimation of food insecurity status and socio economic variable presented in table 1 indicated that the mean age of the respondent is 45.33 years and the distribution of the households by age shows that 60 percent of the households are headed by person of age 41 – 60 years with 89 percent of the household made up of 5 persons. In the study area, education seems not be of much importance as 82.5 percent of the respondents has no formal (education 70 percent) or did not go beyond primary school (12.5 percent). Male headed households in the study area were on majority (77 percent) and married people accounted for 83.3 percent of the respondents.

The result further indicates that the respondents have varying farming years of experience with 32.5 percent of them being in cashew farming for over 21 years and 72 percent of them also cultivating nothing less than 5 hectares of farm land; as about 88 percent of the respondent are primarily farmers and they are small farm holders.

Foods Insecurity profile of the Cashew Farming Households

This aspect decomposes food insecurity among cashew farming households in Kogi State based on demographic, occupational and socio-economic characteristics to enable us see the variation between subgroups for the years under study:

Comparison of food insecurity by household size:
This factor has a strong influence on food insecurity of the respondents as the result shows that food security index increases as the household sixe increases; but more in early rain of 2012 than in late rain of 2011. This

could be attributed to the fact that cashew enter into fruiting season towards the end of late rain stretching through the dry season thus the scarcity of food due to depletion of stored food would have gone down is compensated for with the cash availability from sale of cashew nuts.

On the marital status , the finding was similar as the insecurity as food is concern increases with married individual them for single. This could be true as being married may definitely increases household size coupled with polygamous nature of our people thus being more vulnerable to poverty dimension. Besides, the food scarcity has a stronger claim to cashew farming households purse or on stored produce meant for consumption.

Comparing the age as it relates to the food insecurity follows the same trend as it also directly related to the issue (food insecurity index). As one get older, there is reduction in terms of farm work they can do, this then affect farm size as children of school age are already enrolled in school.

Occupationally, food insecurity severity and depth among the cashew farming households whose heads who have farming as their primary occupation was observed in the periods of study than for those who have it as secondary occupation. This implying that vulnerability to food insecurity is higher for primarily farming households as they are more hit during learn period as they lack storage facilities during bumper harvest that pressurized them to sell off excess at giveaway prices hence reduction in income of individual belonging to this group of households while there is opportunity for spreading the incidence for those with farming occupation as secondary.

For households with access to credits, they are less vulnerable than those without access. This is so because the loanable funds can be used to expand production through purchase of improved inputs thus improving the food security situation of such households.

Education brings about change in individual. This is no exception among cashew farming households as those with higher level of education have higher adoption rate and use of new improved farming inputs, techniques and varieties thereby raising their income and consequently reducing food insecurity. Besides, they may control the number of children they would have which could have led to an increase in the dependency ratio of such a household.

Correlates of Food Insecurity for the Two Periods of Study
Of the nine variables included in the model, four of the variables each were significant for 2011 and 2012 respectively (Tables 2 and 3). They are age, household size, educational level and occupation. These findings further confirmed earlier explanation for the food insecurity profile. The significant variables will affect the food insecurity of the cashew farming households by the magnitude of their coefficient values positively or negatively as the case may be.

Food Insecurity Transition

The transition matrix table explains the probability that a household move in and out of food insecurity at different time depending on the prevailing circumstance though with varying degree. The result in table 4 shows that 48% of those who were food secure in 2011 remained secured in 2012 while 52% of those that were food secured in 2011 transitioned to food insecurity in 2012. In the same vein, 41 percent of those that were food insecure in 2011 transitioned to food security while 59 percent who was food insecure in 2011 remained so in 2012.

Conclusion and Recommendation:

Since most of the rural farming households who engage in farming as primary occupation are worst hit by food insecurity special training to enable them acquire skills fully is advocate . This will guarantee them more income to meet their needs food wise during planting and off season.
Sensitization effort should be made at educating them to observe family planning so as to have the number of children they can cater for as households with large family size are worst hit by food insecurity.
There should also be improvement in access to education and credit facilities as households with access to these two are more food secure than those without access.

References

Agboola, P.O, Ikpi, A. E. and Kormawa, P. M. (2004). Factors Influencing food Insecurity Among Rural Households in Africa: Results of Analysis from Nigeria. http://www.freewebtown.com

Baulch, B. and N. McCulloh. (1998): Being Poor and Becoming Poor: Poverty status and Poverty Transitions in Rural Pakistan. Preliminary material and interim research results circulated to stimulate discussion and critical comment. Institute of Development Studies, University of Sussex.

Foster J; J. Greer, and E. Thorbeck. (1986): A class of Decomposable Poverty Measure. Econometrical Vol. 52 Pp 761 – 766

Omonona, B. T. (2001). Poverty and its correlates among Rural Farming Households in Kogi state, Nigeria. Unpublished Ph, D Thesis, Department of Agricultural Economics, University of Ibadan.

Ribar, D. and K. Hamrick. (2003): Dynamics of Poverty and Food Insufficiency: Food Assistance and Nutrition Research Report No. 36 Washington, DC. USA

Table 1: Socio Economic Characteristics of the Respondents

Variables	**Frequency**	**Percent**	**Food insecure (2011)**	**Food insecure (2012)**
Age				
21 – 40	11	9.2	7	11
41 – 60	72	60	43	51
>61	**37**	30.8	18	22
Total	**120**	100	68	84
Household size				
1 – 5	89	74.16	19	23
6 – 10	26	21.67	34	40
≥ 11	5	4.17	15	21
Total	**120**	100	68	84
Educational level				
No formal education	84	70	29	38
Primary	15	12.5	18	22
Secondary	13	15	12	13
Tertiary	3	2.5	9	11
Total	**120**	100	68	84

Variables	**Frequency**	**Percent**	**Food insecure (2011)**	**Food insecure (2012)**
Marital Status				
Single	4	3.3	8	10
Married	100	83.3	45	52
Divorced	4	3.3	5	8
Widowed	12	10	10	14
Total	120	100	68	84
Gender				
Male	**92**	77	56	68
Female	**28**	23	12	16
Total	**120**	100	68	84
Farming Experience				
< 6	8	7	18	23
6 ≤ 10	22	18.3	11	14
11 ≤ 15	35	29.2	14	17
16 ≤ 20	16	13.3	9	12
≥ 21	39	32.5	16	18
Total	**120**	100	68	84
Farm size				
1 – 5 ha	86	72	53	66
≥ 6ha	34	18	15	18
Total	**120**	100	68	84
Credit Accessibility				
Access	23	19.2	22	29
No Access	99	80.8	46	55
Total	**120**	100	68	84
Occupation				
Farming (Primary)	106	88.3	42	53
Farming (Secondary)	14	11.7	26	31
Total	**120**	100	68	84

Table 2: Maximum Likelihood Estimate of the Tobit Regression for Food Insecurity 2011

Variable	Coefficient	Standard Error
Constant	1.927020	0.202893
Age X_1	0.572809	0.161806*
Household size X_2	0.168386	0.090322***
Educational level X_3	0.098372	0.345622**
Marital status X_4	0.154851	0.226195
Gender X_5	0.2029089	0.117257
Farming experience X_6	0.103381	0.075050
Farm size X_7	0.699208	0.568402
Credit accessibility X_8	0.036316	0.018298
Occupation X_9	0.82825	0.038373*

Source: Computer Printout of Tobit Regression

Table 3: Maximum Likelihood Estimate of the TobitRegression for Food Insecurity 2012

Variable	Coefficient	Standard Error
Constant	5.001521	0.272926
Age X_1	0.632590	0.210886**
Household size X_2	0.228627	0.121936***
Educational level X_3	0.006403	0.282361*
Marital status X_4	0.073013	0.237250
Gender X_5	0.332573	0.149324
Farming experience X_6	0.184498	0.095330
Farm size X_7	0.192498	0.315720
Credit accessibility X_8	0.044306	0.025711
Occupation X_9	0.050834	0.023937**

Source: Computer Printout of Tobit Regression

Table 4: Food Insecurity Transition

	Early rain 2012	
	Food secure	Food insecure
Late rain 2011		
Food secure	40 (0.4762)	44 (0.5238)
Food insecure	28 (0.4118)	40 (0.5882)
Total	68	84

Source: Computed from field survey 2011 and 2012
Figure on parenthesis are probability transition matrix

Experimental Title: Efficacy of *Trichoderma asperellum* against *Phytophthora megakarya* (Agbeniyi, S. O., Adedeji, A. R. and Adeniyi, D. O.)

Introduction

Theobroma cacao L. is one of the most important cash crops grown by farmers in Central and West Africa representing more than 59.9% of the world production. Cacao, the source of cocoa beans used to make chocolate, is a tropical, low–input, perennial tree crop grown by small scale farmers. Unfortunately, the crop suffers from a number of devastating diseases, among the most important is black pod disease caused by various species of *Phytophthora*.

Small holder production in Central and Northern South America has been devastated by frosty pod rot, and production in West Africa is threatened by the highly virulent black pod pathogen, *Phytophthora megakarya*. Diseases of cacao can account for losses of more than 30% of the potential crop and this, along with old, less productive trees has caused a steady decline in global production. Black pod, caused by various *Phytophthora* spp. is the most widely spread and destructive disease of cacao causing losses that have been estimated in recent years at 30% of pod production and up to 95% in cacao farms even in Nigeria. *Phytophthora* spp. pathogenic to cacao pods are arguably some of the most important cacao pathogen in Africa because of the annual crop losses inflicted and the costs associated with its management. Due to various reasons, black pod is difficult to control, chemical control of black pod by spraying with copper fungicide is a well established control method but not completely effective in wetter areas. In addition, fungicidal control can be expensive and polluting. So, an urgent need exists for an effective biologically based integrated approach to the management of such plant diseases. A renewed interest in biological control of plant diseases in agriculture has evolved partly as a response to public concern about the use of hazardous agrochemicals. Attempts have been made to use biocontrol agents against *Phytophthora* species, effective biocontrol microorganisms are expected to contribute to reduction in the use of chemical fungicides, and increasing farmer's profit margins.

Until disease-tolerant cultivars are readily available and adequate extension services are provided, a low-input IPM strategy disseminated through farmer field school training is seen as a short-to-medium-term solution to the current challenges in pest management.

Objectives:

Application of *Trichoderma asperellum* in disease management, rational use of fungicides.

Inclusion of biocontrol agents (BCA) as part of the IPM strategies.

Methodology

Biocontrol agents: The biocontrol agents used was isolated from the leaves of cacao tree and natural forest reserve soils in Ibadan, Nigeria and stored in sterile distilled water on small plugs of modified potato dextrose agar. Isolate of *Trichoderma* were cultured and maintained on potato dextrose agar. Eight day old cultures of *Trichoderma* were flooded with sterile distilled water harvested by scrapping the plates gently. The obtained suspensions 50ml were then adjusted to 10^8 conidial/ml and mixed to get a 300ml solution of a 1.5% sterile cassava flour liquid suspension. The biocontrol isolate suspension was stored in a refrigerator and transported to the field.

Field Trial: The field trials were carried out at three locations (Iloro-Idanre, Owode, Khalime and Bendeghe). The experimental plots were set up in a completely randomized block experimental design with 3 replicates, in cacao fields left untreated with chemical fungicides for 5 years due abandonment but was newly re-opened, on which the pathogen pressure was well established. Five treatments (F, Tr, Tr+F, Tr+F_1 and C) where F is Funguran OH; Tr = *Trichoderma*; Tr+F = Funguran OH sprayed only once +*Trichoderma* 5 times; Tr+F1 = Funguran OH sprayed twice +*Trichoderma* 4 times; C = Sprayed with sterile water. Six applications of each treatment were made during this field trial. All treatments were applied in liquid suspension using a hand – operated sprayer and 150ml/tree was appliedin one pass over each plot.

Disease incidence ratings were taken for each tree in each plot every week after the first application till the end of the trial. Data were taken on number of pod and cherelles production, while number of damaged and *Phytophthora* pod rot were taken as total pod loss on each tree in each plot. All data collected were subjected to analysis of variance (ANOVA) while the means were separated with Duncan's Multiple Range Test (DMRT).

Results

The output of the different treatments application of *Trichoderma* and chemical fungicide (funguran OH) in Iloro-ldanre are as shown in table 1.

Table 1: Pod production and incidence of *Phytophthora* Pod rot in Iloro-Idanre

Treatment	Pod Production	Cherelles Production	*Phytophthora* Pod rot	
			No. of Pod	% Pod rot
F	215.0b	100.0b	12	5.6
Tr	224.0a	172.0a	11	4.9
Tr+F	122.0e	51.0e	20	16.4
Tr+F1	160.0c	72.0d	22	13.8
C	153.0d	91.0c	28	18.3

Each value is the mean of 3 replicates. Means followed by the same letter in the same column are not significantly different according to DMRT (5%) .

The highest pod and cherelle production of 224 and 172 respectively were observed in *Trichoderma* treatment while the least (122 and 51 respectively) was observed in a combination of *Trichoderma* and funguran treatment. However the lowest percent of *Phytophthora* pod rot incidence (4.9%) was observed in *Trichoderma* treatment whereas it was higher(16.4%) in the combination of *Trichoderma* and funguran, both of which differ significantly (P=0.05) compared to 18.3% in the untreated control (table 1). The pod productions in all the treatments differ significantly from the untreated control, likewise are the number of cherelles production in the treatments as well as the percent of *Phytophthora* pod rot incidence obtained from Iloro-Idanre (table1).

The effects of the different treatments on the control of *P. megakarya* was the primary target of this research work, which could be seen from the result in the tables of this but significant effect of *Trichoderma* could be seen in Iloro-Idanre as it influenced the pod production of the cacao tree.

In table 2, both the number of pod production and cherelles production differ significantly in all the treatments and compare to the control. However, the pod production was highest (328) in trees treated with funguran application and the least percent (6.9%) of *Phytophthora* pod incidence was recorded in the same followed by that of *Trichoderma* and funguran combination and *Trichoderma* alone respectively in Khalime. The untreated control has 473 numbers of cherelles produced and the highest percent (14.8%) of *Phytophthora* incidence in this community.

This study shows that the treatments *Trichoderma* and funguran when applied alone improved the number of pod production in Iloro-Idanre and Khalime which differ significantly from the untreated control. *Trichoderma* treatment applied in Iloro-Idanre has the highest number of pod and cherelles production with the least occurrence of *Phytophthora* spp. after applications. This shows *Trichoderma* to be effective as a bio-control agent of *P. megakarya*.

Table 2: Pod production and incidence of *Phytophthora* Pod rot in Khalime

Treatment	Pod Production	Cherelles Production	*Phytophthora* Pod rot	
			No. of Pod	% Pod rot
F	328.0a	391.0c	22	6.7
Tr	297.0b	394.0b	35	11.7
Tr+F	192.0d	333.0d	20	10.4
Tr+F1	176.0e	324.0e	24	13.6
C	256.0c	473.0a	38	14.8

Each value is the mean of 3 replicates. Means followed by the same letter in the same column are not significantly different according to DMRT (5%)

The untreated control in Bendeghe community (table 3) has the highest number of pod production (129), while the number of cherelles produced is significantly high (151) following the highest of 154 in funguran application. The least percent incidence (9.8%) of *Phytophthora* pod rot was found in a combination of *Trichoderma* and funguran followed by that of funguran (12.9%) treatment. The untreated control in this community has the highest number of pod production of 129 pods but also recorded the highest percent (17.8%) of *Phytophthora* pod incidence (table 3).

The pod production in *Trichoderma* and untreated control do not differ significantly in Owode community (table 4), though both differ significantly from other treatments. However, cherelles production of 111 cherelles was also highest in the untreated control but least in funguran treatment (37.0).

The observation of highest pod production in funguran application in Khalime community, the highest cherelles production and the least percent of *Phytophthora* in the untreated control require further experimental studies.

It could be observed in this study that the efficiency of *Trichoderma* and funguran OH treatments when applied alone and in combinations differ significantly from one community to the other when compared to the untreated control. This however could be linked to the climatic and ecological diversity of the communities as the applications were done at the same period.

Table 3: Pod production and incidence of *Phytophthora* Pod rot in Bendeghe

Treatment	Pod Production	Cherelles Production	*Phytophthora* Pod rot	
			No. of Pod	% of Pod
F	77.0d	154.0a	10	12.9
Tr	72.0e	124.0d	12	16.7
Tr+F	102.0b	52.0e	10	9.8

Tr+F1	98.0c	128.0c	14	14.3
C	129.0a	151.0b	23	17.8

Each value is the mean of 3 replicates. Means followed by the same letter in the same column are not significantly different according to DMRT (5%)

Whereas, the percents incidence of *Phytophthora* (23.8%) was least in the funguran treatment which differ significantly from the untreated control which has (72.1%) the highest *Phytophthora* incidence (table 4).

Table 4: Pod production and incidence of *Phytophthora* Pod rot in Owode

Treatment	Pod Production	Cherelles Production	*Phytophthora* Pod rot No. of Pod	% of Pod
F	63.0b	37.0d	15	23.8
Tr	68.0a	99.0b	26	38.2
Tr+F	43.0d	41.0c	13	30.2
Tr+F1	55.0c	44.0c	20	36.4
C	68.0a	111.0a	49	72.1

Each value is the mean of 3 replicates. Means followed by the same letter in the same column are not significantly different according to DMRT (5%)

The results also show diversity in the pod production and reduction of *Phytophthora* pod rot under different treatments. Except in Iloro-Idanre, the treatment with the highest number of pod production does not have the least incidence of *Phytophthora* pod rot.

Conclusion and Recommendation

There is need to investigate the integrated pest management (IPM) strategies including biocontrol, rational use of chemicals and technology transfer. Also, the integration of botanicals into the IPM for black pod disease needs to be investigated.

Experimental Title: Remediation potential of sokoto rock phosphate in heavy- metal contaminated cocoa soil in Nigeria (Aikpokpodion Paul E)

Introduction

As human activity impacts the environment, metal contamination issues are becoming increasingly common (Fernandes and Herriques, 1991). Metals are a natural part of terrestrial system and occur in soil, rock, air, water and organisms. Afew metals inmcluding Cu, Mn and Zn are required by plants in trace amount. It is only when metals are present in bioavailable forms at excessive levels that they have the potential to become toxic to plants. Part of the sources of metals in agricultural soils is use of fertilizers, sewage sludge and animal wastes used as fertilizers, pesticides and irrigation water (Reddy *et al*., 1995). Many cocoa soils in Nigeria have accumulated copper in them due to long term application of Cu-based fungicide in the control of the black pod disease of cocoa (Aikpokpodion et al., 2010; Aikpokpodion, 2010). Copper being a metal is not biodegradable by soil microorganisms which is the main reason why it accumulates in soil. The build-up of copper in soil can lead to its undue absorption and translocation to various vegetative parts of the tree including the beans which is the economic part of the crop. In order to keep the level of copper residue in cocoa beans within the acceptable limit set by the European Union, it became necessary to apply in situ remediation technique which will not involve excavation of soil before treatment.

Objectives

The study was carried out to evaluate the potential of Sokoto rock phosphate in the remediation of heavy metal-contaminated soils.

Methodology

Surface soil (0-30cm in depth) contaminated with copper was collected with soil auger in a cocoa plantation in Owena, South-Western part of Nigerian. The farm has the history of twenty five years of continuous application of copper fungicide. The soil samples were air-dried and then ground and passed through 2mm sieve prior the introduction of Sokoto rock phosphate. Chemical analysis of the soil sample used for the study was also carried out.

Treatments: Sokoto rock phosphate (36% P) was purchased from Glamour Nigeria Limited, Ibadan, Nigeria. The pulverized rock phosphate was sieved through 266µm before application. The rock phosphate material contained 2.5mg/kg cadmium. For pot experiment, 20g, 40g and 60g rock phosphate were mixed with the soil sample. There were four treatments including the control pot in which no rock phosphate was added. Rock phosphate application rate was based on the specific P/total metal molar ratio. Total metals, for the purpose of the immobilization treatments in this study, were defined as the sum total of Cu, Pb, Zn and Cd which was determined by Atomic Absorption Spectrophotometer. This application rate was chosen with the intent to immobilize the total concentrations of the main four metal specie of interest in the studied soil. In related work, authors have used the ratio of 3/5 P/M total as the basis of hydroxyapatite and apatite treatments to Pb-contaminated soils (Laperche et al., 1997; Qiao et al., 2003; Ryan et al., 2001 and Zhang and Ryan, 1991). This ratio corresponds to the P/Pb ratio for chloropyromorphite [$Pb_5(PO_4)_3Cl$]. However, due to the solubility of rock phos[hate in soils, since the total P may not react with insoluble Pb, higher P/Pb molar ratios (up to 11.2) have been suggested by Zhang and Ryan, (1999); Basta and Gradwohl, (2001) and Hettiarachchi and Pierzynski (2002)

Pot Experiments

Two and half kilogram of the treated and untreated soil samples were packed into each polypropylene pot. Four treatments were: a control with no rock phosphate amendment, amendment with 20g RP, 40g RP and 60g RP. The treatments were kept moist and incubated for one month before the sowing of cocoa beans. This was done to allow the solubilization of rock phosphate in soil solution in order to make the phosphate active in the stabilization of the heavy metals in soil. The seedlings were allowed to grow for six months after which the experiment was terminated. At termination the plant was removed from the pot and washed with distilled water, sun-dried and kept in oven for 4 hours at 60^{o}C. The leaves, stem and roots were pulverized and digested with $HCl/HNO_3/HClO_4$(3:2:1, v/v/v) and the concentration of Cu, Pb, Zn and Cd were determined. But for this report Cd is not included.

Metal speciation

After the removal of cocoa seedlings from the rock phosphate treated soils, some portion of the remaining soil samples in the various pots were air-dried and sieved with 2mm sieve prior to sequential extraction of Cu, Pb, Zn and Cd. One gram of each of the samples including the control was weighed into 30ml sample bottles and the procedure of Tessler (1979) was used to separate the heavy metals into various fractions.

Statistical analysis

The data generated from the various chemical analysis were subjected to ANOVA analysis using SPSS Version 15 and differences ($P < 0.05$) between means were determined using Duncan test.

Results and Discussions

Result showed that, foliar bioaccumulation factor of Cu was 2.48 in the control cocoa seedlings while bioaccumulation factor of Cu was 0.5, 0.76 and 0.38 in seedlings from soils treated with 20, 40 and 60g kg^{-1} phosphate respectively (Table1). Bioaccumulation factor is the ratio of heavy metal in plant to the heavy metal in soil. This result is an indication of significant reduction in the absorption and accumulation of copper in plant tissue as a result of immobilization of soil copper by the applied rock phosphate. The bioaccumulation factor of Pb in the foliage of control cocoa seedlings was 24.94 while bioaccumulation factor of Pb was 3.12, 2.73 and 5.84 in seedlings from soils treated with treated with 20, 40 and 60g kg^{-1} phosphate respectively. Bioaccumulation factor of Zn in foliage of control seedlings without rock phosphate was 21.66 while bioaccumulation factor of Zn was 13.13, 5.20 and 5.00 in seedlings planted in 20, 40 and 60g kg^{-1} rock phosphate treated soils respectively. Result show that, Zn bioaccumulation factor in all the treated seedlings were significantly lower than that of the control. Result show that, bioaccumulated Cu, Pb and Zn in foliage of cocoa seedlings planted in soils treated with 20g, 40g and 60g were significantly ($P < 0.05$) lower than the control (Table 1). Translocation factor of Cu in foliage of the control seedlings was 0.49

while translocation factor of Cu was 0.10, 0.15 and 0.08 in seedlings planted in soil treated with 20, 40 and 60g kg^{-1} rock phosphate respectively. Translocation factor of metal in foliage of cocoa seedlings is the ratio of heavy metal in leaves and metal in the roots. There was significant reduction in translocated Cu in foliage of seedlings planted in soils treated with rock phosphate than the control which had no rock phosphate treatment. Translocation factor of Pb in foliage of the control experiment was 6.86 while factor of 0.86, 0.79 and 1.64 was obtained in foliage of seedlings planted in soil treated with 20, 40 and 60g kg^{-1} phosphate respectively. Translocation factor of Zn in the control seedlings (0.39) was significantly higher than the translocation factors (0.24, 0.09 and 0.09) of Zn in foliage of seedlings planted in soil treated with 20, 40 and 60g kg^{-1} rock phosphate respectively. Result showed that, the application of rock phosphate significantly ($P<0.05$) reduced the uptake of zinc from the soil treated of seedlings treated with rock phosphate. Figure 1show the reductive effect of rock phosphate on Cu, Pb and Zn mobility in Owena cocoa soil. Result showed that, the treatment of the contaminated soil with 20, 40 and 60g kg^{-1} rock phosphate reduced Cu mobility by 19%, 35% and 42% respectively while Pb mobility was reduced by 12%, 23% and 25% respectively zinc mobility was reduced by 38%, 54% and 54% by the application of 20, 40 and 60g kg^{-1} phosphate respectively to the contaminated soil.

The relationship between metals in cocoa foliage and heavy metal fractions in Owena cocoa soil is presented in Table 3. Linear regression of data generated from the determination of metals in cocoa seedlings' foliage and heavy metal fractions of rock phosphate-treated soil showed that, Pb in exchangeable fraction had the highest R^2 value with foliar Pb (0.85).

Relationship between water soluble Pb and foliar Pb had R^2 value of 0.37 while carbonate bound Pb had R^2 value of 0.15 with foliar Pb. Fe-Mn oxide bound Pb had R^2 value of 0.26 with foliar Pb. R^2 values between water soluble Cu, exchangeable Cu, carbonate bound Cu, Fe-Mn oxide Cu and foliar Cu was 0.83, 0.07, 0.43 and 0.02 respectively. Regression analysis between zinc in the various metal fractions in soils and foliar Zn had R^2 values of 0.61, 0.82, 0.71 and 0.26 for water soluble, exchangeable, carbonate bound and Fe-Mn oxide respectively.

Discussion

Metals remobilization

The effect of rock phosphate on heavy metals transformation from non residual fraction to residual fraction was shown by the reduction of mobility factor of the various metals in the treated soil samples (Figure 1). The reduction in mobility factor is an indication that, the metals have been stabilized in soil by being remobilized from available to non available fraction . Mobility factor was calculated by the formula $MF=F1+F2+F3/F1+F2+F3+F4+F5+F6 \times 100$. The Fs are the various fractions of heavy metals in soil. When a particular heavy metal is in its labile state (soluble) it can easily be bioavailable. But when the metal is transformed or remobilized from available (non residual) state to unavailable state (residual). Such metal becomes inactive, stable and unavailable for plant uptake. By this, success would have been made in reducing the toxicity and contamination of such metal in soil environment. The non residual fractions include; water soluble fraction, exchangeable, carbonate, Fe-Mn oxide and organic fractions. Heavy metals bound or associated with the water soluble, exchangeable and carbonates are bioavailable to plants and the environment. The remaining two fractions in the non residual fraction (Fe-Mn oxide and organic) are not readily available except there are favorable chemical reactions in soils.

Effect of rock phosphate on heavy metal uptake in cocoa seedlings

The concentration of metals in foliage of cocoa seedlings planted in rock phosphate - treated soil were significantly ($P< 0.05$) lower than the concentration of metals in foliage of controlled cocoa seedlings which had no rock phosphate (Table 1). This implies that, the applied rock phosphate significantly immobilized Cu, Pb and Zn in the contaminated soil thereby, reducing the amount of metals taken by cocoa seedlings. Translocation factor was calculated as TF= metal in foliage/metal in root. On the other hand, Bioaccumulation factor was calculated as BF = metal in foliage/metal in soil. Two main different mechanisms have been proposed for the immobilization of Pb: first mechanism involves rock hydroxyapatite (rock phosphate) followed by phosphate reaction with dissolved Pb and precipitation of pure hydroxypyromorphite (Ma *et al*., 1993; Xu and Schwartz, 1994; Chen *et al*, 1997). At 60g rock phosphate treatment, it was observed that, translocated and bioaccumulated Pb was higher than those treated with 20 and 40g rock phosphate which appeared to be a deviation from the trend of Cu and Zn. This suggests a release of Pb from the rock phosphate which is a confirmation of the report of McLaughlin *et al*., (1996) and Mort ve dt, (1996) who stated that rock phosphate compounds contain a range of metals. According to McLaughlin *et al*., (1996), addition of phosphate compounds to soils does not only help to overcome the deficiency of some of the essential trace elements, but could also introduce toxic metals. However due to the fact that, rock phosphate slowly dissolves, its recommendation has been made for use by many authors without fear of soil contamination.

Result (Table 3) show that, among the various fractions of heavy metals studied, the water soluble and extractable fractions are well correlated with heavy metals in the foliage which suggest that, availability of Cu, Pb and Zn for cocoa seedlings in rock phosphate amended soil depend on available metal present in the water soluble and exchangeable fractions. This implies that, the bulk of these metals found in cocoa tissue are mainly mined from these two fractions. According to so many authors, metals in the water soluble and exchangeable fractions are the most available for plant uptake. Metals within the soil solution are the only soil fraction directly available for plant uptake (Fageria *et al*., 1991; Marschner, 1995; Whitehead, 2000).

Table 1: Effect of rock phosphate on soil pH

	Month1	% Inc	Month 2	% Inc	Month 4	% Inc	Month 6	% Inc
Control	5.72^{b}	-	5.54^{c}	-	5.59^{b}	-	6.55^{b}	-
20g/kg	6.57^{a}	14.86	6.60^{b}	19.13	6.68^{a}	19.50	7.34^{a}	12.06
40g/kg	6.79^{a}	18.70	6.73^{ab}	21.48	6.67^{a}	19.32	7.35^{a}	12.21
60g/kg	6.63^{a}	15.91	6.79^{a}	22.56	6.66^{a}	19.14	7.34^{a}	12.06

Key: % Inc = Percent Increment in soil pH

Same alphabets on the same column are not significant at $p<0.05$

Different alphabets on the same column are significant at $p<0.05$

Table 2: Effects of rock phosphate on heavy metal translocation and mobility factors

	Translocation factor			Bioaccumulation factor		
Treatments	Cu	Pb	Zn	Cu	Pb	Zn
Control	0.49±0.03a	6.86±0.05a	0.39±0.03a	2.48±0.06a	24.94±0.3a	21.66±1.5a
20gP/kg soil	0.10±0.02c	0.86±0.02c	0.24±0.02b	0.50±0.02b	3.12±0.14c	13.13±1.6b
40gP/kg soil	0.15±0.02b	0.79±0.02c	0.09±0.02c	0.76±0.04b	2.73±0.17c	5.20±0.41c
60gP/kg soil	0.08±0.01c	1.64±0.01b	0.09±0.03c	0.38±0.03c	5.84±0.21b	5.00±0.52c
	% reduction in Translocation factor			% reduction in Bioaccumulation factor		
	Cu	Pb	Zn	Cu	Pb	Zn
20gP/kg soil	69.39	87.46	38.46	80.00	87.50	39.42
40gP/kg soil	68.39	88.48	76.92	69.23	89.06	75.96
60gP/kg soil	83.67	76.09	77.00	81.0a	76.56	76.92

Key: Different alphabets on same column are significantly different ($P < 0.05$)

Table 3: Linear regression of metals in leaves and various metal fractions

	Lead	
Fractions	y	R^2
Water soluble	0.0037x + 0.886	0.371
Exchangeable	0.0157x + 13.747	0.850
Carbonate	-0.0014x + 3.84	0.150
Fe-Mn oxide	0.0124x + 2.169	0.266

	Copper	
Water soluble	0003x + 0.42	0.839
Exchangeable	-0.0017x + 1.924	0.079
Carbonate	0.0021x + 1065	0.432
Fe-Mn oxide	0.0063x + 6.415	0.027
	Zinc	
Water soluble	0.006x + 0.239	0.614
Exchangeable	0.0219x + 2.66	0.820
Carbonate	0.0157x + 18.42	0.717
Fe-Mn oxide	-0.0076x + 7.94	0.269

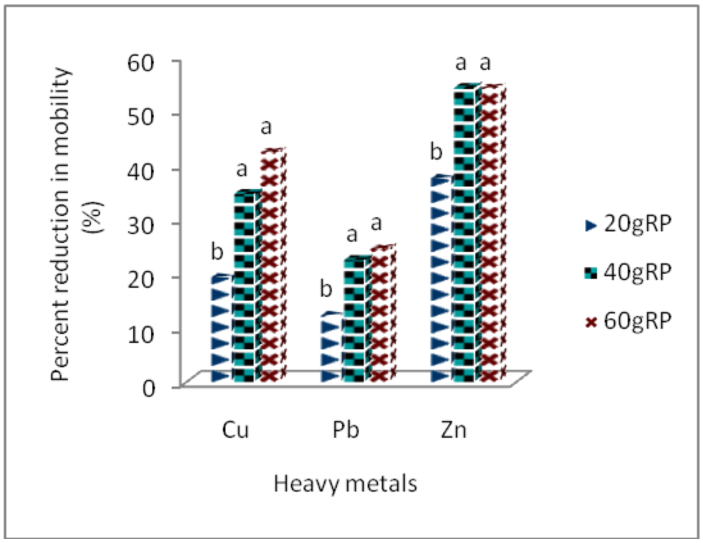


Figure 1: Reductive effects of rock phosphate on heavy metal mobility factor

Conclusions and Recommendation

This study has shown that, Sokoto rock phosphate is a potential remediation material for copper, Pb and Zn contaminated soil by significantly reducing bioaccumulated and translocated metals in cocoa seedlings tissue. This material has a double advantage in its application on agricultural soils. It increases soil fertility and at the same time reduces the mobility of heavy metals in soil. However, due to the presence of trace metals in rock phosphate, its application should be based on calculated total heavy metals in soils to be treated in order to avoid undue introduction of trace metals into the environment.

References

Aikpokpodion P.E (2010) Assessment of heavy metal pollution in fungicide treated cocoa plantations in Ondo State, *Nigeria. Journal of Biosciences* 33:2037-2046.

Aikpokpodion P.E, Lajide L. and Aiyesanmi A.F (2010) heavy metal contamination in fungicide treated cocoa plantations in Cross River State, Nigeria. *American-Eurasian J. Agric & Environ Sci*. 8(3) 268-274.

Basta N, Gradwohl R, Snethen K, Schroder J (2001) Chemical immobilization of lead, zinc and cadmium in smelter contaminated soils using biosolids and rock phosphate. *J Environ Qual*

Chen X., Wright J., Conca J., Perurrung L. (1997). Evaluation of heavy metal remediation using mineral apatite. *Water Air Soil pollution* 98:57-78

Fageria N.K., Baliger V. and Jones C.A (1991). Growth and Mineral Nutrition of Field Crops. Marcel Dekker, New York.

Fernandes, J.C and Henriques F.S (1991) Biochemical, physiological and structural effects of excess copper in plants. The Botanical Review 57: 246-273

Hettiarachchi G, Pierzynski G (2004) Soil Lead bioavailability and in situremediation of Lead-contaminated soils: a review. *Environ Prog*. 23: 78-93

Laperche V, Logan T.J., Gaddam P., Traina S.J. (1997) *Environmental Science Technol* 31: 2745

Ma QY, Traina SJ, Logan TJ (1993) In situ lead immobilization by apatite. *Environ Sci Technol* 27:1803–1810

Marschner H. (1995). Mineral Nutrition of Higher plants 2nd edn. Academic Press, London.

Mclaughlin M.J., Tiller KG, Naidu R., Stevens D.P (1996) Review: the behaviour and environmental impact of contaminants in fertilizers, *Australian Journal of Soil Research* 34:1-54

Mort Vedt J.J. (1996) heavy metal contaminants in organic and organic fertilizers. *Fertilizer Research* 43:55-61

Qiao X.L, Luo Y.M, Christie P., Wong M.H (2003) *Chemosphere* 50:823

Reddy J., Wang L. and Gloss S.P.(1995) Solubility and mobility of copper, Zinc and Lead in acidic environments. *Plant and Soil* 171: 53-58

Ryan J.A, Zhang G P. Hesterberg D., Chou J., Sayers D.E (2001) *Environmental science and Technology* 35:3798

Tessier A., Campbell P.G.C and Bisson M. (1979). Sequential extraction procedure for the speciation of particulate trace metals. *Anal. Chem*. 51:844-851

Whitehead D.C. (2000). Nutrients elements in Grasslands: Soil – plant – Animal Relationship: CABI Publishing Wallingford

Xu Y, Schwartz F (1994) Lead immobilization by hydroxyapatite in aqueous solution. *J Contam Hydrol* 15:187–206

Zhang P., and Ryan J.A (1999*) Environmwntal Science and Technology* 33:625

Zhang P., Ryan J. (1999). Formation of chlorophyromorphite from galena (Pbs) in the presence of hydioxyapatite. *Environ Sci. Technol* 33:618-624

Experimental Title: Cost effectiveness of intercropping patterns by Cashew farmers in Oyo State(Lawal, J.O and Uwagboe, E.O)

Introduction:

In the bid to get rural farmers out of the vicious circle of poverty in Nigeria, efforts have to be intensified on improving farmers' productivity, whereby they can generate higher revenue that leads them to improved welfare and food security. As part of capacity development efforts, research was done on the ideal, most cost effective and profitable intercrop on cashew plantations.

Objective:

(i) Determine the socio-economic characteristics and its relation to intercrop patterns among cashew farmers;
(ii) Assess the cost effectiveness of the various intercrops on cashew plantations;
(iii) Ascertain the most ideal, cost effective and profitable intercrop on cashew plantations.

Materials and Methods:

The study assessed the cost effectiveness of the various intercrops on cashew plantations in Oyo State, Nigeria considering the cost of production, revenue accruable to the farmers at the end of the production season. Primary data were collected from 130 cashew farmers in Eruwa, Lanlate and Ogbomoso areas using well structured questionnaire administered through multi-stage random sampling technique. Data collected were analyzed using descriptive statistics, budgetary and multiple regression analysis.

Result and Discussion:

The results revealed that 84.62% are males, 7.69% are graduates of university while 19.23% have primary education. Most (88%) of the farmers are married, with mean year of cashew farming experience at 23 ±8.49 years, mean age of plantation as 17 ±9.27 years, mean age of farmer was 48 ±12.57 years and mean household size at 5 ±2.96persons. The mean farm size was 2 ±2.14acres, the total revenue accruable to the farmer is ₦109, 237 ±₦18, 390 ($728.25) from intercropping on cashew plantation while the estimated expenditure on the plantation per season was estimated at ₦47, 084 ±₦15, 134($313.89). The revenue accruable from the different intercrops such as maize is ₦95, 666.67± ₦34, 826.56($637.78), cowpea ₦13, 573.33 ±₦11, 828.19($90.49); yam and cassava ₦50, 066.67 ±₦98, 167.34($333.78) and from Vegetable intercrop ₦5, 742.86 ±₦4, 007.02. The regression results revealed that Maize is the most cost effective intercrop ($p<0.01$) on cashew plantations in Oyo State, Nigeria during early stages from which high profit can accrue to the farmer for food security and improved livelihood.

Conclusion:

This study concludes that in the study area Maize is a better intercrop in cashew plantations compared to the other intercrops used by cashew farmers in their plantations. This will ensure food security and increased income for the faming households.

Experimental Title: Farm labour structure and its determinants among cocoa farmers in Nigeria (Oluyole, K.A., Oduwole, O.O. and Adebiyi, S.)

Introduction

Agricultural production is the mainstay of the Nigerian economy; considering the fact that over 80 percent of the economically active populations are involved in agricultural production and that over 90 percent of the food consumed in the country is from the local agricultural production. It is the second largest earner of foreign exchange; next to the nonsustainable petroleum sector, and also it provides a ready market for industrial products (Ayanwale, 2002). Nigerian agricultural sector is dominated by small-scale farmers whose farms vary between 0.10 and 5.99 hectares in size and constitute about 80.35% of all the 29,800 million farm holdings in Nigeria. Their farmers used traditional technologies called hoe-cutlass culture and their capital structure is in form of small tools and predominant usage of family labour (Oluyole *et al*, 2009). Human labour is about the only main source of labour available to smallholder farmers in Nigeria. Smallholder farmers contribute over 85% of domestic agricultural output in Nigeria, hence, human labour accounts for domestic food supply in Nigeria. Therefore, the needs to continue supplying food the ever-growing Nigerian population anchors on human labour productivity. In Nigerian agriculture, hired labour is predominantly used. In fact, it carries 88% of the total labour used on farms (Okuneye, 2000). Apart from hired labour, the other types of labour that could be employed are family labour and cooperative labour. The availability of labour has been found to have impact on planting precision, better weed control, timely harvesting and crop processing (Oluyole *et al,* 2007). Therefore, labour is a major constraint in peasant production especially during planting, weeding and harvesting (Gocowski and Oduwole, 2003).

With the foregoing, it could be observed that human labour plays a very significant role in agricultural development especially in the developing countries in which the level of technological development is still very low. In view of the importance of labour in agricultural production, this study was designed to investigate the structure and determinants of farm labour in the study area. The study was undertaken through the following objectives:

(i) to determine the structure of labour used for cocoa production in the study area.

(ii) to assess the determinants of labour supply for cocoa production in the study area.

Methodology

The study was carried out in Ondo state, Nigeria. Ondo state lies within the Southwestern part of Nigeria with the total area of about 20,595 hectares. The state is characterized by heavy rainfall with climate following usual tropical pattern. The state is predominantly an agricultural area and most of the inhabitants (about 70%) are farmers (Akinsorotan, 1997). The farmers engage primarily in the production of cocoa but often intercropped with kolanut, oilpalm, plantain and banana. Also, food crops like cassava, maize, yam and vegetables are cultivated. Two high cocoa producing Local Government Areas (LGAs) in the state were randomly selected for the study and one hundred respondents were randomly selected from the two LGAs. Structured questionnaire was used to collect information from the respondents and the data retrieved from the information was analysed using descriptive statistics as well as multivariate regression model. Descriptive statistics such as frequency, percentages, mean, standard deviation, minimum and maximum were used to analyse the socio-economic variables of the farmers as well as the structure of labour used for cocoa production in the study area. Regression model was used to evaluate the determinants of the use of labour for cocoa production in the study area.

The model could be represented thus:

$Z = \beta X_i + e$

Where:

Z = Vector of dependent variable and it represents the quantity of labour (in mandays) used by ith farmer for cocoa production in the study area,

β = Vector of unknown parameters,

e = Random error term,

X = Vector of explanatory variables and *i* is the number of respondent cocoa farmers. The explanatory used in the model includes:

X_1 = farming experience of farmers (years);

X_2 = household size;

X_3 = labour cost (₦);

X_4 = wage rate (₦);

X_5 = farm income (₦);

X_6 = farm size (hectare);

X_7 = farm input (₦);

X_8 = cocoa output (₦).

Results and Discussion

Table 1 shows the socio-economic characteristics of the respondents. The table shows that 76% of the respondents were males showing that a greater proportion of cocoa farmers in the study area were males. The dominance of the males over the females may be attributed to the fact that male children are considered in the inheritance of farm land in the study area. Also, females are involved in off-farm activities such as buying and selling of farm produce, storage of crops and packing of farm produce while their male counterparts were highly involved in tree crop production most especially cocoa in the study area. Table 1 also shows that 86% of the respondent farmers were married. The large percentage of those who were married connotes that marriage is highly cherished by the people of the study area and could lead to an increase in household size which has implication on family labour supply. It could also observed from the result that 66% of the respondents had more than eight members as household size. Meanwhile, the mean household size for the study area was nine showing that a greater proportion of the respondents had large household size. This has a great implication on family labour supply as large household size has tendency to supply more family labour. Table 1 also shows that 65% of the respondents had formal education while just 35% of the respondents had no formal education. This has an impact farmer's productivity as farmer's productivity increases with increase in the farmer's level of education (Oluyole, 2005). It could be observed on the table that 80% of the total respondents had farm size between one and five hectares while just 1% of the respondents had more than ten hectares farm. This is a typical characteristics of Nigerian farmers. Most Nigerian farmers are small scale farm holders and this has been the bane of agricultural development in developing countries. One of the causes of small holding farms is the use of crude implements such as hoes and cutlass and lack of technical know-how that may be required to cultivate large farms.

Table 1: Socio-economic characteristics of farmers

Variables	Frequency	Percentages
Gender		
Male	76	76
Female	24	24
Total	100	100
Marital status		
Married	86	86
Single	5	5
Widowed	9	9
Total	100	100
Household size		
1-44	4	
5-8	30	30
>8	66	66
Total	100	100
Mean	9	
Standard deviation	2.79	
Level of education		
No formal education	35	35
Primary education	31	31
Secondary education	19	19
Post-secondary education1515		
Total	100	100
Farm size (hectare)		
1-5	80	80
6-10	19	19
> 10	1	1
Total	100	100
Mean	4	
Standard deviation	2.71	

Source: Field survey: 2009

Table 2 shows the type of labour used by the farmers for cocoa production. The table shows that most (44%) of the farmers in the study area used sharecropping while 18% and 16% of the farmers used reciprocal and hired labour respectively. Meanwhile, only few (8%) of the farmers used family labour. The result however showed that sharecropping is mostly used as source of labour for cocoa production in the study area. Table 3 shows the type of labour used for different activities in cocoa production in the study area. The result shows that 94% of the farmers used hired labour for farm clearing while only 6% used family labour indicating that hired labour is predominantly used for farm clearing in the study area. It could also be observed in table 3 that 66% of the farmers used hired labour for seedling planting and 34% of the farmers used family labour for the operation. As for fertilizer application, 6% of the farmers used family labour for the operation while 25% used hired labour. However, there was no response from 69% of the total farmers as regards the use of labour for fertilizer application. Their response was that they don't use fertilizer on their farms. Eighty-nine percent of the farmers used hired labour for chemical application while just 11% used family labour. It could also be observed in table 3 that 61% and 51% of the respondent farmers used hired labour for cocoa harvesting as well as on-farm cocoa processing indicating that on the average, hired labour was used for these activities in the study area. Table 4 shows the type of gender used for different farm activities for cocoa production in the study area. The table shows that all (100%) of the farmers used male for farm clearing while none of the farmers used female for farm clearing. Hence, male is predominantly used for farm clearing in the study area. Results also shows that 92% of the farmers used male for seedling planting while 8% used female indicating that male is predominantly used for seedling planting in the study area. Twenty-six percent of the farmers used male for fertilizer application while just 2% of the total farmers used female for the operation. There was no response from seventy-two farmers as regards the use of labour for fertilizer application. As for chemical application, 94% of the respondent farmers used male and just 6% used female for the operation. However, 60% and 75% of the farmers used female for cocoa harvesting as well as on-farm cocoa processing indicating that females are predominantly used for these operations in the study area. Table 5 shows the age structure of labour used for cocoa production. The table shows that 98% of the respondent farmers used adult for farm clearing while only 2% of the farmers used under aged children for the same operation. This is quite obvious in as much farm clearing is a tedious work, hence it is only the adults that could have such a required strength to carry out such an operation. As regards planting of seedlings, 92% of the farmers used adults for the operation and just 8% used under-aged children for the operation. Therefore, it is adults that are predominantly used for cocoa planting in the study area. These findings conform with the UNICEF's (United Nations Children Fund) recommendation that under-aged children should not be used to produce cocoa. Table 5 also shows that 100% of the farmers used adults for chemical application and on-farm cocoa processing while 99% of the respondent farmers used adults for cocoa harvesting. Table 6 shows the wage rate for different operations carried out on cocoa production in the study area. The table shows that the mean wage rate ranges between ₦514.00 ($3.43) and ₦583.50 ($3.89). The result revealed that farm clearing had the highest mean wage rate of ₦583.50 (($3.89)) while fertilizer application had the least mean wage rate of ₦514.00 (($3.43)). However, it could be said that farm clearing had higher wage rate because it is more tedious than fertilizer application. The mean wage rate for other operations were N563.04 ($3.75), N565.15 ($3.77), N559.69 ($3.73) and N557.65 ($3.72) for planting of cocoa seedlings, chemical application, harvesting and on-farm cocoa processing respectively.

Table 2: Type of labour used for cocoa production

Types of labour used	**Frequency**	**Percentage**
Family labour	8	8.00
Hired labour	16	16.00
Reciprocal labour	18	18.00
Casual labour	14	14.00
Sharecropping	44	44.00
Total	100	100.00

Source: Field survey, 2009

Table 3: Type of labour used for different farm activities

Farm activities	Hired labour	Family labour
Farm clearing	94	6
Seedling planting	66	34
Fertilizer application	25	6
Chemical application	89	11
Harvesting	61	39

On-farm cocoa processing	51	49

Source: Field survey, 2009.

Table 4: Gender of labour used for different farm activities

Farm activities	Male	Female
Farm clearing	100	0
Seedling planting	92	8
Fertilizer application	26	2
Chemical application	94	6
Harvesting	40	60
On-farm cocoa processing	25	75

Source: Field survey, 2009.

Table 5: Age category of labour used for different farm activities

Farm activities	Under-aged	Adult
Farm clearing	2	98
Seedling planting	8	92
Fertilizer application	1	30
Chemical application	0	100
Harvesting	1	99
On-farm cocoa processing	0	100

Source: Field survey, 2009.

Table 6: Wage rate (in Naira) for different farm activities

Farm activities	Mean	Std. Dev.	Min	Max
Farm clearing	583.5	113.2743	400	1000
Planting of seedlings	563.0435	119.2627	200	800
Fertilizer application	514	131.9091	200	800
Chemical application	565.1515	110.9915	300	800
Harvesting	559.6939	113.6685	300	800
On farm processing	557.6531	119.568	300	800

Source: Field survey, 2009.

The result of regression analysis was shown on table 7. The table shows that out of the eight variables investigated, three variables were found to have significantly affected labour use among the respondents. The significant variables were wage rate ($p<0.05$), farm income ($p<0.01$) and farm size ($p<0.01$). Wage rate significantly and negatively affected labour use. This is quite obvious because wage rate determines the extent to which labour could be used. When wage rate is low, more labour could be employed and vice versa. The negative sign complied with the apriori expectation and it indicates that as the wage rate decreases, this will give the farmers an opportunity to use more labour. Farm income also significantly and positively affected labour use. Increase in farmers' income enables farmers to employ more labour for farm activities, this is because farmers with high income will be able to pay labour wages more and hence will be able to use more labour than the farmers with low income. The positive sign shows that as farmers' income increases, labour use also increases. Farm size was also found to be significantly affected labour use. This is because the extent to which labour would be used is determined by the size of the farm. Large sized farms would require more labour than small sized farms and vice-versa. The positive sign of the coefficient of the variable indicates that as income increases, labour use also increases.

Table 7: Regression result

Variables	Coefficient	Prob.
Farming experience	-0.0871264	0.987
Household size	-0.6730173	0.414
Labour cost	0.0000496	0.301
Wage rate	-0.0339324**	0.051
Farm income	0.0003459***	0.000
Farm size	0.9782383***	0.012
Farm input	0.0000947	0.190
Cocoa output	-3.175744	0.299
Constant	-18.30204	0.431
Prob.	0.000	
Log likelihood	-423.41735	
Chi-square	754.95	

Source: Field survey, 2009.

Conclusion and Recommendation

Sharecropping is the type of labour that is mostly used for cocoa production in the study area. Sharecropping is a system in which the sharecropper provides all the labour required for cocoa production and will later entitled to a certain proportion of cocoa proceeds realized from the farm. More tedious operations such as farm clearing, planting of seedlings as well as chemical application were mostly undertaken by men while less tedious operations such as harvesting and on-farm cocoa processing were mostly undertaken by women. In all the operations, adults were predominantly used to carry them out while under-aged children were not majorly used in all the operations. Wage rate, farm income and farm size significantly affected labour for cocoa production.

Based on the empirical findings, the study therefore gives the following recommendations.

(i) Since income of farmers was found to have significantly affected labour use, therefore, farmers' income should be strengthened so as to be able to employ more labour for the farm activities. Enhanced income can be achieved by encouraging farmers to use improved technologies during establishment and maintenance of cocoa farms. This will improve the farmers' output and hence their income.

(ii) Rural infrastructural facilities should be provided as this would encourage the youths to stay on farms thereby increases farm labour strength. If the supply of labour is high, therefore the wage rate may be forced down and this would encourage farmers to employ more labour for farm activities.

References

Akinsorotan, A. O. (1997). Concept of labour pattern among cocoa farmers in Ondo state, *Journal of Rural Economic Development*. 13 (1): 85-95.

Ayanwale, B. A. (2002). Family investment in the Education of Children and Adolescents in Rural Osun State, Nigeria. In: Issues in African Rural Development Monograph Series.No. 21 Winrock International. pp. 9.
Gocowski, J. and Oduwole, S. (2003).Labour Practices in the Cocoa Sector of Southwest Nigeria with a special focus on the role of children. STCP/IITA monograph IITA, Ibadan, Nigeria.
Okuneye, P. A. (2000).“Employment Generating Potentials of Agricultural Processing and Storage Technology: Additional Gain in Increased Food Availability Pursuit” Paper presented at the workshop for local government officials in Lagos state.
Oluyole, K. A. (2005). Evaluation of the Economics of Post Harvest Processing of Cocoa in Cross River State, Nigeria. *Journal of Agriculture, Forestry and the Social Sciences.*3 (2): 58-64.
Oluyole, K. A., Adebiyi, S. and Adejumo, M. O. (2007).An Assessment of the Adoption of Cocoa Rehabilitation Techniques Among Cocoa Farmers in Ijebu East Local Government Area of Ogun state. *Journal of Agricultural Research and Policies.* 2 (1): 56-60.

JANUARY – DECEMBER REPORTS: ADMINISTRATION AND SUPPLIES DEPARTMENT

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

A. (1) STRUCTURE OF THE DEPARTMENT

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

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

Administration Division - Human Resources Management Section, Legal and CorporateMatters Section, Pension Section and Catering Services Section.

.

Supplies Division - Purchase and Supply Section and Stores Section.
The organogram of the Department is attached as **Annexure I**.
The personnel in the Department are made up of 12 Professionals in Administration, 21 Executive Officers and 22 Clerical Officers.

(2) ACTIVITIES OF THE DEPARTMENT

Detailed reports of the activities carried out are as follows:

(a) Cost-effective management of all the administrative activities of the Institute, including all elements of Personnel function, Legal and Corporate Matters, incorporating Governing Board affairs and Public Relations.

(b) Planning, organizing, co-ordinating and control of all activities, personnel, funds, materials, equipment and infrastructural resources in the Administration and Supplies Department of the Institute.

(c) Identifying, articulating, formulating and reviewing from time to time the administrative activities of the Institute in compliance with the statutory mandate of the Institute, current Government policies and priorities, as well as all rules and regulations for the management of Government Institutions as 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.

(d) Human Resources Management, including appointments, staff training and development, promotion, discipline, disengagement, post-disengagement, and staff welfare. Records of the aforementioned administrative functions are highlighted below:

(i) **PROMOTION**

Briefs on staff due for year 2012 promotion exercise are currently being prepared. A copy of the briefs will be submitted to the Executive Director/Chief Executive Officer on or before 30 August, 2012 for Management's consideration and further directive.

(ii) **APPOINTMENTS**

During the period (January - December, 2012) under review appointments of four (4) Senior officers, forty one (41) Junior officers, two (2) Contract officers were approved by the Management while contract appointment of Mr. Jonathan Olanrewaju was renewed for another year. The said approved appointments, details of which are stated hereunder, have been fully effected as appropriate.

LIST OF SENIOR OFFICERS EMPLOYED BETWEEN JANUARY AND DECEMBER, 2012

S/N	NAME	DESIGNATION	DATE OF APPOINMENT	REMARKS
1	Oyeledun Ibukun Oyenike	Nursing Sister/Nurse Superintendent	2/4/2012	
2	Ololowo Oluwatoyin Patience	,,	21/3/2012	
3	Popoola Abiola Tolu	,,	27/3/2012	
4	Abioye Bosede Folasade	,,	5/4/2012	

LIST OF JUNIOR OFFICERS EMPLOYED BETWEEN JANUARY AND DECEMBER, 2012

S/N	NAME	DESIGNATION	DATE OF APPOINMENT	REMARKS
1.	Oladele Olayemi	Assist. Agric. Supt.	6/1/12	
2.	Robert Oladare	Clerical Officer II	24/1/12	
3.	Makinde Gbolagade	Motor Driver	25/1/12	

4.	Sanni Ibirahin	Agric. Field Attd. III	26/1/12	
5.	Lawal Kafayat (Miss)	Agric. Field Attd. III	2/5/12	
6.	Olorungbami Nike	Agric. Field Attd. III	2/5/12	
7.	Taofeek Animashaun	Agric. Field Attd. II	2/5/12	
8.	Muritala Waheed	Agric. Field Attd. II	2/5/12	
9.	Olorunkalu Taye	Agric. Field Attd. III	2/5/12	
10.	Akinola Wasiu	Agric. Field Attd. III	2/5/12	
11.	Ramoni Aransi	Agric Field Atttd. III	2/5/12	
12.	Tijani Sadia Titi	Agric. Field Attd. III	2/5/12	
13.	IseOluwa Samuel	Agric. Field Attd. III	2/5/12	
14.	Sikiru Koro	Agric. Field Attd. III	2/5/12	
15.	Solomon Adeyemo	Watchman	2/5/12	
16.	Onipe Modupe (Mrs.)	Agric. Field Atted. III	2/5/12	
17.	Saheed Ganiyu	Agric. Field Attd. III	2/5/12	
18.	Bakare Motunrayo	Agric. Field Attd. III	2/5/12	
19.	Falana Maria (Mrs.)	Agric. Field Attd. III	2/5/12	
20.	Saheed Ademola	Agric. Field Attd. III	2/5/12	
21.	Bayo Babalola	Agric. Field Attd. III	2/5/12	
22.	Gabriel Ibhazukar	Watchman	2/5/12	
23.	Gift Oghenegueke	Agric. Field Attd. III	2/5/12	
24.	Sarafa Hammed	Agric. Field Attd. III	2/5/12	
25.	Bello Jelili Ademola	Agric. Field Attd. III	2/5/12	
26.	Jimoh Abdulahi	Agric. Field Attd. III	2/5/12	
27.	Adesina Motunrayo (Mrs.)	Agric. Field Attd. III	2/5/12	
28.	Taoheed Ojo	Agric. Field Attd. III	2/5/12	
29.	Ropo Ishola	Agric. Field Attd. III	2/5/12	
30.	Israel Adedokun	Agric. Field Attd. III	2/5/12	
31.	Hammed Abiola	Watchman	2/5/12	
32.	Ojo Olawale	Agric. Field Attd. III	2/5/12	
33.	Ogah Sunday	Agric. Field Attd. III	2/5/12	
34.	Taofeek Azeez	Agric. Field Attd. III	2/5/12	
35.	Idorenyin Okpo. E.	Agric. Field Attd. III	2/5/12	
36.	Udoh Johnny	Agric. Field Attd. III	2/5/12	
37.	Mathew S.Oluwale	Agric. Field Attd. III	2/4/12	
38.	Oni-osun Bashiru	Agric. Field Attd. III	2/4/12	
39.	Obileye F.O.	Secretarial Assist. III	18/7/12	
40.	Irumekhai F.A.	Secretarial Assist. III	26/7/12	
41.	Dada Victor	Agric. Field Attd. III	26/7/12	

Appointment into CRIN Agricultural Science and By Products Limited

Two (2) retired staff were given Contract appointment as Supervisors in the Soap Production and Wine Production Unit respectively of CRIN Agricultural Science and By-Products Limited. The Contract officers are:

S/N	Names	Designation	Remarks
1.	Mr. S. A. Otubu Laboratory Superintendent (rtd.)	Supervisor	Soap Unit

2. Mrs. S. Onarinde Supervisor Wine Unit
Agric. Field Overseer (rtd.)

(iii) **Training**

As at 30 June, - 30 December 2012,tirtheen (13) Research Scientists were on training for their Ph.D programmes training,fifty-three (53) Non-Research Scientists were also on training on part-time and self-sponsorship basis, while one (1) Programme Analyst was also on training for his PhD programme.

The table below shows the list of Research staff on Training as at 30 June, 2012

RESEARCH SCIENTISTS CURRENTLY ON TRAINING

S/N.	NAMES	DESIGNATION	QUALIFICATION	COURSE OF STUDY	SCHOOL ATTENDED
1.	Mr. Adeniyi Omoyele	R O I	Ph.D	Crop, Soil & Pest Mgt.	Federal University of Technology Akure.
2.	Mr. Adeniran Aderolu	RO I	Ph.D	Crop Protection and Environment Biology	University of Ibadan
3.	Mr. Adejobi Babatunde	RO I	Ph.D	Crop Soil and Pest Mgt.	Federal University of Technology Akure.
4.	Mr. Ugioro Osasogie	RO I	Ph.D	Plant Physiology	University of Agriculture Abeokuta
5.	Mr. B. K. Adejobi	RO I	Ph.D	Crop, Soil & Pest Mgt.	Federal University of Technology Akure.
6.	Mr. Olasupo Festus	RO I	Ph.D	Crop Protect & Environmental Biology	University of Ibadan
7.	Mr. Oluyole K. A.	PRO	Ph.D	Agric. Econs.	University of Ibadan
8.	Mr. Adewale O.	R. O. I	Ph.D	P/Breeding and Seed Technology	University of Agriculture Abeokuta.
9.	Mr. Ugioro Osasogie	R. O. I	Ph.D	(Plant Physiology)	University of Agric, Abeokuta
10.	Mr Oduwaye O. F	R. O. I	Ph.D	Pathology	Univeristy of Agric. Abeokuta, Ogun State
11.	Mr Kolawole Oluwaseun	R. O. I	Ph.D	Microbiology	University of Ibadan
12.	Mr. Adeniyi D. O	R. O. I	Ph.D	Plant Breeding	University of Agriculture, Abeokuta Ogun State
13.	Mr. Olaniyi Olayinka O.	R. O. I	Ph.D	Plant Breeding	University of Agric. Abeokuta,

					Ogun State.

The table below shows the list of Non-Research staff on part-time/weekend training as at 30 June, 2012.

NON-RESEARCH SCIENTISTS CURRENTLY ON TRAINING

S/N	NAMES	DESIGNATION	PROPOSE COURSE OF STUDY	NAME OF INSTITUTION
1.	Mrs. Oketokun Grace	AFO	ND Agric. Tech.	Moor Plantation
2.	Mrs. C. B. Olatunji	SAFO	ND Agric. Tech.	Moor Plantation
3.	Mrs. B. F. Alade	SSA II	ND Office Tech. & Mgt.	The Polytechnic Ibadan
4.	Mr. N. F. Chila	SAS	M. Sc. Agriculture	Any Govt. Recognized University
5.	Mr. Idi Mohammed	PAS II	PGD Crop, Soil and Pest Mgt.	FUTA Akure
6.	Mr. Baba Nitsa	HAS	M.Sc. Crop, Soil and Pest Mgt.	FUTA Akure
7.	Miss Osinowo Bukola	CO II	B. Sc. Mass Comm.	OOU, Ago - Iwoye
8.	Miss. Obi Esther	CO II	ND Public Admin.	The Polytechnic Ibadan
9.	Mrs. Ariyibi Esther	SAFO	ND Agric. Tech.	Moor Plantation
10.	Mr. Komolafe	AFO	HND Crop Production	Moor Plantation
11.	Mr. A. B. Adigun	PAS II	M.Sc. Crop Improvement	FUTA Akure
12.	Mrs. F. B. Ejenobor	SSA II	ND Office Tech. & Mgt.	The Polytechnic Ibadan
13.	Mr. I. B. Ibine	AFA II	ND Public Admin.	The Polytechnic Ibadan
14.	Miss. Lawal Esther	CO II	ND Accounting	Osun State College of Tech.
15.	Mr. E. Agbebaku	HAS	M.Sc. Comm. Rural Dev.	LAUTECH Ogbomoso
16.	Mrs. O. A. Ogunde	SA II	B.Sc. Psychology	U. I.
	Mrs. O. E. Akinyode	SSA II	ND Office Tech. & Mgt.	The Polytechnic Ibadan
18.	Mr. Tiku G. B.	CS I	M.Sc. Public Admin	University of Calabar
19.	Miss. Oladepo Kemi	AFA II	ND Accounting	The Polytechnic Ibadan
20.	Mrs. Oluwabunmi Ojo	SA I	ND Office Tech. & Mgt.	The Polytechnic Ibadan
21.	Mr. Akintoroye Johnson	Watchman	B.Sc. Managerial Psychology	U. I.
22.	Mrs. A. Y. Mustapha	AFA II	HND Crop Production	Moor Plantation
23.	Mr. Felix Ajulo	Head Security Guard	ND Business Admin.	The Polytechnic Ibadan
24.	Mr. Haruna John	AFA I	2 years Certificate course Agric. Tech. Field Asst.	Agric. Training Centre Ochaja
25.	Mrs. J. Adegboye	HAS	HND Crop, Soil and Pest Mgt.	FUTA AKure
26.	Mr. K. M. Fabowale	Head Internal Audit	B.Sc. Accounting	Lead City University
27.	Mr. Musa Yahaya	CSK	HND Accounting	Fed. Poly Idah
28.	Mrs. J. O. Ojo	AFA II	HND Accounting	The Polytechnic Ibadan
29.	Mr. V. O. Enagu	PAS	M.Sc.Agric. Tech.	FUTA Akure
30.	Mr. J. O. Oladokun	AFO	HND Crop Production Tech. (Option)	Fed. College of Agric. Ibadan
31.	Mrs. Morakinyo R. A.	CSA	HND Office Tech. & Mgt.	The Polytechnic

S/N	NAMES	DESIGNATION	PROPOSE COURSE OF STUDY	NAME OF INSTITUTION
				Ibadan
32.	Mr. S. Adeyanju	Senior Foreman	ND Electrical Engr.	The Polytechnic Ibadan
33.	Mr. Fawusi Oluwatobi	CO II	ND Business Studies	The Polytechnic Ibadan
35.	Mrs. Ekundayo-Benson	SA III	NCE English/Social Studies	Fed. College of Education Special Oyo
36.	Mrs. O. E. Sekoni	E. O.	HND Business Admin.	Akwa Ibom State Poly, Ibadan
37.	Mr. S.T. Modebei	SEC (Acct.)	PGD (ANAN) Accounting	ANAN
38.	Mr. S. A. Ebulu	PSLT II	PG Study Agric. Engineering	LAUTECH Ogbomoso
39.	Mr. S. T. Balogun	HSLT	M.Sc. Environmental	LAUTECH Ogbomoso
40.	Mr. P. Ibiyomi	AFA II	HND Office Tech. Mgt.	The Polytechnic Ibadan
41.	Mrs. Ogunsola G. B.	CSA	HND Office Tech. & Mgt.	The Polytechnic Ibadan
42.	Mrs. B. O. Togun	Senior Foreman	ND Agric. Engineering	Moor Plantation
43.	Mr. A. Onifade	Senior Accountant	B.ScAccounting	Lead City University
44.	Mr. Adewoye G. Adebowale	Higher Science Lab. Tech	M.Sc (Environmental science) Environmental Toxicology)	Olabisi Onabanjo University Ago - Iwoye
45.	Mr. A. O. Orimogunje	Agric Supt	M.Sc (Agric Extension and Rural Development	University of Ibadan
46.	Mrs. Arowosafe F. F	Snr. Clerical Officer	ND (Public Admin)	The Polytechnic, Ibadan, Akure Study Centre
47.	Mrs. Ogundare O.A	Snr. Agric Field Overseer	ND (Agric Technology)	Federal College of Agriculture, Moor Plantation Ibadan.
48.	Mr. Robert V. O	Clerical Officer II	Bachelor of Law National	National Open University of Nigeria Sango, Ibadan
49.	Miss Ganiyu B. Omolaja	Clerical Officer II	OND(Office Tech. and Management)	The Polytechnic, Ibadan
50.	Mr. Ganiyu Ibrahim	Agric Field Attd. III	ND (Computer Sci.)	The Polytechnic, Ibadan
51.	Mr. Oghenegueke Gift	Agric Field Attd. III	ND (Agric Tech.)	The Federal College of Agriculture Moor Plantation, Ibadan
52.	Miss Alhassan Gloria E.	Agric. Field Attd. III	ND (Business Admin. and Management) Gateway (ICT)	Gateway (ICT) Polytechnic, Igbesa, Ogun State
53.	Adesina Motunrayo C.	Agric Field Atted. III	ND (Accountancy) The Polytechnic, Ibadan	The Polytechnic, Ibadan

PROGRAMME ANALYST CURRENTLY ON TRAINING FROM JANUARY TO DECEMBER, 2012

S/N	NAMES	DESIGNATION	PROPOSE COURSE OF STUDY	NAME OF INSTITUTION
1.	Mr. Ibe Osita	Programme Analyst	PhD (Physics Lower Atmospheric physics)	University of Ibadan

The table below shows the list of staff that went for Seminars/Workshops/Conferences between 01 January - December, 2012.

LIST OF STAFF THAT ATTENDED SEMINARS, WORKSHOPS AND CONFERENCES BETWEEN JANUARY - JUNE, 2012.

S/N	NAMES/ DESIGNATION	DATE	TYPE OF CONFERENCE	VENUE
1.	Mr. Festus Olakunle Olasupo Research Officer I	06 February - 05 April, 2012	Adapting to climate change: Biotechnology in Agriculture in a World of Global Environmental change	Hebrew University of Jerusalem
2.	Engr. Adewale Sunday Mofolasayo Senior Research Officer	17 - 19 February, 2012	Conference and General Assembly of African Network for Solar Energy (ANSOLE)	University of Yaounde, Cameroon
3.	Dr. O. A. Fademi Director (PB&T)	21 - 24 February, 2012	Mid-Way Workshop on the Regional Project on Controlling Swollen-shoot disease in West and Central Africa	Yamoussoukro, Cote d'ivoire
4.	Dr. (Mrs.) L. N. Dongo Director (Crop Protection)	,,	,,	,,
5.	Mr. Uche Asogwa Principal Research Officer	,,	,,	,,
6.	Dr. O. A. Fademi Director (PB&T)	28 May - 01 June, 2012	Peer-review meeting, In-house Research Review	Cocoa Research Institute of Ghana, New Tafo, Ghana
7.	Mrs. Justina O. Lawal Principal Research Officer	17 - 23 June, 2012	Training course on Research Design and Data Analysis organized by (IFS)	Accra, Ghana
8.	Dr. S. O. Agbeniyi Asst. Director/Deputy Head (PB&T)	11 - 30 June, 2012	World Cocoa Foundation Partnership meeting	Washington DC, USA
9.	Dr. L.E. Yahaya Principal Research Officer	18 - 29 June, 2012	Course on products from cocoa By- Products	Cocoa Research Institute of Ghana, New Tafo, Ghana
10.	Mr. M. A. K. Ogunjobi Principal Research Officer	,,	,,	,,
11.	Dr. S. Ogunwolu Chief Research Officer	15 - 17 May, 2012	Workshop on the consumption of Chocolate and Cocoa Products	Abidjan, Cote d'ivoire
12.	Dr. (Mrs.) F. A. Okelana Ag. Executive Director/CEO	25 - 28 June, 2012	Wages and Salaries Accounting and	Conference Hall, Ogba, Lagos

			Administration under the Contributory Pension Scheme and Intergrated Payroll System	
13.	Mr. J. O. Babafemi Director (A&S)	,,	,,	,,
14.	Head, Finance & Accounts Department	,,	,,	,,
15.	Mr. K. M. Fabowale Head, Internal Audit	,,	,,	,,
16.	Mrs. S. E. Oluwadare Senior Admin. Officer	,,	,,	,,
17.	Mrs. F. O. Olawole Higher Executive Officer	,,	,,	,,
18.	Mr. Fagbami O.O. A.D(Hd. LID)	21-28 October, 2012	32nd Nigeria Library Association Cataloguing an dclassification workshop	Benin City, Edo-State
19.	Mr. Obatolu B.O. (P.R.O.)	19-23 November, 2012	The GIS / Remote Sensing training Workshop	ARCSSTEE in lle-lfe, Osun State.
20.	Mr. Fagbami O.O. Ass. Director/Hd LID	25th July, 2012	One day free workshop for library and information professionals	American corner, 54, Magazine Road(former British Council Library) Jericho, Ibadan
21,	Mrs. Ogunjobi T.E. (Senior Librarian)	25th July, 2012	One day free workshop for library and information professionals	American corner, 54, Magazine Road(former British Council Library) Jericho, Ibadan
22.	Mr. Ibe Osita Prog. Analyst	25th July, 2012	One day free workshop for library and information professionals	American corner, 54, Magazine Road(former British Council Library) Jericho, Ibadan
23.	Mr. Folarin V.A Higher Library Officer	25th July, 2012	One day free workshop for library and information professionals	American corner, 54, Magazine Road(former British Council Library) Jericho, Ibadan
24.	Mrs. C.O. Jayeola (P.R.O.)	15-31 October, 2012	An international course on Agricultural Business – a tool for the empowerment of Rural ~Woman at MASHAV Isreal.	MASHAV Isreal.
25.	Dr. O. Olubamiwa (D) EUR	20 July, 2012	A day training Workshop for Association lecturers	University of Ibadan.
26.	Mr. A.E. Agbongiarhuoyi(P.R.O.)	8-11 October, 2012	The Nigeria Rural Sociological Association (N.R.S.A) conference	University of Ibadan, Ibadan
27.	Mrs. C.O. Jayeola (P.R.O.)	8-11 October, 2012	The Nigeria Rural Sociological Association (N.R.S.A) conference	University of Ibadan, Ibadan
28.	Mr. Famuyiwa B.S. (R.O.1)	8-11 October, 2012	The Nigeria Rural Sociological Association (N.R.S.A) conference	University of Ibadan, Ibadan
29.	Mr. Abdul-karim I.F. (R.O.1)	8-11 October, 2012	The Nigeria Rural	University of Ibadan,

			Sociological Association (N.R.S.A) conference	Ibadan
30.	Mrs. Uduak B.A. (R.O.1)	8-11 October, 2012	The Nigeria Rural Sociological Association (N.R.S.A) conference	University of Ibadan, Ibadan
31.	Mr. Ndaji Idris (S.R.O.)	8-11 October, 2012	The Nigeria Rural Sociological Association (N.R.S.A) Conference	University of Ibadan, Ibadan
32.	Dr. S.O. Aroyeun (C.R.O.)	17-22 November, 2012	World Association for sustainable development 10th international Conference	Abu.Dhabi Arab Emirates
33.	Dr. S.O. Ogunwolu	10-14 December, 2012	Working visit to Bottom Line Process Technologies	Florida, U.S.A
34.	Dr. (Mrs.) Okelana F.A. Director (P & S)	8-11 October, 2012.	The 43rd Annual Conference of the Entomological Society of Nigeria(ESN)	University of Benin, Benin City, Edo-State.
35.	Mr. Mokwunoye F. Chukwuka S.R.O.	21-24 November, 2012	The National delegates conference (NDC) of the Academic Staff Union of Research Institution (ASURI)	National Root Crop Research (NRCRI) Umudike, Abia State.
36.	Engr. Mofolasayo A.S. (S.R.O.)	3-4 December, 2012	The third coast-Net conference	Accra, Ghana
37.	Engr. Mofolasayo A.S. (S.R.O.)	13-14 November, 2012	The Ninth International Conference on sustainable development	Ebitimi Banigo Auditorium University of Porth-Hacourt, Nigeria
38.	Mr. Uwagboe E.O. (P.R.O.)	26 – 29 July, 2011	Seventh International Conference on Sustainable development.	University of Calabar, Nigeria
39.	Mr. Oyedokun Victor Adegoke (R.O.I.)	19- 25 August, 2012	24 International Congress on Entomology (ICE) 2012	Daegu, South Korea
40.	Mrs. Mokwunye, I.U. (S.R.O.)	21 -24 January, 2013	The 1st International Confence on pesticidal plants (ICPP)	ICIPE, Nairobi, Kenya
41.	Dr. S.O. Aroyeun (CRO)	11-21 October, 2012	17th International Cocoa Research Conference(CRC)	Yaounde, Cameroon
42.	Dr. Ogunlade M.O. (C.R.O)/ H.O.S. Owena	14-21 October, 2012	17th International Cocoa Research Conference(ICRC)	Yaounde, Cameroon
43.	Dr. (Mrs.) L.N. Dongo Director (R)	14-21 October, 2012	17th International Cocoa Research Conference(ICRC)	Yaounde, Cameroon
44.	Prof. Akoroda M.O. E.D.	14-21 October, 2012	17th International Cocoa Research Conference(ICRC)	Yaounde, Cameroon
45.	Mr. Aderolu, Ismaila A. R.O. 1	19-25 August, 2012	The 24th International congress of Entomolgy (ICE, 2012)	Daegu, south Korea.
46.	Mr. Aderolu, ismaila A. R.O. 1	8-11 October, 2012	The 43rd Annual conference of entomological society of Nigeria (ESN)	University of Ibadan.
47.	Mr. Kolawole Oluwaseun O. (R.O. 1)	t6- 3 AugusNovember 2012	A short-term fellowhsip	Wageningen University of Netherlands
48.	Mr. Paul E. Aikpokpodion	14-21 October, 2012	17th International Cocoa	Yaounde Cameroon

	(S.R.O.)		Research Conference(ICRC)	
49.	Dr. Adedeji A.R. (C.R.O.)	14-21 October, 2012	17th International Cocoa Research Conference(ICRC)	Yaounde Cameroon
50.	Mr. Tiku G.B. Confidential Secretary	15-19 October, 2012	National Association of Professional Secretarial studiesof Nigeria (NAPSSON) Annual National Conference	Obafemi Awolowo University Teaching Hospital complex, Ile-Ife, Osun-State.
51.	Mrs. Ogunsola G.B (CSA)	15-19 October, 2012.	National Association of Professional Secretarial studiesof Nigeria (NAPSSON) Annual National Conference	Obafemi Awolowo University Teaching Hospital complex, Ile-Ife, Osun-State.
52.	Mrs. Oyelami R.A.(CSA)	15-19 October, 2012	National Association of Professional Secretarial studiesof Nigeria (NAPSSON) Annual National Conference	Obafemi Awolowo University Teaching Hospital complex, Ile-Ife, Osun-State.
53.	Mrs. Nze J.U	15-19 October, 2012.	National Association of Professional Secretarial studiesof Nigeria (NAPSSON) Annual National Conference	Obafemi Awolowo University Teaching Hospital complex, Ile-Ife, Osun-State.
54.	Mrs. Adepoju O.A Confidential Secretary	15-19 October, 2012.	National Association of Professional Secretarial studiesof Nigeria (NAPSSON) Annual National Conference	Obafemi Awolowo University Teaching Hospital complex, Ile-Ife, Osun-State.
55.	Mrs. Okanigbua, J.O. (S.S.A.)	15-19 October, 2012.	National Association of Professional Secretarial studiesof Nigeria (NAPSSON) Annual National Conference	Obafemi Awolowo University Teaching Hospital complex, Ile-Ife, Osun-State.
56.	Dr. Orisajo S.B.(C.R.O.) H.O.S. Ajassor Sub-Station	14-17 October, 2012.	The inagural conference of the Nigeria Society of Nematologists(NISON)	University of Ibadan, Oyo State
57.	Dr. S.B. Orisajo (C.R.O.)/ H.O.S Ajassor sub-station	4 -7 September, 2012	NORMAN E BORLAUG ALUMNI SEMINAR	Accra -Ghana
58.	Dr. Ogunlade M.O CRO/H.O.S Owena Sub-Station	4- 7 September, 2012	African Alumni of Norman E Borlang International Agricultural Science and Technology Followship programme.	Accra- Ghana

(iv) **Discipline**

One staff was disciplined between January - December, 2012. Details are as follows:

S/N	NAME	DESIGNATION	OFFENCE(S)	ACTION TAKEN	DEPLOYMENT
1.	Mr. Okon Victor Chuks	AFA III	Absence from duty without permission	Stoppage of salary	P E M

(v) **Left the service**

Fourteen (14) staff retired from the Institute on grounds of statutory retirement age of 60 years or length of service of 35 years, while six (6) left on account of death. six (6) resigned their appointments with the Institute. Details are as follows:

Left the Service Records: January – December 2012

/N	NAME	DATE OF BIRTH	DATE OF 1ST APPT.	DESIGNATION/ RANK	CONRAISS	RETIREMENT DATE	MODE OF EXIT
.	Aigbedion Richard	15/10/52	1/12/97	Agric. Field Attd. I	03	15/10/12	AGE
.	Oluwagbeyi, Julius Akinniyi	22/11/52	25/5/99	Chief Tech. Officer	13	22/11/12	AGE
.	Adedire Sarah Olufunmilayo (Mrs.)	15/11/56	20/9/77	Chief Secretarial Asst.	08	20/9/12	Length of service
.	Ajisebiolola Tayo (Miss.)	7/6/83	18/1/12	Administrative Officer II	07	6/11/12	Resignation
.	Adediran Rasheed	30/3/62	1/10/99	Agric. Field Attendant I	03	26/11/12	Deceased
.	Lasisi Isiaka	16/9/63	14/6/96	Head Security Guard	05	3/9/12	,,
.	Nwosu Joy	5/9/63	29/9/83	Senior Accountant	09	16/9/12	,,
.	Popoola Abiola (Mrs.)	14/5/84	27/3/12	Staff Nurse	07	13/8/12	Resignation
.	Abiade Dauda	4/12/60	1/7/98	Agric. Field Attendant I	03	9/7/12	Deceased
0.	Ukaegbu Chika	6/6/65	2/10/09	Snr. Health Attendant	02	13/12/12	Resignation
1.	Innocent Chiara	15/1/52	9/12/96	Agric. Field Attd.I	03	15/1/12	Age
2.	Obadan Solomon	12/1/52	9/12/96	Agric. Field Attd.I	03	12/1/12	Age
3.	Wabbi Yohanna	1/1/52	9/12/96	Head Watchman	03	1/1/12	Age
4.	Babatunde, Juliana Modupe (Mrs)	2/2/52	1/10/97	Senior Clerical Officer	05	2/2/12	Age
5.	Ikheloa Stephen	15/2/52	1/12/97	Agric. Field Attd.I	03	15/2/12	Age
6.	Adeyemi Sunday Oladele	20/4/52	20/4/83	Chief Clerical OffIcer	06	20/4/12	Age
7.	Godwin Taye	25/4/52	15/7/97	Agric. Field Attd I	03	25/4/12	Age
8.	Matthews Christiana Mopelola (Mrs)	8/8/56	1/6/77	Higher Executive Officer	07	1/6/12	Length of service
9.	Ajila Gbeminiyi Kudirat (Mrs)	16/2/52	22/4/79	Chief Matron	13	16/2/12	Age
0.	Ugbesia Samuel	25/1/52	1/12/97	Agric. Field Attd I	03	25/1/12	Age
1.	Adeyemo Gideon Olusola	18/1/54	3/1/77	Chief Agric. Supt.	13	3/1/12	Length of service
2.	Adelani, Ademayowa Solomon	25/7/77	08/10/10	Higher Sc. Lab. Tech.	07	16/03/12	Resignation
3.	Onanuga, Odubola Adekunle	02/02/80	02/01/09	Watchman	01		Resignation

4.	Anikwe, Joseph Chucks	22/1/73	18/12/02	Prin. Research Officer	11		Resignation
5.	Rafiu, Ibrahim	18/08/80	01/12/12	Agric. Field Attd. III	01	19/01/12	Deceased
6.	Dr. S. S. Omolaja	16/3/62	1/11/93	Assitant Director	14	27/04/12	Deceased

(vi) **Pension Administration**

In the period under review, Pensioners were attended to as at when necessary. All matters relating to post service matters were also attended to.

The monthly pension of retirees were prepared and paid till date in spite of the non release of premiums by the Federal Government since April, 2012. Regular payment of pensions had been made possible as a result of investment made by the Scheme's BOT.

However, fund generated from the investment has been exhausted as no new investment was made following the non-release of funds by the Federal Government as at when due. The Scheme may have to rely on funds released by the Federal Government before pensions are paid, henceforth.

Meetings of CRIN BOT

Meetings of the Board of Trustees are held quarterly in rotation round the Headquarters and the Institute's six substations. (i.e. Ajassor, Ibeku, Mambilla, Ochaja, Uhonmora and Owena).

Between January and December 2012, the BOT held four Business meetings to deliberate on the way forward with respect to prompt payment of pension to pensioners as at when due.

The first quarter Business meeting was held at the Institute's Headquarters on 27 February, 2012.

The second quarter business meeting was held at CRIN Owena Substation, Ondo State between 14 and 15 June, 2012.

The third quarter business meeting was held at Uhomora Substation Edo state between 6-7 August 2012

Fourth quarter business meeting was held at Ochaja substation, Kogi state between 29 – 31 October, 2012.

Also Workshops and Seminars for members of board of trustee and staff of pension secretariat were held as follows:

(i) 18 – 20 July, 2012 Projectlink Konsult Limited at Conference Hotel Ijebu-ode, Ogun State.

(ii) 13 – 15 December, 2012 Workshop/Retreat organized by Babbabes International at Ilorin, Kwara State

(vii) **Health Services**

Between 01 January and December, 2012, eight (8) qualified Nurses were on ground at the Institute's Health Centre, four (4) were employed this year (March and April), and the Nurses were assisted by seven (7) attendants, one (1) Typist, two (2) Storekeepers.

a. **Dispensary**

Between January - December, 2012, a total of 5,176 patients were attended to in the Dispensary Section.

b. **Maternity**

Between January - December, 2012, a total of 554 cases were seen amongst whom are pregnant women and children under 1 year.

c. **Delivery**

15 babies were delivered normally by spontaneous vaginal delivery without any complications.

d. **Family Planning**
39 clients attended the family planning clinic.

e. **Death**
One death was recorded between January - December, 2012.

f. **Immunization**
50 children were immunized during the period of report.

g. **Income Generated**
Income generated from Maternity Section was ₦39,500.00. From Dispensary Section ₦50,700.00 was generated. Therefore a total amount of ₦90,200.00 was generated between January - December, 2012.

h. **Sources of Income Generation**
Income is being generated from non-CRIN staff that came for treatment in the form of registration and consultation/delivery fee from both staff and non-staff. Treatments of emergency cases like suturing of laceration or cutlass/matchet cut from non-staff. Admission fee for both staff and non-staff though, at a reduced rate for staff members.

i. **Sick-off/Referrals**
Sick-off was given to casual workers and staff members depending on the medical condition on presentation in the Health Centre.
Few cases of patients of both staff and non-staff were equally referred to the Hospital for expert management.

j. **Imprest review**
The Ag. Executive Director/CEO approved the upward review of Health Centre's imprest from ₦20,000.00 to ₦40,000.00 with effect from June, 2012.

k. **Cash advance for drug purchase**
An amount of ₦250,000.00 was released in the month of March, 2012 for drug purchase for Headquarters and Substations for treatment of staff and casual workers while a sum of ₦197,700.00 was equally released in June, 2012 for purchase of drugs for staff benefit.

(viii) **Supplies Division**

The activities of the Supplies Division from 01 January - December, 2012 are stated below:

a. **Ledger Balancing**

- The balancing of all the ledgers in the various Stores for the end of year 2011 is done every first week of every month by Supplies Division, Audit Division and Finance and Accounts Department. All ledgers in the various Stores from January - December, 2012 were balanced at the end of every month and checked accordingly.

b. **Checking of Stores and Stocks:-**

- The various stores were visited regularly to check the store and the stocks therein and everything was in order.

- Other duties performed during the period under review were as follows:

c. **Stock Taken List:-**

- In preparation for the end of the year stock taken, stock list were extracted from the ledger books

d. **Physical Stock Counting:-**

- Stock physical counting was carried out together with the Account Staff and Audit Staff. Although the exercise was late this year because of the nationwide strike. The exercise was thus carried out in our entire Substations in April, 2012. During this exercise, four (4) staff from Supplies Division, Finance and Accounts Department and Audit Division visited all the Substations for the stock physical counting while other staff in the Supplies Division were busy in the Headquarter for this same exercise.

e. **Taken Material on Charge**

- Materials purchased during the period under review were checked and the receipts were treated accordingly.

f. **LPO**

- LPO was raised to Alwod Remseg Nig. Ltd for the construction of Bill Board for the beautification of the CRIN Gate vide Praf No 001 and LPO No 890 on 15 June, 2012. The bill board is yet to be delivered into the Institute but the materials for the construction have been physically seen.

g. **Re-order Level**

- Request for re-order level of diesel into the Institute's store was done as at when due.

(ix) **OTHER DUTIES UNDERTAKEN BY ADMINISTRATION AND SUPPLIES DEPARTMENT BETWEEN JANUARY -DECEMBER, 2012**

(a) Appropriate actions were taken on staff salaries and wages administration, other elements of staff welfare, including office and residential accommodation, health care delivery, staff recreation, staff union management relations, staff children school, wedding, funerals, land loans, motor vehicle and motorcycle purchase/refurbishing loans.

(b) Legal and Corporate Matters including agreements, intra-Institute Publicity and enforcement of all the rules and regulations for the administration and management of Government organizations, Public Service Rules (2004 edition), Financial Regulations, (2004 edition), other relevant Federal Government Circulars, the Constitution, Anti-Corruption Act 2000 and all the laws of the Federal Republic of Nigeria, were attended to.

The Institute's cases presently in court are stated below:

(i) 10 retreched staff of 1985 v. CRIN.

(ii) Mrs. Stella-Maris Ogunjobi and two (2) others v. Mr. Gbadebo and CRIN

(iii) Mr. Ibrahim Suleiman v. CRIN

(iv) Academic Staff Union of Research Institution v. Minister of Agriculture and Rural Development, Cocoa Research Institute of Nigeria, Lake Chad Research Institute, National Food Crop Research Institute and Head of Civil Service of the Federation.

(c) Institute's Rest House Management, Corporate Entertainment and Hospitality, Ceremonial and Protocol Matters and public relations matters were duly attended to.

(d) Top Management meetings, Internal Management Committee meetings and Ad-hoc/ Standing Committee meetings were serviced as and at when scheduled.

Three (3) Top Management meetings and Six (6) IMC meetings were held from 01 January to December, 2012

Some of the Standing Committees and Ad-hoc Committee meetings which are still ongoing are listed below:

(i) CRIN budget Committee
(ii) Committee on staff training.
(iii) Committee on disposal of obsolete chemicals/laboratory equipments at the Institute's Headquarters.
(iv) Housing allocation and maintenance Committee.
(v) Ad-hoc Committee on allocation and functionality of CRIN vehicles.
(vi) Ad-hoc Committee on development of CRIN Substations.
(vii) Ad-hoc Committee on sourcing for fund for infrastructural development of CRIN Headquarters and Substations.
(viii) Ad-hoc Committee on electricity supply, house rent and staff quarters maintenance.
(ix) Other duties assigned by the Ag. Executive Director/Chief Executive Officer in pursuit of the accomplishment of the Institute Mandate and Mission Statement were carried out.

(x) CONSTRAINTS/CHALLENGES OF THE DEPARTMENT

The Department was faced with the under-listed challenges in the months under review.

1. Inadequate fund to cater for the needs of the Department especially stationeries.
2. Inadequate office equipment and working tools.
3. Erratic power supply from the National grid and insufficient power supply from the Institute's generator.
4. Inadequate office accommodation.
5. Lack of laboratory equipments and reagents at the Institute's Health Centre.
6. Lack of electricity supply in the research store.

STATISTICS SECTION

CRIN has a section which plays the role of DATA BANK for the Institute, the statistics section. Here, data are collected, updated, documented, analyzed, interpreted and reports written for final dissemination of research findings and adoption.

Data Collections

(a) Cocoa yield Statistics

At the CRIN Fermentary cocoa pods harvested at different experimental plots are counted and documented at the cocoa record unit of the Statistics Section as shown in Table 1

Table 1: 2012 MONTHLY COCOA YIELD SUMMARY

	2	3		4	5	6	7	8	9	10
vesting nths	Total No of Harvesting pods	Field B/Pods	D/pods	No issued	No. of healthy Pods obtained	No. of Damage pods	No. of Fermen -table pods	Wet weight	Weight After Fermenta - tion	Dry weight
uary	77,852	14,303	5,383	100	58,061	17,198	55,166	4,812.7	4,295.5	1,621.3
ruary	18,514	3,520	1,291	27	13,616	4,442	12,694	1,281.1	970.3	430.4
rch	8,964	1,694	923	506	5,857	2,154	5,397	434.8	401.4	166.2
il	79,887	11,787	9,105	676	58,319	16,324	53,782	4,519.6	3,978.3	1,551.8
y	65,610	12,474	7,923	-	45,213	16,384	41,303	3,438.0	3,073.4	1,297.12
e	34,965	8,163	3,727	500	22,575	9,250	21,488	1,735.6	1,474.8	540.62
	17,037	4,086	1,519	30	11,402	3,814	11,674	1,007.4	808.2	277.4
gust	5,539	1,159	247	-	4,133	1,305	3,987	340.2	284.2	100.5
tember	20,427	4,455	2,020	-	14,852	4,258	15,049	1,343.68	1,111.86	404.2
ober	20,833	7,339	650	-	12,844	3,256	16,927	1,571.2	1,365.9	475.22
vember	61,558	9,076	1,778	6,899	43,678	6,813	45,941	4,279.86	3,808.3	1,449.52
ember	37,553	4,847	839	-	29,855	5,201	29,501	2,705.8	2,386.4	9,228.18
TAL	448,739	82,903	35,410	8,738	320,405	90,399	312,909	27,469.94	23,958.56	17,542.46

(b) **Agro meteorology:**

At the CRIN Meteorological garden or station, weather data and soil temperature at different depths (cm) were collected: 5, 10, 20, 30,50 ,and 100.

Mean Temp ºC	**MONTHS**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
	Min	18	20	19	20	20	20	20	20	19	20	21	20
	Max	27	28	27	29	28	27	26	25	25	27	28	27
	Mean	23	24	23	25	24	24	23	23	22	24	25	24
Mean Rel. Hum (%)	AM	71	80	78	79	82	86	88	89	87	85	83	76
	PM	43	55	52	66	73	78	80	88	78	75	66	51
	Mean	57	68	65	73	78	82	84	87	83	80	75	64

The heaviest rainfall (mm) was 242.3 in June. Annual rainfall (mm) was 1106.1. Mean maximum temperature (ºc) was 29 and mean minimum temperature (ºc) was 18. Mean relative humidity (%) morning 89 and afternoon (lowest) 43 as shown in Table 2.

Table 2: CRIN HQ: 2012 AGROMETEOROLOGICAL READINGS

Mean Monthly Soil Temp ºC

epth(cm)	**Time**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
	AM	27.3	28.7	29.7	29.4	28.8	27.5	26.9	25.8	26.9	27.6	28.5	28.2
	PM	33.9	34.9	36.0	34.2	33.1	30.4	29.4	27.4	30.4	31.0	32.8	33.7
0	AM	27.3	28.6	22.8	28.3	28.6	27.7	27.1	25.9	26.9	27.6	28.5	28.1
	PM	32.8	33.7	34.6	33.6	32.6	30.5	29.4	27.5	30.1	31.0	32.5	33.4

0	AM	28	29.2	31.8	29.2	29.7	27.8	27.2	26.2	26.8	27.4	28.4	28.5
	PM	30.7	31.9	32.8	31.9	31.0	29.2	28.4	27.2	28.6	29.5	30.8	30.9
0	AM	28.8	29.7	30.6	30.0	29.4	28.3	27.8	26.8	27.5	28.1	29.1	29.4
	PM	29.6	29.6	31.5	31.0	30.5	29.0	28.3	27.2	28.1	28.8	30	30.4
0	AM	25.3	25.3	25.4	25.3	25.4	25.7	25.5	25.5	25.5	25.5	25.5	25.6
	PM	25.4	25.4	25.5	25.4	26.3	25.5	25.5	25.5	26.4	25.6	25.6	25.6
00	AM	29.3	28.7	31.3	29.3	29.9	28.8	28.2	27.5	28.4	28.2	28.8	29.3
	PM	29.7	29.0	30.6	30.4	30.1	29.1	28.5	27.6	28.7	28.3	28.4	29.6

Survey on CRIN mandate crops:

Members of Staff in Economics and Statistics Sections embarked upon a survey between February 1, to June 27, 2012, in which CRIN mandate crops were counted here in the Headquarters.

The survey gives information on the number of Cocoa, Cashew, Coffee, and Kola trees on each of the experimental plots.

The survey was coordinated by Messrs Shittu, T.R; Obatolu B.O and Emaku L.A.

Table 3: Survey on Effective Hectarage

Below are zones and plots

Plots/Zones	**cocoa**	**cashew**	**coffee**	**kola**	**Tea**	**Coffee Research**	**Cashew Research**	**Demonstration plot**
1	17	2*	5*	3*	-	1	2	-
2	7	1*	-	1*	-	-	-	-
3&4	4	1**			-			-
5	13	-	8	-	-	-	-	-
6	14	3***			-			
7	3*	-	-	9	-	-	-	-
8	19	1++	1++	1*1++	-	-	-	1
9	5	-	-	-	-	-	-	-
CFC	6	-	1	-	-	-	-	-

Note:

The seventeen (17) cocoa plots in zone one (1) had cashew in two (2) plots, coffee in five (5) plots and kola in three (3) plots. Thus, only seven (7) cocoa plots were not intercropped. Other zones also have cocoa plots with few stands of other tree crops.

+ Few stands of cocoa trees were found in the kola plots.

++Plot W8 is intercropped with kola. Surviving stands: cocoa (473) and kola.

**Of the four (4) plots, one (i.e. Ibiremo plot) has seventy (70) stands of cashew and twenty –three (23) stands of cocoa trees.

***Two (2) of the three (3) plots have few stands of cashew and mainly intercropped with cocoa.

HECTARES PER PLOT

With the aid of the Global Position System (GPS) the coordinates of each plot was taken.

Information on the HA of each plot is yet to be ready. The information would enable us carry out Econometric analysis of each plot.

d. Data Analysis.

Research Scientists who sent in their data for analysis were attended to.

It will be appreciated if Statistical packages such as SPSS, SAS and Computers are bought for use by Statisticians in the section for better performance.

PLANTATION MANAGER MRS. M. A. AKANDE

A INTRODUCTION

Plantation and Estate Management Section consists of these units namely:

UNIT I– This unit consists the plantations and plots of all CRIN scheduled crops with the exception of tea established for experimental or commercial purposes. The unit is divided to Zones such as Zones 1, 2, 3/4, 5, 6, 7, 8, 9 and BCOO cocoa plot at Moor-Plantation, Ibadan. The total hectrage and crops in each zones are stated in Table 1.

UNIT II – Consists of the Ground Maintenance and Estate Sanitation Section which is involved in:

(a) The general maintenance of front of the CRIN headquarters, Oil palm plot opposite CRIN gate, Junior Staff quarters grounds, all grounds from CRIN'S gate up to horticultural garden, T.O. quarters, PEM, ERLS, Office blocks, Main office blocks, Old laboratory, road sides from Horticultural garden through Senior Staff quarters, Senior Staff club house up to the Nursery and all Senior Staff quarters ground.
(b) Propagation and maintenance of horticultural/ornamental plants.
(c) Landscaping/floriculture

Unit III – Nursery Development and Management: This unit deals with the raising of all CRIN scheduled crops with the exception of tea for both commercial and research purposes.

Unit IV – The Fermentary Unit is involved in:

(a) Custodian of harvested and broken cocoa beans.
(b) Weighing of cocoa beans, fermentation and sun drying of the beans, bagging before onward release of the beans to the marketing section with the authority of the Director (P & S).
(c) Processing of coffee berries and air drying of cashew nuts.
(d) Drying of plantain chips.

Unit V – Palm Oil Milling Unit involved in:

(a) Regular maintenance of oil palm from plots to plots
(b) Top dressing and pruning of oil palm trees
(c) Harvesting, evacuation and processing of oil palm fruits
(d) Bottling, releasing and forwarding of palm oil to the marketing section
(e) Cracking of palm kernel nut and processing into palm kernel oil (PKO)
(f) Processing of other palm fruit products such as oguso,eesan

B DISPOSITION OF STAFF/PERSONNEL

Personnel was grossly down sized during the year under review and this posed a lot of challenges on the anticipated higher level of achievements of our expected responsibilities. However, the duties and responsibilities of Plantation Management were judiciously carried out with the available labour force. In the year under review, the Plantation and Estate Management Section worked with a total number of 174 permanent staff and 122 regular casuals from January to August and ended up with a total number of 345 members of senior 27 staff, 242 junior staff and 76 casual workers.

During the period under review, thirty-seven (37) field staff were deployed to the section, out of which four (4) were already in the section while four (4) were withdrawn back. They are Ogunlusi Olayemi, Nwankwo Ruth, Adetunji Salawu, Adende Saheed witnessed. The section with vessel reshufflement of junior field workers and casual workers from one zone to another, breaking and reduction of casual workers in the month of October 2012 and total laying off of causal workers on the 31st December, 2012. Messers Idi Mohammed (PAS), Olayiwola Moruf (PAS), Oladumoye Akinola (SAS) and Abioye Adeyemi (SAS) were transferred to Owena, Ajasor, Ibeku and Ocheja sub-stations respectively. The sad event of sudden death of 3 junior staff Mr. Adediran Rasheed, Abiade Dauda and Ibrahim Raifu and 2 Messers Osegbe Ireti casual workers occurred during the year report. Table 2 shows the staff disposition.

C ACHIEVEMENT

i. Plantation activities: Routine and required cultural operations were adequately and effectively carried out in the existing plots in all the zones at the headquarter and the BCOO plot in Moor Plantation Ibadan was not left out. Activities carried out involved.

(a) Weeding (internally and chemically controlled)
(b) Supply of missing stands
(c) Removal of mistletoes/moribund plants
(d) Pruning of branches, thus reducing the canopies
(e) Watering of young cocoa plants and kola plants
(f) Cutting of fire traces round the plantations
(g) Preparation of mini cocoa nursery in the zones to avoid transportation problem at the time of distribution during the planting season and for closeness to the planting site.

ii. Research activities: Adequate labour was supply to perform the following activities in research plots that situated in zones 1, 2, ¾, 5, 6, 7, 8 and 9 and at times around the office complex and in the glass house which include slashing, weeding, felling and cross cutting of forestry areas, marking out and pegging, holing, coppicing of coffee berries, fertilizer application, harvesting, filling of poly bags with top soil, cutting of traces, watering and data collections.

iii. Rotational General Duties: The sustenance and strict compliance of the twice weekly rotational general work has gone a very long way whereby all zonal leaders released their labour force together to work in a specific zone on rotational basis. This system had helped the PEM a lot in all units of our field cultural activities especially during the rainy season when weeds become menace to both Estate and Plantation. Moribud/abandoned plots opened up between November and December 2009 were properly maintained as a result of rotational general work organized by the section.

iv. Special Task Force Operation: During the year under review, due to the weediness of environment and plantations and enormous work at hand, approval was given to carry out special task work in certain area of Plantation and Estate Management's zone and Ground Maintenance which had helped us to maintain general cleanliness we are seeing now. We say thank you Ma, to the Director (P&S).

v. Imprest: During the year under review PEM's imprest was increased from ₦50,000.00 to ₦70,000.00 and there was an improvement on the release. We were very grateful because it made the local running of the section easier than the previous year when we were running it from personal purse. This imprest was used mainly for the purchase of herbicide, diesel, petrol and lubricants for the Institutes tractor, Eicher truck, lawn mower, chain saw and supervisor's motorcycles, prompt release of the imprest would still be highly appreciated.

vi. Digging of Borehole: In the year under report, the Executive Director made effort to dig two boreholes at different zones (zone 6 and 8). We are very grateful Sir, but still expecting more at the remaining zones.

C GROUND MAINTENANCE: General cleanliness and sanitation of the Institute's physical environments, residential quarters (ED'S house, Directors Quarters, Rest House/Chalets building) Health Center, SS and JS club house, internal roads toward SS quarters and Nursery were effectively carried out. Ornamental plants were raised, nurtured and planted to replace old hedges so as to produce beautiful environment. Road sides were lined with yellow bush up to ERL's environment. Lawns were mowed to shape while ground fields were properly maintained.

D FERMENTARY UNIT: Harvesting of cocoa pods ought to be done weekly but due to unavailability of enough space for drying and occasionally when there is no fund to purchase diesel, it had to be done every other week. Harvested pods were transported to the breaking point, broken, weighed, fermented and dried at the fermentary unit. Coffee berries harvested were depulped and dried while cashew nuts were air dried. Harvested of unmatured bunches of plantain and banana were sliced into chips and dried and sold to the interested staff through marketing. The cocoa yield record and all other harvested farm produce from the various zones are presented as Table III & IV.

E PALM OIL PROCESSING UNIT: In order to prevent wastage of the Institute's Oil Palm fruits and to boost revenue expected therein, the section decided to have its own palm oil processing unit. This dream came to reality. Pipe borne hole water and storage tank were also connected to the milling unit in order to elevate the problem of water for processing. Oil palm fruits harvested with the quality of palm oil presented for sales to the marketing section are hereby shown in Table V.

F CHALLENGES FACING THE DEPARTMENT

i. **Insufficient tables, chairs, stools and office cabinet*:*** There are no sufficient tables, chairs, stools and cabinets in all zones and other units even in the offices. There is no cabinet in PEM's office to keep essential documents. Immediate upgrading of furniture items will be highly appreciated.

ii. **Computer system*:*** This section's desk top has not been functioning. We will really appreciate if management can help the section to improve PEM's secretariat unit.

iii. **Brakata Bridge*:*** This is an alternative route to zone 9 at the peak of the rainy season which is at the verge of collapsing. This bridge links SS club to zone 9 and water works. During the period under review, complaints had been made about this bridge but nothing is forth coming out of it. This problem needs urgent solution.

iv. **Dedicated vehicle*:*** We became joyous when the VW combi bus was allocated to the section but this was cut short when the vehicle did not function as expected until it was retrieved from us. In order to touch every hook and corner of the various zones and BCOO plot at Moor Plantation the section needs a supervisory vehicle.

v. **Farm tools**: Farm tools such as cutlasses, rain boots, baskets, bowls, watering can etc available in the zones are worn-out thus needing replacements.

vi. **Supervisory motorcycles*:*** Maintenance of the sectional supervisory motorcycles needs to be looked into. The section finds it difficult to maintain and fueling these motorcycles and it has to be done with individuals personal. Money for the durability of these motorcycles, we shall be grateful, if certain amount could be approved for such purpose.

vii. **Zonal offices*:*** The ground maintenance (GMESS) and fermentary have no suitable building to accommodate their field staff. We shall be grateful if action can be taken.

Table I

Zones	Total hectrage	Effective hectrage	Crops planted
1	36.09	35.76	Cocoa, coffee, kola & cashew
2	13.91	11.90	Cocoa, kola & cashew
3 & 4	14.46	11.70	Cocoa, cashew, oil palm
5	32.335	24.75	Cocoa, coffee,
6	37.88	26.75	Cocoa, cashew, kola
7	25.94	23.35	Kola
8	40.78	35.71	Cocoa, cashew, oil palm
9	44.09	18.48	Cocoa, oil palm, cashew
BCOO	6.20	6.00	Cocoa

Total Effective hectrage 194.4

Table II: RECORD OF HARVESTED FARM PRODUCE

Zones	Cocoa pods	Cashew nut	Kola nuts	Coffee kilogram	Oil palm fruit bunches	Plantation bunches	Banana bunches
1	71,322	30	-	204.2	-	56	290
2	30,454	-	416	-	-	235	54
¾	15,347	58kg	-	-	-	42.5	-
5	74,227	-	-	177.60	-	-	-
6	112,442	116	-	-	-	129	-
7	-	-	₦44,000	-	-	-	-
8	100,889	-	-	-	-	134	-
9	33,606	-	-	-	-	61	-
BCOO plots	4,007	-	-	-	-	-	-
GM	-	1,355	-	-	-	-	-
Total	442,294	1,559	416	381.80	-	65.5	34.4
Palm oil processing unit	-	-	-		3,390	-	-

Table III: RECORD OF HARVESTED FARM PRODUCE

Zones	Plantain chips kilogram	Cashew bag	Firewood tractor load	Cherry fruits trees stand	Vegetable bunches
1	58.6	7½	-	4	-
2	-	-	-	-	-
¾	-	3bag	3	-	45
5	40	-	-	-	-
6	-	8½ bag	-	4	-
7	-	-	-	-	-
8	-	-	-	-	-
9	-	-	-	-	-
GM	-	-	-	-	-

TABLE IV: CHARCOAL PRODUCTION PROCESSBUDGETING

S/No	Materials		Unit	
1	Big cutlass	10	1,000	10,000
2	Small cutlass	5	700	3,500
3	India hoe	10	1,000	10,000
4	Shovel	10	800	8,000
5	Spade	10	800	8,000
6	Digger	5	1,000	5,000
7	Hoe (local) big	5	1,500	7,500
8	Rain boots	5pairs	1,100	5,500
9	Overall coat	5	2,000	10,000
10	Lighter/matches	1pack	500	500
11	Chain saw (complete set)	2	200,000	400,000
12	Engine oil	4l	150	600
13	Fuel petrol	50l	110	5,500
14	Wheel barrow	5	4,500	22,500
15	Hoe (local) small	5	1,000	5,000
	Total			₦501,600

Chimney period of 5 days Chimney is plugged brick kilns, briquettes concrete retort

Types of wood

i. Hickory
ii. Oak
iii. Maple
iv. Fruit wood

Better grades of charcoal come from raw materials with low sulfur content

ARMTI TRAINING

YEAR 2013 TRAINING PROGRAMME

Code Arm	Course Title	Date	Amount
219	Agric. Policy Analysis	April 15 – 19	35,500.00
315	Farm planning & Management	May 20 – 24	35,500.00
211	Workshop on Agro-Based Enterprise Promotion & Development	May 20 – 24	35,500.00
109	Agric. Project Planning and Implementation Management	June 3 – 7	35,500.00
422	Agricultural Project Monitoring & Evaluation (1st Run)	June 17 – 21	35,500.00
307	Agro-Forestry Extension Management for Sustainable Agric. Production	July 1 – 5	30,000.00
343	Agricultural Credit Analysis & Risk Management	July 15 – 19	30,000.00
237	Computer Application for Project Management	July 29 – Aug. 2	43,500.00
314	Management of Public Relation in the Agricultural Rural Sector	July 29 – Aug. 2	30,000.00
222	Management Skills Development for Women in Leadership Position	Aug. 19 – 23	30,000.00
205	Training Workshop on Agric Produce Marketing Extension	Aug. 23 – 30	30,000.00
319	Agric. Project Monitoring & Evaluation (2nd Run)	Nov. 4 – 8	35,500.00

ARMTI TRAINING

- Transport allowance
- Duty tour allowance
- Course fee

Beekeeping Materials

S/No	Materials
1	Bee hives – 4,000
2	Wooden wire
3	Bee keeper clothing (overall)
4	Honey Extraction equipment & Tools – uncapping knives - capping tubs
5	Beekeeping veils
6	Beeking veils
7	Bee smoker
8	Honey extractor
9	Pollen traps
10	Hive nets
11	Honey bucket
12	Hive carrier
13	Serrated un
14	Beekee

S/No	Zones	Units
1	Z1	4

2	Z2	4
3	Z3/4	4
4	Z5	4
5	Z6	4
6	Z7	4
7	Z8	4
8	Z9	4
9	GM + a	5
10	Fer	3
11	NDM	4
12	VPU/SG	4
13	PEN	1

LEGEND PEM:- Plantation & Estate Management
CAS - Chief Agric. Superintendent
Acas - Assistant Chief Agric. Superintendent
PAS - Principal Agric. Superintendent
SAS - Senior Agric. Superintendent
HAS - Higher Agric. Superintendent
AEO - Assistant Executive Officer
AS - Agric. Superintendent
AAS - Assistant Agric. Superintendent
CAFO - Chief Agric. Field Overseer
ACAFO - Assistant Chief Agric. Field Overseer
SAFO - Senior Agric. Field Overseer
AFO - Agric. Field Overseer
AFA - Agric. Field Assistant
SNRT - Senior Typist
CO - Clerical Officer
NYSC - National Youth Service Corps
FMNT - Fermentary
MP - Moor Plantation
GM - Ground Maintenance

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

Library Division(Acting Head: Ogunjobi T.E)

Between January 2012 to 31December 2012, a total number of 2,207 staff were recorded, 770 visitors were received, 1,015 Industrial training and Corp members visited the library. The breakdown on monthly basis is shown below:

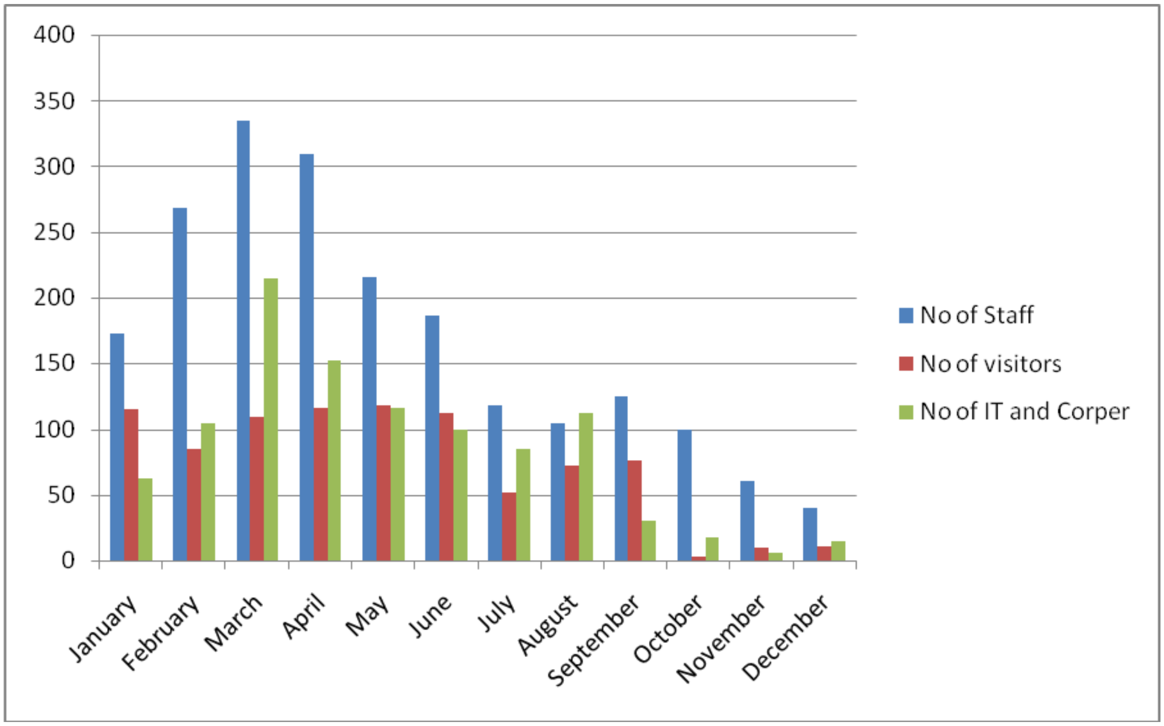


Figure 1: Library Users in 2012

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

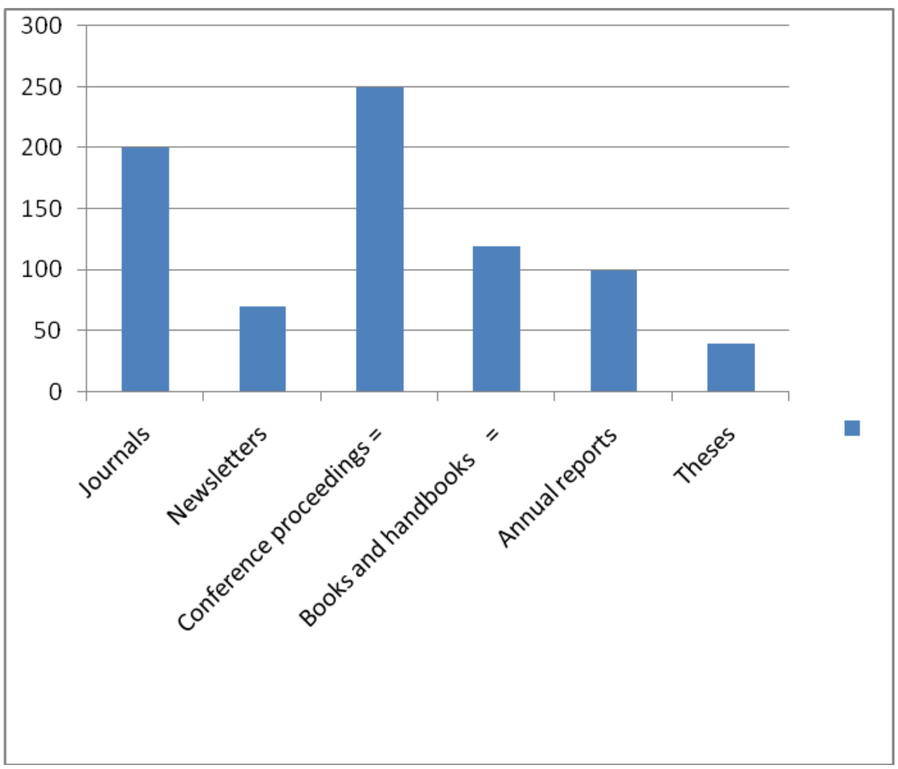


Fig 2: Usage of library facilities

1. Compilations of Bibliography and CRIDAN on CRIN mandate crops are in progress, Overdue books and journals were retrieved from users, used books and journals shelved, while shelf readings were done occasionally.

2. Charging and discharging of library materials were done regularly, while cataloguing and classification of some of gifts and exchange materials got in the library was done.

3. Articles published on CRIN mandates crops by CRIN scientists and other scientists outside CRIN were added to databases in the library.

4. Few copies of Information handbook and new cocoa Hybrid Handbook were sold and photocopies were made.

5. Paper cutting was not left out, all matters on CRIN mandate crops and agriculture related matters were kept for consultation of scientists and all interested users.

6. Accessioning, stamping and displaying of new information resources were done on regular basis.
7. Bidding of collated journals and damaged books were done for future consultation. Two Industrial Attaché sent to library division were trained.

8. Few of the books that were damaged by rainfall during strike were sun dried and has since been arranged back to the shelves.

9. Compilation of CRIN News is ongoing and very soon it will be released.

Publications

Adedeji, A.R.(2012). Cocoa in Etung- Facts and future prospects. A paper presented at a conference organized by Micro project programme in the nine Niger- Delta States (MPP9) 2nd to 4th May, 2012 at Local Government Unit, Etung LGA, Effraya. Cross River State.

Adedeji, A.R.(2012)Cocoa in Etung- Facts and future prospects. A paper presented at a conference organized by Micro project progrmme in the Nine Niger Delta States (MPP9) 2nd to 4th May, 2012 at Local Government Unit, Etung LGA, Effraya, Cross River State.

Adedeji, A.R., Agbeniyi, S.O., Odedele, A.C., Adeniyi, D.O., Sanusi, R.A., Olaiya, A.O and Fademi, O.A. (2012) .Occurrence, distribution and potentials of Trichoderma strains as bio-control agents of phytophthora pod rot of cocoa in Nigeria. 17th International Cocoa Research Conferen (ICRC) to be held in Cameroon between 14th and 21st October, 2012

Adedeji, R.A., Agbeniyi, S.O., Odebode, A.C., Adeniyi, D.O., Sanusi, R.A., Olaiya, A.O. and Fademi, O.A. (2012). Occurrence, Distribution and potentials of Trichoderma strains as Bio-control agents of phytophthora pod rot of cocoa in Nigeria. 17th International Cocoa Research Conference (ICRC) to held in Cameroun between 14th and 21st October, 2012.
Adeigbe, O.O., Omoloye, A.A., Aliyu, M.O.and Oyewole, S.O.(2012).Karyomorphotypic variation in Eriospermum abyssinicum Baker.African Journal of pharmacy and phamacology(AJPP): Accepted September 2012. In Press.
Adeniyi, D.O., Kolawole, O.O, Oduwaye,O.F, Adejobi, K.B, Adenuga, O.O, Adepoju, A.F, Olaniyi, O.O and Anagbogu, C.F. (2012).Incidence of mycoflora complexes on retail kola nuts(nitida and C. acuminate) in North Central Nigeria. Journal of Applied Biosciences 56: 4075-4079.
Adeniyi, D.O., Kolawole, O.O., Oduwaye, O.F., Adejobi, K.B., Adenuga, O.O., Adepoju,A.F Olaniyi, O.O. and Anagbogu, C.f.(2012).Incidence of Mycoflora Complexes on Retail Kolanuts (C. Nitida and C. Acuminata) in North Central Nigeria . Journal of applied Biosciences 56. 4075-4079.
Adeniyi, D.O., Kolawole, O.O., Oduwaye, O.F., Adejobi,K.B., Adenuga, O.O., Adepoju, A.F, Olaniyi,O.O and Anagbogu C.F. (2012)
Adenuga, O.O., Mapayi, E.F., Olasupo, F.O., Olaniyi, O.O and Oyedokun, A.V.(2012).Nigeria's Cola Genetic Resources. The Need for Renewed Exploration Asian Journal of Agricultural Sciences 4(3). 177-182.
Adenuga, O.O., Mapayi, E.F., Olasupo, F.O., Olaniyi, O.O., Oyedokun, A.V.(2012).Nigeria's cola genetic resources: The need for renewed exploration. Asian Journal of Agricultural Science, 4(3): 177-182Pp.
Adewale, B.D., Nduka, B.A.,Adeigbe, O.O. and Taiwo, N. (2012).Differential variability and stability of cocoa clones to varied root stock ages of patch budding. Journal of chemical, Biological and Physical sciences (JCBPS): Accepted Sept. 2012. In press.
Adewale, B.D., Adeigbe, O.O., Adenuga, O.O and Omolaja, O.O(2012).Variability and Diversity Analysis of some Cocoa Genotypes in Nigeria Based on pod and Bean Quantitative Value. Proceedings of the 17th International cocoa Conference 15th -20th October, 2012. Yaunde Cameroon.
Adewale, B.D., Adeigbe, O.O., Adenuga, O.O and Omolaja, S.S.(2012).Variability and Diversity analysis of some cocoa genotypes in Nigeria based on pod and bean quantitative values. Proceedinds of the 17th International Cocoa Conference, 15th-20th October 2012. Yaounde Cameroon.
Adewale, B.D., Nduka, B.A., Adeigbe, O.O and Taiwo,N. (2012)Differential variability and stability of cocoa clones to varied root stock ages in Nigeria based on pod and bean quantitative values. Proceedings of the 17th International Cocoa Conference, 15th-20th October 2012. Yaounde Cameroon.
Asogwa, E.U., Mokwunye, I.U and Oyedokun, A.V.(2012). A report on the survey of Ondo, Osun, Oyo and Edo States for the outbreak of Achea catocaloides in cocoa plantations.
Asogwa,E.U., Adedeji, A.R., Ndubuaku, T.C.N., Oyedokun, A.V, and Ndagi, I.(2012).Strategies for improving production and Storage of Kola in Nigeria. American- Eurasian J. Agric & Environ. Sci., 12(1): 37- 43Pp.
Famaye, A.O , Iremiren, G. O, Ayegboyin K. O, Adejobi, k. B (2012)Evaluation of coffee intercrop with Rice and plantain at early stage of field Establishment in Nigeria. Journal of Agricultural Sciences. Vol. 3, No. 3, 347-350.
Famuyiwa,B.S, Adesoji, S.A, Agbongiarhuoyi, A.E., Orisajo,S.B. and Lawal, J.O.(2012).Training needs of smallholder cocoa farmers on integrated pest management (IPM) techniques: an antidote to sustainable cocoa production in Osun State, Nigeria. International Journal of Applied Research and Technology 1(4): 37-46.
Ibiremo, O.S, Ogunlade, M.O, Oyetunji, O.J and Adewale, B.D.Dry Matter yield and Nutrient uptake of Cashew seedlings as influenced by Arbuscular Mycorrhizal inoculation Organic and inorganic fertilizers intwo soils in Nigeria.ARPN Journal of Agricultural and Biological Science. Vol.7 No. 3 Mar. 2012.
Ibiremo, O.S, Fademi, A.O and Adegboye, J.Effect of NPK fertilizer Application and root mat pruning on the effect field establishment of Cocoa in Ondo State, Nigeria.Obeche Journal Vol. 30, No. 1: 389-395, 2012.
Ibiremo, O.S, Olubamiwa, O., Agbeniyi, S.O and Akanbi, O.S.O.Response of Cashew seedlings from different nut sizes to Phosphate fertilizers and Arbuscular Mycorrhizal inoculation in two soilsin Nigeria. International Journal of Plant, Animal and environmental sciences. Vol. 2, Issue 1, Jan- Mar 2012.
Idrisu, M, Babalola, F.D., Mokwunye, I.U., Anagbogu, C.F., Aderolu, I.A., Ugioro, O., Asogwa, E.U., Ndagi,I and Mokwunye, F.C.(2012).Adaptive measures for the Factors Affecting Marketing of Coffee (Coffea robusta) in Kogi State, Nigeria. Agrosearch 12(1): 37-49.
Idrisu, M., Babalola, F.D., Mokwunye, I.U., Anagbogu, C.F., Aderolu, I.A., Ugioro, O., Asogwa,E.U., Ndagi, I and mokwunye, F.C. (2012).Adaptive Measures for the Factors Affecting Marketing of Coffee (coffea robusta) in Kogi State, Nigeria Agro search 12(1): 37-49.
Karyomorphotypic variation in eriospermum abyssinicum Baker, African Journal of Pharmacy and Phamacology(AJPP): Accepted September 2012. In press.
Mofolasayo, A.S., Otuonye, A.H., Ojediran, O.J.(2012). Development and evaluation of a 400 kg/ batch cocoa fermentation equipment International journal of Agriculture, Vol. 4(2): 89- 95.
Mokwunye, I.U., Hammed, L.A., Ndubuaku, T.C.N and Asogwa, E.U. (2012).Evaluation of Manual defoliation on some yield parameters of Anacardium occidentaleL. During fruiting season at CRIN, Head-quarters, Ibadan, Nigeria. International Journal of Science and Nature 3(3).

Mokwunye, I.U., Hammed, L.A., Ndubuaku, T.C.N., and Asogwa, E.U.(2012).Evaluation of manual defoliation on some yield parameters of Anacardium occidentale L. during friiting season at CRIN, Head-quarters, Ibadan , Nigeria. International journal of Science and Nature 3(3).
Muyiwa, A.A., Esan, E.B., Liasu, M.O., Anagbogu, C.F (2012).Development of Coffee (Canephora somatic embryos and plantlet regeneration in vitro international organization of scientific research journal of biotechnology Vol.10 Issue 22, Pp.1338-5178.
Muyiwa, A.A.,Velasquez, R.A., Liasu, M.O., Vincent, N.F (2012) Recent advances on coffee improvement through biotechnology functional plant science journal and biotechnology vol.2,11(80) Pp.14612- 14626.
Muyiwa,A.A., Anagbogu, C.F., Balogun, S.T, Mapayi, S.A and Iyoha, S.O.(2012). Evaluation of four explants type for production of somatic embryos in Tea International journal of plant, Animal and environmental science Vol.34 issue 7 ISSN 2912-1444.
Muyiwa,A.A., Oloke, J.K, Liasu, M.O, Esan, E.B, Guiltinan M.J Maximova S.N.somatic embryos and plantlet regeneration among some Nigeriacocoa clones. 2012 International Journal on current Research Vol. 12 issue 7,Pp. 038-049.
Ndagi, I., Babalola, F.D., Mokwunye, I.U., Anagbogu, C.F., Aderolu, I.A., Ugioro, O., Asogwa, E.U., Idrisu, M and Mokwunye, F.C. (2012).Potentials and Challenges of Kolanut production in Niger State, Nigeria. International Scholarly Research Network ISRN Agronomy Vol. 2012: 1-9.
Ndagi,I., Babalola, F.D., Mokwunye, I.U., Anagbogu, C.F., Aderolu, I.A., Ugioro, O., Asogwa,E.U., Idrisu,M. and Mokwunye, F.C.(2012).Potentials and Challenges of Kolanut production in Niger State, Nigeria. International Scholarly Research network ISRN Agronomy Vol.1 (9).
Orisajo, S.B.(2012).Effect of plant-parasitic nematodes associated with Tea in Nigeria. World Applied Sciences journal 19(7) in press.
Orisajo, S.B.(2012).Integrated pest Management.Manufacturing Confectioner 92(5): 52-63.
Orisajo, S.B.(2012). Disrtibutoinand effects of plant parasitic nematodes associated with Cashew in North Central Nigeria. International Journal of Applied Research and Technology 1(4): 95-99.
Orisajo, S.B., Agbeniyi, S.O Dongo, L.N., Fademi, A.O., Otuonye, A.H., Okeniyi, M.O.,Adeniyi, D.O., Oduwaye, O.F.and Kolawole, O.O.(2012).Evaluation of foliar fertilizer for the management of black pod disease of cocoa. Proceedings, 17^{th} international Cocoa Research Conference, Yaounde, Cameroon .(in press)..
Otuonye, A.H, Agbeniyi, S.O ., Otuonye, T.C, Muyiwa, A.A (2012). Isolation and identification of fungi associated with Cashew (anarcadium Occidentale) leaf spot disease international journal of agriculture.
Oyedokun, A.V., Omoloye, A.A., and Okelana, F.A. (2012).Assessment of the influence of artificial dietary supplements on aspects of biology of adult cocoa moth, ephestia cautella. Journal of pharmacy and Biological Sciences. Acceted, in press.
Oyewole, S.O., Omueti, J.I.A. and Ipinmoroti. (2012). Growth of cocoa (Theobroma cacao L.)seedlings on old cocoa soils amended with organic and inorganic fertilizers. African journal of Agricultural Research, vol. 7(24):3604-6083.
Yahaya, L.E, Adebowale, K.O, Menon A.R and Olu- Owolabi, B.I (2012)Natural rubber/organolay nanocomposite from tea seed oil derivative. Amer.J. Mat. Sci. 2 (2) 1-5.
Yahaya, L.E., Ajao, A.A., Jayeola, C.O., Igbinadolor,R.O and Mokwunye, F.C (2012)Soap production from agricultural residues-A comparative study. Amer. J. Chem. 2(1):7-10.
Yahaya,A.T, Taiwo,O, Shitu,T.R, Yahaya, L.E, Jayeola, C.O (2012)Investment in Cashew Kernel Oil production:Cost and Return Analysis of Three processing Methods. Amer. J. Econ. 2(3):45-49.