ANNUAL REPORT

OF THE

COCOA RESEARCH INSTITUTE OF NIGERIA, IBADAN.

2023

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COCOA PROGRAMME

The Cocoa Programme is a technical Group that coordinates research on cocoa - the first mandate crop of CRIN since 1964. Besides various landmark achievements of the Group in the past years, the Cocoa Research Programme, working under the central theme, "Varietal Development of Cocoa, Kola, Coffee, Cashew and Tea for Sustainable Circular Economic Growth in Nigeria," was last year (2023) saddled with the responsibility of carrying-out two key tasks namely: (a) Cocoa Integrated Pest Management, and (b) New Cocoa Cultivar Development. Out of the nine projects (activities) funded last year, five (5) fell under the former, while the remaining four (4) aligned with the latter. The Programme commenced the consolidation of its past achievements in the year 2023 by kick-starting: (i) the establishment of a new cocoa parental clonal garden at CRIN headquarters, (ii) the development of improved cocoa clones, and (iii) the development of environmentally safe and cheap biopesticides for the control of diseases of cocoa, both on the field (black pod) and at storage (control of mycotoxin contamination of dried fermented cocoa beans). The Programme also carried out farmers' participatory research activities aimed at validating the economic benefits of IPM techniques towards encouraging lesser dependence on chemical pesticides for increased cocoa production in Nigeria. It is, however, expected that further pragmatic steps would be taken in the year 2024 toward consolidating our past efforts and thus, achieving the set goal of increasing wholesome cocoa beans production in Nigeria.

TASK: COCOA INTEGRATED PEST MANAGEMENT

Experimental Tittle: Development and formulation of biofungicides for the control of black pod disease of cocoa

Investigator: Okeniyi, M. O., Agbeniyi, S. O., Adedeji, A. R., Orisajo, S. B., Otuonye, A. H., Ogundeji, B. A., Ayanwole, S. and Oladigbolu, Y. O.

Introduction

Agriculture has been faced with the destructive activities of numerous pests like fungi, insects and weeds from time immemorial, leading to radical decrease in yields. With the advent of chemical pesticides, this crisis was resolved to a great extent. But the debilitating effects of over dependence on chemical pesticides and their uncontrolled use have necessitated the need for alternatives mainly for environmental concerns. Degraded soils and groundwater pollution have resulted in nutritionally imbalanced and unproductive lands. Volatile pesticide residues also sometimes raise food safety concerns among domestic consumers and pose trade impediments for export crops. Therefore, the use of eco-friendly alternatives known as biopesticides, is the need of the moment (Gupta and Dikshit, 2010; Kandpal, 2014).

Objectives

In view of the foregoing, the research therefore aimed at developing bio-fungicide mixtures for the control of black pod disease of cocoa

Materials and Methods

Black pod infected cocoa pods were obtained from cocoa plots at CRIN headquarters, Ibadan and Ajassor Sub-station. The infected pods were transported in Ziploc bags to the Mycology Laboratory at CRIN headquarters. The pods were surface sterilized with 2% sodium hypochlorite solution and small portions of the lesions formed on the infected pods were cut at the margins with the aid of sterile scalpels. The cut portions were inoculated into freshly prepared potato dextrose agar plates and incubated at $25\pm2^{o}C$ in cooled incubator for 5 days.

Fresh samples of some plant materials with known antifungal effects: Neem (*Azadiractha indica*), Siam weed (*Chromolaena odorata*) and Scent leaf (*Occimum gratissimum*) were collected, identified and air-dried in preparation for ashing and other uses.

Soil samples, apparently healthy leaves and pods were collected from the cocoa plots visited, for the isolation of fungi that could be utilized for biopesticide formulation. Pure cultures of the isolated fungi were obtained for further characterization.

Results and Discussion

A total of fifteen *Phytophthora* isolates were obtained from the inoculated infected cocoa pods, virtually all of which were *P. megakarya,* according to cultural morphology. Also, various fungi of antimicrobial potentials were isolated from the soil samples, and from apparently healthy cocoa pods and leaves obtained from the cocoa plots visited (Figure 1a-c).

Conclusion and Recommendation

Phythophthora megakarya were mostly associated with cocoa black pod disease at the plots visited. Persistent problems and losses caused by the pathogen however needed to be tackled with the aid of safe and cost effective biopesticide formulations. This is the main focus at the next phase of this project.

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Experimental Tittle: Development of eco-friendly and safe approach for preservation of stored cocoa beans

Invesigator: Ogundeji, B. A., Agbeniyi, S. O., Adedeji, A. R., Orisajo, S. B., Okeniyi, M. O., Oyedokun, A. V., Otuonye, A. H., Olorunmota, R. T., Ayanwole, S., Oladigbolu, Y. O.

Introduction

Cocoa beans are of commercial, nutritional and medical importance to man. Wholesome cocoa beans can be processed into different products like chocolate, cocoa beverages, cocoa butter, etc., which are of immense benefits to the body systems of consumers. Cocoa is a very important ingredient in foods such as cakes, biscuits, child-foods, ice-creams and sweets. It is also the source of cocoa powder (Sánchez-Hervás *et al.*, 2008).

Since neither storage nor processing conditions of cocoa are strictly controlled in the tropics, fungal contamination of cocoa beans is possible at many critical points in the cocoa production chain (Magan and Aldred, 2005). The beans are susceptible to fungal spoilage during and after fermentation, drying, storage, and in the course of shipment to foreign countries. Fungal species belonging to the genera *Aspergillus, Mucor, Penicillium* and *Rhizopus* have been observed on mishandled or improperly dried fermented beans (Sánchez-Hervás *et al.*, 2008; Fagbohun *et al.*, 2011).

The development of moulds on cocoa beans during storage has constituted a major challenge to cocoa production in Nigeria and other cocoa growing countries. Continuous presence of these organisms results in some alterations in the physical and biochemical properties of the stored beans, thereby reducing their overall qualities, marketing values and overall acceptability in the world market. Some of these fungal species are capable of producing toxic substances known as mycotoxins (aflatoxins, ochratoxins, fumonisins, etc.) which if taken in with the infected beans or their products, may pose much threat to life (Fagbohun *et al.*, 2011; Ogundeji and Olufolaji, 2014). In a bid to reduce the impacts of storage moulds on stored cocoa beans, farmers have resulted in the use of synthetic fungicides within the stores and even on the stored beans, which has consequently made the commodity harmful for consumption, mainly because of the associated health concerns.

The effective, eco-friendly and safe potentials in the use of botanicals for the control of toxigenic moulds and mycotoxin contamination of feed and food have made their possible application as storage fungi management/control options on dried fermented cocoa beans a necessity. Exploring these safer alternatives would no doubt, significantly reduce the huge postharvest losses experienced by cocoa farmers across the tropics, and make cocoa beans and their by-products safer for consumption across the globe.

Objectives

In order to address the highlighted problems, this study sought to develop botanical pesticides for effective control of stored cocoa beans bio-deterioration.

Materials and Methods

Samples of dried cocoa beans obtained from randomly selected (big) cocoa stores (about 18) across the cocoa producing states of Southwest Nigeria were transported in Ziploc bags to the Mycology Laboratory at CRIN headquarters and the associated storage moulds were isolated in freshly prepared potato dextrose agar plates. All the isolated storage moulds were morphologically identified with the aid of Fungi atlas.

Fresh samples of some plant materials with known antifungal effects: Neem (*Azadiractha indica*), Siam weed (*Chromolaena odorata*) and Scent leaf (*Occimum gratissimum*) were collected, identified and air-dried in preparation for ashing and other uses.

Results and Discussion

Most of the storage fungi isolated from the beans were *Aspergillus* spp. (3.85 – 100.00%), with others like *Rhizopus* spp. (14.29 – 30.43%) and *Fusarium* spp. (7.69 - 100.00%). *Neurospora* sp. (20.00%), *Pythium* sp. (25.00%) and *Trichoderma* spp. (50%) however only occurred once in the cocoa beans samples (Table 1).

Conclusion and Recommendation

Aspergillus, Rhizopus and *Fusarium* spp. were dominantly associated with cocoa beans during storage at the store locations. Development of botanicals (in the place of synthetic chemicals) is a safe and sustainable method to tackle this problem headlong. This forms the next phase of this project.

References

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Table 1: Percentage occurrence (%) of moulds associated with stored cocoa beans obtained in dry season across South-West, Nigeria

Location	Storage moulds											
	Aspegillus flavus	***A. parasiticus***	***A. nidulans***	***A. niger***	***A. ochraceous***	***A. fumigatus***	***Fusarium* spp.**	***Pythium* spp.**	***L. theobromae***	***Rhizopus* spp.**	***Neurospora* spp.**	***Trichoderma* spp.**
Osun *1*	4.76	52.38	-	-	9.52	-	-	-	-	33.33	-	-
Osun 2	76.92	-	-	7.69	7.69	-	7.69	-	-	-	-	-
Osun 3	45.45	27.27	-	-	9.09	-	-	-	-	18.18	-	-
Osun 4	-	-	56.25	18.75	-	-	-	-	-	25.00	-	-
Oyo 1	-	-	-	-	-	-	50.00	-	-	-	-	50.00
Oyo 2	19.23	26.92	-	19.23	3.85	7.69	-	-	-	23.08	-	-
Oyo 3	14.29	-	-	28.57	-	-	-	-	42.86	14.29	-	-
Oyo 4	8.70	-	39.13	-	-	-	-	-	21.74	30.43	-	-
Ogun1	75.00	-	-	-	-	25.00	-	-	-	-	-	-
Ogun 2	-	-	-	-	-	-	100.00	-	-	-	-	-
Ogun 3	-	-	-	100	-	-	-	-	-	-	-	-
Ogun 4	-	-	-	25.00	-	-	25.00	25.00	-	25.00	-	-
Ondo 1	77.78	11.11	-	11.11	-	-	-	-	-	-	-	-
Ondo 2	20.00	-	20.00	13.33	6.67	6.67	-	-	-	33.33	-	-
Ondo 3	33.33	-	-	-	-	-	66.67	-	-	-	-	-
Ondo 4	77.78	11.11	-	11.11	-	-	-	-	-	-	-	-

Ekiti 1	27.27	18.18	-	9.09	13.64	-	-	-	-	31.82	-	-
Ekiti 2	-	-	-	76.92	-	-	7.69	-	-	15.38	-	-
Ekiti 3	30.00	-	-	50.00	-	-	-	-	-	-	20.00	-
Ekiti 4	50.00	-	-	10.00	20.00	-	-	-	-	20.00	-	-

Key:

Experimental Tittle: Prune-Slash and Char for Pest Management and Soil Amendment in Cocoa Plantations

Invetigator: Ogunlade Moses O., Asowata F. E., Fagbami S., Oyedokun A. V., Ogundeji, B.A., Adejobi K.

Introduction

Prune-slash and char is an agricultural technique that involves cutting of above ground biomass, drying the cut biomass and converting it into biochar on-site in simple earthen pits (soil pyrolyzer). Pruning improves growth and production in tree crops as it optimizes the balance of vegetative and reproductive growth and increases the efficacy of fertilization and pest control. This is also true of pruning in cocoa. However, the current pruning practice in cocoa where pruned materials either from cocoa or any other trees within the plantation are piled up in the plantation has created more problems of providing habitat for pests and diseases which also prey on the crop(s), thus causing damage and reduction in yield and crop quality.

Objectives

This study was done to convert the pruned and slashed materials into biochar and then use the biochar as soil amendment in the same plantation against conventional practices.

Materials and Methods

The study was carried out at Zone 1 experimental plot, CRIN Headquarters, Ibadan. The experiment occupied an area of 0.4ha, marked out for the trial. Pre-treatment soil samples were randomly collected with the use of soil auger to the depth of 0-20cm in the marked out area for the trial. The core soil samples randomly collected were bulked into one composite soil sample, processed and sent to the laboratory for routine soil analysis. It was a two- treatment trial: (i) prune-slash and char –tagged with red cloth ribbon, (ii) prune-slash and leave to decompose-labelled with blue cloth ribbon, replicated three times in Blocks 1, 2 and 3 with each block separated by 6m. The pruned materials from cocoa and other crops such as palm fronds and slashed weeds within the randomly allocated (red tagged) plots (12mx12m) were gathered, weighed and charred (pyrolysis) using soil pyrolyzer as seen in Plate 1. Then the materials on blue tagged plots were left in the plantation as being practiced by farmers.

Each experimental units contained sixteen cocoa trees, giving a total of 96 cocoa trees for the trial. Soil microbial population, soil nutrient status, termite (pest) infestation rate and other insect pest populations (intrinsic and influenced) were evaluated at the commencement of the trial. At the inception of the project, visual observation and scoring of insect species were done and hand sweep nets were used to capture the insects species on the plot for the study, which were captured into kilner jars containing cotton wool soaked with ethyl acetate, taken to the Entomology Laboratory for further processing and identification to determine the insects species diversity at undisturbed cocoa ecosystem level.

Subsequently, 3 fly traps and 1 termite monitoring box were purchased with rechargeable lights, pitfall traps and light traps were improvised and the fly traps had been set up with baits on the plot as soon as the plot was slashed to monitor the flying insects' population diversity.

Results and Discussion

The pH was near neutral with values ranging from 7.30 to 7.39 with an average value of 7.34. This fell within the required 5.5 and 7.5 pH range for cocoa (Table1). Available phosphorus contents of the various samples were grossly below the critical value of 10mg/kg required by cocoa as reported by (Egbe *et al*.,1989). The total nitrogen contents of the samples were adequate for cocoa soils being above the critical value of 0.09% as seen in Table 2. The Ca values were all above the critical values for calcium in cocoa growing soils. Meanwhile, Mg and K values of the soil samples were inadequate for cocoa. The soil texture was loamy sand.

Plate 3: Entomological insects traps at the study site.

Most of the microbes (fungi) isolated from the cocoa soil samples were pathogenic in nature, though not on cocoa pods. Virtually all of them were however biodegraders (Table 3; Plate 2), signifying their potential involvement in the decay of cut weeds and cacao branches on the ground of the cacao plot. Some of them are known to be carried from the field to the store where they infect the (cocoa) beans during and after fermentation, and at storage. The percentages of occurrence of the isolated fungi were in the following order: *Fusarium* spp. (20.00-44.44%) > *Aspergillus carbonarius* (20.00-28.57%) > *Mucor* sp. and *Colletotrichum* sp . whose occurrence

Exchangeable Bases				Total	Total Org	Avail.
Ca	**Mg**	**K**	**Na**	**N**	**C**	**P**
Cmol	Cmol	cmol	cmol	%	%	mg/kg
7.89	0.47	0.26	15.00	0.36	2.69	2.64
5.07	0.07	0.24	0.12	0.14	1.84	0.67
7.58	0.55	0.28	13.04	0.41	2.72	3.04
6.03	0.13	0.23	0.13	0.13	2.01	1.04

range between 0.00-10.00%. *Fusarium* spp. are well known as cacao pathogens especially at the seedling stage and on open, less shaded fields (Rosmana et al., 2013).

The major insect species Order encountered on the plot were: Lepidipotera (about 62%), Diptera (about 18%), Hymenoptera (about 12%) and Isoptera (about 8%). So far, the main flying insects captured by the traps were Dipterans, Lepidopterans and Braconidae.

Table 1. Soil physical properties at the experimental site

Table 2. Some of the nutrients contents of the soil before treatment application

Sample ID	Percentage occurrence of isolates (%)				
	Aspergillus carbonarius	*Fusarium oxysporium*	*Fusarium* sp.	*Mucor* sp.	*Colletotrichum* sp.
PRSL 1	22.22	44.44	33.33	-	-
PRSL 2	20.00	20.00	40.00	10.00	10.00
PRSL 3	28.57	42.86	28.57	-	-
Average Occurrence	23.60	35.77	33.97	3.33	3.33

Table 3: Fungi associated with cocoa soil

Samle		**Particle size**			
ID	pH	Sand %	Silt %	Clay %	Textural class
1	7.39	78.40	16.80	4.80	Loamy sand
2	7.31	73.80	19.40	6.80	Loamy sand
3	7.30	78.80	19.40	6.80	Loamy sand
4	7.35	78.40	16.80	4.80	Loamy sand

Concl usion and Recommendation

The soil was depleted especially in phosphorus and potassium, owing to continuous harvest of pods and non- application of fertilizers. The isolated fungi will be potentially useful in biodegrading pruned cacao branches and cut weeds when left on the ground. The insects diversities collected from the entomology traps were being evaluated as the study is still ongoing.

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Experimental Tittle: Economics of Cocoa Integrated Pest Management (IPM) in Cross-River State

Investigator: Lawal, J. O., Oyedokun, A.V. and Taiwo, O.A.

Introduction

Integrated Pest Management (IPM) is an approach to making pest control decisions with increased information and the use of multiple “strategies” to manage pest populations in an economically efficient and ecologically sound manner. IPM on cocoa farms considers any and/or all combinations of various techniques for the management of weeds, insects, diseases and animals pest problems within the context of the cocoa farm. The economic effects of IPM are realized both by individual farmers and by society at large.

Pests generally constitute economic nuisance which wastes resources of farmers posing them to total crop losses, damages and reduced income. Insecticides are generally toxic, creates problems and economic externalities (Onstad and Crain, 2019). IPM programs can influence pest control costs, the level and variability of producer income, and the health of pesticide applicators. The technique also can improve food safety, quality of life and in the long-run, sustainability of crop production. This study therefore evaluated the existing IPM techniques being used by cocoa farmers in Cross River state.

Hence, the objectives of this study were to:

1. ascertain the IPM techniques used by cocoa farmers on the fields in the study area;
2. determine the factors influencing IPM adoption among cocoa farmers in the study areas; and
3. empirically determine constraints to the use of IPM techniques on cocoa farm in the study areas.

Materials and Methods

Primary data were collected in Cross-Rivers State (CRS) in the South-south region of Nigeria using the Open Data Kit. CRS is another fast cocoa growing region and second largest producer after Ondo State. A multistage sampling technique was used to administer sixty-five questionnaires to cocoa farmers to elicit needed information. The first stage was the random selection two Local Governments Areas (LGA); namely Ikom and Etung Local Government Area, then the second stage was the purposive selection of three villages per LGA then the third was the random selection of 10 registered farmers based on the Agricultural Development Programs (ADP) list per village. Data collected were subjected to descriptive and inferential analysis.

Results and Discussion

The Demographic characteristics of the cocoa farmers

The demographic characteristics of the farmers such as age, gender, educational status, years of experience in cocoa farming among others are important variables that determined the use or dis-use of Integrated Pest Management (IPM) on the cocoa farm. Analysis on Table 1 shows that majority of the cocoa farmers (99.77%) interviewed were male cocoa farmers of which 72.31% were married indicating that most of the farmers were assumed to be socially responsible. Majority of them (89.27%) had both secondary and tertiary education, indicating a high probability of farmers adopting new research innovations like the IPM. The farmers were primarily cocoa farmers who also grew other tree and arable crops.

Furthermore, most of the farmers (51%) had between 1 to 5 ha of cocoa plantations, while 33.77% possessed between 6 to 10 ha. This shows that the farmers in the study area were relatively medium to large scale cocoa farmers. Most of them (49.28%) planted the (F3 Amazon) breed of cocoa, while only few planted the Tc-series hybrid cocoa.

IPM techniques used by Cocoa farmers

Further analysis on Table 1 shows that about 70.77% of the cocoa farmers did not know or have the knowledge of IPM techniques while only 29.23% had heard about it but did not have full understanding of IPM but they only knew it was used for controlling pests. About 83% of the farmers controlled pests on their cocoa farms with chemicals of various brands on fungi, insects, and also made use of acaricides and very limited use of herbicides. This indicates that farmers were not aware of the use of IPM; their main technique of cocoa pest control / maintenance was the use of chemicals. Therefore, there is a high possibility of chemical residues in the cocoa products from the study area. This could be detrimental to human and environmental health. There is also the possibility of cocoa bean rejection by exporters if the chemical residues exceed acceptable limits of 0.01 to 0.02mg/kg in the cocoa products required for cocoa consumption.

Constraints to the use of IPM

This study found empirically that high cost of the needed chemicals (35.5%) for use on the cocoa farms served as a barrier to the use of IPM techniques on the farms, coupled with the fact of lack of funds by the farmers. The most important constraint discovered was the difficulty in the application and use of IPM due to poor technical know-how/ knowledge of the use of IPM techniques. Majority of the farmers just continued to mix all sorts of chemicals without due consideration to their health (they sprayed without the use of the PPE), the plant (over use or use of inappropriate chemicals) and the soil (direct mixture of herbicides, fungicides and insecticide all loading the soil). And the third constrain found among the farmers was poor labour availability for farm operations (18.4%). Majority had diversified into other income sources other than doing the drudgeries that come with cocoa farm labour. This further corroborate the fact that majority of the farmers seeks government intervention on credit support and subsidy on the various chemicals used on their cocoa farms.

Conclusion and Recommendation

Findings from the study area on the use of IPM by cocoa farmers showed that the farmers were young/vibrant and educated, and with relatively large cocoa farms. Majority of the farmers did not have knowledge of the use of IPM nor have undergone training on IPM; inferring that most of them use agrochemicals to control the pests on their farms which posed resultant hazards on the health of both cocoa farmers and consumers. Also, the lack of training and knowledge of IPM on cocoa farm were important variables for adopting the use of IPM in the study area.

It is therefore recommended that relevant agencies such as Cocoa Research Institute of Nigeria with the mandate on cocoa should urgently organize training for farmers on the use of IPM. This will lead to the production of much more healthy cocoa beans that will be acceptable internationally and safe for consumption. It will also be cost effective for farmers and at the same time attract premium price on their cocoa thereby increasing their income and hence, the livelihood of cocoa farmers.

Table 1a: Demographic characteristics of the cocoa farmers

Gender

Gender	**Freq.**	**Percent**	**Cum.**
Female	6	9.23	9.23
Male	59	90.77	100.00
Total	65	100.00	

Source: Field survey, 2023

Marital status

Marital status	Freq.	Percent	Cum.
Married	47	72.31	72.31
Single	17	26.15	98.46
Widowed	1	1.54	100.00
Total	65	100.00	

Source: Field survey, 2023

Educational level

Educational level	Freq.	Percent	Cum.
Adult education	1	1.54	1.54
Primary Education	6	9.23	10.77
Secondary Education	38	58.46	69.23
Tertiary Education	20	30.77	100.00
Total	65	100.0	

Source: Field survey, 2023

Primary occupation

Primary occupation	Freq.	Percent
Artisan	3	4.64
Cocoa buyer	8	12.32
Cocoa Farming	44	67.76
Cocoa buying/poultry farming	1	1.54
Driving	2	3.08

Laundry	1	1.54
Timber business	3	4.64
Trading	3	4.64
Total	65	100

Source: Field survey, 2023

IPM used on cocoa

IPM Used	Freq.	Percent	Cum.
Biological control	2	3.08	
Chemical control	54	83.08	
Cultural control	5	7.69	
Physical control	2	3.08	
Use of botanical pesticides	1	1.54	
All of the above	1	1.54	
Total	65	100	

Source: Field survey, 2023

Table 1b: Summary statistics

Variable	**Observation**	**Mean**	**Std. Dev.**	**Min**	**Max**
Age	65	39.07692	9.966048	20	62
Year of cocoa farming	65	15.78462	8.425208	3	40

Farm size	65	10.21462	7.950588	1	40
Number of cocoa plot	65	2.292308	1.168908	1	5
Cost of chemical	65	319184.6	262311.1	27000	1800000

Source: Field survey, 2023

Table 2: Determinants of Adoption of IPM (factors influencing adoption)

F (7, 58) = 143.46 1

Source	SS	df	MS	Number of obs = 65
Model	189.079149	7	27.011307	Prob > F = 0.0000
Residual	10.9208507	58	.188290529	
Total	200	65	3.07692308	

R-squared = 0.9454 Adj. R-squared = 0.9388 Root MS = .43392

Variables	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
Age	.0022939	.006038	0.38	0.705	-0097925	.0143802
Gender	.0234762	.0442064	0.53	0.597	-.0650125	.111964
Educational Level	.0391246	.0759747	0.51	0.609	-.1129552	.1912045
Farm Experience	-.0007896	.0084325	-0.09	0.926	-.017669	.0160899
Farm Size	.0085545	.0078278	1.09	0.279	-.0071147	.0242236

Training on IPM	.3019849	.1535805	1.97	0.054	-.0054399	.6094096
Knowledge about IPM	.4609038	.1453091	3.17	0.002	.1700361	.7517716

Source: Field survey, 2023

Experimental Tittle: Perception on adoption of Integrated Pest Management for the enhancement of cocoa production and income among cocoa farmers in Osun State, Nigeria

Investigator: Uwagboe, E.O; .Adebiyi, S; Williams, O.A and Agulanna, F.T.

Introduction

Cocoa is one of the major cash crops in Nigeria, and it is primarily grown by smallholder farmers who rely on cocoa production for their livelihoods. Cocoa also play tremendous role in the health sector as it is reported through researches that the consumption of cocoa products prevents malaria, diabetes and hypertension and also reduces fatigue among others (Ashton, 2013). In West Africa cocoa is mainly grown by small holders who traditionally planted their cocoa at random under thinned forest shade. It is a low input cultivation system which uses the forest soil fertility and the existing shade. This simple method explains that some six million ha of the West African forest zone are planted with cocoa, which provides about 70 percent of the total world production (Marius Wessel & P.M. Foluke Quist-Wessel, 2015).

In Nigeria, the decline in cocoa production is mainly due to the incidences of insect pests and diseases along with other factors (Asogwa, Anikwe and Ndubuaku 2004). The damage caused by the pests is up to an estimated loss of 100,000 tonnes. The main disease of cocoa is the ‘Black pod’ caused by *Phytophthora palmivora* and *Phytophthora megakarya* which resulted to 100% total loss in some cocoa producing countries and in Nigeria with a loss of 75% (Asogwa, Anikwe and Ndubuaku 2004).

Nigerian cocoa farmers use a lot of agro-chemicals (insecticides, herbicides and fungicides) to increase production, but they often do not consider the negative impacts of this on the cocoa beans. However, with the idea of integrated pest management (IPM), the number of spray applications has been further reduced (Ojelade, Anikwe, and Idowu, 2005). IPM practices promotes crop quality, protects the environment and profit potentials of stakeholders.

The general objective of this study was to assess the perception of cocoa farmers on the adoption of IPM on cocoa production in the study area.

Materials and Methods

Pre-Survey

The pre-data survey was carried out in Ayeoba in Ife- South LGA of Osun State. The survey which also represented advocacy visit was achieved in order to be familiar with the culture, norm and tradition of the farmers in the study area. Unequivocally, it was during the pre-survey activities that we determined the applicability of the questionnaire and also got legitimization for the proposed survey work.

Study Area

The study was carried out in Osun State. Two Local Government Areas (LGAs) namely Ife South and Ife Central were selected for the study. The main survey was carried out in Aye Oba and Olode in Ife-South LGA of Osun State. Eighty cocoa farmers sampled for the survey work were drawn from Aye Oba and Olode in Ife South, while seventy cocoa farmers were drawn from Aye Koka and Iyanfoworogi in Ife-Central LGA. Structured interview schedule was used to collect information from the sampled farmers who were assembled at Aye Oba, which was in the center of the communities around the area. The programme was organized in a participatory approach manner. The farmers comprised of both male and female cocoa farmers. A total of one hundred and fifty (150) cocoa farmers were used for the study.

Instrument for Data Collection

A structured questionnaire was used to elicit information from the cocoa farmers in relation to the study objectives. The questionnaire was divided into five sections as follows; (a) Socio-economic characteristics, (b.) Perception on the use of IPM, (c.) Constraints experienced in adopting IPM, (d.) Attitude of respondents towards adoption of IPM, (e.) Adoption behaviour rate of IPM usage.

Analytical Tools

Descriptive and inferential statistics; frequency distribution, percentages, mean, standard deviation and weighted mean scores.

Results and Discussion

The variables in Table 1 shows the socio-economic characteristics of farmers which include sex, marital status, educational status, age in years, religion, farming experience (years), farm size (Hectares). The Table reveals that 48.7% of the respondents were males with a minimum of half being females. Most (84.7%) were married, a status that confer a sense of responsibility. With regards to education, 84% of the respondents had one form of formal education ranging from adult to primary to tertiary. Farmers who have higher levels of education are likely to embrace innovation that can enhance their livelihoods and productivity. Respondents within the age brackets of 56-63 years were 22.1%. It means that majority of the farmers though not young were still productive and active in cocoa farming. This indicates that most of them are still in their prime age and would be ready to learn and apply IPM techniques on their farms. 68.7% had between 20 and 31 years farming experience. It could be inferred that they were well experienced in cocoa production. Most (46.0%) of the respondents had farm size of 3-5 hectares which is an indication of relatively small-scale cocoa farming.

This implies that majority of the farmers own small farms, which could have effect on IPM adoption. The farm size owned by the cocoa farmers showed that most of them were smallholders growing cocoa on less than 10 hectares of farmland. This may be attributed to land tenure system in the country which favours land fragmentation through inheritance. A farmer having large cocoa farms could harvest more cocoa which may translate into higher income for the purchase of the relevant inputs to implement the technologies. Cocoa farm size could have a positive effect on adoption due to availability of large expanse of land for cocoa cultivation resulting to increase in cocoa output giving rise to increase in income which would enhance the probability of the technology being adopted. This finding is similar to an earlier report by

(Ojelade, Anikwe and Idowu, 2005) who posited that 75.5% of the cocoa farmers in Nigeria were either small or medium scale farmers.

Table 1: Socio-economic characteristics of farmers N=150

Variables	Frequency	Percentage
Sex		
Male	73	48.7
Female	77	51.3
Marital Status		
Single	19	12.7
Married	127	84.7
Divorced	-	-
Widowed	4	2.7
Educational Status		
Non formal	24	16.0
Adult	12	8.0
Primary	48	32.0
Secondary	50	33.3
Tertiary	16	10.7
Religion		
Christianity	104	69.3
Islamic	44	29.3
Traditional	2	1.3
Age (Years)		
24 – 31	23	15.3
32 – 39	10	6.6
40 – 47	31	20.6
48 -55	31	20.6
56 – 63	33	22.2
64 – 71	9	6.0

72 and above	13	8.7
Farm size (Hectares)		
0 – 2	60	40.0
3 – 5	69	46.0
6 – 8	15	10.0
9 and above	6	4.0
Farming Experience (Years)		
8 – 19	6	4.0
20 – 31	103	68.7
32 – 43	25	16.7
44 – 55	14	9.3
56 and above	2	1.3

Source: Field Survey, 2023

Table 2 reveals cocoa farmers' awareness of IPM, years in IPM training, amount spent on IPM, bags of cocoa sold and the amount realized from the sale. A high percentage of farmers (87.3%) were aware of IPM while (92.1%) had 0 - 9 years of training in IPM indicating that this is a recent innovation in cocoa farming. About 63.3% of the respondents realized more than half a million naira from the sales of cocoa per annum in the study area. About forty-three percent (42.7%) of the respondents spent less than forty-two thousand naira on IPM per annum. This suggests that the farmers' production level can be increased or boosted with IPM as it improves the nutrients in the soil and may give higher yield.

Table 2: Awareness and amount spent on IPM N=150

Variables	Frequency	Percentage
Awareness of IPM		
Yes	131	87.3
No	19	12.7
Years in IPM Training		
0 – 9	138	92.1
10 – 20	2	1.3

21 – 31	10	6.6
Bags of cocoa produced (65kg=1 bag)		
2 – 10	63	42.0
11 – 19	43	28.7
20 – 28	19	12.6
29 – 37	14	9.4
38 and above	11	7.3
Amount realised on sale of cocoa(₦)		
50,000 – 643,000	55	36.7
643,001 – 1,236,001	71	47.3
1,236,002 – 1,829 002	17	11.3
1,829,003 – 2,422,003	3	2.0
2,422,004 – 3,015,004	4	2.7
Amount spent on IPM per year (₦)		
0 – 41,400	64	42.7
41,401 – 82,801	38	25.3
82,802 – 124,202	43	28.7
124,203 and above	5	3.3

Source: Field Survey, 2023

Table 3 shows the perception of the respondents on the use of IPM. Respondents that perceived that improved farming system are not easily adoptable so they do not adopt them had the highest weighted mean score (WMS) of 2.55 so was ranked 1st while those that indicated that they adopt new practices based on information about them from those who have adopted (WMS=2.19) and those that responded that since new farm practices are not profitable, they are not interested in any of them (WMS=1.43) were ranked 2nd and 3rd respectively. Those that perceived that they are very much interested in adopting new practices that are helpful in conserving input, soil and water had the lowest WMS of 1.04 and was ranked 6th. This could be linked to the fact that, extension delivery in respect of conserving inputs, soil and water conservation is grossly inadequate. Hence, farmers are not giving it priority. This is in line with Gockowski and Ndoumbe (2004) who opined that a major factor underlining low yield is the failure of research and extension to deliver necessary and affordable services to the farmers.

Table3: Perception on the use of Integrated Pest Management N=150

Perception on the use of Integrated Pest Management	A	U	D	WMS	Rank order
I am very much interested in adopting new practices that are helpful in conserving input, soil and water	0(0.0)	6(4.0)	144(96.0)	1.04	6th
Since am not sure of success of new practices, I will like to wait till others adopt it	22(14.7)	5(3.3)	123(82.0)	1.33	4th
Since new farm practices are not profitable, am not interested in any of them	30(20.0)	4(2.7)	116(77.3)	1.43	3rd
I try to keep myself inform about improved farming practices to adopt it as earlier as possible	17(11.3)	0(0.0	133(88.7)	1.23	5th
Improved farming system are not easily adoptable so I don't adopt them	113(75.3)	6(4.0)	31(20.7)	2.55	1st
I adopt new practices based on information about them from those who have adopted	88(58.7)	2((1.3)	60(40.0)	2.19	2nd

Source: Field survey, 2023 A= Agree U= Undecided D= Disagree

Conclusion and Recommendation

In conclusion, most of the farmers were in their prime age and ready to learn and apply IPM techniques on their farms. Most of the small scale farmers were females with long years of farming. Government should encourage youths to be involved in cocoa production to enhance sustainability. The size of farm of the farmers was relatively small; they needed to be supported probably with soft loan to enhance increase in the hectares of their cocoa farms. Also, yield improvement programmes such as good agricultural practices and rehabilitation via agronomic practices, should be initiated and taught in order to increase yield of farmers. Men should also be encouraged to grow cocoa in the study areas.

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Experimental Tittle: Structure and Labour Use Pattern among Cocoa farmers in Ondo state, Nigeria.

Investigator: Oluyole, K.A., Akinpelu, A.O. and Oladokun Y.O.M

Introduction

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 (Ayanwale, 2002; Saror *et al*., 2021). 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; Gomez *et al*., 2022). 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 need to continue supplying food for 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; Emmanuel and Oba, 2019). 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; Idiake-Ochei, 2019). Lele and Stone (1989) and Adipala and Egeru (2018) affirmed that rapid growth in population which increases farm labour supply exerts so much pressure on land and reduces farm size per hectare. Empirical evidence has shown that available labour force comprised mostly of old people to the exclusion of young men and women within the active working age thus having a negative impact on agricultural productivity. This is because the role of youths in agricultural production cannot be over-emphasized.

Oluyole *et al*. 2013 examined the labour structure and its determinants among cocoa farmers in Nigeria. One hundred cocoa farmers were selected in the study area using stratified sampling technique. Eighty percent of the respondents are smallholder farmers having between 1-5 hectares of cocoa farm. Ninety four percent of the cocoa farmers used hired labour for farm clearing while 61.0% and 51% used family labour for harvesting and on farm cocoa processing, respectively. The major determinants of labour use among cocoa farmers were wage rate ($p<0.05$), farm size ($p<0.01$), farm income ($p<0.01$). The study recommended that infrastructural facilities should be provided in rural South West to encourage youth involvement in agriculture.

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.

Objectives of the study

To examine the structure and use patterns of farm labour in the study area.

Materials and Methods

Study Area

The study was carried out among cocoa farmers in Ondo State. Ondo State is one of the Southwestern States in Nigeria. The State is the highest cocoa producing State in Nigeria. Out of the Local Governments Areas (LGAs) in Ondo State, Ondo East is one of the major cocoa producing LGAs in the State.

Source: Akinsanmi *et al*. 2016

Figure 1: Map of Ondo state

Sampling Technique

Multistage random sampling was used to select cocoa farmers. Ondo East Local Government Area was purposively selected from the State and from the LGA, Laagba community was also purposively selected because cocoa farmers are mostly concentrated in the community. Simple random sampling technique was used to collect data from a total of 144 farmers randomly selected from the community. Data were collected from the respondents with the aid of structured questionnaire and the data obtained from the questionnaire were analysed using Descriptive analysis. Descriptive Statistics was used to describe the socio-economic characteristics of the farmers as well as the structure and use of labour pattern in the study area

Analytical Procedure

Descriptive Statistics was used to describe the socio-economic characteristics of the farmers as well as the structure and use of labour pattern in the study area.

Results and Discussion

The result of the socio-economic characteristics of the farmers is shown in Table 1. The table shows that 74.99% of the total respondents are above 50 years of age indicating that the proportion of old people among the respondents is very high. Meanwhile, only 25.01% of the total respondents were 50 years and below. The lowness in the proportion of the youths is a bad pointer to cocoa production efficiency as younger farmers are more active on farm work than the aged ones. Oluyole *et al*. 2013 affirmed that the provision of infrastructure in rural areas would attract more youth to the rural areas. Table 1 also shows that 79.17% of the respondents were males. This is quite obvious in that farm work is a tedious work and is only men that could cope effectively with it. Apart from this, most of the farms were inherited and some traditional cultures permit only the male children to inherit farms. As regards the educational level of the respondents, the result of the analysis shows that 75.07% of the respondents were having formal education. This would improve the efficiency of the farmers in as much that literate farmers would find it easier to adopt new technologies on cocoa than the illiterate ones. The analysis on farm size shows that 66.67% of the respondents had farm size of 5 hectares and below which shows that most of the farmers are small scale farmers. Table 1 also shows that 50.0% of the farmers had the age of their farms greater than 30 years showing that most of the farms are old and hence the farm's productivity would reduce, therefore such farms needs to be rehabilitated. This is a good pointer to an increased productivity. Table 1 also revealed that majority (75.00%) of the farmers had purchased farms while just 12.5% inherited their farms.

Table 1: Socioeconomic Characteristics of Farmers

Variables	**Frequency**	**Percentage**
Age of farmers (years)		
≤ 30	6	4.17
31-40	6	4.17
41-50	24	16.67
51-60	48	33.33
>60	60	41.66
Total	144	100.00
Sex of farmers		
Male	114	79.17
Female	30	20.83
Total	144	100.00
Educational Status		
No formal education	36	25.00
Primary education	36	25.00
Secondary education	54	37.50
Tertiary education	18	12.50
Total	144	100.00
Marital Status		

Single	0	0.00
Married	126	87.50
Widow/widower	12	8.33
Divorced	6	4.17
Total	144	100.00
Farm size (Ha)		
≤ 5	96	66.67
6-10	30	20.83
11-15	18	12.50
Total	144	100.00
Age of farm (years)		
≤ 10	6	4.17
11-20	24	16.66
21-30	42	29.17
31-40	36	25.00
41-50	18	12.50
>50	18	12.50
Total	144	100.00
Nature of ownership		
Inherited	18	12.50
Purchased	108	75.00
Rented	12	8.33
Sharecropping	6	4.17
Total	144	100.00

Source: Field survey, 2021

Table 2 shows the structure of labour according to the different types of labour used for different activities in cocoa farming. The table shows that contract type of labour is majorly used for most activities in cocoa farming. However, cooperative labour was seldom used for any activity showing that cooperative labour is no more utilized in cocoa farming in the study area. Family labour is also utilized for all activities but at different magnitude. Activities such as land clearing, planting, weeding, application of chemicals, removal of mistletoes, harvesting of cocoa pods, conveyance of cocoa pods to the pod breaking point, breaking of cocoa pods and conveyance of cocoa beans to the point of fermentation were majorly carried out by contract labour. This is because 75.0%, 83.32%, 95.83%, 91.67%, 87.50%, 87.50%, 95.83%, 100.0% and 88.33% of the farmers respectively indicated that they utilized contract labour for such activities. However, activities such as drying of cocoa beans, parking of dried cocoa beans and preservation of cocoa beans were majorly carried out with family labour.

Table 2: Distribution of labour by types of labour used for different activities in cocoa farming

Activities	Types of Labour					
	Family		Contract		Cooperative	
	Freq	%	Freq	%	Freq	%
Land clearing	36	25.00	108	75.00	0	0.00
Planting	18	12.5	120	83.33	0	0.00
Weeding	6	4.17	138	95.83	0	0.00
Application of chemicals	24	16.67	132	91.67	0	0.00
Application of fertilizer	12	8.33	108	75.00	0	0.00
Removal of mistletoes	6	4.17	126	87.50	0	0.00
Harvesting of cocoa pods	30	20.83	126	87.50	0	0.00
Conveyance of cocoa pods to the point of pod breaking	24	16.67	138	95.83	0	0.00
Breaking of cocoa pods	42	29.17	144	100.00	0	0.00
Conveyance of cocoa beans to fermentation spot	42	29.17	120	88.33	0	0.00
Fermentation of cocoa beans	42	29.17	96	66.67	0	0.00
Conveyance of cocoa beans from the fermentation spot to the drying spot	38	25.00	108	75.00	0	0.00
Drying of cocoa beans	144	100.00	12	8.30	0	0.00

Parking of dried cocoa beans	144	100.00	6	4.17	0	0.00
Preservation of cocoa beans	144	100.00	0	0.00	0	0.00

Source: Field survey, 2021.

Table 3 shows the distribution of the labour used for cocoa farm activities based on the gender of the labour. The table shows that male labour were mostly utilized for all the activities as indicated by most respondents. On the other hand, female labour were sparingly utilized for some activities such as land clearing, planting, application of chemicals (spraying of chemicals), removal of mistletoes and harvesting of cocoa pods as only 8.33%, 0%, 8.33%, 4.17%, 0% and 12.5% of the farmers respectively indicated that they use female labour for the respective farm activities. However, female labour were mostly used for conveyance of cocoa pods to the point of pod breaking, breaking of cocoa pods, conveyance of cocoa beans to the spot for fermentation and drying of cocoa beans.

Table 3: Distribution of labour by the gender of labour used for different activities in cocoa farming

	Gender of labour			
Activities	**Male**		**Female**	
	Freq	**%**	**Freq**	**%**
Land clearing	144	100.00	12	8.33
Planting	144	100.00	0	0.00
Weeding	126	87.50	12	8.33
Application of chemicals	126	87.50	6	4.17
Application of fertilizer	114	79.17	24	16.67
Removal of mistletoes	126	87.50	0	0.00
Harvesting of cocoa pods	114	79.17	18	12.50
Conveyance of cocoa pods to the point of pod breaking	120	83.33	126	87.50
Breaking of cocoa pods	126	87.50	132	91.67
Conveyance of cocoa beans to fermentation spot	144	100.00	138	95.83
Fermentation of cocoa beans	120	83.33	12	8.30

Conveyance of cocoa beans from the fermentation spot to the drying spot	120	83.33	132	91.67
Drying of cocoa beans	138	95.83	120	83.3
Parking of dried cocoa beans	126	87.50	30	20.83
Preservation of cocoa beans	132	91.67	24	16.67

Source: Field survey, 2021.

Conclusion and Recommendation

The study was carried out on the structure and use pattern of labour among cocoa farmers. The study found out that labour could be structured according to the types of labour (family labour, contract/hired labour and cooperative labour) and according to the gender of the labour. The study further revealed that contract labour is mostly used for activities such as land clearing, planting, weeding, application of chemicals, removal of mistletoes, harvesting of cocoa pods, conveyance of cocoa pods to the pod breaking point, breaking of cocoa pods and conveyance of cocoa beans to the point of fermentation while family labour is mostly used for drying of cocoa beans, parking of dried cocoa beans and preservation of cocoa beans. However, cooperative labour is no more used as a form of labour in the study area. Funds should be made available to farmers to contract labour and also the need to use equipments and machineries to reduce drudgery.

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TASK: NEW COCOA CULTIVAR DEVELOPMENT

Experimental Tittle: Effect of rootstock on drought tolerance abilities of cocoa in Nigeria

Investigator: Ayegboyin, K.O., Famaye, A.O., Orisajo, S.B., Ugioro, O., Dada, K.E. and Ibe, O.

Introduction

Cocoa is naturally an under-storey tree species of the lowland rainforest of the Amazon basin which is characterised by high annual rainfall. In Nigeria, there is a defined dry season that typically last from mid-November until mid to late March. New plantings of cocoa in the field are usually made at the onset of the rainy season. However, post establishment losses can be high, during the following dry season. Two factors have been making establishment more difficult. An area that has received relatively little attention to date is the use of different rootstocks.

In Nigeria, the first attempt at investigating the relative importance of the interaction between rootstock and scion in cacao establishment started in 1971 (Atanda, 1975) but the results showed a general poor performance and the failure was attributed mainly to late transplanting and the period of time that the budded materials stayed in the nursery (Atanda, 1975). However, study carried out by Yin (2004) in Malaysia indicated that cocoa rootstock influences the vigour and the yield of the scion, at least, in the early years of establishment. However, no information exists for cocoa as to whether the performance of the scion is impacted by rootstock under water-limiting conditions in Nigeria.

Objectives

The aim of the experiment was to test the performance of a range of cocoa clones on two genetically distinct rootstocks and develop cocoa cultivars that are high yielding and relatively more tolerant to water stress to enhance cocoa production in marginal cocoa climates of Nigeria.

Materials and Methods

The study was carried out at the Cocoa Research Institute of Nigeria (CRIN) Headquarters in Ibadan, Oyo State and at a CRIN substation located at Owena, Ondo State, Nigeria. Ibadan is located between $7^{o}26'$ North and $3^{o}54'$ East with an altitude of 200 m above sea level and has a bimodal rainfall pattern; annual rainfall for the period of the study ranged from 1045-1237 mm. Owena lies between $7^{o}12'$ North and $5^{o}1'$ East and is located in the tropical rain forest ecosystem; annual rainfall for the period of the study ranged from 1309-1405 mm. The Owena location is considered an ideal cocoa climate, with a less pronounced dry season (Aikpokpodion *et al*., 2009).

The project was in 3 different phases but part of the results of the 2nd phase of the project is reported and deliberated upon in this presentation. The 1st phase involved hand pollination (self0 to produce cocoa pods for greenhouse and field establishment. The 2nd phase was the greenhouse trial as well as the laboratory studies/analyses of the experimental soil and cocoa seedlings produced from the 1st filial generation of the trees.

For the greenhouse experiment, the cocoa seeds were pre-germinated in the sawdust for two weeks before being transplanted into pots containing 4kg of topsoil collected between 0 and 15 cm of the soil surface. The top soil was passed through 10 mm sieve before being placed in the experimental pots. There were 330 experimental seedlings with 11 cocoa genotype, 5 stands per genotype, 2 field capacities 950 and 100 field capacities) and replicated 3 times (11 x 5 x 2 x 3 = 330). At 2 weeks after sowing, the seedlings were transferred from the pre-germination chamber into the soil in the pots and were watered at the same rate for another 2 weeks. Imposition of water regimes on the seedlings started exactly at 1 month after sowing (MAS) at 50 and 100 field capacity (FC) using the procedure described by Ayegboyin (2012).

Soil samples were taken from the top layer of soil used for the greenhouse experiment in Ibadan. The samples were air-dried under room temperature for three weeks and then bulked together. A sample of the air-dried bulked soil was taken and kept in a sealed coded zip lock bag before being sent to an internationally accredited laboratory for soil analysis. The result is shown in Table 5.

Data obtained for the growth parameters (plant height, stem girth, number of leaves and number of branches) of the cocoa seedlings for greenhouse experiment were analysed using ANOVA.

The treatment means were compared using a Duncan Multiple Range Test at 5% probability level (Gomez and Gomez, 1984).

Results and Discussion

Greenhouse Experimental Results

Physico-chemical Analysis of Soil used in the Greenhouse Experiment

The physical and chemical properties of the soil as presented in Table 1 showed that soil used for the greenhouse trial had a pH of 6.9 which is ideal for cocoa growth. Cocoa grows well in soils with a pH in the range of 5.0 - 7.5**.** It can therefore cope with both acid and alkaline soil, but excessive acidity (pH 4.0 and below) or alkalinity (pH 8.0 and above) must be avoided. Cocoa is tolerant of acid soils, provided the nutrient content is high enough. Based on the established critical levels for soils in Southwest Nigeria, the soil was good in organic matter compared to the critical level at 2.49 % O.M. (Agboola and Corey, 1973). The total N was 0.15 % and considered optimal for most crops according to Sobulo and Osiname, 1981. The available P was 10.79 m gkg-1 and higher than 10m gkg-1 P regarded as adequate for crop production (Agboola and Corey, 1973).

The exchangeable K, Ca, Mg and Na were higher than 0.2 mmol/kg regarded as the critical levels for cocoa seedlings (Folorunso *et al.*, 1995), thus, indicating rich soil fertility. The distribution of particle sizes of Sand (85.04%), Silt (12.00%) and Clay (2.60%) showed that the sampled soil was Sandy loam. This results revealed that the soil used for the greenhouse experiment was ideal for cocoa production. Cocoa requires deep and well drained soils. Poorly drained soil affects growth of plants. Majority of area under Cocoa cultivation is on clay loam and sandy loam soil. The results of the exchangeable bases, Ca, Mg, K and Na) in the sampled soil showed that the soil had enough of Calcium, Magnesium and Potassium nutrients for good cocoa production.

The term “exchangeable bases” or “total exchangeable bases” refers to the sum of the bases (calcium, magnesium, potassium, and sodium) in exchangeable form expressed as milligram equivalents per 100 g of soil. The 0.07 exchangeable Al+H showed a very low exchangeable

Aluminum hydride. However, hydrated Aluminum species (combined with hydroxyl [OH-]) usually are not toxic to plants because their charge is too weak to displace basic cations (Ca^{2+}, Mg^{2+}) from soil exchange sites. As soil pH becomes lower, decreasing soil pH provides increasing H+ ion activity, which reacts with OH- ions combined with the Al^{3+} ion, stripping the OH- away from the Al^{3+}, thereby increasing the charge on the Al-species to a +2 or +3 charge.

Table 1. Results of Laboratory Analysis of Soil Sample for Greenhouse Trial

	Parameter	***Unit***	***Value***
	pH		6.9
Particle size	Sand	%	85.40
	Silt	%	12.00
	Clay	%	2.60
Exchangeable Bases	Ca	Cmol/kg	5.36
	Mg	Cmol/kg	1.08
	K	Cmol/kg	0.364
	Na	Cmol/kg	0.494
	Al+H	Cmol/kg	0.07
	ECEC	Cmol/kg	7.37
Base	Salinity	%	99.05
Total	N	%	0.149
Total	Organic C	%	2.49
Available	P	mg/kg	10.79
Micro nutrients	Mn	mg/kg	66.30
	Fe	mg/kg	1.35

Cu	mg/kg	6.47
Zn	mg/kg	12.75

Performance of Cocoa seedlings in the Greenhouse: The performances of cocoa seedlings under different treatments of SARO application rates and control in the greenhouse in Ibadan are shown in Figures 1 & 2.

Plant height, stem girth, leaf number and number of branches (growth parameters) of the cocoa seedlings increased with time during the first 3 months after sowing (Figs. 1 & 2). While there were no significant differences ($p = 0.05$) among cocoa genotypes at the 3rd MAS for seedlings under 100% FC (Fig. 1), there were significant differences ($p = 0.05$) between treatments for those under 50% FC at 3 MAS in all parameters tested. While the height of TC2 (30 cm) was significantly higher than that of AMAZ15 (25 cm) at $p = 0.05$, the average stem girth of AMAZ15 (30 mm) was not significantly higher ($p = 0.05$) than those of TC2 (29 mm) under 50% FC.

At 6 MAS under 100 and 50 FC (Fig. 3 & 4), there were significant differences between treatments and genotypes. For instance, at 6 MAS under 100%, the height of N38 (57.8 cm) was significantly higher than those of P 150 (51.2cm), but on the contrary, at 50 FC at 6 MAS, the height of N38 (40.8 cm) was significantly lower than those of P150 (46.2 cm) and hence established some traits of variations in the drought tolerance abilities of cocoa genotypes during the period.

Fig. 1. Cocoa seedlings performance at 3 months after sowing under 100% field capacity

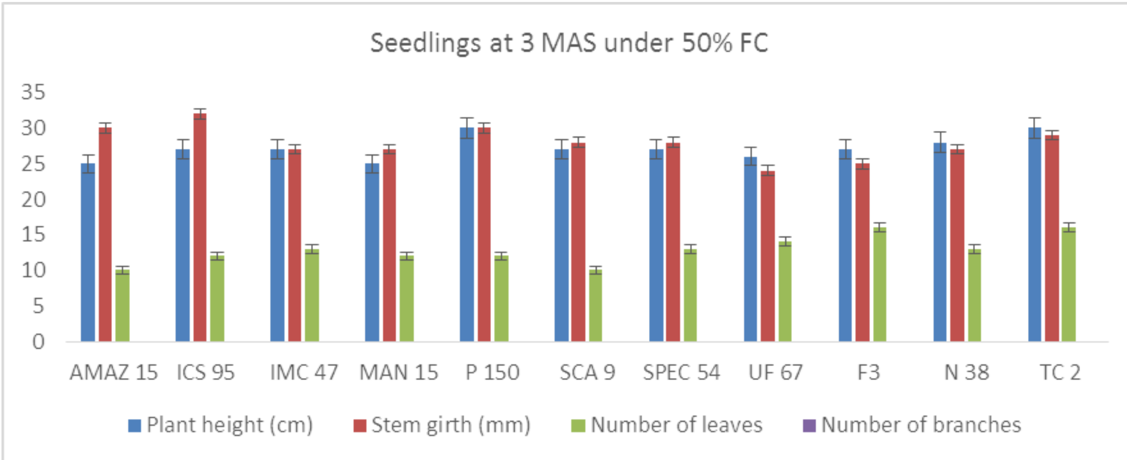

Fig. 2. Cocoa seedlings performance at 3 months after sowing under 50% field capacity

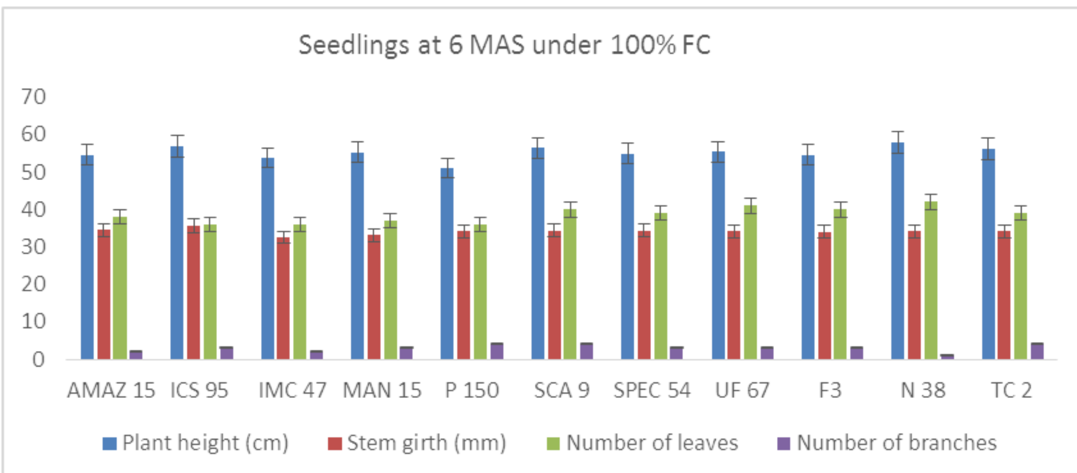

Fig. 3. Cocoa seedlings performance at 6 month after sowing under 100% field capacity

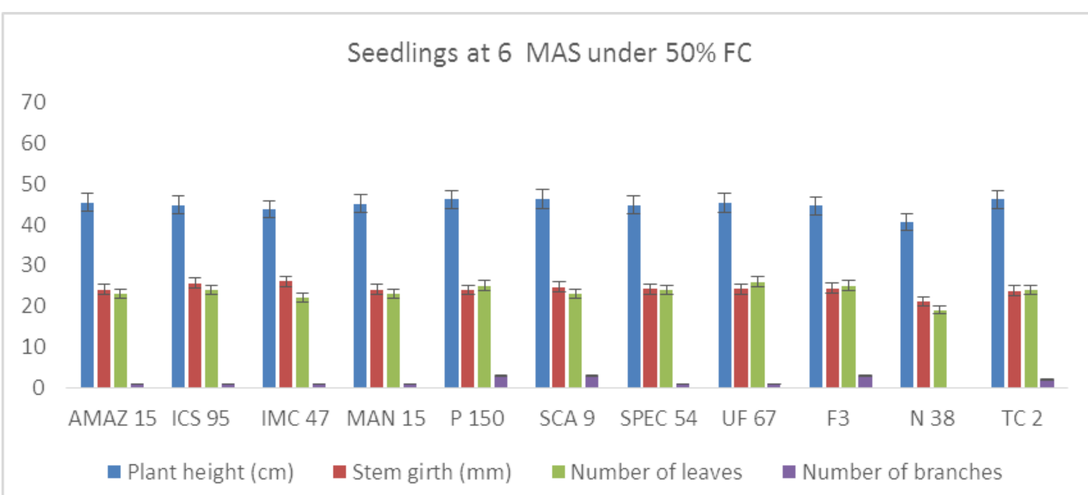

Fig. 4. Cocoa seedlings performance at 6 months after sowing under 50% field capacity

Conclusion and Recommendation

In conclusion, the experiment confirmed genotypic differences in the drought tolerance abilities of the cocoa clones in the Cocoa Research Institute of Nigeria, Ibadan although, the project is still on-going and more studies would still be carried out later. The budding of rootstock and field establishment aspects of the experiment will be carried out later in 2024.

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Experimental Tittle: Expansion of parental clonal garden; a source of planting material for Nigeria cocoa farmers

Investigator: Muyiwa A. A, Sobowale, I. O, Orisajo S. B, Adejobi K. B., Ogunlade, M. O. and Ogundeji B. A.

Introduction

The global demand for cocoa has grown consistently higher over the years; predominantly consumed in form of chocolate, level of cocoa consumption in a particular country tend to follow advances in economic development. Production level of cocoa in several countries are under threat for several reasons; ageing tree stocks, the use of non-improved planting materials, incidence of pest and disease, incidence of fire outbreak, and decline in soil fertility. The ever increasing demand for cocoa by the world growing population and market makes breeding for higher cocoa yield a usual and primary aim of most breeding programmes. Demand for cocoa is increasing rapidly with emerging countries consumption now exceeding production and the demand for improved planting materials has increase dramatically in Nigeria, higher performance planting maetrials is the cornerstone of a sustainable cocoa econmy. CRIN developed eight hybrids which had consistently outperformed the popular F3 Amazon cocoa variety in yield and earliness and were presented and release to Nigeria farmers in year 2011, the institute has not been able to meet the demand for this improved materials as the demand keep increasing yearly, a major obstacle in achieving higher production of the hybrid for farmers is the small size and few numbers of parental materials available in Nigeria. The establishment of the parental clones of the hybrids will increases the volume of improved planting materials to farmers, increase the country cocoa production and farmer's income generation.

Objectives

The objective of this study was to develop a hectare parental clonal garden to meet the demands of cocoa farmers for sustainable production.

Materials and Methods

The plot upon which the parental clonal garden was to be established was selected and cleared. Plantain suckers were also planted and established on the plot, while viable cocoa beans were planted at the nurseery to raise cocoa seedlings that will be used as the rootstock.

Results and Discussion

Over three thousand cocoa seedlings were raised in the nursery as root stock waiting to be grafted on. Vegetative materials (budwood) will however be collected from different field trials of the parental materials at diffeerent locations. The vegetative materials collected will be grafted on already established rootstock at the nursery, CRIN headquarters. The successful graft will be established on the plantain-established hectare of land at CRIN headquarters, Ibadan.

Plot of land cleared **Rootstock raised**

Conclusion and Recommendation

The work is on-going and cannot be concluded for now; the remaining and other activities will follow after grafting.

Experimental Tittle: On-station and On-farm evaluation of 4 new cocoa varieties in Nigeria by farmers' participatory approach

Investigatior: Muyiwa, A.A., Adeigbe, O.O., Adepoju, A.F., Olasupo, F.O., Sobowale, O., Baba Nitsa, M., Ogunlade, M.O., Adenuga, O.O., Olaniyi, O.O

Introduction

One of the major breeding goals is the development of high-yielding cocoa genotype (hybrids and clones) that are well adapted to local growing conditions and give optimum returns on investment to farmers. However, cocoa breeding and varietal development is constrained by many factors of which relatively long gestation period of the crop and funding of breeding programs are of great importance. The last cocoa breeding program in Nigeria was carried out in the CFC/ICCO/Bioversity funded project. In 2011, twelve cocoa hybrids which had consistently outperformed the popular F3 Amazon cocoa variety in yield and earliness were presented to the National Committee on Naming, Registration and Release of Crop Varieties for evaluation and for release. However due to some reasons, only eight of these hybrids were accepted for release by the Committee. Some of the remaining genotypes have huge potential for improving cocoa productivity and income at the farm level as well as the national production output. As such this proposal is put forward to further evaluate the remaining 4 varieties in order to collate recent and up to date necessary data and information on them; needed for putting them forward for release by the National Committee on Naming Registration and Release of Crop Varieties. This is necessary considering the fact that these four hybrids are equally good as the other eight previously accepted.

Objectives

The main objectives of this project were to select high-yielding and early-bearing hybrid families, to select hybrid progenies showing resistance to *Phytophthora pod rot* and to select the best performing crosses progenies on farmer's field at both ideal and marginal ecological growing conditions.

Materials and methodology

Pods of the four selected hybrids were generated through hand pollination at the Institute's headquarters. The four hybrids will be evaluated after maturation at the CRIN headquarters, one Sub-station, and on two farmers' fields in the cocoa agro-ecologies of Nigeria including Ideal climate, Ideal soil and Marginal climate. The four genotypes will be laid out in a randomized complete block design of three replicate.

Result and Discussion

The hybrid cocoa pods are at the cherelle stage of development and the developing cocoa pods at the cherelle stage are more than the required number proposed to raise seedling for the trials at different locations.

Conclusion and Recommendation

The work is ongoing and cannot be concluded for now. The remaining and other activities will follow after the maturation of the hybrid cocoa pods.

Experimental Tittle: Cacao Super Tree Selection for Cultivar Development in Nigeria

Investigator: Olasupo F.O., Sobowale I.O., Adedeji R.A., Orisajo S.B., Ogunlade M.O. and Oloyede A.A.

Introduction

Cocoa is one of the major foreign exchange-earning commodity crops for West and Central African countries such as Ivory Coast, Ghana, Nigeria and Cameroon which together produce more than 70% of the world's cocoa export of 3.592 million metric tons. In West Africa, more than 96% of cocoa production is carried out by smallholder farmers who rely on proceeds from the sale of cocoa beans as a major source of family income (Guiltinan *et al*., 2008, Aikpokpodion, 2010, Olasupo and Aikpokpodion, 2019). Proceeds from export also provide substantial revenue for the governments' capital development projects (Aikpokpodion, 2007). Cocoa is a very important crop in Nigeria, because it provides food, income, employment, industrial raw materials and resource for poverty reduction beside the provision of livelihood for millions of smallholder farmers. Cocoa also provides raw materials for the multibillion global chocolate industries (Peprah, 2019). Accurate estimates of genetic variability levels among farmer's germplasm accessions can increase the breeding efficiency of crop species. Since field gene banks serves as the repository of cocoa genetic resources, there is the need for targeted exploitation of useful underutilized genetic resources available in the germplasm collections for varietal development in future breeding program (Olasupo and Aikpokpodion, 2019). Therefore, to improve cocoa production in Nigeria, it is necessary to explore field gene banks for trees with high potential for yield and bean quality (super trees) for their selection and evaluation to provide information that could be useful for breeding programs and germplasm conservation.

Objectives: To select high yielding cocoa trees with good bean quality among cocoa accessions in the field gene banks (farmers' fields) to be utilized for improved cultivar development.

Materials and Methods

The superior cocoa genotypes on the field genebank (farmers' field) was explored using standard cocoa selection criteria based on the tree architecture, yield, diseases and pest tolerance, pod and bean index as well as the bean flavour quality traits. Only the trees that meet the selection criteria as indicated above were selected preliminarily for cocoa pods and budwoods collection. Ripe cocoa pods were collected from each of the selected cocoa trees on farmer's fields from different farms in Ondo, Abia and Cross River states (Table 1). Data sets collected from the sample pods and beans were subjected to the statistical analysis using Statistical Analysis Software (SAS), version 9.2, (SAS, 2007). The analysis of variance (ANOVA) was calculated using the PROC GLM procedure and significant means separated using Duncan's Multiple Range Test (DMRT).

Result and Discussion

The trees pre-selected were characterized with pods of diverse morpho-agronomic traits (Figure 1) that were of economic interest. Significant ($P \leq 0.01$) variation (with CV range from 10.64 to 27.7) existed among the cacao accessions selected across all the locations explored for agronomic and yield related parameters (pod and bean index) studied**.** Mean performance of cocoa pods evaluated for six agronomic and yield traits are presented in Table 2. Significant differences were observed among all the traits studied with the accessions from Atewolara Reserve (ATE) showing best performance in pod width (1102.22cm, pod length (22.99cm), pod girth (12.80cm), and outer pod diameter (10.45cm). Whereas, cacao accessions selected from Ilado farm were outstanding in inner pod diameter (6.11cm) and number of beans per pod (48.44). It is noteworthy to report that all these accessions pre-selected were based on their unique and diverse fresh bean flavour attributes. Considering the accessions based on their mean performance of the studied traits, the accessions have unique genetic constitution and they differ from each other in the phenotypic expression of the traits. The characters of the accessions offer them desirable parent for breeding programme.

Table 1: Farm Locations Explored for Cocoa Super Tree Selection in Ondo, Abia and Cross River States

State	Farm Location	Geo-reference		Farm Sample Code	No. of Trees Selected
		Longitude	Latitude		
Ondo	Owena Ayetoro	5.02364	7.19439	OW-AY	6

Ondo	Bolorunduro	4.96824	7.16229	BLD	6
Ondo	Idanre	5.12388	7.11583	IDR	6
Ondo	Atewolara Reserve, Omifan	4.85772	6.83307	ATE	6
Ondo	Ilado	5.26739	7.21001	ILD	6
Ondo	Afun farm, Wasimi	4.99262	7.17942	AFUN	6
Abia	Ibeku	7.58237	5.54216	IBK	6
Cross River	Bikpare Ajassor	8.86885	5.88668	BAJ	6
Cross River	Ajassor I	8.80992	5.82765	AJ1	6
Cross River	Ajassor II	8.81696	5.86634	AJ2	6
Cross River	Ikom	8.70453	5.97733	IKOM	6

Table 2: Mean performance of cacao accessions of cocoa evaluated for pod and bean agronomic and yield traits

Location	PdWT	PdLT	PdGT	IPD	OPD	NBPP
OW-AY	587.22bc	16.94c	9.47b	5.83ab	9.15b	42.67abc
BLD	513.89bc	17.70c	8.89b	5.44abc	8.55bc	41.72abc
IDR	628.33bc	18.88bc	9.44b	5.42abc	8.94bc	46.83ab
ATE	**1102.22a**	**22.99a**	**12.80a**	4.90bcde	**10.45a**	45.94abc
ILD	520bc	18.46bc	9.02b	**6.11a**	9.39ab	**48.44a**
AFUN	593.33bc	21.78ab	8.91b	5.30abcd	8.40bcd	47.17ab
IBK	434.72c	18.34bc	7.94b	4.46de	7.13e	42.78abc
BAJ	451.72bc	18.02bc	8.33b	4.83bcde	7.31de	42.83abc
AJ1	630.83bc	18.93bc	8.82b	5.06bcde	8.53bc	40.67bc
AJ2	668.38b	19.28bc	8.36b	4.72cde	7.93cde	44.72abc
IKOM	533.83bc	17.43c	8.18b	4.21e	6.93e	38.97c

CV	27.7	15.48	14.39	14.19	10.64	12.09

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

NB: Pod weight (PdWT), Pod length (PdLT), Pod girth (PdGth), Inner pod diameter (InPD), Outer pod diameter (OutPD), Number of beans
per pod (NoBP), Placental length (PLL), Placental weight (PLWT) Hundred Dry bean weight (HBWT)

Figure 1: Sample of some suspected and selected cocoa supper trees' pods from farmers' fields in Abia, Cross River and Ondo states

Conclusion and Recommendation

This project is on-going; hence it is too early to draw conclusion. However, the performance of the accessions makes them promising accessions and the observed phenotypic diversity in the study indicates that there is possibility for selection of genetic materials for further breeding programme. Therefore, we recommend that continuation of this project be given high priority for funding in 2024.

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Experimental Tittle: Economic Analysis of Cocoa Production Cropping Pattern in Nigeria

Investigator: Oluyole, K.A., Akinpelu, A.O., Orisasona, T. M., and Oladokun, Y.O.M.

Introduction

Nigeria is currently the world's fourth largest cocoa producer having recently moved from fifth largest, dislodging Ecuador from the former (NEPC, 2022; The Punch, 2022). Nigeria is also the third largest exporter of cocoa beans after Ivory Coast and Ghana. The top two countries (Ivory Coast and Ghana) combined to cultivate more than half of the world's cocoa (WCF, 2013; Odijie, 2018). Cocoa is the most prominent export crop in Nigeria in terms of her production and export capacities (Abdullahi *et al*., 2021; Nwachukwu *et al.*, 2010). According to (Awoyemi and Aderinoye-Abdulwahab, 2019; Adebile and Amusan, 2011) cocoa contributes about 15 percent to the total Nigeria export in 1970 and its contribution to Nigeria's foreign earnings is ₦122.9 billion in the first quarter of 2022 (*Premiumtimes, 2022).*

Cocoa production is a labor-intensive process that involves a variety of skill sets and backgrounds, with each group taking up a portion of its own in the value chain. In addition, the rural population, including elderly farmers (men and women) and recent graduates, derive employment prospects from planting, maintenance, harvesting, and drying of cocoa. Similarly, government employees, national and international businessmen, and consumers all benefited from the quality control marketing processing and exporting (Nkang *et al*. 2007). Meanwhile, intense and ongoing discussion concerning the benefits and drawbacks of cocoa mono-cropping systems as compared to cocoa Agricultural Farming Systems (AFS) has resulted from the deployment of these systems (Lennon *et al*. 2021). Ghana, which rose from 4th to 2nd position in 2014, has overtaken Côte d'Ivoire ranked globally as the topmost leading cocoa beans producer over the past four decades. Nigeria, however, has been struggling to maintain its fourth-place ranking in the production of cocoa since 2014.

According to Oluyole and Sanusi, (2009); Nkang *et al.* (2009), there are three cocoa cropping management systems. These are sole cocoa cropping, cocoa/arable cropping and cocoa/tree cropping systems. Sole cocoa cropping system involved planting only cocoa on a plot of land in a cropping season. Cocoa/ arable cropping involves the cultivation of cocoa and arable crops such as maize, vegetables on the same piece of land during a cropping season. This is usually done such that the farmers have something to feed on with their families before cocoa matures. Cocoa/tree cropping system involves the planting of cocoa and other tree crops on the same piece of land. These management systems are practiced across all cocoa producing regions in Nigeria basically for land intensification and food diversification. Despite the fact that some studies on cocoa affirmed that there are cocoa production systems and that cocoa production in general is profitable, there is however dearth of information on the extent at which different cocoa production management systems affect cost and return and hence the level of profitability of each of the cropping systems. In as much that the basic objective of a rational producer is to maximize profit and to minimize cost through efficient allocation of resources over a period of time.

Therefore, this particular study found it quite imperative to determine the costs and returns of cocoa production management systems in the study area.

Materials and Methods

Multistage sampling technique was used to select respondents for this study. The first stage, involved purposive selection of three geopolitical zones (South West, South South, North Central) based on the volume of cocoa production in these zones. Similarly, the second stage involved purposive selection of one state each from the three geopolitical zones representing high, medium and low cocoa production states, respectively. These are Ondo state (South-west), Cross River state (South-south) and Kwara state (North-central). In each of the selected states, two Local Governments Areas (LGAs) were randomly selected thus making a total of six LGAs selected for the study. Thirty five cocoa farmers were randomly selected in each LGA. In each state, seventy cocoa farmers were selected making a total of two hundred and ten cocoa farmers were randomly selected for the study. Finally, one hundred and eighty farmers' information were used for analysis after sorting out for missing data.

Information was collected from the farmers with the aid of structured questionnaire. The parameters obtained from the farmers were socio economic characteristics (age, gender, marital status, educational level, types of land ownership, farm size, socio economic group membership, type of cocoa seedling used) , cost incurred on (cocoa seedlings, fertilizer, fungicides, insecticides, herbicides), cost incurred on labour activities in cocoa production in the last production season (bush clearing, land preparation, weeding, planting, agro-chemical application, harvesting), average quantity of cocoa produced(kg), price of cocoa per kg. The information collected were analyzed using Descriptive statistics, budgetary analysis and linear regression analysis.

(i) Budgetary analysis

Total Variable Costs (TVC)-= Total variable Input cost + Total labour cost

Total Fixed Cost (TFC)-= Cost of equipments and machineries

Total fixed cost/farmer = Total fixed cost/number of farmers

Total cost= (TVC +TFC)

Gross Revenue= output * price

Gross Margin= Gross Revenue - Total Variable Costs

Net Income= Gross Revenue –Total Fixed Cost

Profit = Gross Revenue –Total Variable Cost

(ii) Linear Regression Analysis – this was used to determine the factors that affect the revenue of cocoa farmers for each of the cropping systems.

The implicit model is:

$Y_i = \beta_1 x_l + \beta_2 x_2 + ... + \beta_p x_p + e_i$ ....(i)

Where: Y= Revenue from cocoa and other crops.

ei= error term

The X_is are

cost of cocoa seedling, cost of fertilizer, cost of fungicide, cost of insecticide, cost of herbicide, labour cost on bush clearing, land clearing, weeding, planting, agrochemical application, cost of harvesting, sex of farmer, educational level of farmers and age of farm (years).

The variable costs used in the cocoa farms were cost of seedling, cost of fertilizer, cost of fungicide, cost of herbicide, labour cost of bush clearing, land preparation, weeding, planting.

The fixed cost used in the cocoa farms were depreciation cost of hoe, cutlass, tractor, jute bag

NOTE: All the costs were measured in USD equivalent

Results and Discussion

Socio-economic characteristics of cocoa farmers

Table 1 below shows the socio-economic characteristics of cocoa farmers in the study area. The table revealed that twenty seven farmers practiced sole cocoa cropping, seventy five farmers practiced cocoa/arable cropping and seventy eight farmers practiced cocoa/tree cropping systems, respectively. The table revealed that for all the cocoa cropping systems considered in the study, majority of the farmers are in their productive years (31-60years).. Similarly, the mean age of farmers in sole cocoa cropping system was 49.3±13.4, for cocoa/arable cropping system the mean age was 47.8±13.1 while for cocoa/tree cropping system the mean age of farmers was 47.2±12.5 In sole cocoa cropping system all the farmers were male while in cocoa/arable cropping 28% were female and 31% female farmers were also involved in cocoa/tree cropping. In the study women farmers were more involved in cocoa/arable and cocoa /tree cropping system as compared with sole cocoa cropping system. This may probably be that they are able to get other crops on their farm apart from cocoa which they can eat/sell to sustain their families. Majority of the farmers involved in cocoa cropping systems in this study were married. In sole cocoa cropping system, 33.3% of the farmers had no formal education, 55.6% had secondary education while 11.1% had tertiary level of education. For cocoa/arable cropping system, 32% of the farmers had no formal education, 36% had primary education, 28% had secondary education and 4% had tertiary education. Furthermore, in cocoa/tree cropping system 19.2% of the farmers had no formal education, 77% had primary and secondary level of education and 3.8% had tertiary education. According to Ammann *et al*., (2022) education plays a key role in the technological advancement among farmers. Majority of the cocoa farmers in this study owned the land in which they planted cocoa. Land ownership is a key factor in crop production (Austin *et al*. 2012). The other types of land ownership considered are inheritance, sharecropping and rentage. Also, in sole cocoa cropping system 88.9% used hybrid cocoa seedling and 11.1% used Amelonado cocoa seedling as planting materials. In cocoa/arable cropping system 64% of the farmers used hybrid cocoa seedling, 28% used F3 amazon while 8% used Amelonado as planting materials. Also 92.4% of the farmers who practiced cocoa/tree cropping system used hybrid and F3amazon type of cocoa seedling, 7.6% used Amelonado. In this study farmer who practiced cocoa/tree cropping system used more of hybrid seedlings compared to farmers that used other cropping systems. The mean farm size for sole cocoa cropping system was 8.7±8.0 ha, for cocoa/arable crop the mean farm size was 7.3±7.0 ha and for cocoa/ tree crop it was 8.4 ±7.7 ha.

Table 1: Socio-economic characteristics of Cocoa farmers in Nigeria

Variable	Sole cocoa Cropping (N = 27)	Cocoa/Arable cropping (N = 75)	Cocoa/Tree cropping (N = 78)	All (N =180)

Age				
≤30	3(11.1)	9(12)	9(11.5)	15(10.6)
31-60	24(88.9)	66(88)	69(88.5)	126(89.4)
Mean	49.3±13.4	47.8±13.1	47.2±12.5	48±13
Gender				
Male	27(100)	54(72)	54(69.2)	105(74.5)
Female	0(0)	21(28)	24 (30.8)	36(25.5)
Marital status				
Single	3(11.1)	6(8)	3(3.8)	9(6.4)
Married	24(88.9)	69(92)	75(96.2)	132(93.6)
Educational level				
No formal education	9(33.3)	24(32)	15(19.2)	36(25.5)
Primary education	0(0)	27(36)	30(38.5)	42(29.8)
Secondary education	15(55.6)	21(28)	30(38.5)	54(38.3)
Tertiary education	3(11.1)	3(4)	3(3.8)	9(6.4)
Land Ownership				
Self ownership	21(77.8)	69(92)	60(76.9)	111(78.7)
Inherited	6(22.2)	6(8)	12 (15.5)	24(17.1)
Sharecropping	0	0	3(3.8)	3(2.1)
Rentage	0	0	3(3.8)	3(2.1)

Type of cocoa seedling used				
Hybrid	24(88.9)	48(64)	36(46.2)	87(61.7)
F3amazon	0	21(28)	36(46.2)	87(61.7)
Amelonado	3(11.1)	6(8)	3(7.6)	12(8.5)
Socio economic group membership	27(100)	69(92.0)	69(88.4)	132(93.6)
Number of cocoa farms				
1-3	21(77.8)	60(80.0)	48(61.5)	99(70.2)
4-7	6(22.2)	15(20.0)	30(38.5)	42(29.8)
Farm size (ha)	N=27	N=75	N=78	
1-5	15(55.6)	42(56)	39(50)	78(55.3)
6-10	3(11.1)	18(24)	21(26.9)	30(21.8)
>10	9(33.3)	15(20)	18(23.1)	33(23.4)
Mean	8.7±8.0	7.3±7.0	8.4 ±7.7	7.9±7.5

Source: Field Survey, 2021 Figures in parenthesis are percentages

Table 2 below presents the cost and return analysis for sole cocoa cropping system. The Total Variable Cost was ₦ 2,935,624 ($7266.4) while the Average Variable Cost/farmer was ₦108,726.8 ($269.1). The Total Fixed Cost was ₦201,212.5 ($ 498.1) and the Average Fixed Cost/farmer was ₦7,452.314 ($18.4). The Total Cost for sole cocoa cropping system was ₦3,136,836 ($7764.4) while the Average Total Cost/farmer was ₦116,179.1 ($288). The gross revenue which was the total amount the farmer makes in the sale of cocoa beans was ₦17,684,874 ($43,774.4) and the amount made per farmer was ₦654,995 ($1,621.3). The gross margin which is Gross revenue minus total variable cost is ₦14,749,250 ($36,508) and the gross margin per farmer was ₦ 546,268.5 ($1352.1). The net income was ₦17,483,662 $43,276.4 and net income per farmer was ₦647,543 ($1602.8). The profit which is the total amount that the farmers gains from this farming enterprise after removing all the cost from the sale of cocoa beans was ₦14,548,037 ($36,010) and profit made per farmer was ₦538,816.2 ($1334).

Table 2: Cost and Returns Analysis for Sole Cocoa cropping system

S/N	Item	Amount(Naira)	Amount ($)
1.	Total Variable cost	2,935,624	7266.4
2	Average Variable Cost/farmer	108,726.8	269.1
3	Total Fixed Cost	201,212.5	498.1
4	Average Fixed Cost/farmer	7,452.314	18.4
5	Total Cost	3,136,836	7764.4
6	Average Total Cost/farmer	116,179.1	287.6
7	Gross Revenue	17,684,874	43,774.4
8.	Average Gross Revenue/farmer	654,995	1,621.3
9.	Gross Margin	14,749,250	36,508
10	Gross Margin/farmer	546,268.5	1352.1
11.	Net Income	17,483,662	43,276.4
12.	Net Income/farmer	647,543	1602.8
13	Profit	14,548,037	36,010
14	Profit/farmer	538,816.2	1334

Source: Field survey, 2021.

Table 3 below presents the cost and returns analysis for cocoa/tree cropping system in Nigeria. The Total Variable Cost was ₦6,681,180 ($16,537.6) and the Average Variable Cost/farmer was ₦85,656.15 ($212). The Total Fixed Cost was ₦591951 ($1465.2) and the Average Fixed Cost/farmer was ₦7589.11 ($18.8) . The total cost which is the sum of the total variable cost and total fixed cost was ₦7,273,131 ($18,002.8) and the Average Total Cost/farmer was ₦93,245.27 ($230.8). The gross revenue of cocoa/tree cropping system in Nigeria was ₦50,138,137

($124,104.3) and the average Gross Revenue/farmer was ₦642,796.63 (1591.1). The gross margin was ₦43,456,957 ($107,567) and the gross margin/ farmer was ₦557,140 ($1379.1). The Net income was ₦49,546,186.4 ($122,639.1) and the Net Income/farmer was ₦635,207.51 ($1572.3). The profit made by farmers that practice cocoa/tree cropping system was ₦42,865,006 ($106,102) and the Profit/farmer in the study area was ₦549,551 ($1360.3).

Table 3: Cost and Returns Analysis for Cocoa/Tree crop farming system

S/N	Item	Amount (Naira)	Amount ($)
1.	Total Variable cost	6,681,180	16,537.6
2	Average Variable Cost/farmer	85,656.15	212
3	Total Fixed Cost	591,951	1465.2
4	Average Fixed Cost/farmer	7,589.11	18.8
5	Total Cost	7,273,131	18,002.8
6	Average Total Cost/farmer	93,245.27	230.8
7	Gross Revenue	50,138,137	124,104.3
8.	Average Gross Revenue/farmer	642,796.63	1591.1
9.	Gross Margin	43,456,957	107,567
10	Gross Margin/farmer	557,140	1379.1
11.	Net Income	49,546,186.4	122,639.1
12.	Net Income/farmer	635,207.51	1572.29
13	Profit	42,865,006	106,102
14	Profit/farmer	549,551	1360.27

Source: Field Survey, 2021

Table 4 below shows the cost and returns analysis for cocoa/arable cropping system. The Total Variable cost was ₦6,025,920 ($14,916) and the average Variable Cost/farmer was ₦80,345.6 ($199). The Total Fixed Cost was ₦525,058.8 ($1300) and the Average Fixed Cost/farmer was ₦7,000.8 ($17.3). The total cost was ₦6,550,979 ($16,215.3) and the Average Total Cost/farmer was ₦87,346.39 ($216.2). The Gross Revenue was ₦44,379,128 ($109,849) and the Average Gross Revenue/farmer was ₦591,721.7 ($1465). The Gross Margin was ₦38,353,208 ($94,933.7) and the Gross Margin/farmer was ₦511,376.1 ($1266). The net income ₦43,854,069

($108,550) and the Net Income/farmer was ₦584,720.9 ($1447.3). Profit made from cocoa/arable cropping system was ₦37,828,148 ($93,634) and the Profit/farmer was ₦504,375.3 ($1249). Cocoa/tree and cocoa/arable cropping systems were more profitable than sole cocoa cropping system. Farmers should be encouraged to venture into this profitable venture. Ngwang and Meliko (2021), Yahaya *et al.*, 2015, Ononja *et al.*, (2012) confirmed the profitability of cocoa production in Cameroon, Ghana and Nigeria.

Table 4: Cost and Returns Analysis for Cocoa/Arable crops farming system

S/N	Item	Amount(Naira)	Amount ($)
1.	Total Variable cost	6,025,920	14,916
2	Average Variable Cost/farmer	80,345.6	199
3	Total Fixed Cost	525,058.8	1,300
4	Average Fixed Cost/farmer	7,000.8	17.3
5	Total Cost	6,550,979	16,215.3
6	Average Total Cost/farmer	87,346.39	216.2
7	Gross Revenue	44,379,128	109,849
8.	Average Gross Revenue/farmer	591,721.7	1465
9.	Gross Margin	38,353,208	94,933.7
10	Gross Margin/farmer	511,376.1	1265.8
11.	Net Income	43,854,069	108,549.7
12.	Net Income/farmer	584,720.9	1447.3
13	Profit	37,828,148	93,634
14	Profit/farmer	504,375.3	1249

Source: Field survey, 2021

Table 5 below presents the determinants of the revenue of sole cocoa cropping system. The result showed that the regressors can explain 69.9% of the variations in the dependant variables, that is, the coefficient of determination (R^2) was 69.9%. The coefficients for educational level, cost of seedling were all significant at 1% level of probability. This implies that as educational level increases the revenue for sole cocoa cropping system decreases. It is expected that as the educational level of a farmer increases, his/her level of exposure increases; and the farmer knows that it does not make economic sense to practice sole cocoa farming. Hence, an educated farmer would introduce other crops along with cocoa to sustain themselves economically (Author). Also as the cost of seedling increases the revenue of sole cocoa cropping system increases. This may be that the farmers need to plant more seedlings on another land or the hectare of the land used as increase. As farmers plant more seedlings, more harvest is expected and then more profit. Similarly, cost of fungicides was significant at 5% level of probability with a negative coefficient. This implies that the lower the cost of fungicide, the higher the revenue from this cropping system. This perhaps may be due to the availability of different types of fungicides among which the farmers can choose.

Table 5: Determinants of the Revenue of Sole Cocoa Cropping System

Variable	Coefficient	T	P>|t|
Age	0.1416	0.15	0.884
Marital Status	0.3054	0.88	0.388
Educational level	-0.2275***	-3.06	0.006
Cost of seedling	0.1772***	3.45	0.003
Cost of fungicide	-0.4917**	-2.26	0.035
Constant	-0.8183	-1.16	0.262
N=27			
R-squared	0.6985		
F	7.72		

Source: Field Survey, 2021 p<0.01=1% ***, p<0.05=5% **, p<0.1=10% *

Table 6 below shows the result of the regression analysis of the determinants of revenue for cocoa/arable crops cropping system. The result shows that the regressors can explain 76.9% of the variations in the dependant variables, that is, the coefficient of determination (R^2) was 76.9%. The coefficients for gender, marital status, educational level, cost of fertilizer, cost of fungicide, labour cost on bush clearing, land preparation, weeding, planting, harvesting and agrochemical application were all significant at 1 and 5% levels of probability, respectively. The positive signs of the inputs' coefficients showed that the enterprise conforms to the rule of the economics of scale, that is, the more output generated, the more inputs that would be needed to be able to cope with the increased output. Invariably, more output brings about more revenue. Therefore, an increase in all these inputs (labour cost on land preparation, weeding and harvesting) is necessary but not compulsory to generate more revenue on cocoa/arable crops production in the study area. Furthermore, the negative signs of the coefficients of fertilizer cost, labour cost on bush clearing and labour cost on planting, respectively indicate an inverse relationship between the costs and the revenue generated from the enterprise. Moreover as the educational level of the farmer increases the revenue generated from cocoa/arable crops enterprise increases. This is in tandem with Ammann *et al* (2022) who opined that education plays a great role in the acceptance of new techniques/technology by farmers. Furthermore, the coefficient of the marital status revealed a positive and 1% level of probability. This implies that married farmers practicing cocoa/arable crop enterprise are likely to have more revenue compared with their unmarried counterparts. This is because family labour help on the farm to boost farmer's production.

Table 6: Determinants of Revenue for Cocoa/Arable crops Cropping System

Variable	**Coefficient**	**T**	**P>|t|**
Age	-0.3694	-0.88	0.382
Gender	0.7711***	5.24	0.000
Marital Status	0.1648***	4.67	0.000
Married			
Educational level			

Primary	0.2367	1.37	0.177
Secondary	0.1278***	5.05	0.000
Tertiary	0.7732***	3.22	0.002
Cost of seedling	1.3293	0.62	0.537
Cost of fertilizer	-0.2148***	-3.29	0.002
Cost of fungicide	0.1316***	3.21	0.002
Cost of Insecticide	0.1590	1.17	0.245
Cost of herbicide	0.3434	0.27	0.787
Cost of bush clearing	-0.1694***	-3.31	0.002
Cost of land preparation	0.2549***	8.71	0.000
Cost of weeding	0.2785***	5.81	0.000
Cost of planting	-0.2407**	-2.66	0.010
Cost of agrochemical application	0.3364***	6.56	0.000
Cost of harvesting	0.5958***	-6.46	0.000
Constant	-0.2116***	-3.06	0.003
N=72			
R-squared	0.7693		
F	9.12		

Source: Field Survey, 2021 p<0.01=1% ***, p<0.05=5% **, p<0.1=10% *

Table 7 below shows the result of the regression analysis of cocoa/tree crop cropping system. The result shows that the regressors can explain 82.5% of the variations in the dependant variables, that is, the coefficient of determination (R^2) was 82.5%. The coefficients for age, gender, marital status, educational level, cost of seedling, cost of fertilizer, cost of fungicide, cost of herbicide, labour cost of bush clearing, land preparation, weeding, planting were all significant. The positive signs of the coefficients of the inputs (cost of seedling, cost of fertilizer, cost of fungicide, cost of herbicide, labour cost of land preparation, planting) show that the enterprise conforms to the rule of the economics of scale, that is, the more output generated, the more inputs that will be needed to be able to cope with the increased output. Invariably, more output brings about more revenue (Oluyole *et al*., 2022). Therefore, an increase in all these inputs is necessary but not compulsory to generate more revenue on cocoa/ tree crop production in the study area. The negative sign of the coefficients of the inputs (labour cost of bush clearing, weeding) indicates that as the costs of the input decrease, the revenue that is generated from the enterprise increases. Akinniran and Taiwo (2016) confirmed that both cost of seedlings and cost of labour are major factors influencing the profitability of cocoa farmers.

Table 7: Determinants of Revenue for Cocoa/ Tree crops Cropping System

Variable	**Coefficient**	**T**	**P>|t|**
Age	0.1303**	-2.08	0.042
Gender	0.1144***	5.60	0.000
Marital Status	-0.5542***	-4.70	0.000
Educational level			
Primary	0.2638*	1.72	0.092
Secondary	0.8249	0.05	0.964
Tertiary	-0.2919	-0.62	0.535
Cost of seedling	0.1279**	2.52	0.015

Cost of fertilizer	0.3632***	-2.81	0.007
Cost of fungicide	0.7376***	3.27	0.002
Cost of Insecticide	0.2272	0.29	0.773
Cost of herbicide	0.3661**	2.48	0.016
Cost of bush clearing	-0.4190***	4.78	0.000
Cost of land preparation	0.1979***	4.78	0.000
Cost of weeding	-0.1401**	-2.45	0.017
Cost of planting	0.1947***	-4.40	0.000
Cost of agrochemical application	-0.1856	-0.56	0.578
Cost of harvesting	0.7157	1.57	0.123
Constant	0.6261***	4.76	0.000
N=75			
R-squared	0.8250		
F	13.64		

Source: Field Survey, 2021 p<0.01=1% ***, p<0.05=5% **, p<0.1=10% *

Conclusion and Recommendation

The study was carried out on the economic analysis of cocoa production cropping pattern in Nigeria, West Africa. The study revealed that cocoa/tree cropping system was the most profitable among the three identified cropping systems in the study area. It showed a profit of about ₦42,865,006 ($106,102) while cocoa/arable showed a profit of ₦37,828,148 ($93,634) and sole cocoa showed a profit of ₦14,548,037 ($36,009), respectively. Furthermore, the determinants of revenue for the three cocoa cropping systems were age, gender, marital status, educational level, cost of seedling, cost of fertilizer, cost of fungicide, cost of herbicide, labour cost of bush clearing, land preparation, weeding and planting.

It is thus recommended that cocoa farmers and other stakeholders in cocoa industry should device means of reducing all the cost items that affected each of the cropping systems for optimum productivity. This could be achieved through trainings on the use and affordability of different resource inputs such as fungicides, insecticides, herbicides and fertilizers.

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Experimental Tittle: Month of coppicing enhances cacao chupons flowering and yield in Edo State, Nigeria

Investigator: Adejobi, K. B.

Introduction

Cocoa is a tree crop which is among long list of commercially important species in tropical region of the world. It shares features of being perennial plant with long cycle and declining yields with age, also expensive to establish and has long waiting periods before starting to reap benefit of the harvest .Cocoa farmers are mostly driven into rehabilitation when there is fall in cocoa yield due to the combine effect of plant ageing, reduction in cocoa population density, linked to accumulated natural mortality and increased incidence of pest and disease (Adebiyi *et al*., 2018; Akinnagbe, 2015).

Coppicing is one of the perfected techniques of cocoa rehabilitation that CRIN has developed. It involves cutting down of the old cocoa tree in a slanting position at 30 cm above ground level with a view to allow chupons growth out of which the most vigorous and basal one or two are retained to replace the old cocoa tree. Odegbaro (1972) showed that regenerated Amelonado trees in their sixth year after coppicing gave a yield of 1, 680 kg dry cocoa bean per hectare which is about four times the national average production of 460 kg per hectare, Olaiya *et al*. (2003) got similar results on F3 Amazon where coppicing in November performed best in a monthly coppicing trial. Low bean yield of 400kg/ha as obtainable in most cocoa plantations in Nigeria has been to old age of the plantations and poor manager practices. Adeyemi (1999) also got yield improvement under rehabilitated plot with soil application of NPK fertilizer.

However, economic yield could only be evaluated after six years. In spite of these reported achievements on coppicing or chupon regeneration as a method of rehabilitation in cocoa, many cocoa farmers in Nigeria are still reluctant in adoption of the technology because it involves cutting down of their 'cocoa trees,' accompanied with high cost implication and not wanting to miss a year of harvest on coppiced cocoa plantation, or these reasons in Nigeria, rehabilitation project (CRP) through coppicing and other rehabilitation techniques should be Federal Government Initiative and part of the Economic Recovery Programme (ERP) package under the supervision of the World Bank (WB) and the International Monetary Fund (IMF) in conjunction with other institutions , such as Cocoa Research Institute of Nigeria (CRIN) and Agricultural Development Bank , as it is being done in Ghana and some cocoa producing nations of the world (Kwaw-Nimeson and Yian,2019). Though rehabilitation through coppicing and chupon regeneration have been reported to improve yield by Olaiya *et al*. (2003), Chibinga *et al*. (2016) and Adebiyi *et al*. (2018) but the appropriate month in a year to carry out this productive operation is grossly scarce in the literation . Therefore, the objective of the study was to study the effect of month of coppicing on cocoa flowering and yield performance of cocoa in Edo State, Nigeria.

Materials and Methods

Study Area

Field experiment was carried out at the experimental farm of Cocoa Research Institute of Nigeria (CRIN), Uhonmora Substation in Edo State between 2017 and 2019, covering two consecutive rainy seasons and two dry seasons. The location lies the latitude 6'5N and longitude 5'50'E, a derived savanna zone of Nigeria. The rain fall is between 1000 – 1500 mm per annual. The maximum temperature ranges between 26 to 35 ^{0}C with an average of about 30 ^{0}C while minimum temperature ranges from 15 to 25^{0}C with an average of 20^{0}C. Relative humidity is high during the rainy season, ranges from 50 to 85 % with an average of 75%. There are seasonal variations in the values of relative humidity, which varies from 65 to 89% during the rainy season and 46 – 70 % during the dry season. The rainy season which runs from April to October is characterized by heavy rain, low ambient temperature and high humidity; while the dry season runs from November to March is characterized by little or no rain , high ambient temperature and very low humidity .

Acquisition and preparation of experimental materials

About 50 x 30 m land area of old cacao plantation of about fifty years was selected for the experiment. Plantain suckers used as a shade crop for regenerated chupons were collected from experimental plots in the station. Other materials used for the experiment were: Chain saw for cutting down of the cacao trunks, Long ruler for measurement of cacao height to be coppiced , Vernier ‘Caliper for measuring the stem girth, Red paint for covering the cut surfaces against pest and disease infestation and infection respectively. Experimental plot of 50 by 30 m were mapped out and the experiment was laid out with an average of 144 stands of cocoa trees.

Treatments and experimental design

The field experiment was conducted in Cocoa Research Institute of Nigeria (CRIN), Uhonmora Substation, Edo State. Four trees were randomly selected for each treatment, making forty eight (48) and one hundred and forty four (144) cacao stands per block and experimental site respectively. Two stands were eventually tagged per treatment for data collection. The experiment was conducted between 2018 and 2020, laid in Randomized Complete Block Design (RCBD) with three replications. The months of coppicing considered as treatments were: December, 2017 to November, 2018 to make up to twelve treatments based on the number of months in a calendar year. One hundred and forty four (144) plantain suckers were planted at 3 x 3m spacing as shade crop. The experiment was monitored for 22 months after transplanting. Measurement, pegging and holing for plantain suckers were carried out before coppicing. The rehabilitation through coppicing was carried out on treatment monthly basis by complete removal of the main stems of cocoa trees to encourage the regeneration of the canopy by chupon growth. 30 cm from the soil surface of cocoa trees to be coppiced was marked out with red paint. Chain saw was placed on the marked portion of trunk ready for coppicing in a slant position. Old cacao trunk was cut down in a slant position 30 cm above the soil surface. The cut surfaces were painted with red paint (Red paint contains red oxide) to prevent infestation and infection of pest and disease. A month after coppicing, there was chupon growth which was left for three (3) months before thinning. Three month after coppicing, the chupons on cocoa stump were pruned to two strong basal shoots. The two shoots were retained and allowed to develop mature canopies.

Data collection

Data were collected on the yield parameters of cacao chupons such as: number of flowers per chupon,, number of cherelles per chupon , number of pods per chupon (They were measured by counting), Fresh pod weight per chupons , fresh bean weight per chupon and dry bean weight per chupon, were measured by weighing using weighing balance, These yield parameters were taken monthly for 22 months commencing from 4 months after coppicing (3MAC).

Data collected were subjected to statistical analysis using analysis of variance (ANOVA) and significant means were separated by Tukey"s HSD ($P<0.05$) test

Results and Discussion

Effects of month of coppicing on yield performance of cocoa is presented in Tables 1 - 6. Only old cocoa coppiced in the month of April produced flowers at 4 and 5 months after coppicing. Month of April gave significant ($P<0.05$) higher number of flowers at 4,5,6,7, and 8 month after coppicing compared to other months of coppicing. The significant higher number of flowers recorded in the month of April was gapply followed by old cocoa coppiced in the months of June, July, March, May and September at 8 months after coppicing respectively (Table 1) The results of table 2 – 3 also showed that coppicing in the month of April improved the number of cherelles and pods when compared to other treatments. It was the most vigorous and showed early and steady yield attributes than the other treatments, coming into full flowering, cherelles and pods formation as early as 4 and 9 months after coppicing (Tables 1, 2 &3). Therefore, the old cocoa coppiced in April was able to produce 9, 14, 21, and 27 pods per tree after 9, 10, 11, 12 and 13 months respectively. These pod yields were translated to 9,999, 15, 189, 19,631, 23,331 and 30,363 pods per hectare of coppiced cocoa plantation respectively (Table 4).

Also, it was clearly observed that old cocoa coppiced in the months of April and January produced the highest fresh pod weight, fresh bean weight and dry bean weight respectively (Tables 4, 5 &6). It is worthy of note that at 13 month after coppicing , month of July gave the lowest dry bean weight of 484kg/ha while the highest dry bean weight of 13,654kg /ha was obtained from the month of April (Table 6). This implies that the low bean yield of 400kg/ha as obtainable in most cocoa plantation in Nigeria has been attributed to old age of the plantation and poor management practices by the farmers, Montgomery (1981) reported that the highest cocoa yield are achieved between 15 and 25 years while Krung and Quartey- Papafio (1964) after conducting cocoa survey throughout the growing regions of the world recommended 30 – 40 years as the average economic life span of cocoa trees.

The highest dry bean weight of 13,654kg/ha obtained 13 MAC for the month of April was far beyond 1,800kg/ha dry bean of cocoa that Olaiya *et al*. (2003) recorded after 18 month of coppicing. Also, Odegbaro (1972) noted that regenerated Amelonado trees in their sixth year after coppicing gave a yield of 1,680 kg/ha which was about four times the national average of 460 kg/ha at that time. The relative low yields recorded by the two authors could be as a result of the fact that appropriate techniques and period of application were not taken in to consideration to get the require results. This work has right confirmed that rehabilitation through coppicing and chupon regeneration significantly enhanced the yield performance of cocoa as earlier reported by Olaiya et *al.* (2003), Riedel *et al.* (2019), Chibinga *et al.* (2016) and Adebiyi *et al.* (2018) but the appropriate month in a year to carry out this productive operation is grossly scarce in the literature and that is the essence of this study.

Table 1: Effects of months of coppicing on Number of flowers per hectare at 4, 5, 6, 7& 8 MAC.

Treatments	Months after coppicing

Month of Coppicing	4	5	6	7	8
January	0.00b	0.00b	0.00b	0.00c	0.00c
February	0.00b	0.00b	0.00b	0.00c	0.00c
March	0.00b	0.00b	23,320a	10,360b	10,360b
April	10,350a	26,290a	23,330a	49,99a	102,570a
May	0.00b	0.00b	0.00b	4,077b	7,770b
June	0.00b	0.00b	0.00b	0.00c	18,880b
July	0.00b	0.00b	0.00b	0.00c	11,111b
August	0.00b	0.00b	0.00b	0.00c	0.00b
September	0.00b	0.00b	0.00b	0.00b	6,290b
October	0.00b	0.00b	0.00b	0.00b	0.00c
November	0.00b	0.00b	0.00b	0.00b	0.00c
December	0.00b	0.00b	0.00b	0.00b	0.00c

Means followed by the same letters in each composite bars are not significantly different by Duncan Multiple Range Test (DMRT) ($P<0.05$)

Table 2: Effects of months of coppicing on Number of cherelles per hectare at 3, 4, 5, 6, 7& 8 MAC.

Treatments	**Months after coppicing**				
Month of Coppicing	**9**	**10**	**11**	**12**	**13**
January	10.00c	16,630a	18,221a	22,554a	22,554a
February	4.00c	8,855b	11,077b	14,410bc	13,521b
March	4,077cd	8,477b	9,588b	11,077c	12,555b

April	21,109a	16,254a	20,332a	21,409a	23,142a
May	1,111d	14,399a	18,110a	20,332ab	23,398a
June	6,666bc	9,222b	11,444b	12,555c	15,521b
July	3,699cd	9,222b	11,810b	12,555c	14,410b
August	10.00c	8,477b	11,444b	10,333c	12,555b
September	7.00c	8,477b	11,077b	10,333c	11,810b
October	8.00c	8,477b	11,810b	11,810c	11,188b
November	2.00c	8,477b	11,444b	11,810c	12,188b
December	11.00c	8,855b	12,555b	11,077c	12,921b

Means followed by the same letters in each composite bars are not significantly different by Duncan Multiple Range Test (DMRT) ($P<0.05$)

Table 3: Effects of months of coppicing on Number of pods per hectare at 9, 10, 11, 12 & 13MAC.

Treatments	**Months after coppicing**				
Month of Coppicing	**9**	**10**	**11**	**12**	**13**
January	4,810b	9,254b	12,587b	15,554b	19,998b
February	4,477b	2,222c	3,333d	4,444cd	4,810d
March	3,333b	5,921bc	7,777c	7,410c	10,743c
April	9,999a	15,187a	19,631a	23,331a	30,363a
May	1,477b	2,588c	2,588d	2,588d	4,444d
June	2,222b	2,966c	3,699d	3,333cd	4,444d

July	4,077b	2,588c	4,077d	3,333cd	4,444d
August	2,222b	2,966c	3,333d	4,444cd	4,810d
September	2,222b	2,588c	3,333d	5,188cd	5,188d
October	2,222b	3,333c	2,966d	5,188cd	5,188d
November	1,855b	2,966c	3,699d	3,333cd	5,555d
December	2,588b	2,966c	3,333d	4,077cd	6,299cd

Means followed by the same letters in each composite bars are not significantly different by Duncan Multiple Range Test (DMRT) (P<0.05)

Table 4: Effects of months of coppicing on fresh pod weight per hectare at 9, 10, 11, 12 & 13MAC. (Kg)

Treatments	Months after coppicing				
Month of Coppicing	**9**	**10**	**11**	**12**	**13**
January	8,069a	10,703a	17,654a	29,000a	40,987a
February	1,938b	1,776c	2,664c	2,840d	4,549c
March	1,265ab	1,570bc	3,040bc	3,841bcd	5,751abc
April	7,925a	9,595a	16,501a	29,610a	40,407a
May	169.0b	266.0c	722.0bc	1,280bc	1,317bc
June	1,029ab	1,894bc	2,380bc	9,468ab	4,356abc
July	932.0b	840bc	1,324bc	1,099cd	1,444bc
August	788ab	882.0bc	762c	1,380cd	1,707bc
September	992.0ab	805.0bc	2,400bc	2,130cd	2,002c
October	666.0ab	2,571bc	2,571bc	4,968cd	2,862bc

November	659.0ab	882.0bc	4,886bc	4,126cd	4,286abc
December	2,385ab	1,334bc	1,487bc	1,334cd	7,205abc

Means followed by the same letters in each composite bars are not significantly different by Duncan Multiple Range Test (DMRT) (P<0.05)

Table 5: Effects of months of coppicing on fresh bean weight per hectare at 9, 10, 11, 12 & 13MAC.

Treatments	**Months after coppicing**				
Month of Coppicing	**9**	**10**	**11**	**12**	**13**
January	2,688a	3,576a	5,876a	9,908a	13,246a
February	532b	592bc	788b	845b	1,058b
March	429ab	523bc	1,013b	1,280ab	1,917ab
April	2,641a	3,198a	5,500ab	9,987a	13,654a
May	70,0b	90,0c	280,0b	475.0ab	456,0ab
June	364.0b	654.0bc	795b	3,167ab	1,452ab
July	320b	290bc	445b	369b	484.0b
August	262.0b	294.0bc	257.0b	469b	572.0b
September	334ab	271bc	850b	723b	669b
October	223b	859abc	859b	1,656ab	954.0b
November	220b	294bc	1,630ab	1,375ab	478.0ab
December	798ab	447.0bc	495.0b	447ab	3,401ab

Means followed by the same letters in each composite bars are not significantly different by D uncan Multiple Range Test (DMRT) (P<0.05)

Table 6: Effects of months of coppicing on dry bean weight (Kg/ha) at 9, 10, 11, 12 & 13 MAC.

Treatments	**Months after coppicing**				
Month of Coppicing	**9**	**10**	**11**	**12**	**13**
January	899.0a	1,190a	1,959a	3,577a	4,400a
February	148c	222d	333d	355c	481c
March	147b	176c	3340c	429	639.0b
April	889a	1,266a	1,834a	3,629a	4,514a
May	30c	35d	95d	158c	152c
June	123b	98c	270c	1,056b	543.0bc
July	108b	97.0cd	150c	124.0bc	162.0bc
August	88.0bc	98.0cd	87.0cd	157.0b	195.0bc
September	122.9b	91.0cd	289.0c	245.0b	223.0bc
October	75.0bc	287.0bc	289.0c	557.0b	318.0bc
November	73.0bc	99.0cd	547.0bc	459.0b	1,667bc
December	267.0b	149.0c	165.0c	150.0b	1,133b

Means followed by the same letters in each composite bars are not significantly different by Duncan Multiple Range Test (DMRT) (P<0.05)

Conclusion and Recommendation

This work has confirmed that rehabilitation through coppicing and chupon regeneration significantly enhanced the yield performance of cocoa. The appropriate techniques and period of application should be taken into consideration to get the required results. To obtain results close to what was recorded in this work in farmers' farm, more training of farmers (through farmers' field school) should be embarked upon by research scientists, to enable them (farmers) to rehabilitate their farms by themselves. The month of April is consequently recommendation for coppicing in Edo State for optimum yield. However, the recommendation could be location specific. It is therefore imperative for this research to be carried out in all cocoa ecologies in Nigeria .

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CASHEW PROGRAMME

OVERVIEW OF ACTIVITIES AND ACHIEVEMENTS OF THE CASHEW PROGRAMME IN THE LAST ONE YEAR

Dr. O. O. Adeigbe (Cashew Program Leader)

The theme for the 2023 cashew program research was Varietal Development of Cocoa, Cashew, Coffee, Kola and Tea for Sustainable Circular Economy Growth in Nigeria. The task for Cashew Programme under this theme was Cashew Cultivar Development and Assessment. The importance of improved planting materials cannot be overemphasized. It influences yield, quality, and return on investments. The last official release of cashew cultivar in Nigeria was the CRIN Cashew G-series which were released in 1980 having the attributes of medium sized nut and yield of about 1000kg/ha. To enhance the global competitiveness of Nigeria in cashew production, the development and release of new improved cashew cultivars for Nigeria farmers is long overdue.

Further research efforts at CRIN have identified cashew genotypes with better performances in various attributes such as genotypes with bolder-high-premium kernel, higher nut yield and high testa pealability which are undergoing selective evaluation as potential mother trees. Resent collaborative research between CRIN, USDA/CNFA and Pro-Cashew have broadened the list of requirements to be considered in choosing a cashew tree to serve as mother tree. The gene pool of Cashew growing in Nigeria today is derived from genes/genotype of cashew introduced by the Portuguese explorers in the 16th Century, the India introduced materials for commercial purpose in 1950, the India, Mozambique and Tanzania materials introduced from 1978 and the Brazilian genotypes introduced by affluent farmers in Nigeria since the 1980s. A lot of gene transfers have occurred over the years through both natural and controlled pollination to create a lot of gene reshuffling reflected in new combination of varying traits. Some of these diversities have been identified in the country to combine many traits required in a potential mother tree, with the assistance of the Pro-cashew project. These were termed pre-selected elite mother trees. CRIN, in the year started to select best out of these pre-selections to be further evaluated for new cultivar development. More than 70 cashew trees on different cashew plantations and farms across some states in Nigeria including Kogi, Kwara, Edo and Oyo States have been identified. These trees were selected based on important field characteristics such as small to medium tree size, compact canopy type, early flowering characteristics, high yield, cluster and gradual fruiting pattern, ease of nut detachment from apple, bold and kidney shaped nut and good weight of nuts and apples. The nuts collected from these trees would further be analysed or assessed for their shelling percentages, kernel outturn ratios and peelability. CRIN in the year under review also carried out the assessment of phenotypic, edaphic, climatic, morphological and pest statuses of pre-selected elite cashew mother trees for new cultivar development. This study was also to elucidate the mapping, and climate modelling of cashew mother trees which could provide valuable information on their distribution, diversity, and productivity potential for immediate and long term planning purposes. There was also a study on the trend of cashew production in Nigeria from 1982 to 2021, and a forecasted cashew production in Nigeria from 2022 to 2030. The reports of these activities are well presented below.

Project: **Cashew Varietal Development**

Task: **Selection of Elite Cashew Mother Trees in Nigeria**

Olasupo F.O., Adeigbe O.O., Adeniyi D.O., Ibiremo O.S., Ogunlade M.O., Iloyanomon C.I., Adeyemi E.A, Babanitsa M., Babatunde P.O., Adejobi K.B., Adebiyi S., Akinpelu A.O., Lawal J.O., Uwagboe E., Agbongiarhuoyi A.O., Mokwunye I.U., Asogwa E.U., Jayeola C.O., and Yahaya L.E.

Introduction

Cashew is of a considerable economic importance in Nigeria because of its numerous local uses and as a source of foreign exchange earnings. Like cocoa, cotton, palm produce and sesame, cashew provides considerable contribution to Gross Domestic Production, national income and generation of foreign exchange. The world cashew production has continued to increase steadily over the year, the Africa's share drastically diminished and this has been principally attributed to tree low yields. More importantly, one of the main challenges of the production of cashew in Nigeria is lack of improved planting materials. Cashew tree population in Africa mostly comprises low yielding trees and little has been done to improve the yield potential of African cashew germplasm (Aliyu, 2005, 2007). In addition, the Kernels of Nigerian cashew were difficult to peel (i.e. remove the testa which cover the kernel) to the extent that 64% of the total labour required for processing 180MT raw nuts by a small-scale plant per month were expended on peeling (Chemonics International inc., 2002) unlike nuts produced from other countries. There have been purposeful efforts by the Plant Breeding Section supported by the entire Cashew Department to select peelable cashew genotypes for cultivation in Nigeria. This activity which started in late 2017 has led us to select 13 accessions with quality nuts and a good peelabilty. Aside the nut peelability there are other agronomic and economic traits that must be put into consideration before a tree could be chosen as parents for hybrid development and selection breeding. Therefore, there is the need for further exploration of cashew genetic resources in the field gene banks (on farmers' fields) in order to make selections of potential mother trees for selection breeding, germplasm expansion, and hybrid varieties development. Therefore, the objective of this project is to select cashew elite mother trees from the field gene banks, and establish them in germplasm plots at CRIN research stations.

Project Components:

The project was divided into the following components:

1. Training of Research Team on Selection of Elite Cashew Mother Trees – Year 1
2. Germplasm Exploration / Mother Trees Pre-selection Activities – Year 1
3. MT Scions Collection and Grafting to Raise MT Clonal Seedlings – Year 1
4. Field Establishment of Selected Elite Mother Trees – Year 2
5. Molecular Characterization of Selected Mother Trees – Year 2
6. On-station (Multilocation) Evaluation of Selected Mother Trees – Year 3 -7

Materials and Methods

<u>Cashew Mother Tree Pre-Selection Training</u>

The activities started with training of the team of scientist listed on this project on cashew mother trees selection procedure. Basic parameters used as pre-selection criteria were itemized during the training to evaluate a potential elite cashew mother tree. An indoor and field assessment was carried out in the training.

<u>Cashew Mother Tree Selection Exploration</u>

The explorations for potential mother trees were conducted in selected farms and locations initially surveyed by enumerators in cashew farm Oyo, Kwara, Edo and Kogi states at the peak of fruit production session (March). This objective was carried out in collaboration with activities of elite mother tree selection been executed by USDA/CNFA Pro-cashew project in Nigeria. The follow up activity was based on re-evaluation of the pre-selected trees and collection of nut and apple samples from the potential mother trees. The samples were collected from each of the pre-selected trees for evaluation and data collection. Each of the pre-selected trees were marked with appropriate label for ease of identification. The field activities are in progress, data collected still being analyzed and documented.

Results

<u>Training on Cashew Mother Tree Selection</u>

Training of the team of scientist on this project was conducted at CRIN Headquarters, Ibadan. The training involved knowledge sharing and practical demonstrations was facilitated by Dr. Olasupo F.O. and Dr. D.O. Adeniyi and supported by Dr. Ibiremo O.S. and Dr. Adeigbe O.O. who served as resource persons. A total of 18 cashew scientists were trained on the selection criteria and assessment parameters and the CRIN Executive Director, Dr. P.O. Adebola grace the training by his physical presence.

<u>MTS in Collaboration with Pro-Cashew Project</u>

Plates 1 shows two of the pre-selected mother trees using standard selection criteria. These trees are characterized with intensive branching pattern and compact tree architecture which enhance their yield and effective farm land management. Some other important traits that were considered in the selection of the mother trees are fruit yield and nuts quality (Plate 2). Fruit yield trait in cashew is determined by some other factors which include the number of fruits by each of the flower panicles. Some of the preliminary selections of cashew mother trees from different locations and local governments across Edo, Kogi, Kwara and Oyo states are shown in table 1 below. The nuts collected from each of these selected trees shall be evaluated to justify if a tree pre-selected would be finally selected as a mother tree.

Plate 1: Cashew Mother trees selected from cashew farms in Oyo state (left) and Kwara state (right) showing intensive branching and compact tree architecture

Plate 2: Portions of the pre-selected cashew mother trees showing their high yield traits by many panicles producing numerous healthy fruits and quality large nuts (left) and medium nuts (right)

Table 1: Number of pre-selected cashew mother trees across the surveyed states

State	Local Government	Town/Community	No of Trees Pre-selected
Kogi	Olamaboro	Ochaja	3
		Uluku	2
	Dekina	Akwe	3
Kwara	Oyun	Igbotele	6
		Igbo Akosi	2
	Asa	Yewe Ajimonsin	2
		Alapa	5
	Irepodun	Buari	6
		Babanla	1
		Oyo Idera	2
		Isanlu Isin	2
		Gaa Mainasara	1
Oyo	Orire	Ilode	1
		Ajinapa	1
		Obamo	2
		Etelu	1
		Orintinrin	1
	Surulere	Orineran	4
		Atowode	1
		Elesinmeta	1
	Saki East	Ogboro	2
		Isale oke	2
	Ibarapa East	Eruwa	3

		Lanlate	1
	Ibarapa Central	Igbo ora	2
	Irepo	Kisi	1
	Atisbo	Tede	1
Edo	Etsako East	Weppa	3
		Iviari	1
		Ekwotsor	2
	Etsako West	Ayogwiri	1
		Ikabigbo	2
	Akoko Edo	Ayanran	1
		Ikhakumo	1

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Theme: Cashew mother tree assessments and clonal evaluations for developing new improved varieties with enhanced yield and quality

Task: Assessment of phenotypical, edaphic, climatic, morphological and pest statuses of pre-selected elite cashew mother trees for new cultivar development

Investigator: Adeniyi, D.O., Adeigbe, O.O., Babanitsha, M., Akinpelu, A.O., Obatolu, B.O., Olasupo, F.O., Agbogriarhuyi, A.O., Adeyemi, E.A., Ibe, O., Iloyanomon, C.I., Asogwa, E.U., Otuonye, A.H., Adesanya, K., Lawal, J.O., Adesanya, K.A. and Adeji, A.O.

Introduction

The genetic diversity of cashew is critical for its adaptation to different agro-ecological conditions, resistance to pests and diseases, and productivity potential. Cashew mother trees are the source of scions for grafting and the foundation for the establishment of cashew orchards. Therefore, identification, characterization, and systematic climatic description and evaluation of cashew mother trees are essential for the sustainability of the new cashew cultivar being proposed for the industry in Nigeria.

Reported cases of decline in cashew nut production across growing ecologies of Nigeria have been associated with many factors which ranges from drought as experience through climate change related events, declining soil fertility, unimproved low yielding genotypes, insect pests and diseases (Ellias, 1980; Brown et al., 1984). Of the factors, diseases which is presently causing serious devastating effect and severity in cashew production in Nigeria. There is therefore a necessity to have a baseline information on the status, spread and severity of diseases on pre-selected elite cashew mother trees in Nigeria. It is then imperative to develop a wholistic package for the development of new varieties of cashew as the varieties released decades ago need to be improved upon towards the development of materials that will be resistant to emerging pests and diseases which may be attributed to climatic changes and other factors.

Sustainability, mapping, and climate modeling of cashew mother trees can provide valuable information on their distribution, diversity, and productivity potential for immediate and long run planning purposes.

Objectives of the study:

- To measure the architecture and morphological parameters of pre-selected elite mother trees, document prevailing weather condition and edaphic features around the mother trees
- To evaluate health status of cashew cultivars pre-selected as elite mother trees and assess tolerance and susceptibility of the materials to pests

- To assess level of awareness on elite mother trees/clonal materials among farmers, determine factors influencing cultivar development and identify constraints militating against development of elite mother trees/clonal materials
- To map and model distribution of pre-selected cashew mother tree, with a specific area in relation to climate

Methodologies

The pre-selected elite cashew mother trees (EMT) were sorted by the activities of PROcashew project in Nigeria and were studied at different communities in Oyo, Kwara and Kogi states. The trees were evaluated based on the phenological and morphological attributes; tree architecture, canopy size, diameter, branching pattern, fruiting development, nut shape, weight and quality. Insect pest infestation and disease signs and symptoms were also evaluated based on the cashew organs affected and damages caused by the pests and pathogens and the evaluated potential mother trees were geo-referenced.

Focus group discussion was held and well-structured questionnaire was administered to the farmers groups. The data entry and analysis of the results are on-going and will be presented as soon as they are ready. The pre-selected potential mother trees were subjected to phenological traits evaluation and the following parameters were measured: height, girth, canopy size and type, branching pattern, apple weight etc. Some nut size samples collected are currently been evaluated for the size, count, weight, shelling percent and kernel outturn ratio. The parameters evaluated are currently been analyzed

Preliminary Results

The least preferred attributes expected of a new cashew variety were cashew nuts with small, large and jumbo sizes while majority of farmers have high preference for cashew with medium nuts size. This preference was driven by highest price and premium the nut size command in the market. The bigger and smaller cashew nut sizes were mostly rejected by the buyers. In addition, it was reported that prices per bag of raw cashew nuts (RCN) range between ₦15,000-₦50,000, ₦25,000-₦120,000 and ₦35,000-₦50,000 in Kwara, Oyo and Kogi states respectively. This implies that cashew farmers will be more interested in new cashew variety that has medium nuts. It was observed that majority of the farmers do not mulch or irrigate young cashew farms as a strategy for climate adaptation during dry season and neither do they use organic manure to improve soil fertility. Cashew farmers are however not satisfied with the productivity of their farms as a result of old age of the trees, pilfering of cashew nuts, pests and diseases (termites, mirids, powdery mildew) and climatic variations. The data entry and analysis of the results are on-going and will be presented as soon as they are ready.

A total of 53 cashew trees were evaluated on farmers' fields across fourteen twelve cashew growing communities in eight local government areas of Kogi, Kwara and Oyo states of Nigeria. The study areas were illustrated in figure 1 showing the geo-reference coordinate of the farm locations in the study states.

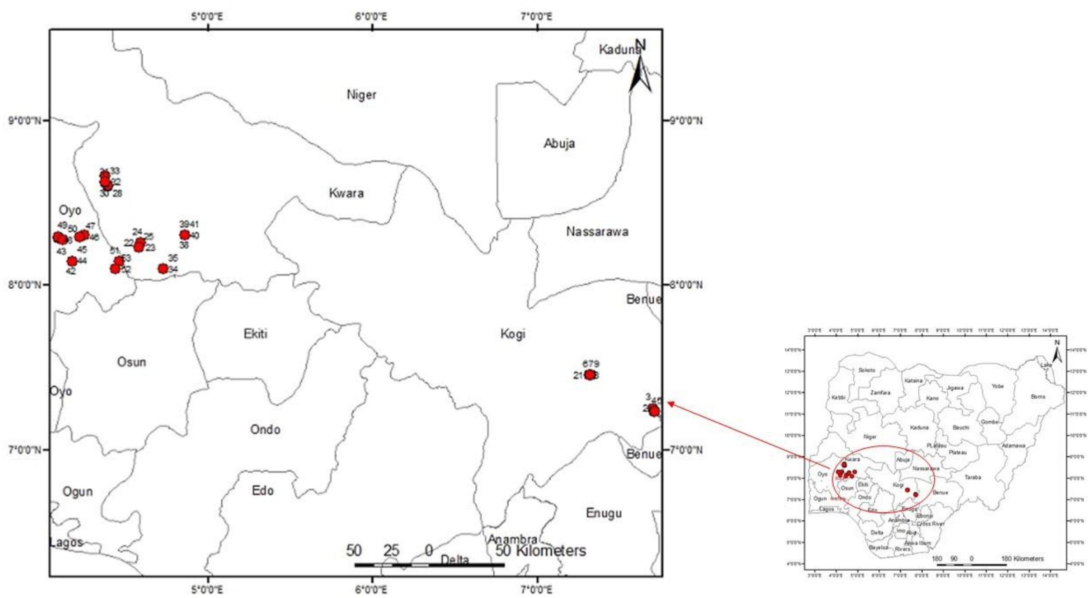

Figure 1: Map showing locations of pre-selected potential cashew mother trees

The pest survey outcome recorded absence of stem borer infestation in the pre-selected potential mother trees and very rare attack of *Analeptes trifasciata* on trees in study locations. The interception of *Helopeltis shoutedeni* is common to all farms and locality but are however more on certain trees than another. Likewise, was the incidence of leaf miners and bugs in study areas. The presence of beneficiary tailor ants (*Oecophylla longinoda*) was not a common experience on cashew trees in farm locations, some location has many tailor ants on trees than the other.

Typical symptoms and expressions of anthracnose, bacteriosis, dieback, powdery mildew, rust and chlorosis were localized in many farms and their statuses were documented (table 1).

The cashew trees were having record of high yielding with extensive canopy architecture and branching and were characterized with early flowering and fruiting, cluster and gradual fruiting pattern, ease of nut detachment from apple, nuts are bold and kidney shaped and good weight of nuts and apples. The evaluated trees recorded a range of 0.2 to 1.8m height, aged 5 to 40 years and average nut weight of 5.60 to 13.9g. there were more tree with extensive branching pattern than intensive branching among the pre-selected potential mother trees. The colour of the apple on the trees were more of yellow on most of the trees in study areas, compare to predominantly red colour apples in all pre-selected trees at Buari in Kwara state and a rarely pink apple colour was recorded only on a tree at Alapa in the same state.

Table 1: Status of pre-selected potential mother trees in study areas

State	LGA	Community	No. of pre-selected trees	Pests intercepted on trees	Beneficial insect
Kogi	Olamaboro	Agaliga Efabo	3	Leaf miner, dieback, powdery mildew (leaf, flower), bacteriosis	Nil
		Agaliga Uloko	2	Leaf miner, dieback, bacteriosis	Tailor ants
	Dekina	Akwu Egume	16	Helopeltis, leaf miner, dieback, powdery mildew (apple, nut), rust	Tailor ants
Kwara	Oyun	Igbotele	4	Helopeltis, leaf miner, dieback, powdery mildew (flower, apple, nut), bacteriosis (leaf, apple, nut)	Tailor ants
		Yowere Ajimosin	3	Helopeltis, leaf miner, dieback, powdery mildew (flower, apple, nut), anthracnose (leaf), bacteriosis (leaf, apple, nut), rust	Nil
		Igbo-Akosi	2	Helopeltis, leaf miner, dieback, powdery mildew (apple, nut), bacteriosis (apple, nut), rust	Nil
	Asa	Alapa	5	Helopeltis, leaf miner, dieback, powdery mildew (flower, apple, nut), anthracnose (leaf), bacteriosis (leaf, apple, nut), rust	Tailor ants
	Irepodun	Buari	6	Helopeltis, leaf miner, dieback, powdery mildew (apple, nut), bacteriosis (apple, nut), rust	Tailor ants
Oyo	Orire	Onitinrin	4	Helopletis, leaf miner, anthracnose (leaf), bacteriosis	Tailor ants

				(leaf, nut), powdery mildew (apple, nut), rust	
		Ajinapa	1	Leaf miner, anthracnose (leaf), powdery mildew (apple, nut), bacteriosis (nut), rust	Tailor ants
		Ilodo	1	Helopletis, Leaf miner, anthracnose (leaf), powdery mildew (apple, nut), bacteriosis (nut), rust	Tailor ants
		Elelu	1	Helopletis, Leaf miner, anthracnose (leaf), powdery mildew (apple, nut), bacteriosis (nut), rust	Tailor ants
		Obamo	2	Leaf miner, anthracnose, pwdery mildew (apple, nut), bacteriosis (nut)	Nil
	Surulere	Orieran	3	Helopeltis, leaf miner, powdery mildew (apple, nut), baceriosis (apple, nut), cholorosis	Nil
Total			**53**		

Plate 1: Canopy architecture of one of the pre-selected potential cashew mother trees

The pre-selected cashew trees were evaluated based on their canopy architecture and branching pattern. A typical example of extensive branching pattern shown in plate 1 in one of the study locations.

Plate 2: Fruiting capacity of some pre-selected potential cashew mother trees in study locations

Similarly evaluated were the fruiting statuses of cashew trees pre-selected as potential mother trees. Plate 2 shows pictorial example of yielding status of tree in one of the study areas. Other parameters evaluated on the trees are currently been analyzed and further work on the evaluated trees to take place in the nearest future.

FORECASTING CASHEW PRODUCTION IN NIGERIA: ARIMA ECONOMETRIC MODELLING APPROACH

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ABSTRACT

Cashew is one of the major agricultural exports in Nigeria. The crop has been a major foreign exchange earner for more than fifty years. Cashew production forecasting is of utmost importance in the choice of agricultural diversification strategy to be employed by the government as well as the livelihood of cashew farmers in the coming years. The study examined the trend of cashew production in Nigeria from 1982 to 2021. The study also forecasted cashew production in Nigeria from 2022 to 2030 using ARIMA model. The automated analytical procedure on E-views 10 software package indicated that ARIMA (1,1,12) is the combination with the least Akaike Information Criteria (AIC) and Sigma square as well as the highest adjusted R-square amongst other structures, hence, it is the most appropriate for forecasting. The trend analysis result revealed that cashew production in Nigeria was at its peak in the year 2009 with 800,000 tonnes, however, cashew production started declining in the years succeeding 2009. The forecast result revealed that cashew production will rise gradually from 2022 to 2030 where it is expected to reach a decade high of 526,176 tonnes. This is still well below the 2009 production level. The study recommends that cashew farmers should be given financial and technical incentives in order to ensure that the forecasted level can be attained and even surpassed as well as to improve the livelihood of cashew farmers. It is also recommended that government should prioritize cashew production and encourage export in the development of

agricultural policies aimed at diversifying the economy due to the potentials of the commodity in terms of production and value.

KEYWORDS: Cashew production, ARIMA, Forecasting, Trend

INTRODUCTION

Nigeria is one of the major producers of cashew nuts globally, known for its significant contribution to the cashew industry. The country's favourable climate and suitable growing conditions have made it an ideal location for cashew cultivation. Nigeria is consistently ranked as one of the top cashew-producing countries in the world. According to the Food and Agriculture Organization (FAO) of the United Nations, Nigeria was the fourth-largest cashew producer in 2019, with a production volume of approximately 172,000 metric tons (MT) (FAOSTAT, 2019). The Nigerian Export Promotion Council (NEPC) reported that Nigeria produced about 220,000 MT of cashew nuts in 2020, indicating an increase in production compared to previous years (NEPC, 2021). Cashew production plays a vital role in Nigeria's agricultural and economic sectors. The country is a significant exporter of cashew nuts, generating foreign exchange earnings and contributing to employment and rural development.

According to the NEPC, Nigeria earned about 350 million dollars from cashew exports in 2020, making it the country's leading agricultural non-oil exports (NEPC, 2021). The cashew industry has also attracted investments and created opportunities for value addition, including processing and packaging, leading to the establishment of cashew processing factories in Nigeria (Onwuka *et al*., 2021).

Nigeria is highly dependent on oil exports, which account for a significant portion of its government revenue and foreign exchange earnings. Oil contributes to around 90 percent of Nigeria's total export earnings. This heavy reliance on oil makes the Nigerian economy vulnerable to fluctuations in oil prices, which can have a substantial impact on the country's economic stability (Kelechi and Anthony, 2020). This resulted in an economic recession in 2016, primarily driven by the sharp decline in global oil prices. The recession was further exacerbated by issues such as low oil production, disruptions in oil infrastructure, and challenges in the non-oil sector (Olujobi *et al*., 2022). The diversification of the Nigerian economy into agriculture has been a significant focus in recent years. Nigeria, as an oil-dependent economy, has recognized the need to reduce its reliance on oil and develop other sectors, with agriculture being a key area of potential growth. Cashew industry as a sub-sector can indeed serve as a means of diversifying the Nigerian economy. Nigeria is already a major player in the global cashew market, but there is significant potential for further growth and development in this sector. According to Nigerian Investment Promotion Commission (NIPC) (2020), cashew production offers several advantages, including job creation, export revenue generation, and poverty reduction. In light of the above this study sought to carry out a nine-year forecast to project the prospects of future cashew production.

OBJECTIVES

The objectives of the study were:

- To evaluate the trends of cashew production and yield
- To forecast cashew production from 2022 to 2030

METHODOLOGY

The study adopts annual cashew production in Nigeria from the Food and Agriculture Organization of the United Nations statistical database for a period of 39 years ranging from 1982 to 2020. The study adopted both descriptive and inferential statistics. Descriptive statistics adopted was in form of graphs used to examine the trends of cashew production in Nigeria and the properties of Auto-regressive Integrated Moving Average (ARIMA) model. Inferential statistics was employed in the form of ARIMA modelling to forecast cashew production in Nigeria.

ARIMA MODELLING

According to Box *et al*. (1974), Auto-regressive Integrated Moving Average (ARIMA) model is the most frequently used model stochastic time series model. The model helps in the identification, estimation and diagnostics of models where time is the major independent variable (Ajetomobi and Olaleye, 2019). ARIMA models are often regarded as an extension of the Autoregressive Moving Average (ARMA) model in which the lags of the variable under study and the lags of the error term are used to explain the behaviour of the model. The ‘integrated’ aspect of ARIMA model stems from the level of stationarity of the model. Auto-regression (AR) and Moving Average (MA) terms forecasts a univariate time series data values and errors (Eni and Adeyeye, 2015). The ARIMA modelling approach allows the data to speak for itself using the various attributes of the data such as the time, stationarity and stochastic error term. Annual cashew production data from 1982 to 2021 was employed and analyzed using the ARIMA model to forecast the production values from 2022 to 2030. According to Ajetunmobi and Olaleye (2019) the model is suitable for large time series data with an observable historical pattern. ARIMA is usually specified using three order parameters, p, d and q. The auto-regressive component of the model refers to the use of past values to predict the observed values. The auto-regressive parameter, p, refers to the number of lags allowed in the model. A generalized AR model is expressed as thus:

$$y_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 y_{t-2} + \dots \beta_k y_{t-k} + \varepsilon_t \qquad (1)$$

β_0 *to* β_k *are the parameters in the model*

The integrated component of the model represented by *d* refers to the degree of differencing which is determined by the stationarity of the model.

The moving average (*q*) component of the model refers to the lagged errors in the model i.e the error term as a function of past errors terms:

$$y_t = \theta_0 + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + \dots + \theta_k \varepsilon_{t-q} + e_t \qquad (2)$$

The full ARIMA model consisting of the auto-regressive, differencing and moving average is linearly stated below:

$$y_t = c + \beta_1 y_{dt-1} + \beta_2 y_{dt-2} + \dots \beta_k y_{dt-k} + \theta_0 + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + \dots + \theta_k \varepsilon_{t-q} + e_t \qquad (3)$$

Where y_d is y differenced d times and c is a constant.

RESULTS AND DISCUSSION

Trend analysis of cashew production in Nigeria (1982-2020)

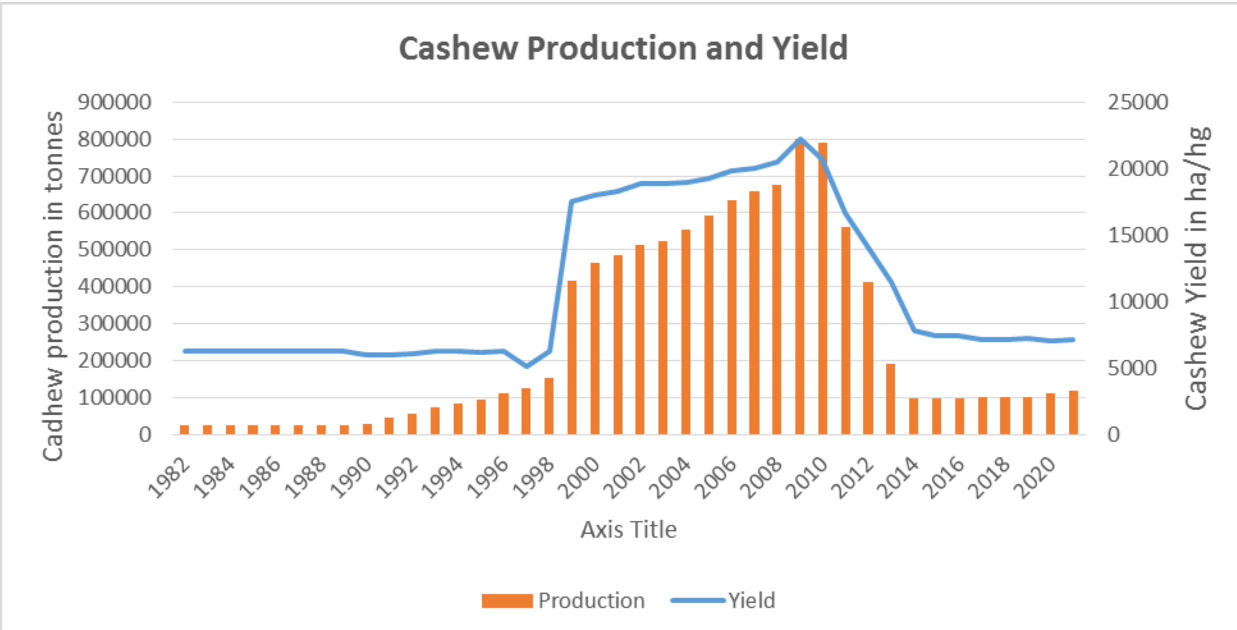

Figure 1: Cashew Production and Yield in Nigeria
Source: FAOSTAT 2022

It can be observed in Figure 1 that cashew production in Nigeria varied overtime. There was a stable but low production and yield between 1982 and 1990. This low output in cashew could be attributed to the government decision in the early 80's to abolish commodity marketing boards and liberalization of the commodity market in the country. This was followed by a gradual growth in cashew production between 1991 and 1998. According to Ogunwolu *et al.*, (2022), the growth in production during this period can be directly attributed to the increase in cashew cultivation areas across the country. Cashew production and yield increased by more than 100% in the periods between 1999 and 2009. Cashew production in Nigeria hit a 30 year peak in 2009 with 800,000 tonnes. The increase in yield suggests that cashew farmers were introduced to better agricultural practices. The introduction of new cashew varieties such as medium and jumbo to cashew farmers could also be attributed to the rise in production during this period.

However, cashew production started declining from 2010 till 2014. The fall in value of Nigerian cashew nut in the international market during this period affected cashew farmers in the country hence, a fall in production quantity and yield. Adeigbe *et al*. (2015) cited poor peel-ability and storage as the main factors behind the dip in the prices of Nigerian cashew. Furthermore, cashew production and yield were relatively stable between the periods of 2014 and 2021 with average production and yield for the period being 103,409 tonnes and 7303 ha/hg respectively. Olukunle (2022) and Olomu *et al*. (2020) cited inadequate technical incentives inform of training and input subsidy as well as inadequate financial incentives as factors contributing to the dwindling cashew production in Nigeria.

Stationarity Test

One of requirements for fitting an ARIMA model is that the series in question must be stationary, hence Augmented Dickey Fuller (ADF) unit root test was carried out to ascertain the stationarity of cashew overtime. The result of the ADF unit root test as presented in Table 1 shows that cashew production is not stationary at levels but stationary after first differencing at 10 per cent level of significance. The implication of this is that the *d* component of the ARIMA model is 1.

Table 1: ADF Unit Root Test

	T-Statistics	**Lag Order**	**P-value**	**Comment**
Levels	-1.480735	1	0.8183	Non-stationary
First Difference	-3.422568	1	0.0637	Stationary

Model Identification

After the order of integration (d) has been identified, the next stage in the ARIMA modelling process is the identification of the optimal model (finding the optimal order of AR(p) and MA(q)) using the Auto-correlation Function (ACF) and Partial Auto-correlation Function (PACF). Figure 2 shows the graph for the ACF and PACF from which three ARIMA models were identified, they are: ARIMA (1,1,1), ARIMA (1,1,12) and ARIMA (12,1,1) models. According to Satrio *et al.* (2021) among different options of ARIMA models the model with the smallest sigma square and Akaike Information Criterion (AIC) is considered the optimal model. From the list of identified models in Table 2 ARIMA (1, 1, 12) is considered as the optimal model and therefore adopted for forecast.

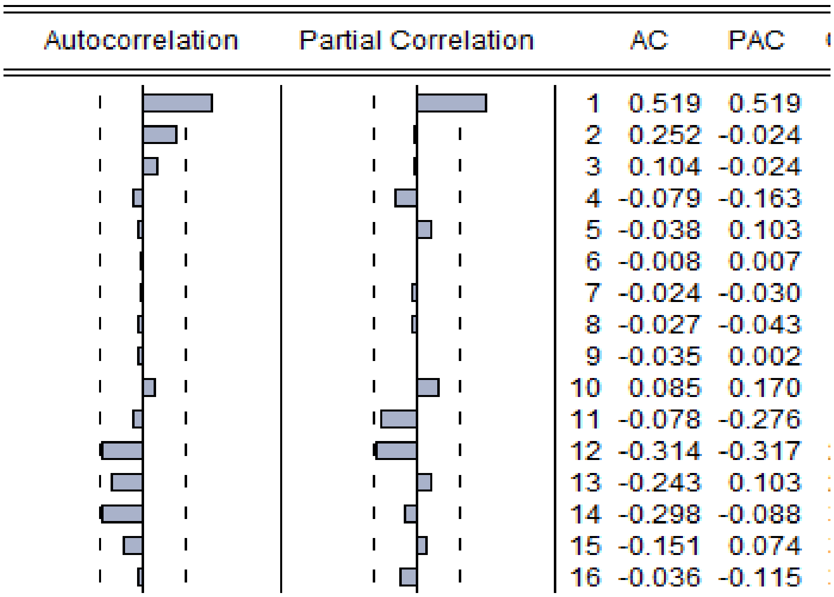

Figure 2: Auto-correlation Function and Partial Auto-correlation Function for cashew production in Nigeria

Table 2: ARIMA Optimal Model Selection Result

MODELS	**AIC**	**Sigma Sq.**	**Decision**
ARIMA (1,1,1)	25.22986	4.29E+09	Not optimal
ARIMA (1,1,12)	25.08035	3.41E+09	Optimal
ARIMA (12,1,1)	25.12337	3.63E+09	Not optimal

Model Diagnostic Checking

There is a need to carry out diagnostic check for the model adopted to ensure that the order of the parameters and the structure of the model are correct before proceeding to forecast. Depicted in Figure 3 are the residual auto-correlation and partial-correlation plots. It can be deduced from the plots that there exists no significant auto-correlation in the model. It can be observed from the

Figure that the residual ACF and PACF lies within the 90% confidence interval. Hence, we can conclude that the model is correctly specified.

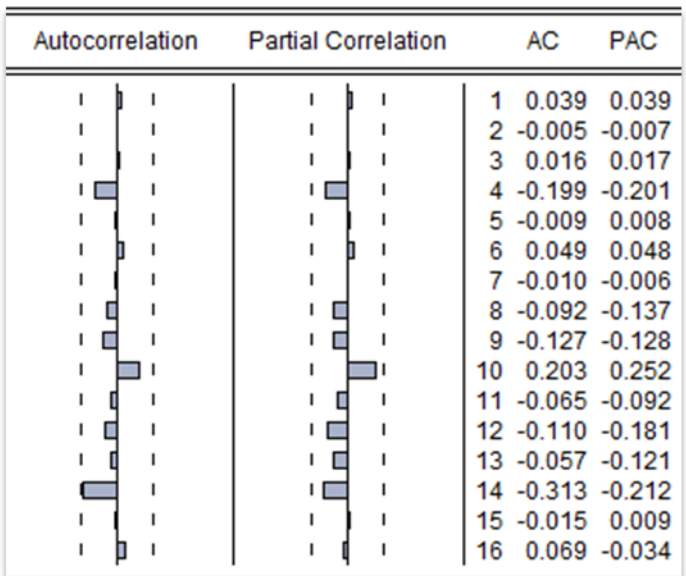

Figure 3: ACF and PACF of cashew production residuals

FORECAST

According to Chiatra *et al.*, (2019) a well fitted ARIMA model has the ability to adequately forecast a tested time series data. Therefore, forecast result of the ARIMA (1,1,12) model is presented in Table 3 and Figure 4 respectively.

Table 3: ARIMA forecast result

YEARS	CASHEW PRODUCTION IN TONNES	PERCENTAGE INCREASE (%)
2022	158253.4	33
2023	237588.1	50.13
2024	320037.9	34.70
2025	439349.5	37.28
2026	494253.2	12.50

2027	507991.4	2.78
2028	515754.7	1.53
2029	520477	0.92
2030	526176.5	1.10

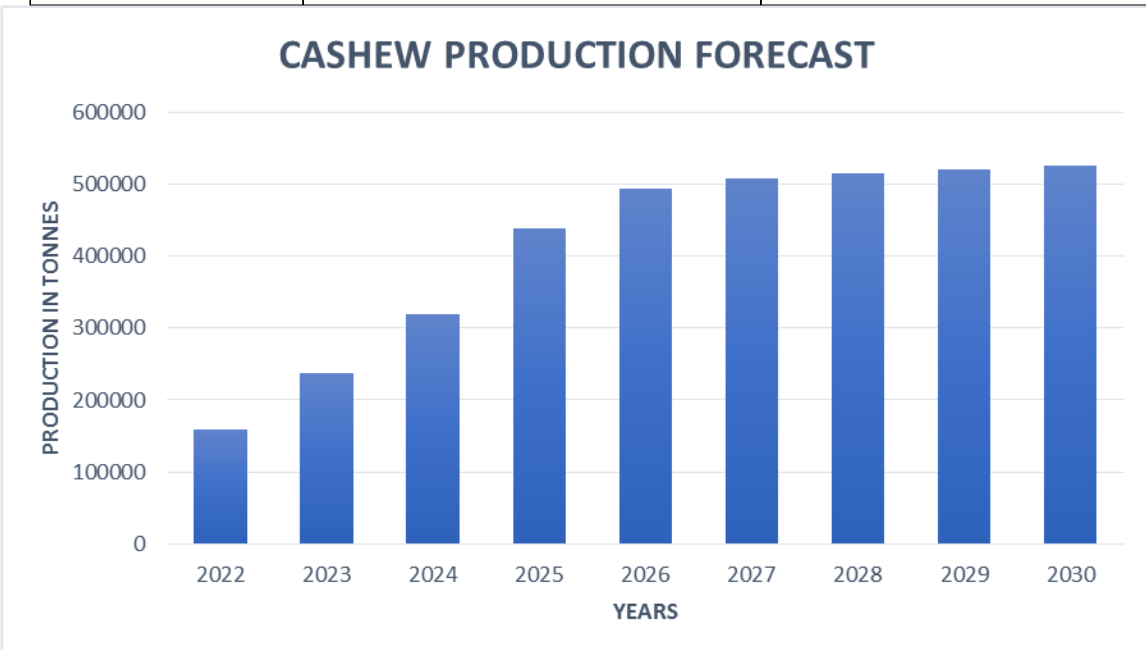

Figure 4: Cashew Production Forecast Plot

From the forecast results in Table 3 and Figure 4 it can be observed that cashew production will rise gradually from 2023 to 2030. Cashew production in Nigeria will rise at an average rate of 24% from 2022 to 2026. However, this growth will diminish between 2027 and 2030 to an average annual production rate of 1.5 per cent. According to the forecast result, cashew production will reach a decade peak in the year 2030 with 526,176.5 tonnes. However, this is still quite low to the production volume obtained in 2009 which was 800,000 tonnes.

Nigeria possesses favourable agro-ecological conditions for cashew production, including suitable climate, rainfall patterns, and diverse soil types. These factors contribute to the country's potential for large-scale cashew cultivation and increase in future production levels (Ogundele *et al.*, 2020). Furthermore, cashew is a highly sought-after commodity worldwide due to its nutritional value and versatile uses in various industries. According to Ayodeji *et al.* (2020), Nigeria is one of the major cashew-producing countries and has a competitive advantage in meeting the increasing global demand for cashew kernels, this could be a reason behind the potential increase in cashew production in the years to come. Cashew production contributes significantly to Nigeria's economy by generating employment opportunities, foreign exchange earnings, and rural development. The cashew value chain, including processing and export, has the potential to boost economic growth, improve farmers' livelihood and reduce poverty in the long run (Ugwu *et al*., 2019). According to Okoye *et al*. (2021), one of the major factors affecting cashew production is inadequate access to extension agents and lack of new cashew varieties. This is a major factor which if not addressed in the coming years may hinder the projected cashew production in Nigeria.

CONCLUSION

The result of the analysis revealed that cashew production in Nigeria is highly likely to rise from 2023 till 2030. However, despite the positive forecast result, literature identified inadequate financial and technical support, inadequate extension contact and lack of new cashew varieties as issues which could derail the forecast results.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations are made:

1. The government should consider cashew industry in the quest for diversification as it holds potentials for expansion
2. Cocoa Research Institute of Nigeria and other cashew industry stakeholders in Nigeria should work towards the development of new cashew varieties which are high yielding
3. Government and other cashew industry stakeholders should endeavour to make available more financial and technical support for cashew farmers.

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Progress Report

Title: HARNESSING CASHEW APPLE WASTES FOR ETHANOL PRODUCTION

By

Igbinadolor, R.O

Introduction

Cashew (*Anacardium occidentale L.*) is a very popular and widely grown tree in Nigeria. It is often propagated for the economic importance of the nut.

In Nigeria, much attention has been placed on cashew nut and cashew nut processing while very little attention is placed on its apple. Often times, cashew nut processors in Nigeria harvest fresh and ripe cashew fruit just for its nut, while the apples are left to rot away. Furthermore, during the process of cashew juice production, most ripe cashew fruits falling on the ground are considered not suitable for juice production for fear of contamination. This has increasingly lead to monumental wastages of the apple during the peak season.

The conversion of these waste cashew apples into a suitable substrate like ethanol for industrial purposes will help to reduce these wastages is the main reason for this research project.

Progress Report

Cashew apples have been harvested and prepared

Fermentation (currently ongoing)

Fermentation was carried out on extracted cashew juice. Some litres of the juice were put in fermentation vat fitted with caps from which samples were drawn and tested. The initial pH and temperature were recorded and then subjected to fermentation by yeasts strains.

Project Title: Growth and yield of cashew as influenced by biotype and spacing in different agro-ecologies in Nigeria.

Investigators: Ibiremo, O.S (**PI**), Adeyemi, E.A. (Agronomist), Ogunlade, M.O (Soil Scientist), Iloyanomon, C.I (Soil Scientist) Ogbeide C.E. (Soil Scientist), Aremu Dele, Agbongiarhuoyi, A.E. (Extensionist) and Agulana F. (Economist)

Introduction

The plant cashew (*Anacardium occidentale* L.) is a perennial tree crop that is widely cultivated in the tropics. The tree could grow to a height of 15 meters with a crown diameter of 14 to 20 meters. The spacing at which cashew is cultivated is crucial to its yield since the crop fruits at the peripheral such that once there is interwoven of the canopies; the fruit yield is negatively affected. Presently, 6m x 6m and 9m x 9m are usually recommended irrespective of ecologies. In view of differences in climatic factors, such as rainfall and solar radiation among others, the present study seeks to evaluate the higher plant spacing of 8m X 8m 10mx10m and 12mx12m which are the common practices in other cashew producing regions of the world in conjunction with two cashew biotypes in three agro-ecologies in Nigeria.

Objectives

1. To evaluate the influence of spacing of cashew biotypes on establishment and of yield of cashew nut
2. To assess the soil fertility status of the four locations for appropriate management.

Methodology

Three plant spacing via: 8 m x 8m (156/ha), 10 m x 10 m (100/ha) and 12 m x 12 m (69/ha) with two cashew biotypes (medium and jumbo) were evaluated in three agro-ecologies namely: rainforest, derived savannah and guinea savannah. The States selected in the ecologies were: Ekiti, Oyo and Kogi respectively. Cashew was established in all the locations in 2022. However, as a result of insecurity issue in most of the States selected, the team step down Ekiti and Kogi States. The two-factor (cashew biotypes and plant spacing at two and three levels respectively) experiment consisting of six treatment combinations were randomly placed in a Split Plot Design with three replications. The Experimental plot dimensions were 144 m x 70 m to give an area of 10,080 m^2 (approximately 1.008 ha). The plots were established through nuts planting insitu.

However, some seedlings were raised in polythene bags to gap up missing stands, one month after planting. Arable crops were planted as intercrop. In Ibadan, cassava and maize were planted, while the farmers were allowed to plant any crops of their choice within the earlier years of establishment.

Data on growth parameters commenced a month after planting in all the trial locations, but cashew planted in Ibadan had a high level of mortality and it would be necessary to replant the entire plot in year 2024.

However, the initial soil physical and chemical characteristics of the four location were determined and explained below.

Results and Discussion

The initial soil physical and chemical properties are presented in Table 1. The soil physical characteristics indicated that the sand fraction of the soil ranged from 632 in Isanlu (Kogi) to 932 g/kg soil in Iyemero (Ekiti). In Ibadan, the sand fraction was 7% higher than that of Ilaji –Ile within Oyo State, while the sand content in Iyemero was 29% higher than that of Isanlu. The sand content of the soils decreased with increasing soil depths in all the locations except Iyemero. The silt across the soil depth ranged from 8 to 208g/kg soil. Silt content in Ilaji-Ile was 9% higher than that of Ibadan, while the silt in Isanlu was 75 % higher that the silt content in Iyemero. The clay content ranged from 36 to 120 g/kg soil across the four locations evaluated. Specifically, the clay in Ilaji-Ile was 49%higher than that of Ibadan. Similarly, the clay in Isanlu soil was 45 % higher than that of Iyemero Ekiti. It was observed that except at Iyemero, the clay across the four locations increased with soil depth. The soils in the four locations are classified as sandy loam and cashew thrives well under sandy loam soils. This is because the roots extends far and wide within the soil. The high sand content implies that water retention will be low in most of the sites, but the level of silt and clay is moderate for cashew cultivation as cashew does not thrives well under water logged conditions.

The pH of the soils across the four location ranged from 5.33 to in Isanlu to 7.20 in Ibadan. The soil in Ilaji-Ile is slightly acidic, while that of Ibadan was alkaline. The soil pH in Iyemero soil was 4% higher than that of Isanlu soil. Cashew grows in wide range of soils pH from 4.5 to 7.5. The pH of the soils in the four locations where the trial was sited are suitable for cashew cultivation.

Soil organic carbon was low across location with the highest organic carbon content obtained in Ilaji-Ile with a value of 1.81g/kg soil compared with the least found in Iyemero Ekiti (0.48 g/kg).There is need for organic fertilizer to boast the organic carbon content of the soil

The total N of the soils of the site evaluated followed similar trend of soil organic carbon. Total N ranged from 0.051 to 0.152 g/kg across soil depth and location and was highest in Ilaji- Ile and lowest in Iyemero Ekiti. Total N in Ilaji-Ile (0.139g/kg) was also higher than the other locations. It was also observed that except at Ilaji-Ile, the total N at 0-20 cm was higher compared to 20-40cm soil depth. Total N values at 0-20 cm soil depth across locations were low, as it fell below the soil N critical level of 1 g/kg (Egbe *et al*., 1989). Nitrogen supplementation as fertilizer is required for good growth of cashew.

Soil available P was generally high and ranged from 2.2 to 11.25mg/kg soil across soil depth and location. Soil available P at 0-20 cm soil depth was also adequate for cashew cultivation with values of 8.11-11.25 mg/kg .This is above the soil P critical value of 3.7 mg/kg (Egbe *et al*., 1989) Iyemero soil gave the highest available P of 11.25mg/kg soil compared with Isanlu having the lowest value of 8.11 cmol/kg at 0-20 cm soil depth. There may not be need for external supplementation of P for now.

The C: N ratio of Ilaji-Ile was the highest with a value of 14.25 at 0-20 cm soil depth, while that of Ibadan gave the lowest value of 7.04 at 20-40 cm soil depth.. This implies that the rate of decomposition in Ibadan would be faster than that of Ilaji-Ile.

The exchangeable K ranged from 0.13cmol/kg soil in Iyemero to 0.42cmol/kg in Ibadan soil. The exchangeable K in Ibadan soil was higher than that the exchangeable K in all the other three locations. The exchangeable K was adequate for cashew cultivation. Hence there is no need for K fertilizer application.

Soil exchangeable calcium decreased with increasing soil depth. Exchangeable Ca in 0-20 cm soil depth was highest in Ilaji-Ile, with a value of 4.48cmol/kg soil compared with Ca content in Ibadan, Iyemero and Isanlu with values of 1.97, 2.09, and 3.03 cmol/kg soil respectively. Soil calcium was adequate and was above the soil critical level of 0.8 cmol/kg. There is no need for calcium fertilizer

The exchangeable Mg followed a similar trend of Ca and ranged from 0.75 cmol/kg in Iyemero soil to 2.16 cmol/kg in Ilaji-Ile, with the highest value of 2.16 cmol/kg at 0-20 cm in Ilaji-Ile . The exchangeable Mg just like Ca also decreases with soil depth in all the four locations. Soil Mg was adequate and was above the soil critical level of 0.08 cmol/kg. There is no need for Mg fertilizer

The exchangeable acidity ranged from 0.06 cmol/kg soil to 0.11 cmol/kg. Exchangeable acidity was higher in Ibadan and Isanlu with an average value of 0.09cmol/kg compared with 0.07cmol/kg obtained in Ilaji-Ile and Iyemero soils.

Table 1: Soil physical and chemical properties of soils at cashew plots at Ibadan, Ilaji-Ile, Iyemero and Isanlu

		Soil physical properties (g/kg)			Soil chemical Properties		(g/kg)	(g/kg)	(mg/kg)		cmol/kg		
Locations	Soil depth	Sand	Silt	Clay	pH	Org. C	Total N	C/N	Avail. P	Exch. K	Ca	Exch. Mg	Exch. Acidity
Ibadan (Oyo)	0-20cm	842	122	36	7.20	1.27	0.098	13.0	8.79	0.42	1.97	1.115	0.08
	20-40cm	832	112	56	7.05	0.50	0.071	7.04	2.2	0.20	0.93	0.778	0.10
Mean		**837**	**117**	**46**	**5.74**	**0.88**	**0.084**	**10.48**	**5.49**	**0.31**	**1.45**	**0.946**	**0.09**
Ilaji-Ile (Oyo)	0-20cm	832	108	60	5.84	1.81	0.127	14.25	8.9	0.24	4.48	2.16	0.09
	20-40cm	732	148	120	5.64	1.17	0.152	7.70	4.92	0.26	2.95	2.09	0.06
Mean		**782**	**128**	**90**	**5.74**	**1.49**	**0.139**	**10.72**	**6.91**	**0.25**	**3.71**	**2.12**	**0.07**
Iyemero (Ekiti)	0-20cm	852	88	60	6.17	1.11	0.084	13.21	11.25	0.19	2.09	1.11	0.08
	20-40cm	932	8	60	6.14	0.48	0.051	9.41	4.7	0.13	1.38	0.75	0.06
Mean		**892**	**48**	**60**	**6.15**	**0.79**	**0.067**	**11.79**	**8.10**	**0.16**	**1.73**	**0.93**	**0.07**

Isanlu (Kogi)	0-20cm	752	188	60	6.49	1.33	0.098	13.57	8.11	0.39	3.03	2.03	0.07
	20-40cm	632	208	160	5.33	0.55	0.067	8.21	6.73	0.15	1.2	1.090	0.11
Mean		**692**	**198**	**110**	**5.91**	**0.94**	**0.082**	**11.46**	**7.42**	**0.27**	**2.11**	**1.56**	**0.09**

Conclusion

Nitrogen was insufficient to meet the soil nutrient requirement of cashew. Soil organic carbon was also low. There is therefore need to return nitrogen to the soil through the use of both organic and inorganic form.

Status: On-going

Future plan: Replant cashew in Ibadan

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KOLA PROGRAMME

Experimental Title: Vegetative propagation in Germplasm Expansion: The search for Improved Cola Genotypes in Nigeria

Investigators: Sobowale, I. O, Adenuga, O.O, Adejobi K. B., Orisajo S. B, Adebiyi, S,

Introduction

Kola nut is an important commodity crop cultivated mostly in Africa (Dadzie et al., 2013). It has a lot traditional, social and medicinal importance, such as treatment of asthma and whooping cough (Adedayo et al., 2019; Dorathy et al., 2014). In the pharmaceutical industry, they are used to develop drugs against cardiovascular diseases (Madingou *et al*., 2012) and are highly valued in traditional pharmacopoeia as a fertility regulator and as a remedy against migraines and indigestion (Esimone *et al*., 2007). Propagation using clones obtained from grafts of selected desirable variety will enhance the possibility of obtaining uniformly growing trees, uniform maturation, moderate to dwarf trees and increased nut yield. Planting clones instead of open pollinated varieties could also reduce gestation time and to develop early-fruiting kola genotypes.

Objectives

The objective of this research is to produce and establish clones of kola trees identified on farmers' fields and CRIN collections in new germplasm collection for development of improved kola varieties.

Materials and methods

Selected farms (Osun, Ondo and Ekiti State) were surveyed for kola trees with records of good and desirable traits. Vegetative materials (budwood) was collected from different farmers field from each of the locations. Young stems collected from selected kola trees were grafted on already established rootstock at the nursery, CRIN headquarters for field establishment. The successful graft was established on 1ha at CRIN Headquarters.

Result and Discussion

Over two thousand kola seedlings were raised for rootstock and a total number of six hundred (600) seedlings were grafted and 100 cuttings were raised from the budwood collected, both the grafted seedlings and the cuttings are still at green stage.

Kola Budwood Collection at Okuku in Osun state

Grafting of Kola at the Nursery

Grafted Kola at the Nursery

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Experimental Title: Economics of the use of botanicals for Storage and Preservation of Kolanut among Stakeholders in Ekiti and Ogun States, Nigeria

Investigators: Lawal, J.O., Oyedokun, A.V., and Ugwu, C.A.

Introduction

It is estimated that field and storage pests destroy approximately 43% of potential production in developing Asian and African countries (Jackobson, 1982; Ahmed and Grainge, 1986; Ogendo et al., 2004). A combination of botanicals and natural components for the storage and preservation of Kolanut by the stakeholders offers considerable promise for increasing income and sustainability on the crop. It nonetheless remains unclear whether these techniques are cost-effective and lend themselves easily to adoption by smallholder farmers than synthetic ones mainly because of the latter's adverse effects such as safety, cost and crop failure.

Abedi and Bedragheh (2011) asserted that indigenous knowledge is a principal factor at the field of research of sustainable development, decreasing poverty, local participation in farming activities and rural development programs which develops and produces appropriate technology, self-reliance of rural societies and country. In recent years, there has been an attempt to replace the synthetic insecticides with less expensive, locally available, ecologically safe and socio-friendly options including botanicals (Banwo and Adamu, 2003; Ogendo et al., 2006; Talukder, 2006; Isman, 2007). However, traditional farmers perceptions of pest problems and indigenous control methods employed are yet to be critically evaluated in terms of cost benefits. The available information is mostly observational/ anecdotal and does not provide quantitative details about various socio-economic factors that influence the indigenous pest control practices (Altieri, 1993). Since adoption of agricultural production technologies in developing countries is influenced by a wide range of economic, social, physical as well as technical aspects of farming, understanding the role of these factors to ensure the development of sustainable technologies and the design of successful development projects is germane. According to Rogers (1995), the adoption of an innovation goes through a decision-making process beginning with awareness, then the formation of positive or negative attitudes, and finally deciding whether or not to adopt the technology. Each stage of this process is influenced by various factors, including: household factors (socio-economic, resource base and outside contacts), community factors (access to extension, education, market, infrastructure, indigenous knowledge and ecological factors), and institutional factors (extension services, training and material support, through government and national/local NGOs). Hence, this study seeks to analyse the factors driving the use of botanicals by farmers in the bid to manage pests and diseases of Kolanut in preservation.

Objectives

4. Identification and documentation of botanicals used in Kolanut preservation and storage in the study areas;
5. Analyze the factors driving the use of botanicals in Kolanut storage and preservation;
6. Determine the cost-effectiveness of the use of botanicals for storage and preservation.

Methodology

The study was carried out in two states which are predominant for Kolanut production and trade, of which the marketing functions include postharvest processing, preservation and storage. Following a multistage sampling procedure, structured questionnaire were used to elicit information from the Kolanut stakeholders using a Stratified Random Sampling technique, at the Local Government (LG) level, two LG areas that are planting and dealing in Kolanut were chosen and at the village level, three villages each from the LGAs were selected of which the stakeholders were stratified into two: adopters of botanical method and non-adopters. Each stratum was proportionately sampled based on size to give a population of 60 respondents. Data collected were subjected to descriptive, budget and inferential analysis.

Results and Discussion

Summary and descriptive statistics of the socio-economic characteristics of kolanut traders

Tables 1 and 2 show the summary and descriptive statistics of the socio-economic characteristics of the respondents interviewed. Table 2 reveals that the mean age of these kolanut traders in Osun and Ekiti State, Nigeria is about 47 ±14.67 years. This indicates that the respondents in the study area are still in their productive years and probably explains the high frequency in secondary occupation (81.7%) amongst the kolanut traders. Thus, kolanut storage and preservation business allows these traders time to diversify to other money-making ventures in the study area. In addition, most respondents (76.6%) had formal education meaning that majority of the respondents have at least Primary School Leaving Certificates and thus by implication may, have access to information about improved kolanut storage and preservation techniques especially with kolanut-botanical use as well.

Furthermore, mean years of kolanut postharvest handling experience among respondents in Osun and Ekiti State, Nigeria is 21±13.75 years while on the average 3 years have been spent by the traders on kolanut storage and preservation training whilst income of the traders average at about ₦504,666.66. The traders are largely married (79.7%) with mean household size of 7±3. Also, membership of cooperative society is common (35.0%) amongst the traders potentially indicating a level of community involvement, shared resource management, or participation in cooperative economic ventures; besides, respondents also have high frequency of extension visit (53.3%) and monthly extension contact (35.0%). These possibly explains the long standing mean use (17 years) on, the average with kolanut botanical and invariably implies that majority of the respondents have access to agricultural specialists and safe kolanut storage technique such as the use of botanicals. Most of the kolanut storage and preservation traders in the study area of Osun and Ekiti State, Nigeria are females (51.6%) and do not have access to credit (71.6%). This may imply constrained economic opportunities, limited financial mobility and poor business growth for majority of the kolanut storage and processing traders, farmers and marketers in the study area.

Table 1: Summary and descriptive statistics of kolanut storage and preservation traders in Osun and Ekiti State, Nigeria

Descriptive Statistics	N	Minimum	Maximum	Mean	Std. Deviation
Age	60	22.00	85.00	47.4407	14.67260
Kolanut storage and preservation experience	60	2.00	60.00	21.1500	13.34271
Household size	60	3.00	20.00	7.8214	3.33089
Kolanut trade income	60	10000.00	3000000.00	504666.6667	50,431.28
Number of kolanut farming, storage and preservation training received	60	00.00	12.00	2.0370	2.54738
Years of Kolanut botanical use	60	00.00	60.00	17.8182	12.79770

Source: Field survey, 2023

Table 2: Selected socio-economic characteristics of kolanut storage and preservation traders in Osun and Ekiti State, Nigeria

Educational qualification	**Frequency**	**Percent**
No formal	11	19.3
Primary education	22	38.6
Secondary education	19	33.4
Tertiary education	8	13.8
Total	**60**	**100.0**
Sex		
Male	29	48.3
Female	31	51.7
Total	**60**	**100.00**
Credit access		
Yes	15	25.9
No	45	77.4
Total	**60**	**100.0**
Marital status		
Single	7	11.9
Married	47	79.7
Divorced	1	1.7
Widowed	5	8.5
Total	**60**	**100.0**
Secondary occupation		
Kolanut farmer	17	28.3

Artisan	2	3.3
Trader	7	11.7
Arable farmer	5	8.3
Kola marketer	17	28.3
Others	12	20.0
Total	**60**	**100.0**
Kola nut store		
Communal	3	5.0
Owned	43	71.7
Lease	14	23.4
Total	**60**	**100.0**
Botanical source		
Private	2	3.4
Market	25	41.7
Famer/trader friend	1	1.7
Free-lance	32	53.3
Total	**60**	**100.0**

Source: Field survey, 2023

Furthermore, Table 2 provides insights into the ownership patterns of kolanut storage facilities among the surveyed individuals. The majority (71.7%) own their kolanut storage facility(ies), indicating a high degree of individual ownership within the sampled area. A smaller proportion (5.0%) reported communal ownership, suggesting that some storage facilities are shared or collectively owned by Kola traders.

The distribution of kolanut storage botanical sources amongst the sixty (60) surveyed traders and/or respondents in the study area shows that, a significant number (53.3%) source free-lance. The market is also a substantial source (41.6%), while private and family/friends both (1.6%) respectively contribute smaller percentages. The implication of this is that most of the botanicals are sourced free of charge by the respondents which likely reduces their storage cost.

Identification of the botanicals used by kola-nut traders

Table 3 reveals frequency of botanical brand used by the sixty respondents thus; Alum (6.6%), Bitter leaf (25%), ground pepper (11.6%), Lapalapa leaf (15%), Sandpaper leaf (3.3%) and Camphor (28.3%).

The use of camphor (28.3%), Bitter leaf (25.0%) and lapalapa leaf (15.0%) by majority of the kola-nut traders and preservers may not be unconnected to the availability and accessibility of the materials within the study area. However, the farmers and traders of kola-nuts have indigenous knowledge and native intelligence to identify these bioactive materials and have been putting them into use in kola-nut preservation against biotic pressures during storage.

These botanicals and other preservation materials like camphor have bioactive compounds in them that are either biocidal and/or having repellency characteristics in nature, thereby putting the pest population in check and reducing their damage potentials on stored kola-nuts.

Table 3: Kola-nut botanicals used by traders in the study areas

Botanicals	Frequency	Percent
Alum	4	6.6
Bitter leaf	15	25.0
Ground pepper	7	11.6
Lapalapa leaf	9	15.0
Sandpaper leaf	2	3.3
Camphor	17	28.3

Others	6	1.0
Total	**60**	**100.0**

Source: Field survey, 2023

In the study areas, as presented in Table 4, kolanut traders utilize various agrochemicals for kolanut pre-storage treatment and during storage. Lambda cyhalothrin 2.5 EC (a Pyrethroid) and Chlorpyrifos 20% EC (an Organophosphate) are frequently used by 23.3% of the respondents respectively as pre-storage treatment agrochemicals for soaking the kolanuts before removing the testa, contributing to 46.6% of the total. Aluminum phosphide (a fumigant derivative of phosphine)for preserving kolanuts during storage is used by 20% of respondents, constituting 12 respondents of the total. Similarly, Profenofos-an Organophosphate- (40%) + Cypermethrin (4%) EC is the most predominantly used as it was identified and been used by 28.3% of the traders for pre-storage treatment of kolanuts.

Table 4: Chemical brand used for Kolanut treatment

Active ingredients in the brands of agrochemical used for treatments	**Frequency**	**Percent**
Lambda cyhalothrin 2.5 EC	14	23.3
Chlorpyrifos 20% EC	14	23.3
Aluminum phosphide	12	20.0
Profenofos (40%) + Cypermethrin (4%) EC	17	28.3
No response	3	5.0
Total	**60**	100.0

Source: Field survey, 2023

Analysis of the factors that drive the use of botanicals in storage and preservation of kolanut

Analysis of the factors that drive the use of botanicals in storage and preservation of kolanut among kolanut traders in Osun and Ekiti State, Nigeria was done by means of a four-point Likert scale of a critical mean of 2.0 and is presented in Table 5. The factors with a mean value greater than 2.5 are taken as the factors which drive the use of botanical in storage and preservation of kolanut among kolanut traders in Osun and Ekiti State, Nigeria. Thus, aside religion and presence of subsidies, loan/grants for storage and preservation; Profit, Variety of kolanut available per farming season, Demand for kolanut, Years of experience in kolanut storage and preservation, Selling price of Kolanut(farm gate), price of kolanut at the point of storage, policies and programs of government, membership of association, Availability of cheap labour, Availability of public trees and, Availability of botanicals (bags, leaves, flowers, seeds, bark, roots, twigs, basket, pots/trays, sand) all; drive the use of botanicals for storage and preservation of kolanut

Table 5: Factors driving the use of botanicals in storage and preservation of kolanut

Factors	**Mean**	**SD**	**Decision**
Profit	3.8000	.65871	Accept
Religion	1.6000	.97772	Reject
Variety of kola nut available per farming season	3.0000	1.13496	Accept
Demand for kola nut	3.3167	1.03321	Accept
Years of experience in kola nut storage and preservation	3.6500	.77733	Accept
Selling price of kola nut (/farm gate)	3.4167	.99646	Accept
price of kola nut at the point of storage	3.1833	1.09686	Accept
Policies and programs of government	2.7667	1.11030	Accept
Presence of subsidies, loan/grants for storage and preservation	2.4167	1.12433	Reject
Membership of association	2.5424	1.27742	Accept
Availability of cheap labour	3.6780	.75294	Accept
Availability of public trees	3.5167	.92958	Accept
Availability of botanicals (bags, leaves, flowers, seeds, bark, roots,	3.4333	.96316	Accept

twigs, basket, pots/trays, sand)

Source: Field survey, 2023

Economic analysis of the storage and preservation of kolanut

Analysis of the storage and preservation of kolanut was determined using budgetary analysis as presented in table 6. The results showed that the mean amount spent on kolanut bought for storage and preservation is N99,572.72±17,072.09, quantity of Kolanut bought for storage and preservation as 101,007.5kg±14,544.75 and mean value of stored Kola nut at the time of visit was N240,946.66±15.67 this result corroborates the finding by Adeleye et al(2015) who reported shortfall of storage facilities and transportation problems as factors which make farmers sell all their produce immediately after harvest. The mean amount spent on Kolanut transportation is N26, 135.08±1,318.23 and the mean quantity of stored Kolanut sold 626.80±50.52kg; mean amount spent on Kolanut botanicals for storage N4, 610.46± 492.55 this cost is not much when compared to those stored with chemicals; and according to Eze et al(2015) Kola stored with botanicals has better post-harvest and culinary qualities. The mean income accruing to the trader on the sales of stored or preserved Kolanut is up to N504, 666.66 ± 50,431.28 per annum, mean amount spent as labour and tax levies for kolanut trade for storage and preservation respectively are N21,991.52 ±2,418.84 and N3,685.00± 921.29 respectively. While a mean of N6, 122. 72 ±291.93 is paid as rent for the storage facilities and preservation of Kolanut in the study areas. Furthermore, the result showed that the cost of 50kg botanical and agrochemical are N922.81±95.33 and N2039.05±737.35 respectively which clearly indicates that botanicals are cheaper and can be safer to use compared to the agro-chemicals. The mean cost of Kola agro-chemicals is N7, 382.45±1,407.90 while the mean cost of chemicals used in preservation of Kolanut is N4, 824.07±631.82. Another cost major cost incurred by trader is the cost of water used during storage and preservation Kolanut which has the minimum value of N500 and maximum of N10, 000 but with the mean value of N2,757.57±266.70 spent; this result corroborates the finding of Amon-armah et al.,(2021) who reported that 82.7% of traders depulp the nuts by soaking in water, and 89.8% also rinse Kolanut in water mixed with chemicals after depulping. It was also recorded that extra mean value of N5, 248.95 ±1966.53 accrued to the farmer or trader for the sale of a stored, well cured and preserved Kolanut per basket compared to sale of fresh Kolanut. This study has showed that Kolanut trade is profitable in the study area whilst use of botanical and storage/preservation of kolanut accrued more profit to the farmers and traders in the study areas.

Table 6: Economic Analysis of the Storage and Preservation of Kolanut

Expenditure/Income	Mean	Standard deviation
Amount spent on Kolanut bought for storage and preservation	₦99,572.72	±17,072.09
Value of kolanut stored (at time of visit)	₦ 240,946.66	±15.67
Fresh Kolanut bought for storage and preservation	101,007.5kg	±14,544.75
Transportation cost	₦ 26,135.08	±1,318.23
Quantity of Stored Kolanut	626.80 kg	±50.52kg
Cost of botanicals	₦ 4,610.46	±492.55
Cost of agrochemicals	₦ 7,382.45	±1,407.90
Income/Return	₦ 504,666.66	±50,431.28
Labour cost	₦ 21,991.523	±50,431.28
Tax levies	₦ 3,685.00	±921.29
Cost of Rent	₦ 6,122.72	±291.93
Cost of botanical per 50kg Kolanut	₦ 922.81	±95.33
Cost of chemical per 50kg Kolanut	₦ 2,039.05	±737.35
Water cost	₦ 2,757.57	±266.70
Income per basket of stored Kolanut	₦ 5,248.95	±1966.53

Source: Field survey, 2023

Table 6 shows that botanical use in the storage and preservation of kolanut was more profitable and thus more cost-effective while increasing profit than the synthetic agrochemicals in the storage and preservation of kolanut.

Conclusion and recommendation

This study identified and analysed the factors driving the use of botanicals by farmers in the bid to sustainably manage pests and diseases of kolanut especially during storage and preservation.

This study recommends that:

1. Efforts should be geared towards the increased use of botanicals for Kolanut storage and preservation as studies have revealed lower cost, safe and better post-harvest/ culinary qualities of such stored Kolanuts.
2. Also, farmers and traders should be encouraged to store /add more value to their Kolanut as this study has discovered that more money accrued to stored kolanuts than the sale of freshnuts at farm gates;
3. In the same vein, storage facilities used by traders should be improved upon to ensure proper storage of Kolanut for better income to farmers/traders.

4. This study also recommends awareness campaign and training of kolanuts postharvest handlers and traders (stakeholders) on the economic and health benefits of botanicals materials usage in kolanut storage and preservation.
5. Finally, this study recommends the development of nanoparticle biopesticide and/or botanical pesticides to replace synthetic agrochemicals with potential health risks being used in kolanut storage and preservation in Nigeria.

Recommendation for further studies:

- The development of nanoparticle bio-pesticide and/or botanical pesticides to replace synthetic agrochemicals and its economic evaluation for sustainable use of farmers.

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Experimental Title: Kolanut Processing for Quality Improvement among Kolanut Processors in Ogun State of Nigeria

Investigator: Oluyole, K.A., Adebiyi, S. and Oladokun, Y.O.M.

Introduction

Kola an evergreen tree and a member of sterculiaceae family is an important commodity crop in West Africa and other tropical regions of the world (Onaolapo and |Onaolapo, 2019). It is native to tropical Africa with its center of diversity in West Africa especially Cote d'Ivoire and Ghana (Gestrich *et al*. 2021). Among about 40 Cola species in West Africa, the Cola nitida and Cola acuminata are the species of real economic importance (Asogwa *et al*.2011; Adesida *et al.* 2021). They are important economic crops in the forest areas of West and Central Africa, Caribbean Islands, Mauritus, Sri Lanka and Malaysia (Adesida *et al*. 2021). Although Cola nitida is of more economic importance in Nigeria especially in the north, Cola acuminate has its origin and is consumed mainly among the Yoruba tribe of Western part of Africa. Kolanuts are extremely popular due to their high caffeine content. Kolanuts have a bitter taste and contain between 1-1.5% caffeine by weight (Clayon, 2002). They are also a source of antioxidants and contain small amounts of theobromine, d-catechin, L-epicatehin, kolatin, phlobaphens, antioxidant pigment, betaine and protein. Kola extract is a popular ingredient in fat loss supplements. It suppresses hunger, aids digestion of food and acts as a diuretic.

Cola acuminata: The processing of *Cola acuminata* begins with a meticulous inspection to separate healthy pods from those afflicted by weevils, diseases, or deformities. Following this, the seed coat or testa of the nuts from the healthy pods is removed. This is done by immersing the nuts in clean water for 24 hours to encourage rotting, after which the nuts are peeled and rinsed in fresh water. The rinsed nuts are then gathered in wide, flat baskets to allow excess water to drain before being placed in a room at ambient temperature for three days for curing. During this curing process, defective or infested nuts are identified and removed, and there might be some moisture reduction through sweating. Finally, the nuts are sorted by size and stored in large basket for proper storage.

Cola nitida: For *Cola nitida*, the testa or seed coat of the fresh nuts can be made to rot by placing them on the bare ground with intermittent moistening, covering them with jute bags for 3-4 days. This method causes the nuts to become wet and turn black while also aiding the maturation of premature nuts. Alternatively, the testa of fresh nuts can be soaked in water for 24 hours. After soaking, the nuts are peeled, rinsed, and collected in baskets to drain excess water. During this process, defective and infested nuts are removed. Next, the nuts are cured in flat baskets for three days. Throughout this period, they are subject to regular inspection to eliminate any remaining defective or infested nuts. For storage, the nuts can be transferred to baskets lined with polythene sheets, followed by layers of paper (such as old newspapers) and fresh leaves from specific plant species. These layers are replaced during weekly inspections. Alternatively, the nuts can be stored in jute bags lined with thin transparent polythene sheets, layered with paper and fresh leaves. After two months, the frequency of inspections can be reduced to intervals of 2-3 weeks. These processing techniques are crucial for maintaining the quality and safety of cola nuts for various purposes, including their use in the production of cola-flavored beverages.

Nigeria is the leading world producer of kolanut (Amon-Arma *et al.* 2021). It is estimated that Nigeria produced 171,428.8 metric tonnes of fresh nut in 2021 (FAOSTAT, 2021). Kola has numerous socio-economic as well as nutritional importance. Kola nut is an important article of trade in West Africa and in the trans-Saharan trade routes for many centuries. Kola nut was harvested in 257114 hectares in 2021 (FAOSTAT, 2021). kolanut is majorly consumed within Nigeria thus efforts must be put in place to increase its consumption through post-harvest processing to reduce its bitter taste. This study thus seeks to examine kolanut processing for quality improvement among kolanut processors in Ogun State of Nigeria

Methodology

The study was carried out in Ogun state, Nigeria. In the State, Shagamu Local Government Area (LGA) was purposively selected. Within the LGA, Shagamu town was purposively selected because of the high concentration of kolanut marketers/processors in this area. Random sampling technique was used to select One hundred and eight (108) kolanut processors from the market and structured questionnaire was used to collect information from the selected processors. The data retrieved from the information collected were analysed using using descriptive statistics.

Results and Discussion

Table 1 presented the socio economic characteristics of kolanut processors in Ogun state. The mean age of kolanut processors in the study area was 59 ± 14 years. Kolanut processors in the study area are middle aged thus they are still active and could be sensitized and trained on the right processing techniques to improve the taste of kolanut. Ninety four percent of the processors are female. This finding is in conformity with Oluyole *et al*. 2023 which confirmed that men are more into production of tree crops while women are into processing and marketing. In the study area 42.6% of the processors do not have formal education while 47.4% have a level of education (primary/secondary). Kolanut processors do not really need formal education for their trade, most times they get trained informally from marketers who have been in this trade for a while.

Table 1: Socio Economic Characteristics of Kolanut Processors in Ogun State

Variable	Freq (108)	%
Age (years)		
<30	1	1.9
31-60	60	55.5
>60	46	41.6
Mean 59 ± 14		
Sex		
Male	6	5.6
Female	102	94.4

Educational Status		
No formal education	46	42.6
Primary	44	40.7
Secondary	18	6.7

Source: Field Survey, 2021

Table 2 presented the quality improvement among kolanut processors. Majority (96.3%) of the processors in the study process more of gbanja/goro type of kolanut. Gbanja/goro is *cola nitida* and it is one of the most popular specie of economic importance in Nigeria (Odo *et al*. 2023). One hundred percent of the processors affirmed that they process their raw kolanut to avoid spoilage. Also 48.1% of the processors reported that to reduce the bitter taste of kolanut they store the nut for a long time or allow it to be well dried. Good post harvest processing techniques could also reduce the bitter taste of kolanut to enhance its consumption. Eighty percent of the processors use leaf to preserve kolanut. They use this to avoid spoilage (33.3%), to enhance the appearance of kolanut (27.8%) and to avoid being heated (20.4%). On the other hand, 77.8% of the processors use nylon to preserve kolanut and some of the reason they use it is to make it airtight thus avoiding spoilage, it also enhance storage for a long time. Majority (96.3%) of the processors use chemical to preserve their nut. They use chemicals such as Gamallin 20 and Phostocin to prevent weevil infestation on kolanuts. They use the two chemicals together probably to make preservation more effective. Eighty three percent of the processors affirmed that they ferment their kolanut before peeling. The reasons for this were to ease peeling, to enhance long term storage and to enhance the appearance of the nut.

Table 2: Quality Improvement among kolanut processors

Variable	Freq(N=108)	%
Type of Kolaut processed		
Local Kolanut (*Cola acuminata*)	4	3.7
Gbanja/Goro (*Cola nitida*)	104	96.3

Why do you process your kolanut?		
To avoid spoilage	108	100.0
How do you reduce the bitter taste of kolanut		
Store the nut for a long time/well dried	52	48.1
Nothing could be done to remove the bitterness	40	37.2
Others	16	14.8
Do you use leaf to preserve kolanut?		
Yes	86	79.6
No	22	20.4
Reasons for using leaf		
To enhance the appearance of the kolanut	30	27.8
To dry up the nuts quickly	8	7.4
To be used as airtight material	8	7.4
To preserve the nuts from being spoit	36	33.3
To improve the taste (to reduce bitterness)	4	3.7
To avoid being heated up	22	20.4
Do you use nylon to preserve your nuts?		
Yes	96	77.8
No	12	22.2
Why do you use nylon to preserve kola?		
Nylon is airtight and avoid spoilage of nut	54	50.0
Nylon saves labour and does not need to be changed regularly as leaf	6	5.5
Leaf makes kolanut to burn	4	3.7

Nylon moistens nuts	6	5.6
Nylon enhances storage for a long time	34	31.4
Leaf dries up quickly	2	3.8
Do you use chemical to preserve your nut?		
Yes	104	96.3
No	4	3.7
Chemicals used to preserve kolanut		
Gamallin 20 and Phostocin	84	80.8
Gamallin 20 alone	10	9.6
Phostocin alone	10	9.6
Do you ferment your kolanut before	90	83.3
Peeling?		
Yes	90	83.3
No	18	16.7
Why do you ferment before peeling?		
To ease peeling	36	40
To enhance long term storage	36	40
To enhance colour	8	8.9
To enhance the appearance of the nut	10	11.1

Source: Field Survey, 2021

Conclusion

In the context of this study, kolanut processing reduces the bitter taste of kolanuts, especially, when the kolanuts are stored for a long time or allow it to be well dried. The use of leaves to preserve kolanuts avoid kolanut spoilage; it enhances the appearance of kolanuts and it avoids kolanuts from unnecessarily being heated. It is quite disheartening that majority of the processors still use chemicals such as gamallin 20 and phostocin to preserve kolanuts against insecticidal infestation. The study therefore recommended that sensitization on the non-usage of chemicals to preserve kolanuts should be intensified.

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BIOACTIVITY OF *Hippocratea velutina* AFZEL LEAF AND STEM POWDERS AS STORAGE PROTECTANTS AGAINST *Balanogastris kolae* (DESBROCHER DES LOGES) ON *Cola nitida*

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Abstract

The bioactivity of *Hippocratea velutina* leaf and stem powders was tested against *Balanogastris kolae* adult emergence on stored *Cola nitida*. The quantitative phytochemical screening of *H. velutina* leaf powder gave the following mean absorbance values: Total tannin (1.6885 mgTAE/mL); Total phenolic (1.8387 mgGAE/mL); Total alkaloids (4.1600 mg/mL) and Total flavonoids (2.0510 mgRE/mL) while that of the stem powder was as follows: Total tannin (0.9135 mgTAE/mL); Total phenolic (1.8395 mgGAE/mL); Total alkaloids (5.0000 mg/mL) and Total flavonoids (1.3797 mgRE/mL). Powders were applied at 5 g, 10 g, 15 g and 20 g concentrations. Data were recorded at 2, 4, 6, 8, 10 and 12 weeks after treatment application. Kolanuts protected with 15 g leaf powder and stored for 12 weeks had the lowest number of emerged adults (2.00), which was significantly different ($p < 0.05$) from other treatments. The least number of adults (0.67) was recorded from 5 g stem powder-coated nuts, while the highest number of adults (26.67) was recorded from 15 g coated nuts. However, there was no significant difference ($p > 0.05$) in the number of adults found on untreated (control) kolanuts and all other treatments. The few numbers of adult weevil emergence obtained from nuts coated with 15 g and 20 g *H. velutina* leaf powder showed it successfully restricted adult weevil emergence which may be due to its higher flavonoid content. *H. velutina* stem powder did not significantly reduce adult emergence from treated nuts compared with the untreated.

Keywords: Adult emergence, *Balano gastris kolae*, Bioactivity, Cola nitida, *Hippocratea velutina* leaf.

Introduction

In the last few decades, chemical pesticides have been used to control agricultural insect pests. As a result of massive and repeated applications, these synthetic pesticides have brought a lot of detrimental effects on the environment and caused contamination of non-target organisms. Hence, they are termed ecologically unsafe as they persist for a more extended period in the environment and exhibits residual effect as they enter into the food chain, where they cause serious havoc on non-target organisms, most especially humans (Alavanja *et al*., 2004; Upadhyay 2016; Ifebueme *et al.* 2020).

One of such insect pest usually controlled by these chemical pesticides is *Balanogastris kolae*, a significant pest of kolanuts. It is the most common and economically important weevil of kolanut. *B. kolae* is a destructive field-to-store pest of kolanuts in West Africa, as they are capable of causing close to 100% damage if not checked on time (Asogwa *et al*., 2015; Azeez, 2015; Popoola *et al*., 2020). Several kinds of research have been carried out on using different plant parts to control *B. kolae*. Azeez (2015) reported that ethanolic plant extracts of *Lycopersicon esculentum* Mill, *Hyptis suaveolens* (L) Poit, *Cymbopogon citratus (*Stapf), *Loranthus braunii* (Spaague Var), *Alstonia boonei* (De Wild) and *Sarcocephalus latifolius* (Sm) resulted into 100% mortality of the weevils. A similar trend was observed by Ugwu *et al*. (2019) when 100% concentrations of *Azadirachta indica* (A Juss), *Piper guineense* (Schum and Thonn) and *Afframomum melegueta* (K Schum) caused 100% mortality of the adult *B. kolae*. Despite the array of plant extracts reported to be effective in decimating this weevil's population, there is a need to explore other plant species having insecticidal properties to reduce pressure on the existing ones.

The insecticidal property of *Hippocratea*, a genus of flowering plants belonging to the family Celastraceae, has been documented. They are distributed across all the tropics and comprise more than a hundred genera and 1300 species. Most of them are climbers, using their branchlets to twist around their supports (Okwute *et al*., 2018; Onyekere *et al.*, 2019). The common species of *Hippocratea* are*; H. africana, H. indica, H. excelsa, and H. velutina*. The use of this plant family in controlling insect pests of stored products has been studied, though not extensively.

Methanolic leaf extract *of H. africana* exhibited suitable insecticidal property against *Sitophilus zeamais* (Oboho *et al*., 2022) and beta-cell cytotoxicity effects (Okokon *et al.*, 2013). Ndem *et al*. (2013) reported that the crude root extract of *H. africana* has anti-plasmodial properties. More so, Folawewo *et al*. (2017) investigated the antibacterial activities of the hexane and methanolic root bark extract of *H. africana* and discovered that the crude methanol extract exhibited the largest zone of inhibition against *Morganella morganii.* According to Reyes-Chilpa *et al.* (2003), the root cortex of *Hippocratea excelsa* possesses antifeedant and toxic properties against *Sitophilus zeamais.*

Information on the biological activities of *Hippocretea velutina* Afzel, a member of this family, is not currently available; hence, the need to assess its insecticidal activity on *B. kolae.* Therefore, this research aims to investigate the efficacy of the stem and leaf powder of *Hippocratea velutina* in the control of kolanuts weevils, *Balanogastris kolae* adult emergence.

Materials and Methods

Study Area and preparation of the plant materials

This work was carried out at the Insect Chemical Ecology Laboratory, Department of Crop Protection and Environmental Biology, University of Ibadan, Ibadan, Oyo State, Nigeria.

The plant material, *Hippocrates velutina,* was obtained from the Forest Research Institute of Nigeria in February 2022. It was sorted into leaves and stems, air-dried for two weeks, and the dried plant materials were ground to a coarse powder using an electric corn mill grinder M6FFC-160. The leaf and stem powders were then stored separately in airtight containers and kept in a dry place until needed.

Quantitative phytochemical analysis

Total flavonoid content: Procedure to determine the total flavonoid content of the plant extracts was as described by Deepika & Savita (2017). To 0.5 mL of extract (5mg/mL), 2 mL of distilled water and 0.15 mL of Sodium Nitrite (5% $NaNO_2$w/v) was added, and the mixture was allowed to stand for 5 mins. To the mixture, 0.15 mL of Aluminium chloride (10% $AlCl_3$) was added and left to stand for 6 min. 1 mL of sodium hydroxide (4% w/v, NaOH) was added. The mixture was made up to the 5 mL mark, and incubated at room temperature for 15minutes. The absorbance was measured at 510 nm. The procedure was repeated to obtain the blank and calibration curve for standard flavonoid Rutin (5-100 µg/mL) (Kavitha *et al.,* 2016).

Total phenolic content: Procedure from Deepika & Savita, (2017) was used to determine the total phenolic content of the plant extract. To 2 mL of Folin- ciocalteu (1:10) was added to 0.5 mL of the plant extract (5 mg/mL) in a test-tube, and incubated for 5minutes at room temperature (in the dark). Sodium carbonate (7.5% w/v, 4 mL) was added to the mixture. The resultant mixture was incubated in the dark for 30 mins at room temperature with intermittent shaking. The absorption was measured at 765 nm. Calibration curve for Gallic acid (1-20 µg/mL) and blank was also determined using the same procedure.

Total tannins: Total tannin content was determined with procedure from Kavitha *et al.* (2016). Folin ciocalteu (0.25 mL) was added to 3.75 mL of distilled water. The extract (0.05 mL of 5 mg/mL) and 0.5 mL of Na_2CO_3 was added to the solution. The mixture was made up to 5 mL mark with distilled water. The mixture was well shaken and incubated at room temperature in the dark for 30 mins. Absorbance was measured at 700 nm. Calibration curve was obtained for Tannic acid (20 -100 µg/mL).

Total alkaloids content: Alkaloid content of the extracts were determined by titrimetric method. Obtained supernatant of the samples (10 mL of each) were taken into 10 mL of 0.1 N HCl in a flask and shaken thoroughly for 2-3 min. The lower layer contains alkaloids neutralized with 0.1 N HCl. The HCl portion (10 mL) was collected in a beaker and 2-3 drops of methyl red were added giving a slightly reddish colour. This was then titrated against 0.1N NaOH till colour changes from red to pale yellow. This was done in triplicate. The total amount of alkaloids was calculated by considering the following equivalent: 1 mL 0.1 N HCl = 0.0612 g of alkaloid (Taiwo *et al.* 2020).

Source of kolanuts

Freshly skinned kolanuts (*Cola nitida*) was purchased from a local market in Osogbo, Osun State, Nigeria. The kolanuts were cured for three days (72 hours) before the application of treatments.

Experimental set up

The method described by Akunne *et al*. (2018) was followed with some modifications. Exactly 140 g of clean uninfested kolanuts was measured into 1.5 L transparent plastic cylindrical containers with perforated lids to allow aeration. The leaf and stem powders in the proportions of 5 g, 10 g, 15 g and 20 g were added separately into the containers holding the 140 g kolanuts and then shaken vigorously to mix thoroughly. Another 140 g kolanuts, not treated with plant material, was also measured in a container and served as a control. Each of the treatments was replicated thrice. All treatments were arranged in a completely randomized design (CRD). The set-ups were kept in the laboratory at 28±2 ℃ and 80±2 % relative humidity.

Data Collection and Statistical Analysis

The number of emerged adults from the different treatments was counted and recorded fortnightly from 2 weeks after storage until 12 weeks (3 months). Data generated were subjected to one-way analysis of variance (ANOVA) using Genstat Release 12.1 at a 0.05 significant level. The ANOVA results were used to determine the most effective concentration of the powders that could mitigate adult weevil emergence from kolanuts.

Results

The quantitative phytochemical analysis of the leaf and stem powder of *Hippocretea velutina* revealed the presence of flavonoids, tannins, alkaloids and phenols (Table 1). Total tannin (1.6885 mgTAE/mL); Total phenolic (1.8387 mgGAE/mL); Total alkaloids (4.1600 mg/mL) and Total flavonoids (2.0510 mgRE/mL) while that of the stem powder was as follows: Total tannin (0.9135 mgTAE/mL) ; Total phenolic (1.8395 mgGAE/mL); Total alkaloids (5.0000 mg/mL) and Total flavonoids (1.3797 mgRE/mL).

Table 1: Quantitative phytochemicals analysis of *Hippocretea velutina* (HV) leaf and stem powders

Phytochemicals	*Hippocreatea velutina*		T-test value	Significance
	Leaf	Stem		
Total Flavonoids	2.0510	1.3797	0.001252	$P < 0.05$*
Total Phenols	1.8387	1.8395	0.978686	$P > 0.05^{NS}$
Total Alkaloids	4.1600	5.0000	0.087012	$P > 0.05^{NS}$
Total Tannins	1.6885	0.9135	0.084513	$P > 0.05^{NS}$

Adult weevil emergence from Kolanuts treated with *Hippocratea velutina* Leaf Powder

The number of adults that emerged from kolanuts protected with *Hippocratea velutina* Leaf Powder (LP) from 2 Weeks After Storage to 12 Weeks After Storage (WAS) is depicted in Figure 1. The number of weevils that emerged from the treated and control kolanuts increased with time. At 10 and 12 WAS, more weevils were recorded from 5 g (13.67, 24.0) and 10 g (14.67, 22.67) and control (13.33, 13.7), respectively. A few weevils emerged from kolanuts stored with 15 g (2.0, 2.0) and 20 g (3.0, 10.0) LP at 10 WAS, and 12 WAS, respectively.

Adult weevil emergent from kolanuts treated with *H. velutina* LP and stored for three months are displayed in Table 2. Kolanuts protected with 15 g LP had the lowest number of emerged adults (2.00), significantly different ($p < 0.05$) from other treatments. Also, kolanuts coated with 20 g LP and stored for three months (12 weeks) had a low number of weevils, 10.0, and it was significantly ($p < 0.05$) lower than the control (untreated) (13.67). The number of emerged adults on kolanuts decreased in the order of 10 g (22.67) > 5 g (20.67) > Control (13.67) > 20 g (10.00) > 15 g (2.00) (Table 2).

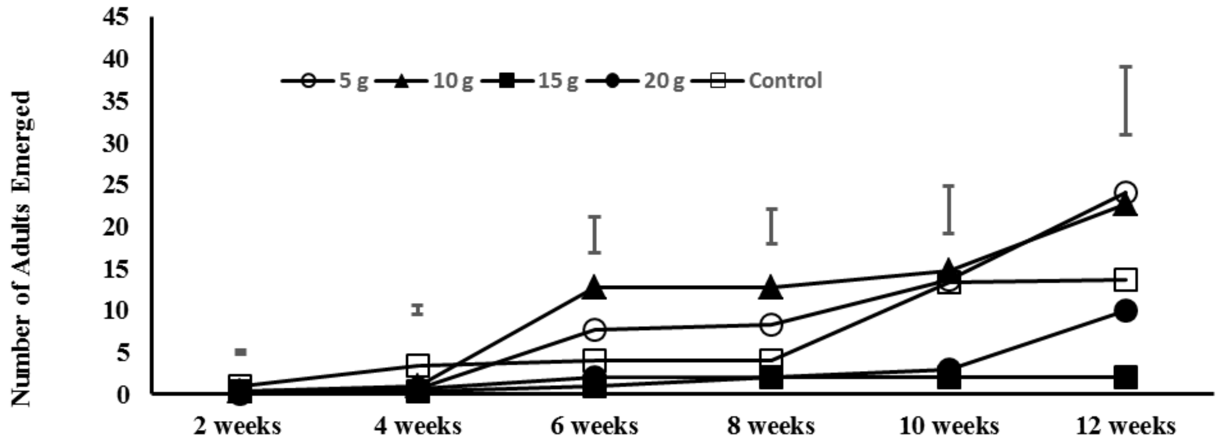

Figure 1: Adult emergence from Kolanuts protected with *Hippocratea velutina* leaf powder

Table 2: Number of Adults emergent from kolanuts protected with *Hippocratea velutina* leaf powder after 3 months of storage.

Concentrations	Number of emerged Adults
5 g (4%)	4.0 ± 1.6 ab
10 g (7%)	3.78 ± 1.7 a
15 g (11%)	0.33 ± 0.14 d
20 g (14%)	1.67 ± 1.1 c
Control	2.27 ± 1.1 b

Means ± SE with the same letters are not significantly different at $p < 0.05$ using SNK test.

Adult weevil emergence from Kolanuts treated with *Hippocratea velutina* Stem Powder

Figure 2 shows the number of adults that emerged from kolanuts coated with *H. velutina* Stem Powder (SP) and stored for 12 weeks (3 months). Adult weevils were recorded fortnightly from 2 weeks after storage to 12 weeks after storage (Figure 2). The least number of adults emerged from kolanuts coated with 5 g, while the highest number of adults was found on kolanuts coated with 15 g SP. At six weeks of storage, the number of emerged weevils increased tremendously compared to the number of weevils at 2 and 4 weeks of storage from kolanuts coated with 15 g and 20 g SP.

Adult emergent from kolanuts coated with different concentrations of *H. velutina* SP are shown in Table 3. There was no significant difference at $p > 0.05$ in the number of adults found on control (untreated) kolanuts and all other treatments. However, the least number of adults (0.67) was recorded from 5 g (4% w/w) coated nuts, while the highest number of adults (26.67) was recorded from 15 g (11% w/w) coated nuts (Table 3).

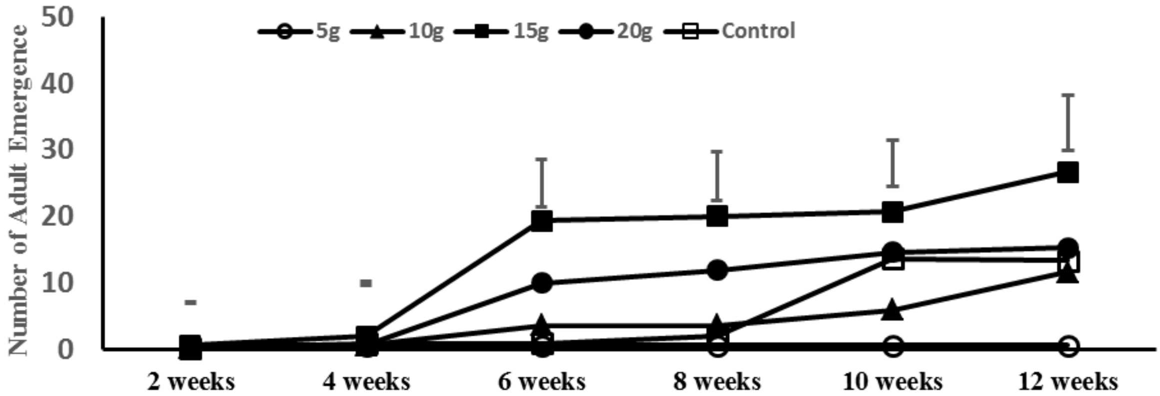

Figure 2: Adult emergence from Kolanut protected with *Hippocratea velutina* stem powder

Table 3: Number of Adults emergent from Kolanuts protected with *Hippocratea velutina* Stem powder after 3 months of storage.

Concentrations (w/w)	Number of emerged Adults
5 g (4%)	0.11 ± 0.1 b
10 g (7%)	1.94 ± 0.7 ab
15 g (11%)	4.44 ± 2.1 a
20 g (14%)	2.56 ± 1.1 ab
Control	2.28 ± 1.9 ab

Means ± SE with the same letters are not significantly different at $p < 0.05$ using SNK test.

Discussion

The present study established the insecticidal ability of the *Hippocratea velutina* plant samples which can be attributed to their phytochemicals constituents. Phytochemicals such as flavonoids, tannins, alkaloids and phenols found in this plant sample have been reported to possess pesticidal activities against a host of insects (Zain *et al*., 2022; Maazoun *et al*., 2019; Ghosh *et al*., 2010). Flavonoid has been documented to have strong insecticidal activities (Maazoun et al., 2019; Ghaly *et al*., 2014). From this study, there is a significant difference in the quantity of the flavonoids present in the leaf powder of the botanical sample as it is higher (2.0510 with $p > 0.05$) than that of the stem (1.3797). This may account for the reduced number of adult emergence in *H. velutina* leaf compared to that of the stem powder observed in this study.

The effect of the various concentrations of the leaf and stem powders of *H. velutina* could mitigate the rate of kola weevil emergence from cured stored kolanuts. The number of adult weevils emerging from nuts coated with 15 g (11% w/w) and 20 g (14% w/w) *Hippocratea velutina* Leaf powder was few, which suggests that these powders successfully restricted adult emergence. The phytochemical constituents in the leaf powder would be responsible for the low adult emergence. The protection of kolanuts achieved by *H. velutina* leaf powder is in agreement with Oboho *et al.* (2022), which reported the severe disruption of *Sitophilus zeamais* (Mots.) mid-gut sections by *Hippocratea africana* plant extract. Also, Reyes-Chilpa *et al.,* (2017) further corroborate this present study as it was noted that *H.excelsa* root cortex was equally toxic to *Sitophilus zeamais*. Similarly, Onyekere *et al.,* (2019) found that crude methanolic extracts of *H. welwitschii* leaves showed activity against a broad spectrum of microorganisms, including gram-positive – *Staphylococcus aureus, Pseudomonas aeruginosa*, *Bacillus subtilis* and gram-negative – *Escherichia coli* and *Salmonella typhi.* It also exhibited antifungal activities against *Candida albicans* and *Aspergillus niger.* The plant species *Hippocratea africana, H. excelsa* and *H. welwitschii* all belong to the same genus as *H. velutina.* Hence the bioactivities of the members in the genus Hippocratea against organisms could be similar.

Meanwhile, Anikwe *et al*, (2004) reported that the fruit powder of *tetrapleura tetraptera* (Shum and Thonn) was toxic to the adult *B. kolae* resulting in high mortality of the insect pests. Also, Akunne *et al*, (2018) investigated the effect of the root powder of *Derris elliptica* (Wall.) Benth in controlling *B. kolae* infestation and discovered that across all the concentrations, a very high mortality was observed. The root powder application at the 10g and gave the most increased mortality of *Balanogastris kolae.*

More so, the insecticidal ability of the leaf powder of *H. velutina* reported in this study can equally be attributed to the mode of action of powder samples as the particles of the powder may cause blockage of the adult weevil spiracles resulting in to anoxia, a condition in which there is no sufficient oxygen for normal respiration which consequently leads to suffocation of the insects (Chougourou *et al*., 2015, Fernando *et al*., 2012). Furthermore, plant powder could also act as an antifeedant as well as a repellent because the odour emanating from it can repel the adult weevil from colonizing the nuts after the application of treatments thus, hindering the insects from penetration and feeding on the kolanuts (Chougourou *et al*., 2015). Powdered plant products may also penetrate the insect body via the *respiratory system causing poisoning of the adult weevil and resultant death (Kedia et* al., 2015). Also, Sousa *et al.* (2005) reported that the plant powders caused dehydration to insects by gradualy removing the cuticle layer and their subsequent death. *Hippocratea velutina* stem powder did not significantly reduce adult emergence from treated nuts compared with the untreated (control) kolanuts. Secondary metabolites in the stem powder were not potent in forestalling adult emergence compared to the leaf powder from the same plant, *H. velutina.*

Conclusion

The study evaluated the efficacy of *Hippocratea velutina* at 4, 7, 11, and 14% w/w (5, 10, 15, and 20 g, respectively) leaf and stem powders in protecting kolanuts in storage from Kola weevil infestation and damage. Clean, uninfested kolanuts (140 g) were coated with varying concentrations of leaf and stem powders of *H. velutina*. Leaf powder at 15 and 20 g / 140 g Kolanut (11 – 14% w/w) was superior to stem powder of *H. velutina* in reducing the number of emergent adult kola weevils after three months. Plant extracts and powders of plant origin are biodegradable and leave no residue on crops; hence 11 – 14% *H. velutina* leaf powder could be increased and reapplied repeatedly to ensure its ability to protect kolanuts against weevils' infestation and damage. Reduction in the number of emerged adults from kolanut coated with 15 g and 20 g Leaf powder over 12 weeks (3 months) will subsequently reduce damage to nuts by the activities of the kolanut weevils. Identifying the chemical compounds in *Hippocratea velutina* leaf powder responsible for reducing adult emergence in stored kolanuts is necessary. These findings on the insecticidal potential of *H. velutina* are the first report because there is no accessible documentation of any research work conducted on this plant at the time of writing this report. Hence the need to investigate further the phytochemical properties of *Hippocratea velutina*..

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Task: Development of safe botanicals for kolanut storage and preservation

Experimental Title: Assay and development of botanical alternatives against storage pests of kolanuts

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Introduction

Nigeria accounts for about 70% of the total world production of kolanuts. About 90% of the kolanuts produced in Nigeria is consumed within the country while 10% is exported. A major challenge associated with kolanuts storage is the attack by kolanuts weevil both prior to the harvest and during storage. In order to prevent stored kola nuts from the attack of store pests and moulds, kola nuts farmers and traders use various types of chemical pesticides including banned ones. The applied pesticides in their characteristic nature have the ability to permeate plant cells and remain as residues. Several authors have reported the presence of pesticide residues in various foods, vegetables, soils, sediments and diverse environmental matrices. Tolerances are pesticide residue levels that should not be exceeded in or on a raw agricultural commodity in the channels of interstate commerce when the pesticide is applied according to label directions. When plant and animal material having pesticide residues at concentrations inimical to human health are consumed, several health hazards could be created within the system which can lead to cancer, kidney failure and a host of other health problems.

Justification

Kolanuts are mostly consumed in its raw state except for industrial use. An array of pesticides residue in kolanuts samples from Ogun and Osun States include Chlordane, Endosulfan, Alachor and Endrin. Residues of these chemicals in kolanut have been found to have adverse effects on the health of the consumers. Hence, the need to explore plant extracts which are suitable alternatives to synthetic pesticides, thereby making the commodity safer for consumption.

Objective

The objective of this study is to bridge the gap in pesticide residue identified in kolanuts by development of botanical alternative control measures that could be easily administered and adoptable by farmers.

Materials and Methods

Samples of apparently healthy kola nuts and infected kola nuts were separately collected from randomly selected local markets in Osun and Ondo States. All the nuts obtained were transported to the laboratory in sterile Ziploc bags. The kola nuts were surfaced sterilized with 2% sodium hypochlorite solution, blotted dry in sterile serviette paper, and incubated at ambient temperature for 5-7 days. The isolated fungi were characterized and identified using standard laboratory methods. The percentages of occurrence of the isolated fungi were determined using the formula:

$$\% \text{ Fungus occurrence} = \frac{\text{Frequency of occurrence of isolate}}{\text{Total occurence of all the isolates}} \; x\,100$$

Fresh samples of some plant materials with known antifungal effects were collected, identified and air-dried in preparation for ashing and other uses, and for storage of freshly purchased kola nuts.

Results and Discussion

A total of twelve fungi were isolated from both apparently healthy and infected kola nuts. Results from the experiment showed that all the implicated storage fungi (except for one- *C. gloeosporioides*, were isolated from the infected kola nut samples. Eight out of the twelve storage fungi were however isolated from the apparently healthy nuts at different percentages of occurrence (Table 1). These findings suggest that most of the implicated storage fungi of kola nut actually infected the nuts (though not visibly seen) prior to storage.

Each of the isolated fungal pathogen has been known to induce rot in agricultural produce. The findings by Sharma and Pandey (2010) revealed the occurrence of *A. niger*, *Penicillium* sp, and *Fusarium* sp. on decayed vegetables. More than 10% occurrence was indicated for *C. lindemuthianum* (24.82%), *F. oxysporum* (18.18%), *P. expansum* (13.64%) and *A. flavus* (13.09%) on the apparently healthy nuts, while *Fusarium oxysporum* (25.18%), *L. theobromae*

(16.09%) and *C. lindemuthianum* (15.02%) and *F. solani* (11.49%) had high occurrence on the infected kola nuts (Oduwaye *et al*., 2018).

Plant materials with known antifungal effects: Neem (*Azadiractha indica*), Siam weed (*Chromolaena odorata*) and Scent leaf (*Occimum gratissimum*) were identified, with some other botanical preparations for pre-storage and storage treatments.

Table 1: Percentage occurrences of fungi associated with apparently healthy and infected kola nuts

Fungi	**Percentage occurrence (%)**	
	Apparently healthy nuts	**Infected nuts**
A. flavus	13.09	10.1
A. niger	6.38	1.15
A. fumigatus	-	1.25
B. cinerea	-	8.09
C. gloeosporioides	4.55	-
C. lindemuthianum	24.82	15.20
F. oxysporum	18.18	25.41
F. solani	9.09	11.49
L. theobromae	9.00	16.39
P. expansum	13.64	4.00
P. atramentosum	-	7.02
R. stolonifer	-	1.15

Conclusion and Recommendation

Findings from this study showed that most of the storage fungi associated with kola nuts actually infected the nuts prior to their storage, while others gained access to the nuts only during storage. There is therefore an urgent need to tackle this problem headlong through the development and application of safe and cheap botanicals. This forms the next stage of this research.

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COFFEE PROGRAMME

Experimental Title: Competitiveness and the effects of policies on coffee production in Nigeria
Investigator: Oluyole, K.A., Akinpelu, A.O. and Orisasona, T.M.

Introduction

Coffee as a crop is a member of the family *Rubiaceae*, a large family of over 5500 species widely distributed in the tropics. There are three species of coffee grown for commerce, these are *Coffea arabica*, which is highland coffee and it grows very well at altitude of 600m and above, it has a mild taste and is more fragile; *Coffea canephora* (popularly known as *Coffea robusta*), this is more resistant and is lowland coffee thriving best at the altitude range of 0 to 750m above sea level and the third species is *Coffea liberica* which is a mild-altitude coffee thriving best at an altitude of 400m to 600m (Opeke, 2005). However, *Coffea arabica* and Coffee *robusta* are the two major species in Nigeria. *Coffee arabica* produces the best quality of coffee and still supplies the bulk of the world coffee, but it grows well only at cooler air temperature (Akinbode, 1980).

Coffee is used throughout the world and is being brought to most of the countries during colonial period itself. Coffee became a cash crop and provides labor to many people in developing countries (James, 2000). Many of the countries are suitable for coffee production and the agricultural sector supported its planting (Cleland, 2010). One of the previous studies explained the growth habits and ideal conditions for growing coffee plants. Different types like *Coffea arabica* and *Coffea robusta* are in use in almost all countries (Milford, 2004).

Despite the significance of the crop in the world market, its production encountered a downward trend in Nigeria in the last few decades**.** The major challenge was due to low price which being offered by the buyer. However, low price is being offered by the buyers as a result of the type of primary processing method being used by the farmers to process their coffee berries before selling. The impact of this was mainly felt by the producers with little (if any) by the consumers at the end of the marketing chain (Aderolu *et al*, 2014). These assertions were corroborated by (Alli *et al*, 2020) who reported low prices and poor farm management as challenges coffee farmers in Nigeria face. Similarly, this trend caused immense hardship to countries where coffee is a key economic activity, as well as to the farmers who produce it. It was reported that losses resulting from coffee crisis made some producers to fall into debts while some took loans which they found difficult to pay back (CIRAD, 2009). Also, some have eventually been forced to sell their land and transfer their workforce to other farm activities. In many developing countries, low coffee production which resulted from poor pricing implies declining income for farming communities, especially for basics such as food, medicine and education of children thus affecting the general welfare of the coffee farming households. Premise on this, it is therefore, quite imperative that this study investigates the competitiveness and the effect of policies on coffee production in Nigeria.

Methodology

The study was carried out in Kogi State of Nigeria. Agriculture forms the predominant occupation of the populace alongside other vocations like trading, crafts, agro-processing among others. Substantial proportion of coffee production activities takes place in Kogi State of Nigeria. Apart from coffee, other major cash crops grown in the area include cocoa, kolanut, cashew, oil palm, orange, mango etc.

The study employed multistage random sampling technique to select coffee farmers. The first stage involved a purposive selection of Kogi State as a major coffee producing State in Nigeria. The second stage involved a random selection of one Local Government Area (LGA), Ijumu LGA from the selected State. The third stage involved a random selection of 72 coffee producers from the selected LGA. Structured questionnaire was used to collect information from the selected respondents. The data retrieved from the information collected were analysed with the use of Policy Analysis Matrix (PAM). PAM is a product of two accounting identities, profitability, defined as the difference between revenue and cost while the other measure the effect of the divergencies (distorting policies and market failures) as the difference between observed parameters and parameters that would exist if the divergence were removed (Monke and Pearson, 1989).

Private Profitability (PP) as well as Private Cost Ratio (PCR) were used to measure competitiveness of coffee production in the study area while Social Profitability (SP), Domestic Resource Cost (DRC) and Social Cost Benefit ratio (SCB) were used to measure comparative advantage.

Private Profitability (PP) – This demonstrates the competitiveness of the marketing system given current technologies, prices of input and output and policy.

$$\prod = P_0 Q_O - P_i Q_i$$

$\prod$ = Private Profit;

$P_o q_o$ = Value of output produced at private prices; $P_i q_i$ = Value of inputs used at private prices.

Private Profit < 0 shows that the product is not competitive given current technologies, prices of inputs and outputs; Private profit = 0, operators are earning normal profit while private profit > 0 implies that the product is competitive given current technologies, prices of inputs and outputs, and policy.

Private Cost Ratio (PCR) - This shows the private efficiency of the marketing channels and is an indication of how much one can afford to pay domestic factors (including a normal return to capital) and still remain competitive.

$$PCR = \frac{\sum a_{ij} P_k{}^p}{Y_i{}^p P_i{}^p - \sum a_{ij} P_j{}^p}$$

$\Sigma a_{ij}P_k{}^p$ = Cost of domestic factors at private prices; $Y_i{}^pP_i{}^p$ = Revenue at private prices;

$\Sigma a_{ij}P_j{}^p$ = Cost of tradable inputs at private prices.

PCR < 1 indicates that the product is highly competitive; the PCR > 1 implies entrepreneurs are making losses while PCR = 1 indicates the breakeven point.

Social Profitability (SP) – The social profit reflects social opportunity costs and it measures efficiency and comparative advantage.

$$SP = \sum Y_i{}^s P_i^s - (\sum a_{ij} P_j{}^s + \sum a_{ij} P_k{}^s)$$

SP = Social profit; $\Sigma a_{ij}P_j{}^s$ = Cost of tradable inputs at social price;

$\Sigma Y_i{}^sP_i{}^s$ = Revenue at social price; $\Sigma a_{ij}P_k{}^s$ = Cost of domestic factors at social price.

A positive social profit indicates that the system uses scarce resources efficiently and contributes to national income (Nelson and Panggabean, 1991; Keyser, 2006), hence, the commodity has a comparative advantage. A negative social profit indicates social inefficiencies and suggests that production at social costs exceeds the costs of import, thus indicating that the sector cannot sustain its current output without government intervention at the margin.

Domestic Resource Cost (DRC) – The DRC indicates how much domestic resources are needed to generate an additional value of export revenue. It is a measure of relative efficiency of domestic production by comparing the opportunity of domestic production to the value generated by the product (Tsakok,1990).

$$DRC = \frac{\sum a_{ij} P_k{}^s}{\sum Y_i P_i{}^s - \sum a_{ij} P_j{}^s}$$

$\Sigma a_{ij}P_k{}^s$ = Cost of domestic factors at social prices; $\Sigma Y_iP_i{}^s$ = Revenue at social prices;

$\Sigma a_{ij}P_j^s$ = Cost of tradable inputs at social prices.

DRC of less than unity indicates efficiency of producing the goods domestically; DRC of more than unity indicates inefficiency in domestic production while a DRC of unity indicates a balance, in which case the country neither gain nor lose foreign exchange through domestic production.

Social Cost Benefit (SCB) - The SCB indicates how much greater the value of output created in relative to the associated cost of production estimated in social prices.

$$SCB = \frac{\sum a_{ij} P_j^{\ s} + \sum a_{ij} P_k^{\ s}}{\sum Y_i P_i^{\ s}}$$

$\Sigma Y_iP_i^s$ = Revenue at social price; $\Sigma a_{ij}P_k^s$ = Cost of domestic factors at social price.

A ratio less than one indicates that an activity is profitable and a ratio that is greater than one shows that the activity is not profitable (Monke and Pearson, 1989).

However, the effects of government policies on coffee production in the study area were measured with protection coefficients. The protection coefficients used are Nominal Protection Coefficient (NPC), Effective Protection Coefficient (EPC) and Profitability Coefficient (PC).

Nominal Protection Coefficient (NPC) - The NPC is a measure of the extent to which domestic price policy protects the domestic marketers from the direct input of foreign market (Tsakok, 1990). It is the ratio of domestic price to a comparable world (social) price.

$$NPC_o = \frac{P_o^{\ p}}{P_o^{\ s}}$$

P_o^p = Private (domestic) price on output; P_o^s = Social (world/border) price on output.

Nominal Protection Coefficient on output (NPCo) measures the effect of policy intervention on output prices. NPCo less than one indicates that domestic farm gate price is less than the international price for output and that policies were decreasing the market price. Hence, there is negative protection on output and this confirms the presence of taxes or any other policy that is detrimental to the realization of the maximum output while NPC greater than one indicates the presence of subsidies. It shows that the private price of the goods has been kept higher than the border price. This means that government policies provide incentives to the local producers of the goods thus enabling the producers to realize the maximum output.

Effective Protection Coefficient (EPC) - EPC is the ratio of the difference between the revenue in private price and cost of tradable inputs in private price to the difference between the revenue in social price and the cost of tradable inputs in social price. Hence:

$$EPC = \frac{Y_i^{\,p} P_j^{\,p} - \sum a_{ij} P_j^{\,p}}{Y_i^{\,s} P_i^{\,s} - \sum a_{ij} P_J^{\,s}}$$

$Y_i^p P_i^p$ = Revenue in private price; $\Sigma a_{ij} P_j^p$ = Cost of tradable inputs in private price;

$Y_i^s P_i^s$ = Revenue in social price; $\Sigma a_{ij} P_j^s$ = Cost of tradable inputs in social price;

An EPC greater than one suggests that government policies provide positive incentives to producers and hence the production of such goods are encouraged through introduction of subsidies and reduction or an outright withdrawal of tax while EPC that is less than one implies producers are not protected through policy intervention, hence producers face high taxation.

Profitability Coefficient (PC) - The PC shows the impact of all transfers on the profitability. It is an extension of the EPC to include factor transfers. It measures the incentive effects of all policies and thus serves as a proxy for the net policy transfer.

$$PC = \frac{Y_i^{\,p} P_i^{\,p} - (\sum a_{ij} P_i^{\,p} + \sum a_{ij} P_k^{\,p})}{Y_i^{\,s} P_i^{\,s} - (\sum a_{ij} P_i^{\,s} + \sum a_{ij} P_k^{\,s})}$$

$Y_i^p P_i^p$ = Revenue in private price; $\Sigma a_{ij} P_j^s$ = Cost of tradable inputs in social price;

$Y_i^s P_i^s$ = Revenue in social price; $\Sigma a_{ij} P_k^p$ = Cost of domestic factors in private prices;

$\Sigma a_{ij} P_j^p$ = Cost of tradable inputs in private price; $\Sigma a_{ij} P_k^s$ = Cost of domestic factors in social price.

PC > 1 = Policy transfer income into the production system;

PC < 1 = Policy transfer income away from the production system.

Results and Discussion

Table 1 shows the socio-economic characteristics of coffee farmers. The table shows that the mean age of the farmers is 61 years. This shows that most farmers are aged. This is a negative implication to coffee production as some of the farmers will not have the needed strength to do farm work. There is a need to encourage youth into coffee production in the study area. The table also shows that none of the farmers has more than two hectares of farm, even about 55.6%

of them do not have up to one hectare. All these translate to the fact that all the farmers there are small scale farmers. The average age of coffee farms in the study area is about 30 years. This indicates that most farms are old and are due for rehabilitation. About 66.7% of the farmers are formally educated. This is a good indicator towards an increased productivity as farmers will be able to read and interpret the result of any innovation given to them.

Table 1: Socio-economic variables of the respondents

Variables		Frequency	Percentage
Age of respondents (Years)			
≤ 40		8	11.11
41-50		16	22.22
51-60		8	11.11
> 60		40	55.56
Total		72	100.00
Mean	61		
Marital Status			
Single		0	0
Married		64	88.89
Widow/widower		8	11.11
Total		72	100.00
Educational Status			
Non-formal education		24	33.33
Primary education		16	22.22
Secondary education		8	11.11
Tertiary education		24	33.33
Total		72	100.00

Association membership		
Member	48	66.67
Non-member	24	33.33
Total	72	100.00
Cropping System		
Sole Coffee cropping	16	22.22
Coffee/arable cropping	40	55.56
Coffee/tree cropping	16	22.22
Total	72	100.00
Farm size (Ha)		
< 1	40	55.56
1-2	32	44.44
Total	72	100.00
Age of Coffee farm (Years)		
≤ 10	8	11.11
11-20	24	33.33
21-40	24	33.33
> 40	16	22.23
Total	72	100.00
Mean 30		

Source: Field survey, 2023.

The result of private profitability of coffee production among coffee producers is shown in Table 2. The result showed that coffee farmers had positive private profit of ₦7,711.78 per hectatre. The result showed that the private profit for the farmers is positive. This implies that coffee production in the study area is competitive given current technologies, prices of inputs and outputs and the prevailing policies. Also, the coffee farmers are earning financial gains and can produce coffee without any assistance from the government. The result of Private Cost Ratio (PCR) indicated that coffee production by coffee farmers had a PCR of 0.42. The result showed that coffee production among the coffee farmers had PCR less than one. This shows that coffee production among coffee farmers is competitive given current technologies and the prevailing policies. Hence, the farmers are earning profit and can be able to pay for the domestic factors and the productive activities would still be competitive. The coffee producers were able to achieve this because their private factor costs were less than the value added in private price.

Table 2. Competitiveness of coffee production among coffee farmers

Indicators	Value
Private Profitability (PP)	₦7,711.78
Private Cost Ratio (PCR)	0.42

Source: Field survey, 2023.

The result of the analysis of social profitability is shown in Table 3. The result showed that coffee producers had social profit of ₦43,718.50 per hectare. The result showed that coffee producers had positive social profit. This shows that coffee production in the study area is socially profitable. Hence, the coffee producers in the study area are utilizing scarce resources (such as labour and capital) efficiently in the production of cocoa. This also means that coffee production by coffee farmers can survive without government interventions. The result of the analysis of Domestic Resource Cost showed that coffee producers had DRC of 0.12. From the result, it was discovered_that the DRC for coffee production was less than one. This indicates that there is efficiency in the production of coffee domestically. It shows that the value of domestic resources utilized in coffee production is lower than the value added and therefore there's an efficient use of domestic resources in coffee production. Coffee production is therefore said to be economically profitable and is having a comparative advantage. The result of the analysis of SCB showed that coffee production had SCB of 0.43. The result shows that the SCB of coffee production for coffee producers was less than one indicating that the sum of both the tradable inputs and domestic factors costs are less than the gross revenue under the prevailing production conditions. Coffee production among coffee producers is therefore profitable. However, the lower the SCB, the higher the degree of efficiency of the system.

Table 3. Comparative Advantage of Coffee Production Among Coffee Producers

Indicators	Value
Social Profitability (SP)	₦43,718.50
Domestic Resource Cost (DRC)	0.12
Social Cost Benefit (SCB)	0.43

Source: Field survey, 2023.

The result of the analysis of Nominal Protection Coefficient on Table 4 showed that the NPC for coffee producers was 0.41. It could be observed from the result that the producers had NPC of less than one. This indicates that the domestic price of coffee is less than the border price. Therefore, there's negative protection on the domestic price of coffee beans and there's disincentive on output prices as it relates to producers. This confirms the presence of taxes or any other policies that are detrimental to the realization of maximum revenue from coffee production. The table further showed that the Effective Protection Coefficient (EPC) for coffee production was 0.27. The result showed that the EPC for coffee production was less than one. This shows that the value added at the market price was lower than the value added at the international price. Hence, the coffee producers are not protected through policy intervention. The result of the analysis of Profitability Coefficient (PC) showed that the PC for coffee producers was 0.18. The PC for the coffee producers was less than one. This indicates that the private profit was less than the profits evaluated at the world reference price. Hence, there's lack of incentive in the marketing system.

Table 4. Protection Coefficients on Coffee Production among Coffee Producers

Indicators	Value
Nominal Protection Coefficient (NPC)	0.41
Effective Protection Coefficient (EPC)	0.27
Profitability Coefficient (PC)	0.18

Source: Field survey, 2023.

Conclusion and recommendations

Coffee production was privately profitable. This was indicated by the findings from the analysis of Private Profitability and Private Cost Ratio. There was comparative advantage in producing coffee in Nigeria as revealed by the result of the analysis of Social Profitability, Domestic Resource Cost and Social Cost Benefit. However, the existing government policies on agriculture did not protect coffee production as indicated by the result of the analysis of Nominal Protection Coefficient, Effective Protection Coefficient and Profitability Coefficient. Hence, resources were diverted away from the system and the system was taxed.

The study recommended that efforts should be made on the part of key stakeholders in the agricultural and coffee subsector to strengthen subsidizing agricultural inputs to coffee farmers. This is quite imperative because findings from NPC, EPC and PC have shown that farmers were not deriving incentives (such as subsidized inputs) from government policies.

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Experimental Title: Demonstration of mechanical primary processing of coffee in selected growing states

Investigator: Adeleke, S. A. and Abdul-karim, I. F.

Introduction

Coffee is one of the major economic agricultural produce which serves as a mean of income to many nations and farmers worldwide. About half of Africa countries produce coffee which makes it a strategic crop. Among 36 states in the country, 22 are producing one type of coffee or the others while 13 out of these states are on commercial production. Robusta (*coffea canephora*) and Arabica (*coffea arabica*) are the commonest grown among Nigerian farmers and globally, based on the climatic conditions. Robusta is commonly grown in relatively low altitude of the Southwest and North central,.There are different types of coffee which are genetically different in term of taste, size and shape but are very similar in many aspects. Generally, coffee fruit consists of exocarp (pulp), mesocarp (mucilage), endocarp (parchment or hull), spermoderm (testa or silver coat), endosperm (albumen) and embryo, made up of two cotyledons. These components dried together to give husk and bean (dicotyledons) which can be separated manually or mechanically. Dry method involves sun-drying fully ripe coffee cherries at most 48 hours after harvesting to prevent Ochratoxin Aand mould growth which will result in deteriorating beans quality. Wet/washed and dry/natural are the two common processing methods. Wet requires more resources and labour input; it is adopted where water is available and depending on tradition. Proper attention and nutritious soils can produce quality coffee beans rarely found in wet method using dry method. In Nigeria, dry method is usually employed for processing *C.canephora* (Robusta) which is most common as it thrives well in many lowland areas. The use of pestle and mortar has been the common traditional way of removing pulp/husk from coffee cherries in Nigeria as mechanical means of processing are relatively scarce. This approach is very laborious with attendant drudgery and time wastage. Appropriate processing machines will not only reduce drudgery, but bring about timely processing and improve quality of beans which will culminate in increased production and utilization of local coffee.

Objectives

To encourage improved primary processing of coffee cherries for better production and utilization in Nigeria.

Materials and Methods

Fresh Robusta coffee cherries were harvested from the plantations of CRIN at Ibadan. The Cherries were sorted, soaked, pulped and dry following the acceptable standards of wet and dry methods. A motorized dehusker developed in CRIN and a manual pulper were used to demonstrate dry and wet methods of coffee cherries processing respectively to farmers at Omuo-Ekiti, Ekiti State. Structured questionnaires were given to the farmers to request for their opinions on salient aspects of mechanical primary processing of coffee berries.

Results and Discussion

A large turn-out of about 50 farmers was recorded at the event. General standard procedure of primary processing for the two popular methods was also explained to the participants. The farmers expressed their pleasure about the possibility of handling pulping and husking operations mechanically. They expressed the availability of market for their produce as a major problem. They solicit for the support of CRIN for availability of seedlings and financial assistance. Analysis of data collected through the questionnaires is in progress.

Conclusion

Coffee pulping and husking operations were performed mechanically in the presence of the farmers.

Experimental Tittle: Role of pathogens in coffee seedling/cutting production failure and their control using botanical alternatives

Investigator: Ayanwole, S., Orisajo, S. B., Okeniyi, M. O., Otuonye, A. H., Ogundeji, B. A., Omoleye and Oladigbolu, Y. O., Olaoye and Olorunleke

Introduction

The coffee plant or tree is a woody perennial tree crop. Coffee beans are the seeds of the coffee plant, which are found inside the coffee berry or cherries .As with most crops, coffee is beset with insect pest and disease problems such as the coffee berry borer, coffee berry disease, white coffee stem borer, coffee wilt disease, parasitic nematodes, root mealy bug, green scales, leaf rust, and brown eye spot. Some can be very serious and can have a major impact not only on individual farmers but on the economy of countries or regions heavily dependent on coffee for foreign exchange earnings and importing countries worldwide (IITA, 2023).

A number of diseases can affect coffee plants in the nursery as seedlings, in the field while young and later as bearing trees. Prominent among coffee nursery diseases include damping-off and *Cercospora* leaf spot (brown eye spot). Damping off (browning/rotting of seedling stems), caused by a complex of soil-inhabiting *fungi* such as *Rhizoctonia solani* and *Pythium* spp. occurs on young coffee seedlings in the germination bed, after germination and before transplanting. *Cercospora* leaf spot on the other hand, occurs on leaves when plants are under stress. The fungus can develop both in seedbeds and after plants have been transplanted into bags. It is the most common nursery disease and a sign of poor management. The disease is characterized by brown spots on both sides of the leaves gradually expanding with reddish brown margin. When the spots are many, the leaves appear to have been burnt. Although there are beliefs in some quarters that this disease must have been as a result of excessive shade, too much sun (dry spell) and lack of nitrogen and potassium, the disease has been found to be greatly mediated by soil pathogen(s) (FAO, 2023). Coffee diseases have however led to seedling losses of up to 80–100% and final yield loss of up to 30% (FAO, 2023), which if left unabated, would send coffee farmers and other stakeholders along the value chain out of business.

In a bid to correct the huge losses due to the aforementioned coffee nursery diseases, farmers have resulted in the use of synthetic chemicals such as soil drenches of either Benlate (Benomyl) or Captan Copper sprays (copper cupravit (85% WP), copper oxychloride and copper hydroxide), in addition to some cultural practices like avoiding over-watering, maintining 50% shade cover, etc. The use of chemical treatments, contribute greatly to heavy metal contamination of both the soil and crop, and have in many instances, led to the reduction of the soil pH which have often made coffee seedlings and/or its cuttings more susceptible to fungal attacks (Craig, *et al.*, 2015).

Objectives

In view of the above, this research is therefore aimed at determining the specific roles of fungal pathogens in coffee seedlings/cuttings production with a view to developing botanical/biological alternatives for their control.

Materials and Methods

Infected coffee leaves and soil samples were obtained from coffee plots in Oyo State and transported in sterile Ziploc bags, to the Mycology Laboratory, Plant Pathology Section. The samples were inoculated in freshly prepared potato dextrose agar (PDA) and incubated at $30 \pm 2^{o}C$ for 5-7 days. The isolated fungi were sub-cultured and identified using standard laboratory methods. Some of the botanicals (neem, Siam weed, and scent leaf) to be used for the control of the implicated pathogens were thereafter collected from the premises of CRIN headquarters for further studies.

Results and Discussion

Out of the five fungi isolates obtained from soil samples collected from the coffee plot, four- *Aspergillus niger* (45.45%), *Pythium* sp. (27.27%), *Fusarium* spp. (18.18%) and *Colletotrichum* spp. (9.09%), were isolated from the infected coffee leaf samples, while only two- *A. niger* (85.71%) and *Penicillium* spp. (14.29%),were isolated from the infected coffee berry samples (Table 1). This suggests that the isolates found on the coffee leaf and coffee berry samples must have come from the soil on the ground of the coffee plot. The coffee leaf samples however seem to be more exposed or susceptible to more of the soil fungi than the berries. Besides, the coffee leaves tend to stay longer on the tree than the berries. Hence, the greater exposure.

Table 1: Occurrence of fungi associated with coffee samples

Coffee samples	**Percentage occurrence of fungi isolates (%)**				
	A. niger	*Fusarium* spp.	*Pythium* sp.	*Colletotrichum* sp.	*Penicillium* spp.
Coffee leaf	45.45	18.18	27.27	9.09	-
Coffee berry	85.71	-	-	-	14.29

Soil	20.00	20.00	20.00	20.00	20.00

Conclusion and Recommendation

Findings from this preliminary study show that fungi associated with various coffee leaf or berry infections are of soil origin, and that the coffee leaf, due to several factors, harbor or are susceptible to more of the pathogens. Further work however still need to be done to ascertain their pathogenicity.

Experimental Tittle: Improving method of Coffee Seed Processing: Reducing Drudgery for Large Scale Production

Invistigator: Adeleke, S. A., Baba Nitsa, M., Oloyede A. A. and Idrisu, M.

Introduction

Coffee is one of the agricultural products that is of economic importance and serve as a means of income to farmers (Muleta, 2007). In Nigeria, many farmers established their coffee plantation using seedlings derived from seeds. Coffee cherry is a drupe containing two flat seeds which are used for propagation. Germination of the coffee seeds under field condition is defined as emergence of seedling from soil, with radicle extending downward. Report of had revealed that presence of the endocarp delay early germination of coffee seeds and its removal will initiate timely germination. Da-Silva et al., (2004), carried out studies on the mechanism and regulations concerning coffee seed germination. It was observed that parchment causes the cell wall not to expand on time or making surrounding endosperm from being in active (Da-Silva et al., 2004).
Coffee cherries can be processed after harvest by the removal of both the pulp and hulk either by dry, wet or semi-dry method (Mussatto et al., 2011). Mucilage is removed by fermentation, followed by washing or machines processes (Brando and Brando, 2015). Selmar *et al.*, (2006), reported that germination process of coffee seeds start after post-harvest processing which involved removal of fruit flesh (pulp) either manually or mechanically. They further corroborated their findings through the use of germination-specific isocitrate lyase (ICL) test with b-tubulin, a maker for cell division or elongation (Selmar *et al.*, 2006).

Traditionally, the exocarp (pulp) is manually removed during seed processing by farmers as it is widely been practiced and believed to be devoid or at least reduces seed damage. Traditional coffee processing method of de-pulping requires soaking of cherries, use of mortar and pestle or even matching or tramping on cherries to remove pulp. This is followed by separation of pulps from the beans (scooping) and drying of beans. Unfortunately, the process is very tedious with attendant, drudgery and low work rate, specifically separation of pulp (scooping) is very difficult and discouraging. Damage is a very vital index to be considered in seed production approach. Improved process of pulping coffee cherries using mechanical methods with the aim of reducing labour, time and cost should be focused for the purpose of increasing coffee production **(**Weinberg *et al.*, 2001). According to Murthy and Naidu (2011), removal of pulp from fresh berries; using a pulper is one process to achieve increased coffee seed production. The use of machine has been immemorial for increased efficiency and for large scale production with little or no drudgery. Proper understanding of coffee seed germination will help in improvement of agricultural activities and increase in production of coffee needed for international market. Work done on coffee seed germination with regards to seed production using mechanical pulper is very scarce considering the economic important of coffee crop in the world market. Hence effort should be intensified toward processing coffee seeds (*C. canephora* L.) for planting using mechanical pulpers. The purpose of this study is to determine the effectiveness of coffee seed production using mechanical pulpers. It is therefore necessary to compare usual traditional manual method of pulping with mechanical method to ascertain whether mechanical pulper can be injurious to seed production. Findings from this study will provide basic information needed for large scale coffee seed processing and production through mechanical pulper which will also encourage development of improved machines and techniques for increased viable seed production.

Materials and Methods

Ripe matured robusta coffee cherries were harvested and unripe and dried cherries were sorted to obtain good ones. Three genotypes of C. *canephora* were harvested from CRIN plantations. Harvested cherries were de-pulped using manually-operated mechanical pulper and I.C engine powered mechanical pulpers while the traditional manual method of mortar and pestle commonly used was the control. The standards procedures of wet processing method of soaking, depulping and separation of pulp were followed. Wet coffee beans obtained were air dried for about one week to average moisture content of 3.18% d.b.; good (undamaged) seeds were selected and planted on pre-nursery on a seedbed mixed with sawdust.

The drum pulper consists of a perforated cylinder rotating against an adjustable plate and a fixed plate where depulping (through abrasion force) and separation take place respectively. The cylinder is rotated by hand through a handle joined to a wide flywheel. The engine powered pulper is a screw shaft rotating inside a cylinder lined with metal plate and operated by a medium petrol engine. Depulping occurred through rupturing and shearing actions of the cylinder, screw and plate. The pulp was then separated manually from the beans. Equal weights of each genotype of cherries were fed into the pulpers at the appropriate feed rates and machine speeds which were pre-determined before the actual operations. Each treatment was replicated thrice. The same procedure was also applied to the manual depulping.

Equal weights of 20g of seeds from each replicate of the genotypes were planted on pre-nursery bed in Complete Randomized Block Design (CRBD) in 3 replicates. Necessary nursery practices such as watering at regular intervals, weeding, shade replacement and prevention from rodents were observed during the experimental period. Data was taken on germination count at 3 days intervals for about 3 months. Healthy and well grown germinated seeds were transplanted (at one seed per bag) into black polythene bags filled with loam soils and arranged under the shade in a complete randomized design (CRD). Watering and weeding were carried out at regular intervals. Data were taken on plant architecture including height, leaf length and width, leaf number and stem girth of the seedlings at regular intervals for the period of 3 months.

Results and Discussion

Both the seed germination rate and percentage were affected by de-pulping methods and genotypes as indicated by Tables 1 and 2. This was also true of agronomic characters such as leaf number and plant height, but these were not significantly different as in Tables 3 and 4. But, both C2 and C4 genotypes showed the highest means of about 9.7 and 11cm respectively for leaf numbers and plant height for MM, while genotype DE had the lowest mean values of 8.6 and 9.3cm for these agronomic parameters and the method of pulping. Engine powered (motorized) pulper were significantly different from other methods in respect to germination rate, having the least mean of 29.67 for MMC2. However, germination percentage was not different significantly for all the treatments while MMC2 had the lowest mean of 33%. Genotype DE had the highest mean of 44 and 54% for engine powered (motorized) pulper (MM) in terms of germination rate and percentage respectively. Manually operated mechanical pulper gave the highest germination rate of 65.3 and germination percentage of 56.2% for DE genotype. The implication is that germination rate was somehow affected by methods of pulping while percentage germination was not seriously affected by the three pulping methods studied. Manual mechanical pulping machine showed the best performance for germination rate and percentage. This may be caused by removal of endocarp layer by the machine which had been earlier reported as a factor to improve germination (Rosa et al, 2005 and Da-Silva et al, 2004). Genotypes can also determine both the rate and percentage of germination; this may be due to difference in genotypes sizes which may be affected by the clearance of the pulping unit of the machine, resulting in possible bruises and damage to the seeds. Although, pulping methods tested did not seriously affect agronomic characters, the trend of response by the genotypes in the nursery indicated that engine powered pulpers may have best developmental quality which is also affected by the genotype itself (probably seed size). Descriptive statistics indicated mean values range of 1.62mm for stem girth to 225.2 for leaf area factor, while the highest maximum value (1144.5) was greater than grand mean (256.15).

Conclusion

Mechanical pulpers compare favourably well with common traditional method of mortar and pestle for coffee seed processing considering relevant germination parameters and agronomic characters. It is therefore possible to handle effective production of large quantity of seeds through this method involving labour and time saving. But the design of the machine mechanisms and components plays a vital role in effective performance of such machine to avoid bruises and damages. Variation in crop genotypes also needs to be considered in such machine design.

Table 1: Comparison of Seed Germination Rate

Treatments	N	Mean	Grouping		
MNDE	3	65.3333	A		
MTC4	3	61.3333	A	B	
MNC4	3	58.6667	A	B	
MTC2	3	58.6667	A	B	
MTDE	3	52.3333	A	B	C
MNC2	3	51.3333	A	B	C
MMDE	3	44.0000	A	B	C
MMC4	3	39.0000		B	C

MMC2	3	29.6667	C

*** Means that do not share a letter are significantly different.*

Table 2: Comparison of Seed Germination Percentage

Treatments	N	Mean(%)	Grouping
MNDE	3	56.1986	A
MTC2	3	54.3322	A
MMDE	3	54.0114	A
MNC4	3	49.8430	A
MTC4	3	48.5491	A
MNC2	3	47.9575	A
MMC4	3	45.3128	A
MTDE	3	42.9153	A
MMC2	3	33.0025	A

*** Means that do not share a letter are significantly different.*

Table 3: Comparison of LN

Treatments	N	Mean	Grouping
MMC2	18	9.72222	A
MMC4	18	9.66667	A
MNDE	18	9.55556	A
MTC4	18	9.27778	A
MTDE	17	8.58824	A
MMDE	18	8.55556	A
MNC4	18	8.33333	A
MNC2	18	8.23889	A
MTC2	18	7.94444	A

*** Means that do not share a letter are significantly different.*

Table 4: Comparison of PH

Treatments	N	Mean(cm)	Grouping	
MMC2	9	11.6222	A	
MMC4	9	11.0444	A	B
MTDE	9	10.3778	A	B
MTC4	9	9.6667	A	B
MNC4	9	9.5111	A	B
MNC2	9	9.3556	A	B
MMDE	9	9.2778	A	B
MNDE	9	8.7667	A	B
MTC2	9	7.9333		B

** *Means that do not share a letter are significantly different.*

** MN – Manual pulper, MT - Mortar and pestle, MM – Engine powered pulper, C2, C4 and DE are different genotypes

Table 5: Estimation of mean and range of agronomic characters

Variables	Mean	Minimum	Maximum
PH (cm)	9.73	4.50	16.20
SG (mm)	1.62	0.64	2.680
LN	7.12	2.00	10.30
LL (cm)	8.82	2.20	14.00
LW (cm)	3.67	1.20	14.20
LAF	225.2	32.8	1144.5
Total	256.15		

** PH – Plant height, SG – Stem girth, LN – Leaf number, LL – Leaf length, LW – Leaf width, LAF – Leaf area factor

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A.Coffee seeds in the pre-nursery during germination

Germinated coffee seeds in the nursery   C. Growing coffee seedlings in the nursery

Experimental Tittle: Marketing Efficiency and Profitability Analysis of Coffee among Farmers in South West Nigeria

Investigator: Adesida F.A., Oluyole, K.A and Oladokun Y.O.M.

Introduction

Coffee which is referred to as a food drink is prepared from roasted coffee beans. However, roasted coffee beans are obtained from coffee plants which are evergreen shrubs or trees classified in the large family Rubiaceae. The tree could reach a height of up to 5 meters when not pruned. The leaves of coffee trees have dark green coloration and glossy in nature.

Coffee trees are cultivated in more than 70 countries of the world, primarily in the equatorial regions of the Americas, Southeast Asia, the Indian subcontinent, and Africa. However, the two most commonly grown coffee bean types are Coffee arabica and Coffee robusta. Coffee drinks which is produced from the roasted beans has dark color, bitter taste and slightly acidic. Coffee contains caffeine, a stimulant that is known for its ability to stimulate the central nervous system and also reduce fatigue and serves as energy boost. However, coffee is regarded as the most popular hot drink globally (Coffee Report, 2022). Coffee is taken as a brewed beverage that is prepared from the roasted seeds. The coffee beans, are contained in berries that, once matured, are processed and dried.

Coffee is an important cash crop and it plays a huge role in the economies of many nations globally Nigeria inclusive (Mustopha et al., 2022). It functions as a source of export and foreign exchange generation (Musoli *et al.*,2009). Over one hundred million people in developing countries depend on coffee as their primary source of income. (Ndayitwayeko *et al*., 2014).

Marketing efficiency involves the distribution of agricultural products from farmers to the final consumers. It also helps to determine the difference in the prices farmers give products out with that paid by the final consumers. Marketing is one of sub-systems which is very essential to ensure the successfulness in agriculture. Marketing efficiency is the measure of market performance. It can be defined as the maximization of the ratio of output to input in marketing.

Value addition to raw coffee beans is necessary to increase the market value. There is however the need to evaluate the marketing efficiency of coffee in south-west Nigeria.

Marketing Concepts

Though there is no universally accepted definition of marketing. Marketing involves strategically planning the production, pricing, promotion, and distribution of ideas, goods, and services to facilitate exchanges that meet individual and organizational objectives (AMA, 1995, as cited in Kotler, 2003). There are two main categories of marketing definitions: classical (narrow) and modern (broad). Classical definitions focus on the physical movement of goods and services, emphasizing the flow from producer to consumer, while modern definitions encompass a more comprehensive approach.

Kotler (2003) defines marketing as a societal process in which individuals and groups obtain what they need and want through creating, offering, and freely exchanging products, services, and value. Rodger (1971), cited in Barker (1989), offers a definition applicable to most agricultural systems, stating that marketing is the primary management function that organizes and directs business activities to convert consumer purchasing into effective demand and move products or services to the final customer to achieve company-set objectives.

Market is defined as "a particular group of people, an institution, a mechanism for facilitating exchange" (Solomon, 2002). The concept of perfect market, used by economists as a benchmark, evaluates deviations from its specifications, considering factors like communication among buyers and sellers and the substitutability among goods (John and Sathan, 1988, as cited in Demeke, 2007).

The marketable coffee supply in Ethiopia is forecasted to reach 343,352 metric tons, with an export market generating over 1.2 billion US dollars (Alemseged & Getaneh, 2012/13). Coffee types with unique characteristics, such as Sidamo, Yirgachefe, Hararge, Gimbi, and Limu, command premium prices in both domestic and international markets due to their distinct quality and appropriate processing approach (ITC, 2002, as cited in Anwar, 2010).

Objectives of the Study

The main objective of the study is to evaluate the profitability and marketing efficiency of coffee in the study areas.

The specific objectives are to

1) Assess the socioeconomic characteristics of coffee farmers in the study area.
2) Determine the profitability of coffee production, processing and marketing in the study area.
3) Identify the constraints militating against coffee production, processing and marketing in the study area.

Materials and Methods

Study Area:

This research work was carried out in Kogi State Nigeria due to the presence of many coffee farmers and processors in this state. Multi-staged sampling technique was employed for the random selection of the coffee farmers. The first stage involved purposive selection of Kogi State while the second stage involved the selection of two local government areas within the State where coffee is produced in abundance. The third stage involved the selection of two villages within each local government area where coffee farmers reside. Well structured questionnaire was developed and administered to the coffee farmers to elucidate vital information as regards their socioeconomic characteristics as well as coffee production, processing and marketing in the study area. Sixty questionnaires were administered. Data obtained from this exercise were subjected to statistical analysis.

Data Collection

Data was collected with the aid of well-structured questionnaire. Data collected included: gender, age of coffee farmers, educational status, marital status, years of experience in coffee farming and marketing, variety of coffee grown, family size, total size of coffee farms, sources of farm labour, source of finance, quantity of coffee produced in year 2022/23,quantity of coffee sold and so on.

Analytical Techniques:

The analytical techniques used included descriptive statistics, gross margin analysis. Gross margin analysis was used to determine the profitability of the enterprise. Gross Margin analysis was used to estimate the cost of production and processing as well as the revenue generated from the sales of processed coffee beans.

G.M = GR – TVC

Where G.M = Gross Margin

GR = Gross revenue

TVC = Total variable cost

Results and Discussion

Table 1: Socioeconomic Characteristics of Respondents

Variables	Frequency	Percentage
Sex		
Male	16	26.67
Female	44	73.48
Age		
30-39	2	3.34
40-49	2	3.34
50-59	28	46.76
60-69	26	43.42
70-79	2	3.34
Mean Age = 57		
SD = 7.6		
Marital Status		
Single	0	0
Married	50	83.50
Widowed	8	13.36
Divorced	2	3.34
Educational Status		
No Formal Edu	4	6.68
Primary	8	13.36
Secondary	14	23.38

Tertiary	34	56.78
Farming experience		
1-10	12	20.04
11-20	8	13.36
21-30	16	26.72
31-40	20	33.40
41-50	4	6.68
Mean = 25		
SD = 12.8		
Farm Size(acre)		
1-4	52	86.84
5-8	4	6.68
9-12	4	6.68
Mean = 2.8		
SD = 2.4		
Family Size		
1-4	4	6.68
5-8	42	70.14
9-12	14	23.38
Mean = 6.8		
SD = 2.1		

Field Survey,2023

Table 1 above shows the socioeconomic characteristics of the sampled coffee farmers. Socioeconomic characteristic such as ages of farmers, sex, marital status, family size, level of education and so on are very critical to decision making and performances of the farmers. From the table, most of the coffee farmers are between the ages of 50-59 with average age of 57. Majority of them 33.4% have between 31-40 years experience in coffee farming. In fact some of these farmers alluded to the fact that they started working on their parents coffee farms from their childhood. The implication of this is that they are well versed in coffee farming. On the contrary, they may not be energetic enough to carry out tedious work associated with coffee farming and also be enthusiastic or interested in long time investment in coffee plantation. This might however lead to low output of coffee in the future. Most of the farmers are married (83.5%) with average family size of 6 people. The implication of this is that family labour may be available or be a potential asset for coffee production in Nigeria. Majority of the sampled farmers (57%) had tertiary education which means they would be able to understand and utilize technical and market information about coffee. This would inevitably go a long way to boost the production of this crop in the area as long as new technologies and market information are made available to these farmers. The average farm size for coffee production of the sampled farmers is 2.8 acres which shows that majority of them cultivate less than 4 acres implying that coffee is still produced at low scale in Nigeria which could be as a result of small farm holdings in the country.

Majority of the sampled coffee farmers were female (73.48%). This is contrary to the general belief that the male folks dominate coffee production in Nigeria due to cultural restraints that deprive women right to land inheritance or ownership. The above result could also be as a result of renewed efforts by the government to involve women in agricultural production.

Table 2: Variable cost and cost of Processing of Coffee

Variables	Total Cost(N)	AverageCost (N)
Weeding	178800	2980
Chemicals	239000	3983
Harvesting	178800	2980
Processing	106200	1770
Transportation	99600	1660
Others	68400	1140
Grand Total	870800	14513

Field Survey, 2023

Table 2 above shows the total variable cost incurred by the 60 coffee farmers on weeding and agrochemicals as well as cost of harvesting, processing, transportation and other cost incurred in the course of their production. The total cost of weeding by incurred by the 60 coffee farmers was N178,800 while the average cost of weeding (per each farmer) was N2980. Also, the total cost of harvesting, processing and transportation of the coffee produce by the 60 coffee farmers are N178,800, N106,200 and N99,600 respectively. Their average costs are also indicated in table 2 above.

Table 3 below shows the cost and return of the 60 coffee farmers sampled. The total variable cost for the 60 coffee farmers was N870800. This covers cost of weeding, chemicals, harvesting, processing, transportation and other minor costs. The total variable cost per farmer was N14513. The gross income or revenue from sales of coffee by the 60 sampled farmers was N1,314,000 while the income from sales of coffee per farmer was N21,900

Table 3: Cost and Return Analysis

S/no	Items	Amount (₦)
1	Total Variable Cost	870,800
2	Total Variable cost per farmer	14,513
3	Gross income or revenue from sales of coffee	1,314,000
4	Income from sales of coffee per farmer	21,900
5	Gross margin	443,200
6	Gross margin per trader	7,387

Field Survey, 2023

The gross margin which is

Gross Margin = Gross revenue – Total variable cost

GM = N1,314,000 – N870800

GM = N443,200

Gross margin per farmer is

N443,200

60

N7,387

However, considering the average total variable cost of ₦14,513 and the average income per farmer or Income from sales of coffee per farmer of ₦21,900, it could be safely deduced that coffee production is a profitable venture in the sampled areas. The profit level can be increased through the expansion of coffee production and getting better prices for the sales of their produce. Also, to increase the profit level of coffee farmers in the study area, the constraints militating against coffee production must be overcomed. These constraints or problems include old or moribund coffee trees, high cost of farm inputs, finance, problems associated with climate change and so on.

Conclusion and Recommendation

Coffee production is a profitable venture in the study area as shown by the gross margin per farmer of N7,387. Thus, the farmers were able to cover their total operating costs and also made profit. However, considering the total variable cost per farmer of ₦14,513 and gross margin per trader of ₦7,387, it could be safely deduced that coffee production is a profitable venture in the sampled areas. The net profit can be increased by expanding the scope of their coffee production or the quantity of coffee traded in the study areas. The major factor that accounts for the seemingly low profit from coffee production in this area is the low prices of coffee beans as a result of low demand for coffee produced in this area. Further enquiry shows that the coffee farmers and processors in this area use dry method of coffee processing which involves drying the coffee berries in the sun after sorting. This method of coffee processing produces poor quality coffee beans with poor flavor unlike wet processing which produces good quality coffee beans and with better flavor. This invariably leads to very low demand for coffee produced in this area by licensed buying agents or companies involved in coffee export,

In view of this, the following recommendations are given

1) T here should be periodic training organized by governments or companies involved in coffee export for coffee farmers on improved method of processing coffee which is wet

processing method. This will go a long way to improve the quality of coffee produced in this area.

2) Government should advance soft loan to coffee farmers in this area or these coffee farmers should be encouraged to form cooperative societies or join existing associations to obtain loans that help promote the development of their coffee businesses.
3) The average farm size for coffee production of the sampled farmers is 2.8 hectares which shows that majority of them cultivate less than 4 hectares implying that coffee is still produced at low scale in this area which could be as a result of small farm holdings in the country. Therefore these coffee farmers should be encouraged to expand their scope of production by planting more coffee tress.
4) Observation shows that most coffee plants in Nigeria have become aged and surpassed their fruitful age. There is, however, a need to sensitize coffee farmers in the study area to embark on massive rehabilitation of their coffee farms in order for them to obtain better yields. On the other hand, the farmers can engage in complete replanting which involves complete removal of old coffee trees and replanting with young and high yielding and disease resistance cultivars. This would invariably go a long way in increasing coffee production in the area.
5) Coffee farmers in the study area need to be trained on the use of adequate farm inputs such as correct application of recommended fertilizer and other agrochemicals at the appropriate time which would inevitably increase coffee yield. Also, these agrochemicals should be made available to these coffee farmers at subsidized rates.

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Experimental tittle: Assessment of Economic Factors Influencing Cultivar Development among Coffee Farmers in Northcentral Nigeria

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

Introduction

The vast majority of coffee production has its roots in colonialism, during which missionaries or colonialists usually imported the plant. Coffee then became a “cash crop, planted and harvested by serfs or wage laborers on large plantations, then exported to imperial countries” (James, 2000). Consequently, governments, ethnic relations and general ways of life were changed in these countries because of the shift to the new reliance on coffee production. However, with the growth of the United States economy, the market for exporting coffee also expanded. Therefore, coffee became a major source of income for many countries in Central and South America, Africa, and South Asia where colonialism was present and the environment was ideal for coffee trees (Cleland, 2010). Meanwhile, the coffee plant originated in Ethiopia. However, coffee-drinking habits had spread to Europe by the 17th century.

According to Milford (2004) the coffee tree can be grown only in warm areas without frost or sudden temperature shifts, and it also needs plenty of rain. This explains why it is a common export commodity for countries in tropical areas, and an unsuitable one for the rest of the world. Commercially grown varieties are *Coffee Arabica* and *Coffee Robusta*. *C. Arabica* has a mild taste, it is more fragile, and its best growing conditions are found in warm zones or in the highlands of tropical zones. Contrastingly, *C. Robusta* is more resistant and can be grown between sea level and 800 metres above sea level (Milford, 2004).

There is the need to add to the aforementioned characteristic features of these varieties and increase the coffee germplasm in Nigeria, hence the desire to develop new varieties that will be high yielding with very low input, early bearing, resistant to pest and diseases, very good quality traits, and adaptability to climatic conditions of various growing regions of the country. It is then imperative to develop a wholistic package for the development of new coffee varieties as the known varieties need to be improved upon to be resistant to emerging pests and diseases which may be attributed to climatic changes and other factors. Meanwhile, the low input for high productivity of these materials will greatly encourage enhanced coffee cultivation, thus making the venture more profitable and attractive for those involved, while also encouraging others to tap into its production. These and other qualities will encourage farmers to accept the cultivation of these varieties. However, there is a dearth of information on economic factors influencing development of new coffee cultivars for smallholders who depend on it for livelihood. The broad objective of this study is to assess the economic factors influencing cultivar development among coffee farmers in southwest Nigeria.

Specific objectives are to:

1. assess level of awareness of cultivar development among the farmers
2. assess the profitability of existing cultivars among the farmers
3. determine factors influencing cultivar development
4. identify constraints militating against cultivar development in the study area

Methodology

The study employed multistage random sampling technique to select coffee farmers. The first stage involved a purposive selection of Kogi State from North Central Nigeria. The second stage involved a purposive selection of one Local Government Areas (LGA) among the coffee producing LGAs. The third stage involved a random selection of Iyamoye community from the selected LGA based on the volume of coffee production in the area. A total of seventy two (72) coffee farming households were randomly selected. Well-structured questionnaire was used for the primary data. Literatures on previous and similar studies were utilized. Data was analyzed using simple descriptive statistics (means, frequencies and percentages).

Results and Discussion

Table 1 below shows the socio economic characteristics of coffee farmers in Kogi State, Nigeria. These include age of farmers, age of coffee farms, marital status, membership of coffee association, farm size, coffee biotypes, sources of planting materials and selling price. The table revealed that majority (55.56%) of the farmers is above 60 years; about 66.67% of the coffee farms in the study area are above twenty years old. In addition, the table shows that the only coffee biotype prominent in the study area is *Coffee robusta* with about 55.56% of the respondents reporting that they are not satisfied with the yield from this biotype. About 44.44% of the farmers reported that the biotypes are tall while 55.56% associated inadequate marketing channels to the coffee type available in the study area. Furthermore, about seventy eight percent of the farmers sourced their planting materials from fellow farmers and majority of the farmers (55.56%) have between 0.1-1.0 hectare. Also, the table revealed that most of the farmers (66.67%) belong to coffee association and were able to sell their produce between ₦1000-₦1100/kilogramme (kg) with about sixty seven percent of the farmers selling less than or equal to ₦1000/kg.

The results as shown in the table have far reaching implications in the development of new coffee cultivar. Farmers in the study area are old and may not be well disposed to new ideas as they are likely to stick to the attitudinal beliefs of holding on to biotypes they are used to. Similarly, age of the coffee farms may perhaps make it difficult for the farmers to replace with new varieties probably because of the costs incurred on the farms. Also, having a particular biotype of coffee with farmers in the study area implies that the area supports its cultivation; although the tall nature of this biotype and planting materials being sourced from fellow farmers may be responsible for the yield as these materials have been planted over the years and are susceptible to a lot of agronomic factors that may affect farmers' yield. Inadequate marketing channels may perhaps mean that the farmers are not equipped with enough market information thereby selling the produce to any buyer that comes around at low premium. The farm size reported is an indication that the farmers are smallholder as majority of them engaged in coffee/arable cropping system which may perhaps indicate that some of the coffee plantations might have been replaced with arable crops. Hence, the reason for the low sale recorded from the coffee crop. Nevertheless, it was found out that coffee farmers in the study area are desirous of new varieties that will improve their income and livelihood.

Conclusion and Recommendation

This study shows the economic factors influencing cultivar development among coffee farmers in the study area. These factors are age of farmers, farm size, coffee biotypes, age of the farms, sources of planting materials, selling price and cropping patterns. It could be recommended that policies to encourage youths to be active in coffee cultivation should be implemented. Also, farmers in the study area need coffee biotypes that will enable them increase their farm holdings by getting their planting materials from research institute that has mandate on the crop. In addition, efforts should be made to replace ageing coffee trees with young seedlings; while efforts and adequate resources should be directed to the development of new coffee varieties as the study reveals that farmers in the study area are expectant.

Table 1: Socio economic characteristics of Coffee Farmers in Kogi State, Nigeria

Variables	Frequency	Percentage
Age (Years)		
40-49	8.00	11.11
50-59	24.00	33.33
≥60	40.00	55.56
Total	**72.00**	**100.00**
Educational Level (No of years)		
No Education	24.00	33.11
Primary	16.00	22.22
Secondary	8.00	11.11
Tertiary	24.00	33.33
Total	**72.00**	**100.00**
Age of Coffee Farms (Years)		
10-14	16.00	22.22

15-19	8.00	11.11
≥20	48.00	66.67
Total	**72.00**	**100.00**
Coffee Biotypes		
Coffee robusta	**72.00**	**100.00**
Coffee arabica	----	
Are you satisfied with the yield?		
Yes	32.00	44.44
No	40.00	55.56
Total	**72.00**	**100.00**
Reasons for New Coffee Biotypes		
Low Yield	24.00	33.33
Trees are tall	32.00	44.44
Late maturing	8.00	11.11
Indifference	8.00	11.11
Total	**72.00**	**100.00**
Problems Associated with Old Coffee Biotypes		
Inadequate marketing channels	40.00	55.56
Lack of awareness of benefits of new biotypes	16.00	22.22
Indifference	16.00	22.22
Total	**72.00**	**100.00**
Source of Planting Materials		
Cocoa Research Institute of Nigeria	16.00	22.22
Fellow Farmers	56.00	77.78
Total	**72.00**	**100.00**
Farm Size (Hectares)		
0.1-1.0	40.00	55.56
≥1.5	32.00	44.44
Total	**72.00**	**100.00**
Membership of Coffee Association		
Yes	48.00	66.67
No	24.00	33.33

Total	**72.00**	**100.00**
Quantity of coffee bag sold (Kg)		
1-5	40.00	55.56
6-10	8.00	11.11
Above 10	24.00	33.33
Total	**72.00**	**100.00**
Selling Price (₦/Kg)		
≤1000.00	48.00	66.67
≥1100.00	24.00	33.33
Total	**72.00**	**100.00**
Marital Status		
Married	64.00	88.89
Widowed	8.00	11.11
Total	**72.00**	**100.00**
Coffee Farming Experience (Years)		
10-14	16.00	22.22
15-19	8.00	11.11
≥20	48.00	66.67
Total	**72.00**	**100.00**
Types of Cropping System		
Sole Coffee	16.00	22.22
Coffee /Arable	40.00	55.56
Coffee/ Tree Crops	16.00	22.22
Total	**80.00**	**100.00**

Source: Source: Field Survey, 2023

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Introduction

Agriculture is a way of life in Africa. The agricultural sector is of great importance to any African economy. The sector is not only dependent upon for food availability, but also for employment opportunity (Osabohien *et al*. 2019). The continent is known for the cultivation of agricultural major grains such as corn, wheat, and rice (Raheem *et al*.2021), corn has the widest distribution, being grown virtually in all the ecological zones. The Sub-Saharan region of Africa is very dominant in the production of economic beverage crops which are largely grown for export. They include cocoa, coffee and tea. Ethiopia, Uganda, Côte d'Ivoire, Tanzania, and Madagascar are the major producers of coffee (Ayele *et al*. 2021). Coffee production is vital in the economic prosperity of producing countries especially in East and Central Africa (Bouet *et al*. 2022) Coffee production is mostly regarded as a labour-intensive process implying that the activity assists in the employment of a significant number of people (Dube and Vargas, 2013). According to Wondemu (2017), rural smallholder farmers are responsible for the production of about 95 percent of the coffee produced in Africa. This implies that the production trends of coffee has serious implication on rural poverty alleviation and economic growth of producing countries.

Objectives

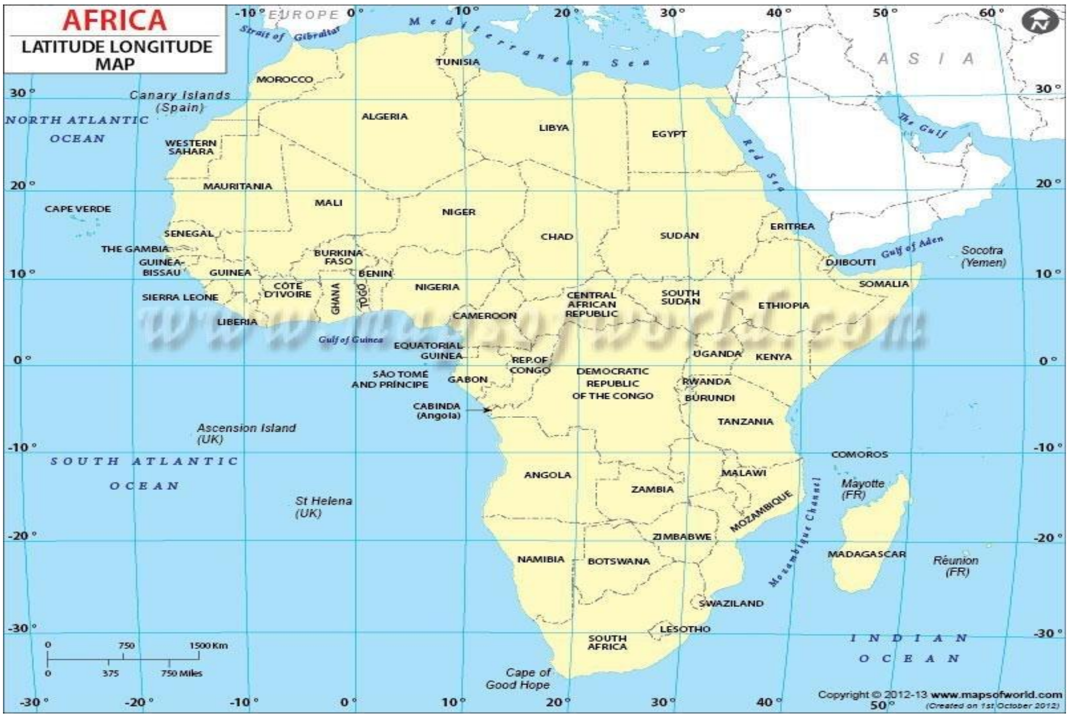
This study therefore, seeks to assess the trends of coffee production in Africa from 1976 to 2020. The specific objectives of the study are to:

I. examine the trend of coffee production from 1976 to 2020.
II. identify the factors influencing the observed trends.

Materials and Methods

Study Area

The study area adopted for this study is Africa. Africa is a vast continent with diverse physical features, including deserts, mountains, rivers, and lakes. Africa is situated in the eastern hemisphere, lies to the south of Europe and southwest of Asia. Its borders are defined by the Mediterranean Sea to the north, the Red Sea to the northeast, the Indian Ocean to the southeast, and the Atlantic Ocean to the west (Clarke *et al*., 2023). Covering a vast expanse, Africa spans from approximately Latitude 37°21′N to 34°51′15″S and Longitude 51°27′52″E to 17°33′22″W. From its northernmost point near Al-Ghīrān Point in Tunisia to the southern tip at Cape Agulhas in South Africa, and from Xaafuun (Hafun) Point near Cape Gwardafuy (Guardafui) in Somalia to its westernmost point at Almadi Point in Senegal, Africa extends around 5,000 miles (8,000 km) from north to south and approximately 4,600 miles (7,400 km) from east to west.



Source: www.mapsofworld.com

Figure 1: Map of Africa

Source of Data

The source of data adopted for this study is Food and Agricultural Organisation (FAO, 2020) statistics. This source was adopted due to the consistency and availability of adequate data suitable for this study.

Analytical Techniques

Descriptive statistics technique specifically trend graphs, chart and tables were adopted in the course of this study. Both tables and graphs were used in tandem to offer a comprehensive understanding of the data. Tables used provide exact figures, while a graphs and charts illustrate trends and patterns present in those figures. These tools were adopted in order to enhance the comprehension of data and make findings more accessible to a wider audience.

Results and Discussion

Coffee Production in Africa

Coffee is arguably one of the most important agricultural products in Africa. The crop serves as a major source of foreign exchange for many African countries. Coffee exports is responsible for about 30 percent of the export earnings in Ethiopia and Uganda (FAOSTAT, 2020). The crop has been having a huge impact on the GDP of many African countries. Coffee crop is classified into different species. However, the two most common species in Africa are *Coffea Arabica* and *Coffeacanephora*. The crop is of the tropical woody genus, Coffea belongs to the *Rubiaceae* family. *Coffeaarabica* originated from southwestern Ethiopia and can be found in Boma plateau in Southern Sudan, as well as in Mount Marsabit in Kenya (Meyer, 1965; Thomas, 1942). C. canephorahas much wider distribution, from West to East Africa in Ghana, Guinea, Guinea Bissau, Cote d'Ivoire, Liberia, Nigeria, Cabinda, Cameroon, Congo, Central African Republic, Democratic Republic of Congo, Gabon, Sudan, South Sudan, Tanzania, and Uganda and to the south to Angola (Davis & Rakotonasolo 2021). According to FAOSTAT (2020) there are 30 countries involved in the production of coffee in Africa(Table 1) in the year 2020.

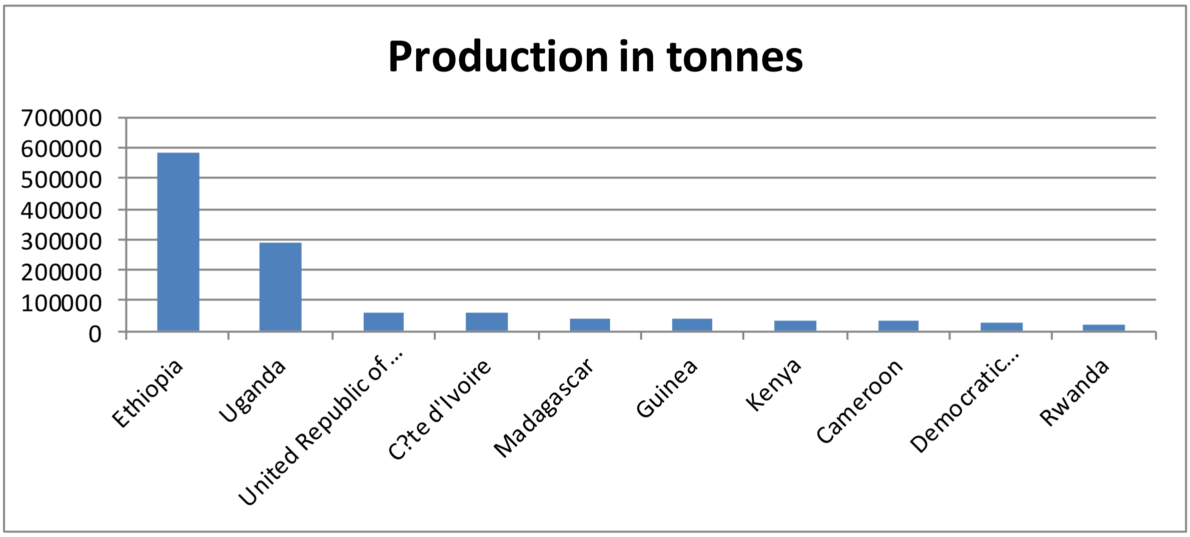
Table 1. Coffee Production in selected countries in Africa

Countries	Production in tonnes
Angola	14855
Benin	55
Burundi	15900
Cape Verde	48
Cameroon	36207
Central African Republic	10448
Comoros	140
Congo	3043
Cote d'Ivoire	59412
Democratic Republic of the Congo	29834
Equatorial Guinea	4187
Ethiopia	584790
Gabon	99
Ghana	736
Guinea	38572

Kenya	36900
Liberia	638
Madagascar	42220
Malawi	10000
Mozambique	805
Nigeria	1887
Rwanda	20459
Sierra Leone	2400
Togo	17404
Uganda	290668
United Republic of Tanzania	60651
Zambia	6536
Zimbabwe	508

Source: FAOSTAT, 2020

Ethiopia is the largest producer of Coffee in Africa. Close to a quarter of the population in Ethiopia derive their livelihood from coffee production, marketing, and export (Abafita & Tadesse 2021). Uganda is the second largest producer of coffee, producing only about half of what is being produced in Ethiopia. About half a million smallholders in Uganda produce coffee, and it is the primary source of income for 2.5 million people, which is about 8 percent of the



population (FTF, 2012). The next eight highest coffee producing countries in Africa did not produce up to 100000 tonnes of coffee in the year 2020 (Fig.2).

Figure 2.Top ten producers of coffee in Africa in the year 2020
Source: FAOSTAT, 2020

Africa's Aggregate Coffee Production

Africa's aggregate coffee production has been steady in the past 45 years. Although, there are times in which the production increases significantly and there are periods of decline (Table 2). However there is no observed significant deviation in the trend of coffee production in Africa since the mid 70's. The continent experienced the highest production level in the years 1981, 2020, 2019 and 2000 all within the range between 1,280,779 and 1,293,046 tonnes. According to Balgah (2019), one of the major reasons for the rise in coffee production is Africa is due to the high demand for the commodity in the international market. The lowest production of coffee was witnessed in the years 2003 with production quantity of 811,189 tonnes. Aggregate coffee production in Africa was steady between periods of 1976 to 1985, with an average aggregate production of 1,173,685 tonnes(table 2). However, in the eighties the average production was 1,210,080 tonnes which was a bit higher than what was obtained in the previous period. Much promise was shown in the production of the crop in the 90's as the average production for the decade was high with a value of 1,254,127 tonnes. The same cannot be said for the following decade as there was a fall in the aggregate production of coffee in Africa to 1,141,356 tonnes. The fall in coffee production during this period (2001-2010) can be attributed to high transaction cost and information asymmetry in the market which reduces the economic benefit of coffee production (Barret, 2008). Surprisingly, the last decade (2011 to 2020)had the lowest average with 1,138,444 tonnes.Kudama (2019), cited aging coffee farms and the increasing incidence of pests and diseases as the major factors that could be attributed to the dip in coffee production during this period.

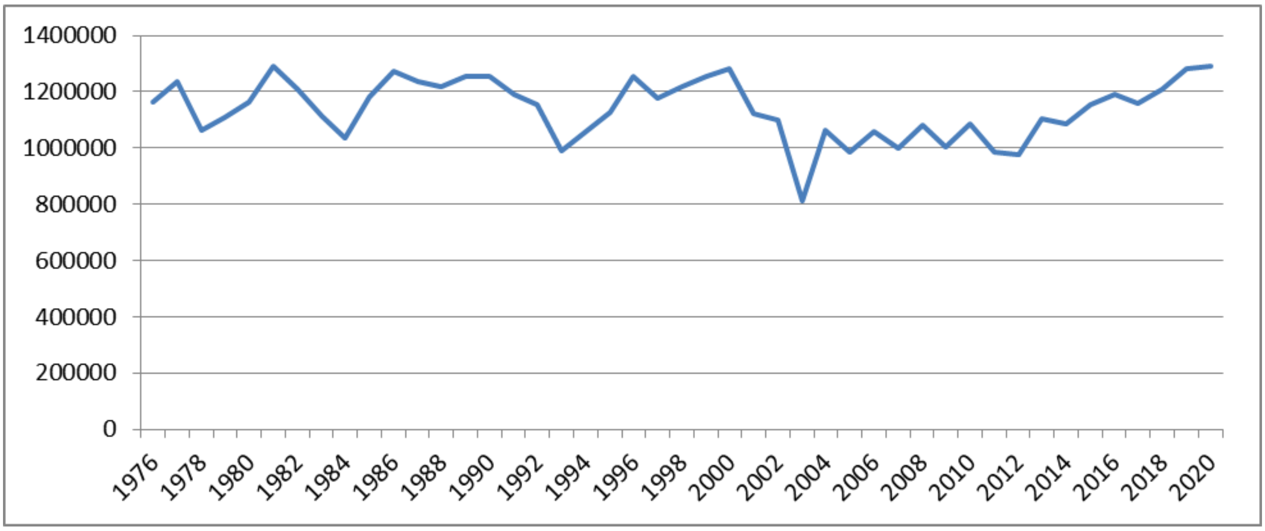
Table 2. Production of coffee in Africa 1976-2020.

YEAR	Production Quantity in Tons
1976	1165512
1977	1235352
1978	1063658
1979	1110744
1980	1163648

1981	1293046
1982	1206872
1983	1113475
1984	1036465
1985	1181857
1986	1274895
1987	1235947
1988	1218793
1989	1256511
1990	1254209
1991	1192734
1992	1156200
1993	991822
1994	1058408
1995	1127036
1996	1254436
1997	1176346
1998	1219222
1999	1254045
2000	1280779
2001	1121272
2002	1098674
2003	811189
2004	1063193
2005	984258
2006	1060500
2007	999820
2008	1079152
2009	1001933
2010	1085219
2011	987479
2012	975108
2013	1104530

2014	1086609
2015	1153373
2016	1192022
2017	1158042
2018	1207175
2019	1282933
2020	1289409

Source: FAOSTAT 2020



Source: FAOSTAT 2020

Figure 3: Trend of coffee production in Africa (1976-2020)

Factors Influencing Coffee production in Africa

According to the International Coffee Council (ICC, 2015) the factor which could be attributed to the relatively stable trend observed in coffee production is the increased cultivation of the crop among the smallholder farmers. Due to the increasing economic benefit attached to the production and marketing of the crop, many smallholder farmers get involved in the cultivation of coffee, thereby increasing the cultivated area for the crop.

According to Oko-Isu *et al*. (2019), the international commodity price for coffee is important to growers in Africa. It influences the prices growers get for coffee in their respective countries. However, the growers have little to no control over the international commodity price for coffee, thus farmers have been advised to target yield increase as this will help increase the economic benefits from coffee production. In Africa, average yields are generally poor and have even declined in some countries (Otieno*et al*. 2019). They range from 100 to 800 kg/ha. Estimates for crop years 2011/12 to 2014/15 indicate an average of 408.7 kg/ha (FAOSTAT, 2020). However, yields from estate farms are slightly higher. Generally, African agriculture is characterised by low productivity due to under-fertilization of soil and the lack of regular husbandry.

Conclusion and Recommendation

The study assessed the trends of coffee production in Africa from 1976 to 2020. The trend analysis for aggregate coffee production in Africa showed that coffee production in Africa has been relatively stable during the period under study. Coffee production in Africa peaked in the nineties while the lowest production during the 46 years under study occurred in 2003. Low yield was identified by literature as the major factor inhibiting coffee production in Africa.

Based on the findings above the study recommends the following:

- Coffee producing countries in Africa should prioritize the development of high yielding coffee varieties so as to improve coffee yield and production in the continent

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Experimetal Title: - Coffee cultivar development for sustainable coffee industry in Nigeria

Investigator:- Adepoju, A.F., Dada, K.E., Baba Nitsa, M., Odey, C.F., Balogun, S.T. and Solomon, O.M.

Introduction

Genetic improvement has increased agricultural production, reduced the pressure on land, improve nutritional value of coffee beans and improve resistance to disease and pest. Stem cuttings lead to production of new plants that is stable and could be used for field establishment (Adepoju *et al*., 2021). Identification of superior parental lines with high yielding potential and desirable traits is of important in the coffee breeding program. Development of improved varieties is a major requirement for sustainable coffee production (Baba Nitsa *et al*., 2020). Breeding coffee involve application of various methods of breeding, including conventional and molecular breeding techniques (Anagbogun *et al*., 2021). Thus collection of more genetic materials and their evaluation for combined ability become necessary. Coffee seedlings produced through vegetative means give good yield, with greater advantage on early fruit bearing (Tomiwa *et al*., 2019) The goal of this work was to enhancement coffee production, quality, and marketability including the release of new cultivar of coffee for Nigeria farmers. This is to building on the past successes recorded on the coffee breeding and genomics programs that will lead to increase in coffee genetic materials. Finding from this work will lead development of improved cultivars and production practices that will contribute to adoptability of new cultivars there by increase food security, income, health and nutritional value of coffee production.

Justification

Coffee cultivation is among the major occupation of many smallholding farmers where coffee plants are grown together with other crops. Most of the farmers are having challenges of low yield due to planting of inferior genotypes of coffee seedlings during field establishment (Adepoju *et al*., 2020). Most of the coffee varieties grown by farmers in Nigeria are landraces or adopted varieties that has been in existence long time ago that lack high market value and of low yield. The coffee genetic materials are going into extinction Dada *et al*. (2019) and needed to be supplied back to the coffee germplasm at the headquarters and the substations. Therefore, increase the genetic variability of coffee population that will lead to more selection and development of improve varieties of coffee for Nigeria farmers become inevitable.

Objectives are:

1 to increase genetic materials and widen the variations among the coffee population

2 to develop better and high yielding varieties with good cup qualities and other desirable traits

Materials and methods

Experiment 1:

Broadening the genetic base of C. *canephora* in CRIN germplasm required collection of more accessions from farmlands. Robusta coffee accessions were obtained from farmer`s farm in Kogi and Ekiti states in Nigeria and named accordingly. These states are known to be among the highest cultivators of robusta coffee in Nigeria. The stem cuttings were taken from the mother trees with use of sterilized pruner (secateurs) after proper assessments. About 8 to 10 cm in length of stem cuttings with the leaves attached were collected, with the both edges of the cuttings covered with paraffin wax. After then the cuttings were wrapped with kitchen toilet roll and put inside wet jute bag. Occasional wetting was carried out to prevent dehydration. The stem cuttings were cut with one node and later split into two to obtain half node stem cutting with all the attached leaves being reduced to half. The cuttings were dipped into 100 ppm of Indole-3-butyric acid (IBA) rooting hormone to ensure good contact with the hormone and planted into the polythene bags filled with top soil arranged in complete randomized design. The cuttings were covered with a clear white nylon to prevent free movement of air there by creating humid environment for the cuttings to sprout. The accessions were named after the collection areas.

Figure 1: Showing two scientist with the farmer during collection of stem cuttings at Omuo-Ekiti Ekiti State

Figure 2: Showed the sprouted coffee cuttings at nursery 6 weeks after setting.

Results and Discussion

The results showed that a total numbers of 316 coffee stem cuttings were set in the pre-nursery. The resulting rates of sprouted leaves by the stem cuttings (figure 2) revealed high significant number of successes that ranges from 50 to 93% of the total cuttings set Table 1. The highest sprouted percentage of 93% was recorded in accession BKB4 followed by ABUK1 with 83%. The lowest sprouting percentage of 50% was observed in accessions OMU3. The result implies that with the use of 100 ppm IBA as rooting hormone, it is possible to achieve high success in the coffee stem cuttings to replace the use of seeds in the establishment of coffee plantation. This will eventually reduce the gestation period and improve the quality and quantity of coffee production.

Figure 2: Sprouted robusta coffee stem cutting in the pre-nursery

Table 1: Number of cuttings set, sprouted cuttings per accession and percentage sprouted

S/N	Accessions Name	No of cuttings set	No of sprouted cuttings	Percentage sprouted (%)	Location
1	ABUK 1	24	20	83	Kogi
2	ABUK 2	15	8	53	Kogi
3	ABUK 3	27	22	81	Kogi
4	ABUK 4	15	13	87	Kogi
5	ABUK 5	15	10	67	Kogi
6	BKB1	24	14	58	Kogi
7	BKB3	20	17	85	Kogi
8	BKB3	25	19	76	Kogi
9	BKB4	15	14	93	Kogi
10	OMU1	20	14	70	Ekiti
11	OMU2	10	7	70	Ekiti

12	OMU3	10	5	50	Ekiti
13	OMU4	15	9	60	Ekiti
14	OMU5	26	17	65	Ekiti
15	OMU6	15	10	67	Ekiti
16	IY-Azeez	40	33	83	Kogi

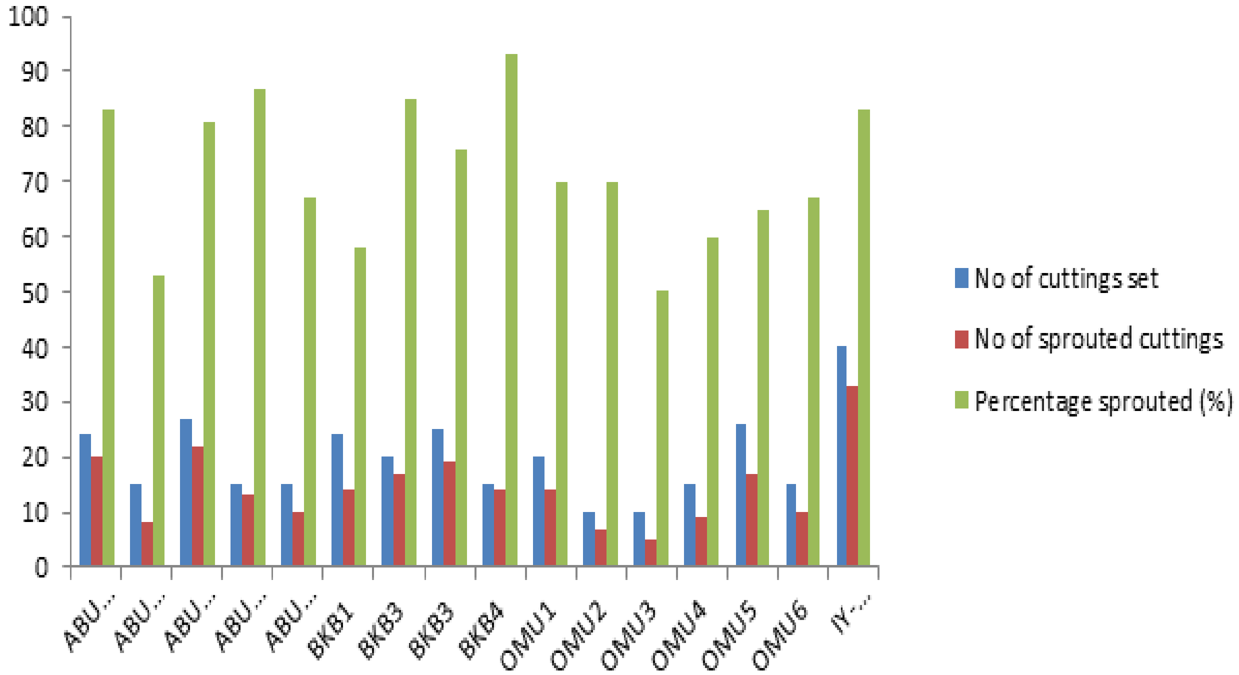

Figure 3: Graph of number of cuttings, number of sprouted cuttings and percentage sprouted per accessions.

Conclusion and Recommendation

The percentage of the sprouted stem cuttings indicated the possibility of have high number of coffee seedling that could lead to increase in genetic materials of coffee there by prove basis for improvement in coffee breeding in Nigeria. It can be concluded that increase in coffee genetic material could be achieved through collection of accessions from various places that would be through to type.

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Experimental Title:- Production of Coffee cookies using date powder as sweeteners

Investigator:- Jayeola C.O, Ogunjobi, M.A.K, Adebowale, Olalekan, Adeleke, Ogunsowo and Akinola

Introduction

Coffee is one of the most popular beverage with about 1.5 billion cups daily consumed worldwide. Coffee is an important source of bioactive compounds, including caffeine, trigonelline, and phenolic compounds. Several studies have highlighted the preventive effects of coffee consumption on major cardiometabolic (CM) diseases. Consumers are concerned about caloric content and glycaemic index (GI) of the food as well as balanced nutrition comprising dietary fibre content. The benefits of low GI diets extend beyond weight loss and have favourable effects on obesity-related diseases such as type 2 diabetes (Esfahani, Wong, Mirrahimi, Villa, & Kendall, 2011). Food industry needs to fulfil the increasing consumer's demand of healthier and tastier foods hence this research activity.

The search for healthier, fast, innovative and tasty food especially that of bakery products is becoming a reality in this modern days of the world.

Cookies are one of the best known quick snack products (Farheena et al.; 2015). Olaoye et al.; (2007) described cookies as nutritive snacks produced from unpalatable dough that is transformed into appetizing product through the application of heat in an oven. They are popular examples of bakery product of ready -to-eat snack that possess several attractive features including wide consumption, more convenient with long shelf-life and have the ability to serve as vehicles for important nutrient (Ajibola et al.; 2015).

Date Palm fruit (Phoenix dactylifera L) locally called ‗debino' in Hausa language, from the family of Arecaceae (Al-daihan Bhat, 2012) is a sweet edible fruit. The fruit is a drupe in which an outer fleshy part consists of pulp and Pericarp surrounding a shell of hard endocarp with a seed inside (Farheena et al.; 2015). Date fruit contains more than 70% sugar mainly glucose and fructose and therefore are high energy food sources (Dada et al.;2012), thus making it an ideal replacement for sugar (sucrose) in the cookies recipe, which is also of great nutritional benefit to diabetics and other metabolic health related patients. Besides, date fruit is rich in

fibre (Hamza et al.; 2014), very rich in antioxidant flavonoids such as beta-carotene, lutein and zeaxanthin. They are also excellent source of iron, calcium, copper, magnesium, potassium, and minor source of vitamins A,and B2 (Dada et al.; 2012; Farheena et al.; 2015). This work aims to evaluate the partly substitution of coffee with whole wheat flour and the use of date powder as sweeteners in the formulation of coffee cookies as an innovative bakery products with high nutritional and sensorial quality and potential to reduce the risk of chronic diseases such as hypertension, obesity and diabetes.

Objective:

To formulate a healthy coffee cookies using date powder as sweeteners

Formulation / Blends Combination used for the Preparation of the coffee Cookies The main ingredients of cookies are wheat flour, fat (margarine) and sugar and water, while otheringredients such as milk, salt, aerating agent, emulsifier, flavor and colour can be included. They can also be enriched or fortified with other ingredients in order to meet specific nutritional or therapeutic needs of consumers (Ajibola et al.; 2015).

Materials and Methods

Ingredients: wheat flour, sunflower oil, Dates powder, whole egg salt, baking powder were purchased from a popular supermarkets in Ibadan. Coffee seeds were obtained from CRIN coffee plots, wet processed, roasted and ground in to powder

Recipes for coffee cookies

The ingredients for coffee cookies are whole wheat flour, coffee powder, date powder, sugar (control), sunflower oil, egg, water, baking powder.

Cookies Formulation

Control 1: Whole wheat flour (100%) with sugar added according to standard cookie recipe, for comparison.

Blend 1: Whole wheat flour: Date powder: Coffee powder (80:10:10)

Blend 2: Whole wheat flour: Date powder: Coffee powder (70:20:10)

Blend 3: Whole wheat flour: Date powder: Coffee powder (60:30:10)

Blend 4: Whole wheat flour: Date powder: Coffee powder (50:40:10)

Blend 5: Whole wheat flour: Date powder: Coffee powder (50:45:15)

Cookies Production with Whole Wheat Flour/Date Palm/ coffee

The ingredients (the whole wheat flour, date palm fruit powder and coffee powder) were measured into a bowl, with the use of a mixer, sunflower oil and other ingredients were added and mix under low speed for 5 minutes. In a separate bowl, egg and water were mixed and added to the flour based mixture and kneaded and made into dough. The dough was rolled and flattened into a uniform thickness of about 3.5mm before cutting out to shapes using a hand-cutter. The cutout dough was baked at 150oC for 30 minutes in the oven. After baking, the cookies were cooled to room temperature, packed in low density polyethylene (LDPE) bags and sealed in a plastic transparent container.

Physicochemical Analysis and shelf life studies

Samples were subjected to physical and proximate analysis using AOAC, 2000. Sensory evaluation of the samples were conducted using 15 trained panelists in a 9 point hedonic scale ranging from 1 dislike extremely to 9 like extremely. Statistical analysis done using analysis of variance and means are separated using Duncan test at P<0.05

Results and Discussion

The organoleptic characteristics of blend 3 and 4 were rated best in all the parameters tested and no significance difference was observed in the blends of 3 and 4 while others recorded significantly different. The control was adjudged good but too sugary. The incorporation of date palm pulp in coffee cookies should not be less than 30%.

Coffee Cookies samples stored for six (6) weeks had no microbial loads as compared to other cookies and the recommended maximum count in literature. This has shown that date palm fruit could be used for substitution of sugar in production of quality coffee cookies and also as sweetener in other bakery products.

Conclusion

Therefore, considering the nutritional constituents of cookies with coffee, wheat flour and date powder as a substitute for sugar, cookies baked with this combination will not only be an ideal snacks/food for diabetics and other metabolic health related patients but will also become a good functional food of great nutritional benefit.

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Experimental Title:- Use of Information and Communication Technologies (ICT) among Coffee producing Households in North Central Nigeria.

Investigator:- Oluyole, K.A., Akinpelu, A.O. and Oladokun, Y.O.M.

Introduction

The use of Information Technologies (IT) among coffee-producing households can not be over-emphasized as it has the potentials to revolutionize various aspects of coffee sub-sector, from cultivation to consumption. Some of the potentials of IT towards improving coffee sub-sector are as follows.

Access to Agricultural Information: Farmers can access crucial agricultural information via mobile phones or the internet. This includes best practices for coffee cultivation, pest and disease management techniques, soil management strategies, and weather forecasts. Apps, websites, and SMS services deliver real-time updates and advice, empowering farmers to make informed decisions (Khan *et al*. 2020).

Market Information and Access: IT tools enable coffee producers to stay informed about market trends, prices, and demand. Online platforms, mobile apps, and SMS services disseminate market information, allowing farmers to strategize their sales and negotiate fair prices. This access to market data helps in reducing information asymmetry and improving market efficiency (Hidalgo *et al*.2023)

Financial Services and Transactions: Mobile banking and digital financial services are increasingly accessible to rural communities. Coffee farmers can conduct financial transactions, receive payments, and access credit and insurance services using their mobile phones. This financial inclusion enhances the financial resilience of coffee-producing households and facilitates investment in farm inputs and equipment (Peprah *et al*.2020).

Supply Chain Management: IT solutions facilitate efficient supply chain management for coffee producers. Digital platforms and mobile applications enable farmers to track their produce from farm to market. This transparency enhances traceability, quality control, and accountability, which are critical for meeting international standards and consumer preferences (Peprah *et al*. 2020).

Capacity Building and Training: Online resources, webinars, and virtual training programs provide coffee farmers with access to agricultural extension services and technical expertise (Gomez *et al*. 2021). These platforms offer guidance on sustainable farming practices, post-harvest handling, and value addition. Continuous learning opportunities empower farmers to improve productivity, quality, and resilience to environmental challenges.

Market Linkages and Direct Sales: IT platforms connect coffee producers directly with buyers, exporters, and processors (Singh and Dey, 2023). Online marketplaces, social media platforms, and e-commerce websites enable farmers to showcase their products, negotiate prices, and establish direct relationships with buyers. This bypasses traditional middlemen and increases farmers' share of the value chain.

Data Collection and Analysis: IT tools facilitate data collection and analysis for informed decision-making (Wang *et al*. 2023). Mobile-based surveys, geospatial mapping, and remote sensing technologies help in gathering agricultural data, monitoring crop health, and assessing yield potential. Data-driven insights enable farmers to optimize resource allocation and mitigate production risks.

Despite the above potentials of IT to coffee farmers, it is not impossible that this important facility might be hampered by some challenges. This study therefore aimed to assess the use of IT in coffee farming via-a-vis the inherent problems associated with the use of IT among coffee households in the study area.

Objective

The objective of the study was to examine the use of information and communication technologies among coffee producing households in the study area.

Methodology

The study area is Kogi State in the North Central zone of Nigeria. Kogi State is a State known for major production of coffee in Nigeria. The variety of coffee produced in the State is coffee robusta being the lowland area. Within the State, Ijumu Local Government Area (LGA) was purposively selected being a high coffee producing LGA in the State. In the LGA, Iyamoye community was also purposively selected for the study. Simple random sampling technique was used to select 130 coffee farming households from the selected community. Structured questionnaire was used to collect information from the selected farming households and the data retrieved from the information collected were analysed with the use of simple descriptive statistics involving frequencies and percentages. Though–data from 130 coffee farming households were sourced for using well-structured questionnaire, after sorting out for missing data, information from one hundred and twenty farmers was eventually used for the analysis.

Results and Discussion

Table 1 presented the socio-economic characteristics of coffee producing households in North Central Nigeria. The mean age of coffee farmers in the study area was 60.8±16.1. Sixty percent of them were above 60 years. This reveals that coffee farmers in the study area are old. This could limit their acceptance of improved technologies and techniques as they might prefer to stick to their old practises. Also, if young farmers are not introduced to coffee farming coffee production may go into extinction in the study area. Young farmers need to be supported with finance and inputs to enhance their interest in coffee production. Seventy five percent of the respondents were married. This is a positive indicator towards the availability of family labour. Eighty three percent of the farmers were formally educated. Their educational level could help in their adoption of latest farming techniques. The mean household size in the study area was 7 ±5 persons. This is also an indication to the availability of family labour. However, large household size could also mean the farmers are spending more money on running their families and lesser on inputs and farming activities. Eighty percent of coffee farmers in the study area belonged to socio-economic groups such as town union, cooperative and Coffee Farmers Association of Nigeria (CFAN). These socio- economic groups especially CFAN help farmers to get support and inputs from the government and Cocoa Research Institute of Nigeria (CRIN). Majority (83.3%) of the farmers own their own farm and cultivated ≤ 2 hectares. Hence, majority of the coffee farmers are smallholder farmers. The mean years of experience was 28 ±10 years, therefore, the farmers have high experience in coffee production which is of great importance for their business. Sixty percent of the farmers in the study area grow coffee with kolanut. They practise mixed cropping to maximise the use of their farmland. Half of the farmers get their planting material from fellow farmers and 80% of the farmers affirmed that coffee planting material is readily available.

Table 1: Socio economic characteristics of Coffee producing Households in North Central Nigeria.

Variable	Freq (N= 120)	Percentage
Age of the farmer (years)		
31-60	60	50.0
61-84	60	50.0
Mean 60.8±16.1.		
Marital status		
Single	30	25.0
Married	90	75.0
Educational Level		
No formal education	20	16.67
Formal education	100	83.33
Household size		
1-5	40	25.0
6-10	80	75.0
Mean 7 ±5		
Membership of Socio economic association		
Non-member	20	16.7
Cooperative	30	25.0
Town Union	20	16.7
CFAN	50	41.6

Type farm ownership		
Own farm	100	83.3
Rented farm	20	16.7
Farm size (Ha)		
≤ 2	100	83.3
2.1-5.0	20	16.7
> 5.0	0	0
Farming experience (Yrs)		
≤20	20	16.7
21-40	80	66.6
41-60	20	16.7
Mean 28 ±10		
Other crops grown with coffee		
Kolanut	60	60.0
Plantain	20	20.0
Maize	20	20.0
Cassava	20	20.0
Cropping system		
Coffee/arable	50	41.7
Coffee/tree crops	70	58.3
Source of planting material		
CRIN	30	25.0
ADP	30	25.0
Fellow farmers	60	50.0
Is the planting material available?		
Yes	80	66.7
No	40	33.3

Source: Field Survey, 2022

Table 2 presented the information and communication technologies used in coffee production. The technologies considered in this study are phone calls, text messages, whatsapp messages, e-mail, facebook, radio, television and newspaper. The table shows that 41.7% of the respondents used text messages and whatsapp messages respectively to enhance coffee productivity while all (100%) used phone calls. The other sources of information technologies are radio (70.8%) and television (25.0%). However, the information and communication technologies in the low category in terms of usage were television and newspaper, the ones in the medium category were whatsapp messages, e- mail, facebook and text message. The ones in the high category were radio and phone calls.

Table 2: Information and Communication Technologies used in Coffee production

S/N	Information and Communication Technologies	Frequency	Percentage	Level of Use
1	Phone calls	120	100.0	High
2	Text messages	50	41.7	Medium
3	Whatsaap messages	50	41.7	Medium
4	E-mail	60	50.0	Medium
5	Facebook	55	45.8	Medium
6	Radio	85	70.8	High
7	Television	30	25.0	Low
8	Newspaper	20	16.7	Low

Source: Field Survey, 2022

Table 3 presented the effect of the use of information and communication technologies on the productivity of coffee farmers. About 33.2% of the respondents affirmed that information and communication technologies increased their productivity by 75% while 16.7% of the respondents in each case reported that information and communication technologies affected their productivity by 10%, 25% and 75%. About 16.7% in each case submitted that information and communication technologies improved their soil management skill, improved their agronomic practices knowledge and also improved the marketability of their produce. However, 50% of the farmers affirmed that the technologies have improved both their soil management skill and the marketability of their produce.

Table 3: Effect of the use of Information and Communication Technologies (ICT) on the productivity of coffee farmers

S/N	Variable	Frequency	Percentages
1	Has the ICT improved your coffee productivity?		
	Yes	80	66.7
	No	40	33.3
2	At what percentage has the ICT affected your productivity?		
	10%	20	16.7
	25%	20	16.7
	50%	20	16.7
	75%	40	33.2
	100%	20	16.7
3	Areas where ICT has improved your productivity		
	It has improved my soil management skill	20	16.7
	It has improved my agronomic practices knowledge	20	16.7
	It has improved the marketability of my produce	20	16.7
	It has improved both my soil management skill and the marketability of my produce	60	50.0

Source: Field Survey, 2022

Conclusion and Recommendation

The use of Information and communication technologies is prominent among coffee farming households in the North Central, Nigeria and they affirmed the positive effect on their productivity. Government and non-governmental organisations should educate farming households on the need to use information and communication technologies to further enhance their farming activities.

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Experimental Title:- Establishment of coffee clonal gardens in selected Substations of CRIN in Nigeria

Investigator:- Oloyede, A.A, Keji Dada/Baba'Nitsa Mohd Famuyiwa,B.S and Orisasona T.M.

Introduction

Most coffee plantations in Nigeria are unproductive, low yielding and eventually abandoned. These were majorly due to poor planting materials, old age of trees and poor agronomic practices. In view of the above, on-station experimentation was done to replace unimproved coffee materials through top grafting of improved clones. About 60 % grafting success was achieved through this. Stem cutting propagation of compatible clones with up to 80% success have also been achieved. Also, establishment of clonal seed gardens to supply improved planting materials of which yield of >2 tonnes per hectare was obtained. Since most coffee farms are unproductive, low yielding and abandoned with less than 500kg per hectare, there is the need for urgent intervention in view of the above technologies we have on shelf.

Objective of the study

To replace the existing unproductive plantation with improved materials within the nearest possible time through the establishment of clonal seed gardens in selected substations and on-farms establishment of coffee model farms and establishment of community nurseries.

Materials & Methods

Coffee seedlings were obtained in the Central Nursery as root stock and transplanted accordingly in July,2023 planting season, rootstocks were top grafted upon in-situ on the coffee clonal seed garden on-station at CRIN Headquarters. The in-situ top grafting was to replaced the missing stands as a result of fire outbreak at the clonal garden. Stem cuttings of three improved clones (C111, C36 and T1049) set at Uhonmora Substation using one-node cuttings and maintenance of such till 2024 planting season. The scions were obtained from the rescued clones C1, C2 and C4

Grafting in-situ and stem cutting success was determined as percentages. Data collected shall be analyzed using sas stastiscal package

Results and Discussion

Tables 1, 2 and 3 reveal the success recorded in vegetative propagation of coffee clones with average of 61.11%; 55.56% and 32.22% for in-situ top grafting, stem cutting in wooden propagator and stem cutting in humid chamber of polythene sheet respectively. Success recorded in in-situ top grafting compared with other methods revealed a novel method of increasing coffee productivity on-farm. Kumar (2021) reported top grafting in coffee as a good method of increasing coffee production through replacement of unproductive grooves by improved ones. It is also a method of controlling nematodes in coffee plantations.

Plate 1 shows the constructed coffee prenursery using mixture of topsoil and sawdustat 1;1 ratio. This method encourages easier method of getting improved coffee materials from CRIN as the coffee seed loses viability readily. Plate 2 shows what clonal Robusta coffee can give, the yield of this particular clone has risen to up to > 6 tons/ha, Kibrige-Ssebunye(1993) reported green bean yield of between 1368-2205kg/ha in Uganda with an average of 1734kg/ha. The figure gotten from our clonal garden especially C4 outweighs the above. Plates 4-7 shows the top grafted coffee clones in-situ, a confirmation that it is a good way of replacing unproductive Robusta coffee plantations. Poor cutting success rate of 32.22% could be as a result of post cutting set handling at the substation at Uhonmora and possibly that the polythene sheet got perforated along the line. In earlier work using the same method at the HQ, success of up to 80% has been recorded.

Conclusion and Recommendations

This study has underscored the possibility of in-situ top grafting at improving coffee productivity in Nigeria. The method having eliminate cost of nursery operation will definitely reduce cost of coffee production. This technology could be extended to unproductive coffee farms in Nigeria to boost production..

Table 1: In-situ grafting of clonal coffee at coffee seed garden plot at CRIN Headquarters

Rows	Total grafted	Number Graft Take	Percentage graft take
1	**12**	**8**	**66.67**
2	**9**	**4**	**44.44**
3	**6**	**2**	**33.3**
4	**3**	**3**	**100**
5	**10**	**4**	**40**
6	**-**	**-**	**-**
7	**2**	**1**	**50**
8	**-**	**-**	**-**
9	**1**	**1**	**100**
10	**2**	**2**	**100**
12	**5**	**4**	**80**
Volunteer Rootstock	**4**	**4**	**100**
Total	**54**	**33**	**61.11**

Table 2: Stem cuttings of clonal coffee in wooden propagator@ HQ

Coffee clones	Number set	Number take and rooted	% take & rooted
C1	**150**	**75**	**50.00**
C2	**150**	**80**	**53.33**
C4	**150**	**85**	**56.67**
Total	**450**	**240**	**55.56**

Table 3: Stem cuttings of clonal coffee in polythene humid chamber@ Uhonmora

Coffee clones	Number set	Number take&rooted	% Take & rooted
C1	**150**	**02**	**1.33**
C2	**150**	**71**	**47.33**
C4	**150**	**72**	**48.00**
Total	**450**	**145**	**32.22**

Plate 2: Clone C4

Plate 3: Hardened C4 cuttings in propagator

Plate 4: In-situ top grafted coffee

Table 5: Another in-situ top grafted coffee

Table 6: fully grown in-situ grafted coffee

Table 7: another fully grown in-situ graft

Plate 8: coffee cuttings within cuttings@Uhonmora

Plate 9: hardened coffee humid chamber@ Uhonmora

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Experimental Title:- Model Robusta Coffee Plantation Establishment and its impact on Economic Empowerment of Farmers in Ogun State

Investigator:- Adeyemi, E.A. Oladokun Y.O.M, Daniel M.A. and Adepoju, A.F.

Introduction

Coffee is mainly an agricultural export produce that is vital to the economies of the nations that produce it. Krishnan (2017) stated that the gross domestic product (GDP) is heavily dependent on coffee export profits and that a sizable section of the rural population is employed in this industry in Democratic Republic of Timor-Leste in Southeast Asia. Coffee is widely consumed for its great taste, aroma and nutritional value (Gebeyehu and Bilika, 2015). Coffee plant is categorized among medicinal plant (Eva *et al*. 2016).

It has been reported that coffee farmers in Nigeria have cut down their plantations due of lack of market (Alli *et al*., 2021; Oladokun *et al*., 2022). Embedded in coffee research project in Ogun State in 2022 was the distribution of *Coffea canephora* (Robusta coffee) seedlings to farmers as means of awakening interest in coffee cultivation since the bane of lack of market has been surmounted. This study thus seeks to strengthening the ignited farmers interest through the establishment of model *Coffea* farm in Obafemi Owode Local Government Area (LGA) of Ogun State

Methodology

The project was carried out in Idofin Igbore Obafemi Owode LGA in Ogun state. A contact farmer was selected along with the farmers' group in the LGA. The project was executed on the farmer's farm. Dimension of the effective experimental plot was 24m x 15m with an area of 360m^2. Pre- cropping soil samples were collected by the use of soil auger at 0-20cm depth. Composite soil sample formed from the core soil samples was air-dried, ground and sieved using

2.0 mm mesh. Analysis of both the physical and chemical properties of soil sample was done using the methods described in International Institute of Tropical Agriculture Manual. The soil pH was measured in water (1:1). Particle size distribution was carried out using the hydrometer method; while organic carbon was determined using chromic acid method. Microkjehldal method was used to analyze for total nitrogen. Available P in the soil was determined using ascorbic acid method. The Cation Exchange Capacity (CEC) of the soil was determined by using pH 7.0 buffer solution of calcium ammonium acetate, while EDTA titration was used to measure Ca^{2+}, Mg^{2+} and K^{+}.

Land preparation was done; farm was laid out, planting of plantain shade crop and transplanting of *Coffea* planting materials were done in October 2023. Three different planting materials used in the establishment were:

1) C111 - an improved clonal material obtained from stem cuttings
2) C36 - an improved clonal material obtained from stem cuttings
3) Seedling - obtained from seeds (*Coffea* beans) obtained through sexual propagation

Plant spacing adopted for both the plantain shade crop and the *Coffea* planting materials used in the field establishment was 3m x 3m. The three types of planting materials were the treatments which were randomly placed and replicated three times on the demonstration/experimental plot. Quantities of the *Coffea* planting materials used in the plot establishment were as listed below:

- Clone C111 20
- Clone C36 14
- Seedlings 6

Total 40

Quantity of plantain suckers planted as shade crop was also 40

Data on survival of the plantain shade crop, survival and morphology (plant height, stem diameter, number of leaves, branches and leaf area) of *C. canephora* materials transplanted were taken at 3 months after transplanting (MAT) and planned to be taken at quarterly interval after the initial data records. GPS of the experimental site was taken. The field establishment was done in the dry season (October, 2023) because that was the time the research fund for the project was released. Consequently provision was made for irrigation of the plot in-order to minimise dead of transplanted materials and poor establishment. Mulching with plant debris was done to reduce evapo-transpiration so that the watering done could be optimally utilised by the plants (*Coffea* cuttings, seedlings and plantain)

Row 8	C36	C36	C111	C36	C111
Row 7	C36	C36	C111	C36	C111
Row 6	C36	C36	C111	C36	C111
Row 5	C111	C36	C111	C36	C111
Row 4	C111	SEEDLING	C111	SEEDLING	C111
Row 3	C111	SEEDLING	C36	SEEDLING	C111
Row 2	C111	C111	C36	C111	SEEDLING
Row 1	C111	C111	C36	C111	SEEDLING

Figure 1: Experimental layout showing the treatments placement on Idofin-Igbore Coffee Model Plot, in Obafemi-Owode LGA, Ogun State

Results and Discussion

The GPS of the experimental plot was

Latitude: 6.994610 N6^{o}59’40.59492

Longitude: 3.562133 E3^{o}33’43.67808

Soil sample analysis

The chemical properties of the soil indicated that the Organic carbon and total nitrogen of the soil was low (Table 1) which suggest that there is need for intercrop or fertilizer augmentation. The pH of the soil falls within the acceptable range. The clay + silt content of 94gkg-1 soil was low for sufficient soil water retention required for sustainable coffee plant growth especially in the dry season of the year. Consequently, intercropping with cover crops such as melon, mulching with plant debris and or provision for irrigation in the dry season

Table 1: Pre-cropping physical and chemical properties of the soil on coffee experimental plot.

Properties	Value
Chemical properties	
Organic Carbon (gkg^{-1})	0.52
Total Nitrogen (gkg^{-1})	0.04
Available P($mgkg^{-1}$)	15.24
Exchangeable bases (Cmol gkg^{-1})	
Potassium (K^{-1})	0.11
Calcium (Ca^{2+})	3.70
Magnesium (Mg^{2+})	1.29
Sodium (Na^{+})	0.14
Manganese (Mn)	4.37
Exchangeable acidity (Cmol gkg^{-1})	
Aluminum (Al^{+}+ H)	0.06
ECEC	5.29
Base saturation (%)	98.87
pH (H_20) 2:1	7.19
Physical properties (gkg^{-1})	
Sand	906
Silt	20
Clay	74
Textural Class	Sandy loam

Could help to guard against the adverse effects of drought on the growth and development of the coffee plant on the field. The exchangeable cations (K^+, Ca^{2+} and Mg^{2+}) of the soil were 0.11, 3.70 and 1.29 cmolkg-1 soil respectively. The textural class of the soil is sandy loam which is suitable for coffee production. The soil is marginal in terms of nutrient compositions particularly N, P and K. Suggestions on intercropping with crops that will be in a complementary and not competitive association with *Coffea* couple with mulching with plant debris when necessary such that these crop plant and plant materials could enhance the organic matter and nutrient contents of the soil as well as protect the soil from the vagaries of weather among other benefits could profer solution to the major nutrients that are marginal. The application of organic fertilizers could be an additional option.

Survival count (%) of materials planted

The survival count of the planted materials indicated that plantain had 100 % survival at 3 MAT (Table 2). Among the *Coffea* materials transplanted, seedlings had the highest survival of 83.3 % followed by C36 and C111 with values of 78.6 and 70.0 % respectively. The highest survival obtained in the seedling as planting material could be because it was hardier than the other two planting materials that are clonal as against the seedlings that emanated from sexual reproduction.

Table 2: Percentage survival of materials planted

Crop	Types	Number planted	Number survived	% survival
Coffea	C111	20	14	70.0
	C36	14	11	78.6
	Seedling	6	5	83.3
Plantain		40	40	100

Morphological growth of Coffea planting materials

At 3 MAT the highest plant height was obtained in C111 followed by C36 and the lowest height was in the seedling planting materials treatment with values of 62.70, 41.98 and 9.22 cm respectively (Table 3). Similar pattern was obtained for the stem diameter and leaf area. The number of leaves on Clones C111 and C36 at 3 MAT was 16 each which was higher than the number of leaves (10) observed on seedling planting material treatment

Table 3: Growth parameters of Coffea planting materials used in the field establishment of Coffea model plot at Idofin-Igbore

Treatment	Plant height (cm)	Stem diameter (cm)	Number of leaves	Leaf area
C111	62.70	0.47	15.7	89.40
C36	41.98	0.40	15.7	56.37

Seedlings	9.22	0.24	9.5	17.97

In general, the growth (as measure by the plant height, stem diameter, number of leaves and leaf area) of the *C. canephora* planting materials used in the field establishment of the model plot was in the order of C111> C36 > Seedling. The better performance of the clonal materials over the seedling could be due to the fact that they were obtained from *Coffea* of desirable traits propagated through vegetative method which made them to breed true to type.

Conclusion

The preliminary results obtained in this project showed that while the order of survival count of the three planting materials of the *C. canephora* (Robusta coffee) used in the field establishment was in the order of Seedling > C36 > C111, their growth was in the order of C11> C36 > Seedling.

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TEA PROGRAMME

OVERVIEW

Tea improvement started in 1982, with the acquisition of 33 clones and since then moderate achievements have been recorded. Five out of the clones, namely 35, 68, 143, 236, and 138, with an average harvest of 2.5 tons./ha/year were selected and released to farmers. The confinement of commercial tae production to Mambilla highland was orchestrated by the fact that highland is adjudged the most suitable ecology for tea production. However, the expansion of tea production has been constrained by limited land availability for tea cultivation in the highland and the incessant insecurity which has also affected further research on tea. This has necessitated the need to explore new areas for tea production, where tea adaptability trials have been successfully established (Omolaja and Esan, 2005). Among the locations Ajassor in Cross River State was outstanding in enhancing tea growth and establishment because of its acidity soil as well as heavy widespread rainfall. These attributes qualify Ajassor to be selected for tea expansion. This has led to training and sensitization program organized for prospective farmers by tea scientists and also in conjunction with the Nigeria Export Promotion Council.

ACHIEVEMENTS

Identification of Cross River State as a good location for the production of both lowland and highland Tea, Multiplication of over five thousand clonal tea cuttings in the lowland, the first of its kind which we intend to increase in the year 2024 for distribution for farmers. Tea farmers and prospective investors have been trained at Ikom and Calabar on Tea Nursery management and Establishment using cuttings. Meetings with stakeholders (NACOFTAN and Investors) which has resulted in the release of 0.5 hectares in Bashua for Farmer’s On- Farm Tea Experimental plot, which will take off in the year 2024 and increase in Tea seedlings demand.

TEA PROGRAMME

REPORT 1

Theme: Varietal Development of Tea for Sustainable Circular Economy growth in Nigeria

Task: Land Suitability Mapping for Lowland Tea

Experimental Title:- Determination of Rooting Hormones Efficacy and Success of Tea Cuttings Generation in Lowland of Nigeria

Investigator:- Olaniyi O.O,Okeniyi M., Oloyede A.A., Ebunola T. E., Sulaimon F. O.

Introduction

Tea *Camellia sinensis* is one of the most admired non-alcoholic beverages in the world. It is a woody perennial shrub that can attain the height of 10m if not pruned or controlled. The young leaves are processed into various type of tea such as green tea, black tea, oolong tea, yellow tea and white tea. Tea was introduced into Nigeria in the year 1972 and since then it cultivation is domicile in Sadauna Local Government area in Taraba State. It is important to extend it cultivation to lowland area where there is availability of land. Tea is mostly cultivated through stem cuttings of elite clones, though it can also be grown through seed but due to its large extent of variability and low viability characterized the seed formation as a result of outcrossing (Heterozygosity).

However, efforts have been made to improve raising of tea seedling which seems to be a major factor for adequate expansion of tea cultivation in both upland and lowland areas of Nigeria.

Objectives

1. To determine the success rate of tea cuttings establishment in the lowland area.
2. To determine the effectiveness of rooting hormones on the tea cuttings in the lowland areas of Nigeria.
3. To find out the success rate of mass propagation of tea cuttings through tissue culture.

Materials and Methods

The mother plants were pruned 6 months before the commencement of the settings of the cuttings. The pots were filled with top soil first at the base of the pot to about 2/3 full followed by the sub soil to fill the remaining 1/3 portion. The pots were arranged in a prepared bed. The cuttings were harvested carefully with the aid of secateur and quickly dipped in a basin containing water to prevent loss of water.2 grams, 1 gram of each of auxin, IBA and NAA were prepared in butanol of 1 liter respectively. Aloe vera and honey as natural hormones were also tested. The cuttings were prepared in one node and quickly dipped in the prepared solution and planted at an angle of 45°. The leaf of each of the cuttings was not allowed to touch the soil.

The whole bed at the end of the day was covered with transparent nylon sheet and the edges were buried after the cuttings were thoroughly watered to prevent air from outside to come in contact with the experiment.

The humidity was checked the following day to ascertain effective covering of the cuttings.

The experiment was laid in Completely Randomized Design (CRD)

Results

Current Progress:

Monitoring development and overall growth ongoing.

REPORT 2

Task: Land suitability mapping for lowland tea

Soil characterization and suitability evaluation for lowland Tea production

Olasoji H. O.,Ogunlade M. O.Adeyemi E. A. Nduka B. and Fagbami S.

Introduction

Tea **(***Camellia sinensis* L.**)** is an essential commercial crop, perennial evergreen shrub belonging to the Camellia genus of the Theaceae family (Ohe et al., 2001). It is one of the most popular beverages consumed in the world.Soils of tea lands in different countries differ widely in parent material and morphological characteristics but the most important requirement is soil pH of between 4.5 to 5.5. Soils should also be deep, permeable and well drained (Somaratne, 1986). Li and Pan (2004) stated that tea plants need large amounts of N, P, K and Mg for growth. The deficiency of these nutrients could adversely affect the yield and quality. Nutrient deficiency in soils and poor fertilization can also limit the yield and quality of tea (Yuan et al., 2000).

Soil is a mixture of minerals, organic materials, air and water. The contents of soil vary at different locations and are constantly changing. There are many different kinds and types of soils; each has certain characteristics including a specific colour and composition. Different kinds of soil support the growth of different types of plants and also determine how well that plant grows (Turrion*et al*., 2000). Therefore, soil evaluation is essential for sustainable crop production. Soil depth of less than 50 cm, graveliness of more than 50% and rockiness of 20% affect the growth of tea adversely. Tea plants growing in shallow and compacted soils are likely to suffer from drought and water logging during the rainy months (TRFK 2002). Tea production can promote food security and poverty alleviation in Nigeria greatly if given right attention is given to its recuperation. This study aimed at soil characterization and suitability evaluation for expansion of tea production to southern part of Nigeria.

Materials and Methods

The study was carried out in Cross-River State. Two Local Governments (Obanliku and Boki) were visited in the State. Three profile pits were established only at Obudu hill in the Obanliku Local Government Area (LGA) and described following the FAO/UNESCO (2006) guidelines. Coordinate of each profile pit was recorded. Soil samples were collected from each identified horizon and surface soil samples were randomly collected for fertility evaluation. Morphological characteristics of two profile pits are reported in this report. Soil samples (0-20 and 20-40 cm) were collected randomly at Bashua in Boki LGA for fertility evaluation as well. Collected soil samples were processed, then taken to the laboratory for physical and chemical analyses. Particle size distribution, soil pH, organic carbon, phosphorus, total nitrogen, exchangeable cations (Ca, K, Mg and Na), exchangeable acidity (Al^{3+} + H^{+}) and micronutrients (Fe, Mn, Zn and Cu) contents of the soils were analyzed using standard laboratory methods. The FAO framework for soil suitability evaluation was used for the research (Sys et al., 1993; FAO, 2007).

Results and Discussion

Physical and chemical properties of the soils at Obudu Hill

Physical properties of the soils are presented in Table 1. The texture of the soils ranged from loamy sand to sand. Sandiness of these soils suggest easy leaching of nutrients and heavy metals (Onweremadu,2008). It may also suggest the degree of erodibility of the soil of the area. Generally, the results of the three profile pits showed that silt and clay particles were low while sand contents were high. This could be attributed to the effects of pedogenic processes of translocation in which silt and clay particles were moved from the upper horizons to lower horizons.

The chemical properties of the soils of profile pit 1 are presented in Table 2. The pH of the soils in water varied from 5.73 at surface to 6.19 at sub-surface. The mineral content and pH of soil among other factors play indispensable role in tea production. Hajiboland, (2017) and Kariuki et al., (2022) reported that tea plant requires soil having optimum soils drainage conditions and Soil reaction ranged from 4.5-5.6 for better development. Organic carbon (OC) at the surface soil of the three profile pits were high. The OC content of the soils decreased with soil depth. The calcium content increased with soil depth and the values ranged from 1.10 cmol/kg at the surface to 1.28 cmol/kg at sub surface which were above the critical values of 0.5 to 0.7 cmol/kg. Generally, the exchangeable Mg contents of all the profile pits were higher than 0.2 cmol/kg which is the critical value for optimal tea production (Egbe et al., 1989). Potassium content of the soils is below the critical level of 1.5 to 1.8 cmol+/kg soil for optimal tea production. Thus, Kfertilizer supplements would be necessary to attain sustainable tea production.The soils total nitrogen (TN) contents and available phosphorus (AP) of the profile pits were lower than the critical level (4.5 to 5 %) and (2.6 to 3 ppm) respectively for soils suitable for tea (Egbe et al., 1989).

Suitability evaluation of the soils

The study area records 2254 mm as the annual rainfall, mean annual temperature of 34.16 ^{o}C, relative humidity of 83.16%, mean annual wind speed (at 2 meters maximum) of 1.55 m/s and annual wind direction of 228.66^{o} (NASA, 2022). Tea is grown across a range of altitudes, from sea level up to about 2200 m above sea level. The tea plant requires a minimum rainfall of 1200 mm year-1, but 2500-3000 mm year-1 is considered optimum (Hajiboland, 2017). The annual rainfall of the study area falls into suitability class S1(highly suitable) and rated 100% due to sufficient rainfall. The mean annual temperature (34.16^{o}C) of the study area is in class N1 (presently not suitable), rated 40% and therefore not suitable for tea production (Abdule and Woyesa 2023). With reference to relative humidity, the soils fall within S1 suitability class and highly suitable for optimal yield of tea.

The factor rating of land use requirements for tea were matched with soil properties of the study area. The actual or current suitability of the soils under parametric approach as calculated with the index of productivity for each profile pit (Udoh et al. 2006) showed that all the profile pits are presently not suitable (N1) for commercial tea production. In the potential suitability, profile pits 1 and 2 would be marginally suitable for tea production. TRFK (2002) stated that soil depth of less than 50 cm, graveliness of more than 50% and rockiness of 20% affect the growth of tea adversely. Mean annual temperature, flooding (evidence of erosion), amount of coarse fragments and slope put limitation on the study area and rendered it presently not suitable. Therefore, the area is recommended not to be used for economic tea production because the properties that put limitation to tea production in this area are unchanging in nature and cannot be altered or changed without excessive cost.

Fertility evaluation of the proposed land for lowland tea cultivation

Physical and chemical properties of the soils

Table 3 shows result of physical properties of surface soil samples from Obudu hill and Bashua respectively. The result indicated that the soils were sand and loamy sand respectively.

Table 4 shows result of the soils chemical properties. At Obudu hill, the pH, organic carbon, total N and available P of the soil were 5.96, 0.37%, 0.52 % and 5.41 mg/kg soil respectively. Organic carbon content of the soil and total nitrogen were low. de Silva (2007) reported that the optimum soil conditions recommended for tea growth include a well-drained, deep and well-aerated soil with more than 2% organic matter. The exchangeable cations (K+, Ca2+ and Mg2+) of the soil were 0.09, 1.38 and 0.36 cmol/kg soil. Ca and Mg contents of the soils were adequate for tea production while K content is lower than the critical value (1.5-1.8) required for optimal tea yield. This is an indication that K and N fertilizers are needed in the study area.

At Bashua farm, the pH, organic carbon, total N and available P and exchangeable cations of the soil decreased with depth. Organic carbon is high in the surface soil and adequate for tea production than the subsurface soil due to the accumulation of leaf droppings and decayed plant residues. The total nitrogen content of the soil was low. The soil nitrogen levels were below the critical level of 4.5 -5 % that has been established as ideal soil for tea cultivation in Nigeria (Egbe*et al.,* 1989). The available P content was adequate as the value were above the critical value of 2.6 -3 mg/kg for optimum tea yield. The value of Mg and Ca for surface soil were 0.53 and 2.12 cmol/kg respectively. The values were higher at the surface than sub surface and are adequate for tea. K content of the soils were low at surface and subsurface levels.

Conclusion and Recommendation

Morphological characteristics of the studied soils showed that the surface horizons were black. The profile pits were well drained but very gravelly. Suitability assessment of the soils showed that the study area (Obudu hill) is presently not suitable for tea production. Mean annual temperature, flooding (evidence of erosion), amount of coarse fragments/gravel contents and slope put limitation on the area. Therefore, the area is recommended not to be used for economic tea production because the properties that put limitation to tea production in this area are unchanging in nature and cannot be altered or changed without excessive cost.

Low organic matter contents of the soils of the study area (Bashua) would require good management technique to obtain optimal productivity of tea and will also require caution in the type and method of fertilizer application on the soils. Fertilizer having appreciable amount of K and P would be of uttermost benefit for tea production in these study areas. However, only fertility evaluation is not enough to determine suitability of the soils. Hence, there is need for soil profiling. Further research is therefore needed in lowland areas to ascertain its suitability or otherwise for tea production.

Table 1: soils physical properties at Obudu hill

Horizon	Depth (cm)	Sand	Silt	Clay	Silt/Clay	Textural Class
		←	(%)	→		
Profile pit 1						
Ap	0-15	86.6	8	5.4	1.4	loamy sand
AB	15-44	91.6	2	6.4	0.3	Sand
B2	44-90	88.6	6	5.4	1.1	Sand
BC	90-125	82.6	12	5.4	2.2	Loam sand

Horizon	Depth	pH	Exchangeable bases				Al +H	ECEC	BS	TN	OC	Avail. P	Micronutrients			
		H_20	Ca	Mg	K	Na							Mn	Fe	Cu	Zn
	(cm)		← (cmol/kg) →						← (%) →			← (mg/kg) →				
Profile pit 1																
Ap	0-15	5.73	1.1	0.29	0.05	0.3	0.1	1.89	93.6	0.1	3.10	4.89	0.56	4.56	0.17	0.35

Table 2: soils chemical properties at Obudu hill

			0			2	2		4	9						
AB	15-44	6.03	1.12	0.26	0.05	0.19	0.08	1.70	95.29	0.21	2.94	4.74	0.15	3.01	0.19	0.23
B2	44-90	5.95	1.02	0.21	0.04	0.10	0.10	1.47	93.22	0.13	1.58	3.25	0.19	4.17	0.21	0.31
BC	90-125	6.19	1.28	0.31	0.04	0.12	0.07	1.82	96.15	0.86	0.65	4.97	0.18	3.97	0.19	0.35

Table 3: Soils physical properties

Locations	Depth (cm)	Sand	Silt	Clay	Textural Class
		← (%) →			
Obudu hill	0-20	88.6	6	5.4	Sand
Bashua	0-20	80.6	14	5.4	Loamy sand
Bashua	20-40	80.6	10	9.4	Loamy sand

Location	Depth	pH	Exchangeable bases				Al+H	ECEC	BS	TN	OC	Avail. P
		$H_2$0	Ca	Mg	K	Na						
	(cm)		← (cmol/kg) →						← (%) →			(mg/kg)
Obudu hill	0-20	5.96	1.38	0.36	0.09	0.17	0.09	2.10	95.71	0.52	0.37	5.41
Bashua	0-20	5.68	2.12	0.53	0.12	0.136	0.11	3.02	96.36	1.90	4.55	8.37
Bashua	20-40	5.54	1.69	0.33	0.07	0.102	0.10	2.30	95.66	0.09	1.32	7.73

Table 4: Chemical properties of the soils

THEME: Varietal Development of Tea for Sustainable Circular Economy growth in Nigeria

TASK: Nursery establishment in the lowland

Experimental Title:- Field establishment of tea under varying watering regime and different shade levels in lowland agro-ecologies of Nigeria

Investigators: Adeosun, S.A., Ayegboyin, K. O.,Akanbi, O. S. O., Yahaya, A. T. and Famuyiwa, B.S.

Introduction:

Tea thrives well on Mambilla highland owing to its cool climate and slightly acid soil. Tea production in Nigeria is at marginal level because it is limited to the Mambilla highlands where expansion of tea production is constrained by poor land availability. The land constraint on Mambilla highland has necessitated the need to expand tea production to the warm lowland of southern Nigeria.

One major constraint to tea production in the lowland is high ambient temperature. High ambient temperature occasioned by high light intensity in greater part of the year in Southern Nigeria is detrimental to tea growth and survival in the area. However, producing tea in the lowland under shade of 45 - 65% light intensity has proven to be highly beneficial to tea production (Adeosun*et al*., 2019 and 2022). This was due to the fact that the entire photosynthetic apparatus of tea is adapted to function with maximum capacity under shade (Jannedra*et al*., 2007).

Moreover, inadequate and poorly distributed rain is another constraint to tea production in southern part of Nigeria. The complete cessation of rain in the dry season and its resultant excessive rise in ambient temperature causes soil water to fall below wilting point, thus leading to irreversible wilting of tea plants, especially in the absence of irrigation. This underscores the call for artificial watering of tea plants for it to maintain its vegetative growth during this period. Although, there is extremely dearth of information on irrigation of tea to enhance its field establishment, information obtained from field experience shows that tree crop (especially, cacao) farmers in Nigeria practice manual irrigation in order to obtain high field establishment in successive dry seasons after seedling transplanting. Therefore, this trial was aimed at investigating the effect of artificial watering on tea growth and field establishment under different shade levels in Ibadan and Ikom Stations of Cocoa Research Institute of Nigeria.

Objectives

1. To determine the effects of watering on the growth performance of established tea plants during the first dry season after transplanting.
2. To determine the optimum water regime that would enhance ≥70% tea seedling survival at the end of first dry season after seedling transplanting.

3. To determine the interaction effects of artificial watering and plantain shade on survival rate of cultivated tea plants at first dry season after seedling transplanting.

Materials and Methods

The experimental sites

This study was carried out in Cocoa Research Institute of Nigeria (CRIN) Stations in Idi-Ayunre, Ibadan, (Oyo State) and Ikom (Cross-Rivers State). Ibadan is located on Latitude 07º 10' N and Longitude 03^{o} 52' E, on 122m elevation above sea level in the tropical rain forest zone of Southwest Nigeria. Ikom is located on latitude 5º 54' N and longitude 8º 48' E, 128 m above sea level in the tropical rain forest zone of South-south Nigeria.

Experimental design and layout

This field trial comprises 2 factors which include plantain shade at 2 levels - plantain shade and zero shade; 5 watering regimes - watering at 40% FC (Field capacity) 2 times per week, 40% FC 3 times per week, 80% FC 2 times per week, 80% FC 3 times per week, zero watering (control). The experiment was laid out in Randomized Complete Block Design (RCBD) arranged in Split plots with 3 replications. Plantain shade served as main plots; watering regimes as subplots.

Land preparation and soil analysis

The land for the field trial was cleared. Field lay out was done and the site was laid out into three blocks. Each block comprised two main plots and 5 subplots. Five composite soil samples were collected from the sites with soil auger. Each composite sample was collected at 0 – 20 cm and 20 – 40 cm soil profile. The soils were bulked, air dried and assayed in a soil laboratory for physical and chemical properties. Soil pH (1:1 soil/water) was determined with pH meter, organic matter by Wet Oxidation method (Walkey and Black, 1934). Soil available P was extracted by the Bray PI and measured by the Murphy blue colouration and determined on a Spectronic 20 at 882µm (Murphy and Riley, 1962). Soil K, Ca and Mg were extracted with IMNH4 OAC. Phosphorus, magnesium and total nitrogen were determined with flame photometer, atomic absorption spectrophotometer and Microkjedahl methods, respectively (AOAC, 1990)

Sources of planting materials

Mature plantain suckers were sourced from CRIN stations in Ibadan and Ikom.

Healthytea cuttings of 143 cultivar were sourced from CRIN Substation in Kusuku, Mambilla, Taraba State.

Planting and application of treatments

Plantain was established at planting distance of 3 x 1.5 m (Adeosun, 2021). Tea clonal materials were planted at a spacing of 100 x 60 cm in the avenue (3 m wide) of two rows of plantain. Four tea clones of cultivar 143 were transplanted per plot in September 2022. In November, when the rain stopped, application of water treatment commenced. In the water treatment, 40% and 80% FC (Field capacity) of water was applied 2 and 3 times per week according to the layout. The water was applied manually at the base of the tea stands.

Data collection and analysis

The following growth parameters and survival count were measured starting from 5 MAT (Months after transplanting) on monthly basis: Number of leaves, Number of branches, Plant height and leaf area. The data were analysed with Analysis of Variance (ANOVA) using STAR (Statistical Tools for Agricultural Research) (2013) software, and significant means were separated with Tukey's Honest Significant Difference (HSD) Test (P=0.05).

Results and Discussion

Table 1 presents the physical and chemical properties of soils from Ibadan and Ikom. The particle size analysis result indicated that the soil in Ibadan contained 80.6% sand, 13.4% silts and 6.0% clay at the surface depth (0 -20cm) compared to 76.4% sand, 15.4% silt and 8.2% clay recorded for Ikom soil. The pH (H_2O) ranged from slightly alkaline 7.24 to slightly neutral 7.12 in Ibadan; while Ikom soil ranged from slightly acidic (5.48) to neutral (7.01). These values were slightly above the critical values of 4.5 – 6.5 (Egbe*et al*., 1989). However, with good cultural and other agricultural practices, tea cultivation in these areas is possible. The Ibadan soil is generally higher in total N, P, K, Mg, and ECEC compared to Ikom soil. However Ikom soil was better than Ibadan soil in base saturation, clay particles and organic carbon. The total N and K were low relative to the critical value of 4.5 – 5.0% N required for the sustainable tea cultivation as reported by Egbe*et al*. (1989). The Organic carbon and Mg are far above the critical level.

Table 1: **Pre-cropping particle size and chemical properties of soils used in the experiments**

PROPERTIES	**IBADAN SOIL**		**IKOM SOIL**	
	0 – 20cm	**20– 40cm**	**0 – 20cm**	**20 – 40cm**

pH ((1:1 soil/water)	7.24	7.22	7.01	5.48
PARTICLE SIZE ANALYSIS				
Sand (%)	80.6	82.6	76.4	60.4
Silt(%)	13.4	11.4	15.4	24.4
Clay (%)	6.0	6.0	8.2	14.2
EXCHANGEABLE BASES				
Mg (cmol/kg)	1.665	1.314	0.88	0.19
K(cmol/kg)	0.46	0.36	0.08	0.08
Na (cmol/kg)	0.317	0.256	0.08	0.10
Al +H(cmol/kg)	0.07	0.05	0.05	010
ECEC(cmol/kg)	7.05	5.33	6.21	1.51
Base Saturation (%)	99.01	99.06	99.19	92.72
Total N (%)	0.13	0.10	0.08	0.14
Total Org C (%)	1.550	1.130	1.58	2.62
Avail P (mg/kg)	9.11	7.51	6.13	10.57
MICRO – NUTRIENTS				
Fe (cmol/kg)	7.7	8.45	31.75	9.95
Cu (cmol/kg)	0.80	1.26	1.67	2.57
Zn (cmol/kg)	8.63	5.48	7.41	3.12
Mn (cmol/kg)	57.75	52.3	61.35	23.75

Shade and watering levels significantly (P=0.05) affected vegetative growth of tea as shown in tables 2-5. In table 2, tea grown under plantain shade produced more leaves than those grown without shade both in Ibadan and Ikom. Shaded tea produced 21.57, 21.80 and 27.30 leaves per plant in 5, 7 and 9 MAT, respectively at Ibadan compared to the unshaded tea that produced 6.70, 14.73 and 9.79 leaves per plant. This same trend was observed in Ikom. However, shaded tea did not differ significantly (P>0.05) from unshaded ones in number of branches; although, there was more branching under shade than under zero shade. In the same vein, tea under shade grew taller significantly (P=0.05) than the unshaded ones in Ibadan throughout the sampling periods. However, in Ikom, shade did not enhance any significant higher height, especially at 5-7 MAT. Similarly, leaf area of tea progressively increased under shade from 522.50 to 992.72 per plant at 5-7 MAT while leaf area under zero shade increased from 95.83 to 729.4 per plant at the same time, showing a significant higher values. However, in Ikom, although leaf area under shade was higher than that under zero shade, the different was not significant (P>0.05) (Table 5).

Watering regimes significantly (P=0.05) influenced vegetative growth of tea plants both in Ibadan and Ikom. In Ibadan, watering with 80FC twice per week enhanced the highest number of leaves and the highest leaf area throughout the sampling periods; while zero water produced the least number of leaves and leaf area at the same periods. Similar trend was observed in number of branches and plant height of tea in Ibadan as watering at 80FC twice per week caused the highest branches of 5.00 and plant height of 46.53 at 9 MAT which are significantly higher than the values under zero watering and watering at 40FC once per week. However, at Ikom, watering at 80FC three times per week was superior significantly to other watering regimes as it enhanced significantly higher number of leaves compared to 40 FC once per week, 80FC twice per week and zero watering; higher number of branches and plant height compared to all other watering regimes; and significantly higher leaf area compared to watering at 40FC per week and zero watering (9 MAT) (Tables 2, 3, 4 and 5).

On interaction between shade and watering regimes at 9 MAT, the highest number of leaves was caused by watering at 80FC twice per week under shade in Ibadan and watering at 40 FC thrice per week in Ikom. Highest number of branches, plant height and leaf area were caused by watering at 80FC twice per week under shade at Ibadan; while watering at 80 FC thrice per week under zero shade produced the highest number of branches at Ikom. Similarly, watering at 80 FC thrice per week under shade enhanced highest tea plant height and leaf area at Ikom.

Table 2: Effects of shade and watering regimes on number of leaves of tea plants on the field at Ibadan and Ikom

Treatments		**Ibadan**			**Ikom**		
Shade levels		**5MAT**	**7MAT**	**9MAT**	**5MAT**	**7MAT**	**9MAT**
S0		6.70b	14.73b	9.79b	15.10a	16.30a	21.83a
S1		21.57a	21.80a	27.30a	2193a	19.67a	29.77a
Watering regimes							
W_{12}		11.83bc	21.33a	17.33ab	14.92b	10.83bc	3.08c
W_{13}		17.67ab	21.25a	22.25a	22.83ab	13.25b	46.33ab
W_{22}		20.17a	21.00a	28.63a	27.00a	32.83a	21.33bc
W_{23}		19.00ab	14.50a	24.50a	27.83a	33.00a	58.25a
W_{00}		2.00d	13.25a	0.00b	0.00c	0.00c	0.00c
Watering x Shade level Regimes							
W_{12}	S0	15.00a	5.67b	11.00a	19.50a	19.33a	6.17a
	S1	27.00a	18.00a	23.67a	10.33a	2.33b	0.00a
W_{13}	S0	17.00a	6.33b	1.67b	19.67a	15.83a	23.17b
	S1	25.00a	29.00a	42.83a	26.00a	10.67a	69.50a
W_{22}	S0	12.00a	2.00b	11.27b	12.67b	24.33b	20.67a
	S1	29.00a	38.33a	46.00a	41.00a	41.33a	22.00a
W_{23}	S0	14.67a	19.50a	25.00a	23.67a	22.00b	59.17a
	S1	14.33a	18.50a	24.00a	32.00a	44.00a	57.33a
W_{00}	S0	14.00a	4.00a	0.00a	0.00a	0.00a	0.00a
	S1	12.50a	0.00a	0.00a	0.00a	0.00a	0.00a

Means with the same letters in a column under same treatment are not significantly different by HSD (P=0.05)

W_{12} = watering at 40% Field capacity two times per week;W_{13} = watering at 40% Field capacity three times per week; W_{22} = watering at 80% Field capacity two times per week; W_{23} = watering at 80% Field capacity three times per week; W_{00}= Zero watering (Control); MAT = Months after transplanting

Table 3: Effects of shade and watering regimes on number of branches of tea plants on the field at Ibadan and Ikom

Treatments		**Ibadan**			**Ikom**		
Shade levels		**5MAT**	**7MAT**	**9MAT**	**5MAT**	**7MAT**	**9MAT**
S0		1.23b	3.13a	2.00a	2.30a	2.33a	5.93
S1		4.73a	3.07a	4.37a	3.47b	3.73a	2.00a
Watering regimes							
W_{12}		2.17bc	4.33a	2.17ab	1.83bc	0.83c	3.42b
W_{13}		3.67ab	2.92abc	4.17a	4.75a	4.75ab	3.75b
W_{22}		3.67ab	3.67abc	5.00a	4.17a	5.83a	4.50b
W_{23}		4.08a	1.92c	4.58a	3.67ab	3.75b	8.17a
W_{00}		1.92c	2.08c	0.0b	0.00c	0.00c	0.00c
Watering x Shade levels regimes							
W_{12}	S0	2.00a	1.67b	2.33a	2.67a	1.67a	6.83a
	S1	2.33a	7.00a	2.00a	1.00a	0.00b	0.00b
W_{13}	S0	3.17a	1.33b	0.67b	2.50b	2.50b	4.17a
	S1	4.17a	4.50a	7.67a	7.00a	7.00a	3.33a
W_{22}	S0	2.67a	1.33b	1.33b	3.33a	5.00b	8.00a

S1	4.67a	6.00a	8.67a	5.00a	6.67a	1.00b
W_{23} S0	5.17a	0.83b	5.67a	3.00a	2.50b	10.67a
S1	3.00a	3.00a	3.50a	4.33a	5.00a	5.67b
W_{00} S0	2.67a	1.09b	0.00a	0.00a	0.00a	0.00a
S1	1.17a	3.17a	0.00a	0.00a	0.00a	0.00a

Means with the same letters in a column under same treatment are not significantly different by HSD (P=0.05)

W_{12} = watering at 40% Field capacity two times per week;W_{13} = watering at 40% Field capacity three times per week; W_{22} = watering at 80% Field capacity two times per week; W_{23} = watering at 80% Field capacity three times per week; W_{00}= Zero watering (Control); MAT = Months after transplanting

Table 4: Effects of shade and watering regimes on plant height (cm) of tea plants on the field at Ibadan and Ikom

Treatments	**Ibadan**			**Ikom**		
Shade levels	**5MAT**	**7MAT**	**9MAT**	**5MAT**	**7MAT**	**9MAT**
S0	22.74b	40.18a	18.22b	25.77a	28.21a	33.22a
S1	39.62a	41.42a	42.44a	36.67a	25.83a	26.47a
Watering regimes						
W_{12}	39.93a	28.38a	29.40a	21.83b	21.69b	20.71bc
W_{13}	46.53a	37.19a	34.33a	32.17b	36.00a	35.75b
W_{22}	47.20a	40.48a	46.53a	36.83b	39.89a	31.00b
W_{23}	41.07a	37.83a	41.38a	65.25a	37.52a	61.75a
W_{00}	29.28a	12.00b	0.00b	0.00c	0.00c	0.00c
Watering x Shade levels regimes						

W_{12}	S0	39.20a	16.67b	12.70b	33.50a	38.88a	41.00a
	S1	40.67a	40.10a	46.10a	10.17b	4.50b	0.00b
W_{13}	S0	44.20a	31.07b	14.47b	28.67a	31.67a	26.50a
	S1	48.87a	43.32a	54.20a	35.67a	40.33a	45.00a
W_{22}	S0	39.30a	21.80b	31.40b	29.17b	35.28a	40.00a
	S1	55.10a	59.17a	61.67a	44.50a	44.50a	22.00a
W_{23}	S0	47.40a	31.47b	32.53b	37.50b	35.20a	58.67a
	S1	34.73a	44.20a	50.23a	93.00a	39.83a	65.33a
W_{00}	S0	30.82a	12.70a	0.00a	0.00a	0.00a	0.00a
	S1	27.75a	11.30a	0.00a	0.00a	0.00a	0.00a

Means with the same letters in a column under same treatment are not significantly different by HSD (P=0.05)

W_{12} = watering at 40% Field capacity two times per week;W_{13} = watering at 40% Field capacity three times per week; W_{22} = watering at 80% Field capacity two times per week; W_{23} = watering at 80% Field capacity three times per week; W_{00}= Zero watering (Control); MAT = Months after transplanting

Table 5: Effects of shade and watering regimes on leaf area (cm^2) of tea plants on the field at Ibadan and Ikom

Treatments	**Ibadan**			**Ikom**		
Shade levels	**5MAT**	**7MAT**	**9MAT**	**5MAT**	**7MAT**	**9MAT**
S0	95.83b	152.02b	729.46b	244.15a	290.37a	592.94a
S1	522.50a	648.18a	992.72a	312.65a	377.29a	867.25a
Watering regimes						
W_{12}	841.46b	252.91cd	498.11a	82.45b	194.95bc	79.91b
W_{13}	1019.62ab	462.91abc	542.40a	475.55a	389.26b	1285.68a

W_{22}	1428.76a	604.07a	608.82a	331.71a	389.73b	306.64b
W_{23}	730.26bc	226.05d	351.18a	502.30a	690.21a	1978.26a
W_{00}	285.35c	0.00e	0.00b	0.00b	0.00c	0.00b
Watering x Shade levels regimes						
W_{12} S0	420.54b	206.78b	151.57a	159.26a	368.82a	159.81a
S1	1262.37a	789.43a	354.25a	5.62b	21.08b	0.00a
W_{13} S0	954.15b	148.18b	62.51b	339.57b	295.40b	756.63b
S1	1085.09a	936.63a	863.11a	611.53a	483.12a	1814.72a
W_{22} S0	1188.33b	47.75b	84.23b	251.73b	328.38a	0.00b
S1	1669.19a	1169.90a	1123.91a	411.69a	461.08a	613.29a
W_{23} S0	754.69a	357.40a	180.87a	470.18a	459.25b	2048.28a
S1	705.84a	344.97a	271.23a	534.41a	921.17a	1908.25a
W_{00} S0	329.58a	0.00a	0.00a	0.00a	0.00a	0.00a
S1	241.13a	0.00a	0.00a	0.00a	0.00a	0.00a

Means with the same letters in a column under same treatment are not significantly different by HSD (P=0.05)

W_{12} = watering at 40% Field capacity two times per week;W_{13} = watering at 40% Field capacity three times per week; W_{22} = watering at 80% Field capacity two times per week; W_{23} = watering at 80% Field capacity three times per week; W_{00}= Zero watering (Control); MAT = Months after transplanting

Table 6 shows better seedling establishment under shade compared to zero shade in Ibadan, unlike in Ikom where survival of tea was not different under shade compared to zero shade. In Ibadan, 70% of transplanted tea plants under shade survived the first dry season compared to 28% that survived without shade. Watering at 80FC thrice per week enhanced tea survival at

Ibadan and Ikom, while the least survival was caused by zero water. However, there was more tea survival in Ibadan (89%) than in Ikom (79.17%). In Ibadan, the interaction of watering at 80FC thrice per week with shade produced the highest survival of 100%, which was significantly higher than tea survival of 78% caused by the same watering without shade. In Ikom, however, although watering at 80 FC twice and thrice per week under shade produced the highest survival of 83.33%;it was not significantly higher than the survival of 75% it caused without shade.

From the results above, it is apparent that the growth and survival of tea planted was enhanced in watered tea plants grown under plantain shade in the dry season at Ibadan and Ikom. This underscores the essentiality of watering of tea to its survival in the dry season when light intensity is brightest, ambient temperature is highest and rainfall is at lowest level. It explains the importance of water to tea growth and field survival. Water is essential for photosynthesis, chemical reactions, transpiration and translocation of photo-assimilate in plants (Fatubarin, 2003).

All tea grown under zero water and many of those that received little water (40FC twice per week) did not survive the first dry season in both locations. This indicates that poor water availability in the soils led to negative water potential in the leaf and also precipitated flaccidity, closure of the guard cells and resultant inhibition of diffusion of CO_2 into the leaf, thus limiting the photosynthetic capacity of the leaf: a fact which corroborates the findings of Smith *et al.* (1993) and Sivapalan (1993). Growing tea without shade in the dry season could lead to excessive rise in leaf temperature and evapo-transpiration which makes soil water less available for plant growth and build up of vapour pressure gradient between the leaf and the surrounding air (Hopkin, 1995). These findings corroborate Adeosun*et al.* (2022) and Adeosun (2023) who concluded that growth of tea was significantly undermined when grown without shade in the dry season. Tea grown under plantain performed better than those grown in the open. This might be because, at lower light intensities occasioned by shade, soil water is conserved as a result of reduced evaporation, thus making enough water, an important reagent for photosynthesis available for plant use (Mohotti and Lawlor, 2002).

Generally, tea performed better in Ikom than in Ibadan because of the slightly acidic soil of Ikom which enhanced tea growth (Egbe *et al.*, 1989). Besides, unshaded tea plants performed better in Ikom than in Ibadan probably because Ikom soil is richer in clay particle. The higher proportion of clay in Ikom soil might have enhanced better conservation of soil water, making more water available for tea growth.

Table 6: Effects of shade and watering regimes on seedling survival count (%) of tea plants after the first dry seasonon the fieldat Ibadan and Ikom

Treatments		**Ibadan**	**Ikom**
Shade levels			
S0		28.93b	53.33a
S1		70.00a	53.33a
Watering regimes			
W_{12}		55.50ab	45.83b
W_{13}		52.83b	62.50ab
W_{22}		50.00b	79.17a
W_{23}		89.00a	79.17a
W_{00}		0.00c	0.00c
Watering x Shade levels Regimes			
W_{12}	S0	33.33b	66.67a
	S1	77.67a	25.00a
W_{13}	S0	16.67b	50.00a
	S1	89.00a	75.00a
W_{22}	S0	16.67b	75.00a
	S1	83.33a	83.33a
W_{23}	S0	78.00b	75.00a
	S1	100a	83.33a

W_{00}	S0	0.00a	0.00a
	S1	0.00a	0.00a

Means with the same letters in a column under same treatment are not significantly different by HSD (P=0.05)

W_{12} = watering at 40% Field capacity two times per week;W_{13} = watering at 40% Field capacity three times per week; W_{22} = watering at 80% Field capacity two times per week; W_{23} = watering at 80% Field capacity three times per week; W_{00}= Zero watering (Control); MAT = Months after transplanting

Conclusion and Recommendations

Tea plants were grown in Ibadan and Ikom under different shade levels and artificial watering in the dry season, a time when rainfall almost completely ceased. Through monitoring of the trial in the two locations, it was found that artificial watering of tea is highly indispensable in both locations as watering at 80FC twice per week in Ibadan and thrice per week in Ikom enhanced more than 70% tea survival after the first dry season, as well as its steady and uninterrupted growth during the dry season. However, growing tea under plantain shade is more desirable in Ibadan than in Ikom as shade enhanced the effectiveness of watering more in Ibadan. Therefore, it is recommended that tea should be maintained in early years of field establishment in the dry season with watering at 80FC twice per week in Ibadan, and this can be done under plantain shade of 2222 plants/ha; while watering at 80FC thrice per week in the dry season can be applied by tea farmers with or without plantain shade in Ikom.

Report 6

Task: Land suitability mapping for tea in Cross River State

Experimental Title:- Prevailing climatic variables and cropping systems as indicators for tea cultivation using GIS in selected locations of Cross River State.

Investigator:- Oloyede, A.A, Obatolu,B.O.,Okeniyi,M.O and Ayanwole,S.A

Introduction

Tea (*Camelia sinensis*) a temperate and sub-tropical beverage crop popularly grown for different brands and types of tea; black tea -made from fermented tea leaves; oolong tea- made from partially fermented leaves; green tea made from unfermented tea leaves and white tea made from unfermented leaves buds of tea this is an elitist tea brand as it is expensive and highly medicinal.

Tea was introduced to the high land of Mambilla Plateau in the early 80s. the introduction of this important beverage crop has resulted in springing up of the Nigeria Beverage Production Company initially produced by the Gongola State Government, presently been managed as public liability company. Tea cottage industries are springing up as well.

As important as this crop is to the farmers and the companies, there is limited land to its cultivation. This is due to competing demands viz; livestock, forest plantation, food crops and infrastructural projects. The above limitation has led to adaptation trials on some of the available tea clones on the Mambilla Plateau in the lowland areas of Nigeria. The trials have led to discovery of some adaptable clones to the lowland areas in Ibadan (Oyo State), Ajassor, Iyanonmon (Edo State), Akwete (Abia) and Ikorodu (Lagos State). The identified adaptable clones are C143, C318, C35, C357 and C236. Of the above listed, the first two, C143 and C318 are outstanding.

In the recent times, some tea seeds brought from China by the duo of Omolaja and Aroyeun were sown on the Mambilla plateau. The seedlings derivable were then established with obvious segregation. These when planted out manifested a lot of morphological variations. About 37 biotypes of these were then brought to Ibadan for further evaluation by Olaniyi (Olaniyi*et al*., 2015). He identified another four of the China tea coded as NGC17,18, 25 and 40. The yields were comparable with C143, C318 and C357.

Objective:

To identify low altitude as well as unexploited highland areas in the Southern part, land suitable for tea production

Materials and Methods

This work involves land suitability mapping through the use of GIS and ground truthing, which mostly involved farmers' focus group discussion, interactive session and visual observation of the ecosystems of the selected locations.The farmers were organized through coffee and tea farmers association of Nigeria [NACOFTAN] in the locations.The locations were Ajassor (Etung LG), Basua [Boki LG] and Obudu (Obanliku LG)

Results and Discussion

Short History of Obudu Ranch as Recounted by Mr. Sidney Ayile

In 1949 when Mack Collins exploited, hunters were the ones occupying the Plateau. Collins was flying a craft over the Plateau in June/July/ August, the atmosphere was foggy and so cannot land there.. When the fog eventually cleared, he landed. On seeing Collins, the hunter scampered for safety. Some of the hunters eventually came back. He eventually informed them of his intention to start rearing cattle on the Plateau- this was the beginning of cattle rearing on the Obudu Plateau.

Cropping systems on the Obudu plateau Cross River State

Obudu plateau apart from tourism is noted for production of crops like maize, irishpotatoe, banana, strawberry,lettuce, cabbage,cucumber, spinach, tomato. This findings was corroborated by John et al(2019) who listed some of these crops as grown on Obudu. We were even informed of the Cross river State Government establishing hectares of Irish potato at a particular time.

Forest trees: Eucalyptus**,** Cypress- these trees are also found on the Mambilla plateau as timber species either sole or as intercrop with tea. This also indicate similarity in the ecology of the two plateaus

Notable Non-Timber Forest Products

We discover in the botanical garden: tea shrubs that almost attaining timber status and *Aframomummelegueta*(Guinea pepper)- an herbaceous perennial plant native to swanpy habitat along the West African coast, this species belong to Zingiberaceae family. Uses for cultural and medicinal values are documented (Francois (2018)

Tea as a botanical on the Plateau and as life fence

It was discovered that tea is already present on the Obudu cattle Ranch without the residents knowing the import of it.A particular resident discovered that goats cherished the tea fruits as feed. The use of tea as life fence and goat feed was discovered, such has not been reported in Nigeria, however Steve et al(2022) reported the use of green tea in poultry feed with success

The resident also make use of the tea as life fence to prevent intrusion to his premises, the luxuriant growth of tea stands at the botanical garden(Plates 1&2) is a good indication that tea will thrive very well on the Obudu Plateau. In our interaction with the residents they know tea as a medicinal plant however they don't know which part is used in processing tea as a beverage. They are very willing to receive training along production chain of tea.

Altitudes at the selected locations

Geographical locations are as indicated in Table 1 revealed the altitudes of 1519-1550m asl fall within the ideal for upland tea production as we have at the Mambilla plateau. Though Ajassor and Bashua have lower altitude (122.1m and 108m asl), the result obtained at CRIN Ajassor Substation on adaptation trail has manifested the imperativeness of suitability at lower altitude.

Climatic variables and pH in the study locations

The pH of the soils and climatic variables of temperature, rainfall and relative humidity as indicated in Table 2 fall within normal limits(Global Tea science,2018). These are very important indicators for tea cultivation.

Conclusion and Recommendations: from the results gotten from this study considering the pH of the soils and favourable climatic variables of temperature, rainfall and relative humidity, it could be concluded that Cross River State either at a high altitude area of Obudu(1,519-1550m asl) and lower altitude of Ajassor and Bashua ,considering adaptability of some notable clones of C143 , C318 and some selected NGC series is a good destination point for tea cultivation in Nigeria.

We therefore recommend that training along value chain should commence as the farmers through NACOFTAN and even the paramount rulers in the selected locations are ready to cultivate and even process tea thereby boosting the economic diversification of FGN through agriculture. Integration of tea with forest trees(eucalyptus and cypess),choice food crops and Non-Timber Forest Products is as well recommended.

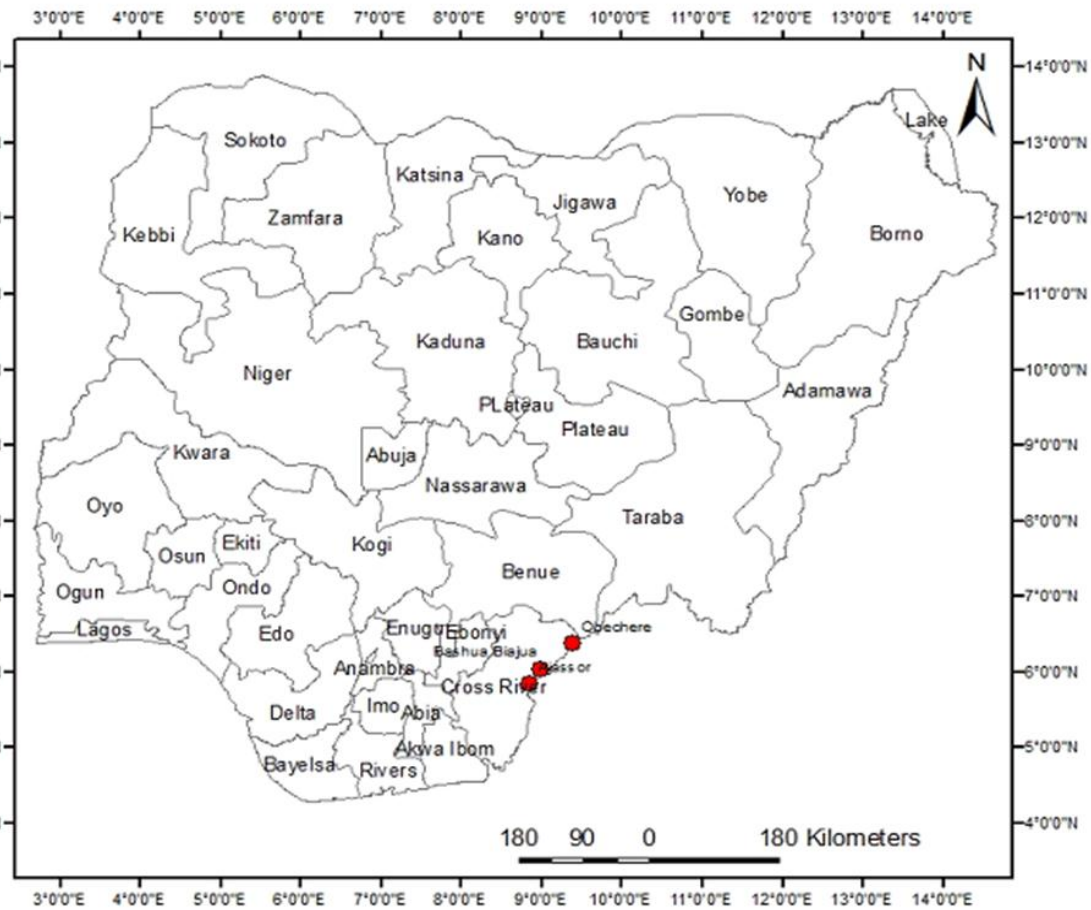
Constraints: inadequate, untimely funding and deplorable state of roads

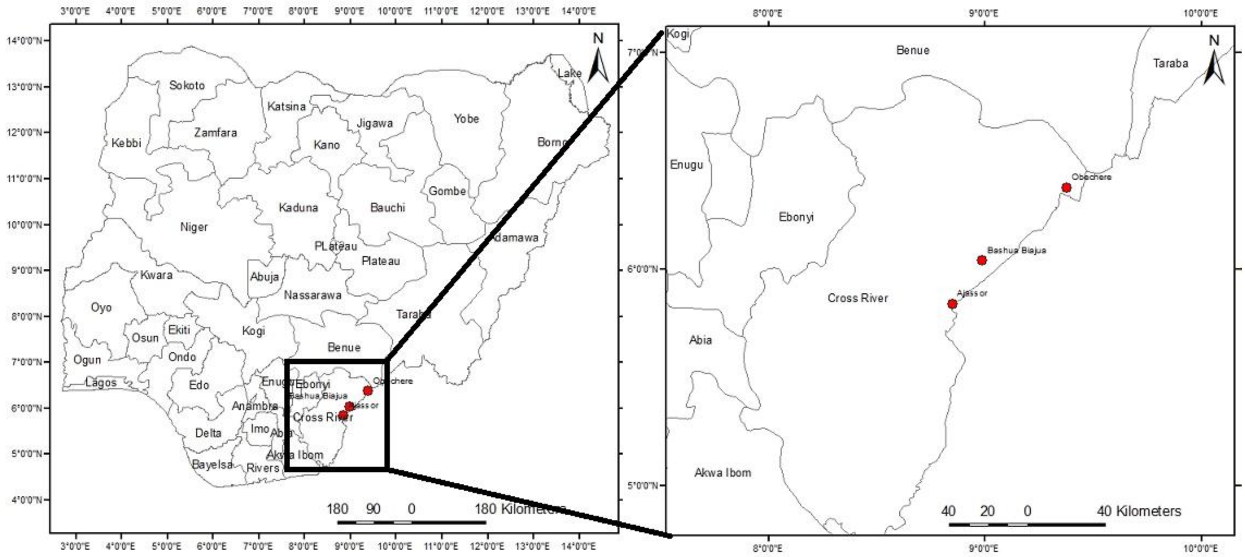
Plates 1&2: Fully grown tea stands at the Obudu botanical garden

Edaphic and Climatic variables in the study locations

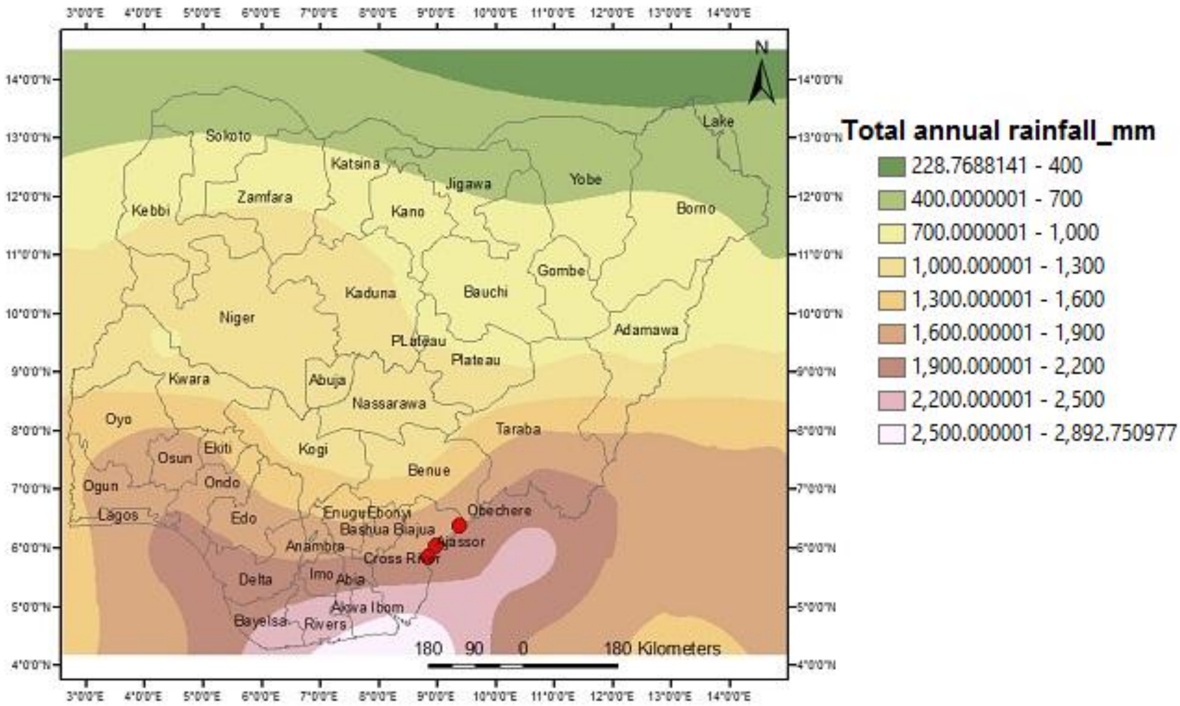
Edaphic and Climatic Variables in the Study area (Ajassor, Bashua and Obudu Cattle Ranch)



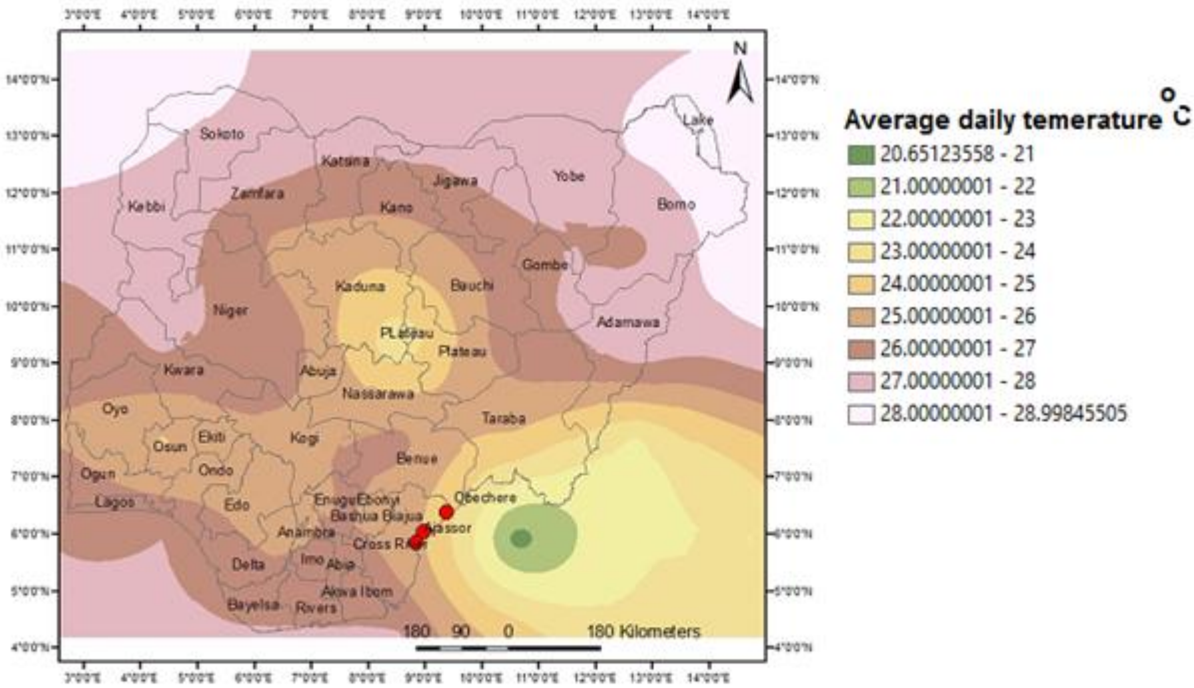
Map indicating visited locations



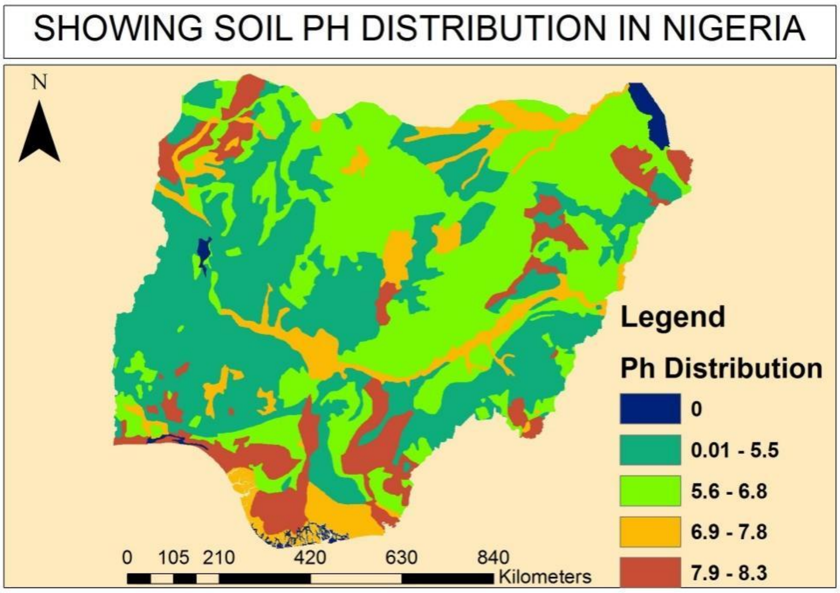
Calll out map indicating visited locations in Cross rivers state

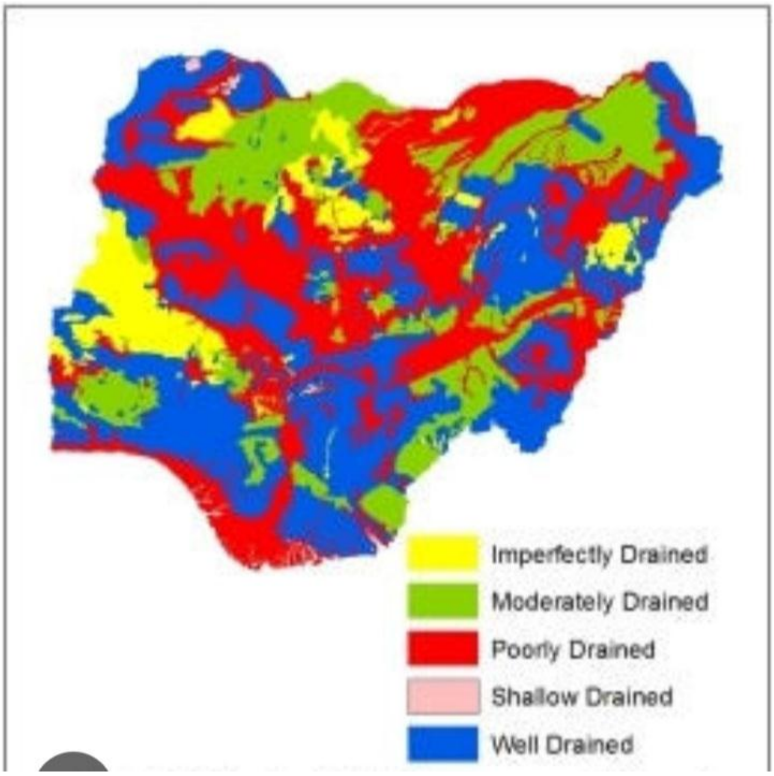


Distribution of total annual rainfall in Nigeria and visited locations



Average Daily Temperature of the study area





Map showing soil drainage of Nigeria

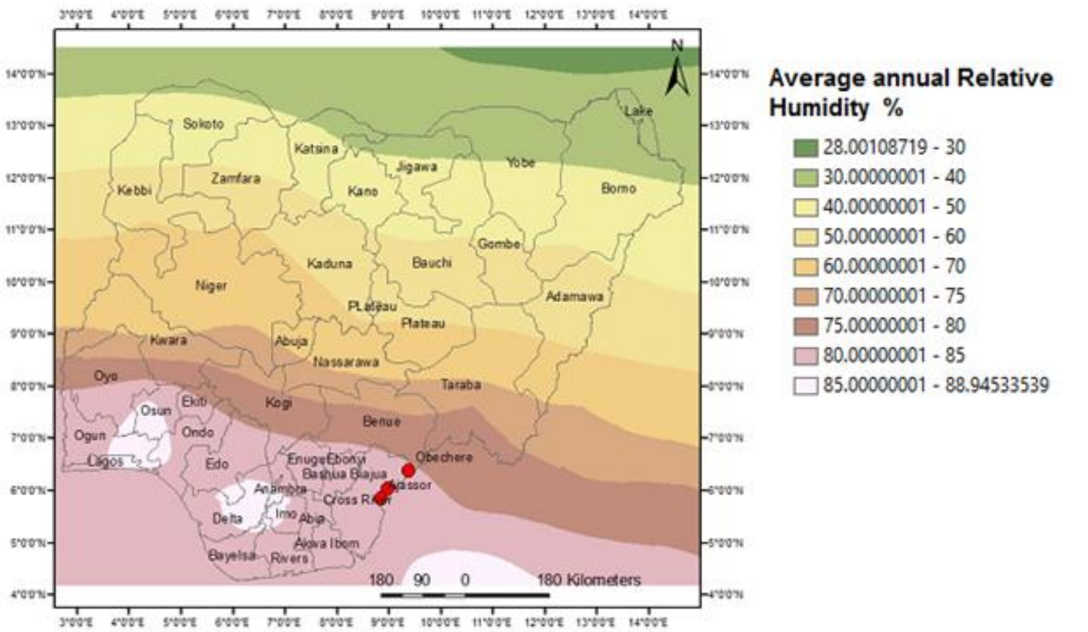


Figure 3: Average annual Relative Humidity

Table 1: GPIS LOCATIONS

LOCATIONS VISITED WITH GPIS				
Location	Altitude (m asl)	Latitude	Longitude	Local Govt
Obudu ranch	1.519.2	6.376666N	9.378738E	Obanliku
Village Head Palace	1,549.9	6.362784N	9.380164N	Obanliku
Kigol Community	1,530	6.361411E	9.379333E	Obanliku
BashuaBiajua	122.1	6.041531N	8.986014E	Boki
Ajassor	108	5.841701N	8.850313E	Etung

Table 2: Climatic variables and pH of the study Areas

Climatic variables	Normal Range	Bashua	Ajassor	Obudu(Obechere)
Temperature	13-26^{0}C	25-26	24-25	23-24
Rainfall(mm)	800-2500	1600-1900	1900-2200	1900-2200
Relative Humidity(%)	70-80	80-85	80-85	75-80
880Soil pH	3.5-6.5	5.2-6.10	4.8-7.10	4.7-5.7

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Report 7

Task: Land Suitability Mapping For Lowland Tea

Experimental Title:- Diagnostic assessment of pest and diseases prevalence for potential land suitability determination for lowland tea.

Investigator:- Agbeniyi, S.O., Adedeji, A.R., Orisajo, S.B., Okeniyi, M.O., Otunonye, A.H., Ogundeji, B.A., Ayanwole, S.A., Oladigbolu, Y.O., Omoleye, M.T., Laoye, F.T. and Olorunleke F.O.

Introduction:

The Food and Agricultural Organization (FAO) recommended a land suitability assessment approach for crops in terms of suitability ratings ranging from very highly suitable to unsuitable based on climatic and terrain data, as well as soil properties. Land suitability evaluation according to FAO standards has been applied in many parts of the world, particularly in the developing countries.

Also, land use planning for tea by individual site assessment using the traditional method is subjective and a time-consuming procedure. Although a few studies have been undertaken to map the suitability of lands for tea cultivation, they did not cover the entire tea-growing region of the country. In the given context, no initiative has yet been taken by the Cocoa Research Institute to classify land or existing tea-growing areas to varying degrees of suitability.

The land suitability assessment for tea is important for identifying the potential areas for maximizing the production and to suggest ameliorating measures for better crop management [Ghalod*et al.*, 2017]. The suitability analysis allows recognizing marginal suitable areas which facilitate decision makers to identify limiting factors and enable them to formulate appropriate management decisions (i.e., new planting, replanting, infilling, diversification, and adopting climate-friendly best practices) for increasing the productivity of the land. An exhaustive study needs to be carried out to determine appropriate land use in the unproductive estates giving due consideration to other factors such as pests and diseases. Also, this allows stakeholders to identify new areas where tea can be planted in accordance with the requirements of the tea crops, emphasizing the qualities of the land unit. Hence, matching crop requirements with available resources through land suitability analysis has become an urgent need to sustain agricultural land productivity in Nigeria.

Objectives:

In view of the above, this research is therefore aimed at determining the specific roles of fungal pathogens in the soil samples with a view of determining suitable land for potential development of lowland Tea.

Materials and Methods

Collection of Samples:

Soil samples was randomly collected and pooled together from the different locations. The samples were subjected to both quantitative and qualitative analyses in order to determine associated pathogens and the microbial population.

Soil samples were obtained from Tea plots in Cross River (Obudu Cattle Ranch and Ajassor Sub Station) transported in sterile Ziploc bags, to the Mycology Laboratory, Plant Pathology Section. Serial dilution was done on the soil samples and were inoculated in freshly prepared potato dextrose agar (PDA), and incubated at 30±2^{o}C for 5-7 days.

Results and Discussion

Five fungi isolates were isolated from soil samples collected from the Tea plots are *Aspergillusniger*(188.3%), *Fusarium*spp. (55.5%), *Rhizopus* spp. (25.00), *Rhizopusstolonifer* (20.00), *Lasidioplodiatheobromae* (11.1%) were isolated from Tea soil samples, while *Aspergillusniger* had the highest average percentage occurrence (62.77%) and *Lasidioplodiatheobromae* had the lowest average percentage occurrence (3.7%) (Table 1). This suggests that *Aspergillusniger*isolates were in large percentage in Tea plot at Cross River State.

Table 1: Occurrence of fungi associated with tea samples

Tea samples	Percentage occurrence of fungi isolates (%)				
	A. niger	*Fusarium* spp.	*Rhizopus Stolonifer*	*Rhizopu ssp.*	*Lasiodioplodia Theobromae*
T_1	75.00	-	-	25.00	-
T_2	33.30	55.5	-	-	11.1
T_3	80.00	-	20.00	-	-
Total	**62.77**	**18.5**	**6.67**	**8.33**	**3.7**

Conclusion and Recommendation

Findings from this preliminary study revealed *Aspergillusniger*showed higher association/affinity with tea cultivation compared with other soil organisms. This shows that tea could be exposed to various soil pathogens in their natural ecologies. Further work however still needs to be done to ascertain the pathogenicity of these soil organisms.

Tea Programme

Task**:** Multiplication of adaptable tea clones through stem cutting for expansion of tea cultivation in the low land.

Research Title: Multiplication of planting materials for expansion of tea cultivation to Cross River State

Investigators: Ayanwole S.A., Okeniyi M.O., Oloyede A.A., Adeosun S.A., Olaniyi O.O., Orisajo S.B., and Yahaya A.T.

Introduction

Tea was introduced into Nigeria in 1952 on Mambilla highland along Gembu, Arrdo-Gori, Kususku, Kakara, Maizat-mari and Ngoroje axis (Hainsworth, 1981; Adedeji, 2006). Commercial tea cultivation started in Nigeria in 1982. The confinement of commercial tea production to Mambilla highland was orchestrated by the fact that the highland is adjudged the most suitable ecology for tea production in Nigeria. This is as a result of its cool environment and acidic soil which are the main climatic and edaphic requirement for tea growth and development. However, the expansion of tea production has been constrained by the limited land availability for tea cultivation on the highland. This has necessitated the need to explore new areas for tea production. The new area which have potentials for tea cultivation include Ibadan, Iyanomo (Edo State), Akwete (Abia State), Ikorodu (Lagos State) and Ajassor (Cross River State) where tea adaptability trials have been successfully established (Omoloja and Esan, 2005). Among these locations, Ajassor is outstanding in enhancing tea growth and establishment because of its acidity soil as well as heavy and widespread rainfall. These attributes qualify Ajassor to be selected as site for tea expansion. This lead to training and sanitization programme organized for prospective tea farmers in the location in 2022. In the training, many of the farmers developed interest in tea cultivation. However, they needed to be empowered with planting materials which were not readily available at the time of training. Therefore, this project is aimed at multiplying tea clonal materials for distribution to farmers at affordable cost.

Objectives

To multiplicate planting materials for expansion of tea cultivation in Ajassor in Cross River State through stem cutting.

Materials and Methods

Nursery Establishment:

Top soil for filling of polythene bags was obtained from Ajassor. Pots were filled with top soil first at the base of the pot to about 2/3 full followed by the sub soil to fill the remaining 1/3 portion. The pots were arranged in rows making a total of 1000 per block and a total of 6,000 in all.

Source of Tea cutting:

Tea cuttings used were obtained from Tea plots in Ajassor Substation, the clone from which vegetative propagation was 318. The mother bushes were pruned two months before the leaf cutting was obtained.

Materials used:

IBA- routine, budding knife, hand trowel, butanol, secateurs, polythene bag, top soil and polythene sheet.

Procedure

3 – 5 suitable cutting per shoot and 15 – 25 shoots could be obtained from a well maintained mother bush. Only single node cuttings from a suitable shoot was used. The cuttings used consist of leaf containing about 2.5cm of stem below it and about 0.5cm of stem above it. The internode cuttings are prepared by giving a top cut immediately above the axillary bud parallel to the leaf blade. The cuttings was dropped into a water container immediately after the cut and were planted as soon as possible without leaving them to dry out. One cutting was planted per bag by inserting vertically down into the soil. 2 grams, of IBA-routine hormone were prepared in butanol of 1 liter to stimulate root growth; this enhances the chances of successful rooting. Soil in the polythene bags was lightly watered and gently pressed prior to inserting cuttings to ensure firm anchorage. Propagation was done under a sealed polythene tunnel to have considerable savings on water and labour. Planting of cuttings should be done in the manner the leaves are oriented in one direction at an angle to the row. After cuttings are planted, the bags as well as the beds are given a thorough watering and covered immediately with a transparent, 300 guage polythene sheet, resting on semi-circular bamboo hoops. The edges of the sheet are buried well on all four sides and made air-tight to create a propagating environment. No additional watering is required in the tent as the water applied initially would be adequate for internal circulation within the tent. The condensed water was placed back in the potted bags by gently tapping the surface of the tent at frequent interval in the mornings. The cover could was retained for 3 months, depending on the rate of growth, and removed in stages extending over a few days for hardening.


Plate 1 and 2: showing the arrangement and dipping of cutting in routine hormone


Plate 3 and 4: showing the planting and covering of the bed with polythene

Results and Discussion

Three months after propagation, a success rate of above 80% was recorded (Table 1). The seedlings are currently undergoing hardening process. This result was in tandem with the work of Topacoglu *et al.*, 2016 which showed that IAA had the highest rooting percentage.

Table 1: The percentage survivor of Tea stem cuttings treated with IAA rooting hormone.

BLOCK	Percentage Survivor (%)	Percentage Mortality (%)	New leaves		New shoots	
			Number	Area (cm)	Number	Length(cm)
1	80c	20c	2.42	3.09	1.0	8.5
II	75e	25e	2.12	2.74	1.0	8.0
III	85b	15b	2.6	3.20	1.0	8.6
IV	90a	10a	3.0	3.67	1.0	8.8
V	68f	32f	2.50	63	1.0	8.6
VI	77d	23d	2.32	2.98	1.0	8.7

The result showed that the percentage survival ranges from 68 to 80 in all the six blocks. The highest percentage survival was obtained from block IV and for new leaves formed it ranges from 2.12 to 3.0 which was the highest. The number of shoots formed was the same across the blocks. There was no significant difference in the length of shoots. According to Kathiravetpillai *et al.*, 1982, the use of a sealed polyethylene cover to propagate cuttings has the advantage that it effects considerable saving of water and of labour and this method could be expected to promote faster vegetative growth due to the higher temperature and humidity that prevails within.

The result of this study indicated the important role of determining the optimal rooting medium in the process of vegetative propagation. Retention of leaves seems to be necessary fo the cuttings as they do not have very large reserves. The ability of cuttings to survive and produce long and massive root is very important Kathiravetpillai *et al.*, (1982).

 

Plates 4 and 5 showing the success rate

 

Plate 6 and 7

Conclusion

This study has clearly shown that adaptable tea clones can be successfully propagated in the lowland as against the belief that it can only be done in the upland.

Programme: Tea

Task: Land Suitability Mapping

Experimental Title:- Assessment of Land Availability and Its Suitability for Lowland Tea Cultivation in Cross River State, Nigeria.

Investigator:- Oluyole, K.A., Dada, A.O., Oladokun, Y.O.M. and Okeniyi, M.O.

Introduction

Camellia Sinensis (L) Kuntze was discovered in China in about 2700 B.C. Tea was discovered in South-East Asia perhaps in the province including the sources and high valleys of the Brahmaputra, the Irranwaddy, the Salween and the Mekong rivers at border separating India, China, and Burma. Tea is an evergreen bush which when cultivated is kept at a low height to enable the young branches from which tea is plucked. Presently, globally compared to other agricultural industries, the industrial tea industry has attained a huge degree of stability (Famaye, 2006).

The Nigerian Beverages Production Company (NBPC), Mambilla Plateau, introduced tea clones from Kenya into Nigeria for commercial planting in 1972 (Olaniyi *et al*., 2014; Hainsworth 1981). The tea clones were later acquired by Cocoa Research Institute of Nigeria (CRIN) for research purposes in 1982 (Esan, 1982). In Nigeria, tea is exclusively grown in the humid, high altitude regions of Mambilla Plateau in Taraba State. The average yield of tea on commercial plots on the Mambilla is 1.5 t/ha (Chen *et al*., 2012). At present, the supply of tea from these regions is inadequate to meet the demand of the local tea processing industries (Adeosun *et al*., 2022; Olaniyi et al., 2014; Obatolu and Ipinmoroti 2000). Indeed, less than 30% of the tea leaf raw material requirement of the local processing industries is met. However, the expansion of tea fields and the opening up of new areas to meet this supply shortfall has proven difficult, because Mambilla Plateau, where most tea is cultivated, has limited land area available for commercial cultivation, and there are land use conflicts, including cattle grazing and industrial and residential purposes. The available alternative is therefore to test tea in the lowland ecological areas of Nigeria, where expanded tea cultivation might be possible. Tea production can contribute immensely to food security and poverty alleviation in Nigeria if much attention is given to improvement.

In Cocoa Research Institute of Nigeria, efforts have so far been made to adapt tea to lowland areas of Nigeria viz-a-vis Ibadan (Oyo State), Ikom (Cross River Estate), Ikorodu (Lagos

State) and Mayo-Selbe in (Taraba State) (Olaniyi *et al*., 2014). Until recently too in Owena (Ondo state). Farmers in these locations have been involved in the cultivation of several crop enterprise (arable and tree crops). Even though the soils in these areas are suitable for lowland tea but are they available? This study will therefore examine land availability and its sustainability for lowland tea cultivation in Nigeria.

Objectives

The objectives of the study were to:

(i) determine the land availability for lowland tea cultivation

(ii) determine the land suitability for lowland tea cultivation

Methodology

The study was carried out in Cross River State of Nigeria. A multistage random sampling was used to select respondents for the study. The first stage is purposive selection of Cross River state. The second stage is the random selection of three Local Government Areas (LGAs) namely Boki, Etung and Obanliku. The third stage is the random selection of one community each from each LGA. The selected communities are Bashua from Boki LGA, Ajassor from Etung and Obudu Cattle Ranch from Obaliku LGA. One hundred and twenty questionnaires were distributed based on proportionate to size. After sorting out for missing data one hundred respondents' information were used for analysis. The data retrieved from the information collected were analysed with the use of descriptive statistics and correlation analysis.

Results and Discussion

Table 1 presented the socio-economic characteristics of farmers in Cross River State. Six out of ten respondents were males. There were more male farmers in the study area compared to the female farmers. The mean age of the farmers was 44 years. Farmers in the study area were mostly middle aged and thus might be more willing to try out new innovations and techniques. They may also be willing to try out the planting of lowland tea on their farms. Majority of farmers in the study area were married. This means that they would have more persons in their households that could be used as family labour thus the cost of labour would drastically reduced.

Table 1: Socio economic characteristics of the farmers

Variable	Frequency	Percentage

Gender		
Male	65	65.0
Female	35	35.0
Age		
< 30	19	19.0
31-60	69	69.0
>60	12	12.0
Mean 44		
Marital status		
Single	16	16.0
Married	84	84.0

Source: Field survey, 2023

Table 2 presented land availability for lowland tea cultivation. Eighty eight percent of the farmers inherited their farmland. This could serve as a hindrance to the adoption of lowland tea as they might want to continue with what their fathers have been planting on the farms. Also, on the other hand, most of these farms may have their nutrients depleted as a result of long years of usage thus if organic/inorganic fertilisers are not added to the soil this could cause the low output of tea thus hindering the total adoption of tea by the farmers. Majority (89%) of the farmers do not have disputes on their farmland. This is a good factor in enhancing the production of lowland tea in the study area. Farmers in the study area grow arable and tree crops on their farm. Twenty seven percent grow arable crops, 38% grow tree crops and 35% grow both. Ninety nine percent of the respondents affirmed that the crops they grow on their farmland are doing well and all the farmers agreed to the establishment of tea on their farm. This is good as it aligns with the plan of Cocoa Research Institute of Nigeria in establishing lowland tea in areas discovered to be suitable in which the study area is part of it. Fifty percent of the respondents agreed that they could use half of their farmlands to grow tea. Seven out of ten farmers agreed that their farms can be used as demonstration/model farms where other farmers can come to see how tea farm is established and maintained.

Table 2: Land availability for lowland tea cultivation

Variable	Freq.	%
Land ownership		
Inherited	88	88.0
Purchased	12	12.0
Dispute on land		
Yes	11	11.0
No	89	89.0
Crops grown on farmland		
Arable crops	27	27.0
Tree crops	38	38.0
Both	35	35.0
Are the crops doing well?		
Yes	94	94.0
No	6	6.0
Can you plant tea on your land?		
Yes	100	100.0
What proportion can you use for tea cultivation		
25%	9	9.0
50%	50	50.0
100%	41	41.0
Can you allow other farmers to have access to your after tea establishment?		
Yes	78	78.0
No	22	22.0

Source: Field Survey, 2023

Land suitability for tea establishment is as shown in table 3. Fifty four percent of the farmers had farmlands that had gentle/flat land topography. This kind of farmland is suitable for farming. Also 65% of the farms had black coloured soil which showed that the soils are fertile. Twenty two percent of the farms had red soil which could be clayey soils and may not be good for tea production. Hence, the substantial proportion of the land is suitable for tea cropping being having black coloured soils. Furthermore 70% of the farmland had well drained soils which are suitable for tea production.

Table 3: Land Suitability for Tea Establishment

Variable	Freq.	%
Gradient of the land		
Slopy	18	18.0
Gentle/flat	58	54.0
Gently slopy	24	24.0
Type of weed on farmland		
Narrow leaved	31	31.0
Broad leaved	15	15.0
Both narrow and broad leaved	54	54.0
Land soil colour		
Black	65	65.0
Red	22	22.0
Grey	5	5.0
Brown	8	8.0
Nature of soil		
Marshy	20	20.0
Well drained	70	70.0
Sticky	10	10.0

Source: Field Survey, 2023

Relationship between land ownership and socio-economic parameters

Table 4 and 5 presented the result of correlation analysis which shows the relationship between land ownership and socio economic parameters

Tables 4 shows the relationship between land ownership and gender. The result showed that there was a significant relationship between land ownership and gender ($\ell \leq 0.05$). The relationship is expected because more male farmers inherit land compared to their women counterparts. What the women do in most cases is to buy land for their farming activities.

The finding fall in-line with the patriarchy system in Nigeria where men have the final say. The study area, that is, Cross River State is not an exception, hence, the women there too do not inherit land.

Table 5 shows the relationship between land ownership and age of the farmer. The result showed that there was no significant relationship between land ownership and age of farmer ($\ell > 0.1$). Hence, land ownership is independent of the age of farmer, whether old or young, so far that he is a male child. The implication of this is that more youths will be more gainfully involved in farming without any hindrance regarding the ownership of land.

Table 4: Landownership by Gender

Variable	Gender		Total
Landownership	Male	Female	
Inherited	60(0.1)	28 (90.3)	88 (0.4)
Purchased	5(1.0)	7 (1.9)	12 (2.9)
Total	65 (1.1)	35(2.1)	

Source: Field Survey, 2023

Pearson $chi^2(1) = 3.26$ Pr= 0.07

Table 5: Landownership by Age

Landownership	Age		
	<30	31-60	>60
Inherited	15(0.2)	61 (0.0)	12 (0.2)
Purchased	4(1.3)	8(0.0)	0(1.4)
Total	19(1.5)	69(0.0)	12 (1.6)

Total	65 (1.1)	35(2.1)

Source: Field Survey, 2023

Pearson $chi^2(1) = 3.12$ Pr= 0.210

Conclusion and Recommendation

The substantial proportion of the land in the study area was inherited, hence it is possible for the farmers to hold the grip of the land to an extent. Also majority of the farmers are ready to make their land available for the cultivation of tea. As regards the suitability of the land for tea cultivation, it was discovered that the land is suitable for the cropping especially when parameters such as gradient, soil colour and nature of the soil are considered. Also, it is concluded that there is a significant relationship between land ownership and gender

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2023 TEA PROGRAMME ANNUAL REPORT
(DR MCHAEL O. OKENIYI PROGRAMME LEADER)

OVERVIEW

Tea improvement started in 1982, with the acquisition of 33 clones and since then moderate achievements have been recorded. Five out of the clones, namely 35, 68, 143, 236, and 138, with an average harvest of 2.5 tons./ha/year were selected and released to farmers. The confinement of commercial tae production to Mambilla highland was orchestrated by the fact that highland is adjudged the most suitable ecology for tea production. However, the expansion of tea production has been constrained by limited land availability for tea cultivation in the highland and the incessant insecurity which has also affected further research on tea. This has necessitated the need to explore new areas for tea production, where tea adaptability trials have been successfully established (Omolaja and Esan, 2005). Among the locations Ajassor in Cross River State was outstanding in enhancing tea growth and establishment because of its acidity soil as well as heavy widespread rainfall. These attributes qualify Ajassor to be selected for tea expansion. This has led to training and sensitization program organized for prospective farmers by tea scientists and also in conjunction with the Nigeria Export Promotion Council.

ACHIEVEMENTS

Identification of Cross River State as a good location for the production of both lowland and highland Tea, Multiplication of over five thousand clonal tea cuttings in the lowland, the first of its kind which we intend to increase in the year 2024 for distribution for farmers. Tea farmers and prospective investors have been trained at Ikom and Calabar on Tea Nursery management and Establishment using cuttings. Meetings with stakeholders (NACOFTAN and Investors) which has resulted in the release of 0.5 hectares in Bashua for Farmer’s On- Farm Tea Experimental plot, which will take off in the year 2024 and increase in Tea seedlings demand.

TEA PROGRAMME

REPORT 1

Theme: Varietal Development of Tea for Sustainable Circular Economy growth in Nigeria

Task: Land Suitability Mapping for Lowland Tea

Determination of Rooting Hormones Efficacy and Success of Tea Cuttings Generation in Lowland of Nigeria

Introduction

Tea *Camellia sinensis* is one of the most admired non-alcoholic beverages in the world. It is a woody perennial shrub that can attain the height of 10m if not pruned or controlled. The young leaves are processed into various type of tea such as green tea, black tea, oolong tea, yellow tea and white tea. Tea was introduced into Nigeria in the year 1972 and since then it cultivation is domicile in Sadauna Local Government area in Taraba State. It is important to extend it cultivation to lowland area where there is availability of land. Tea is mostly cultivated through stem cuttings of elite clones, though it can also be grown through seed but due to its large extent of variability and low viability characterized the seed formation as a result of outcrossing (Heterozygosity).

However, efforts have been made to improve raising of tea seedling which seems to be a major factor for adequate expansion of tea cultivation in both upland and lowland areas of Nigeria.

Objectives

4. To determine the success rate of tea cuttings establishment in the lowland area.
5. To determine the effectiveness of rooting hormones on the tea cuttings in the lowland areas of Nigeria.
6. To find out the success rate of mass propagation of tea cuttings through tissue culture.

Materials and Methods

The mother plants were pruned 6 months before the commencement of the settings of the cuttings. The pots were filled with top soil first at the base of the pot to about 2/3 full followed by the sub soil to fill the remaining 1/3 portion. The pots were arranged in a prepared bed. The cuttings were harvested carefully with the aid of secateur and quickly dipped in a basin containing water to prevent loss of water.2 grams, 1 gram of each of auxin, IBA and NAA were prepared in butanol of 1 liter respectively. Aloe vera and honey as natural hormones were also tested. The cuttings were prepared in one node and quickly dipped in the prepared solution and planted at an angle of 45°. The leaf of each of the cuttings was not allowed to touch the soil.

The whole bed at the end of the day was covered with transparent nylon sheet and the edges were buried after the cuttings were thoroughly watered to prevent air from outside to come in contact with the experiment.

The humidity was checked the following day to ascertain effective covering of the cuttings.

The experiment was laid in Completely Randomized Design (CRD)

Results

Current Progress:

Monitoring development and overall growth ongoing.

REPORT 2

Task: Land suitability mapping for lowland tea

Soil characterization and suitability evaluation for lowland Tea production

Olasoji H. O. Ogunlade M. O.Adeyemi E. A. Nduka B. and Fagbami S.

Introduction

Tea **(***Camellia sinensis* L.**)** is an essential commercial crop, perennial evergreen shrub belonging to the Camellia genus of the Theaceae family (Ohe et al., 2001). It is one of the most popular beverages consumed in the world.Soils of tea lands in different countries differ widely in parent material and morphological characteristics but the most important requirement is soil pH of between 4.5 to 5.5. Soils should also be deep, permeable and well drained (Somaratne, 1986). Li and Pan (2004) stated that tea plants need large amounts of N, P, K and Mg for growth. The deficiency of these nutrients could adversely affect the yield and quality. Nutrient deficiency in soils and poor fertilization can also limit the yield and quality of tea (Yuan et al., 2000).

Soil is a mixture of minerals, organic materials, air and water. The contents of soil vary at different locations and are constantly changing. There are many different kinds and types of soils; each has certain characteristics including a specific colour and composition. Different kinds of soil support the growth of different types of plants and also determine how well that plant grows (Turrion*et al*., 2000). Therefore, soil evaluation is essential for sustainable crop production. Soil depth of less than 50 cm, graveliness of more than 50% and rockiness of 20% affect the growth of tea adversely. Tea plants growing in shallow and compacted soils are likely to suffer from drought and water logging during the rainy months (TRFK 2002). Tea production can promote food security and poverty alleviation in Nigeria greatly if given right attention is given to its recuperation. This study aimed at soil characterization and suitability evaluation for expansion of tea production to southern part of Nigeria.

Materials and Methods

The study was carried out in Cross-River State. Two Local Governments (Obanliku and Boki) were visited in the State. Three profile pits were established only at Obudu hill in the Obanliku Local Government Area (LGA) and described following the FAO/UNESCO (2006) guidelines. Coordinate of each profile pit was recorded. Soil samples were collected from each identified horizon and surface soil samples were randomly collected for fertility evaluation. Morphological characteristics of two profile pits are reported in this report. Soil samples (0-20 and 20-40 cm) were collected randomly at Bashua in Boki LGA for fertility evaluation as well. Collected soil samples were processed, then taken to the laboratory for physical and chemical analyses. Particle size distribution, soil pH, organic carbon, phosphorus, total nitrogen, exchangeable cations (Ca, K, Mg and Na), exchangeable acidity (Al^{3+} + H^{+}) and micronutrients (Fe, Mn, Zn and Cu) contents of the soils were analyzed using standard laboratory methods. The FAO framework for soil suitability evaluation was used for the research (Sys et al., 1993; FAO, 2007).

Results and Discussion

Physical and chemical properties of the soils at Obudu Hill

Physical properties of the soils are presented in Table 1. The texture of the soils ranged from loamy sand to sand. Sandiness of these soils suggest easy leaching of nutrients and heavy metals (Onweremadu,2008). It may also suggest the degree of erodibility of the soil of the area. Generally, the results of the three profile pits showed that silt and clay particles were low while sand contents were high. This could be attributed to the effects of pedogenic processes of translocation in which silt and clay particles were moved from the upper horizons to lower horizons.

The chemical properties of the soils of profile pit 1 are presented in Table 2. The pH of the soils in water varied from 5.73 at surface to 6.19 at sub-surface. The mineral content and pH of soil among other factors play indispensable role in tea production. Hajiboland, (2017) and Kariuki et al., (2022) reported that tea plant requires soil having optimum soils drainage conditions and Soil reaction ranged from 4.5-5.6 for better development. Organic carbon (OC) at the surface soil of the three profile pits were high. The OC content of the soils decreased with soil depth. The calcium content increased with soil depth and the values ranged from 1.10 cmol/kg at the surface to 1.28 cmol/kg at sub surface which were above the critical values of 0.5 to 0.7 cmol/kg. Generally, the exchangeable Mg contents of all the profile pits were higher than 0.2 cmol/kg which is the critical value for optimal tea production (Egbe et al, 1989). Potassium content of the soils is below the critical level of 1.5 to 1.8 cmol+/kg soil for optimal tea production. Thus, Kfertilizer supplements would be necessary to attain sustainable tea production.The soils total nitrogen (TN) contents and available phosphorus (AP) of the profile pits were lower than the critical level (4.5 to 5 %) and (2.6 to 3 ppm) respectively for soils suitable for tea (Egbe et al., 1989).

Suitability evaluation of the soils

The study area records 2254 mm as the annual rainfall, mean annual temperature of 34.16 ^{o}C, relative humidity of 83.16%, mean annual wind speed (at 2 meters maximum) of 1.55 m/s and annual wind direction of 228.66^{o} (NASA, 2022). Tea is grown across a range of altitudes, from sea level up to about 2200 m above sea level. The tea plant requires a minimum rainfall of 1200 mm year-1, but 2500-3000 mm year-1 is considered optimum (Hajiboland, 2017). The annual rainfall of the study area falls into suitability class S1(highly suitable) and rated 100% due to sufficient rainfall. The mean annual temperature (34.16^{o}C) of the study area is in class N1 (presently not suitable), rated 40% and therefore not suitable for tea production (Abdule and Woyesa 2023). With reference to relative humidity, the soils fall within S1 suitability class and highly suitable for optimal yield of tea.

The factor rating of land use requirements for tea were matched with soil properties of the study area. The actual or current suitability of the soils under parametric approach as calculated with the index of productivity for each profile pit (Udoh et al. 2006) showed that all the profile pits are presently not suitable (N1) for commercial tea production. In the potential suitability, profile pits 1 and 2 would be marginally suitable for tea production. TRFK (2002) stated that soil depth of less than 50 cm, graveliness of more than 50% and rockiness of 20% affect the growth of tea adversely. Mean annual temperature, flooding (evidence of erosion), amount of coarse fragments and slope put limitation on the study area and rendered it presently not suitable. Therefore, the area is recommended not to be used for economic tea production because the properties that put limitation to tea production in this area are unchanging in nature and cannot be altered or changed without excessive cost.

Fertility evaluation of the proposed land for lowland tea cultivation

Physical and chemical properties of the soils

Table 3 shows result of physical properties of surface soil samples from Obudu hill and Bashua respectively. The result indicated that the soils were sand and loamy sand respectively.

Table 4 shows result of the soils chemical properties. At Obudu hill, the pH, organic carbon, total N and available P of the soil were 5.96, 0.37%, 0.52 % and 5.41 mg/kg soil respectively. Organic carbon content of the soil and total nitrogen were low. de Silva (2007) reported that the optimum soil conditions recommended for tea growth include a well-drained, deep and well-aerated soil with more than 2% organic matter. The exchangeable cations (K+, Ca2+ and Mg2+) of the soil were 0.09, 1.38 and 0.36 cmol/kg soil. Ca and Mg contents of the soils were adequate for tea production while K content is lower than the critical value (1.5-1.8) required for optimal tea yield. This is an indication that K and N fertilizers are needed in the study area.

At Bashua farm, the pH, organic carbon, total N and available P and exchangeable cations of the soil decreased with depth. Organic carbon is high in the surface soil and adequate for tea production than the subsurface soil due to the accumulation of leaf droppings and decayed plant residues. The total nitrogen content of the soil was low. The soil nitrogen levels were below the critical level of 4.5 -5 % that has been established as ideal soil for tea cultivation in Nigeria (Egbe*et al.*, 1989). The available P content was adequate as the value were above the critical value of 2.6 -3 mg/kg for optimum tea yield. The value of Mg and Ca for surface soil were 0.53 and 2.12 cmol/kg respectively. The values were higher at the surface than sub surface and are adequate for tea. K content of the soils were low at surface and subsurface levels.

Conclusion and Recommendation

Morphological characteristics of the studied soils showed that the surface horizons were black. The profile pits were well drained but very gravelly. Suitability assessment of the soils showed that the study area (Obudu hill) is presently not suitable for tea production. Mean annual temperature, flooding (evidence of erosion), amount of coarse fragments/gravel contents and slope put limitation on the area. Therefore, the area is recommended not to be used for economic tea production because the properties that put limitation to tea production in this area are unchanging in nature and cannot be altered or changed without excessive cost.

Low organic matter contents of the soils of the study area (Bashua) would require good management technique to obtain optimal productivity of tea and will also require caution in the type and method of fertilizer application on the soils. Fertilizer having appreciable amount of K and P would be of uttermost benefit for tea production in these study areas. However, only fertility evaluation is not enough to determine suitability of the soils. Hence, there is need for soil profiling. Further research is therefore needed in lowland areas to ascertain its suitability or otherwise for tea production.

Table 1: soils physical properties at Obudu hill

Horizon	Depth (cm)	Sand	Silt	Clay	Silt/Clay	Textural Class
		←	(%)	→		
Profile pit 1						
Ap	0-15	86.6	8	5.4	1.4	loamy sand
AB	15-44	91.6	2	6.4	0.3	Sand
B2	44-90	88.6	6	5.4	1.1	Sand
BC	90-125	82.6	12	5.4	2.2	Loam sand

Horizon	Depth	pH	Exchangeable bases				Al +H	ECEC	BS	TN	OC	Avail. P	Micronutrients			
		H_20	Ca	Mg	K	Na							Mn	Fe	Cu	Zn
	(cm)		←	(cmol/kg) →					←	(%)	→	←	(mg/kg) →			
Profile pit 1																
Ap	0-15	5.73	1.1	0.29	0.05	0.3	0.1	1.89	93.6	0.1	3.10	4.89	0.56	4.56	0.17	0.35

			0			2	2		4	9						
AB	15-44	6.03	1.12	0.26	0.05	0.19	0.08	1.70	95.29	0.21	2.94	4.74	0.15	3.01	0.19	0.23
B2	44-90	5.95	1.02	0.21	0.04	0.10	0.10	1.47	93.22	0.13	1.58	3.25	0.19	4.17	0.21	0.31
BC	90-125	6.19	1.28	0.31	0.04	0.12	0.07	1.82	96.15	0.86	0.65	4.97	0.18	3.97	0.19	0.35

Table 2: soils chemical properties at Obudu hill

Table 3: Soils physical properties

Locations	Depth (cm)	Sand	Silt	Clay	Textural Class
		← (%) →			
Obudu hill	0-20	88.6	6	5.4	Sand
Bashua	0-20	80.6	14	5.4	Loamy sand
Bashua	20-40	80.6	10	9.4	Loamy sand

Location	Depth	pH	Exchangeable bases				Al+H	ECEC	BS	TN	OC	Avail. P
		$H_2$0	Ca	Mg	K	Na						
	(cm)		← (cmol/kg) →						← (%) →			(mg/kg)
Obudu hill	0-20	5.96	1.38	0.36	0.09	0.17	0.09	2.10	95.71	0.52	0.37	5.41
Bashua	0-20	5.68	2.12	0.53	0.12	0.136	0.11	3.02	96.36	1.90	4.55	8.37
Bashua	20-40	5.54	1.69	0.33	0.07	0.102	0.10	2.30	95.66	0.09	1.32	7.73

Table 4: Chemical properties of the soils

THEME: Varietal Development of Tea for Sustainable Circular Economy growth in Nigeria

TASK: Nursery establishment in the lowland

Experimental Title: Field establishment of tea under varying watering regime and different shade levels in lowland agro-ecologies of Nigeria

Investigators: Adeosun, S.A., Ayegboyin, K. O.,Akanbi, O. S. O., Yahaya, A. T. and Famuyiwa, B.S.

Introduction:

Tea thrives well on Mambilla highland owing to its cool climate and slightly acid soil. Tea production in Nigeria is at marginal level because it is limited to the Mambilla highlands where expansion of tea production is constrained by poor land availability. The land constraint on Mambilla highland has necessitated the need to expand tea production to the warm lowland of southern Nigeria.

One major constraint to tea production in the lowland is high ambient temperature. High ambient temperature occasioned by high light intensity in greater part of the year in Southern Nigeria is detrimental to tea growth and survival in the area. However, producing tea in the lowland under shade of 45 - 65% light intensity has proven to be highly beneficial to tea production (Adeosun*et al*., 2019 and 2022). This was due to the fact that the entire photosynthetic apparatus of tea is adapted to function with maximum capacity under shade (Jannedra*et al*., 2007).

Moreover, inadequate and poorly distributed rain is another constraint to tea production in southern part of Nigeria. The complete cessation of rain in the dry season and its resultant excessive rise in ambient temperature causes soil water to fall below wilting point, thus leading to irreversible wilting of tea plants, especially in the absence of irrigation. This underscores the call for artificial watering of tea plants for it to maintain its vegetative growth during this period. Although, there is extremely dearth of information on irrigation of tea to enhance its field establishment, information obtained from field experience shows that tree crop (especially, cacao) farmers in Nigeria practice manual irrigation in order to obtain high field establishment in successive dry seasons after seedling transplanting. Therefore, this trial was aimed at investigating the effect of artificial watering on tea growth and field establishment under different shade levels in Ibadan and Ikom Stations of Cocoa Research Institute of Nigeria.

Objectives

4. To determine the effects of watering on the growth performance of established tea plants during the first dry season after transplanting.

5. To determine the optimum water regime that would enhance ≥70% tea seedling survival at the end of first dry season after seedling transplanting.
6. To determine the interaction effects of artificial watering and plantain shade on survival rate of cultivated tea plants at first dry season after seedling transplanting.

Materials and Methods

The experimental sites

This study was carried out in Cocoa Research Institute of Nigeria (CRIN) Stations in Idi-Ayunre, Ibadan, (Oyo State) and Ikom (Cross-Rivers State). Ibadan is located on Latitude 07º 10' N and Longitude 03^{o} 52' E, on 122m elevation above sea level in the tropical rain forest zone of Southwest Nigeria. Ikom is located on latitude 5º 54' N and longitude 8º 48' E, 128 m above sea level in the tropical rain forest zone of South-south Nigeria.

Experimental design and layout

This field trial comprises 2 factors which include plantain shade at 2 levels - plantain shade and zero shade; 5 watering regimes - watering at 40% FC (Field capacity) 2 times per week, 40% FC 3 times per week, 80% FC 2 times per week, 80% FC 3 times per week, zero watering (control). The experiment was laid out in Randomized Complete Block Design (RCBD) arranged in Split plots with 3 replications. Plantain shade served as main plots; watering regimes as subplots.

Land preparation and soil analysis

The land for the field trial was cleared. Field lay out was done and the site was laid out into three blocks. Each block comprised two main plots and 5 subplots. Five composite soil samples were collected from the sites with soil auger. Each composite sample was collected at 0 – 20 cm and 20 – 40 cm soil profile. The soils were bulked, air dried and assayed in a soil laboratory for physical and chemical properties. Soil pH (1:1 soil/water) was determined with pH meter, organic matter by Wet Oxidation method (Walkey and Black, 1934). Soil available P was extracted by the Bray PI and measured by the Murphy blue colouration and determined on a Spectronic 20 at 882µm (Murphy and Riley, 1962). Soil K, Ca and Mg were extracted with IMNH4 OAC. Phosphorus, magnesium and total nitrogen were determined with flame photometer, atomic absorption spectrophotometer and Microkjedahl methods, respectively (AOAC, 1990)

Sources of planting materials

Mature plantain suckers were sourced from CRIN stations in Ibadan and Ikom.

Healthytea cuttings of 143 cultivar were sourced from CRIN Substation in Kusuku, Mambilla, Taraba State.

Planting and application of treatments

Plantain was established at planting distance of 3 x 1.5 m (Adeosun, 2021). Tea clonal materials were planted at a spacing of 100 x 60 cm in the avenue (3 m wide) of two rows of plantain. Four tea clones of cultivar 143 were transplanted per plot in September 2022. In November, when the rain stopped, application of water treatment commenced. In the water treatment, 40% and 80% FC (Field capacity) of water was applied 2 and 3 times per week according to the layout. The water was applied manually at the base of the tea stands.

Data collection and analysis

The following growth parameters and survival count were measured starting from 5 MAT (Months after transplanting) on monthly basis: Number of leaves, Number of branches, Plant height and leaf area. The data were analysed with Analysis of Variance (ANOVA) using STAR (Statistical Tools for Agricultural Research) (2013) software, and significant means were separated with Tukey's Honest Significant Difference (HSD) Test (P=0.05).

RESULTS AND DISCUSSION

Table 1 presents the physical and chemical properties of soils from Ibadan and Ikom. The particle size analysis result indicated that the soil in Ibadan contained 80.6% sand, 13.4% silts and 6.0% clay at the surface depth (0 -20cm) compared to 76.4% sand, 15.4% silt and 8.2% clay recorded for Ikom soil. The pH (H_2O) ranged from slightly alkaline 7.24 to slightly neutral 7.12 in Ibadan; while Ikom soil ranged from slightly acidic (5.48) to neutral (7.01). These values were slightly above the critical values of 4.5 – 6.5 (Egbe*et al*., 1989). However, with good cultural and other agricultural practices, tea cultivation in these areas is possible. The Ibadan soil is generally higher in total N, P, K, Mg, and ECEC compared to Ikom soil. However Ikom soil was better than Ibadan soil in base saturation, clay particles and organic carbon. The total N and K were low relative to the critical value of 4.5 – 5.0% N required for the sustainable tea cultivation as reported by Egbe*et al*. (1989). The Organic carbon and Mg are far above the critical level.

Table 1: **Pre-cropping particle size and chemical properties of soils used in the experiments**

PROPERTIES	**IBADAN SOIL**		**IKOM SOIL**	
	0 – 20cm	**20– 40cm**	**0 – 20cm**	**20 – 40cm**
pH ((1:1 soil/water)	7.24	7.22	7.01	5.48
PARTICLE SIZE ANALYSIS				
Sand (%)	80.6	82.6	76.4	60.4
Silt(%)	13.4	11.4	15.4	24.4
Clay (%)	6.0	6.0	8.2	14.2
EXCHANGEABLE BASES				
Mg (cmol/kg)	1.665	1.314	0.88	0.19
K(cmol/kg)	0.46	0.36	0.08	0.08
Na (cmol/kg)	0.317	0.256	0.08	0.10
Al +H(cmol/kg)	0.07	0.05	0.05	010
ECEC(cmol/kg)	7.05	5.33	6.21	1.51
Base Saturation (%)	99.01	99.06	99.19	92.72
Total N (%)	0.13	0.10	0.08	0.14
Total Org C (%)	1.550	1.130	1.58	2.62
Avail P (mg/kg)	9.11	7.51	6.13	10.57
MICRO – NUTRIENTS				

Fe (cmol/kg)	7.7	8.45	31.75	9.95
Cu (cmol/kg)	0.80	1.26	1.67	2.57
Zn (cmol/kg)	8.63	5.48	7.41	3.12
Mn (cmol/kg)	57.75	52.3	61.35	23.75

Shade and watering levels significantly (P=0.05) affected vegetative growth of tea as shown in tables 2-5. In table 2, tea grown under plantain shade produced more leaves than those grown without shade both in Ibadan and Ikom. Shaded tea produced 21.57, 21.80 and 27.30 leaves per plant in 5, 7 and 9 MAT, respectively at Ibadan compared to the unshaded tea that produced 6.70, 14.73 and 9.79 leaves per plant. This same trend was observed in Ikom. However, shaded tea did not differ significantly (P>0.05) from unshaded ones in number of branches; although, there was more branching under shade than under zero shade. In the same vein, tea under shade grew taller significantly (P=0.05) than the unshaded ones in Ibadan throughout the sampling periods. However, in Ikom, shade did not enhance any significant higher height, especially at 5-7 MAT. Similarly, leaf area of tea progressively increased under shade from 522.50 to 992.72 per plant at 5-7 MAT while leaf area under zero shade increased from 95.83 to 729.4 per plant at the same time, showing a significant higher values. However, in Ikom, although leaf area under shade was higher than that under zero shade, the different was not significant (P>0.05) (Table 5).

Watering regimes significantly (P=0.05) influenced vegetative growth of tea plants both in Ibadan and Ikom. In Ibadan, watering with 80FC twice per week enhanced the highest number of leaves and the highest leaf area throughout the sampling periods; while zero water produced the least number of leaves and leaf area at the same periods. Similar trend was observed in number of branches and plant height of tea in Ibadan as watering at 80FC twice per week caused the highest branches of 5.00 and plant height of 46.53 at 9 MAT which are significantly higher than the values under zero watering and watering at 40FC once per week. However, at Ikom, watering at 80FC three times per week was superior significantly to other watering regimes as it enhanced significantly higher number of leaves compared to 40 FC once per week, 80FC twice per week and zero watering; higher number of branches and plant height compared to all other watering regimes; and significantly higher leaf area compared to watering at 40FC per week and zero watering (9 MAT) (Tables 2, 3, 4 and 5).

On interaction between shade and watering regimes at 9 MAT, the highest number of leaves was caused by watering at 80FC twice per week under shade in Ibadan and watering at 40 FC thrice per week in Ikom. Highest number of branches, plant height and leaf area were caused by watering at 80FC twice per week under shade at Ibadan; while watering at 80 FC thrice per week under zero shade produced the highest number of branches at Ikom. Similarly, watering at 80 FC thrice per week under shade enhanced highest tea plant height and leaf area at Ikom.

Table 2: Effects of shade and watering regimes on number of leaves of tea plants on the field at Ibadan and Ikom

Treatments		**Ibadan**			**Ikom**		
Shade levels		**5MAT**	**7MAT**	**9MAT**	**5MAT**	**7MAT**	**9MAT**
S0		6.70b	14.73b	9.79b	15.10a	16.30a	21.83a
S1		21.57a	21.80a	27.30a	2193a	19.67a	29.77a
Watering regimes							
W_{12}		11.83bc	21.33a	17.33ab	14.92b	10.83bc	3.08c
W_{13}		17.67ab	21.25a	22.25a	22.83ab	13.25b	46.33ab
W_{22}		20.17a	21.00a	28.63a	27.00a	32.83a	21.33bc
W_{23}		19.00ab	14.50a	24.50a	27.83a	33.00a	58.25a
W_{00}		2.00d	13.25a	0.00b	0.00c	0.00c	0.00c
Watering x Shade level Regimes							
W_{12}	S0	15.00a	5.67b	11.00a	19.50a	19.33a	6.17a
	S1	27.00a	18.00a	23.67a	10.33a	2.33b	0.00a
W_{13}	S0	17.00a	6.33b	1.67b	19.67a	15.83a	23.17b
	S1	25.00a	29.00a	42.83a	26.00a	10.67a	69.50a

W_{22}	S0	12.00a	2.00b	11.27b	12.67b	24.33b	20.67a
	S1	29.00a	38.33a	46.00a	41.00a	41.33a	22.00a
W_{23}	S0	14.67a	19.50a	25.00a	23.67a	22.00b	59.17a
	S1	14.33a	18.50a	24.00a	32.00a	44.00a	57.33a
W_{00}	S0	14.00a	4.00a	0.00a	0.00a	0.00a	0.00a
	S1	12.50a	0.00a	0.00a	0.00a	0.00a	0.00a

Means with the same letters in a column under same treatment are not significantly different by HSD (P=0.05)

W_{12} = watering at 40% Field capacity two times per week;W_{13} = watering at 40% Field capacity three times per week; W_{22} = watering at 80% Field capacity two times per week; W_{23} = watering at 80% Field capacity three times per week; W_{00}= Zero watering (Control); MAT = Months after transplanting

Table 3: Effects of shade and watering regimes on number of branches of tea plants on the field at Ibadan and Ikom

Treatments	**Ibadan**			**Ikom**		
Shade levels	**5MAT**	**7MAT**	**9MAT**	**5MAT**	**7MAT**	**9MAT**
S0	1.23b	3.13a	2.00a	2.30a	2.33a	5.93
S1	4.73a	3.07a	4.37a	3.47b	3.73a	2.00a
Watering regimes						
W_{12}	2.17bc	4.33a	2.17ab	1.83bc	0.83c	3.42b
W_{13}	3.67ab	2.92abc	4.17a	4.75a	4.75ab	3.75b
W_{22}	3.67ab	3.67abc	5.00a	4.17a	5.83a	4.50b
W_{23}	4.08a	1.92c	4.58a	3.67ab	3.75b	8.17a
W_{00}	1.92c	2.08c	0.0b	0.00c	0.00c	0.00c
Watering x Shade						

levels **regimes**						
W_{12} S0	2.00a	1.67b	2.33a	2.67a	1.67a	6.83a
S1	2.33a	7.00a	2.00a	1.00a	0.00b	0.00b
W_{13} S0	3.17a	1.33b	0.67b	2.50b	2.50b	4.17a
S1	4.17a	4.50a	7.67a	7.00a	7.00a	3.33a
W_{22} S0	2.67a	1.33b	1.33b	3.33a	5.00b	8.00a
S1	4.67a	6.00a	8.67a	5.00a	6.67a	1.00b
W_{23} S0	5.17a	0.83b	5.67a	3.00a	2.50b	10.67a
S1	3.00a	3.00a	3.50a	4.33a	5.00a	5.67b
W_{00} S0	2.67a	1.09b	0.00a	0.00a	0.00a	0.00a
S1	1.17a	3.17a	0.00a	0.00a	0.00a	0.00a

Means with the same letters in a column under same treatment are not significantly different by HSD (P=0.05)

W_{12} = watering at 40% Field capacity two times per week;W_{13} = watering at 40% Field capacity three times per week; W_{22} = watering at 80% Field capacity two times per week; W_{23} = watering at 80% Field capacity three times per week; W_{00}= Zero watering (Control); MAT = Months after transplanting

Table 4: Effects of shade and watering regimes on plant height (cm) of tea plants on the field at Ibadan and Ikom

Treatments	**Ibadan**			**Ikom**		
Shade levels	**5MAT**	**7MAT**	**9MAT**	**5MAT**	**7MAT**	**9MAT**
S0	22.74b	40.18a	18.22b	25.77a	28.21a	33.22a
S1	39.62a	41.42a	42.44a	36.67a	25.83a	26.47a
Watering regimes						

W_{12}	39.93a	28.38a	29.40a	21.83b	21.69b	20.71bc
W_{13}	46.53a	37.19a	34.33a	32.17b	36.00a	35.75b
W_{22}	47.20a	40.48a	46.53a	36.83b	39.89a	31.00b
W_{23}	41.07a	37.83a	41.38a	65.25a	37.52a	61.75a
W_{00}	29.28a	12.00b	0.00b	0.00c	0.00c	0.00c
Watering x Shade levels regimes						
W_{12} S0	39.20a	16.67b	12.70b	33.50a	38.88a	41.00a
S1	40.67a	40.10a	46.10a	10.17b	4.50b	0.00b
W_{13} S0	44.20a	31.07b	14.47b	28.67a	31.67a	26.50a
S1	48.87a	43.32a	54.20a	35.67a	40.33a	45.00a
W_{22} S0	39.30a	21.80b	31.40b	29.17b	35.28a	40.00a
S1	55.10a	59.17a	61.67a	44.50a	44.50a	22.00a
W_{23} S0	47.40a	31.47b	32.53b	37.50b	35.20a	58.67a
S1	34.73a	44.20a	50.23a	93.00a	39.83a	65.33a
W_{00} S0	30.82a	12.70a	0.00a	0.00a	0.00a	0.00a
S1	27.75a	11.30a	0.00a	0.00a	0.00a	0.00a

Means with the same letters in a column under same treatment are not significantly different by HSD (P=0.05)

W_{12} = watering at 40% Field capacity two times per week; W_{13} = watering at 40% Field capacity three times per week; W_{22} = watering at 80% Field capacity two times per week; W_{23} = watering at 80% Field capacity three times per week; W_{00}= Zero watering (Control); MAT = Months after transplanting

Table 5: Effects of shade and watering regimes on leaf area (cm^2) of tea plants on the field at Ibadan and Ikom

Treatments		**Ibadan**			**Ikom**		
Shade levels		**5MAT**	**7MAT**	**9MAT**	**5MAT**	**7MAT**	**9MAT**
S0		95.83b	152.02b	729.46b	244.15a	290.37a	592.94a
S1		522.50a	648.18a	992.72a	312.65a	377.29a	867.25a
Watering regimes							
W_{12}		841.46b	252.91cd	498.11a	82.45b	194.95bc	79.91b
W_{13}		1019.62ab	462.91abc	542.40a	475.55a	389.26b	1285.68a
W_{22}		1428.76a	604.07a	608.82a	331.71a	389.73b	306.64b
W_{23}		730.26bc	226.05d	351.18a	502.30a	690.21a	1978.26a
W_{00}		285.35c	0.00e	0.00b	0.00b	0.00c	0.00b
Watering x Shade levels regimes							
W_{12}	S0	420.54b	206.78b	151.57a	159.26a	368.82a	159.81a
	S1	1262.37a	789.43a	354.25a	5.62b	21.08b	0.00a
W_{13}	S0	954.15b	148.18b	62.51b	339.57b	295.40b	756.63b
	S1	1085.09a	936.63a	863.11a	611.53a	483.12a	1814.72a
W_{22}	S0	1188.33b	47.75b	84.23b	251.73b	328.38a	0.00b
	S1	1669.19a	1169.90a	1123.91a	411.69a	461.08a	613.29a
W_{23}	S0	754.69a	357.40a	180.87a	470.18a	459.25b	2048.28a
	S1	705.84a	344.97a	271.23a	534.41a	921.17a	1908.25a
W_{00}	S0	329.58a	0.00a	0.00a	0.00a	0.00a	0.00a

S1	241.13a	0.00a	0.00a	0.00a	0.00a	0.00a

Means with the same letters in a column under same treatment are not significantly different by HSD (P=0.05)

W_{12} = watering at 40% Field capacity two times per week;W_{13} = watering at 40% Field capacity three times per week; W_{22} = watering at 80% Field capacity two times per week; W_{23} = watering at 80% Field capacity three times per week; W_{00}= Zero watering (Control); MAT = Months after transplanting

Table 6 shows better seedling establishment under shade compared to zero shade in Ibadan, unlike in Ikom where survival of tea was not different under shade compared to zero shade. In Ibadan, 70% of transplanted tea plants under shade survived the first dry season compared to 28% that survived without shade. Watering at 80FC thrice per week enhanced tea survival at Ibadan and Ikom, while the least survival was caused by zero water. However, there was more tea survival in Ibadan (89%) than in Ikom (79.17%). In Ibadan, the interaction of watering at 80FC thrice per week with shade produced the highest survival of 100%, which was significantly higher than tea survival of 78% caused by the same watering without shade. In Ikom, however, although watering at 80 FC twice and thrice per week under shade produced the highest survival of 83.33%;it was not significantly higher than the survival of 75% it caused without shade.

From the results above, it is apparent that the growth and survival of tea planted was enhanced in watered tea plants grown under plantain shade in the dry season at Ibadan and Ikom. This underscores the essentiality of watering of tea to its survival in the dry season when light intensity is brightest, ambient temperature is highest and rainfall is at lowest level. It explains the importance of water to tea growth and field survival. Water is essential for photosynthesis, chemical reactions, transpiration and translocation of photo-assimilate in plants (Fatubarin, 2003).

All tea grown under zero water and many of those that received little water (40FC twice per week) did not survive the first dry season in both locations. This indicates that poor water availability in the soils led to negative water potential in the leaf and also precipitated flaccidity, closure of the guard cells and resultant inhibition of diffusion of CO_2 into the leaf, thus limiting the photosynthetic capacity of the leaf: a fact which corroborates the findings of Smith *et al.* (1993) and Sivapalan (1993). Growing tea without shade in the dry season could lead to excessive rise in leaf temperature and evapo-transpiration which makes soil water less available for plant growth and build up of vapour pressure gradient between the leaf and the surrounding air (Hopkin, 1995). These findings corroborate Adeosun*et al.* (2022) and Adeosun (2023) who concluded that growth of tea was significantly undermined when grown without shade in the dry season. Tea grown under plantain performed better than those grown in the open. This might be because, at lower light intensities occasioned by shade, soil water is conserved as a result of reduced evaporation, thus making enough water, an important reagent for photosynthesis available for plant use (Mohotti and Lawlor, 2002).

Generally, tea performed better in Ikom than in Ibadan because of the slightly acidic soil of Ikom which enhanced tea growth (Egbe *et al.*, 1989). Besides, unshaded tea plants performed better in Ikom than in Ibadan probably because Ikom soil is richer in clay particle. The higher proportion of clay in Ikom soil might have enhanced better conservation of soil water, making more water available for tea growth.

Table 6: Effects of shade and watering regimes on seedling survival count (%) of tea plants after the first dry seasonon the fieldat Ibadan and Ikom

Treatments	**Ibadan**	**Ikom**
Shade levels		
S0	28.93b	53.33a
S1	70.00a	53.33a
Watering regimes		
W_{12}	55.50ab	45.83b
W_{13}	52.83b	62.50ab
W_{22}	50.00b	79.17a
W_{23}	89.00a	79.17a
W_{00}	0.00c	0.00c
Watering x Shade levels **Regimes**		

W_{12}	S0	33.33b	66.67a
	S1	77.67a	25.00a
W_{13}	S0	16.67b	50.00a
	S1	89.00a	75.00a
W_{22}	S0	16.67b	75.00a
	S1	83.33a	83.33a
W_{23}	S0	78.00b	75.00a
	S1	100a	83.33a
W_{00}	S0	0.00a	0.00a
	S1	0.00a	0.00a

Means with the same letters in a column under same treatment are not significantly different by HSD (P=0.05)

W_{12} = watering at 40% Field capacity two times per week;W_{13} = watering at 40% Field capacity three times per week; W_{22} = watering at 80% Field capacity two times per week; W_{23} = watering at 80% Field capacity three times per week; W_{00}= Zero watering (Control); MAT = Months after transplanting

Conclusion and Recommendations

Tea plants were grown in Ibadan and Ikom under different shade levels and artificial watering in the dry season, a time when rainfall almost completely ceased. Through monitoring of the trial in the two locations, it was found that artificial watering of tea is highly indispensable in both locations as watering at 80FC twice per week in Ibadan and thrice per week in Ikom enhanced more than 70% tea survival after the first dry season, as well as its steady and uninterrupted growth during the dry season. However, growing tea under plantain shade is more desirable in Ibadan than in Ikom as shade enhanced the effectiveness of watering more in Ibadan. Therefore, it is recommended that tea should be maintained in early years of field establishment in the dry season with watering at 80FC twice per week in Ibadan, and this can be done under plantain shade of 2222 plants/ha; while watering at 80FC thrice per week in the dry season can be applied by tea farmers with or without plantain shade in Ikom.

Report 6

Task: Land suitability mapping for tea in Cross River State

Experimental:- Prevailing climatic variables and cropping systems as indicators for tea cultivation using GIS in selected locations of Cross River State.

Investigator:- Oloyede, A.A, Obatolu,B.O.,Okeniyi,M.O and Ayanwole,S.A

Introduction

Tea (*Camelia sinensis*) a temperate and sub-tropical beverage crop popularly grown for different brands and types of tea; black tea -made from fermented tea leaves; oolong tea-made from partially fermented leaves; green tea made from unfermented tea leaves and white tea made from unfermented leaves buds of tea this is an elitist tea brand as it is expensive and highly medicinal.

Tea was introduced to the high land of Mambilla Plateau in the early 80s. the introduction of this important beverage crop has resulted in springing up of the Nigeria Beverage Production Company initially produced by the Gongola State Government, presently been managed as public liability company. Tea cottage industries are springing up as well.

As important as this crop is to the farmers and the companies, there is limited land to its cultivation. This is due to competing demands viz; livestock, forest plantation, food crops and infrastructural projects. The above limitation has led to adaptation trials on some of the available tea clones on the Mambilla Plateau in the lowland areas of Nigeria. The trials have led to discovery of some adaptable clones to the lowland areas in Ibadan (Oyo State), Ajassor, Iyanonmon (Edo State), Akwete (Abia) and Ikorodu (Lagos State). The identified adaptable clones are C143, C318, C35, C357 and C236. Of the above listed, the first two, C143 and C318 are outstanding.

In the recent times, some tea seeds brought from China by the duo of Omolaja and Aroyeun were sown on the Mambilla plateau. The seedlings derivable were then established with obvious segregation. These when planted out manifested a lot of morphological variations. About 37 biotypes of these were then brought to Ibadan for further evaluation by Olaniyi (Olaniyi*et al*., 2015). He identified another four of the China tea coded as NGC17,18, 25 and 40. The yields were comparable with C143, C318 and C357.

Objective:

To identify low altitude as well as unexploited highland areas in the Southern part, land suitable for tea production

Materials and Methods

This work involves land suitability mapping through the use of GIS and ground truthing, which mostly involved farmers' focus group discussion, interactive session and visual observation of the ecosystems of the selected locations.The farmers were organized through coffee and tea farmers association of Nigeria [NACOFTAN] in the locations.The locations were Ajassor (Etung LG), Basua [Boki LG] and Obudu (Obanliku LG)

Results and Discussion

Short History of Obudu Ranch as Recounted by Mr. Sidney Ayile

In 1949 when Mack Collins exploited, hunters were the ones occupying the Plateau. Collins was flying a craft over the Plateau in June/July/ August, the atmosphere was foggy and so cannot land there.. When the fog eventually cleared, he landed. On seeing Collins, the hunter scampered for safety. Some of the hunters eventually came back. He eventually informed them of his intention to start rearing cattle on the Plateau- this was the beginning of cattle rearing on the Obudu Plateau.

Cropping systems on the Obudu plateau Cross River State

Obudu plateau apart from tourism is noted for production of crops like maize, irishpotatoe, banana, strawberry,lettuce, cabbage,cucumber, spinach, tomato. This findings was corroborated by John et al(2019) who listed some of these crops as grown on Obudu. We were even informed of the Cross river State Government establishing hectares of Irish potato at a particular time.

Forest trees: Eucalyptus**,** Cypress- these trees are also found on the Mambilla plateau as timber species either sole or as intercrop with tea. This also indicate similarity in the ecology of the two plateaus

Notable Non-Timber Forest Products

We discover in the botanical garden: tea shrubs that almost attaining timber status and *Aframomummelegueta*(Guinea pepper)- an herbaceous perennial plant native to swanpy habitat along the West African coast, this species belong to Zingiberaceae family. Uses for cultural and medicinal values are documented (Francois (2018)

Tea as a botanical on the Plateau and as life fence

It was discovered that tea is already present on the Obudu cattle Ranch without the residents knowing the import of it.A particular resident discovered that goats cherished the tea fruits as feed. The use of tea as life fence and goat feed was discovered, such has not been reported in Nigeria, however Steve et al(2022) reported the use of green tea in poultry feed with success

The resident also make use of the tea as life fence to prevent intrusion to his premises, the luxuriant growth of tea stands at the botanical garden(Plates 1&2) is a good indication that tea will thrive very well on the Obudu Plateau. In our interaction with the residents they know tea as a medicinal plant however they don't know which part is used in processing tea as a beverage. They are very willing to receive training along production chain of tea.

Altitudes at the selected locations

Geographical locations are as indicated in Table 1 revealed the altitudes of 1519-1550m asl fall within the ideal for upland tea production as we have at the Mambilla plateau. Though Ajassor and Bashua have lower altitude (122.1m and 108m asl), the result obtained at CRIN Ajassor Substation on adaptation trail has manifested the imperativeness of suitability at lower altitude.

Climatic variables and pH in the study locations

The pH of the soils and climatic variables of temperature, rainfall and relative humidity as indicated in Table 2 fall within normal limits(Global Tea science,2018). These are very important indicators for tea cultivation.

Conclusion and Recommendations: from the results gotten from this study considering the pH of the soils and favourable climatic variables of temperature, rainfall and relative humidity, it could be concluded that Cross River State either at a high altitude area of Obudu(1,519-1550m asl) and lower altitude of Ajassor and Bashua ,considering adaptability of some notable clones of C143 , C318 and some selected NGC series is a good destination point for tea cultivation in Nigeria.

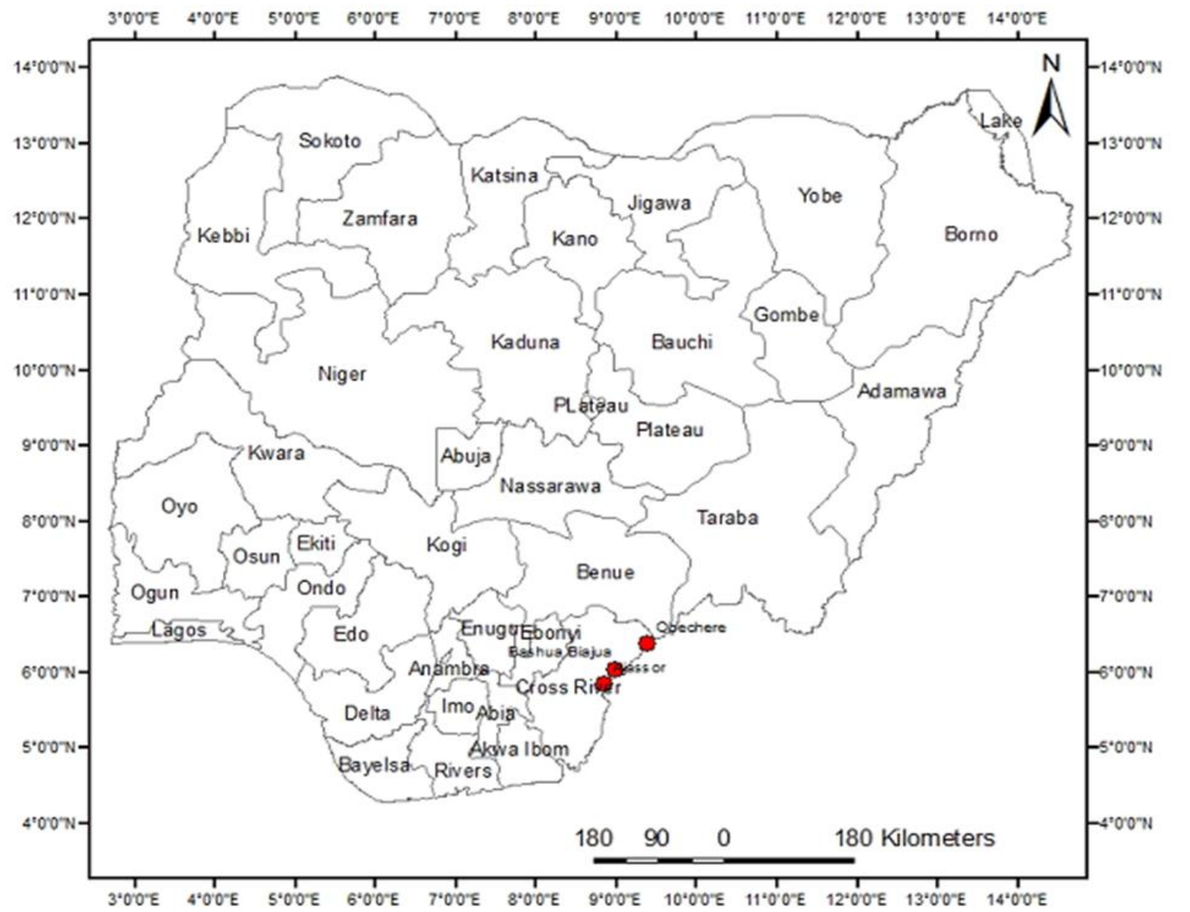
We therefore recommend that training along value chain should commence as the farmers through NACOFTAN and even the paramount rulers in the selected locations are ready to cultivate and even process tea thereby boosting the economic diversification of FGN through agriculture. Integration of tea with forest trees(eucalyptus and cypess),choice food crops and Non-Timber Forest Products is as well recommended.

Constraints: inadequate, untimely funding and deplorable state of roads

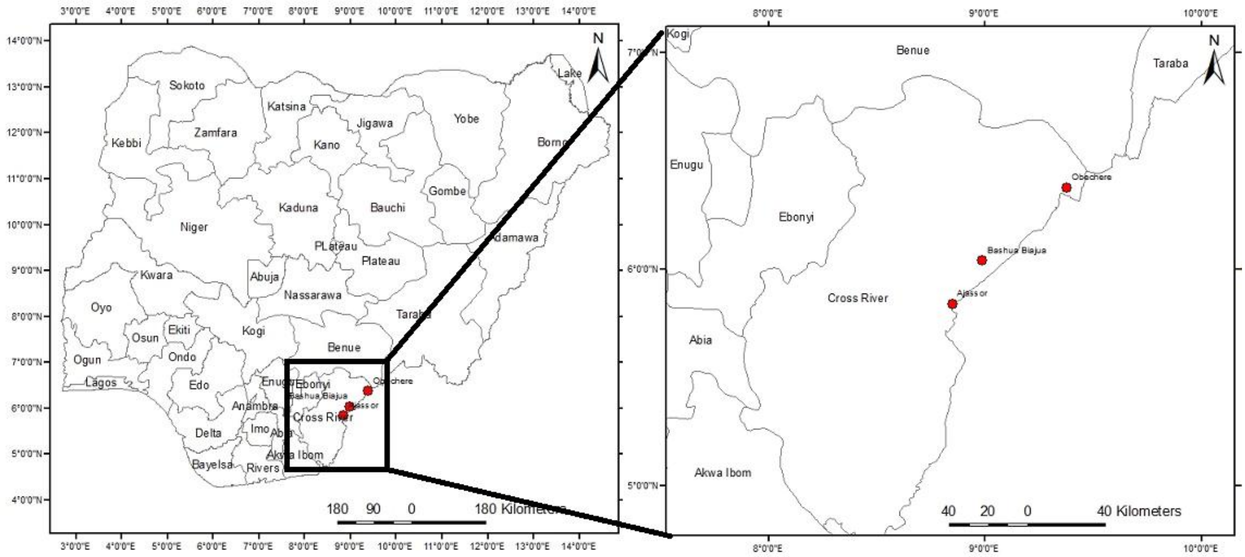
Plates 1&2: Fully grown tea stands at the Obudu botanical garden

Edaphic and Climatic variables in the study locations

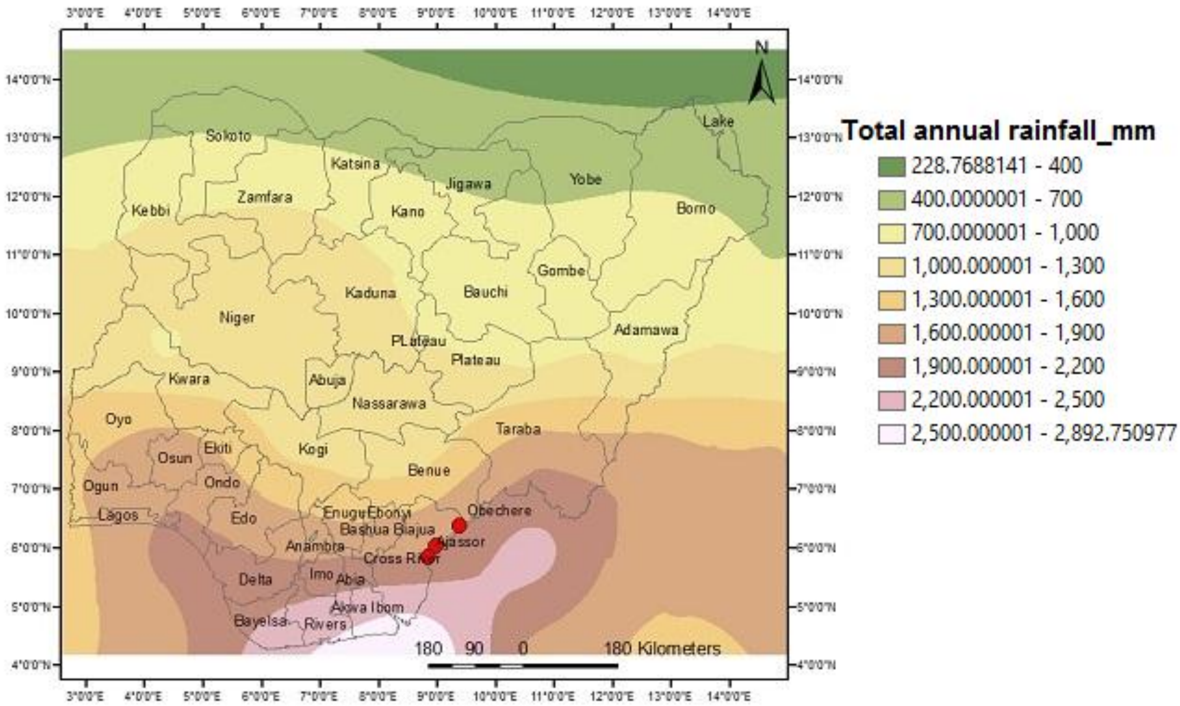
Edaphic and Climatic Variables in the Study area (Ajassor, Bashua and Obudu Cattle Ranch)



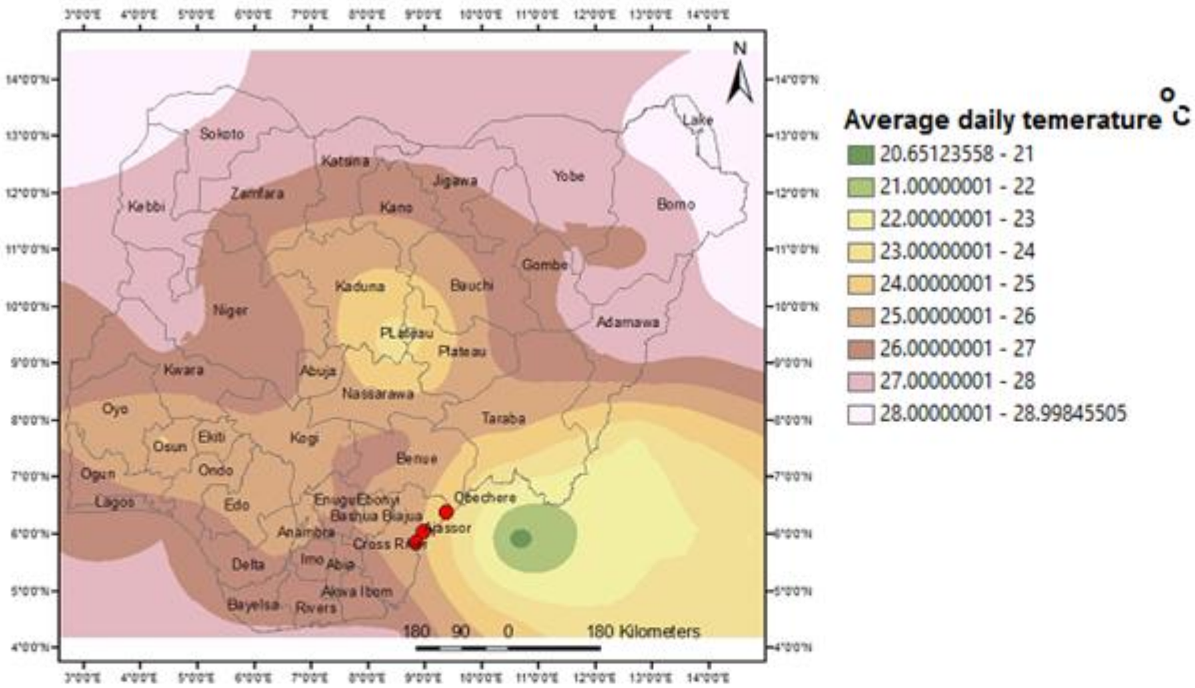
Map indicating visited locations



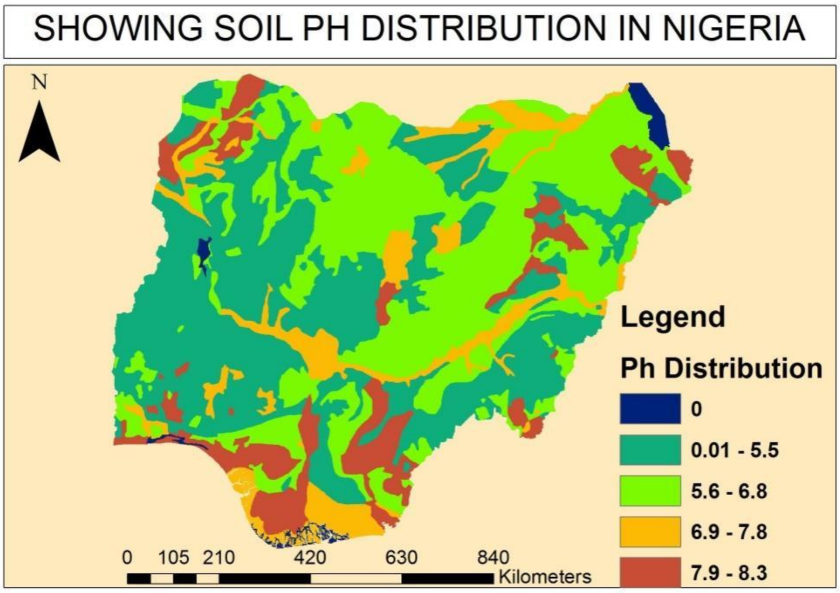
Calll out map indicating visited locations in Cross rivers state

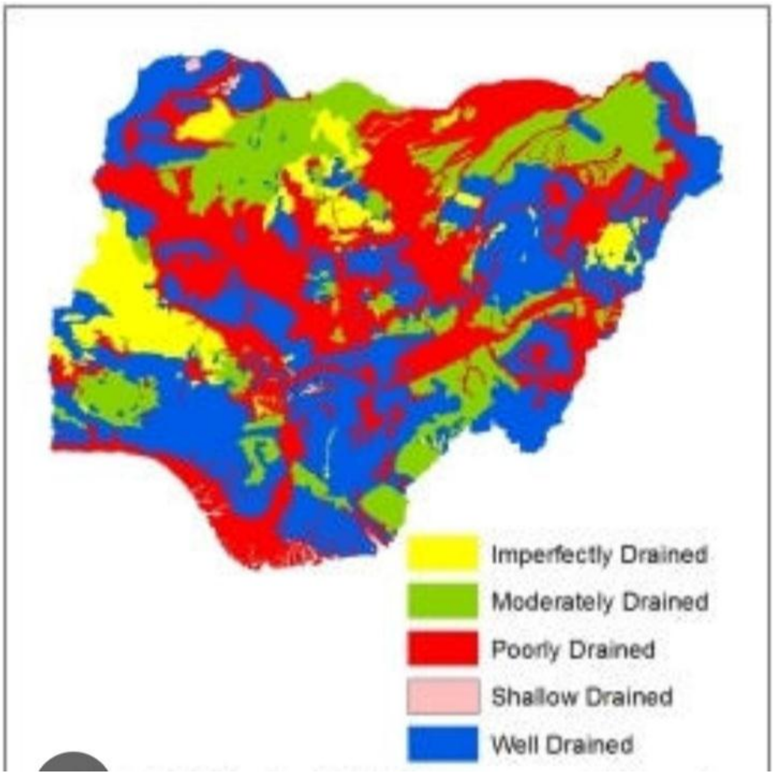


Distribution of total annual rainfall in Nigeria and visited locations



Average Daily Temperature of the study area





Map showing soil drainage of Nigeria

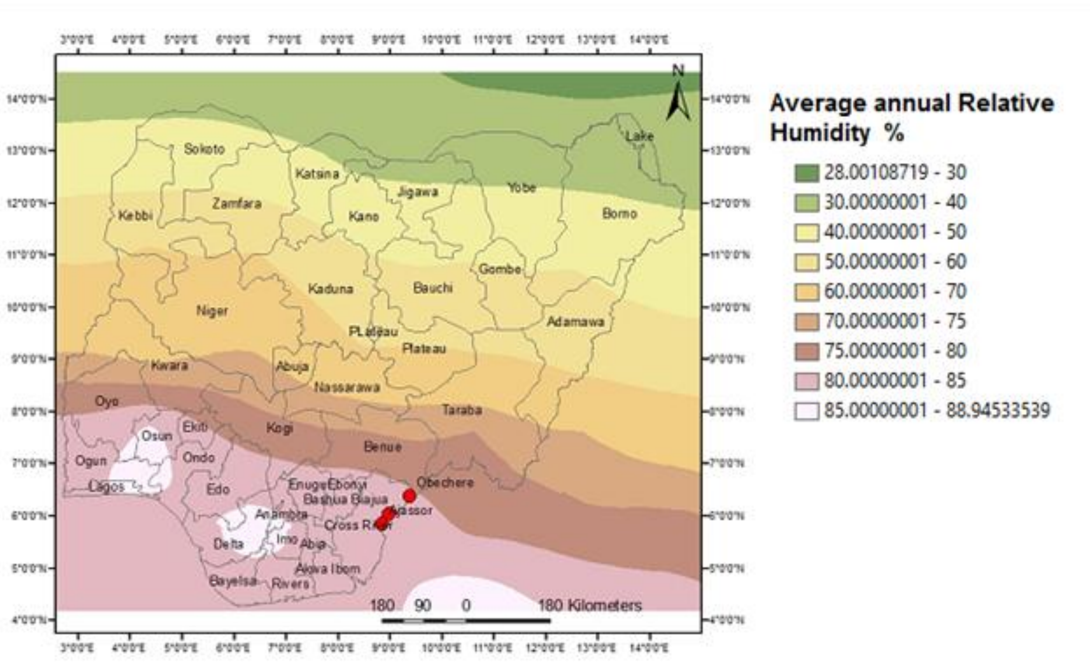


Figure 3: Average annual Relative Humidity

Table 1: GPIS LOCATIONS

LOCATIONS VISITED WITH GPIS

Location	Altitude (m asl)	Latitude	Longitude	Local Govt
Obudu ranch	1.519.2	6.376666N	9.378738E	Obanliku
Village Head Palace	1,549.9	6.362784N	9.380164N	Obanliku
Kigol Community	1,530	6.361411E	9.379333E	Obanliku
BashuaBiajua	122.1	6.041531N	8.986014E	Boki
Ajassor	108	5.841701N	8.850313E	Etung

Table 2: Climatic variables and pH of the study Areas

Climatic variables	Normal Range	Bashua	Ajassor	Obudu(Obechere)
Temperature	13-26^{0}C	25-26	24-25	23-24
Rainfall(mm)	800-2500	1600-1900	1900-2200	1900-2200
Relative Humidity(%)	70-80	80-85	80-85	75-80
880Soil pH	3.5-6.5	5.2-6.10	4.8-7.10	4.7-5.7

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Report 7

Task: Land Suitability Mapping For Lowland Tea

Experimental Title:- Diagnostic assessment of pest and diseases prevalence for potential land suitability determination for lowland tea.

Investigator:- Agbeniyi, S.O., Adedeji, A.R., Orisajo, S.B., Okeniyi, M.O., Otunonye, A.H., Ogundeji, B.A., Ayanwole, S.A., Oladigbolu, Y.O., Omoleye, M.T., Laoye, F.T. and Olorunleke F.O.

Introduction:

The Food and Agricultural Organization (FAO) recommended a land suitability assessment approach for crops in terms of suitability ratings ranging from very highly suitable to unsuitable based on climatic and terrain data, as well as soil properties. Land suitability evaluation according to FAO standards has been applied in many parts of the world, particularly in the developing countries.

Also, land use planning for tea by individual site assessment using the traditional method is subjective and a time-consuming procedure. Although a few studies have been undertaken to map the suitability of lands for tea cultivation, they did not cover the entire tea-growing region of the country. In the given context, no initiative has yet been taken by the Cocoa Research Institute to classify land or existing tea-growing areas to varying degrees of suitability.

The land suitability assessment for tea is important for identifying the potential areas for maximizing the production and to suggest ameliorating measures for better crop management [Ghalod*et al.*, 2017]. The suitability analysis allows recognizing marginal suitable areas which facilitate decision makers to identify limiting factors and enable them to formulate appropriate management decisions (i.e., new planting, replanting, infilling, diversification, and adopting climate-friendly best practices) for increasing the productivity of the land. An exhaustive study needs to be carried out to determine appropriate land use in the unproductive estates giving due consideration to other factors such as pests and diseases. Also, this allows stakeholders to identify new areas where tea can be planted in accordance with the requirements of the tea crops, emphasizing the qualities of the land unit. Hence, matching crop requirements with available resources through land suitability analysis has become an urgent need to sustain agricultural land productivity in Nigeria.

Objectives:

In view of the above, this research is therefore aimed at determining the specific roles of fungal pathogens in the soil samples with a view of determining suitable land for potential development of lowland Tea.

Materials and Methods

Collection of Samples:

Soil samples was randomly collected and pooled together from the different locations. The samples were subjected to both quantitative and qualitative analyses in order to determine associated pathogens and the microbial population.

Soil samples were obtained from Tea plots in Cross River (Obudu Cattle Ranch and Ajassor Sub Station) transported in sterile Ziploc bags, to the Mycology Laboratory, Plant Pathology Section. Serial dilution was done on the soil samples and were inoculated in freshly prepared potato dextrose agar (PDA), and incubated at 30±2^{o}C for 5-7 days.

Results and Discussion

Five fungi isolates were isolated from soil samples collected from the Tea plots are *Aspergillusniger*(188.3%), *Fusarium*spp. (55.5%), *Rhizopus* spp. (25.00), *Rhizopusstolonifer* (20.00), *Lasidioplodiatheobromae* (11.1%) were isolated from Tea soil samples, while *Aspergillusniger* had the highest average percentage occurrence (62.77%) and *Lasidioplodiatheobromae* had the lowest average percentage occurrence (3.7%) (Table 1). This suggests that *Aspergillusniger*isolates were in large percentage in Tea plot at Cross River State.

Table 1: Occurrence of fungi associated with tea samples

Tea samples	Percentage occurrence of fungi isolates (%)				
	A. niger	*Fusarium* spp.	*Rhizopus Stolonifer*	*Rhizopus*sp.	*Lasiodioplodia Theobromae*
T_1	75.00	-	-	25.00	-
T_2	33.30	55.5	-	-	11.1
T_3	80.00	-	20.00	-	-
Total	**62.77**	**18.5**	**6.67**	**8.33**	**3.7**

Conclusion and Recommendation

Findings from this preliminary study revealed *Aspergillusniger*showed higher association/affinity with tea cultivation compared with other soil organisms. This shows that tea could be exposed to various soil pathogens in their natural ecologies. Further work however still needs to be done to ascertain the pathogenicity of these soil organisms.

Tea Programme

Task**:** Multiplication of adaptable tea clones through stem cutting for expansion of tea cultivation in the low land.

Research Title: Multiplication of planting materials for expansion of tea cultivation to Cross River State

Investigators: Ayanwole S.A., Okeniyi M.O., Oloyede A.A., Adeosun S.A., Olaniyi O.O., Orisajo S.B., and Yahaya A.T.

Introduction

Tea was introduced into Nigeria in 1952 on Mambilla highland along Gembu, Arrdo-Gori, Kususku, Kakara, Maizat-mari and Ngoroje axis (Hainsworth, 1981; Adedeji, 2006). Commercial tea cultivation started in Nigeria in 1982. The confinement of commercial tea production to Mambilla highland was orchestrated by the fact that the highland is adjudged the most suitable ecology for tea production in Nigeria. This is as a result of its cool environment and acidic soil which are the main climatic and edaphic requirement for tea growth and development. However, the expansion of tea production has been constrained by the limited land availability for tea cultivation on the highland. This has necessitated the need to explore new areas for tea production. The new area which have potentials for tea cultivation include Ibadan, Iyanomo (Edo State), Akwete (Abia State), Ikorodu (Lagos State) and Ajassor (Cross River State) where tea adaptability trials have been successfully established (Omoloja and Esan, 2005). Among these locations, Ajassor is outstanding in enhancing tea growth and establishment because of its acidity soil as well as heavy and widespread rainfall. These attributes qualify Ajassor to be selected as site for tea expansion. This lead to training and sanitization programme organized for prospective tea farmers in the location in 2022. In the training, many of the farmers developed interest in tea cultivation. However, they needed to be empowered with planting materials which were not readily available at the time of training. Therefore, this project is aimed at multiplying tea clonal materials for distribution to farmers at affordable cost.

Objectives

To multiplicate planting materials for expansion of tea cultivation in Ajassor in Cross River State through stem cutting.

Materials and Methods

Nursery Establishment:

Top soil for filling of polythene bags was obtained from Ajassor. Pots were filled with top soil first at the base of the pot to about 2/3 full followed by the sub soil to fill the remaining 1/3 portion. The pots were arranged in rows making a total of 1000 per block and a total of 6,000 in all.

Source of Tea cutting:

Tea cuttings used were obtained from Tea plots in Ajassor Substation, the clone from which vegetative propagation was 318. The mother bushes were pruned two months before the leaf cutting was obtained.

Materials used:

IBA- routine, budding knife, hand trowel, butanol, secateurs, polythene bag, top soil and polythene sheet.

Procedure

3 – 5 suitable cutting per shoot and 15 – 25 shoots could be obtained from a well maintained mother bush. Only single node cuttings from a suitable shoot was used. The cuttings used consist of leaf containing about 2.5cm of stem below it and about 0.5cm of stem above it. The internode cuttings are prepared by giving a top cut immediately above the axillary bud parallel to the leaf blade. The cuttings was dropped into a water container immediately after the cut and were planted as soon as possible without leaving them to dry out. One cutting was planted per bag by inserting vertically down into the soil. 2 grams, of IBA-routine hormone were prepared in butanol of 1 liter to stimulate root growth; this enhances the chances of successful rooting. Soil in the polythene bags was lightly watered and gently pressed prior to inserting cuttings to ensure firm anchorage. Propagation was done under a sealed polythene tunnel to have considerable savings on water and labour. Planting of cuttings should be done in the manner the leaves are oriented in one direction at an angle to the row. After cuttings are planted, the bags as well as the beds are given a thorough watering and covered

immediately with a transparent, 300 guage polythene sheet, resting on semi-circular bamboo hoops. The edges of the sheet are buried well on all four sides and made air-tight to create a propagating environment. No additional watering is required in the tent as the water applied initially would be adequate for internal circulation within the tent. The condensed water was placed back in the potted bags by gently tapping the surface of the tent at frequent interval in the mornings. The cover could was retained for 3 months, depending on the rate of growth, and removed in stages extending over a few days for hardening.


Plate 1 and 2: showing the arrangement and dipping of cutting in routine hormone

Plate 3 and 4: showing the planting and covering of the bed with polythene

Results and Discussion

Three months after propagation, a success rate of above 80% was recorded (Table 1). The seedlings are currently undergoing hardening process. This result was in tandem with the work of Topacoglu *et al.*, 2016 which showed that IAA had the highest rooting percentage.

Table 1: The percentage survivor of Tea stem cuttings treated with IAA rooting hormone.

BLOCK	Percentage Survivor (%)	Percentage Mortality (%)	New leaves		New shoots	
			Number	Area (cm)	Number	Length(cm)
1	80c	20c	2.42	3.09	1.0	8.5
II	75e	25e	2.12	2.74	1.0	8.0
III	85b	15b	2.6	3.20	1.0	8.6
IV	90a	10a	3.0	3.67	1.0	8.8

V	68f	32f	2.50	63	1.0	8.6
VI	77d	23d	2.32	2.98	1.0	8.7

The result showed that the percentage survival ranges from 68 to 80 in all the six blocks. The highest percentage survival was obtained from block IV and for new leaves formed it ranges from 2.12 to 3.0 which was the highest. The number of shoots formed was the same across the blocks. There was no significant difference in the length of shoots. According to Kathiravetpillai *et al.,* 1982, the use of a sealed polyethylene cover to propagate cuttings has the advantage that it effects considerable saving of water and of labour and this method could be expected to promote faster vegetative growth due to the higher temperature and humidity that prevails within.

The result of this study indicated the important role of determining the optimal rooting medium in the process of vegetative propagation. Retention of leaves seems to be necessary fo the cuttings as they do not have very large reserves. The ability of cuttings to survive and produce long and massive root is very important Kathiravetpillai *et al.,* (1982).

Plates 4 and 5 showing the success rate

 

Plate 6 and 7

Conclusion

This study has clearly shown that adaptable tea clones can be successfully propagated in the lowland as against the belief that it can only be done in the upland.

Programme: Tea

Task: Land Suitability Mapping

Experimental Title:- Assessment of Land Availability and Its Suitability for Lowland Tea Cultivation in Cross River State, Nigeria.

Investigator:- Oluyole, K.A., Dada, A.O., Oladokun, Y.O.M. and Okeniyi, M.O.

Introduction

Camellia Sinensis (L) Kuntze was discovered in China in about 2700 B.C. Tea was discovered in South-East Asia perhaps in the province including the sources and high valleys of the Brahmaputra, the Irranwaddy, the Salween and the Mekong rivers at border separating India, China, and Burma. Tea is an evergreen bush which when cultivated is kept at a low height to enable the young branches from which tea is plucked. Presently, globally compared to other agricultural industries, the industrial tea industry has attained a huge degree of stability (Famaye, 2006).

The Nigerian Beverages Production Company (NBPC), Mambilla Plateau, introduced tea clones from Kenya into Nigeria for commercial planting in 1972 (Olaniyi *et al*., 2014; Hainsworth 1981). The tea clones were later acquired by Cocoa Research Institute of Nigeria (CRIN) for research purposes in 1982 (Esan, 1982). In Nigeria, tea is exclusively grown in the humid, high altitude regions of Mambilla Plateau in Taraba State. The average yield of tea on commercial plots on the Mambilla is 1.5 t/ha (Chen *et al*., 2012). At present, the supply of tea from these regions is inadequate to meet the demand of the local tea processing industries (Adeosun *et al*., 2022; Olaniyi et al., 2014; Obatolu and Ipinmoroti 2000). Indeed, less than 30% of the tea leaf raw material requirement of the local processing industries is met. However, the expansion of tea fields and the opening up of new areas to meet this supply shortfall has proven difficult, because Mambilla Plateau, where most tea is cultivated, has limited land area available for commercial cultivation, and there are land use conflicts, including cattle grazing and industrial and residential purposes. The available alternative is therefore to test tea in the lowland ecological areas of Nigeria, where expanded tea cultivation might be possible. Tea production can contribute immensely to food security and poverty alleviation in Nigeria if much attention is given to improvement.

In Cocoa Research Institute of Nigeria, efforts have so far been made to adapt tea to lowland areas of Nigeria viz-a-vis Ibadan (Oyo State), Ikom (Cross River Estate), Ikorodu (Lagos State) and Mayo-Selbe in (Taraba State) (Olaniyi *et al*., 2014). Until recently too in Owena (Ondo state). Farmers in these locations have been involved in the cultivation of several crop enterprise (arable and tree crops). Even though the soils in these areas are suitable for lowland tea but are they available? This study will therefore examine land availability and its sustainability for lowland tea cultivation in Nigeria.

Objectives

The objectives of the study were to:

(i) determine the land availability for lowland tea cultivation

(ii) determine the land suitability for lowland tea cultivation

Methodology

The study was carried out in Cross River State of Nigeria. A multistage random sampling was used to select respondents for the study. The first stage is purposive selection of Cross River state. The second stage is the random selection of three Local Government Areas (LGAs) namely Boki, Etung and Obanliku. The third stage is the random selection of one community each from each LGA. The selected communities are Bashua from Boki LGA, Ajassor from Etung and Obudu Cattle Ranch from Obaliku LGA. One hundred and twenty questionnaires were distributed based on proportionate to size. After sorting out for missing data one hundred respondents' information were used for analysis. The data retrieved from the information collected were analysed with the use of descriptive statistics and correlation analysis.

Results and Discussion

Table 1 presented the socio-economic characteristics of farmers in Cross River State. Six out of ten respondents were males. There were more male farmers in the study area compared to the female farmers. The mean age of the farmers was 44 years. Farmers in the study area were mostly middle aged and thus might be more willing to try out new innovations and techniques. They may also be willing to try out the planting of lowland tea on their farms. Majority of farmers in the study area were married. This means that they would have more persons in their households that could be used as family labour thus the cost of labour would drastically reduced.

Table 1: Socio economic characteristics of the farmers

Variable	Frequency	Percentage
Gender		
Male	65	65.0
Female	35	35.0
Age		
< 30	19	19.0
31-60	69	69.0
>60	12	12.0
Mean 44		
Marital status		
Single	16	16.0

Married	84	84.0

Source: Field survey, 2023

Table 2 presented land availability for lowland tea cultivation. Eighty eight percent of the farmers inherited their farmland. This could serve as a hindrance to the adoption of lowland tea as they might want to continue with what their fathers have been planting on the farms. Also, on the other hand, most of these farms may have their nutrients depleted as a result of long years of usage thus if organic/inorganic fertilisers are not added to the soil this could cause the low output of tea thus hindering the total adoption of tea by the farmers. Majority (89%) of the farmers do not have disputes on their farmland. This is a good factor in enhancing the production of lowland tea in the study area. Farmers in the study area grow arable and tree crops on their farm. Twenty seven percent grow arable crops, 38% grow tree crops and 35% grow both. Ninety nine percent of the respondents affirmed that the crops they grow on their farmland are doing well and all the farmers agreed to the establishment of tea on their farm. This is good as it aligns with the plan of Cocoa Research Institute of Nigeria in establishing lowland tea in areas discovered to be suitable in which the study area is part of it. Fifty percent of the respondents agreed that they could use half of their farmlands to grow tea. Seven out of ten farmers agreed that their farms can be used as demonstration/model farms where other farmers can come to see how tea farm is established and maintained.

Table 2: Land availability for lowland tea cultivation

Variable	Freq.	%
Land ownership		
Inherited	88	88.0
Purchased	12	12.0
Dispute on land		
Yes	11	11.0
No	89	89.0
Crops grown on farmland		
Arable crops	27	27.0
Tree crops	38	38.0
Both	35	35.0
Are the crops doing well?		
Yes	94	94.0

No	6	6.0
Can you plant tea on your land?		
Yes	100	100.0
What proportion can you use for tea cultivation		
25%	9	9.0
50%	50	50.0
100%	41	41.0
Can you allow other farmers to have access to your after tea establishment?		
Yes	78	78.0
No	22	22.0

Source: Field Survey, 2023

Land suitability for tea establishment is as shown in table 3. Fifty four percent of the farmers had farmlands that had gentle/flat land topography. This kind of farmland is suitable for farming. Also 65% of the farms had black coloured soil which showed that the soils are fertile. Twenty two percent of the farms had red soil which could be clayey soils and may not be good for tea production. Hence, the substantial proportion of the land is suitable for tea cropping being having black coloured soils. Furthermore 70% of the farmland had well drained soils which are suitable for tea production.

Table 3: Land Suitability for Tea Establishment

Variable	Freq.	%
Gradient of the land		
Slopy	18	18.0

Gentle/flat	58	54.0
Gently slopy	24	24.0
Type of weed on farmland		
Narrow leaved	31	31.0
Broad leaved	15	15.0
Both narrow and broad leaved	54	54.0
Land soil colour		
Black	65	65.0
Red	22	22.0
Grey	5	5.0
Brown	8	8.0
Nature of soil		
Marshy	20	20.0
Well drained	70	70.0
Sticky	10	10.0

Source: Field Survey, 2023

Relationship between land ownership and socio-economic parameters

Table 4 and 5 presented the result of correlation analysis which shows the relationship between land ownership and socio economic parameters

Tables 4 shows the relationship between land ownership and gender. The result showed that there was a significant relationship between land ownership and gender ($\ell \leq 0.05$). The relationship is expected because more male farmers inherit land compared to their women counterparts. What the women do in most cases is to buy land for their farming activities.
The finding fall in-line with the patriarchy system in Nigeria where men have the final say. The study area, that is, Cross River State is not an exception, hence, the women there too do not inherit land.

Table 5 shows the relationship between land ownership and age of the farmer. The result showed that there was no significant relationship between land ownership and age of farmer ($\ell > 0.1$). Hence, land ownership is independent of the age of farmer, whether old or young, so far that he is a male child. The implication of this is that more youths will be more gainfully involved in farming without any hindrance regarding the ownership of land.

Table 4: Landownership by Gender

Variable	Gender		Total
Landownership	Male	Female	
Inherited	60(0.1)	28 (90.3)	88 (0.4)
Purchased	5(1.0)	7 (1.9)	12 (2.9)
Total	65 (1.1)	35(2.1)	

Source: Field Survey, 2023

Pearson chi^2(1) = 3.26 Pr= 0.07

Table 5: Landownership by Age

Landownership	Age		
	<30	31-60	>60
Inherited	15(0.2)	61 (0.0)	12 (0.2)
Purchased	4(1.3)	8(0.0)	0(1.4)
Total	19(1.5)	69(0.0)	12 (1.6)
Total	65 (1.1)	35(2.1)	

Source: Field Survey, 2023

Pearson chi^2(1) = 3.12 Pr= 0.210

Conclusion and Recommendation

The substantial proportion of the land in the study area was inherited, hence it is possible for the farmers to hold the grip of the land to an extent. Also majority of the farmers are ready to make their land available for the cultivation of tea. As regards the suitability of the land for tea cultivation, it was discovered that the land is suitable for the cropping especially when parameters such as gradient, soil colour and nature of the soil are considered. Also, it is concluded that there is a significant relationship between land ownership and gender

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TRAINING DEPARTMENT (Prof. R.R Ipimoroti)

Training and development encompass organizational processes designed to improve employees' knowledge, skills, and capabilities. While training concentrates on enhancing specific job-related competencies, development takes a more expansive, long-term approach to foster employees' overall growth and potential. These initiatives involve workshops, courses, on-the-job learning, mentoring, and various methods. The training department arm of the Institute is saddled with the responsibility of enforcing the training policy and capacity building of staff in the Institute. Some of the achievements of the training department are highlighted below:

Partnership - USDA, CRIN and Lutheran World Relief project

The Cocoa Research Institute of Nigeria in conjunction with the United States Department of Agriculture (USDA) and Lutheran World Relief organized a training for Enumerators for Baseline Survey in Nigeria. This was carried out at the Cocoa Research Institute of Nigeria (CRIN), Ibadan. The rigorous training commenced on the 18th January, 2023 and ended on 21st January, 2023. The project will amongst others provide training on improved agricultural production techniques, develop business solutions to improve farmer access to goods and services, strengthen business development capacity, promotes climate-smart agriculture to increase agricultural productivity in Nigeria's cocoa value chain, improves the traceability of cocoa, advocate for improved policy and regulatory frameworks affecting sustainable cocoa development and disseminate better market information.

Cashew Grafting Training for Staff

The Institute organized a training program on cashew grafting for staff from June 5th to 9th, 2023 at the Nursery section. The attendance cut across scientists, trainees and expert grafters. The training session started with theoretical exposition on the cashew tree, usefulness, best method of planting and the detailed aspects of grafting.

PhD Defense

A handful number of scientists bagged their PhD during the year 2023. This has been the highest so far in the history of the Institute. The under listed names are the awardees.

SN	Name	Title of thesis	Institution	Date

1.	Dr. B.A Ogundeji	The use of selected botanicals and nanoparticles to control toxigenic moulds associated with stored cocoa beans	Federal University of Agriculture, Abeokuta	March 22,2023
2.	Dr. A. H. Otuonye	"Evaluation of the Morphological, Molecular and Pathogenic Variability of the Black Pod Pathogen (Phytophthora species) of Cocoa (Theobroma cacao Linn.) in Nigeria	Federal University of Agriculture, Abeokuta	March 31, 2023
3	Dr. S. B. Rahman	Training needs of Agriculture Lecturers for Information and Communication Technology Skills enhancement in Public Universities in Southwestern, Nigeria"	Ladoke Akintola University of Technology, Ogbomoso.	May 24, 2023.
4	Dr. T. M. Orisasona	Technical Efficiency and Profitability of Coffee Production in Kogi State, Nigeria"	Ambrose Alli University Ekpoma, Edo State	April 17, 2023.
5.	Dr. I.F. Abdul-karim	Adoption of Export Standard Practices (ESP) among Coffee-based Farmers in Kogi	Kwara State University, Malete, Ilorin.	July, 2023

		State.		
6.	Dr. Chinyere Florence Anagbogu	Genetic diversity and metabolomic profile of Coffea species in Nigeria.	University of Ibadan.	August 2023
7.	Dr. Aderonke Yahaya	Competitiveness of Tea value chain in selected Nigeria Geopolitical zones	Federal University of Agriculture, Abeokuta	October 27, 2023.
8.	Dr. Abiodun Ajewole	Efficacy of selected spices in mitigation of fungal growth and mycotoxins production in Tea and Coffee	University of Ibadan	October 30, 2023.

International Conferences

As part of the training effort of the Institute, the following staff have benefited from attending conferences at various locations as indicated below:

SN	Attendee	Conference/Workshop	Location	Date
1.	Dr. J.O Lawal	African Cashew Alliance conference	Saly, Senega	18th - 22nd September, 2023.
2.	Dr. D.O. Adeniyi	Cashew health map in West Africa sub-region	Yamoussoukro, Côte d'Ivoire.	21st to 22nd August, 2023
3.	Dr. I.U. Mokwunye	Scientific Exchanges Program (SEP)	North Carolina USA	March 6, 2023 - June 3rd, 2023

Value Addition Research Division (Igbinadolor R.O)

The Value Addition Research Department is one of the department that has mandate to conduct end use research into CRIN mandate crops namely: Cocoa, Cashew, Kola, Coffee and Tea. The department is currently endowed with 36 staff comprising 21 scientists and 15 support staff. (see Table 1.)

Table 1: Staff strength of VAR as at December, 2023

SN	Name	Qualification
1	Yahaya L.E	Ph.D.
2	Jayeola C.O	Ph.D.
3	Igbinadolor R.O	Ph.D.
4	Ogunjobi M.A.K	M.sc
5	Adebowale B.A	M.sc
6	Olalekan-Adeniran, M.A	M.sc
7	Okunade A.F	M.sc
8	Mofolasayo A.S	B.Eng.
9	Adeleke S.A	B.Eng.
10	Orimoloye P.O	M.sc
11	Olorundare B.O	Ph.D.
12	Ekemube R.A	Ph.D.
13	Ajewole A.O	Ph.D.
14	Ogunsowo, A.O	M.sc
15	Odeyemi E.F	M.sc
16	Raji M.O	M.sc

17	Atanda J.F	M.sc
17	Mustapha K	M.sc
18	Adesokan M.A	M.sc
19	Yusuf T.I	M.sc
20	Akinola C.O	M.sc
21	Jimeshio J.G	B.sc
22	Agboola O.O	B. Tech
23	Bolarinde F.	HND
24	Onyemachi O.F	M.sc
25	Amaka E.	B.sc
26	Ezeorah A	B.sc
27	Bamgbose A.A	HND
28	Adesokan A.	HND
29	Mohammed-Bashir W.	HND
30	Ojo O.O	HND
31	Emmanuel T.A	B.sc
32	Alaba O.O	HND
33	Ogunlusi O.R	NCE
34	Adeleye K.	
35	Isaac E.	
36	Alawode S.	

This division comprises of specialized units through which value is added to the Institute's mandate crops.

Bakery unit: The bakery unit which used to be a commercialized aspect under Agricultural and by-product services and originated from the Value Addition division has been leased out to CRIN cooperatives as a separate entity. Cocoa bread is a product of fortification of wheat flour with cocoa powder. It is formulated by substituting a part of the wheat flour base with cocoa powder in a normal bread recipe. The inclusion increased the flavour of this bread tremendously. Beverage unit:

Chocolate unit: This unit is involved in the daily production of chocolate though at a laboratory scale with less than 40 bars per day. Chocolate is a cocoa product formulated with milk, sugar, cocoa butter and roasted cocoa bean. This recipe gives milk chocolate. Substituting the part of the cocoa base with kola powder, coffee powder, cashew or Tea gives flavored chocolate respectively. New researches on chocolate are also conducted here.

Soap unit: This unit specializes in soap production of different kinds such as black soaps and liquid soaps. Cosmetic products are also produced in this unit. There has also been new researches in the area of soap and cream production. Cocoa Pod Husk (CPH) and Kola Pod Husk (KPH) are embedded with potash and are sources of raw material for soap making and other cosmetics.

Winery: This is a laboratory where wine production takes place. Wine is a product of fermentation of sugar. It involves contact between yeast, a sugar source and water in a cooled fermentation vat. The yeast breaks down sugar into alcohol and carbon dioxide. When fermentation is complete, the wine is racked, aged and bottled. The level of alcohol in the wine is determined by the amount of sugar used. Substituting part of the sugar base with cocoa bean or cocoa sweating, Kolanut, Cashew apple, Coffee or Tea leave infusions give cocoa, kola cashew coffee or tea flavoured wine respectively.

Design and Fabrication unit: This unit is saddled with the responsibility of developing appropriate technology for the field and post-harvest handling of the institutes mandate crops. Some research work which has been undertaken by the unit includes the determination of relevant engineering properties of Cocoa, Coffee and kola necessary as design parameters for design and fabrication activities.

Refurbishment of the Division

The division saw a facelift during the year, 2023. The offices and laboratories of the division were renovated.

ECONOMICS AND EXTENSION

TITLE: ECONOMIC ANALYSIS OF *Theobroma cacao* HYBRID VARIETIES (TC Series) ON FARMERS' LIVELIHOOD IN SOUTHWEST NIGERIA

Investigators: Lawal, J.O; Oluyole, K.A.; Akinpelu, A.O.; Obatolu, B.O.; Taiwo, OA..; Yahaya, A.T.; Orisasona, T.M.; Agulanna, F.T.; Oladokun, Y.O.M. and Adesanya, K.A.

Introduction

Theobroma cacao (cacao) or cocoa tree is an evergreen tree which belongs to the family of Malvaceae (alternatively Sterculiaceae). It is an economically important perennial crop and one of the world's most valuable crops, cultivated worldwide on 8.2 million hectares, playing an important role in the social and economic life of more than 5 million households, and affecting 25 million people in poor rural areas. Cacao is grown in 58 countries and its worth is more than US$4 billion per annum to the world economy. Nigeria is the fourth largest cocoa producer in the world after Ivory Coast, Ghana and Indonesia, accounting for about 12 percent of the total world production of the crop (World Cocoa Foundation, 2014). Cocoa is also the most prominent export crop in Nigeria in terms of her production and export capacities (Nwachukwu *et al*., 2012). According to Adebile and Amusan (2011), cocoa contributed about 15 percent of the country's total export and $900 million to its economy in 1970 and 2012 respectively (*The Sun*, 2013). Despite the importance of cocoa production in Nigerian economy, its production in the country is far below expectation which may be due to numerous factors such as low yielding materials, inadequate soil fertility, attack of pests and diseases and weed infestation (Oppong *et al*., 2007). Nevertheless, with the world's rising global demand for cocoa and the growing chocolate appetite, there is the urgent need to fill the technological gap among producers (Nkamleu *et al*., 2010).

Towards this end, wide adoption of improved production technology by the farmers is necessary to boost cocoa yield and ensure sustainable production. Innovation in agriculture has occurred over time and for ages through chance and through deliberate actions of farmers seeking for new and better ways and methods of production (Nmadu *et al*., 2015). Low productivity from ageing cocoa trees and low technology uptake among the farmers are likely to be some of the contributing factors. In fulfilling its mandates to agricultural development, CRIN developed eight different cocoa hybrids known as CRIN TC Series (that is; CRIN TC_1-TC_8) in 2010. Each of the newly developed breeds possess distinctive features such as; early bearing (with the average yield of 2,000 kg/ha as compared to the former 500 kg/ha), insect pests and disease tolerance and other quality parameters. Seedlings of these newly developed genetically improved and high yielding varieties were made available to farmers for planting in the fourteen cocoa producing states in the country. Hybrid cocoa technology is one of the important agricultural innovations introduced to revive cocoa yield as hybrid cocoa shows superior advantages over “Amazon” and “Amelonado” (Olasupo and Aikpokpodion, 2019). Hybrid cocoa produces a high number of pods per tree, has an early maturing period and has two harvesting seasons (Akoa *et al*., 2021). However, there is a dearth of information on the impact of the hybrid cocoa on the livelihood of the farmers, the level of cocoa productivity in comparison to the expected output of cocoa from CRIN, the various constraints being faced by farmers in the establishment of the cocoa hybrid and the economics of production of the varieties.

Meanwhile, Ellis (1998 and 1999) defines livelihoods as the assets, activities, and access that determine the living gained by individuals or households. Impact assessment is thus concerned with impact analysis, which is, finding out how far the introduction of an improved technology has been successful in meeting socio-economic objectives, and how well improved agricultural technologies have satisfied the needs and priorities of households and other units in the target population.

It is important to mention that a good number of farmers have acquired and established the CRIN cocoa hybrid (TC_1-TC_8) in all the cocoa growing regions of the country which started in 2012. To this end, it is imperative that an impact analysis of the improved cocoa varieties (TC_1-TC_8) on the livelihood of farmers is carried out. The general objective of this study was to analyse the impact of *Theobroma cacao* improved varieties on the livelihood of farmers in Southwest Nigeria.

The specific objectives were to:

1. analyze economics of production of the TC_1-TC_8 series
2. analyze access to and use of improved cocoa varieties by the farmers
3. determine the level of production of the TC_1-TC_8 series
4. ascertain the constraints militating against cocoa production among producing households in the study area

Research Methodology

The study was conducted in Southwest Nigeria. The study employed multistage random sampling technique to select cocoa farmers in the study area. The first stage involved a selection of three cocoa producing states from Southwest, Nigeria. These are Ondo, Osun and Oyo states. The second stage involved a purposive selection of one Local Government Area (LGA) from each randomly selected state making a total of 3 LGAs. Ayedaade, Ondo-East, and Ona-Ara LGAs were selected from Osun, Ondo and Oyo States respectively. The communities were purposively selected because CRIN developed TC_1-TC_8 varieties have been disseminated. Fifty farmers were selected from each LGA making a total of one hundred and fifty farmers from the three states. However, one hundred and ten cocoa farmers' information was used for analysis. Well-structured questionnaire were used to elicit information from the respondents. Data were analyzed using descriptive (frequency distribution, percentages, means, and standard deviation), budgetary analysis, inferential statistics and Likert scale.

Model specification for the budgetary analysis is as:

Total Cost (TC) = Total Fixed Cost (TFC) + Total Variable Cost (TVC)……..... (i)

Gross Revenue (GR) = Total Output (Total number of tons of cocoa beans sold) x unit price……………………………… (ii)

Gross Margin (GM) = GR – Total Variable Cost (TVC) …………………......... (iii)

Net Income (NI) = GR – Total Fixed Cost (TFC) …………………………… (iv)

Profit= GR-TC

Results and Discussion

Socio-Economic Characteristics of Respondents

Table 1 below presents the socio-economic characteristics of cocoa farmers in the study area. The table revealed that some (12.7%) of the farmers in the study area are less than or equal to 30 years of age and majority (60.7%) of the farmers were between 31-60 years old while 24.6% were greater than or equal to 61 years. This implies that middle aged people dominated production of cocoa in the study area. The gender of the farmers showed that about fifty nine percent were male while about forty one percent were females. This shows that both the male and female gender is involved in cocoa production in the study area.

In addition, it could be observed from the table that a little above sixty percent of the respondents were married. This study shows that most of the respondents are married suggesting that they may perhaps be more devoted to the course of cocoa production. Marital status of respondents may determine the level of household size which by extension may indicate availability of family labour, income composition and savings pattern (Akerele, *et al.*, 2015). Also, according to the table largest percentage (35.0%) of the farmers had post-secondary education. This corroborates Akerele *et al.,* (2015), who asserted education as a vital tool needed to enhance adoption of modern techniques in improved decision-making, marketing, production and modern practices of farming. and it can be clearly deduced that greater part of the farmers are educated. It therefore suggests that the education could improve farmer's access to information and knowledge which could be a positive impact on cocoa production efficiency.

Furthermore, the table indicates that 34.6% of the respondents had family size of 1-5 persons, sixty percent of the respondents had between 6 and 10 persons and 5.5% had more than 11 persons as members of the same household. This result suggests that family members will be more committed to cocoa farming as an economic venture from which income can be generated to sustain the family. The table shows that 62.7% of the respondents do not have access to credit facilities while 37.3% have access to credit facilities.

Table 2 below shows the awareness level of improved cocoa among farmers in the study area. The results showed that majority (87.3%) of the farmers are aware of the improved cocoa varieties. Only a few (12.7%) of the farmers had no information about the hybrid cocoa. The implication of this is that the sensitization campaign was high and effective in these areas. This could give the impetus to grow the hybrid cocoa among the farmers and lead to improved income. In addition, table 2 reveals that more (73.6%) of the respondents has the improved cocoa in their possession. This confirmed the effectiveness of the awareness creation on the hybrid cocoa among farmers in the study area. This will eventually lead to expansion of the hybrid cocoa cultivation even among few uninformed farmers in the study area.

Table 3 below showed the economics of production for the cocoa farmers in the study area. The result shows that a farmer spends an average of ₦2,345,931.00 on cocoa farm with average gross revenue of ₦1,875,985.00 and a gross margin of ₦347,880.00 per farmer. Similarly, the results further showed ₦1,058,159.00 net income per farmer and a profit margin of ₦469,945.00 per farmer. This result indicates that the TC series is productive and profitable for the farmers.

Table 4 below shows the constraints militating against cocoa production in the study area. The inability of the new cocoa seedlings to be tolerant to water stress when compared to cocoa varieties such as F3 amazon and Amelonado variety ranked first and most important constraint with a mean score of 180. The second constraint of importance from the farmers' opinions was a poor to average yield compared to other cocoa varieties. The mean score was

174. Other constraints considered as least impacting on their decision of using the new hybrid cocoa seedlings were in adequate access to seedlings.

Conclusion and Recommendation

The study revealed that middle aged people dominated production of cocoa in the study area. This had a positive impact on the productivity and efficiency of cocoa production and the result indicated that the farmers are in their productive age with capability and strength for farm operations. Majority of the respondents are aware of the TC_1-TC_8 hybrid varieties and also have the hybrid cocoa. This confirmed the effectiveness of the awareness creation on the hybrid cocoa among farmers in the study area. Better income accrued from planting of the hybrid cocoa was ranked first in the study area. They had the necessary skills and experience needed for farm work. Cocoa (TC_1-TC_8) hybrid varieties are productive and profitable for the farmers with the positive net income and profit obtained from the TC_1-TC_8 cocoa series planted by the farmers in the study area. Adaptation of the hybrid cocoa seedlings to water stress when compared to other varieties such as F3 amazon and Amelonado was the most important constraint discovered in the study area. Hence, more efforts should be put to make *Theobroma cacao* hybrid varieties (TC series) available to more farmers in the study area based on the profitability of these varieties and ability to improve the livelihood of the cocoa farmers in the study area.

Table 1: Socio-Economic Characteristics of Cocoa Farmers in Southwest Nigeria

Variable	**Frequency**	**Percentage (%)**	**Mean/Standard Deviation**
Age (Years)			
Less than 30	14.00	12.70	
30-60	69.00	62.70	
Above 60	27.00	24.60	
			50±15
Gender			
Male	65.00	59.10	
Female	45.00	40.90	
Marital Status			
Single	6.00	5.50	
Married	67.00	60.90	
Divorced	30.00	27.30	

Widowed	7.00	6.40	
Educational Level (Years)			
No formal Education	12.00	10.90	
Primary Education	23.00	20.90	
Secondary Education	33.00	30.00	
Tertiary Education	29.00	26.40	
Adult Education	13.00	11.80	
Household Size (No of Persons			
1-5	38.00	34.50	
6-10	66.00	60.00	
Above 10	6.00	5.50	
			6±3
Access to Credit (Dummy)			
Yes	41.00	37.30	
No	69.00	62.70	

Source: Field Survey, 2024

Table 2: Access to and Use of Improved Cocoa Varieties among Farmers in Southwest Nigeria

Variable	Frequency	Percentage (%)
No	14	12.7
Yes	96	87.3
Possession of improved cocoa		
No	29	26.4
Yes	81	73.6

Source: Field Survey, 2024

Table 3: Economics of production of Cocoa TC_1-TC_8 among farmers in Southwest Nigeria

Items	Average/ Farmer (₦)	Grand Total (₦)
Fixed cost	817,825.60	89,960,816.00
Variable cost	1,528,105.30	168,091,580.00
Total cost	2,345,930.87	258,052,395.90
Gross revenue	1,875,985.50	206,358,405.00
Gross margin	347,880.22	38,266,824.66
Net income	1,058,159.89	116,397,588.70
Profit	469,945.37	51,693,991.27

Source: Field Survey, 2024

Table 4: Constraints militating against cocoa production among cocoa producing households in Southwest Nigeria

Constraints	Weighted Mean Score	Rank
Less tolerant to water stress compared to other varieties	180.33	1
Poor to average yield compared to other cocoa varieties	174.04	2
Pest attack	172.49	3
Inadequate access to chemical	168.11	4
Inadequate access to credit	165.08	5

Source: Field Survey, 2024

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EXTENSION:

Exprimental Title:- Dissemination of selected crin technologies in benin city, edo state.

Investigators:- Uwagboe, E.O., Awodumila, D. J. and Rahman, Saheed

Introduction

CRIN has developed many technologies which are still on shelf and there is need to disseminate these technologies to end users. Technology transfer will improve the living condition and productivity levels of Nigeria people. The benefits of technology transfer include industrialization, job creation, increase in income, poverty reduction, enhance adoption and improved productivity.

Objective of the study

The general objective of the study is to promote CRIN developed technologies to end users in Nigeria.

The specific objectives are to:

(1) To sensitive and create awareness on CRIN developed technologies,
(2) To exhibit CRIN developed technologies,
(3) Evaluation of participant's feedback on the disseminated technologies

Methodology

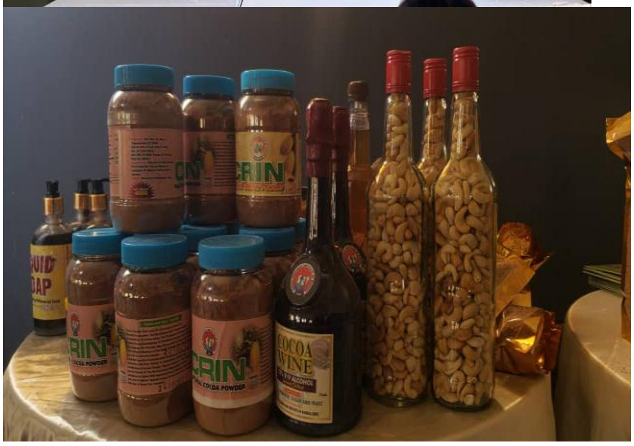
Pre-visit was carried out by the principal investigator Dr. E. O. Uwagboe and an Agricultural Superintendent Mrs Paulina Ejikeme to map out strategies in the selection of the participants.
Multi-stage sampling procedure was used to select participants for the project. Benin city was purposively selected based on their volume of trade. In the city a centralized location at Norland Building Hall at No. 3 James Watts Road, Benin City was selected for the exhibition. Some traders in five markets in Benin City and women groups were invited for the exhibition. Government personnel such as the Commissioner of Business, Trade and Coopprative (Hon.Patrick Iria), The chairman of Oredo Local Government Area (Mr Tom Obaseki), The Programme Manager of Agricultural Development Programme (ADP) (Dr Edward Izevbigie) and Extension Directors, Farmers association, Bakers, Processors, were present. The following CRIN developed products were exhibited; Cocoa Bread, Cocoa powder, liquid soap, cashew kernel and chocolate. Flyers, posters and banners indicating the products were printed. Hero TV Station was also invited for the online transmission. A giggle for the exhibition was aired in Hero Television Station, Uromi, Edo state.

Results

Over Eighty participants attended the programme and products were exhibited. The Extension Section leader made a presentation on CRIN products and the advantages of the different products that were exhibited. The commissioner of the Ministry of business, trade and cooperative, Chairman of Oredo Local Government Area and ADP Programme Manager were very delighted in bringing the programme to Benin City and expressed their willingness to collaborate with CRIN in the area of training on the products of women and youths in the state. Some of the participants indicated their willingness to become distributors of some of the CRIN products.

Cross section of activities and CRIN products on exhibition


COCOA RESEARCH INSTITUTE OF NIGERIA (CRIN) IBADAN
Venue:
Date:


CRIN
CRIN
COCOA POWDER
COCOA WINE

Recommendation

1. Adequate fund should be released in the dissemination of CRIN products for exhibition.
2. This exhibition should be conducted in other major towns or cities in the states especially where CRIN mandates are produced

B. Report on Adopted villages and schools.

Abagbo in Oluyole LGAs of Oyo State is a successful thriving adopted village organized by the Institute in 2009. The farmers were organized into different groups, this has helped them to have a formidable cooperative society called Agbeloba Farmers Multi-Purpose Cooperative Society licensed by Oyo State Government in 2014. This cooperative society has helped them to partially solve problem of finance among themselves.

Based on their request, several trainings and capacity buildings on production, Good Agricultural Practices, On farm processing and marketing were the training received by the farmers. In line with their request, a plot of about 0.4 ha planted with cocoa TC series was established for them.

Also, a poultry pen was constructed and this helped the Institute to demonstrate the inclusion of Cocoa Pod Husk in layer feed.

In the same vein, Prospect High School, Abanla, Oluyole LGAs of Oyo State and Mamu Comprehensive College, Many in Ijebu East LGAs of Ogun State are also Adopted Schools of the Institute. Activities such as establishment of hybrid cocoa plot and inclusion of cocoa pod husk in layer feed for egg production were also achieved.

The three centers are now centers of attraction to Governmental Organization and Non-Governmental Organization, students on excursion, research work for both undergraduate and post graduate students from various Nigerian universities.

Constraints:

Presently, the poultry pen in each of the 3 centers has been abandoned for lack of fund.

The AROC buildings in all the centers need complete renovation and replacement including facilities such as chairs and tables.

C. Excursion Visits within the year 2023

The students and pupils from all walks of life do come on academic excursion to Cocoa Research Institute of Nigeria, Ibadan. The primary aim of the section to every visitor on excursion visits is to transfer knowledge and create positive awareness of activities of CRIN research, developed technologies and innovations of the institute.

Within the year, thirteen (13) schools visited the institute on excursion. The students and staff on excursion intend to have practical knowledge of theories taught by their teachers and lecturers in the schools, their visits corroborate and consolidate their learning.

The students were taken to various sections in the institute to have the knowledge of different activities carried out in such section during the excursion visits. The students were taken to CRIN Extension demonstration plot, where the mandate crops of CRIN were shown to the students. These mandate crops are Cocoa, Kolanut, Cashew, Coffee, and Tea. During the visits all CRIN developed technologies were introduced to the students. More so, students were also introduced to six (6) sub stations of CRIN, which cut across the six geopolitical zones of Nigeria.

During the visits, the dates, names of the schools, number of students, names of staffs attending to the visitors and the remarks from different schools were written down for record purpose.

The list of the schools received for 2023 Excursion is as follows:

S/N	Dates	Name of Schools	Nos of Staff from the School	Nos of Students	Visitors Remarks
1.	02/02/23	FUNAB Abeokuta	3	90	Very good
2.	22/03/23	Breakthrough Ingenious Montessori School, Scout Camp Challenge, Ibadan	6	25	Excellent
3.	09/05/23	Department of Plant Biology, University of Osun, (UNIOSUN	5	72	Excellent

4.	24/05/23	Ijebu North Anglican Model College, Aparaki, Oru-Ijebu, Ogun State	3	31	Excellent
5.	26/05/23	Honour International Group of Schools, Olomi, Ibadan	4	27	Great work, keep it up. Hospitality is superb.
6.	23/06/23	Future Leaders Group of Schools, Sanyo, Ibadan	2	31	Excellent
7.	05/07/23	Leaders Group of Schools, Obalende, Ijebu-Ode, Ogun State	16	52	Satisfactory
8.	25/07/23	Kwara State University, Malete, Ilorin	3	20	We were not disappointed with the reception and lots exposures that added knowledge to the students academically
9.	24/08/23	Micheal Otedola College of primary Education, Epe, Lagos State	3	20	
		College of Agriculture, Mokwa			
10.	20/09/23	Federal Colege of Tech.,Akure	3	21	Wonderful and

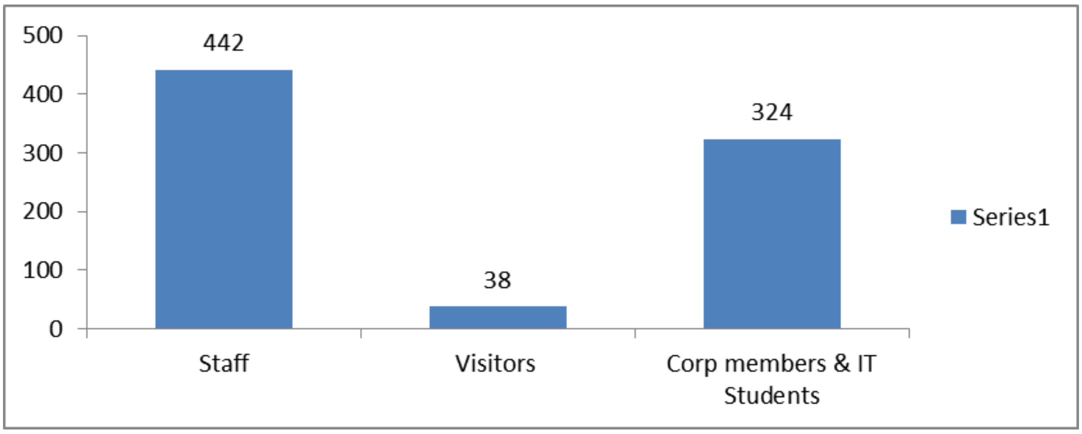
					Interesting
11.	04/10/23	CRIN SSWA Model College, Adebayo, Idi-Ayunre, Ibadan	4	64	Interesting
12.	28/11/23	The Vale College, Ibadan	3	11	Awesome
13.	06/12/23	University of Ibadan	4	27	

Source: CRIN Economics and Extension Division, 2023

INFORMATION AND DOCUMENTATION (DR. MRS OGUNJOBI T. E)

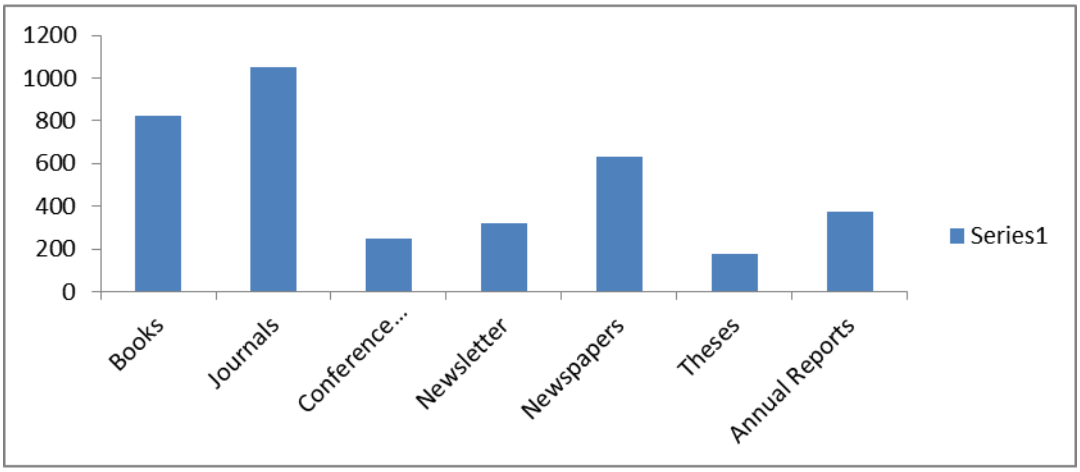
LIBRARY DIVISION – MR. ABODERIN A.K. (HEAD LIBRARY DIVISION)

CRIN Library like other Agricultural Research Institute Libraries acquire, process, store, retrieved and disseminate relevant information resources to its users who are majorly Research Scientists in the year under review. A total number of 804 users were received between January–December 2023. This comprised 442 staff, 38 visitors, and 324 Corp members and Industrial training students visited the library. Below is the breakdown for year 2023:



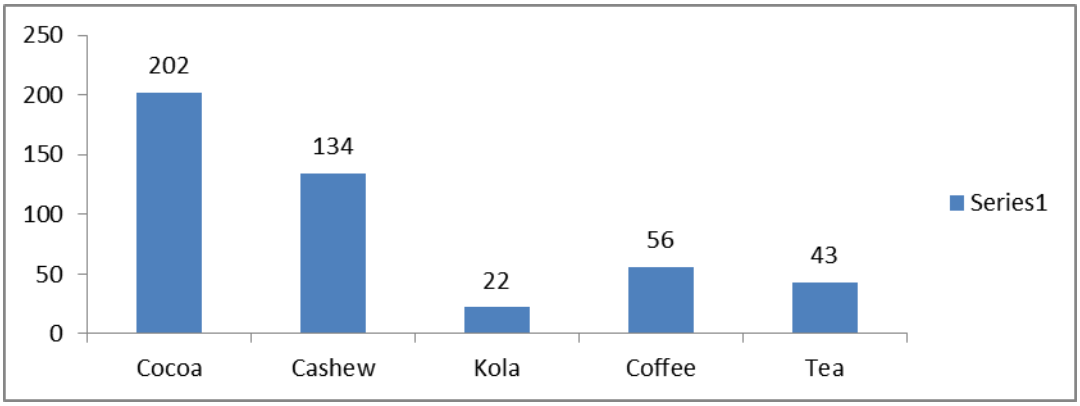
The library acquired publications that are relevant to the institute mandate in print and electronic format. The acquisition is major done through gift and exchange, few books and journals were also acquired through purchase. Two different Newspapers were bought on a daily basis. Accessing, stamping and displaying of new information resources were done regularly.

The institute library primary role is to provide services to its users, these were done through; charging and discharging of books, the use of annual reports, journals and other information resources. Users query were attended to, compilation of bibliographies and CRIDAN were done, inter-library loan was carried out, current awareness services and selective dissemination of information to profiled scientists were also part of the services rendered by the library. Books and periodicals were consulted by users. CRIN library had the record of its resources used. The number and resources used were as listed below:



Also, in the year 2023, Annual reports for the years 2013 – 2021 were edited, produced and distributed to Heads of Directorate, Heads of Divisions and all Research Scientists. Cocoa Research Institute of Nigeria Information Booklet was also reproduced. 2022 and 2023 Annual Reports were Complined and edited.

The Newspapers bought were released to the readers to peruse, while library officers also make use of it for newspaper cutting services (in other to search for relevant information useful to the institute). Information extracted on the newspapers base on CRIN mandate crops were listed below:



Electronic resources such as Teeal and AGORA were used by some scientists. Information was also provided to the ICT division and was uploaded to the institute website. Relevant information resources on the CRIN mandate crops were downloaded from various websites.

The electricity has been a great challenge to the institute library, also cleaners and security personnel should be deploy to the institute library to cub theft and mutilation of library books.

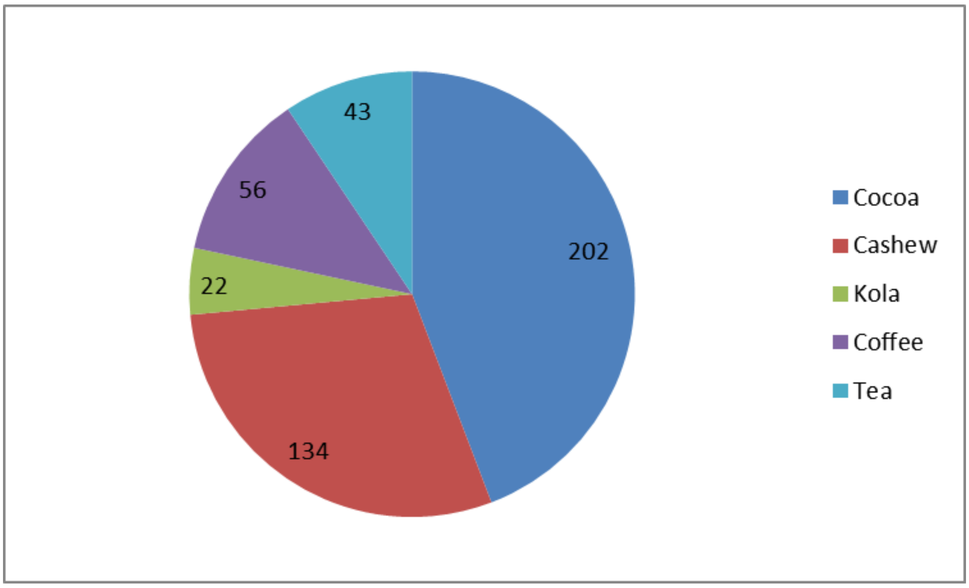
Fig 3: Newspapers extract of information on CRIN mandate crops for year 2023

New Books and Journals should be acquire and agricultural electronic- journals should also be subscribed to.

PUBLICATION DIVISION - MR. OGUNBAJO O.O (HEAD, PUBLICATION)

Documentation division of the institute provide official information and evidence that serves as record, this could be in terms of reports, pictorial activities, video recording, list of visitors to the institute etc. For effective service rendering, the division is divided into four units, library automation system, CRIN ID card Production, photographic unit and Annual report compilation and printing.

Library Automation Systems- Efforts have been on high side to make available, downloaded information resources particularly e-journals on the mandate crop of the institute. In 2023, 457 e-journals were downloaded on the five mandate crops of CRIN. Cocoa took the largest of it with 202 e-journals, while cashew was second with downloaded e-journal of 134. Coffee, tea and kola had 56, 43, and 22 respectively.



CRIN ID card production – The production of new customized ID card printing continued for both old and new staffs of the institute. In 2023, staffs ID cards were produced. Presently, the ID card machine is faulty and it's under repair.

Annual report compilation and printing – In 2023, nine years annual reports were edited and printed (2013-2021). Work is on-going on the compilation of 2023 annual report.

Photographic unit – The unit takes photography of all events in the institute and print such into frame. It also involved in short documentary within the institute. The unit has two personnel attached to it.

The division needs equipment's to function effectively. These include but not limited to, laptop, digital camera, video recorder, ID card machine etc. On the job training should also be encourage among the staffs of the division.

ICT DIVISION (BABAFEMI, I. B. – Head, ICT)

The ICT Division composed of Internet/Website and Automation section. This division was saddled with the responsibilities of providing the Institute with Internet connection, web presence and the digitization of library collections.

Staff Strength: The division comprised of five staff – Programme Analysts (1), Data Processing officer (3) and Chief Printer (1).

Achievements

In the year under review, the achievements of the division cut across maintenance of the Institute website, provision of Internet (wired/wireless) for all staff. Other achievement includes:

1. Provided Technical Support for staff
2. Managed Users' Internet hotspot login accounts
3. Updated institute's website with staff profiles and activities
4. Liaison with Institute's Internet Service Provider (ISP) and Web Host Manager to ensure quality services
5. Trained ICT divisional staff and interns
6. Created Staff (Scientists)Institutional e-mails for professionalism of communication

PRODUCTION AND SUBSTATIONS DEPARTMENT (DR. M.O. OGUNLADE)

PLANTATION AND ESTATE MANAGEMENT

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

A. **Staff Strength/Staff Disposition**

S/N	Unit	Effective Hectarage	No. of Staff	No. of PCW
1.	PEM	-	5	
2.	Zone 1	34.79	19	
3.	Zone 2	15.14	13	
4.	Zone 3/4	15.19	7	
5.	Zone 5	27.63	15	
6.	Zone 6	26.00	14	
7.	Zone 7	23.85	11	
8.	Zone 8	41.05	20	
9.	Zone 9	22.89	11	
10.	BCOO	6.00	2	2
11.	Fermentary	-	11	
12.	Ground Maintenance	-	31	10
13.	CFC/HPU	-	22	2
14.	Oil Mill	-	16	

B. **Farm Activities**

All farm activities in various zones were carried out as at when due but the work could not be done effectively because all materials and chemicals needed for the assignment were not given to us at Plantation and Estate Management.

C. **Harvest Records**

S/N	Unit	Produce	Total
1.	Zone 1	Cocoa Banana Cashew	988 pods 172 bunches 3.2kg
2.	Zone 2	Cocoa	163 pods
3.	Zone 3/ 4	Cashew Cocoa Plantain	47.0kg 80 pods 5 bunches
4.	Zone 5	Cocoa	1,458 pods
5.	Zone 6	Cocoa	
6.	Zone 7	Kola	174 pods
7.	Zone 8	Cocoa	2,748 pods
8.	Zone 9	Cocoa	250 pods
9.	BCOO	Cocoa	1,150 pods

D. **Challenges and Constrains**

1. We have inadequate of everything like chemicals, tools and manpower to handle the plots in the year ended. Nothing was given to us as a division that could make our work easy. We find it difficult to carry out activities in the zone due to Fulani infestation on our farm and nothing is being done to cub their activities.

2. Inadequate/shortage of manpower is another serious problem we are facing on the field

3. Non availability of offices for Agric. Superintendent

4. Porosity of Zonal office complex allows for pilfering of our farm produce

5. Late and inadequate supply of agro-chemicals make weeds in our surroundings to grow and it always compete with our mandate crops

6. Inadequate supply of farm tools and protectives clothing materials

7. Monitoring of our plots is difficult of unavailability of functional motorcycles or utility vehicle

8. Functional Bazuki tricycles are needed for evacuation of our farm produce

9. The oil mill unit needed total renovation

E. **Distribution of Farm Tools**

S/N	Zone	Ultimax plus	Protective goggle	Paraforce	Sharp. File	Cutlass	Rocket	Harvest. hook	Rain boot	Field coat	Jute bag
1.	Zone 1	30 pcs.	2	5	10	15	1	1	8	5	-
2.	Zone 2	30 pcs.	2	2	11	14	1	1	6	4	-
3.	Zone 3/4	30 pcs.	2	3litres	10	10	1	1	6 pairs	4 pcs.	-
4.	Zone 5	30 pcs.	2	5litres	8	8	1	1	7	6	-
5.	Zone 6	30 pcs.	2	5litres	8	7	1	1	7	6	-
6.	Zone 7	-	2	2	3	5	1	1	8	7	-
7.	Zone 8	30 pcs.	2	2	11	15	1	1	7	5	-

8.	Zone 9	30 pcs.	2	2	4	10	1	1	6	6	-
9.	BCOO	30 pcs.	-	1	2	4	-	2	2	2	-
11.	CFC	-	2	2	5	12	1	1	4	4	-
12.	G/M	-	13	17litres	12	15	1	-	8	8	-
13.	Nursery	-	2	2	5	30	1	-	6	6	-
14.	Fermentary	-	-	1	1	11	1	-	1	1	10

Conclusion

We appreciate the Almighty God for the opportunity given to us to be alive, we lost one of our staff to the cold hand of death in the year under review and the person is Mrs. Ganiyu Janet, we pray that what she left behind shall be protected and this death will cease from our Institute.

We also appreciate the Executive Director for his fatherly role in PEM and the Institute as a whole, we are using this medium to let him know that we still need more of his assistance in making our work to go on smoothly.

NURSERY DEVELOPMENT AND MANAGEMENT SECTION

The Nursery section comprises of two units; Sexual propagation unit and Vegetative propagation unit.

The activities of each unit in the year reported upon are as follows:

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

-Propagation of all mandate crops through sexual means

-Maintenance of seedlings of all mandate crops

-Maintenance of plantain orchard

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

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

-General cleaning of Nursery and its environment

-Maintenance of WCF plot.

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

below:

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

--Maintenance of all bud wood gardens.

-Maintenance of old cocoa clonal and seed gardens

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

Purposes

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

-Training of visitors, students and farmers

-General maintenance of Nursery

3. Others activities carried out include:

- Successful grafting of cocoa for field research purposes by cocoa programme

-Successful establishment of cocoa clonal garden at zone 3 and 4.

-New establishment of cocoa clonal garden at WCF plot.

-Successful grafting of cashew for field research purposes by cashew programmer.

-Successful grafting of kola for field research purposes by kola programme.

- Kola stem cutting trial.

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

4. Renovation/ Rehabilitation /Purchase

- Construction of basement for two (2) water tanks

- Purchase and installation of two numbers of water tanks

- Sinking of bore hole to enhance the supply of water in the nursery..

- purchase of 10 pieces of watering cans

-Purchase of 6 jungle boots, 6 field coats, 3 liters of herbicides, 26 cutlasses, insecticide and fungicide

5. Staff strength: The staff strength of the section is 31(5 Supervisors and 26 field Staff)

6. Achievement: The following achievements were recorded within the period reported upon:

-Production of 40,000 hybrid cocoa seedlings.

- Production of 3000 cashew seedlings.

-Production of 4000 of Kola seedlings.

-Production of 3000 cocoa clones

7. Challenges: The nursery section is being faced with some challenges in spite of the

aforementioned achievement. The challenges which include:

-Dilapidation of some shade nets

-lrregular transportation of staff to and fro Nursery

-Lack of security personnel

- Inadequate supply of farm tools and equipment.

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

Signed

CFC - HYBRID PRODUCTION UNIT (HPU)

The mandate of the unit is to generate cocoa pods for sales, raising of seedlings for research purpose and to meet the demand of Nigerian farmers.

Maintenance practices such as harvesting, pruning and continuous weeding of the plots for the season of hand pollination. Five (5) male contract staff were employed by the management for six months to support the staff in the unit to control the excessive weed growth on the plots. The contract of the contract staff ends up by 31st March,2024.

Total number of five hundred and forty three (543) open pollinated pods were harvested as at December 2023. Pollination operation was stopped for three years (3yrs) to allow the cocoa trees to recuperate well. The pods harvested were distributed to the farmers.

From the field assessment of the plots, survival cocoa stands on the hybrid plots were ready for pollination as they have started bearing flowers. The Regional variety trials (RVT) plots were also ready for pollination. Factorial plot was opened up where very good number of cocoa producing trees were found.

RECOMMENDATIONS.

1). Posting of more agile male staff to the unit to join the maintenance operation.

2). Re-new of the 5 contract staff to maintain the level of maintenance.

3). Repair of damage field implements such as wheel barrow, knapsack sprayer etc.

4). Timely supply of inputs e. g. fungicides, insecticides and herbicides.

5). Allocation of motor bike for the unit for more performance of the supervisors.

6). Providing security patrol around the plots during the week days and on weekends.

SUBSTATIONS

AJASSOR SUBSTATION

Introduction

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

CRIN Ajassor substation is the largest Substation with a landmark of about 768 hectares. This total land area which has been reported over the years is currently not certain due to mass encroachment of the border forest and plantations by the local native occupants/ communities. This land loss of estimated areas not yet scientifically estimated but generally believed to be over 40% of the original size of the substation plantations and forests led to the submission of a report to the Institute by the former Head of station (Dr. Uwagboe, E. O.) in collaboration with Mr Obatolu, B. O (GIS Expert) and Late Dr. Ogunwolu, O. S (the then Head of Plantation and Sub-station) in 2019 to scientifically have the actual estimated land area and the effective cultivated area of the sub-station. The report from the GIS work would have confirmed the land estimate of past annual reports of 56.86Ha effective cultivated plots and about 23.7Ha and 7.5Ha categorized as non-effective and abandoned plots, respectively. These figures are exclusive of the ground cover of approximately 113,436m^2 of land area that accommodates the Administrative and Plantation Management Blocks, Staff Residential Quarters, Crop Nursery and Post-Harvest Unit.

Mechanical Workshop, Rest House, Fermentation Building, Cocoa Dryer Compartment, a Staff Clinic as well as a Primary School (now under the control of Cross River State Government). In addition to the main substation in Ajassor, there are two other experimental outposts in Assena-sen community formerly referred to as (Okundi) located at Ikom-Okundi-Etome Road and predominantly cultivated with Cocoa and Coffee while Kalime outpost is located along Ikom –Ajassor Border Road mainly cultivated with T.38 clone of Cocoa. Cocoa Research Institute of Nigeria, Ajassor Substation, engage in exclusive training programme and extension services by disseminating research findings and many relevant information to the farmers, cooperative societies, corporate organizations, local and state governments in her immediate neighborhoods, and other surrounding States.

Table 1: UPDATED LIST OF AJASSOR SUB-STATION STAFF IN ORDER OF SENIORITY AS AT 31ST DECEMBER, 2023.

S/n	Name	PF No.	CONRAISS and step as at 31/12/2021	Designation	Date of 1st appointment
1.	Mr. Odedele Samson O.	314	12/02	Asst. Chief Agric Superintendent	08/04/2008
2.	Mr Ajayi Oluwasegun	375	11/03	Principal Agric. Superintendent II	2/2/2009
3.	Mrs. Joy AwungheTakim	390	09/03	Principal Nursing Sister I	01/04/2010
4.	Mr. Nmeregini Uwadiaru	1206	08/03	Accountant II	17/07/1995
5.	Mrs. Esther Ntomo Echi	1293	07/03	Chief Health Asst.	01/12/1997
6.	Mrs. Maureen Duruaku	1897	07/01	Acct. II	05/12/2011
7.	Ms. Pauline Ukpeukiema Ugi	1566	07/01	Senior Secretariat Asst. I	23/12/2008
8.	Mrs. Blessing Ekama Isong	1288	06/11	Chief Clerical Officer	01/12/1997
9.	Mr. Ezekiel Asuquo Effiong	1289	06/04	Chief Agric Overseer	01/12/1997
10.	Mr. Edet Akpan Robson	1541	06/04	Chief Agric. Overseer	02/06/2003
11.	Mr. Okpokam Ozong Edim	1556	06/04	Chief Store Keeper	10/04/2008
12.	Mr. Adebiyi Oluwabukayomi Sunday	1591	06/05	Senior StatisticalAssistant	01/01/2009
12.	Miss Precious Magagi	1820	06/02	Chief Clerical Officer	06/07/2011
13.	Mr. Sunday Nkanta Ekereobong	1700	06/01	Chief Field Overseer (Security)	02/01/2009
14.	Mr. Abraham Samuel Inyang	1701	06/01	Chief Field Overseer	02/01/2009

15.	Mr. Samuel James Udoh	1702	06/01	Chief Field Overseer	02/01/2009
16.	Mr. Idagu Godwin Echa	1703	06/01	Chief Field Overseer	02/01/2009
17.	Mr. Onah Peter Ogar	1704	06/01	Chief Field Overseer	02/01/2009
18.	Mr. Iwara Eteng Okoi	1706	06/01	Chief Field Overseer	02/01/2009
19.	Mr. Sunday Ime Asua	1705	05/02	Asst. Chief Agric Field Overseer	02/01/2009
20.	Mr. Azogor Isong Echeng	1707	05/02	Asst. Chief Agric Field Overseer	02/01/2009
21.	Mr Augustine Eteng Ubi	1698	05/02	Asst. Chief Agric Field Overseer	02/01/2009
22.	Mr. Emeng Ele Eleng	1708	05/02	Asst. Chief Agric Field Overseer (Security)	02/01/2009
23.	Ms. Mercy Umontia	1814	05/02	Asst. Chief Agric Field Overseer	29/04/2011
24.	Mr. Peter Godwin	1815	05/02	Asst. Chief Agric Field Overseer (Security)	29/04/2011
25.	Mr. Idorenyin Okpo	1950	04/05	Senior Agric Field Overseer	26/04/2012
26.	Mr. Anthony David	1816	03/09	Agric Field Attendant 1	29/04/2011
27.	Mr Monday Echi Enya	1974	02/02	Driver/Mechanic II	5/3/2020
38.	Miss Patience Takon Ayiba	1978	01/02	Agric. Field Attendant III	5/3/2020
29.	Mr Emmanuel Takon Ayiba	1979	01/02	Agric. Field Attendant III	5/3/2020

Mr. Sunday Adebiyi joined the Substation on transfer from Headquarters. No casuality was recorded at the substation.

Staff Disposition As at 31 December 2023 the staff strength across different sections were 30 including the Ag. Head of Station who is an Agricultural Superintendents, 2 Chief Clerical Officers (Administration), 2 Accountants II, 1 Store Keeper, 1 Principal Nursing Sister I, 1 Health Asst, 1 Senior Secretariat Asst. I, 1 Senior statistical Assistant, 3 Security men, 15 Field officers, 1 Mechanic/Driver and 4 contract security personnel. It is pertinent to inform CRIN Management that most staff of CRIN Ajassor especially those on the field and in the Security Section are very few and mostly old people. There is an urgent need to recruit more young and vibrant persons into the system.

Plantation Management: There were various challenges such as inadequate field workersas well as unavailability of enough agro-chemicals for field and ground maintenance. Maintenance of all the Cocoa, Kola and Tea plots under CRIN Ajassor were done throughout the period under review. Weeding is done manually more than six times in a year due to rapid competition of weeds with the mandate crops.

Funds were released for the purchase of pesticides late 2023 to maintain the National Cocoa Seed Garden Plot, survival count was carried out to ascertain the total numbers of surviving cocoa trees available on the plot since it was established. Details of the head count are hereby given thus:

1	C77	196
2	C67	34
3	T57/22	43
4	T65/7	190
		463

Surviving count of National Cocoa Seed Garden Plot

In view of the above, I wish to recommend that proper re-tagging of the entire plot and continuous maintenance should be carried out to prepare for hybrid production of cocoa pods.

The newly prepared survival count map has been submitted to the office of the Director/Production and substations Department for further actions.

Remark: The effective hectare for the crops in other plots is not certain as proper survey has not been carried out to determine the surviving trees. Some of the abandoned cocoa plots were put under share cropping, to discourage encroachment and to enhance increase in revenue and prevent spread of pests and diseases. There is an ongoing plan to replace all the missing stands in all plots to replace the empty or dead space in 2024.

INFRASTRUCTURE/CAPITAL PROJECT: Ajassor Substation did not receive any infrastructure; we appeal the management to remember this station in subsequent year.

RESEARCH EXPERIMENTS: A pocket of research experiments were carried out at CRIN Ajassor Substation as at 31 December, 2023 as indicated in Table 3

Table 3: Research experimental work carried out at Ajassor Sub-station in 2023.

S/N	YEAR OF ESTABLISHMENT	NATURE OF EXPERIMENT	RESERCHER(S)	REMARK
1	2023	Fungicide screening	Dr. Adedeji et. al	Done
2	2023	Cherrel wilt disease experiment	Dr Henry Otunoye et. Al	Done
3	2023	Fungicide screening	Dr. Okeniyi et. al	Done
	2023	Soil profiling experiment	Dr. Ipinmoroti et. al	Completed
4	2023	Tea Experiment	Dr S.A Adeosun	Completed
5	2023	Herbicide screening	Dr. Osasoge	Completed

Disbursement of capital fund: CRIN Ajassor received token capital fund for the maintenance of the Seed garden plot late 2023 in preparededness for subsequent pollination exercise to produce hybrid cocoa pods. The fund released was judiciously spent and retired as appropriate.

The slab and tarpaulin to process cocoa beans are obsolete and non-presentable. We recommend their replacement with more recent and highly acceptable raised platforms and durable tarpaulin. The three (3) shade nets for propagating seedlings need urgent refurbishing as they are in a very bad condition. The roofing of the administrative block is leaking and the ceilings are collapsing. Proposal has been submitted to the office the Executive Director for necessary action.

Environmental Sanitation: At CRIN Ajassor, we know that 'health is wealth' and so we placed a high premium on the cleanliness of our offices and the residential quarters. Against this backdrop, the usual Monthly Environmental Sanitation were carried out on every last Saturday of the month throughout the year under review. We also implore CRIN management to provide more public toilets for staff in their residential quarters in 2024.

List of the vehicles/motorcycles/generators/other equipment and their conditions are as below:

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

2. 404 Pick-Up with registration number FG 2326 B034.

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

4. The Eicher Truck with registration number FG 740 B03 (Not functioning.

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

6. Bedford with registration number FG 238 BO3.

7. Tractor 1 (serviceable) with registration number FG 239 B03 MF 265.

8. Tractor 2 (unserviceable).

9. Motor-cycles 3: We have 1 Daylong Wolf 150 it's not functioning due to accident while on official assignment but the 2 Suzuki 185 motor bikes with registration numbers FG 334 B03 and FG 335 B03 are old and not functioning.

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

11. Generators: 50 KVA Generator plant 1 (functioning but some of its parts needed replacement), 1 Elepaq 10KVA Petrol generator functional, 1 Tiger 2700 (functioning), 1 Sumec SPG 2500 (functioning) and 1 Tiger T 950 (functioning)

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

13. Visual equipment: 1 Overhead projector DLP LG,

14. Laboratory Equipment: 1 Autoclave, 1 Microscope

15. Electronic machines: 1 HP Scanner G4010 (functioning), 1 HP Printer P1006 (Faulty), 2 HP Laptops, 3 HP Laserjet printer (2 faulty, 1 functioning), 1 Desktop computer (Samsung) (Faulty)

Some of these items were inspected, slotted and valued for evacuation by CRIN board of survey led by Late Dr S.O Ogunwolu of blessed memory and the Cross River State ministry of works team in the year 2020, a comprehensive report was submitted to his office before his death which up till this moment awaits further directives.

Visitors to the Substation in 2023.

Over 250 visitors came to CRIN Ajassor sub-station in 2023 but only 34 of them were sampled for this report. The names, addresses and purpose of visit of the sampled visitors are reflected in Table 4 below:

Table 4: Name, address and purpose of visitation of some sampled visitors to CRIN Ajassor sub-station in 2023

S/N	**Date**	**Names**	**Address**	**Purpose**
1	18/10/23	**Ntui Ramond Effiong**	**Ajassor**	**Official**
2	20/10/23	**Enor Mboto**	**Ikom**	**Official**
3	**23/10/23**	**Abu Micheal**	**Ikom**	**Official**
4	**23/10/23**	**Oyeyemi Oyejoke**	**Beyond Beans Akure**	**Official**
5	**23/10/23**	**Samuel Udenik**	**Ajjassor**	**Private**

		Affiong		
6	**25/10/23**	**Corper Yusuf Saadat**	**Effraya**	**Official**
7	**30/10/23**	**Hon Charlse**	**Etung**	**Private**
8	**30/10/23**	**Elder Kingsley**	**Ajassor**	**Official**
9	**30/10/23**	**Mrs Ubi Otare**	**LGEA Etung**	**Official**
10	**30/10/23**	**Ogar Stephen**	**Ajassor**	**Private**
11	**30/10/23**	**Martins Nwanko**	**Ajassor**	**Private**
12	**31/10/23**	**Ogimah Mike E.**	**Ajassor**	**Private**
13	**01/11/23**	**Assam Assam Ogar**	**Ajassor**	**Official**
14	**4/11/23**	**Victor Oseyi Assam**	**Ikom**	**Official**
15	**07/11/23**	**Assam Cyreel**	**Ajassor**	**Official**
16	**10/11/23**	**Pisca Esu**	**Nde**	**Official**
17	**16/11/23**	**Peter Abang**	**Okundi**	**Official**
18	**16/11/23**	**Ntui Raymond**	**Ajassor**	**Official**
19	**17/11/23**	**Ekpor Ekong**	**UNICAL Calabar**	**Official**
20	**18/11/23**	**Victor Oseji Asu**	**Ajassor**	**Official**
21	**24/11/23**	**Manick Z**	**Ajassor**	**Private**
22	**24/11/23**	**Tunde Dele**	**Ikom**	**Official**
23	**25/4/23**	**Ogar Stephen**	**Ajassor**	**Official**
24	**26/11/23**	**Odey Dominick**	**Ikom**	**Official**
25	**28/11/23**	**Dr. Motak**	**Atimaka park,Ikom**	**Official**
26	**28/11/23**	**Patrick Etta**	**Ajassor**	**Private**
27	10/12/23	**Takon V Takon**	**Ikom**	**Official**

28	**12/12/23**	**Ogar Innocent**	**Idomdom**	**Official**
29	**15/12/23**	**Enock Emma**	**Ikom**	**Official**
30	**16/12/23**	**Afolabi Nafisat Seyi**	**Ikom**	**Official**
31	**16/12/23**	**Ewoh Bright**	**Ikom**	**Official**
32	**18/12/23**	**Ndop Laurence**	**Ikom**	**Official**
33	**21/12/23**	**D.P.O Etung LGA**	**Effraya**	**Official**
34	**22/12/23**	**Etta Pelvis**	**Boki**	**Official**

Internally Generated Revenue for 2023

A total amount of Eight Million, Four Hundred and Twenty Seven Thousand and Nine Hundred Naira (**₦8, 427, 900**) only was generated by CRIN Ajassor Sub-station in 2023. The breakdown of the revenue generated is in Table 5 below:

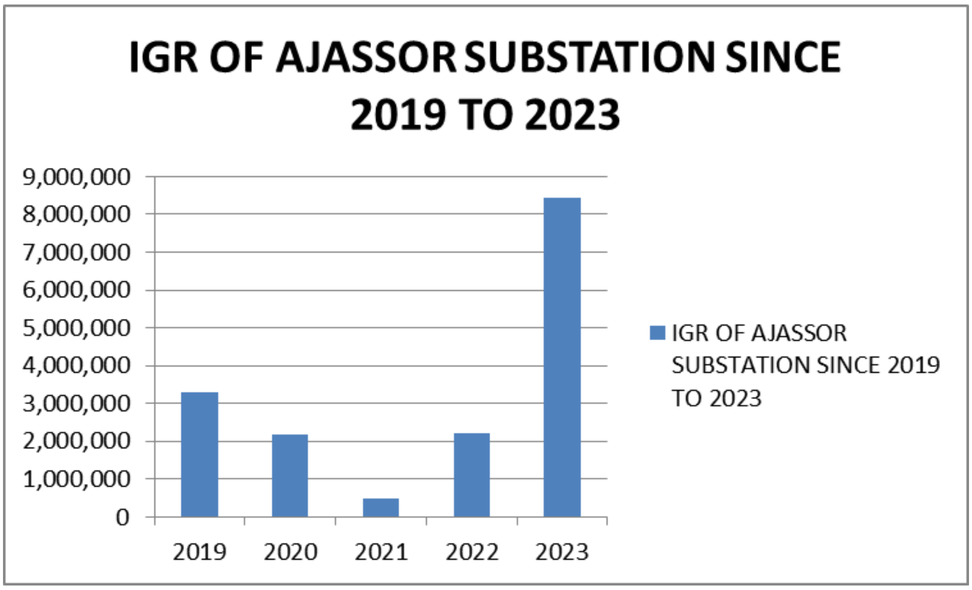
Table 5: Internally Generated Revenue (₦) Analysis for 2023 (January-December)

S/N	*Discription*	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Total**
1.	Cocoa beans									**96,000**	**108,000**			**204,000**
2	Cocoa pods					**10,000**				**10,000**			**300,000**	**320,000**
3.	Palm Oil									**40,000**				**40,000**
4.	Cocoa seedlings			**7,200,000**				**450,000**						**7,200,000**

5	Kola nuts										**3000**	**18,000**	**10,000**	**31,000**
6.	House rent (Tenants)					**9500**	**19,200**	**98,200**			**50,400**	**61,200**	**26,400**	**264,900**
7	House rent (Tenants)								**73,600**	**73,600**	**73,600**	**73,600**	**73,600**	**368,000**
	TOTAL			**1,740,000**		**19,500**		**548,200**	**73,600**	**219,600**	**235,000**	**152,800**	**410,000**	**N8,427,900**

TABLE 6: INTERNALLY GENERATED REVENUE OF AJASSOR SUBSTATION SINCE 2018-2023

S/N	**ITEM**	**IGR (N)**
1	2018	3, 300, 120
2	2019	3, 284, 675
3	2020	2, 184, 975
4	2021	486, 200
5	2022	2, 206, 000
6	2023	8, 427, 900



Challenges and Prospects

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

Internally Generated Revenue (IGR): It was observed that outstanding revenue increase was recorded in the year 2023. This was due to dedication, commitment and ability to propel the few labour to work this period (2023) despite the intensive heat resulting from climate change which still affected drastically the expected production rate at CRIN stations and many plots in Cross River State as reported by farmers.

Precisely, persistency in the habit of sourcing for Internally Generated Revenue for the institutes pave way for excellent relationship with stake holders interest to invest into CRIN mandate Crops reason for the skyrocketed amount generated for 2023 as presented in table five above.

The use of hired labour was continued to open up further some of the abandoned plots for share cropping in 2023 in order to maintain appropriately some abandoned plots and also increase IGR for the station in subsequent years.

Inadequate workforce: We remain the largest substation in CRIN yet with only 15 Field staff, where as some are sick and ageing. We need more staff to adequately maintain all our plots and watch over them. The substation has the capacity for expansion and increased productivity if more staff is engaged. This problem has resulted into the situation where most of our productive plantations are abandoned which, of course, gives room for persistence pilfering of our farm produce, more encroachment and much lower productivity. We urgently need to salvage the situation and produce at our optimal level. To this end, CRIN Ajassor requires nothing less than 60 field staff and 3 Agricultural Superintendents to cope with the weeding, spraying, harvesting, pruning and other cultural practices on our cocoa, kola, and tea plots. Therefore, there is a need to employ additional 45 Field Attendants to complement the existing 15 Field Staff.

Besides, in order to effectively secure lives, properties and forestall order against theft of our farm produce, we need additional 20 Watchmen to complement our 7 current Watchmen (3 staff and 4 contract staff) at the moment.

Funds: The only fund which was released to the station late 2023 was spent for maintenance of the seed garden plots as directed by the management. This fund was judiciously spent on plot maintenance and returns made appropriately. We use this medium to appeal for adequate and timely release of Capital Votes to CRIN Ajassor Sub-Station as soon as possible to enhance efficiency. It is extremely difficult to run a Substation with 30 Staff without funds. Weeding is done more than six times in Ajassor Substation due to high fertility of the soils, persistence rainfall among other factors. We need to repair and fuel our Toyota Hilux, Tractor, Water Tanker as well as Tricycle (Bazuki), machines, equipments and generators especially as we mobilize our field men to go into our three (3) outposts at Assena-sen (Okundi), Rantimankonor near Kalime and Cocoa/Oilpalm experimental plot (NIFOR).

Training/Workshop: A training/Workshop was organized by Nigeria Export Promotion Council on Tea and Coffee propagation for farmers at CAN Guest House, Ikom Local Government Area in Cross River State, Dr.Oluyole and Dr Okeniyi represented the institute by sensitizing the participants on the benefits and need for Tea and Coffee propagation in Cross River State. Ajassor substation was used as venue for Practical which was conducted by Mr Odedele Samson.O (Ag.HOS) for over 500 farmers among which were government agents, traditional rulers, youths,women and some elders across the state to enhance farmers capacity. Some issues that needed to be attended to which generated from the workshop include; consistency in availability of CRIN planting materials , more training on propagation, processing of end use products of coffee and tea likewise extension services required in the growing areas etc.

The Nigeria Promotion and Export Promotion Council team led by Mr. Demia Osai appealed that the institute should make provision for One hectare each of both Tea and Coffee plantation in the substation and a space to establish standard nursery to enable farmers have access to improved planting materials.

In respect to the above, the Nigeria Export Promotion Council promise to submit an official document to CRIN executive Director and also request for further collaborative process that will ginger the reality of the vision.

Encroachment on CRIN Ajassor sub-station land by Ajassor indigenes: This act kept on reoccurring over the years and there has been series of reports by OICs and HOSs on this issue to the headquarters which is still not been properly addressed holistically. Several meetings were held by the Ag. HOS with some of the encroachers including security personnel from Nigerian Army at the Paramount ruler’s palace in Ajassor main town to restrain them from intruding the land. Kuddos to the paramount ruler of Etung Local Government Area, HRM Anthony Ntui Etta for his franctic efforts and acceptability of the sub stations policies to combact peacefully the activity of the encroachers. Effort was made internally by CRIN land committee to remove all permanent crops planted by the stubborn youths. Only those who are ready to cultivate arable crops were temporarily permitted to farm at the boundaries of the research reserves. A proposal of GIS survey project to determine the extent of CRIN land was made to the Institute by the former HOS (Dr. Uwagboe), Mr Obatolu and Late Dr. Ogunwolu (former Director/Head of Sub-stations) in 2019 but it has not been given attention up till this moment. I wish to appeal that this current management revisit that proposal for execution.

STAFF QUARTERS RENOVATION: Virtually all the staff quarters need renovation, most of the existing buildings are now dilapidated, there’s need for urgent attention for renovation of these quarters to avoid total damage.

WATER SUPPLIES CHALLENGES: Water supplies have been a major problem in Ajassor substation despite persistence efforts been made by CRIN management and the occupants of the residential quarters to combat this issue severally, the story has not changed yet. The two bore holes that supplies water for nursery/plantation irrigation and domestic usage are in bad condition. Expert report advised a new borehole and well to be sunk to ease water stress. The occupants do fetch water from a shallow water base running from the rock and this area of water source is very dangerous and may result to accidental disaster if caution is not taken while descending or climbing the hill.

Another means of water supplies is by the use of the Substation water tanker to fetch water from the village streams. The vehicle could not function properly due to lack funds to refurbish the vehicle to a good standard that will enhance productivity. Several requests had been made on this subject matter which still awaits the management approval.

ELECTRICITY SUPPLY: It will be pertinent to know that throughout year 2023 there was no supply of electricity despite all effort mounted on Porthacourt Electricity Distribution Company (PHEDC), Ikom, Cross River State. Funds were released directly to this company by CRIN management but yet effort on supply of electricity was to no avail.

BAD STATE OF THE ENTRANCE ROAD: The only access road (2killometers) linking the substation from the international border road is in a very bad state up till now and this has affected movement of vehicles in and out of the station hereby reducing efficiency and productivity.

POOR COMMUNICATION NETWORK PROVISION: The global communication network system at this part of Cross River state is epileptic in performance which tends to affect research communications and interaction as and when due, so also security networking and strategies.

PERSISTENT PIEFERING: This has been a major challenge because our plots were been troubled by intruders illegally harvesting our mandate crops, mostly at night. The youths and the security men made all effort to combat this problem but the result is still not okay. The available security men who are not armed are few and ageing and likewise there’s no perimeter fence to prevent the intruders from escaping.

Other achievements in 2023:

The under listed are some of the achievements in the year 2023:

Internal re-training of both field and non field workers on maintenance of plantations to enhance sustainability and productivity.

Introduction of recreational activities and fun fare to ease tension and also to calm down fatigue/high blood pressure such as football competition, Father Christmas show for children, viewing center and lots more.

Training on management and maintenance of health status of workers and tenants to avoid sickness and untimely death.

Provision of addittional two solar street lights to boost security activities, this was powered by some concern citizens.

Control of security treat by the encroachers and re-acquisition of CRIN land through the involvement of DSS, Nigeria Army and the Police force to chase and arrest the notorious perpetrators.

Fosterling of peace and order among the occupants by the creation of quarter's chief councils within the estate by enacting and executing the tenancy policies formulated by the Ajassor substation management. This had yielded excellent results up till this moment.

Staff welfares have improved holistically as against the previous years; staff and tenants are granted assistance adequately when the need arises. Especially on health ground.

Maintenance of the refurbished substation's official Toyota hilux to an appreciable standard necessary for extension services, transportation to meetings with some stakeholders and general official services for the smooth running of the station. Although the vehicle is now grounded and packed at Uhunmora Substation,Uhunmora, Edo State due to engine damage.

Consistent maintenance of the plots monthly despite the few workforce available and also non supply of adequate working tools, Pesticides and so on. This has shown in the Internally Generated Revenue of the station for the year 2023.

Awesome hospitality given to visitors and research scientists from the headquarters by rendering full supports at all needed levels to enable them achieve their purpose of visitation.

Other pressing needs of CRIN Ajassor Substation:

1. Vehicles: One new Hilux Pick-up Van and one 18-Seater Staff Bus
2. Motorbikes: Based on the volume of the field work and the need for constant patrol of our plots by the security, there is a need to have 5 functioning motorbikes at our substation.
3. Quick intervention by CRIN Headquarters on the issue of completing the connection of CRIN Ajassor sub-station transformer to National Grid by Port-Harcourt Electricity

Distributor (PHED). So much money has been spent on this issue and yet the PHED has refused to complete the job to enable us have electricity at the station.

4. Surveying and fencing of the station: Surveying of our lands is the only way CRIN can permanently stop the encroachment problem presently being faced by the station. Wire or Perimeter fencing with Oil-palm will also be an added advantage.
5. Construction of concrete and metallic sign posts in all plots for easy identification of name of plants, year of establishment, varieties of plant used, size of each plot, location and general history of all our plots and plants.
6. Tarring or grading of 1.5km road from Border road to CRIN Ajassor main gate which is becoming un-motorable.
7. An internet connection: This could be a broadband internet facility that will facilitate speedy surfing of the web and transfer of research related information to the headquarters. This will help the station to key into the present policy of internet administration strategy in CRIN.
8. Renovation of residential quarters:
9. The buildings at CRIN Ajassor are all dilapidated while toilet facilities are becoming a mirage. Although, government quarters had been monetized, an urgent rescue mission on our Residential buildings to avoid total collapse of these ‘farm houses’. Once collapsed, the tenants and staff will move out of the quarters and that will spell doom for the safety of all farm produce at the station.
10. Renovation of nursery seedling shade nets which are in very bad state.
11. Installation of inverter at the station to bring down the running cost on gasoline/diesel operated generator.
12. Repairs of meteorological station which quotation has been submitted and awaiting approval
13. Re-printing and painting of the CRIN Ajassor Sub-station sign post at the entrance of the station
14. Renovation of the fermentation house, purchase of tarpaulin for drying of cocoa beans, drying oven shed and construction of raised platforms for drying cocoa.
15. Provision of a modern and better equipped laboratory for CRIN Ajassor.
16. Completion of Cocoa bread bakery in the station.
17. Repairs of leaking roof of the administrative block building.
18. Placement of security solar light on each electric poles.

Cocoa Research Plots	**Hectares**	**Status**
Cocoa plots		
1967 Trinidad	2.9	Abandoned
1975 F3 Amazon	1.6	Abandoned
CRIN/NIFOR 1	6.0	Abandoned
CRIN Elite Seed Multiplication	2.2	Maintained
T38 Kalime	2.8	Maintained
Commercial 1	2.0	Abandoned
Cocoa Cuttings	1.0	Maintained
15 Acres Extension	2.0	Abandoned
Amelonado	2.0	Maintained
1973 F_3 Amazon	2.0	Abandoned
Seed Garden Multiplication	2.2	Maintained
Okondi	10.69	Maintained
Planting at stake	1.6	Maintained
Farming System Experiment	2.0	Maintained
Adaptability/Tolerant Trial	2.1	Maintained
65 Lines Experiments	1.0	Abandoned
CRIN Elite Seed Multiplication	2.2	Maintained
Cocoa Research Plot	1.32	Maintained
Ornamental Cocoa Plot	0.5	Maintained
Okundi (Cocoa) Plot	0.4	Maintained
Kola Research Plots		
Kola Progeny	1.6	Moribund
Kola Cuttings	0.65	Maintained
Kola Germplasm	2.92	Maintained
Kola Fertilizer Trials	2.0	Abandoned
Coffee Research Plots		
Okundi	1.46	Moribund
1989 Ajassor	1.57	Moribund
Tea Research Plots		

Tea Ajassor	0.28	Abandoned
Cocoa Research Plots	**Hectares**	**Status**
Cocoa plots		
1967 Trinidad	2.9	Abadoned
1975 F_3 Amazon	1.6	Abandoned
CRIN/NIFOR 1	6.0	Abandoned

Table 5: Plantations/ Research plots with their hectares and maintenance. Status in Ajassor as at 31st December, 2023.

Conclusion/Appreciation: Once again, on behalf of the entire members of staff of CRIN Ajassor Substation, I thank our God sent Executive Director Dr. P. O. Adebola and the entire CRIN management committee for their kind gesture towards the welfare of staff in CRIN Ajassor Substation in 2022.

I appeal and hope that the Executive Director will consider most of our requests, especially in the area of employment of more field/security staff, refurbishing of the station Toyota Hilux engine parked at Uhunmora substation, Edo state or purchase a new Toyota Hilux for carrying out official duties, substation repairs of infrastructure and encroachment issue also need urgent attention.

Mr. Odedele Samson.O
Ag.HOS

Owena Substation:

Owena Substation has a cultivable land area of 17.95 hectares, of which approximately 10.4 hectares are currently under cultivation. The Alade field is 0.5 hectares, of which 0.3 hectares are cultivated, while at Onisere Station the total cultivated area is 1.0 hectares out of 2.5 hectares.

Staff Disposition Lists

The disposition staff lists of the station during the period under review is presented in the table below

S/N	Designation	Owena	Alade	Onisere
1	Chief Research Officer	1		
2	Assistant Chief Agric. Superintendent	1		
2	Principal Agric. Superintendent 1	2		
3	Principal Executive Officer I	1		
4	Agricultural Superintendent (***Chief Health Attendant***)	1		
5	Higher Executive Officer	2		
6	Executive Officer	1		
7	Work Superintendent	1		
8	Chief Agric. Field Overseer (CAFO)	3		1
9	Asst. Chief Agric. Field Overseer (ACAFO)	4		
10	Senior Motor Driver Mechanic Grade 1	1		
11	Senior Agric. Field Overseer	1		
12	Agric. Field Attendant 1	3	1	
13	Agric. Field Attendant II	1		
	Total	**23**	**1**	**1**

NB:

i). During the period under consideration, one member of staff (Mr. Agaji Benard) retired in March, 2023 from active service

ii). There are two outstations (2) under the Substation and two of our staff are attached to work at the outstations which are located at Alade and Onisere very. The staff are **Mr. Bolarinwa Felix and Mr. Ajayi Abiodun**

iii). There was also an addition to the Agricultural Superintendent cadre during the period under review. The Chief Health Attendant (Mrs Allexander Yemi) was converted to Agricultural Superintendent cadre. The total number of Agricultural Superintendents in the station as a result of the advancement are now three (3), this comprises of two (2) supervisors and one Agricultural Superintendent as listed below:

1.	Enosegbe Kelly	M	ACAS (Supervisor)
2.	Ojewale Ezekiel	M	ACAS (Supervisor)
3.	Alexander Yemi	F	HAS (Agric Supt.)

During the periods under review, the following activities were carried out within the scope of the list below.

A. Plot Maintenance

During the periods under review, despite the shortage of field staff, all the plots were adequately maintained except the 10 hectares which was seldom maintained. Regular weeding of the rest plots were promptly carried out as scheduled and as at when due. The plots are

1. Two (2) hectare
2. The rehabilitation plot
3. The seed garden plot
4. Dr. Ayegboyin's plot and
5. The demonstration plot

Also, periodical spraying against black pod diseases and other insects like capsid bugs, mirids e.tc were carried out promptly coupled with the removal of mistletoes.

B. HEAD QUARTER'S FUNGICIDE SCREENING TRIALS

The headquarters sited 2 of their fungicide screening trials here in Owena, one at our demonstration plot while the other was sited at our seed garden plot. The station participated actively in both fungicide screening trials despite with our 10w number of staff, by assisting the headquarters' research scientists.

C. FARM INPUTS AND AGRO-CHEMICALS RECEIVED FROM THE HEADQUARTERS

We wish to register our appreciation to the headquarters for the supply we got from them. Even though what was supplied was not enough to cover all the plantations including the outstations but we are appreciative of the ones given.

D. ACHIEVEMENTS

- ✓ The station recorded some achievements in establishing some new cocoa plantation, gapping up of dead cocoa trees in most of our plots and planting of plantain suckers in open areas of our plots.

- ✓ Similarly, the station also raised 10,000 seedlings which were given to farmers free-of-charge as part of our social responsibility to the community to further encourage the farmers into Cocoa cultivation and the nation at large.

- ✓ The H.O.S equally represented the ED and the Institutes in many Cocoa related programs organized by Cocoa Farmers Association, Ondo state Chapter and the National program.
- ✓ Successful hosting of PIND/CRIN cocoa farmers training program in 2023

E. **REVENUE**

A total sum of One million, Seven hundred and sixty- nine thousand, six hundred and seventy – eight naira, sixty- one kobo only (₦1, 769,678.61) was realized from the sales of farm produce and other services. This is an improvement over the previous year's own

Find below the breakdown:

S/N	**PRODUCE SALES/ SERVICES**	**AMOUNT(#)**
1	Cocoa Beans	627,090:00
2	Cocoa Pods	75,000:00

3	Cocoa Seedlings	170,000:00
4	Rent	265,700:00
5	Rest House	65,000:00
6	Access Fee	75,000:00
7	Cherry	13,000:00
8	Vehicle Hiring	50,000:00
9	Palm Oil	45,000:00
10	Land Loan	148,000:00
11	Rent (IPPIS Deductions)	235,338:61
TOTAL		**1,769,678:00**

F. CHALLENGES, CONSTRAINTS AND SUGGESTIONS

The major challenges bedeviling the station is the **acute shortage of labor,** as only few successes can be achieved with our present number of field staff strength ie. Presently, there are three (3) males and two (2) females' field staff actively working on the plots at Owena station, the two other field staff are working at the outstations. With the enormous land size under our care, very little success can be achieved.

We implore the management to look into this direction and provide us with alternatives by funding the substations to engage casuals mostly the male folks to work on our plots during the four or five months that are crucial for cocoa farms.

Other challenges faced by the station which require urgent attention are listed below:

1) Provision of long aluminum ladder for the station to combat mistotletoes menace in some of our plots, the exact specification distributed to all the zones at the headquarters.
2) Provision of inputs like cutlasses, files, rain boots, field coats, herbicide, wheelbarrows, pesticide e.t.c.
3) Provision of 2(50m) hoses to be used by our water pump machine at the nursery, the one will are currently using is leaking out water excessively.
4) Provision of 2 (2000L) storex tanks to store water, one at the nursery while the other will be placed at the office.
5) Stoppage of the activities of land excavators in our plot at 10 hectares: The continuous activities of the land excavators are endangering our plots at the 10 hectares as the indiscriminate removal of topsoil and the subsoil had degraded

some portions of our plots thereby predisposing our farmland to severe erosion. We enjoin the management to please look into this issue holistically and promptly. Many letters have been submitted to the management on the issue. CRIN may lose the land in Owena to encroachers who dubiously go through the back door to take authority from state Government for excavation and other purposes on the supposed CRIN land.

Though, several letters had already been written to the headquarters in that regard but the excesses and menace of these land excavators remain unabated, even till now.

G. CONCLUSION

With due respect sir, if all the above aforementioned suggestions are looked into and considered and acted upon, it will go a long way at mitigating most of our challenges and increase the productivities and income generation of the station for optimal service delivery.

Dr. Akanbi Olorunfemi Sunday Ojo

HOS, Owena Substation

OCHAJA SUBSTATION

Staff Disposition/Human Resources: As at December 2023, the staff strength of the substation was 27 personnel.

S/N	Names	Designation	Responsibility
	Senior Staff category		
1	Dr. D.O. Adeniyi	CRO/GL13	Head of Station
2	Mr. Uloko B.A.	CAS/GL13	Field officer
3	Mr. Wada, Sunday	ACAS/GL12	Field officer
4	Mr. Magaji, M.	PAS I/GL11	Field officer
5	Mr. Ibrahim Wasiu A.	SEO-Acct/GL08	Office
6	Mr. Ogbechie, Christopher	Prin. Work Supt. II	Office
7	Mrs. Samuel Ladi E.	SSA I/GL07	Office/Secretary
8	Mr. Oguche Nathaniel	CAFO/GL06	Field officer
9	Mr. Ibrahim Noah	CD/MECH/GL06	Office/Driver
10	Mr. Opaluwa Pius	CAFO/GL06	Field officer
11	Mrs. Aye Fatima	SAS/GL05	Field
	Junior Staff category		
12	Mr. Owemidu, M.	Admin. Officer	Office
13	Mrs. Abah Janet	SHHA/GL05	Office
14	Mr. Musa Abdullahi	ACAFO/GL05	Field
15	Mr. Alih Muhammed	ACAFO/GL05	Field
16	Mrs. Yahaya M. Adishetu	ACAFO/GL05	Field
17	Mr. Nda Okpanachi	ACAFO/GL05	Field
18	Mr. Alfa Ndah	ACAFO/GL05	Field

19	Mr. Unubi Attah	AFA I/GL03	Field
20	Mr. Alu Friday	AFA I/GL03	Field
21	Mr. Atawodi Jibrin	AFA I/GL03	Watchman
22	Mr. Otanwa John	AFA I/GL03	Watchman
23	Mr. Nifu Yahaya	AFA I/GL03	Field
24	Mr. Husseni Yahaya	AFA I/GL03	Field
25	Mr. Abubakar Yahaya	AFA I/GL03	Field
26	Mr. Simon Sunday	AAFO II/GL02	Field/Watchman
27	Mr. Umoru James	AAFO II/GL02	Field/Watchman

1. **Land Resource/Asset**

The Substation has a total land mass of 351 hectares, out of this land mass, about 75 hectares had been cropped mainly with cashew and some other crops like kola, oil palm and arable crops. About 25 hectares of this land had been encroached by the indigenes. Below is the details of the land mass and its usage in the Substation.

2. **Land Resource and Utilization**

- Total land coverage of the Substation: 351 Hectares
- Total land area already cropped with cashew: 65.2 Hectares
- Total land area encroached upon by Indigenes: 20 plus Hectares

Total land area under permanent crops cultivation: 76 Hectares:

3. **Plantation and Facility Management:**

<u>Maintenance of Research and experimental plots:</u> The period under review had activities mainly in plantation clearing and weeding to minimize competition by weeds and reducing weed density on research and commercial plots. The activities were carried out timely in preparation for cashew fruiting season of 2024. The scion gardens and clonal material adaptation trial plots were maintained.

Pruning: Regular removal of chupons and unwanted outgrowth was carried out on commercial cashew plots on the plantation.

Fire Traces**:** Fire tracing and control burning all round cashew plots were carried out on the plantations to check fire outbreak which have become a yearly incidence in the substation. This effort have successfully safe the station from the regular incidence of annual fire outbreak o cashew plantation.

Office complex/Staff quarters and environs**:** The office complex and environs were kept hygienic and surroundings cleared, ornamentals trimmed and weeds managed.

Cashew season: The 19 cashew plots sites on the station were managed and maintained in preparation for the fruiting season of year 2024.

Staff strength: During the period under review, the staff strength of Ochaja substation was 27 personnel. Three officers; Mr Attah Ojone, Mr Musa Ibrahim Yahaya and Mr Monday Elugbe retired in 2023 and two officers; Mr Ogbechie Christopher and Mr Owemidu Martins were redeployed to Ochaja from Headquarters. There are fewer junior staff, few field officers and this reduce staff strength on the field as well as security guards on duty. Some field officer were deployed to security section.

4. Cashew Fruiting/Harvesting Season:

Harvesting of cashew nuts: The period under review had major activities on the cashew fruiting season and oil palm harvest with some plot maintenances to keep off fire incidences. These activities were carried out with timely harvesting/picking of cashew nuts, drying and storing. Cashew plots were maintained and prepared for ease of nut picking during the fruiting season of year 2023. However, pilfering of raw cashew nuts, encroachment of land and harassment of staff members affect the outcome of the harvest recorded yearly.

Office complex/Staff quarters and environs**:** The office complex and environs were kept hygienic with regular maintenance of the old structure, the surrounding ornamentals trimmed and weeds managed.

5. Technical/Research Activities:

a. Coordination of cashew health map project for the PROcashew Nigeria.
b. Technical support for the VETToolBox 2 Train of trainers & Cascading project by GIZ-Nigeria.

c. Technical supports for the PROcashew project in training, monitoring and maintenance of cashew scion gardens and demonstrations plots in project locations.
d. Facilitation of training for cashew farmers in Kogi East (PROCashew-Nigeria project).
e. Establishment of half hectare cashew clonal garden plot in August, 2022.

6. Raw Cashew Nut delivery to Headquarters:

At the directive of Director Production & Substation and in response toned for raw cashew nut as planting materials at the headquarter office, Ibadan, a total of 355kg of raw nut (jumbo, large & medium) was delivered to Department of Production and Substation. Also at the directive of the Executive Director, a total of 300kg raw cashew nuts were delivered to Dr. Akin Oloniruha in Kabba, Kogi state.

7. **Insurgence of Disease:** Reports of disease insurgence was recorded in many cashew agro-ecologies across the North Central, South-Eastern, South-Western Nigeria. The symptoms and signs of the trending disease which affect cashew leaves, inflorescence, nuts, apple are very similar to the powdery mildew disease which had caused a devastating decline in cashew yield in the East Africa.
8. **Power Status at Substation:**

   Electricity status at Ochaja station: There is absolutely zero power at the Ochaja substation and the staff quarters. We advocate for alternative power source using the solar panel to power the office complex and security outfits.
9. **Finance:** Financial transactions at the substation are mostly during cashew and oil palm fruiting seasons, which are the main crops of commercial value in the substation.
10. **Internal Generated Revenue (IGR):** A total of ₦1,421,750 was the generated revenue from the Ochaja sub-station in the year 2023 from January to December. The breakdown of revenue generated for the year as shown below in the tables 1 to 3.

Summary of Internally Generated Revenue for year 2023 (January to December)

Table 1: Direct Sales (A)

S/N	Date	Details	Amount (₦)
1	13/04/2023	Sales of 5kg jumbo and 15kg medium raw cashew nut at ₦1,500 & ₦1,200 respectively	25,500
2	13/04/2023	Sales of 285kg of raw cashew nut at ₦250 per kg	71,250
3	13/04/2023	Sales of 420kg of raw cashew nut at ₦250 per kg	105,000
4	13/04/2023	Sales of 400kg raw cashew nut at ₦250 per kg	100,000
5	22/06/2023	Sales of 500 cashew seedlings at ₦150 per seedling	75,000
6	22/06/2023	Sales of 150 bunches of palm kernel bunches at N250 per bunch	37,500
7	22/06/2023	Rent payment on land space	25,000
	Sub-total (A)		**439,250**

<u>Table 2: Value of raw cashew nut delivered to Headquarters (C)</u>

S/N	Date	Details	Amount (₦)
1	04/04/2023	The delivery of 355kg raw cashew nut as planting materials to Headquarters at ₦1,500 per kg	532,500
	Sub-total (C)		**532,500**

<u>Table 3: Value of raw cashew seedlings delivered to Dr Akin Oloniruha (D)</u>

S/N	Date	Details	Amount (₦)
1	08/05/2023	Based on the directive of Executive Director to deliver 300kg raw cashew nut at ₦1,500 per kilogram	450,000
	Sub-total (D)		**450,000**

The grand total of the internally generated revenue Jan. to Dec. 2022: A+B+C+D = ₦1,421,750

11. <u>Visitor to the station:</u>

Students' Field trip/Excursion: Students of the Department of Agriculture, College of Agriculture, Ankpa, Kogi state were on study tour to the station. About 100 of them were guided round the research plots, nursery site and facilities of the station for knowledge sharing and mandate of the Institute and the research station.

The students on Industrial Work Experience Scheme, from Prince Abubakar Audu University, Kogi state, College of Agriculture, Ankpa, Kogi state.

Cashew Scientists from Tanzania

Cashew enumerators of the PROCashew project Nigeria.

12. **<u>SIWES:</u>**

Student from Kogi state College of Education

13. <u>Gift to Substation:</u>

A gift of two (2) solar panel street security light was presented to the Substation in the personal capacity of Dr. Dele O. Adeniyi to improve the lighting of the staff quarters to help the security of the community.

14. **<u>Substation needs:</u>**

The substation needs alternative power source (solar panel): 5KVA for office complex and 2KVA for HOS quarters).

1. Solar panel security light for office complex and staff quarters (12)
2. Renovation of office complex
3. Security personnel (6) and watch light to oversee research plots and staff quarters
4. Cutlasses 10 number for field workers
5. Printing gadget (Printer, Photocopy machine, scanner) and stationeries.
6. Funding is strongly solicited for in form of "overhead" for very pressing needs at the station and daily running of the affairs.
7. Rehabilitation of research and commercial plots

15. <u>Land encroachment:</u>

The incidences of theft continue to be a major challenge to manage as staff are being threatened and attacked on the field on regular bases. In the meantime, the institute should plan perimeter fencing and re-survey of the entire land belonging to Ochaja substation as contention over the land get worsened.

UHONMORA SUBSTATION

Staff Disposition: The staff list at the station during the year 2023 is as shown below

S/N	NAME	DESIGNATION	DISPOSITION
1	DR. B. S. FAMUYIWA	RO	HEAD OF STATION
2	EDIBO GABRIEL	ACAS	PLANTATION MANAGEMENT
3	OGUIGO PHILIP	ACAS	PLANTATION MANAGEMENT
4	ASEIN OYAKHIRE	PED II	FINANCE/ACCOUNT
5	OAIKHENA LYDIA	HEO	FINANCE /ACCOUNT
6	UMAHOIN ALABA	CAFO	FIELD
7	OKPAISE IDOWU	CAFO	FIELD
8	ONOJA JOSEPH	CD/M	TRANSPORT
9	IFIDON IKHUOSHIO TEDDY	CHA	HEALTH
10	ANIJESE FUNMILAYO VICTORIA	CAFO	FIELD
11	DANNIS OJIMAH	CAFO	FIELD
12	AMEDU ACHONU	CAFO	FIELD
13	EBIALE BENJAMIN	CAFO	FIELD
14	EDEH SIME0N TOCHUKWU	CAFO	SECURITY
15	NWAGALA CHARLES	CAFO	FIELD
16	AMAZE AUGUSTINE	CAFO	SECURITY
17	JOSEPH EHIDIAMEN	ACAFO	SECURITY
18	KOKORI PAUL	AFA 1	FIELD
19	JAMGBADI IMOUDU	AFA 1I	SECURITY

20	IMUMOLEN JEFFERY	AFA 1I	FIELD
21	OKEDION FRIDAY	AFA 11	FIELD
22	EHIMIKA KETU	AFA 11	FIELD
23	OKESOLA AMOS O.	SAFO	FIELD.

Land Area:

At Uhonmora Substation, the size of all the land is 268 ha but the effective hectarage is 15.75ha for crops.

The amount supplied from Headquarters:

S/N	DATE	AMOUNT	REFERENCE	PURPOSE
1.	24/08/2022	85,000	REM:/IGR/14/24	A TON OF TOP SOIL
2	TOTAL	85,000		

Activities:

S/N	PLOT DESIGNATION	CROP	SIZE	REMARK
1	A1	CASHEW	1HA	Fruiting
2	A2	CASHEW	1HA	Fruiting
3	B1	CASHEW	1HA	Fruiting
4	B2	OIL PALM	1HA	Fruiting
5	D1	COCOA TC	1HA	Fruiting
6	E1	GERMPLASM	0.5HA	Fire
7	E1	COCOA TC	2HA	Fruiting
8	E1	COCOA F3	1.5HA	Fruiting
9	G1	COCOA	1HA	Fruiting

10	G2			
11	G3			
12	OPPOSITE NURSERY	OIL PALM	2.7HA	Fruiting
13	BACK OF OFFICE	COCOA TC5	1.2HA	
14	ALONG THE ROAD	TC4 & TC6		
15	COFFEE PLOT	COFFEE/PLANTAIN	1HA	Just established
16	COCOA	HYBRID COCOA	0.5HA	Just Established
	Tea Experimental Plot	Tea	0.25 ha	On-going
17	NURSERY		0.5ha	Operational
	TOTAL		15.75ha	

Achievements:

On-going research experimental plots were maintained in collaboration with the scientists involved. Some of the experiments under the station's supervision include:

1. Establishment of 1 ha of coffee intercropped with plantain (Dr. Ipinmoroti *et al.*)
2. Evaluation of field establishment of tea under shade plant and organic manure and low cocoa ecology of Nigeria (Dr. Adeosun *et al*)
3. Nursery preparation for 4,000 cashew seedlings on request
4. Efforts were made to maintain our plantations at the station with the little resources and available labour.
5. Production of cocoa seedlings
6. Production of oil palm seedlings
7. Revenue: A total sum of Five hundred and sixty thousand, eight hundred and seventy naira, sixty kobo only (N**560,870.60**) was realized from the sales of farm produce and other services.
8. Produced 3bags of gari from cassava planted in 2023
9. Ten staff were promoted in 2023; 8 Senior Staff and two Junior Staff

Challenges/Constraints:

1. There was a paucity of funds, which negatively affected the station. The Station’s overhead which cares for the expenses of the day-to-day running of the station was not forthcoming, making the running of the station difficult.
2. The staff strike was another negative effect labor on work
3. Considering the enormity of the work on our plantation, the present field staff is grossly inadequate to take care of the work.
4. The present number of security staff is inadequate for effective guarding of the office, staff quarters, and plantations.
5. By next year, 2024, three staff namely; Edibo Gabriel Ojodale, Okpise Idowu, and Okesola Amos will be retiring which will also reduce the strength of the workforce
6. Incessant felling of trees by the youths in the neighboring community; Ozalla. This was reported for necessary action
7. The station transformer was faulty by rain and has put the station in darkness.

Suggestions for improvement

1. The overhead can be revived so that it will improve the finances of the station.
2. Establishment of cocoa germplasm for increased distribution of CRIN hybrid to farmers.
3. Efforts by the Headquarters to continuously exchange substation principal staff for new ideas and reduce redundancy

However, if the above categories of workers are not available, it will be highly appreciated if we can be allowed to recruit contract workers to replace them.

APPENDIX

2023 INTERNALLY GENERATED REVENUE

MONTH	COCOA SEEDLINGS	PALM OIL	LAND RENT	CASHEW	OIL PALM SEEDLINGS	ACCESS	COCOA DRY BEAN	TOTAL
	N K	N K	N K	N K	N K	N K	N K	N K
JANUARY								
FEBRUARY								
MARCH								
APRIL								
MAY								
JUNE								
JULY	200,000	40,000	22,000					262,000
AUGUST								
SEPTEMBER	20,000	81,000		15,000	100,000			216,000

OCTOBER			11,000			11,000		22,000
NOVEMBER								
DECEMBER		26,000				13,600	21,270.60	60,870.60
TOTAL	**220,000**	**147,000**	**33,000**	**15,000**	**100,000**	**24,600**	**21,270.60**	**560,870.60**

IBEKU SUBSTATION UMUAHIA

A. STAFF DISPOSITION:

The staff strength as at December 31, 2023 stood at nineteen (19). This comprises of eight senior staff, that is, the HOS, Station Accountant, five (5) Agric Superintendents, and two drivers. Eleven junior staff, that is, (1) motor mechanic/driver, 1 watchman, (8) field staff in Ibeku and only 1 field staff in Ugbenu Outstation.

Table 1. Staff list of CRIN Ibeku Substation as at 31st December, 2023

S/N	NAME	GL	PF	DESIGN	DATE OF BIRTH	DATE OF 1ST APPT
1	Dr. Olaniyi O. O.	13/3	410	HOS(CRO)	9/11/71	28/09/2010
2	Mr. Enagu Victor	13/4	275	CAS	30/03/73	31/05/2002
3	Mrs.U.N. Nmeregini	13/4	281	CAS	21/10/68	25/09/2002
4	Mr. Borokini O.	11/4	367	ACAS	27/03/79	08/02/2009
5	Mr. Agbor Charles	8/6	432	PAS 1	27/05/78	13/10/2010
6	Mr. Ojelabi A. A.	8/4	1746	SEO	03/12/82	30/08/2010
7	Miss Nya Emem	7/3	534	HAS	17/12/90	03/03/2020
8	Oladipo Kayode D.	8/3		TO	31/01/1971	
9	Mr.Onwubiko M.	7/2	1521	CD	17/08/64	01/06/2003
10	Mr.	5/2	1736	SMD/MI	15/05/66	17/03/2010

	Onyemuwa J.C.					
11	**Mr. Eze Joseph**	**5/3**	**1680**	**ACAFO**	**13/06/67**	**02/01/2009**
12	**Mr. Animba M.**	**5/3**	**1686**	**ACAFO**	**28/01/65**	**02/01/2009**
13	**Mr. Nwachukwu B.**	**3/12**	**1678**	**HW**	**10/06/67**	**02/01/2009**
14	**Mrs. Chibuo Oluchi**	**4/2**	**1679**	**AFA 1**	**02/01/70**	**02/01/2009**
15	**Mrs Ihueze Chinedu**	**3/12**	**1681**	**AFA 1**	**15/08/68**	**02/01/2009**
16	**Mr. Chimaobi E. I**	**4/3**	**1683**	**AFA 1**	**15/03/68**	**02/01/2009**
17	**Mr. Ani Cyril**	**3/6**	**1684**	**AFA 1**	**18/11/63**	**02/01/2009**
18	**Mr. Nwachukwu A.**	**4/2**	**1890**	**AFA 1**	**12/12/75**	**14/12/2011**
19	**Mr. Uwakwe I.**	**2/10**	**1892**	**AFA 1**	**14/03/65**	**14/12/2011**
20	**Mr. John Muo**	**1/3**	**1976**	**FA**	**05/05/77**	**05/03/2020**
21	**Mr. Uwakwe C.**	**1/3**	**1977**	**FA**	**6/11/76**	**05/03/2020**

Transfer: Mr. Oladipo Kayode was transferred to Ibeku Substation from CRIN headquarters Ibadan and resumed on the 10th May, 2023 as a driver.

B. LAND AREA:

Please find below the landmark of CRIN Ibeku Substation:

Total land area: 80.0 hectares.

Effective hectares: 43.36 hectares

<u>Ugbenu Cashew Experimental Outstation</u>

Total land area: 19.33 hectares

Effective hectares: 11.20 hectares

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

C. ACTIVITIES:

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

D. ACHIEVEMENTS:

1. Maintenance of two hectares of newly established cashew scion project at Ibeku Sub Station
2. Establishment of 1/2 hecter of coffee plot

3. Establishment of 1 hectare of cocoa in 2023 (WCF Project)

4. Supplying of 350 cocoa pods to CRIN accredited out grower

5. Tea germplasm maintenance in Ibeku Substation. It was planted in in the year 2022

6. Construction of drying platform

7. **Visitation to farmers' field at Umuahia North Local Government**

8. Visitation to Mr Kalu's farm at Bende Local Government Abia State

9. Collection of Agronomic data of pathological experiment in Ibeku substation and farmers field in Bende.

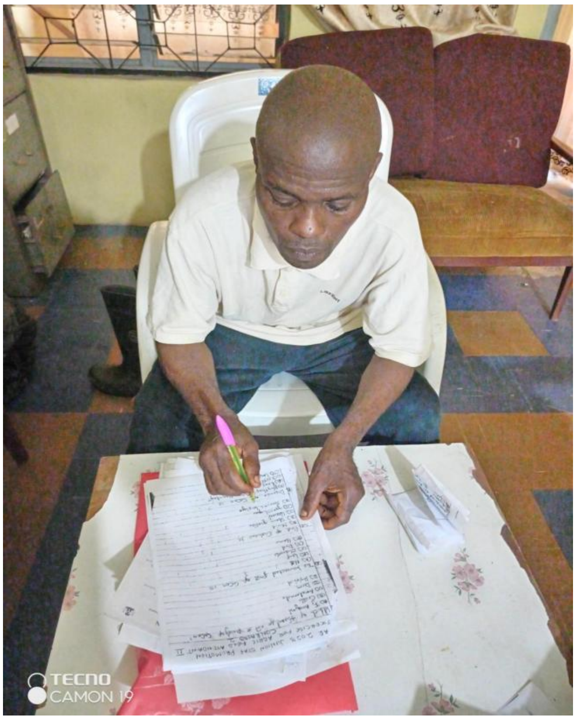
10. Laying out of tea experiment in Ibeku Substation

11. Successful delivering of cocoa seedlings in Owerri, Imo State

12. Rehabilitation of 1985 cocoa plot
13. Rehabilitation of part of 1979 cocoa plot

14. Maintenance of pro cashew projec plot and fertilizer application

15. The main off need an intervention for rehabilitation



16. Mr. Uwakwe Christopher during 2023 junior promotion exam

Mr. John Muo during 2023 Junior promotion exam

Group photograph with Nigerian Export Promotion Council and CRIN team

1. Internally Generated Revenue: A total sum of six hundred and nineteen thousand eight hundred and seventy two naira five kobo only (619, 872.5) was realized in the year 2022. Below is the breakdown.

SN	ITEM	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total
1	Cocoa Beans		-					-		-		99000	180000	279000
2	Cocoa Pods	-	-		-		-	-		-	200000			200000
3	Agbalumo	-	-		-	-	-	-	-	-	-	-	-	
4	Ogbono	-	-		-	-	-	-	-	-	-	-	-	
5	Plantain	-	-	-	-	-	-	-	-	-	-		-	
6	Banana	-	-		-	-	-	-	-	-	-	-	-	
7	Cashew Nut	-	-	-	-			-		-	-	-	20000	20000
8	Firewood	-	80000	15000	-	-	-	-	-	-	-	-	-	95000
9	Cocoa Seedlings	-	-	-		-		-	-	-	200000 -	-	-	200000
10	Palm							-					-	

	Fruit	-	-	-	-	-			-	-	-	-		
	TOTAL							**-**	**-**	**-**	**-**	**-**		**794000**

CRIN IBEKU SUBSTATION IGR SUMMARY FOR YEAR 2022

1. **Peace:** We were able to maintain peace in the station and the hosting communities.

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

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

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

E. Visitors: The following persons visited our office in the course of the year, CFAN Chairman in Abia State Elder Kalu and her members. Dr. Adepoju Dr. Agbeniyi S., Dr. and Dr. Olasupo F.

F. Challenges/Constraints:

1. Lack of portable water**,** both Ibeku substation and Ugbenu experimental station lack portable water

2. Lack of Adequate Work Force: Both Ibeku and Ugbenu lack adequate work force. Presently, only one security officer is available for the entire Ibeku Substation.

3. Our hilux vehicles lack tyres

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

4. **Overhead:** There is high dependency on fuel to keep the substation running effectively. Due to the fact that, out of the 6 substations CRIN Ibeku Substation is the only substation without residential quarters and electricity.

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

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

7. Ugbenu Experimental Station: The outstation has only one staff since No security staff in the outstation.

8. Furniture: Lack of good furniture. The station needs tables and chairs for staff.

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

10. The carpentry shade floor needs serious renovation.

G. ADDITIONAL STAFF REQUEST BY CADRE:

Security	8	(5 in Ibeku and 3 in Ugbenu)
Field Staff	48	(Following the standard set at the headquarters, CRIN Ibeku Substation will require nothing less than 51 field staff to cope with the current 54.56 effective hectares. Therefore, an additional 48 staff at the moment is needed to complement the existing 7 field staff.)
Nurse	1	
Health Attendant	2	
Secretarial Assistant	2	

Clerk

Total 60

H. SUGGESTIONS/WAY FORWARD:

1. Imprest: Imprest should be given on monthly basis. This imprest will be highly appreciated.

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

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

4. Borehole should be dug in the station and Ugbenu to prevent water related disease.

5. More field staff needed in Ibeku and Ugbenu as well as Secretariat staff

Dr .Olaniyi O.O.

HOS CRIN Ibeku Substation

MAMBILLA SUBSTATION KUSUKU

A. PLANTATION:

1. **Weed Control:** Coffee, Tea and Cacao Plots: Periodic weed control exercises were carried out during the year under review at the respective research plots and other holdings as indicated. Hired labour was engaged in plantation clearing of weeds aimed at reducing weed density and the activity was carried out satisfactorily on plots. Precisely, 2 litres of systemic herbicide (Glyphosate) was used to augment the use of labour so as to reasonably manage the weed incidences at the various fields. Clearing of cocoa seed garden and bud wood was also carried out during the period under review. The field clearing was very greatly hampered as a result of non-release of the fund from the Headquarters for the purpose of field maintenance, as enjoyed in the previous years. As a result of this, the entire fields are overgrown with weeds at an alarming rate as there are not enough field staff and herbicides for weed control on the field.
2. **Fire Tracing:** Cutting of fire traces in order to checkmate fire out break from nearby bush into CRIN plantation was carried out during the early part of the first quarter.
3. **Pruning:** In line with agronomic practices the tea and coffee germplasm plots comprising of were pruned to improve the yield plants. This yield includes leaves as well as materials for cuttings. This eventually enhanced uniformity of the plucking table for the tea plants and to encourage fresh shoots to boost high yield. The chupons were removed from the coffee plants for similar purpose and to prevent them from wild growth.
4. **Harvesting:** This was done for the various plants that serve the purpose of Internally Generated Revenue at the station. These include tea leaves, avocado pear, banana and cacao.
5. **Cocoa Plot:** The normal routine maintenance activities, which comprised of removal of chupons, mistletoes climbers, dead branches, epiphytes and harvesting of cocoa pods were carried out during the period of this report.
6. **Disease Control**: During the period, 15 sachets of fungicides (ultmax plus) were sprayed on cocoa trees against black pod disease infection cacao trees.
7. **Cocoa Seed/Budwood Garden:** The World Cocoa Foundation/African Cocoa Initiative/CRIN (WCF/ACI/CRIN) was established 2012. This plot needs urgent attention as

the substation has no wherewithal for its maintenance, a phenomenon which has occurred for the past 7 years. Partial maintenance of the plot of cocoa bud wood and seed garden was carried out using manual method of weed control during the year under review.

8. **Nursery**: Re-roofing of the nursery shade of tea seedlings and coffee Arabica seedlings which was raised in the nursery by Drs. Olaniyi, O.O and Adepoju, A. F. respectively, was carried out during the period. It was re-roofed after being blown off by the wind. The nursery of the station, which is the heart beat of the plantation, was well maintained with the following activities carried out in the nursery. Regular watering of the young tea seedlings and the old coffee and tea few seedlings were carried out. In addition, hardening of tea seedlings in the tent, which were raised by some scientists from CRIN Headquarters for their research purpose, started and was completed during the year in review and with a very high level of survival of the seedlings and clones. A current challenge at the nursery is that the tea seedlings are over grown since neither the scientist who own the experiment materials nor any other scientist indeed visited the station throughout the year 2023 convey for the seedlings or any research activity for that matter.

9. **Potting:** A total of 500 pots were filled with black soil in order to prick the coffee Arabica seedlings which were initially sown on primary bed in the earlier periods in the year 2023.

10. **Office/Rest House Premises:** The office premises yellow bush flowers were trimmed, and the surroundings kept tidy. During the period, the office and the station's Rest House premises were well maintained to keep the surrounding clean. However, it is noteworthy that, as earlier reported, the Rest House and the HoS's Quarters which are severely dilapidated are growing worse in their state of physical conditions.

B. RESEARCH ACTIVITIES:

The 8 experiments sited on the station were well maintained and data records collected when due and sent to the scientist concerned under request during the period under review.

The list of the experiments is shown in Table 1 below:

Table 1: list of the ongoing experiments at the Mambilla substation

S/N0	TITLE OF EXPERIMENT	SIZE	YEAR	RESEARCHER	REMARKS
1	The effect of varying levels of organic and in organic fertilizers on growth of coffee Arabica seedlings.	0.5	2009	Dr. Ipinmoroti	In progress
2	Evaluation of nutrients supplement on tea production	0.5	2009	Mr. Daniel	In progress
3	Setting of 75 Nigerian/China (NGC) 1-5 Tea clone C15 cutting each		2012		
4	Simultaneous selection and genotype x environment interaction of tea in Nigeria Kusuku	0.048	2014	Mr. Olaniyi O.O.	In progress
5	Effect of Neem fortified fertilizers on tea yield.	0.048	2015	Mr. Olaniyi O.O.	In progress
6	Effect of tea yield in the open and under the eucalyptus intercrop.	-	2015	Dr. Ipinmoroti	In progress
7	Simultaneous selection and genotype environment interaction of tea in Nigeria (11) Mayo-selbe	0.048	2016	Dr. Olaniyi O.O.	In progress
8	The effect of diseases on coffee Arabica	-	2016	Dr. Orisajo	In progress

C. COLLABORATION BETWEEN CRIN AND NRCRI

An official request came from the National Root Crops Research Institute (NRCRI) to establish a 'Confined Field Trial (CFT) of Biotech Potato' at CRIN Mambilla Substation. On behalf of the Executive Director (ED), NRCRI, the request was presented by Dr. Charles Amadi, the Principal Investigator of the project, and was received by the ED, CRIN on 6th February, 2023. The ED conveyed approval to this effect via the Director (Production and Substations), who also did the same via the Head of Station (HoS), CRIN Mambilla Substation. Among other things, the NRCRI requested for an area of land of 0.3 hectare within CRIN Mambilla substation premises for the CFT, which was eventually set up in July 2023. This site requested was provided by CRIN at the desired location. Being a Biotech plant material (being tested for the 'late blight' disease of potato), the experiment is being conducted with the supervision of the National Biosafety Management Agency (NBMA).

Sequel to the above, a team composed of NRCRI and NBMA officials visited the CRIN Mambilla substation on Saturday, 22nd April, 2023 to confirm the suitability of the site provided by CRIN for the proposed CFT trial. They were introduced by the substation staff to the site provided for the proposed experiment. The NRCRI scientist confirmed the suitability of the site and land. The NBMA official also agreed with the suitability of the location, particularly as regards the biosafety issues bothering the handling of the plant material in question, given the eventual establishment of the CFT at the location.

The CFT experiment was eventually set up in July 2023. As originally indicated, the research plot was set up in a fenced with wire fencing materials to prevent intrusion, equipped with a security post constructed from red bricks and made composed of two rooms and convenience. The data collection on the plot was aided by CRIN personnel at the Mambilla substation. The harvest of the first season was done on Nov 11, with the expectation of the second season planting to occur in June/July, 2024.

D. INTERNALLY GENERATED REVENUE (IGR):

The sum of one hundred and ninety-one thousand, four hundred and twenty-five naira (₦291,425:00) was generated as Revenue for the year 2023 and the summary of the breakdown of the IGR is stated below on Table 2 below

Table 2. SUMMARY OF INTERNALLY GENERATED REVENUE (IGR) FROM JANUARY 2021– DECEMBER 2023

ITEMS	JAN. 2023	FEB. 2023	MAR. 2023	APRI. 2023	MAY 2023	JUNE 2O23	JULY 2023	AUG 2023	SEPT 2023	OCT 2023	NOV. 2023	DEC. 2023
Banana	-	-	1,200	3,050	-	1,500	-	1,300	-	3,350	-	2,150
Tea Leaves	-	-	17,000	-	-	-	-	40,000	-	29,000	-	-
House Rent	57,500	-	6750	5,000	13,125	-	-	-	-	-	-	-
Coffee Berry	-	-	-	15,000	-	-	-	-	-	-	-	-
Avocado Pear		-	-	10,500	-	-	-	-	-	-	-	-
Land Loan	-	-	-	-	-	-	85,000	-	-	-	-	-
Total	**57,500**	**-**	**24,950**	**33,550**	**13,125**	**1,500**	**85,000**	**41,300**	**-**	**32,350**	**-**	**2,150**

E. STAFF STRENGTH:

(i) **Demise of Staffer:** Mr. Joseph Nuki, an Agric. Field Attendant I, who served as a security guard died in service on 31st August, 2023.

(ii) **Roll call of staffers:** It was earlier observed officially that Mr. Cletus Ayere, a Statistician had not shown up at work since his annual leave expired in the year 2022. This absence from the station by him remained throughout 2023. The roll call of staffers at the Mambilla Substation as at the year ending 31st December, 2022 is presented in Table 3:

Table 3: Staffers at the Mambilla substation

S/N	NAME	DESIGNATION
1.	Dr. O. O. Adenuga	Assistant Director, Head of Station
2.	Mr. F. N. Chila	Chief Agric. Supt.
3.	Mr. Augustine Mari	Chief Agric. Supt.
4.	**Mr. Cletus Ayere**	**Statistician*** **
5.	Mr. Abass Saheed Temilade	Station Accountant
6.	Mr. Peter Numfor	Principal Data Processing Officer
7.	Mr. Francis J. Wakaps	Principal Technical Officer
8.	Mr. Huseini Usman	Chief Health Assistant
9.	Mrs. Anester Lawal	Chief Agric. Field Overseer
10.	Mr. Ahmed Zubairu	Chief Motor Driver/Mechanic
11.	Mr. Adamu T. Dahiru	Chief Motor Driver/Mechanic
12.	Mrs. Regina J. Isaiah	Chief Agric. Field Overseer
13.	Mr. Philippian Moses	Chief Agric. Field Overseer
14.	Mr. James N. Musa	Assist. Chief Agric. Field Overseer
15.	Mr. Zephaniah Numfat	Assist. Chief Agric. Field Overseer
16.	Mr. Joshua N. Paul	Assist. Chief Agric. Field Overseer
17.	Mr. Ahmed S. Buba	Assist. Chief Agric. Field Overseer
18.	Mrs. Philina Stephen	Agric. Field Attendant I
19.	Mrs. Satu Musa	Agric. Field Attendant I
20.	Mr. Genesis Dogo	Agric. Field Attendant I
21.	Mr. Ephesian Clement	Agric. Field Attendant I

22.	Mr. Genesis Miku	Agric. Field Attendant I
23.	Mr. Alim Mohammed	Agric. Field Attendant I
24.	Mr. Manasseh B Andryia	Agric. Field Attendant II

*** Not seen since July 2022

F. <u>WEATHER RECORD</u>: The weather record during the year under review is presented in Tables 4 and 5:

<u>Table 4(A): Rainfall figures for January-March 2023</u>

Month	**Rainfall (mm)**	**Rain Days**	**Mean Rainfall (mm)**
January			
February			
March	**171.9**	**7**	**24.4**

<u>Table 4(B): Rainfall figures for April-June 2023</u>

Month	**Rainfall (mm)**	**Rain Days**	**Mean Rainfall (mm)**
April	**219.7**	**7**	**31.4**
May	**271.2**	**17**	**15.9**

June	**485.4**	**19**	**25.5**

<u>Table 4(C): Rainfall figures for July-Sept 2023</u>

Month	**Rainfall (mm)**	**Rain Days**	**Mean Rainfall (mm)**
July	540.9	18	30.05
August	450.29	16	28.14
September	710.10	22	32.27

<u>Table 4(D): Rainfall figures for Oct-Dec 2023</u>

Month	**Rainfall (mm)**	**Rain Days**	**Mean Rainfall (mm)**
October	383.5	14	27.4
November	47.3	4	11.9
December	20.23	1	20.23

<u>Table 5 (A): Temperature Record For January, February And March 2023</u>

DAYS	JANUARY			FEBRUARY			MARCH	
	10:00AM	2:00PM		10:00PM	2:00PM		10:00 PM	2:00PM
Total	630.1	661.7		541.5	624		613	681.5

Average	30.0℃	31.5℃		28.5℃	32.8℃		26.6℃	29.6℃

Table 5 (B): Temperature Record For April, May And June 2023

DAYS	APRIL 2023			MAY 2023			JUNE 2023	
	10:00AM	2:00PM		10:00PM	2:00PM		10:00PM	2:00PM
Total	431.5	362.1		573.5	562.5		571.5	428.1
Average	26.96℃	22.63℃		27.30℃	26.78℃		30.07℃	22.42 ℃

Table 5 (C): Temperature Record For July, August And September 2023

Month	**TIME 10.00AM**	**TIME 2.00PM**
July	28.09	20.07^0C
August	22.47^0C	24.60^0C
September	24.8^0C	24.67^0C

Table 5 (D): Temperature Record (Average) For October, November And December 2023

DAYS	October 2023			November 2023			December 2023	
	10:00AM	2:00PM		10:00PM	2:00PM		10AM	2:00PM

Total	21.09	26.96		27.25	20.31		27.57	29.68

G. VISITORS AT THE STATION:

Visitors at the station during the year under review are presented in the table below:

Table 6: list of visitors at the Mambilla substation in the year 2023

S/N	DATE	NAME	ADDRESS	PURPOSE
1.	14/4/2023	Mr. Yamsingor Isaac Gideon	Nguroje	Research work
2.	14/4/2023	Mrs. Naomi Isaac Yamsingor	Nguroje	Research work
3.	22/04/2023	Mr. Kahya S. Shuaibu	National Root Crops Research Institute, Jos	CFT project site selection
4.	22/04/2023	Mr. Abisabo Adamu	National Biosafety Management Agency official	CFT project site selection
5.	26/07/2023	Kahya S. Shuaibu	National Root Crops Research Institute, Jos	Construction of CFT Site
6.	27/08/2023	Nuhu Beta Kallastone	National Root Crops Research Institute, Jos	Collection of Data at the CFT site
7	13/09/2023	Samson Kaigama		To make inquiry about coffee

H. **<u>BOUNDARIES MAINTENANCE:</u>**

(i) Replacement of wooden poles of the boundary fence and planting of yellow bush flowers to serve as hedge plants as they grow up to form a permanent boundary between CRIN Land demarcation and the community land was carried out during the first quarter.

(ii) Fencing of part of the coffee plot at Kusuku was done with wooden materials at the areas where the villagers have been frantically encroaching on the territory of CRIN.

(iii) The station plantation and staff quarters of CRIN have boundaries close to Kusuku residents on all the sides as the station is situated right in the midst of the town. This is a major challenge for the station and its staffers, as the indigent residents of the town have always encroached upon CRIN Land with the intent of outright possession of the land by these locals. Insults, assault and threat to the lives of staff have been recurrent as a consequence.

Land boundary issue of CRIN Mambilla substation, therefore, needs a very urgent attention from the Management. The Institute urgently needs to put up a fencing structure on certain parts of its boundaries at this station so as to mitigate the constant threat to its staffers at the station.

Development of physical structures is on the increase and these are pressing very close to the boundaries of the station with the Kusuku community. It is recalled that an instance occure in November 2021, in which some villagers of Kusuku came out for an outright physical fight the CRIN-staff. The station staff, encouraged by the Head of Station (HoS) had to come out to resist the encroachment. The area where the villagers attempted to encroach this time round was Coffee arabica plot along the major road leading to Kakara town (the location of the Mambilla Beverage (Nigeria) Limited).

The village Head of Kusuku (Jouro Halidu) had to be brought in by the Substation to intervene in the dispute. He expressed his support for the CRIN staff as he attempted to calm tense nerves.

The village Head subsequently advised CRIN to fence its land to avoid encroachment. He further confessed that he was no longer finding it easy having his people under check as

they consistently cause trouble to CRIN staff on the land issue. It took some courage and bravery by the staff at the station for CRIN not to have lost any portion of its land, while the boundaries were maintained. Management also needs to remember that the land dispute at the Mambilla substation seems to be a long-drawn battle, as it predates the current Administration. There is therefore an urgent need for the Headquarters to take practical steps to permanently secure its land at this substation so as to eliminate the encroachment tendencies of these locals, thereby preventing the continuous endangering of the lives of CRIN staff at the Mambilla substation.

CROP IMPROVEMENT DIVISION

PLANT BREEDING AND BIOTECHNOLOGY ACTIVITIES

COCOA PROGAMME

Establishment of 2ha Cocoa Hybrid Parental Stock at the Headquarters was done in the year. The parental materials are the parent of the TC series. In order to mitigate against natural disasters (especially fire outbreak), multi-location establishment of parental materials was carried out at CRIN Headquarters in Ibadan at two locations (Zone 8 and Nursery) in 2023. The scions were grafted on the already raised root stock in the nursery and later established at the two locations. Survival count was carried out to know the number of available stand that can be used for pollination exercise to generate hybrid cocoa pods. Table 1 shows the pedigree of the TC series while Table 2 shows the parental clones and number of survival and available clonal trees that can be used to generate hybrid cocoa pods.

Table 1. Pedigree of the TC series

S/N	**TC series**	**Pedigree**	**Female**	**Male**
1	TC1	T65/7 x N38	T65/7	N38
2	TC2	T101/15 x N38	T101/15	N38
3	TC3	P7 x PA150	P7	PA150
4	TC4	T65/7 x T57/22	T65/7	T57/22
5	TC5	T82/27 x T12/11	T82/27	T12/11
6	TC6	PA150 x T60/887	PA150	T60/887
7	TC7	T82/27 x T16/17	T82/27	T16/17
8	TC8	T65/7 x T9/15	T65/7	T9/15

Table 2. Number of available clonal tree stands

Clones	**Zone 8**	**Nursery**	**CFC**	**Total**
T65/7	175	14	10	199
T101/15	60	12	4	76
P7	35	2	4	41

T82/27	35		6	31
PA150	85	32	4	121
N38	21	5	3	29
T57/22	37	3	6	46
T12/11	64	-	10	74
T60/887	-	-	-	-
T16/17	10	5	4	19
T9/15	173	13	11	197
Total				**833**
Female				**468**
Male				**365**

Cashew

Breeders were saddled the responsibility of leading the processes of new cashew cultivar development for farmers in Nigeria. In this wise, Breeders together with other disciplines explored more than 34 communities in 4 cashew producing states including Oyo, Kogi, Kwara and Edo states for potential cashew mother trees that could be used for generating improved genotypes. Selection of potential mother trees was in line with favorable agronomic, yield and processing traits. Singe tree selection was done. Seventy-one cashew trees were selected based on high yield, disease & pest resistance, intensive branching, compact canopy, medium sized tree, early fruiting, ease of nut detachment from apple, and large to medium sized nuts. Nuts from each tree were evaluated for the shelling percentage and kernel outturn ratio (KOR). Results are currently undergoing statistical analysis. Best trees would be multiplied by grafting and subjected to multi-location evaluation for short-time release of improved cultivar. Further improvement through hybridization would be carried out on the selected trees.

Coffee

Fire outbreak, timber cutting, diseases and pests are some of the causes of loss or erosion of coffee genetic materials in the coffee germplasm. The coffee genetic materials are going into extinction and needed to be supplied back to the coffee germplasm at the headquarters and the substations. Therefore, efforts were made in 2023 to expand and increase the genetic variability of coffee population that will lead to more selection and development of improve varieties of coffee for Nigeria farmers.

Broaden of the genetic base of *C. canephora* in CRIN germplasm, required exploration and collection of more accessions from farmers' farms. Collection of sixteen Robusta coffee accessions were obtained from farmers' farms in Kogi and Ekiti states in Nigeria and named accordingly. These states are known to be among the highest cultivators of robusta coffee in Nigeria. The stem cuttings were taken from the mother trees with use of sterilized pruner (secateurs) after proper assessments. About 8 to 10 cm in length of stem cuttings with the leaves attached were collected, with both edges of the cuttings covered with paraffin wax. These cuttings were used to raise half node stem cuttings of coffee in the nursery. Field establishment will be done in 2024.

Kola In attempt to improve kola genotypes in Nigeria, new germplasm collection for development of improved kola varieties is spear headed by kola breeders. Young stems collected from selected kola trees were grafted on already established rootstock at the nursery, CRIN headquarters for field establishment. The successful graft was established on 1ha at CRIN Headquarters.

Tea

Breeders in conjunction with other disciplines embarked on research work of multiplication of adaptable tea clones of C 318 to lowland (Ajasso substation). Ten thousand cuttings were raised with aim of establishing and expansion tea cultivation in Nigeria.

Biotechnology

The section activities have been guided by the institute's mandate: to regenerate our mandate crops: cocoa, coffee, cashew, tea, and kola. On this account, we were able to:

- To initiate culture from international clones, local clones and the TC-series cocoa flowers (using petal and staminode tissue) following tissue culture techniques (somatic embryogenesis)
- Cultures were also initiated from the cocoa seed (organogenesis)

- Callus initiation from leaf tissue and cotyledon was done for coffee
- Pollen culture was done for kola
- Calli obtained were developed and maintained under dark incubation while the cultures derived from organogenesis were maintained under fluorescent light intensity.
- The derived callus was continually maintained and will be converted to regenerate plantlets.
- Besides, training of students from various universities and colleges of Nigeria on the use of tissue culture and molecular biology techniques of our mandate crops was also done.

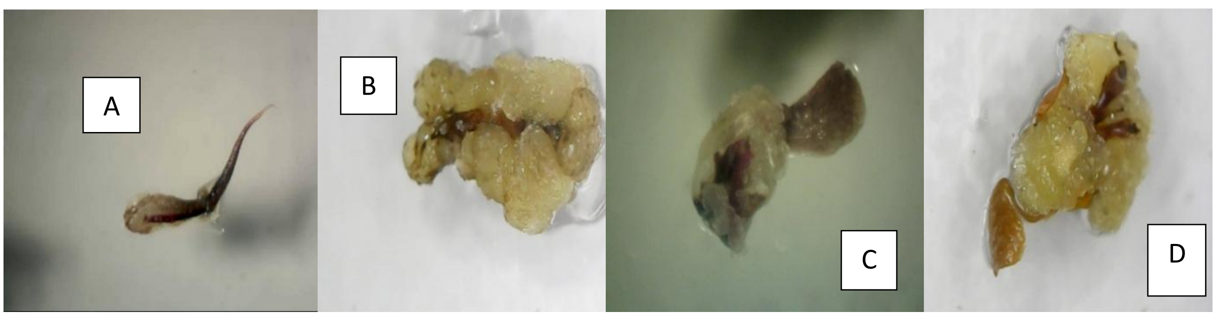


Figure 1: (A) Staminode explant induction on Primary Callus Growth (PCG) medium at 3 days after culture initiation. (B) Callus development on Secondary Callus Growth (SCG) medium for the staminode explant at 14 days after culture initiation
(C) Petal explant induction on PCG medium at 3 days after culture initiation. (D) Callus development on SCG medium for the petal explant at 14 days after culture initiation.