CSIR-FORESTRY RESEARCH INSTITUTE OF GHANA

2023

ANNUAL REPORT

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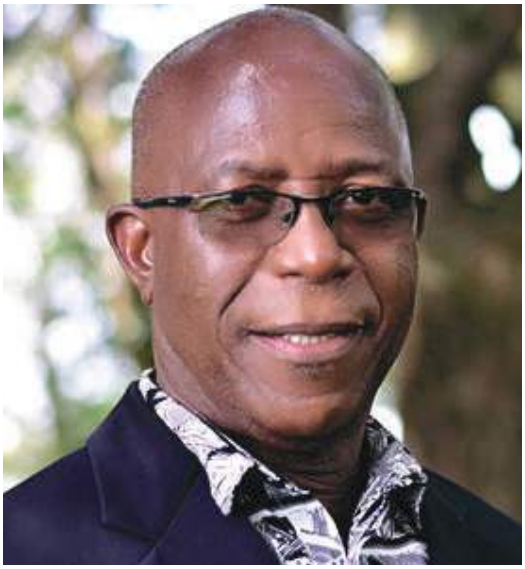
FOREWORD

CSIR-Forestry Research Institute of Ghana, one of the 13 institutes of the Council for Scientific and Industrial Research (CSIR-FORIG) is mandated to undertake forest, forest products and related research disseminate and commercialise research outputs and services in Ghana. To achieve this mandate, the Institute undertakes demand-driven research, builds capacity and promotes the application of technologies for the sustainable management of Ghana's forest resources for the benefit of society.

This document contains the outputs and activities of 2023 grouped under four (4) broad research themes namely: Food Security & Poverty Reduction; Climate Change, Environmental Management & Green Technology; Material Science and Manufacturing; and Science and People.

CSIR-FORIG is strategically positioned as one of the top research institutes in Ghana because of its research staff commitment, the culture of interdisciplinary and multidisciplinary co-operation and its asset in applied research. The Management of CSIR-FORIG kindly and sincerely acknowledges the excellent performance of all staff during the year under review.

Prof. Daniel A. Ofori,
Director, CSIR-FORIG



Prof. Robert Clement Abaidoo,
BOARD CHAIRMAN

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LIST OF ABBREVIATIONS AND ACRONYMS

A2LA	America Association of Laboratory Accreditation
ABC	Alliance for Biodiversity CIAT
ACA	Ankasa Conservation area
BGCI	Botanical Garden Conservation International
CAP	Conservation Action Plan
CCEM&GT	Climate Change, Environmental Management and Green Technology
CCST CSIR	College of Science & Technology
CLT	Cross-laminated timber
CSIR	Council for Scientific and Industrial Research
CSIR- BRRI	Council for Scientific and Industrial Research- Building and Road Research Institute
CSIR-FORIG	Council for Scientific and Industrial Research -Forestry Research Institute of Ghana
CSIR-IIR	Council for Scientific and Industrial Research- Institute of Industrial Research
CSIR-STEPRI	Council for Scientific and Industrial Research -Science and Technology Policy Research Institute
CVC	Campus Visitation Committee
ECOWAS	Economic Community of West African States
ESD	Education for Sustainable Development
FAO	Food and Agriculture Organization
FC	Forestry Commission
FDA	Food and Drugs Authority
FIP	Forest Improvement Programme
GIFMIS	Ghana Integrated Financial Management Information System
GIZ	German Agency for International Cooperation
GoG	Government of Ghana
GRA	Ghana Revenue Authority
GSA	Ghana Standards Authority

GTEC	Ghana Tertiary Education Commission
HSMs	Habitat Suitability Maps
IGF	Internal Generated Funds
IMC	Internal Management Committee
ISO	International Organization for Standardization
ITTO	International Tropical Timber Organisation
LKS	Lesser-known Timber Species
LUS	Lesser-used Timber Species
MAG	Modernizing Agriculture in Ghana
MoE	Modulus of Elasticity
MOPs	Method of Procedure
MoR	Modulus of Rupture;
NRD	National Registration Data
NSS	National Services Scheme
NTSC	National Tree Seed Centre
PBNF	Prince Bernhard Nature Fund
QMR	Quality Management Representative
REDD+	Reduced Emissions of Deforestation and Forest Degradation
RSA	Research Scientist Association
SDGs	Sustainable Development Goals
SIDA	Swedish International Development Cooperation Agency
SI-MFS	Sustainable Intensification- Mixed Farming System
SOP	Schools Outreach Programme
TTIS-Gh	Threatened Tree Information System for Ghana
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
WFTC	Wood and Furniture Testing Center

COMPOSITION OF CSIR-FORIG MANAGEMENT BOARD

Prof. Robert Clement Abaidoo *CANR-KNUST*	Chairman
Prof. Daniel A. Ofori *Director, CSIR-FORIG*	Member
Dr. Daniel Ashie Kotey *Acting Director, CSIR-PGRRI*	Member
Nana Dwomoh Sarpong *President, Ghana Timber Millers' Organization*	Member
Mr. Baffour Awuah Agyemang *President, Furniture and Wood Products Association*	Member
Mr. John M. Allotey *Forestry Commission*	Member
Mrs. Josephine E. Geraldo *CSIR, Director-General's Representative*	Member
Ms. Comfort D. Kontoh *Head of Administration, CSIR-FORIG*	Secretary

EXECUTIVE SUMMARY

A total of nineteen (22) projects were implemented comprising sixteen (16) pure research projects and six (6) service-oriented activities. Twelve (12) of the research projects were undertaken in collaboration with other national and international institutions during the period under review. Five (5) out of the six (6) service-oriented projects linked to CSIR's Thematic Research Areas re; (a) Food Security and Poverty Reduction; (b) Climate Change, Environmental Management and Green Technology (CCEM&GT); (c) Material Science and Manufacturing; and (d) Science and People.

With regard to the Food Security and Poverty Reduction Programme, research in Pomegranate was conducted during the year. Results of the study at Abofour revealed that although the two pomegranate varieties showed better growth in height, there was no significant difference in total height and crown area at all the planting sites for Hicaz and Wonderful.

The Climate Change, Environmental Management and Green Technology Programme established two Paulownia species in four (4) ecological zones in Ghana. Data collected from Paulownia tree studies indicates increases in the growth height, diameter, crown spread and the number of leaves. However, the height and diameter of *Paulownia fortunei* at Pamu-Berekum showed traces of undergrowth as compared to species at Abofour.

So far CSIR-FORIG collaboration with the Forestry Commission/Industry Plantation Development Fund Committee have established a forest plantation with an area of 3,676.14 ha of both indigenous and exotic species such as Ofram (*Terminalia superba*), Kusia (*Nauclea diderrichii*), Onyina (*Ceiba pentandra*) Wawa (*Triplochiton scleroxylon*), Mahogany (*Khaya ivorensis*) and Otie (*Pycnanthus angolense*). The exotic species include Cedrela (*Cedrela odorata*), Teak (*Tectona grandis*) and Paulownia species (*P. elongata* and *P. fortunei*).

The accredited Wood and Furniture Testing Center (WFTC) received twenty (20) plastic chairs from the Ghana Standards Authority (GSA) to be tested for durability and usage. Five (5) out of the twenty (20) sets of plastic chairs passed the GSA tests (drop/impact, seat and back static and rear/back stability test).

The School Outreach Programme Team from CSIR-FORIG distributed books from the Pan African Conservation Education Project to the schools that the team visited with the climate change campaign. Fumesua Model Anglican JHS and the Fumesua MA Primary and JHS were the 3rd and 4th schools that benefitted from the programme. CSIR-FORIG, in a related development hosted twenty-nine (29) students from the Paakoso SHS as part of the campaign.

The students visited the FORIG Nursery and National Tree Seed Centre (NTSC) as part of the schools' outreach programme. They were taken through the various activities including hands-on experiences at the Nursery and the NTSC.

Training in alternative livelihoods; namely Snail Farming (561), Beekeeping (185), Mushroom Production (297); and Nursery and Plantation Establishment (8) were organized for 1,043 beneficiaries during the year. Since the reactivation of CSIR-FORIG training workshops in mid- 2017, nearly 5,000 individuals; over 90% Ghanaians have participated, and approximately 60% of framers have established small to medium scale farms with almost 8% into large scale production.

The Climate Change & Integrated Natural Resources Management Programme has been successfully operating according to schedule. The CSIR College of Science and Technology (CCST) has so far enrolled 66 students and graduated nineteen (19). With regard to the Septemeber 2023 intake, 14 freshers were admitted, comprising eleven (11) M.Phil and three (3) MSc. students including a female. The 7th viva voce for 5 MPhil students was held on 7th November, 2023

1.0 FOOD SECURITY AND POVERTY REDUCTION (FSPR).

1.1 BACKGROUND AND HIGHLIGHTS OF RESEARCH ACHIEVEMENTS UNDER FSPR RESEARCH THEME

In the year 2023 CSIR-FORIG engaged with national and international research institutions on key forestry and agricultural issues under the following thematic areas:

- Forest, trees and plant resources (natural products)
- Soil, mechanization and agro food processing
- Biotechnology (Germplasm collection, conservation, bio-processing)
- Biomedical and Public Health.

Food-related research was conducted under the above themes to meet the challenges of providing Ghana's growing population with access to safe, modest and nutritious food, using sustainable land use practices.

1.2 POMEGRANATE (*PUNICA GRANATUM*) SPECIES TRIAL IN GHANA

***Research Team**: D. A. Ofori and A. Antwi-Wiredu*

***Donor**: Northstone Investment Ltd*

The *Punicaceae* family, including pomegranate (*Punica granatum*), consists of a deciduous shrub or small tree, which typically grows to heights ranging from 5 to 8 meters. Recognized for its health benefits, attributed to its rich organic acids, vitamins, polysaccharides, essential minerals, and antioxidants, the pomegranate is renowned for reducing cardiovascular risks and other chronic ailments. The substantial presence of antioxidants has notably contributed to its increased consumption in developed countries. Its recognized health perks have significantly surged in demand for the fruit and its derivatives. Historically, it is used to treat osteoarthritis, haemorrhoids, conjunctivitis, and stomach ailments. Yet, in Ghana, the fruits are imported for commercial purposes and beverage production by fruit processing factories, mostly Blue Skies Company Ltd. Thus, there is a need to explore the feasibility of cultivating this fruit tree domestically, aiming to alleviate the financial burden on the companies and the nation as a whole. The objective seeks to assess the adaptive capacity, growth, and yield of pomegranates in Ghana. Two pomegranate varieties (*Hicaz* & *Wonderful*) were planted at Mpraeso, Yenku, Abofour and Mesewam in 2018 at a planting density of 200 each.

They have reached their reproductive stages (**Plate 1**). One plant flowered and developed into fruit but aborted prematurely at Yenku and Abofour. There was no flower found at the other two sites over the period (**Table 1**).

Table 1: Number of Plants with Flowers and Fruits per Year

Sites	Flowers/Fruits			
	2020	2021	2022	2023
Abofour	4 (2.0%) – aborted	18 (9.0%) – aborted. 1 (0.5%) fruited but aborted	21 (10.5%) – few aborted	17 (8.5%) – some aborted
Yenku	1 (0.5%) – aborted	0	0	1 (0.5%) – fruited but aborted
Mpraeso	0	0	0	0
Mesewam	0	0	0	0

The two varieties at Abofour showed no significant difference in total height and crown area (**Table 2**).

Table 2: Plant Height (cm) and Crown Area (cm) of the two Species at Abofour

Pomegranate	Height (cm)	Crown Area (cm)
Hicaz	270.45±8.10[a]	216.70±9.65[a]
Wonderful	281.91±8.05[a]	234.00±10.41[a]

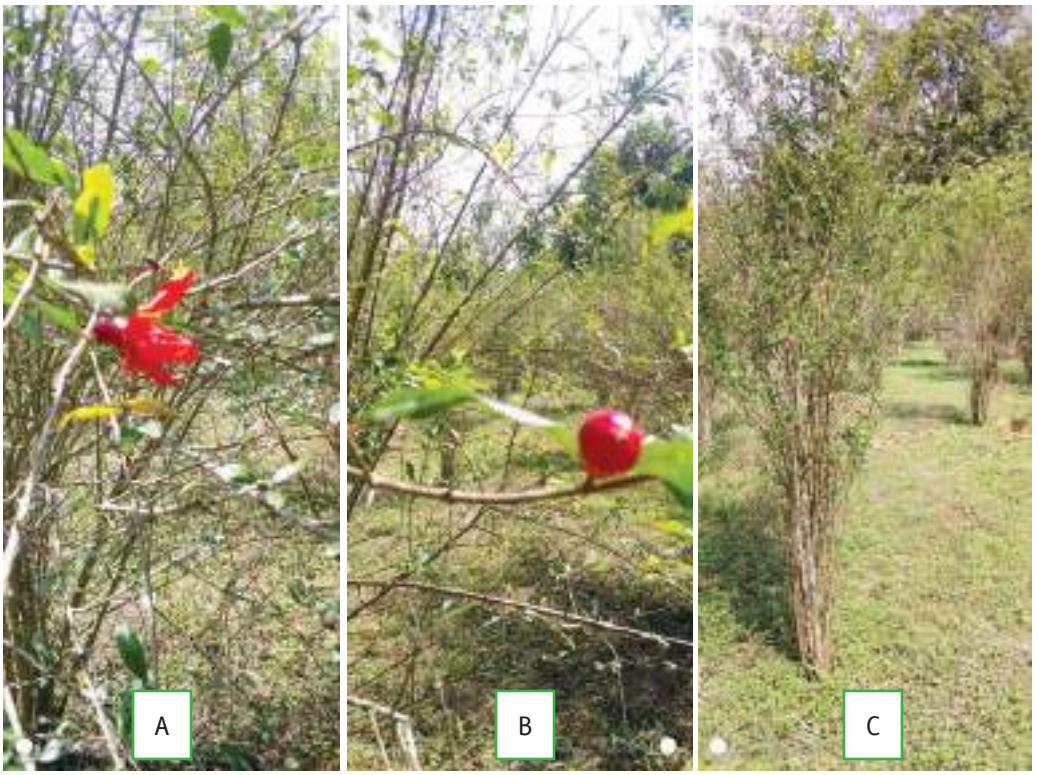


Plate 2A-C: Pomegranate stands at Abofour

2.0 CLIMATE CHANGE, ENVIRONMENTAL MANAGEMENT & GREEN TECHNOLOGY (CCEMGT)

2.1 BACKGROUND AND HIGHLIGHTS OF RESEARCH ACHIEVEMENTS UNDER CCEMGT

The CSIR-FORIG Climate Change, Environmental Conservation and Green Technology improves knowledge of the health and environmental effects of climate change and offers sustainable solutions for communities to successfully accomplish and decrease the impacts of a changing climate. Research activities in 2023 under the theme CCEMGT were related to the following:

- Soil, Water and Biodiversity Conservation
- Climate Change Mitigation
- Climate Change Adaptation and Social Development
- Green Technologies for Sustainable Development

2.2 *PAULOWNIA* FIELD TRIALS IN THREE ECOLOGICAL ZONES IN GHANA

***Research Team**: D. A. Ofori; A. Antwi-Wiredu; P. M. Gakpetor and R.T. Guuroh*

***Donor**: FC Industries*

The *Paulownia* tree, a deciduous member of the *Scrophulariaceae* family with monogenetic origins, is native to East Asia. *Paulownia* timber exports are worth billions of dollars. It has a huge export market due to its quality wood; reforestation works; industrial uses and environmental beauty. It is one of the fastest-growing trees. The species may thrive in dry, high-temperature settings with complete light penetration. It is a terminal leader; as a result, does not accept competition for resources and shade. *Paulownia* root cuttings also grow better than seedlings. In 2012, CSIR-FORIG established *Paulownia* at two locations in Ghana's Moist Semi-Deciduous (MSD) forest zones. The results of its growth performance in 2019 were subpar at both sites. These elements could be responsible for the poor performance; thus, a need to conduct this study while taking the aforementioned fundamental criteria into account. The objective is to determine the growth performance of two *Paulownia* species (*P. elongata* & *P. fortunei*) in three (3) different ecozones in Ghana: Transition (Pamu-Berekum), Moist (Asenanyo), and Dry Semi-Deciduous (Abofour).

The height and diameter of *P. elongata* at Pamu-Berekum were significantly different from the two sites. However, no significant difference existed between Asenanyo and Abofour. For *P. fortunei*, there was a significant difference in height and diameter between Asenanyo and the other sites (**Plate 2**). Contrarily, the height and diameter of *P. fortunei* at Pamu-Berekum and Abofour were not significantly different (**Table 3**).

Table 3: Plant height (cm) and diameter at breast height (mm) of the two species at the three sites

Paulownia spp.	Planting Sites	Height (cm)	Diameter (mm)
P. elongata	Pamu-Berekum	275.66±10.08[a]	32.46±1.85[a]
	Asenanyo	390.00±8.68[b]	44.04±1.14[b]
	Abofour	369.05±16.49[b]	41.00±2.07[b]
P. fortunei	Pamu-Berekum	305.50±12.68[a]	33.50±1.65[a]
	Asenanyo	412.82±9.91[b]	45.20±1.33[b]
	Abofour	293.13±20.29[a]	32.13±2.56[a]

Means with the same letter superscript are not significantly different at the 5% level

Plate 2: Paulownia Stands at Asenanyo

2.3 ESTABLISHMENT OF FOREST PLANTATIONS TO SUPPORT REFORESTATION OF GHANA'S FORESTS

***Research Team**: R. T. Guuroh, F. Asuming-Baffour, D. A., Ofori, K. A. Oduro, S. Adu-Bredu and E. G. Foli.*

***Donor**: Forestry Commission/Industry (FC/INDUSTRY) Fund Board*

The Forestry Commission/Industry (FC/Industry) Plantation Development Fund Committee has set up a programme to contribute towards reforestation of forest estate via plantation development in Ghana. CSIR-Forestry Research Institute of Ghana (FORIG) has been tasked by the Committee to establish best practice plantation of fast growing indigenous and exotic commercial species at various locations in the country. Since 2010, CSIR-FORIG has been establishing forest plantations with support from the FC/Industry Fund. These plantations have been established in the Research Working Circles of CSIR-FORIG at Pra-Anum, Opro/Afram Headwaters and Asenanyo Forest Reserves, and in degraded Forest Reserves at Mankrang, Essen-Apam and Pamu Berekum.

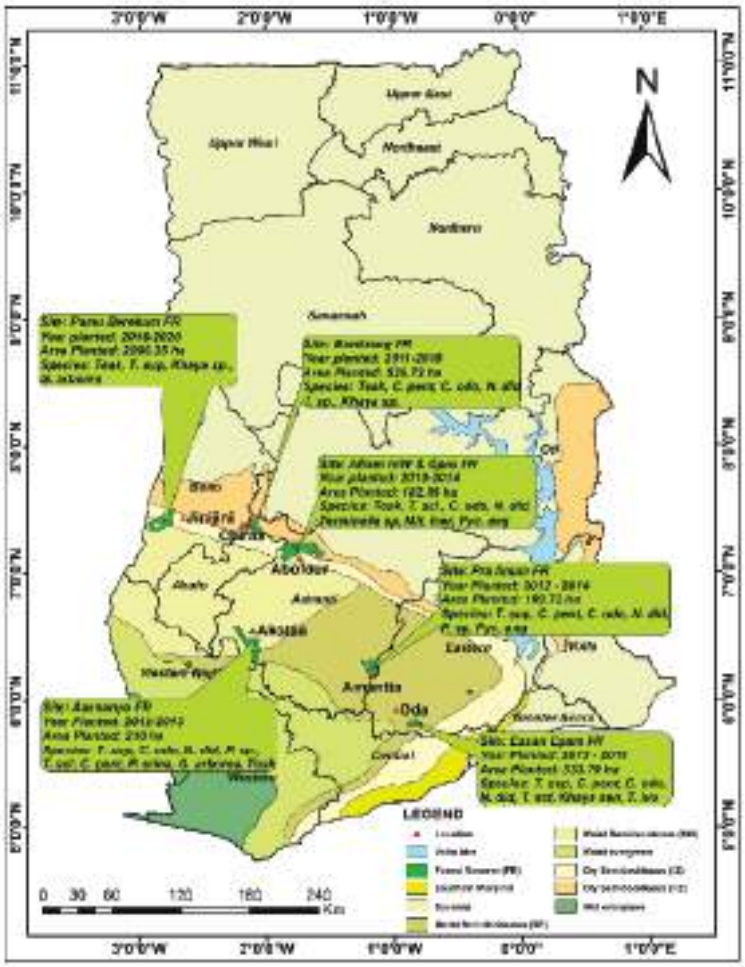


Plate 3: Map of Ghana showing the locations of the six plantation sites (Map by William Brown)

So far, an area of 3,676.64 ha has been planted (see details in Table 4) with indigenous species including Ofram (*Terminalia superba*), Kusia (*Nuclea diderrichii*), Onyina (*Ceiba pentandra*) Wawa (*Triplochiton scleroxylon*), Mahogany (*Khaya ivorensis*) and Otie (*Pycnantus angolense*). The

exotic species are Cedrela (*Cedrela odorata)*, Teak (*Tectona grandis*) and Paulownia species (*P. elongata* and *P. fortunei*).

Plate 5a-b: Pruned six-year-old *Tectona grandis* stand at Pamu Berekum and ten-year-old *Cedrela odorata* stand at Essen Apam undergoing pruning.

Operations from January to December 2023 centered on maintenance of plantations in the form of weeding, singling, pruning, fire rides construction and maintenance. Other activities were patrolling for detection of bush fire threat and illegal encroachments, fire-fighting and fire preventive education in fringe communities, replanting of failed areas and data collection in established permanent sample plots.

The research aspects of the project include assessment of growth performance of the different species in different sites / ecological zones namely the Dry Semi-deciduous zone, the Moist Semi-deciduous N/E zone and the Moist Semi-deciduous S/E zone. There is also ongoing research to assess the growth performance of Paulownia species raised from root cuttings in the three ecological zones. All the research plots have been successfully established and data collection is ongoing.

The plantation presents an opportunity to implement different research components that would lead to a better understanding of plantation establishment in Ghana and this opportunity should be vigorously explored. Scientists are encouraged to make use of the sites for their research activities.

Table 3: Detailed information about the six plantation sites.

Site (Reserve)	Location & (region)	Ecological zone	Area planted (ha)	Species planted	Year planted
Afram Head-waters & Opro	Abofour (Ashanti)	Dry Semi-deciduous	310.06	*Tectona grandis, Cedrela odorata, Nauclea diderrichii, Terminalia superba*	2010 - 2022
Asenanyo	Akotaa (Ashanti)	Moist Semi-deciduous	210.00	*Terminalia superba, Paulownia sp., Cedrela odorata, Triplochiton scleroxylon, Nauclea diderrichii, Ceiba pentandra, Pterocarpus erinaceus, Gmelina arborea, Tectona grandis*	2012 - 2015
Essen Epam	Akim Oda (Eastern)	Moist Semi-deciduous	333.79	*Cedrela odorata, Triplochiton scleroxylon, Terminalia superba, Ceiba pentandra, Nauclea diderrichii, Khaya senegalensis,*	2013 – 2018
Mankrang	Chiraa (Brong Ahafo)	Dry Semi-deciduous	646.22	*Tectona grandis, Cedrela odorata, Terminalia sp., Ceiba pentandra, Khaya sp.*	2011 – 2023
Pamu Berekum	Jinijini (Brong Ahafo)	Dry Semi-deciduous	2006.35	*Tectona grandis* (teak), *Terminaliasuperba, Khaya sp. Gmelina arborea*	2016 – 2019
Pra Anum	Amantia (Ashanti)	Moist Semi-deciduous	169.72	*Terminalia sp., Ceiba pentandra, Paulownia sp., Cedrela odorata, Nauclea diderrichii, Pycnanthus angolensis*	2010 – 2014
TOTAL AREA PLANTED UP TO 2023			**3,676.14**		

2.4 AKYEM MINE WILDLIFE MONITORING PROGRAMME

***Research Team**: B. O. Kankam and C. Ofori-Boateng*

***Donor**: Newmont Golden Ridge Limited*

As part of Newmont's strategies to manage the biodiversity impact of the mine, site-based biodiversity monitoring is important to understand how the operation is affecting biodiversity on-site and how the company could best mitigate and integrate the various biodiversity activities to offset any negative effects in the Akyem mine environment, as recommended in the Newmont Mining Corporation Biodiversity Standard Guidance (2016). Also, the Ahafo South Mine of the Newmont company in Ghana organized a snake-catching training program for nine Emergency Response Team volunteers at the Ahafo South Mine to avoid and minimize the risks of snakebites in the Ahafo South Mine concession area.

The objectives for the project were: 1). Survey and monitor the distribution of wildlife in forest fragments and the 60 ha established plantations within the Newmont Ghana, Akyem Mine boundary, 2). Assess wildlife interaction with the water storage facilities in the Newmont Ghana, Akyem Mine boundary, 3). Describe the trend in wildlife mortality, species diversity and population within Newmont Ghana, Akyem Mine and for the Ahafo South Mine: 4). Provide training materials, practical demonstration of how to catch snakes, and certificates to trainees.

The following outputs were obtained for both Akyem Mine and Ahafo South Mine respectively: 1) Two bat species of interest have been recorded (*Eidolon helvum*; Plate 4 & *Hipposideros jonesi*: Plate 5). Both the African Straw-coloured Fruit Bat (*Eidolon helvum*) and Jones's Roundleaf Bat (*Hipposideros jonesi*) are listed as Near Threatened in the IUCN Red List of Threatened Species and 2) The trainees were taught how to use the correct tools to handle and manipulate snakes, how to bag and bucket a snake, and how to transport snakes to release sites using the right tools (Plates 6 and 7).

Plate 4: *Eidolon helvu*m

Plate 5: *Hipposideros jones*i

Plate 6: Trainee using a hook to handle a snake and transfer it to a bucket safely.

Plate 7: Trainee holding a Royal python.

2.5: IMPACTS OF 2015/2016 EL NINO ON CARBON CYCLING/CUE: SEASONAL VARIATION OF SOIL RESPIRATION AT THE ANKASA CONSERVATION AREA

Research Team: *S. Adu-Bredu; A. Duah-Gyamfi, and S. D. Addo-Danso*
Donor: *Natural Environment Research Council*

Soil carbon dioxide (CO_2) efflux, usually referred to as soil respiration (*R*s), is an important component of an ecosystem's carbon cycle. Soil respiration comprises a release of carbon (C) to the atmosphere. Soil respiration could increase with future global warming as warming may speed up the decomposition of soil carbon and also decrease stored up amounts of CO_2 in soils. Changes in soil CO_2 flux in response to seasonal changes in environmental factors is crucial for projections of climate change, yet information on the controls of soil CO_2 efflux is limited in Ghana. This is particularly important in Ghana with a forest gradient having variations in environmental factors. Even within a forest such as the Ankasa Conservation Area with an undulating terrain, changes in soil respiration could be marked across different stands. Furthermore, there is scarcity of studies on soil CO_2 dynamics; and the lack of data on soil CO_2 efflux makes it difficult for climate change modelers to make accurate predictions on soil carbon. This research aims at assessing the seasonal variation in soil respiration between two stands at the Ankasa Conservation Area, which differ in terms of landform (topography) and elevation.

There was no difference in CO_2 efflux between seasons within each site. However, there was a difference in seasonal CO_2 efflux between the two sites with higher efflux at ANK1 (Figure 1). Average CO_2 effluxes for the wet and dry seasons at ANK1 were 0.64 g CO_2 m^{-2} hr^{-1} and 0.63g CO_2 m^{-2} hr^{-1}, respectively. For ANK2, soil CO_2 effluxes for the wet and dry seasons were 0.46 CO_2 m^{-2} hr^{-1} and 0.52 g CO_2 m^{-2} hr^{-1}, respectively.

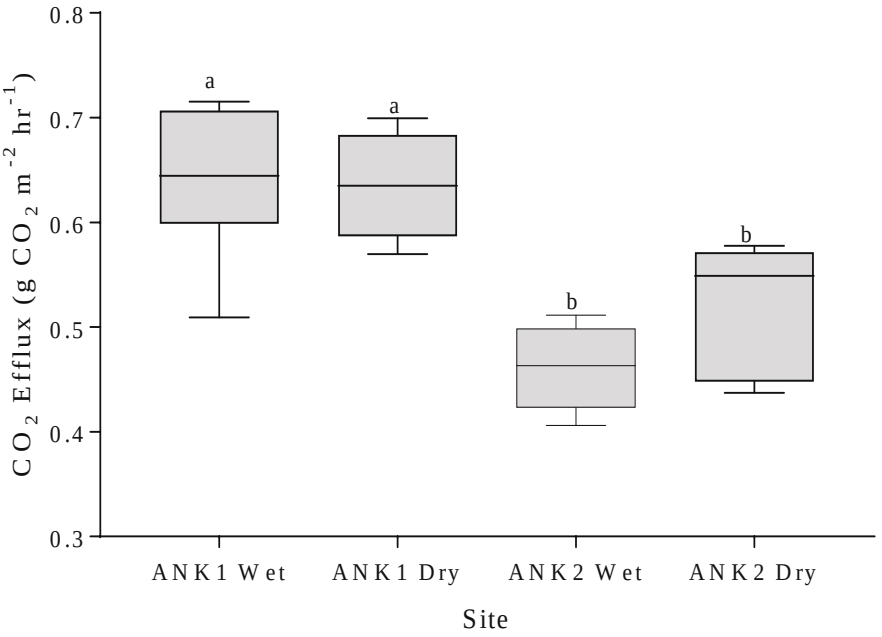


Figure 1: CO_2 efflux recorded in the upper elevation (ANK1) and lower elevation (ANK2) of Ankasa Conservation Area.

Higher moist conditions due to frequent rains in the year coupled with the evergreen nature of the Ankasa Conservation Area may account for the indifference soil CO_2 efflux between seasons within each site. Although the two sites are wide apart, conditions within each plot may be particular within each site and thus an explanation for the patterns observed in soil CO_2 efflux between the dry and wet season. ANK2 is generally flat and frequently inundated with water, this may account for the lower soil CO_2 efflux in both seasons compared to ANK1.

2.6: BIOMASS ESTIMATION IN GHANA'S PERMANENT SAMPLE PLOTS (PSPs) AT THE PLOT LEVEL

ResearchTeam: **S.** *Adu-Bredu, A. Duah-Gyamfi. and K. Kyenkyehene Kusi.*
Donor: *Food and Agriculture Organisation (FAO)*

Quantifying and assessing carbon stocks and carbon emission reductions through sustainable forest management is critical for our understanding of the role of forest ecosystems in climate change mitigation and adaptation. Hence, the development of innovative methodologies for assessing carbon stocks, carbon emissions and carbon sequestration potential of forests is of paramount importance. Ideally, using both traditional ground-based forest inventory (bottom-up) approach and satellite / remote sensing observations-based (top-down) approach are practical ways of obtaining forest ecosystem characterization. This is essential for the assessment of forest biomass carbon stocks, determination of national and regional emission factors for estimating greenhouse gas emissions and for validating estimates based on remote sensing data. Unfortunately, most West African countries lack extensive national forest inventories and where they have been undertaken, they are inaccurate for use in estimating emission factors due to the limited spatial extent. In addition, most West African countries lack robust allometric equations

for estimation of biomass from inventory data. As a result, estimates are unreliable and subject to a high degree of uncertainty and lack of international credibility. Further, there is an urgent need for capacity development for a coordinated approach for data collection and analysis for carbon stocks in the sub-region. This is crucial in order to build a consistent, regional dataset of West Africa carbon stocks.

To address these forest data gaps, the Food and Agriculture Organization (FAO) of the United Nations (UN) in collaboration with the Swedish International Development Cooperation Agency (SIDA) and the Economic Community of West African States (ECOWAS) is implementing a project "*Global Transformation of Forests for People and Climate: a focus on West Africa*". The project, will among other things design and undertake forest and carbon inventories to fill critical information gaps in West Africa and develop sub-regional capacities in forest inventory, providing also opportunities for women's active participation. Using Ghana as a nodal point for the carbon stocks inventory, 38 one-hectare (100 m x 100 m) Permanent Sample Plots (PSPs) were established across an eco-climatic gradient from north to south spanning the Sudan Savannah, Guinea Savannah, Coastal Savannah, Forest-Savannah Transition, Moist Semi-deciduous, Upland Evergreen, Moist Evergreen and Wet Evergreen Vegetation Zones.

Height models were developed for the evergreen, moist semi-deciduous, forest-savannah and savannah eco-climatic zones. The 3-Exponential height model was found to be the most appropriate among seven models that were tested. The results provide evidence of the influence of eco-climatic zone on carbon stocks and thus carbon sequestration. This is particularly important as climate models predict higher temperatures and erratic rainfall patterns for West Africa. The results also highlight the importance of trees in contributing substantially to carbon stocks. Therefore, the conservation of trees across all the eco-climatic zones is essential to avoid declines in carbon stocks.

Plate 8: Routine discussion of field team prior to commencement of activities planned for the day

Plate 9: Measurement of the dbh of a tree with buttress at the Ankasa Conservation area (ACA) in the Wet Evergreen zone

Plate 10: Measurement of dbh of a tree at the Tamire Forest Reserve in the Sudan Savanna zone

2.7: BIODIVERSITY AND RECOVERY OF FORESTS IN TROPICAL LANDSCAPES (PANTROP)

***Research Team**: L. Poorter, F. Bongers, L. Amissah, M. M. Ramos, J. Meave, L. Susan, M. V. Sande, I. Hordijk, T. Matsuo, J. Kok, M. Aviles, Rodrigo, J. Dabo and S. M. Abdul*

***Donor:** European Commission*

Currently, over half of the world's tropical forests are considered secondary forests which provide goods and services including carbon sequestration in human-modified landscapes. However, secondary forests have largely been ignored by scientists and policy makers. Nearly all policies on climate change, conservation, and management of tropical forests are focused on old-growth forest. Secondary forest can form the basis for the design of forest restoration projects, most of which lacks sound ecological basis. To solve this problem, there is the need to understand and predict forest resilience in terms of when, and under what conditions regrowing forests can recover and have the same quality and functioning as old-growth forests.

The project aims to understand and predict the resilience of tropical forests to human-driven disturbance by analyzing the effects of 1) continent and biogeography, 2) climate, 3) landscape and 4) biodiversity on forest recovery rate.

The study results and outputs are expected to help in the design of resilient and multifunctional tropical landscapes, design of effective restoration strategies, improvement of vegetation and climate change models as well as make evidence-based decision regarding the use of secondary succession as a cheap natural solution for forest restoration.

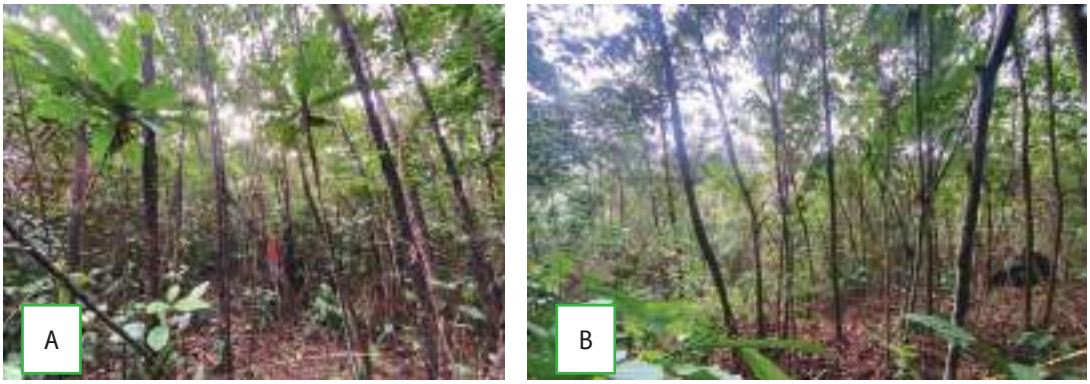


Plate 11A-B: A four-year-old forest cover plot (4 years after abandonment after harvest) in a wet forest at Pataho, near Bonsa.

Plate 12A-B: A 4-year-old forest cover plot (that is 4 years after abandonment after harvest) in a dry forest at Abofour.

Plate 13A-B: Biodiversity experiment in a 7-year-old forest biodiversity plots (that is 7 years after abandonment after crop harvest) in a dry forest site at Kyebi near Abofour; a) removal of dominant species, and b) removal of dominant species.

Plate 14A-B: Litter traps installed in forest cover plots at Abofour

The following findings about forest recovery over time in dry and wet forests were obtained: Above ground biomass (AGB) and species richness increased linearly over time in both dry and wet forests and the recovery rate was faster in wet forests than that in dry forests (Figure. 2). Yearly, the wet forests accumulated an AGB of 15.9-ton ha^{-1} and 6.6 species, while the dry forests accumulated 6.3-ton ha^{-1} and 2.3 species. When the secondary forest plots (7-year-old) was compared with neighboring old-growth forests, the 7-year-old wet forests attained on average 59% of AGB and 97% of local species richness, while 7-year-old dry forests attained 39% of AGB and 80% of species richness. The fast recovery (regeneration) capacity, especially in the wet site demonstrates the potential for the use of natural regeneration as a low-cost option for forest landscape restoration.

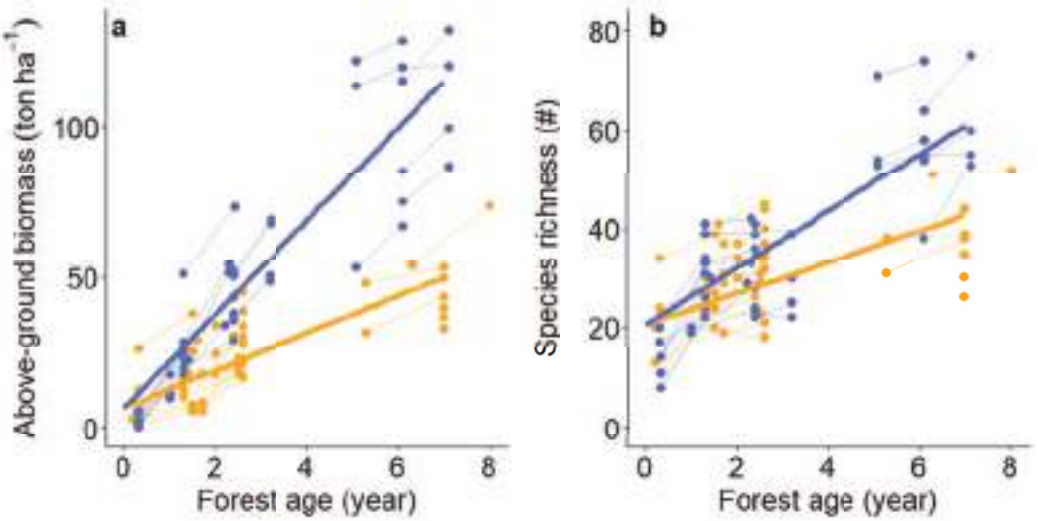


Figure 2: Recovery of a) aboveground biomass, and b) species richness in a 625 m^2 during secondary succession in tropical dry semi-deciduous forest (orange) and wet evergreen forest (blue) in Ghana. Each dot represents a value for each census year and plot. Thick lines indicate regression lines, and thin lines connect the dots of the same plot.

2.8: CONSERVATION OF THE CRITICALLY ENDANGERED *AUBREGRINIA TAIENSIS* TREE IN GHANA.

Research Team: *J.O. Amponsah, D. A. Ofori, J. M. Asomaning, C. Opoku-Kwarteng and P.M. Gakpetor*

Donor: *Botanical Garden Conservation International (BGCI)*

Aubregrinia taiensis, is a critically endangered tree species with very restricted distribution in Ghana and Cote D'Ivoire. CSIR-FORIG has been working collaboratively with partners in both countries since 2019, with the support of BGCI and funding from Foundation Franklinia, to save the tree from the brink of extinction. When the project began, very little was known about the species' distribution, population status, phenology and no conservation actions were in place. Over the past four years, the project has gathered relevant baseline data needed for the long-term conservation of the species. The project team has undertaken extensive population surveys across several forest reserves in Ghana; building a better understanding of main threats, causes of threats and its conservation needs. Further, the project has engaged more than 150 local people from forest fringe communities, where the species have been sighted for conservation awareness creation and alternative livelihood training. These trainings were in Beekeeping and Mushroom cultivation in forest-fringe communities where remnants of the target species have been sited.

The following key successes were achieved during the project: 1). Discovery of 16 new individuals of *A. taiensis* tagged for phenology monitoring, seed collection and *in-situ* protection through extensive field surveys, 2). The development of Habitat Suitability Models for the tree to guide future survey and recovery planting work, 3). Laboratory experiments to improve the success of seed propagation, 4). Improved *in-situ* protection through community engagement, 4). Establishment of the first ex-situ living gene bank of this species, that will act as a future seed source, 5). Seven assisted natural regenerations individuals of *A. taiensis* in Wurobong and Southern Scarp Forest Reserves at Begoro in the Eastern region of Ghana and 6). Awareness creation and alternative livelihood training and certification for 120 local community members in Mushroom cultivation and Beekeping.

Plate 14: Population survey for *A. taiensis* in Worubong,Forest Begoro, Eastern Region

Plate 15: Seedling of *A. taiensis* in the wild target for assisted natural regeneration

Plate 16: Propagation of *A. taiensis* from seeds at the CSIR-FORIG Nursery

Plate 17: Five-year old *A. taiensis* planted in the field genebank at Mpraeso

Plate 18A-B: Conservation awareness creation and alternative livelihood training of 120 forest fringe community members.

2.9: PHENOLOGY AND SEED CONSERVATION IMPROVEMENT OF THE ENDANGERED AFRICAN ROSEWOOD (*PTEROCARPUS ERINACEUS*) IN GHANA

Research Team: *J.O. Amponsah, J. M. Asomaning, E. A Gaveh (KNUST)*

Donor: *International Tropical Timber Organisation (ITTO-Fellowship Programme)*

Rosewood (*Pterocarpus erinaceus*) is a highly valued multipurpose dry forest woody species currently facing over-exploitation within range countries in West Africa. Several harvest/export bans, trade designations and conservation controls have not yielded good results in curbing the problem of illegal exploitation of rosewood. The ever-increasing demand for rosewood timber,

coupled with illegal exploitation and trade, threatens existing stands; as natural regeneration in the species is unlikely to offset the rate of exploitation. Further, existing information on the tree's reproductive phenology, distribution and habitat suitability was rare, scattered and non-existent in some instances; hindering effective field germplasm collection for conservation. Also, seed handling protocols and storage physiology classification to improve germination and storage longevity of rosewood seeds were not clearly established.

The project therefore set out to achieve the following key objectives: (1) characterise the distribution, habitat suitability and the phenology of *P. erinaceus* over a two-year reproductive cycle, across three provenances in Ghana, (2) determine effective physical and chemical pretreatments techniques for improving seed propagation and storage longevity in *P. erinaceus*; (2) model the germination behaviour of seedlots from different provenances in Ghana using the Four-Parameter Hill Function; and (4) classify the seed storage condition of *P. erinaceus* based on Moisture Sorption Isotherms under different temperatures.

The success achieved during the project were: 1). Rosewood phenology monitored and described across three provenances in Ghana namely: Ejura, Mole, and Tumu, 2). Habitat Suitability Maps for the species in Ghana developed through species distribution modelling, 3). Optimum levels of phytohormones to break dormancy and improve seed germination identified, 4). Seed germination behaviour of rosewood seeds across the three provenances modelled using the Four-Parameter Hill Function and 5). Storage physiology of rosewood seeds determined as orthodox based on their Moisture Sorption Isotherm modelling.

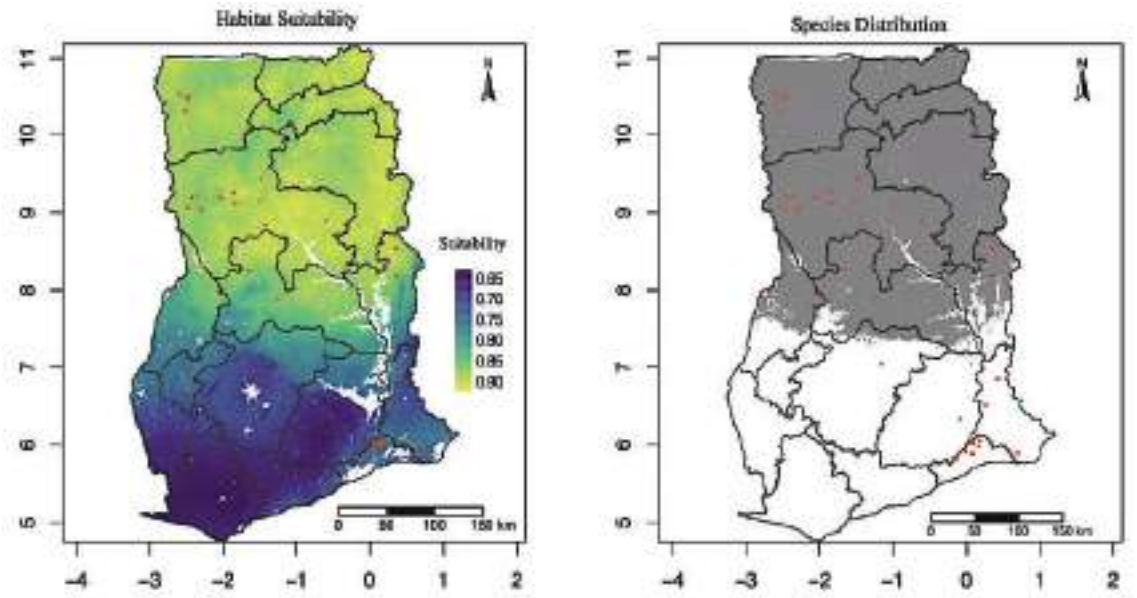


Plate 19: Habitat suitability and species distribution maps of rosewood populations in Ghana

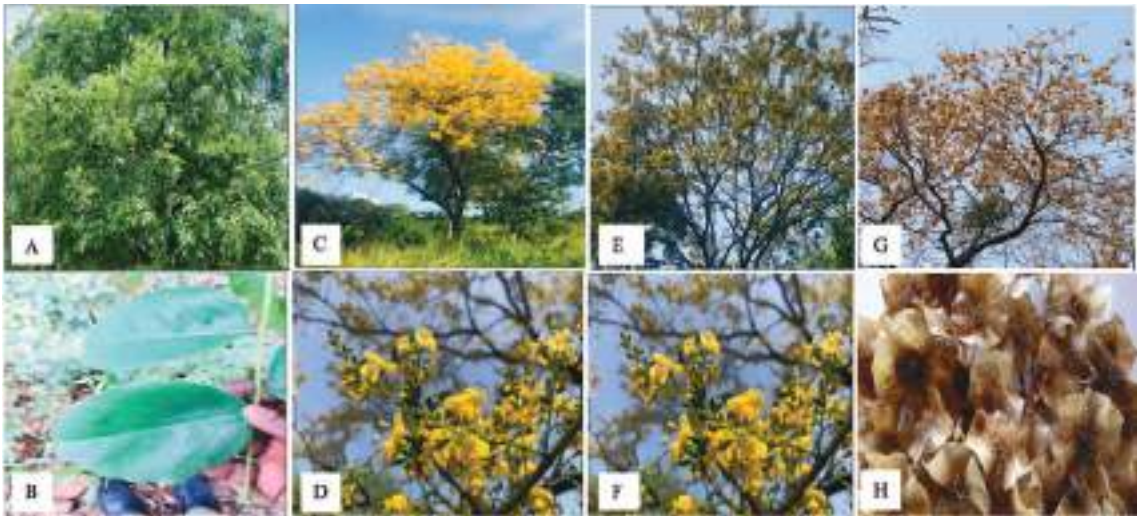


Plate 20 A-H: Photos of the main phenological phases of Rosewood indicating: Leaf flushing (A and B), Flowering (C and D), Fruiting (E and F) and Seed maturity/dispersal (G and H).

Plate 21 A-D: Chemical pretreatments (A), Laboratory rosewood seed germination test (B) and seedling growth and vigour parameters assessment (C and D).

2.10: ENGAGING LOCAL COMMUNITIES TOWARDS SAVING TWO CRITICALLY ENDANGERED TREES IN GHANA.

Research Team: *J.O. Amponsah, J. M. Asomaning, C. Opoku-Kwarteng*
Donor: *Prince Bernhard Nature Fund*

Two important tree species (*Aubregrinia taiensis and Talbotiella gentii*) are currently threatened with extinction from illegal logging and small-scale mining in the high forest zones of Ghana. Lack of information on their current distribution, phenology, successful propagation techniques as well as low awareness amongst forest-fringe local community members are other factors driving the extinction of these trees. The project undertook among other things; botanical survey for the two species to identify remnant populations for *in-situ* mapping and protection, The project further engaged over 300 youths from three forest fringe communities where these trees have been sighted for awareness creation and alternative livelihood venture training. It is envisaged that, building the capacity of youth groups from these communities to identify the target species for *in-situ* protection, whiles gaining skills in alternative livelihood ventures, will reduce incidences of illegal logging and mining, which threaten the future of these trees.

The following key achievements were made: 1). Awareness creation and alternative livelihood training; and certification for 150 local community members in Mushroom cultivation and Beekeeping, 2). A total of 320 local youths were trained and certified in the following local communities; Gambia No:1 near Goaso around the Bia-Tano Forest Reserve in the Ahafo region of Ghana, Feyiase, near Begoro, around the Wurobong Forest Reserve in Eastern Ghana and Hemang, also in the Eastern Region and 3). The capacity of 20 local Forest guards and Farmers were built to identify and protect the two species in-situ.

Plate 22 A-D: Project team engage in local community conservation awareness creation for the target species at Gambia No 1 near Goaso in the Ahafo Region of Ghana on the PBNF Project.

Plate 23: Participants of the Alternative Livelihood Training (Beekeeping and Mushroom cultivation) who received their training certificates.

2.11: COORDINATING AND SUPPORTING THE IMPLEMENTATION OF GHANA'S THREATENED TREES CONSERVATION ACTION PLAN

Project Team: *J. O. Amponsah, E. Opuni-Frimpong, J. Asomaning, P. Mensah, M. Edzesi, P. Gakpetor and S. Britwum.*

Donor: *Foundation Franklinia*

The project is aimed at supporting conservations actions, and ensuring proper coordination between all actors involved in the implementation of the Conservation Action Plan (CAP) for Ghana's threatened trees. The CAP was the key output of a National-Level Stakeholders Workshop on Threatened Tree Conservation held in Ghana in October, 2022. The Workshop was jointly organised by CSIR-FORIG and BGCI with funding from Foundation Franklinia. Specifically, the project seeks to: 1). create a comprehensive and accessible biodiversity information portal for all the 39 priority species identified in the CAP for Ghana's threatened trees over a period of 3 years, 2). undertake botanical surveys for *in-situ* protection, phenology monitoring, and assisted natural regeneration for 20 targeted species selected from the priority list, 3). engage the National Tree Seed Centre (NTSC) at CSIR-FORIG to collect seeds, raise and distribute nearly 400,000 assorted seedlings of the 39 species on the priority list, for restoration planting, and 4). organise annual Stakeholder Workshops to build capacity, track progress, and measure impact of the implementation of Ghana's CAP. Besides increasing species population through the extensive field restoration activities, the project is expected to generate and publish species distribution maps, habitat suitability models and phenology information for all 39 priority species to guide *insi-situ* planting actions. We will develop protocols for improved nursery seedling raising and seed germination for all targeted trees. These actions will no doubt preserve the threatened tree species of Ghana, avoid their extinction and improve their conservation status.

The following key successes was achieved during the project: 1). Successfully bringing together all organisations for a Project Inception Workshop on 14th September 2023 at CSIR-FORIG, to pledge support for the coordination and supportive role of CSIR-FORIG, 2). Designing the framework for the data portal for Ghana's threatened trees; to be known as *Threatened Tree Information System for Ghana* (*TTIS-Gh*), 3). Intensive biodiversity data mobilization for 13 out of the 39 species through intensive field works and 4). Development of habitat suitability maps for 32 out of the 39 species.

Plate 24 A-B: Project Inception Workshop at CSIR-FORIG on 14th September 2023 at CSIR-FORIG

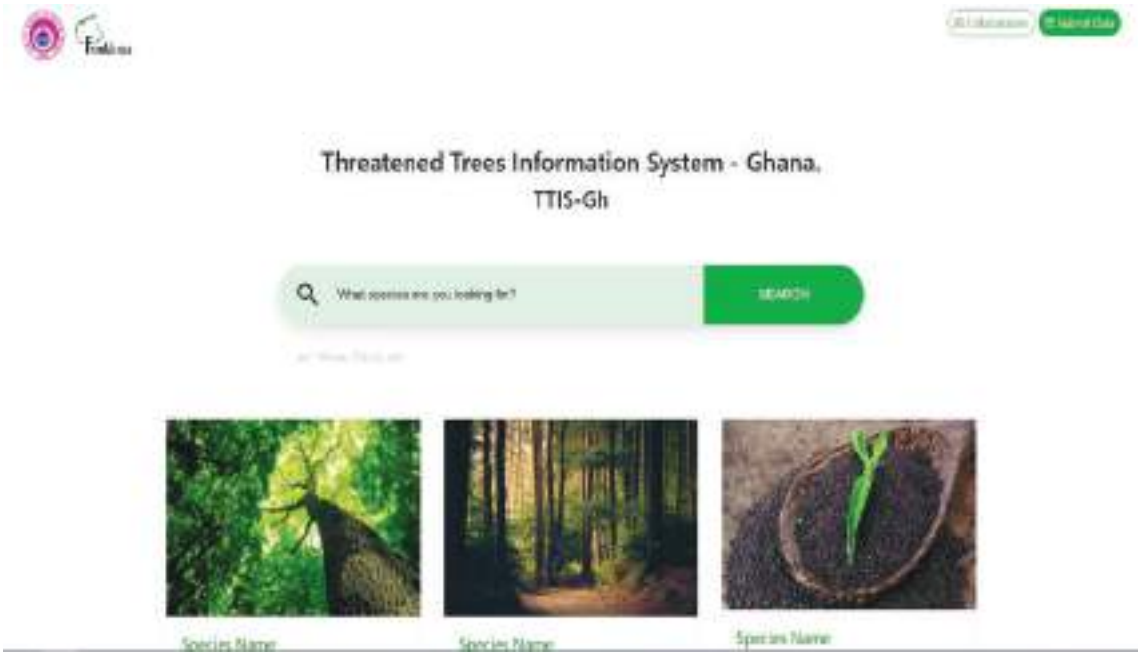


Plate 25: User-interface for the Threatened Tree Information data portal being developed by the Project team

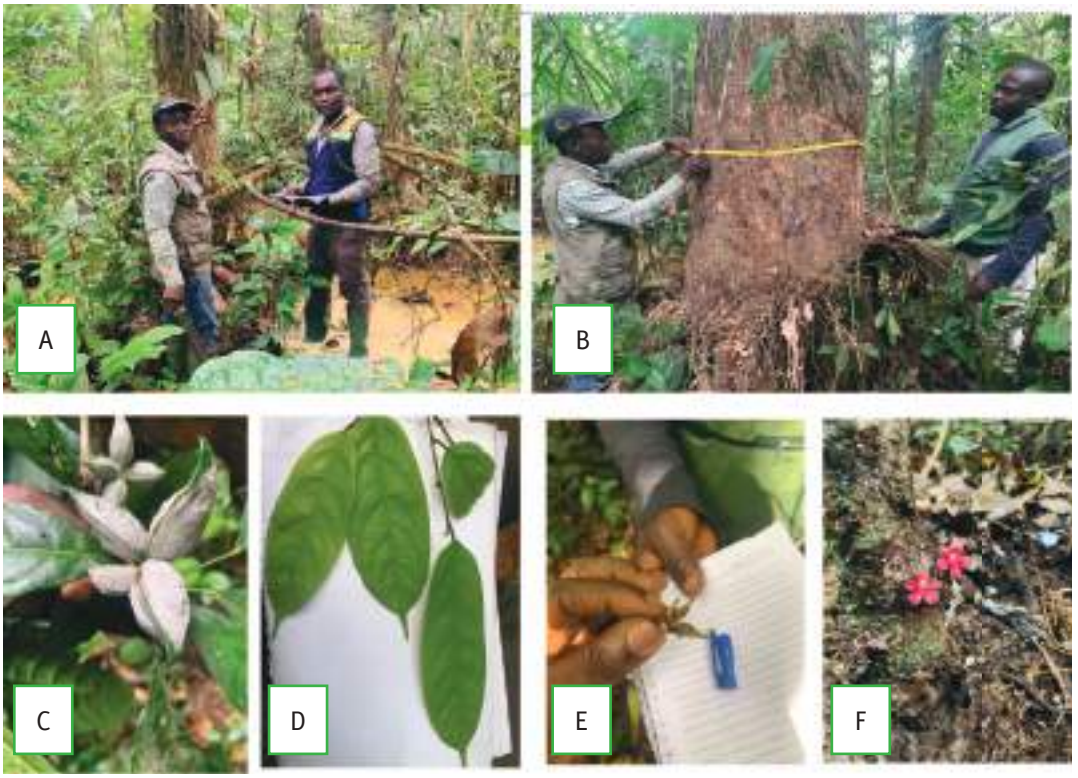


Plate 26 A-F: Field work for propagation material collection and data gathering for the *TTIS-Gh portal*

2.12: SUSTAINABLE INTENSIFICATION OF MIXED FARMING SYSTEMS (IN NORTHERN GHANA)

Project Team: *D. A. Ofori, B. Darko Obiri, J. O Amponsah, J. M. Asomaning and R. Guuroh,*
Donor: *Alliance for Biodiversity CIAT (ABC)*

CSIR-FORIG is implementing the *Sustainable Intensification - Mixed Farming System (SI-MFS)* project in Ghana. The SI-MFS project is an initiative of Alliance of Bioversity International and CIAT, which is a member of the One CGIAR system. The project is expected to contribute to the development of the Diversity for Restoration (D4R) decision support tool in upland farming systems, and to help land users select suitable tree species mixtures and germplasm that meet their land use objectives and site conditions. The study regions consist of Ghana (West-Africa) and Laos (Southeast-Asia).

A sub-grant for CSIR-FORIG in the second year was aimed to support the co-designing of silvopastoral systems jointly with selected local communities within the target Regions in Ghana.

In 2023, CSIR-FORIG was expected to collaborate with ABC and organise series of Training Workshops in Ghana aimed at building the capacities of project partners and other stakeholders. One of such Workshops, which was held from **24-26th April 2023,** was aimed at enhancing the knowledge of trainees on the theoretical aspects behind the D4R decision-making support tool. Additionally, the Workshop was targeted at building the capacities of Forestry and Agroforestry experts in Ghana on spatial distribution modelling of priority trees and their seed sources in

Northern Ghana. Staff of ABC within and outside the country participated in this in-person training workshop. Other participants included staff from CSIR-FORIG, Forestry Commission and other key stakeholders in Ghana.

Specific outputs of the Training Workshop included: (1) the development of species distribution models based on available occurrence records, (2) the modelling of future climatic conditions and their impacts on tree species ranges in the region, (3) identification of species-specific seed zones of the priority trees based on environmental predictor variables. A key highlight of the Training was the validation of Species Distribution models and Habitat Suitability Maps (HSMs) generated from the previous year's survey data by experienced Taxonomist and local experts from CSIR-FORIG.

Plate 27: Workshop Poster on SI-MFS project

Plate 28: Participants at the SI-MFS Workshop at CSIR-FORIG

Plate 29A-B: Two Capacity Building Rural Workshops were organised in the selected communities in Northern Ghana.

Two Capacity Building Rural Workshops were organised as part of implementation in the selected communities in Northern Ghana (Plate 29). The main aim of these Workshops was to build the capacity of rural farmers to develop sustainable silvopastoral systems; selecting suitable tree species mixtures and germplasm that meet their land-use objectives and site conditions. The two targeted communities were Tandan, near Saveleugu in the Northern region of Ghana, and Bussie, near Wa, in the Upper west region of Ghana. Prior to organising the Rural workshops, the farming systems and tree species found on-farms had been characterized by means of an initial large-scale survey through the SI-MFS initiative in the region.

Specifically, these rural workshops helped to open dialogue around the establishment and improvement of silvopastoral systems in the selected communities. It also facilitated the identification of optimal mixes of multipurpose tree species and forages in silvopastoral systems suitable for their local conditions and site characteristics. The main objectives of these workshops were to facilitate the co-designing and establishment of demonstration plots within the selected communities.

3.0 MATERIAL SCIENCE AND MANUFACTURING (MSM)

3.1 BACKGROUND AND HIGHLIGHTS OF RESEARCH ACHIEVEMENTS UNDER MSM

The research themes of CSIR-FORIG helps to improve competitiveness of industry by developing materials which are preferred by Ghanaian industries. During the year under review, the focus of the research was centred on two main programmes, namely;

- Material Science (Wood, Integrated Materials)
- Industrial Products (Bio-Resources)

3:2: WOOD AND FURNITURE TESTING CENTRE AT CSIR-FORIG

***Research Team**: F. W. Owusu, H. Seidu, E. Ebanyenle, J. Korang, F. Boakye, S. Ibrahim, P. Mensah M. Awotwe-Mensah and B. Brentuo.*

***Donor**: SECO / UNIDO*

The Wood and Furniture Testing Centre (WFTC) is a centre that was setup to help improve the quality of wood products on the Ghanaian market. The centre conduct testing on wood, plywood, chairs, tables and others. The centre is ISO/IEC 17025:2017 accredited. This accreditation is very important for businesses that want to export products. The test results from the centre are accepted worldwide.

Several activities took place at the centre during the year 2023, namely 1). Three (3) sectional meetings, consisting of WFTC staff, were held to plan for the testing of plastic chairs supplied by GSA as well as monitoring of the road map on the promotion of WFTC that was drawn during the first quarter and revised in the second quarter and 2) Management Committee meeting was held on 16th October, 2023 to discuss the overview of surveillance assessment, the way forward of the A2LA accreditation renewal as well as appointment of personnel to fill available vacancies for smooth running of WFTC.

Plate 30: Technical Staff of WFTC quietly listening to the auditor during the session

Plate 31: WFTC Certificate of accreditation by A2LA

Plate 32: WFTC technical team after it was announced they had passed the surveillance assessment

Plate 33: A group picture after the successful completion of the surveillance assessment

Five (5) sets of Twenty (20) plastic chairs were received from the Ghana Standards Authority (GSA) to be tested for durability in usage. Plates 34-36 show three of the tests (drop/impact, seat and back static and rear/back stability) that the plastic chairs were subjected to.

Plate 34: Plastic chair under durability test

Plate 35: Plastic chair under drop test

Plate 36: Static bending test on a wood specimen

The Wood and Furniture Testing Center ISO/IEC 17025:2017 was accredited in March 2022. The Surveillance Assessment exercise conducted by A2LA indicated strict compliance to protocls of ISO/IEC 17025.Reac-creditation of WFTC is scheduled to take place next year; hence A2LA has requested for all appropriate documentation. In view of the high charging rates of A2LA, WFTC team has agreed to put the submission of their documents on hold for further discussions. Plastic chairs received from GSA, were subjected to test while the last sets have been completed.

3.3: PREPARATION AND CHARACTERIZATION OF POLYSTYRENE WASTES AND NANO-SAWDUST BIO-COMPOSITE FOR THE MANUFACTURE OF ECO-FURNITURE

Research Team: *J. Korang, B. Y. Antwi, R. Ampadu-Ameyaw, H. Seidu, J. Koranteng and M. Abubakari*

Donor: *Council for Scientific and Industrial Research (CSIR)*

Valorisation of waste is an innovative process of handling waste in urban areas. Large quantities of waste polystyrene and wood are generated annually in Ghana. Developing a value-added product from this urban waste will be economically beneficial to the country. As a result, three (3) Council of Scientific and Industrial Research (CSIR) Institutes are collaborating in inter-disciplinary research to convert polystyrene waste and wood residue into biocomposite material for the manufacture of furniture termed "Eco-furniture".

The research design entails the preparation of Nano wood particle mechanically from wood waste using ball miller at CSIR-Forestry Research Institute of Ghana (CSIR-FORIG). The Nano wood particle is then combined with processed polystyrene waste by the CSIR-Industrial Research Institute (CSIR-IRR) to produce a biocomposite material for furniture manufacture. After the development of the product, CSIR-Science and Technology Policy Research Institute (CSIR-STEPRI) will investigate the sustainability and/acceptability of the product from consumer perspectives.

Several biocomposite of nano-sawdust and polystyrene waste were prepared and characterized. The physical and mechanical properties results indicate the biocomposite with a sawdust and

polystyrene combination of 1:1.3 was the best. The biocomposite had the highest density, lowest water absorption rate, highest tensile strength and the best MOE and MOR.

It can therefore be concluded that, a biocomposite with the ratio of sawdust and polystyrene of 1:1.3 can be used in the manufacturing of furniture. The socioeconomic investigation found that the product is preferred among a sample of carpenters in the Greater Accra region over the conventional chipboards or sawdust plywood they use, because of its durability, water resistance, possibility of increased profit and ease of use.

Plate 36: Production of biocomposite

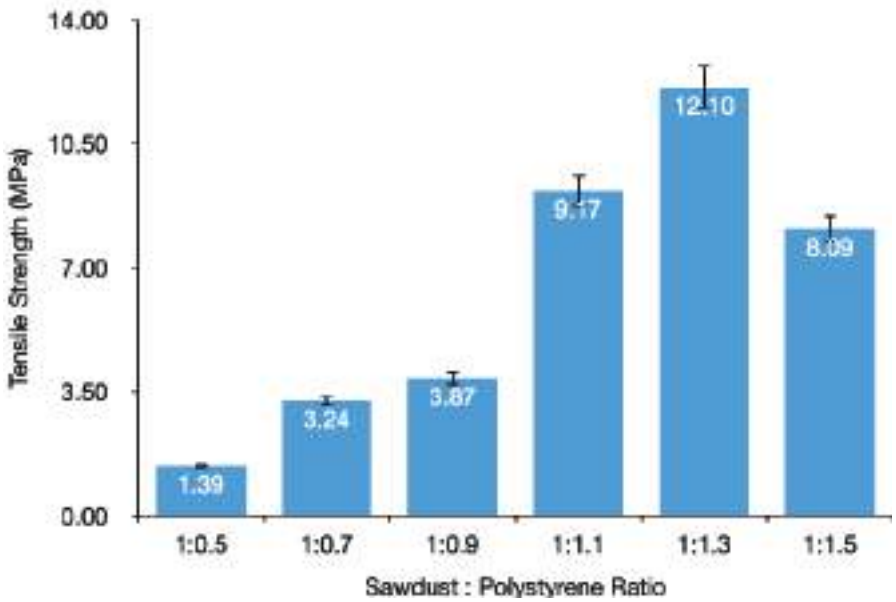


Figure 3: Properties of Sawdust with Tensile Strength

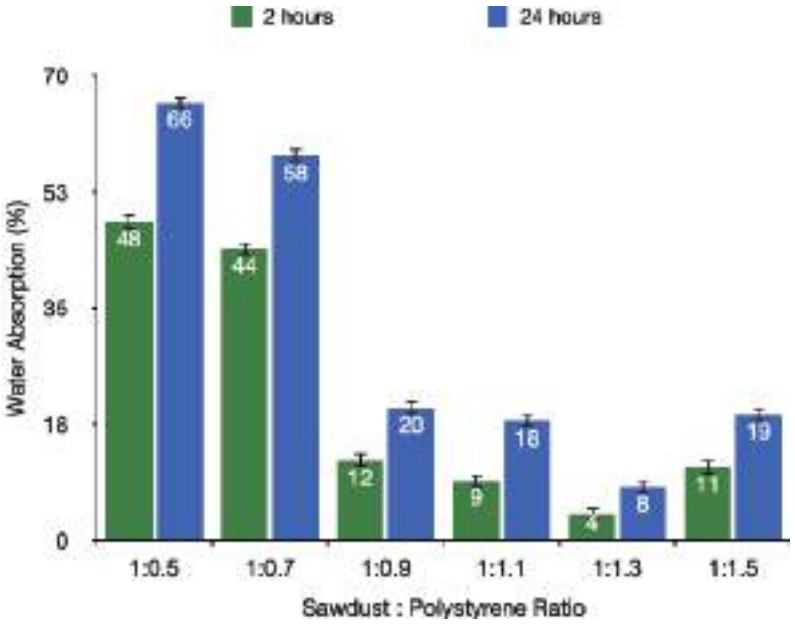


Figure 4: Properties of Sawdust with Water Absorption

3.4: DURABILITY AND RESISTANCE OF ECO-FRIENDLY PARTICLEBOARDS PRODUCED FROM AGROFORESTRY RESIDUES

Research Team: *P. Mensah, J. Govina, J. O. Owusu-Asante, H. Seidu, F. Rodolfo Junior, E. A. de O., Paula, T. D. Pedrosa, and R. R. de. Melo.*

Donor: *CSIR-FORIG*

Biomass materials are resources of the organic, phytochemical, and elemental constitution. The role those chemical constituents of biomaterials play in manufactured particleboards is well recognized. Organic compounds like α-cellulose, hemicellulose, lignin, and extractives have been found to improve the rheological and heat transfer in the matrix during hot pressing, thus ensuring better bonding and mechanical properties of the panel. Among these compounds, lignin can promote rigidity in plant biomass's structure and protect against external biotic elements. Lignin also can influence the degree of aggregation and elasticity of the gel network present in nanocellulose, increasing structural elasticity and improving water release capacity. It is a material capable of thermally deforming during a hot-pressing process of the fibers. Due to its adhesive properties, it can be an alternative to producing low-cost lignocellulosic composites. The major groups of phenolic compounds are simple phenolic acid, flavonoids, coumarins, stilbenes, tannins, and lignin. Literature indicates that these compounds have a high affinity with the o adhesive and greatly contribute to the bonding ability of biomass materials. Various types of phytochemicals such as tannin, alkaloid, saponin, flavonoid, glycoside, phenol, and sterol have been found to contribute to the durability, physical and mechanical properties of the manufactured particleboards.

The identification and characterization of active chemicals in agroforest residues are essential for integration and utilization. Efficiently, the scientific and beneficial use of such agroforest waste in particleboard manufacturing by industries has been acknowledged. Several studies

on the mechanical and physical properties of manufactured particleboards indicate that these properties are improved by biomass materials with high quantities of phenolic compounds. The authors also emphasized that these compounds are largely responsible for forming solid bridge bonds during the pressing of the particleboards. The use of adhesive, additives and the chemical constituents of individual biomass material in the manufacture of the particleboards predicts that various chemical reactions could occur.

The development of this research will bring significant contributions to the industries producing particleboard panels, as it presents characteristics and properties of low-cost agroforestry residues, which can be used as a renewable raw material in making eco-friendly panels. In this context, the present study aims to determine the organic, chemical, and elemental properties of residues from the pseudostem of *Musa paradisiaca*, the stem and pods of *Theobroma cacao*, and the sawdust of *Ceiba pentandra* and characterized particleboard produced from these cellulosic residues together with the natural adhesive from cassava starch and the synthetic glue from urea formaldehyde.

Plate 37A-D: Materials collected for production and characterization of particulate panels. *Musa paradisiaca* pseudostem (a); *Theobroma cacao* stems (b); *Theobroma cacao* pods (c); *Ceiba pentandra* wood (d).

Plate 38A-D: Powdered specimens of the biomass materials for organic composition and phytochemical test. *Ceiba pentandra* sawdust (a); particles of the *Musa paradisiaca* pseudostem (b); particles of *Theobroma cacao* stems (c); particles from *Theobroma cacao* pods (d).

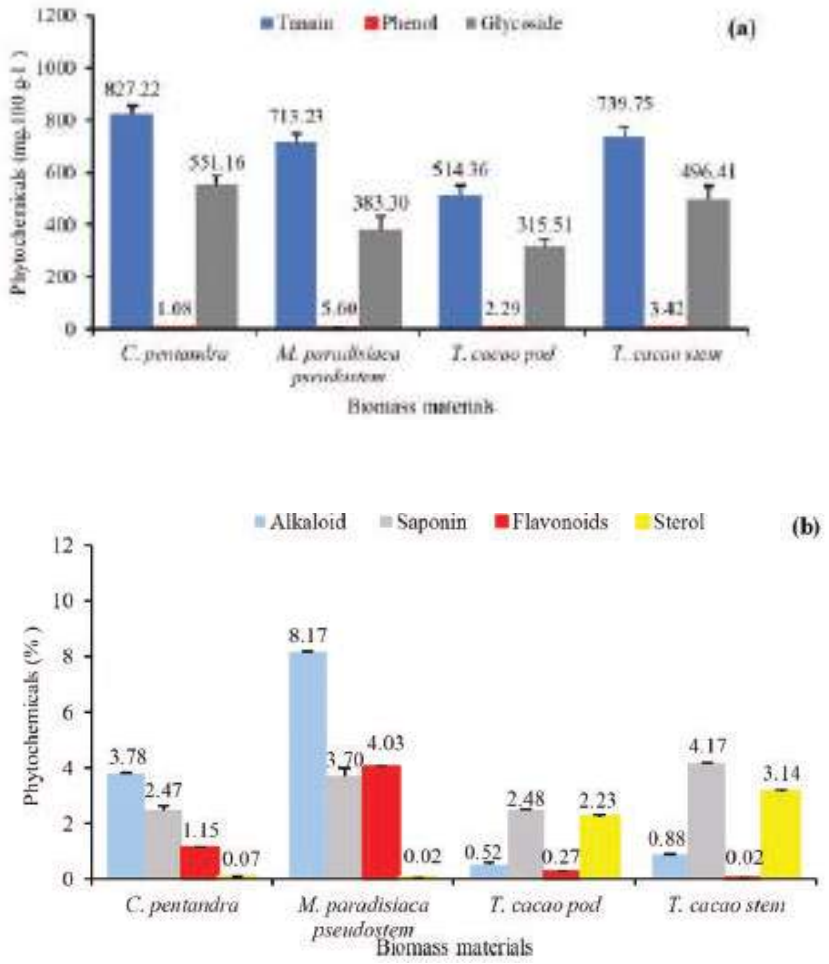


Figure 5A-B: Quantitative phytochemicals in the test specimens. Tannin, phenol, and glycoside (a); Alkaloid, saponin, flavonoids and sterol (b).

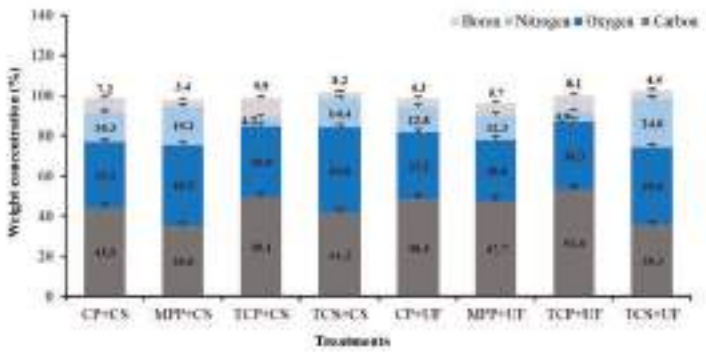


Figure 6: Percentage of elementary constituents in manufactured particleboards. CP = *Ceiba pentandra*; MPP = *Musa paradisiaca* pseudostem; TCP = *Theobroma cacao* pod; TCS = *Theobroma cacao* stem; CS = Cassava starch; UF = Urea-formaldehyde.

It is expedient to appreciate that the selected agroforestry residues contain essential organics, chemicals, and elementals that contribute mainly to the durability and resistance of the particleboards. The ability of these biomass materials to contribute to the improvement of

various properties of the manufactured particleboards in this study may be attributed to the various active chemical components present in them, which, due to individual or synergistic action, exhibit these characteristics. Hence, these research results have established that they have potential in industries, particularly for particleboard production.

This work can serve as fundamental scientific information for using these agroforestry residues in producing particleboards. Aimed at improving the properties and new applications for particleboards, future studies to characterize other physical, mechanical, and thermal properties will be conducted.

3.5: TECHNOLOGICAL PROPERTIES OF MEMECYLON LATERIFLORUM WOOD: A TIMBER SPECIES FROM GHANA

Research Team: *P. Mensah, E. Ohemeng, R. R. Melo, E. Ebanyenle, F. W. Owusu, H. Seidu, and S. J Mitchual.*

Donor: *CSIR-FORIG*

An essential part of Sustainable Forest Management schemes is to promote lesser-known timber species (LKS) and lesser-used timber species (LUS) in the timber market. Notably, as certain timber species are becoming scarce and extinct (such as teak, Odum, and mahogany, especially when certified), buyers are increasingly open to substituting them with so-called "lesser-known timber species" that have similar characteristics but are not yet commonly known in the international timber market. If their characteristics are accurately communicated, this situation can represent an opportunity for exporters. However, if technical information does not exist, testing is required to obtain applicability. This procedure, however, is often not feasible for small-scale exporters due to the expensive technological requirements.

The daunting task for the timber industry is maximizing the resource base by utilizing LKS and LUS for several applications. There is inadequate technical information on the technological characteristics of native Ghanaian tropical species such as *Memecylon lateriflorum* (locally known as 'Otwese'), thereby limiting their end-use applicability and their processing efficiency. This species under study is of unknown commercial importance due to its inadequate technical information. However, it has a promising feature as a potential substitute for some of the endangered, well-known, and well-established timber species. A study on properties of *Milletia oblata*, a lesser known and utilized timber species, has found it to be comparable to *Milicia excelsa*, *Pterocarpus angolensis*, and *Ocatea usambarensis* to the extent of recommending some of their uses to be replaced by these species. Several other species have also been studied and recommended, such as *Uapaca kirkiana*, *Brachystegia bussei* and *Berchemia discolor*, *Trichilia ametica* and *Pterocarpus stolzi*. However, the limited use of the potential LKS and LUS is caused by the scarcity and inaccessibility of technological information with regard to the properties for utilization.

Memecylon lateriflorum belongs to the Melastomataceae family. *Memecylon* taxa have been reported from montane forests, tropical lowland forests, grasslands, tropical rainforests with low to high rainfall, rocky mountain regions, and regions with low to high temperatures and considerable overlap between ranges of different taxa. In Ghana, *Memecylon* spp is mainly found in the primary forest. There are about eight (8) different identified species of *Memecylon*

distributed in Ghana. Among them is *M. lateriflorum,* which is found abundantly in the Wet and Moist Evergreen zone and sparsely found in Moist semi-deciduous forest zones. The International Union cites for Conservation of Nature and Natural Resources has a lower risk of most minor conservation concerns and no information on the wood trade. Hence, since there is no or less technological information on the physical and mechanical properties of *M. lateriflorum,* it is imperative to evaluate these properties and make comparison with other highly known and overutilized timber species to assess how best the use of Otwesecould be a substitute.

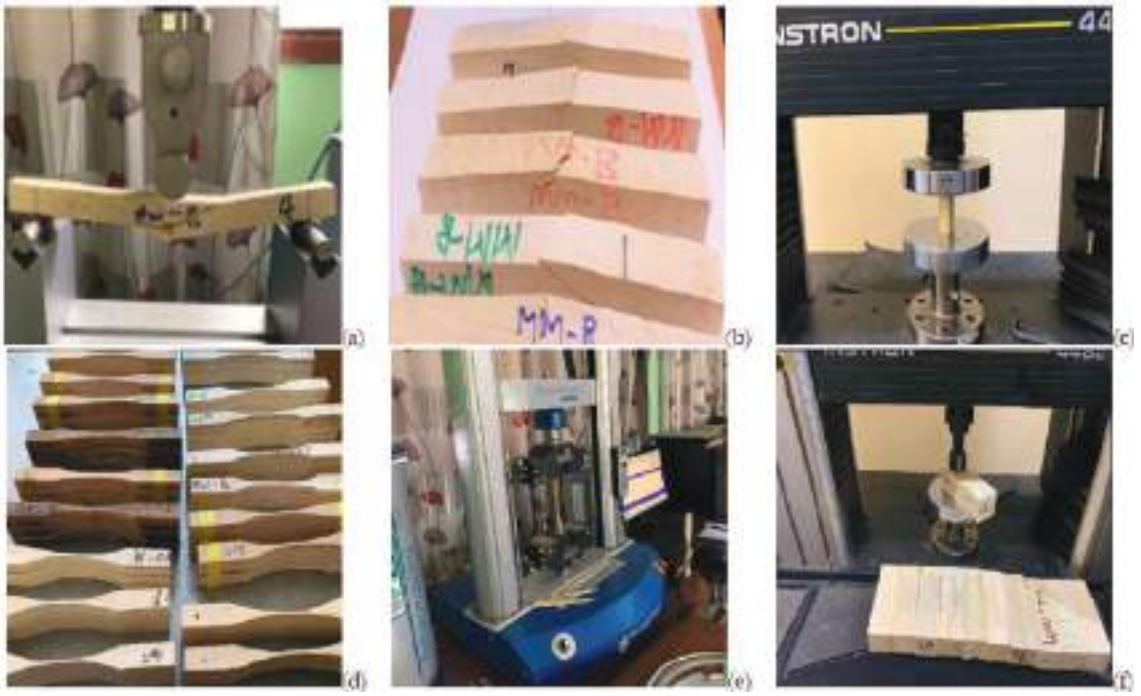


Plate 39A-F: Mechanical properties assay: static bending (a) and specimens after test (b); determination of compressive strength parallel to the grain (c); specimen used for tensile strength parallel to the grain tests according to standard (d) and tensile strength test (e); Janka indentation tests (f).

Correlated properties	Den	MoR	MoE	fv0	fc0	ft0	Hr	Ht
Density	1							
MoR	0.89	1						
MoE	0.92	0.99	1					
Shear	0.89	0.94	0.95	1				
Compression parallel to the grain	0.94	0.96	0.99	0.94	1			
Tensile parallel to the grain	0.89	0.98	0.99	0.98	0.98	1		
Radial hardness	0.93	0.96	0.96	0.94	0.95	0.95	1	
Tangential hardness	0.75	0.86	0.86	0.96	0.82	0.91	0.88	1

Table 5: Correlation between density and strength properties at 12 % moisture content for *M. lateriflorum*

Notes: Den = Density; MoR = Modulus of rupture; MoE = Modulus of elasticity; fvo = shear parallel to grain; fco = Compression parallel to grain; fto = Tensile parallel to grain; Hr = Radial hardness; Ht = Tangential hardness.

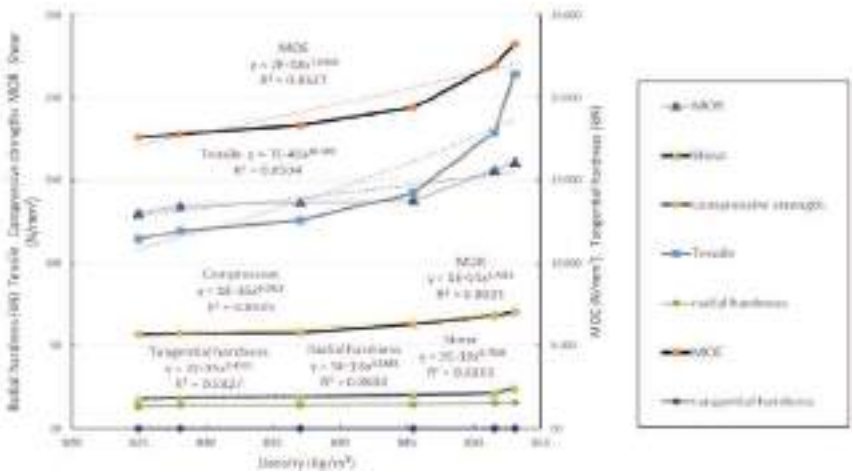


Figure 7: Functional relationship between density and mechanical strength properties at 12 % moisture content for M. lateriflorum.

The study has evaluated some physical and mechanical properties of Memecylon lateriflorum wood at 12% moisture content, which is a lesser-known (LKS) and lesser-used (LUS) tropical timber species originating from two unique ecological zones in Ghana, mainly Wet Evergreen and Moist semi-deciduous regions. M. lateriflorum recorded high density and strength values. The wood can be promoted for use in constructional applications (roof trusses, columns, posts, and as notched timber), bridges, railway sleepers, exterior furniture, flooring, joinery applications, or for other several engineering applications such as glue-laminated timber (Glulam) and cross-laminated timber (CLT). Due to its physical and mechanical properties, it could be promoted for use in ship and boat building, wagon trays, sea defense and dock works, mining timber, and other agricultural implements.

4.0 SCIENCE AND PEOPLE(SP)

4.1 BACKGROUND AND HIGHLIGHTS OF RESEARCH ACHIEVEMENTS UNDER SP

This Research activity aimed at aligning science with the development priorities of local communities, government and development partners by focusing on the socio-economic and sustainable resource management and utilisation as well as stress on the services that forests provide to society. In this regard, the research agenda is primarily focused on the following thematic areas:

- Policy and Governance
- Statistical, Social and Economic Research
- Culture, Indigenous Knowledge and Community Improvement
- Technology for Livelihoods and Wealth Creation

4.2: CREATING AWARENESS AMONG BASIC SCHOOLS ON CLIMATE CHANGE SENSITIZATION & OUTREACH PROGRAMMES

Research Team: *G. D. Djagbletey; E. G. Foli; A. Duah-Gyamfi; S. D. Addo-Danso; G. K. D. Ametsitsi; R. T. Guuroh; J. O. Amponsah; D. A. Opoku; J. J. Twintoh; E. Okyere-Agyapong; C. Opoku-Kwarteng; A. Adu-Gyamfi; A. A. Brako; J. Odei Owusu–Asante; P.M. Gakpetor; M. Gati; E. Minkah, M.E. Nikoi and J. Ebo-Nadel.*

Donor: *CSIR-FORIG*

Climate change poses serious threats to children's health, education, safety, and well-being and future prospects. Children are especially vulnerable because of their developing bodies, depending on adults and spend more time outdoors. To address these concerns, it has become important to step up efforts in awareness creation, education and information sharing on climate change, so as to reach out to as many people as practicable (especially, children and young people) who are the next generation and likely to suffer grave consequences if actions are not taken quickly. This program will instil a sense of responsibility and understanding in these children in the area of climate change and environmental protection.

For that reason, the Forest and Climate Change Division of the CSIR-Forestry Research Institute of Ghana formed a Schools' Outreach Team (a cross-divisional Team), with the slogan *'Plant a tree today, Save a life tomorrow'*.

The activities of the Team fall within the framework of the Education for Sustainable Development (ESD) programme, instituted by the United Nations Educational, Scientific and Cultural Organization (UNESCO), among others, to improve access to high quality education on sustainable development (about climate change and biodiversity) at all levels. It is anticipated that the ESD will transform society by reorienting education and helping people develop knowledge, skills, values and behaviours needed for sustainable development.

Furthermore, the CSIR-FORIG Schools' Outreach Programme addresses six (out of the 17) Sustainable Development Goals (SDGs) directly. These include climate action (SDG 13), life on land (SDG 15), clean water and sanitation (SDG 6), affordable and clean energy (SDG 7), good health and wellbeing (SDG 3), sustainable cities and communities (SDG 11).

The main aim is to sensitize basic school children on climate change and environment and embark on a countrywide school climate change and environmental sensitization campaign starting with schools within the Ejisu and Juabeng Municipal Assemblies. Additionally, the programme aims at enhancing the visibility of CSIR-FORIG locally, nationally and beyond.

SOP focussed on distribution of books on climate change to two schools that had already benefitted from this programme and hosting our first Senior High School (SHS) students.

The SOP team received books "AFRICA Our Home" from the Pan African Conservation Education Project from a partner. These books were distributed to the schools that were visited as part of the climate change campaign. Fumesua Model Anglican JHS and the Fumesua MA Primary and JHS were the 3rd and 4th schools that benefitted from the programme in **2021**. These schools received copies of the books during the year under review.

Also, Agriculture students from Paakoso SHS were hosted at FORIG as part of the campaign. This was the first SHS group to benefit from the programme. Twenty-nine students were hosted at CCST for classroom session. The group then, visited the FORIG Nursery and National Tree Seed Centre (NTSC) as part of the schools' outreach programme. They were taken through the various activities at the nursery and NTSC. These hands-on experiences made it possible for students to deepen their understanding and practical skills based on the classroom lecture they had received.

Plate 40A-B: Presentation of books to Fumesua Model Anglican and Fumesua MA Primary

Plates 41A-B: Students of Paakoso SHS during the classroom lecture and visit to NTSC

5.0 COMMERCIALISATION

5.1: CSIR-FORIG (COMMERCIALISATION DIVISION)

Research Team: *N. Appiah; A. A. Obeng and K. Asumadu*
Donor: *CSIR-FORIG*

The focus of the Commercialization Division, since its inception is to drive business activities of CSIR-FORIG, spearhead, coordinate, provide and implement clear cut strategies for commercially viable activities for the socio-economic well-being of all stakeholders. The 2023 marketing objectives of targeting new customers and growing digital presence of commercial products and services focused on increasing awareness / visibility of all commercial entities. Digital marketing tools via the Institute's website, e-info sheets, flyers, social media platforms and text messages were extensively explored to increase awareness. The Marketing and Training Teams made presentations at the "Church of Jesus Christ of Latter-Day Saints" and "Asawase Presbyterian Church" with the rationale of encouraging religious bodies to build the capacity of members. The following outputs was achieved by the commercialisation division: 1). Over 500 e-flyers and 100 posters; including hard copies about training workshops were designed, printed, aired, distributed and or shared on social media platforms, 2). Market development growth strategy was pursued with the introduction of prekese syrup, honey and training sessions in selectedvirgin regions and districts of the country, 3). The Marketing Team extensively engaged both existing and potential customers through the use of the Institute's website, whatsapp platforms, facebook, instagram and twitter accounts, 4). Media engagements as part of public relation activities resulted in a number of news headlines such as: a).TV3 featured a documentary on the Bobiri Butterfly Sanctuary, b). TV3, GTV, UTV, Myjoyonline, Ghanaian Times and Daily Graphic did a mass coverage of the International Bee Day Celebration hosted by CSIR-FORIG and c). GTV, TV3, UTV, Myjoyonline, Daily Graphic and Ghanaian Times made an excellent reportage regarding MAG sponsored CSIR-FORIG snail farming and beekeeping training sessions at Koforidua and Yenku Research Station. Two resource persons, Prof. Paul Bosu and Mrs. Naomi Appiah during separate interviews threw more light on how vibrant and commercially viable the beekeeping industry is; emphasizing that honey consumption permeates all religious, social, political and ethnic backgrounds.

Plate 42A-D: Selected promotional tools such as prekese information sheets, flyers; and presentations to create awareness of commercial products and services.

In terms of capacity building, the following were also achieved by the commercialisation division: 1). The Food and Drugs Authority (FDA) finally approved the certification of CSIR Honey with the number: **FDA No: S_g 23-048**, 2). Upgrading of guesthouse facilities of the Institute started in phases during the year under review. The Annex 1 guesthouse was completely renovated to remain competitive and customer friendly. Maintenance included correction of rising damp, roof leakage, purchase of air conditioner and furniture for the reception, kitchen cabinet, curtains, bed sheets water heater and painting, among others, 3). Mr. Bernard Oppong; a proud 2019 CSIR-FORIG trained snail farmer was recognized for his outstanding contribution in the Asuokor District of the Eastern Region as "**Special Commodity Awardee – Snail Farmer**" during the 2023 National Farmers' Day Celebration.

In all, a total of **1,043** trainees were empowered to be self-sustaining in three commercially viable technologies namely; 561 trained in Snail farming, 185 trained in Beekeeping for Honey Production, 8 trained in Nursery and Plantation Establishment and297 trained in Mushroom Cultivation.

Plate 43A-C: Mushroom Cultivation and Snail Farming Training Sessions in the Ashanti and Eastern Regions; coupled with post training visitation to a Mushroom Farmer.

5.2: MEDIA ENGAGEMENTS

Research Team: *G. K. Amoshie, E. Minkah, E. Frans-Mensah, E. Sarpong, M. E. Nikoi; E. M. K. Sosu and D. Ofori Oppong.*

Donor*: CSIR-FORIG*

CSIR-FORIG engaged in media outreach through various platforms, including newspapers, websites, and radio and television stations. A total of twenty (20) major publications or articles were featured in prominent media outlets such as: The Ghanaian Times Newspaper and Website, Ghana Report Website, Anyazia.com, The Chronicle Newspaper and Website, Citi Newsroom Online, Citi TV, Citi FM, Peace FM and UTV.

These media engagements allowed CSIR-FORIG to disseminate information, research findings, and updates to a wide audience across Ghana. Through these channels, the institute communicated its initiatives, achievements, and contributions to the forestry and research sectors, enhancing its visibility and impact within the country.

Table 6: Summary of CSIR-FORIG Media Engagements in 2023

No.	Date	Media House	Title of Publication	Source
1.	26th April, 2023	Ghanaian Times News Paper	Effects of illegal mining on forests: Native tree species in danger …faces extinction due to destruction of natural regeneration	Ghanaian Times News Paper
2.	27th April, 2023	Citi FM	Farmers urged to adopt the Mixed farming method.	Citi FM
3.	29th April, 2023	UTV	Need for Mixed farming	UTV
4.	3rd June 2023	Ghana Report online	CSIR's Magic with Trees	https://www.theghanareport.com/csirs-magic-with-trees/

No.	Date	Media House	Title of Publication	Source
5.	5th June, 2023	Ghana Report online	Talbotiella Gentii: The Plant Native to Only Ghana Missing	https://www.theghanareport.com/talbotiella-gentii-the-plant-only-native-to-ghana
6.	6th June, 2023	Ghanaian Times	Trouble looms as Mahogany seeds shortage hits Ghana… unable to export due to galamsey, loses millions of cedis	Newspaper
7.	7th June, 2023	Ghana Report online	Africa's 1st Canopy Tower in Ghana	https://www.theghanareport.com/africas-1st-canopy-tower-in-ghana
8.	11th June, 2023	Citi Newsroom online	Embrace nature-based solutions to restore degraded lands – CSIR	https://citinewsroom.com/2023/06/embrace-nature-based-solutions-to-restore-degraded-lands-csir/
9.	1st July, 2023	Ghana Report online	CSIR-FORIG proposes agricultural intensification	https://www.theghanareport.com/csir-forig-proposes-agricultural-intensification
10.	15th September, 2023	The Chronicle Newspaper	CSIR-FORIG calls for partnership with gov't to conserve threatened tree spices	The Chronicle Newspaper
11.	15th September, 2023	Ghanaian Times	Threats to biodiversity affecting the livelihoods of over 6 million Ghanaians	Ghanaian Newspaper
12.	26th September, 2023	Citi Newsroom online	CSIR emphasises the need to safeguard 40 tree species at risk of extinction	https://citinewsroom.com/2023/09/csir-emphasizes-need-to-safeguard-40-tree-species-at-risk-of-extinction/#:~:text=CSIR-,emphasizes,-need%20to%20safeguard
13.	26th November, 2023	Citi Tv	Timber resources/ CSIR- FORIG on Pests and illegal logging	Citi TV/ Facebook live
14.	30th November, 2023	Anyazia.com	Prioritise-landscapes-ecosystems-management-prof-Ofori	https://anyazia.com/prioritise-landscapes-ecosystems-management-prof-ofori/

As part of our efforts to engage the general public in CSIR-FORIG's activities, social media platforms were extensively utilized. We updated our social media handles across various platforms: Facebook: @ CSIR-Forestry Research Institute of Ghana, Twitter: @csirforig (formerly known as X), LinkedIn: CSIR - Forestry Research Institute of Ghana and Flickr: CSIR – FORIG

Through these channels, updates, research findings, events, and other relevant information were shared to connect with the Institute's audience and increase awareness about forestry research and development work.


CSIR-Forestry Research Institute of Ghana

WTTC SURVEILLANCE ASSESSMENT

Accreditation and Purpose

In March, 2022, the CSIR-FORIG Wood and Furniture Testing Center achieved ISO/IEC 17025:2017 accreditation as a furniture laboratory. This significant milestone was made possible through sponsorship by the Swiss government via the State Secretariat for Economic Affairs (SECO), in collaboration with the United Nations Industrial Development Organization (UNIDO).

The Wood and Furniture Testing Centre (WTTC) stands as a pioneering institution in the West African sub-region and the third of its kind in Africa, following establishments in Egypt and South Africa. This centre plays a pivotal role in promoting trade facilitation and supports the government's principal objective of industrialization across all sectors. Notably, it ensures that both Ghanaian and imported wood and furniture products conform to the necessary trade standards, thereby safeguarding consumer interests.

Mission and Significance

The WTTC was established with a core mission: enabling entrepreneurs in the wood industry to perform tests that evaluate the strength of materials used in wood product manufacturing. These tests encompass the assessment of bonding quality in plywood and the evaluation of durability, stability, and strength in tables and chairs. The results from these

5.3: COLLOQUIA PRESENTATIONS

Research Team: *E. Minkah; G. K. Amoshie, Frans-Mensah, M.E. Nikoi; E., D. Ofori Oppong and E. Sarpong.*

Donor: *CSIR-FORIG*

Colloquium is an academic activity that deals with current, cutting-edge concerns through preparatory study and ensures that all research activities carried out by research scientists are of high standards.

This platform provides an excellent opportunity for scientists, collaborators and other stakeholders to fully engage on various research topics.

Duringthe year 2023, seventeen (17) presentations were delivered by visiting Professors, Research Scientists and Assistant Research Scientists of the Institute. The exercise was to ensure delivery of the institute's mandate.

Plate 44A-B: Colloquium Presentation at CSIR-FORIG

Table 7: 2023 Colloquia Schedule

	Name	Date	Topic
1.	Lucy Amissah	01/02/2023	Pantrop Team
2.	Bright Kankam & James Korang	09/02/2023	Leaf selection by *Colobus vellerosus*: Comparing nutritional content of small and large food plants at Boabeng-Fiema Monkey Sanctuary, Ghana.
3.	CCST	16/02/2023	Students MSc Proposal
4.	Jonathan Dabo	10/03/2023	Plant and Fungal Taxonomy Diversity and Conservation Study
5.	Thomas Meerwijk	15/03/2023	Litter in secondary forests in Ghana

6.	Bas de Wit		Early secondary succession of forests in Ghana: The effects of landscape and climate on functional trait composition
7.	Stella Britwum Acquah	30/03/2023	Changes in size inequality and growth dominance in thinned and unthinned uneven-aged interior Douglas-fir dominated stands
8.	Michael Awotwe-Mensah	20/04/2023	Assessment of Anatomical Features of Juvenile and Matured *Bambusa vulgaris* Internodes and its Effect on Culm Utilisation for Structural Applications
9.	Lucas Chojnacki	01/06/2023	How does tree diversity determine the recovery of young tropical wet forests
10.	Tijs Kuzee	01/06/2023	Recovery of ecosystem functioning in early-successional secondary Ghanaian forests
11.	William Hagan-Brown	08/06/2023	Forest canopy temperature monitoring using thermal infrared cameras
12.	Lordson Richard Kyeremah	13/07/2023	The Role of the Auditor, Yesterday, Today and Tomorrow
13.	Maureen Nieuwschepen	10/08/2023	Water use strategies of pioneer species in a dry secondary tropical forest in Ghana
14.	Lhouyangdar Khulpu	10/08/2023	Drivers of ecosystem processes in young recovering forests after agricultural abandonment
15.	Mr. Francis Asare	16/08/2023	Assessment of innovative kilns technologies for promotion and sustainable biochar production towards agro-industrial applications in Ghana
16.	Mrs. Hamdia Mahama Wumbeidow	30/11/2023	Small mammal attributes and plant diversity responses to silvicultural interventions in moist-tropical forest of Ghana
17.	Ms. Jacqueline Twintoh	7/12/2023	Assessing the potential of multipurpose trees to improve soil health and carbon credit in degraded lands; A case study in Bandai Forest Reserve in Asante Akyem Agogo

6.0 EDUCATION AND CAPACITY BUILDING

6.1: PROMOTING EDUCATIONAL LEADERSHIP IN CLIMATE SCIENCE AND INTEGRATED NATURAL RESOURCES MANAGEMENT AT MASTER OF PHILOSOPHY AND MASTER OF SCIENCE LEVELS

The MPhil./MSc. (Climate Change and Integrated Natural Resources Management) degree programme is specifically designed to cater for the needs of experienced managers, planners, policy makers, prospective scientists/lecturers and students who wish to enhance and develop research/teaching skills and competences in integrated natural resources management. consistent with current and emerging needs in the climate change arena. The focus is to offer both experienced and less experienced students the opportunity to obtain an elevated level practical-oriented training in multi-scale and multi-disciplinary approaches to planning, research, and teaching.The practical-oriented teaching and learning methods develop employability and entrepreneurship as well as equip learners to think and act creatively both in industry, research and teaching.

The College's 2022/2023 academic year re-opened for the second semester on January 9, 2023. A nine (9) member Ghana Tertiary Education Commission (GTEC) Campus Visitation Committee (CVC) team paid a visit to the Kumasi campus on 27th June 2023. The purpose of the visit was to ascertain whether actions proposed by the College in response to the queries in the physical facilities inspection reports were implemented. This was done through inspection exercise of physical facilities and library by a team from the GTEC. The meeting was attended by the President of the College, supported by the Registrar, College Administrator, College Finance Officer, the Dean of the Faculty of Natural Sciences and Environmental Management, Kumasi Campus Library staff, Heads of Division of the three Kumasi Campus Programmes and their respective administrators and other staff.

Plate 45: Cross-section of the 9-member GTEC Campus Visitation Committee team at the meeting.

Plate 46: L - R Head of Department (Climate Change Programme), Dean (Faculty of Natural Sciences and Environmental Management), and the College President at the meeting.

The 2023/2024 academic year began on 2nd May with a matriculation and orientation programme for eight (8) new freshers comprising six (6) M.Phil and two (2) M.Sc students representing the May 2023 cohort. Registration of freshers and continuing students was conducted from 3rd to 5th May, and lectures for the semester began on 8th May 2023. Library orientation was conducted for the new students on 12th May.

Fourteen (14) fresh students were enrolled on the programme for the September 2023 intake comprising eleven (11) M.Phil and three (3) M.Sc students. Only one female candidate was admitted on this cohort. The 7th viva voce for 5 MPhil students was held on 7th November 2023. The *viva voce* session was chaired by the Vice President Rev. Prof. Dr. Hans Adu-Dapaah, supported by Dr. Ernest Foli (Head of Department), Prof. Ernest Okorley (UCC Cognate representative), Dr. Kwame Antwi-Oduro (Thesis Coordinator) and Mr. Osei-Tutu Boateng (Recorder). All the candidates passed the oral examination successfully.

Plate 47: One of the students defending his thesis at the *viva voce*

The College held its 3rd Academic Board meeting virtually via the Google Meeting platform on 23rd November 2023. The second semester of the 2023/2024 academic year ended successfully on 22nd December 2023.

7.0 ADMINISTRATION DIVISION

7.1 OBJECTIVES

The main objectives of the Division include the following:

1. To ensure implementation of policies, procedures, rules and regulations of Corporate CSIR at the Institute level to facilitate effective and efficient performance of work by all Divisions.
2. To provide administrative machinery for the implementation of institutional initiatives and activities.

7.2 STAFF STRENGTH

The total staff strength of the Institute, as of December 2023 was 198. The breakdown is as follows:

Table 8: **Breakdown of Staff Strength**

Staff category	Total Number	Gender	
		Male	Female
Senior Members	59	42	17
Senior Staff	59	40	19
Junior Staff	76	65	11
Contract Staff	4	3	1
TOTAL	198		

7.3 APPOINTMENTS

Prof. Emmanuel Opuni-Frimpong, a Principal Research Scientist was appointed as the new Deputy Director of the Institute with effect from 1st October, 2023. He took over from Dr. (Mrs.) Beatrices Darko-Obiri who ended her 2- year tenure.

7.4 INTERNAL TRANSFERS

The under-listed members of staff were transferred within CSIR-FORIG:

Table 9: **2023 Internal Transfers**

Name	Grade	Division/ Section	New Division/ Sec.	Date
Mr. Osei-Tutu Boateng	Administrative Officer	Accra Guest House	Administration Division	10th January, 2023
Mr. Markfred Mensah	Chief Technical Officer	BCESD	FCCD/Bobiri Forest Reserve	1st June, 2023
Mrs. Anastasia Dua-Gyamfi	Chief Admin. Asst.	FORIG Guesthouse	CAA: Registry	1st January, 2023

7.5 STAFF TRAINING

Thirty-one (31) staff members in different categories of training as at 31st December 2023. The details with respect to level and type of training is summarized in the table below:

Table 10: **Details of Staff in Training as at 31st December, 2023**

No.	Name of Officer	Training Institution	Course Title	Duration	Start Date	Expected Date of Return	Period Overstayed
1	Samar B. Sparkler	Univ. of Calgary, Canada	PhD, Geography	4 years	Sept 2017	Sept 2021	2 years
2	William Kwadwo Dumenu	Univ. of Freiburg, Germany	PhD Environmental Economics	3 years	2017	2020	3 years
3	William Hagan Brown	Uni. Of Plymouth,UK	PhD, Environmental Science	4 years	2021	2025	-
4	Gloria K. Adeyiga	KNUST, Kumasi	PhD, Agroforestry	4 years	Sept 2018	2022	1 year
5	Ms Hamdia M. Wumbeidow	KNUST, Kumasi	PhD, Wildlife and Range Management (Biodiversity Conservation)	4 years	2020	2024	-
6	Bridget Brentuo	Uni. Of Education, Winneba	PhD, Wood Science	4 years	2019	2023	-

No.	Name of Officer	Training Institution	Course Title	Duration	Start Date	Expected Date of Return	Period Overstayed
7	Abigail A. Ofosu-Brako	Eotvus Lorand University, Hungary	PhD	4 years	2021	2025	-
8	Christian Opoku Kwarteng	KNUST, Kumasi	PhD, Entomology, Climate Change and Integrated Natural Resource	4 years	2021	2025	-
9	Jemima Owusu	KNUST, Kumasi	MSc Chemical Engineering	2 years	2021	2023	-
10	Kwaku Asumadu	KNUST, Kumasi	MSc Packaging Technology and Management	2 years	2020	2022	1 year
11	Markfred Mensah	CCST, Kumasi	MPhil, Climate Change and Integrated Natural Resources	2 years	2020	2022	1 year
12	Emmanuel Amponsah M.	CCST, Kumasi	MPhil, Climate Change and Integrated Natural Resources management	2 years	2019	2021	2 years
13	Eunice Bassanio Boadi	Valley View Univ., Kumasi	B.Ed., Management Option	4 years	2020	2024	-
14	Felix Boakye	Uni. Of Education	BSc, Wood Science	3 years	2018	2021	2 years
15	Dorothy Asabea Opoku	KNUST	PhD, Climate Change and Land Use	4 years	2022	2026	-
16	Judith Owusu Asante	KNUST	PhD, Chemistry	4 years	2022	2026	-
17	Haruna Seidu	Univ. of Sopron	PhD, Wood Science & Technology	4 years	2022	2026	-
18	Jacqueline J. Twinto	KNUST	PhD, Agroforestry	4 years	2022	2026	-
19	Kwabena Afriyie Agyekum	UENR	MSc., Climate Change	2 years	2022	2024	-

No.	Name of Officer	Training Institution	Course Title	Duration	Start Date	Expected Date of Return	Period Overstayed
20	Hilda Dokey	Christian Service Univ. College	BBA Human Resource Mgt	2 years	2022	2024	-
21	Michael Amofah	KNUST	MBA, Accounting & Finance	2 years	2022	2024	-
22	John Mensah	Community Devt. Technical Inst., Kwamo	Cert., Plumbing & Gas Fitting	1 year	2022	2023	-
23	Daniel O. Oppong	KNUST	BSc Information Technology	2 years	2019	2021	2 years
24	Emmanuel N. Duodu	Uni of Auburn, USA	MSc Forestry	2 years	2022	2024	-
25	Yaa Agyeiwaa Boateng	Erasmus University, ISSS	MA, Development Studies	1year 6 months	2023	2025	
26	Tracy Amponsah Akoto-Bamfo	CCST	MPhil, Climate Change and Natural Resource Management	2 years	2023	2025	
27	Adu-Gyamfi Asamoah	Nanjing Forestry University	PhD, Agric & Forestry Economics and Management		2023	2027	
28	Anastasia Duah Gyamfi	KNUST	MBA, Management and Organizational Development	2 years	2023	2024	
29	Emmanuel Sarpong	KNUST	MPhil, Publishing Studies	2 years	2023	2024	
30	Douglas Siaw Baah	Ulster University, UK	PhD, Life & Health Sciences	3 years	2023	2026	
31	Ebenezer Frans Mensah	Christian Service University, Kumasi	MPhil Communication Studies	2 years	2023	2025	

Furthermore, out of the thirty-one (31) trainees, fourteen (14) are pursuing PhD studies, twelve (12) Masters Degrees, four (4) pursuing Bachelor's degrees and one (1) certificate course. The table below provides the details

Table 11: Type and Level of Training

Level of Training	Type of Training		Total
	Local	Foreign	
PhD	7	7	14
MPhil/MSc./MA	10	2	12
BSc/BA	4	-	4
Others	1	-	1
Total	**22**	**9**	**31**

7.6 PROMOTION/UPGRADING

A total of twenty (20) members of staff were promoted in the year, 2023. Out of the total, there were eight (8) Senior Members, two (2) Senior Staff and ten (10) Junior Staff. The table below gives details of the affected staff;

Table 12: Staff Promotions

No.	Name	Former Grade	Present Grade	Effective Date
A)	SENIOR MEMBER			
1.	Dr. Lucy Amissah	Senior Research Scientist	Principal Research Scientist	1st January, 2022
2.	Dr. Shalom D. Addo-Danso	Research Scientist	Senior Research Scientist	1st January, 2022
3.	Mr. Isaac Boahene	Accountant	Senior Accountant	1st July, 2022
4.	Ms. Comfort Konto	Senior Administrative Officer	Principal Administrative Officer	1st January, 2023
5.	Mrs. Naomi Appiah	Senior Marketing Officer	Principal Marketing Officer	1st January, 2023
6.	Dr. Mrs. Gloria Djagblatey	Senior Research Scientist	Principal Research Scientist	2nd August, 2023
7.	Mr. Alexander Obeng Ansong	Marketing Officer	Senior Marketing Officer	1st July, 2023
8.	Dr. Reginald Guuroh	Research Scientist	Senior Research Scientist	1st January, 2022
B) SENIOR STAFF				
9.	Ebenezer Ofori	Principal Technical Officer	Chief Technical Officer	1st January, 2023
10.	Mr. Michael Amofah	Accounting Assistant	Senior Accounting Assistant	1st January, 2023

No.	Name	Former Grade	Present Grade	Effective Date
C) JUNIOR STAFF				
11.	Anthony Appiah	Security Assistant 1	Senior Security Assistant	1st January, 2023
12.	Michael Asaa Akgare	Security Assistant 1	Senior Security Assistant	1st January, 2023
13.	Simon Kumah	Supervisor Grade 1	Assistant Overseer Grade 1	1st January, 2023
14.	Stephen Abaidoo	Supervisor Grade 1	Assistant Overseer Grade 1	1st January, 2023
15.	Appiah Kubi	Supervisor Grade 1	Assistant Overseer Grade 1	1st January, 2023
16.	Anthony Osei Kwaku	Supervisor Grade 1	Assistant Overseer Grade 1	1st January, 2023
17.	Francis Yeboah	Supervisor Grade II	Supervisor Grade 1	1st January, 2023
18.	Zac Achab	Principal Caretaker	Chief Caretaker	1st January, 2022
19.	Joseph Ofori	Supervisor Grade 1	Assistant Overseer Grade 1	1st January, 2023
20.	Comfort Adoma	Supervisor Grade 1	Assistant Overseer Grade 1	1st January, 2023

In addition, Mr. Vincent Boakye of the Finance Division was upgraded from Accounting Assistant to Accountant effective August 2022.

7.7 COMPULSORY RETIREMENTS

Eight (8) members of staff retired from the service of the Council in the year 2023. The table below gives details of the members who retired.

Table 13: **Retired Staff (January-December, 2023)**

	Name	Division	Date Retired
1.	Bismark John Amokwandoh	Forest Improvement and Productivity Division	21st March, 2023
2.	Dr. Mrs. Gloria D. Djagbletey	Forest and Climate Change Division	2nd April, 2023
3.	Mr. Richard Lordson Kyeremeh	Internal Audit	27th June, 2023
4.	Dr. Lawrence Damnyang	Forest Economics and Marketing Division	4th July, 2023

	Name	Division	Date Retired
5.	Ms. Ruth Amuzu Esi	Wood Industry and Utilization Division	5th August, 2023
6.	Mr. Francis Wilson Owusu	Wood Industry and Utilization Division	25th August, 2023
7.	Mr. King Hiatorpe Kwabla	Administration Division (Security)	8th October, 2023
8.	Mr. Richard Acquah	Administration Division (Transport)	16th October, 2023

7.8 MAJOR EVENTS

The under-listed events including statutory meetings took place at the Institute during the year 2023.

Table 14: Major Events

No.	Title	Date
1.	90th IMC Meeting 2023	14th March, 2023
2.	Management Board Meeting	13th April 2023
3.	Sustainable Intensification of Mixed Farming Systems Initiative	24th – 28th April, 2023
4.	Issuing of CSIR ID cards	3rd May, 2023
5.	FSF AGM	5th May, 2023
6.	TAT Presentations	8th May, 2023
7.	Meeting between CSIR post-retirement contract and the Director - General	23rd May, 2023
8.	Heads of Divisions meeting the Director	26th May, 2023
9.	Senior Members Welfare Fund- AGM	16th June 2023
10.	91st IMC Meeting	17th July, 2023
11.	Management Board Meeting	19th July, 2023
12.	Accountants Meeting	20th – 21st July, 2023
13.	Mid-year Review	1st – 2nd August, 2023
14.	Heritors Lab Visit	9th August, 2023
15.	Director's Meeting with HoDs	21st August, 2023
16.	Staff Durbar	28th August, 2023
17.	Orientation - Cosmopolitan Health Insurance for CSIR Staff (FORIG/BRRI)	31st August,
18.	Sensitization Workshop on the new Public Sector Performance Management Policy	13th September, 2023

No.	Title	Date
19.	Threatened Trees Conservation Workshop	13th September, 2023
20.	RSA Meeting	15th September, 2023
21.	Northern Sector Senior Staff Promotional Interviews	18th- 20th September, 2023
22.	Arrival of 2023/2024 NSS Personnel	1st November, 2023
23.	92nd IMC Meeting	8th November, 2023
24.	Basic School Board Meeting	10th November, 2023
25.	Management Board Meeting	21st November, 2023
26.	Forest Science Symposium	22nd November, 2023
27.	Orientation for National Service Personnel 2023/2024	6th December, 2023
28.	Annual Planning	11th – 13th December, 2023
29.	Christmas Break	20th December, 2023

7.9 BEREAVEMENT

Two (2) members of staff passed on to glory during the second quarter of the year 2023. Mr. Charles Sarpong (Overseer) of Works and Maintenance Division and Mr. Michael Asaa Akayagre, Senior Security Assistant at the Bolga Guest House. These sad events occurred on 17th May, 2023 and 29th June, 2023 respectively. In addition, a report was received from the family of Dr. Albert Ofosu Asiedu, a former Director (1989-1997) of this Institute about his demise on the 28th day of May, 2023. May their souls rest in perfect peace.

7.10 HUMAN RESOURCES

One major asset of CSIR-FORIG is the number of highly qualified staff in all the Divisions. The names of Senior Members, Senior Staff and Junior staff in each of the nine (9) Divisions are provided in Appendices I, II and III.

8.0 FINANCE DIVISION

8.1 INTRODUCTION

This report focuses on the integral role the Finance Division plays in charting the financial future of the Institute. It provides an overview of the work done in 2023 including the accomplishments, and presentation of the financial position of the Institute. It outlines the priority activities of the Division in the 2024 financial year.

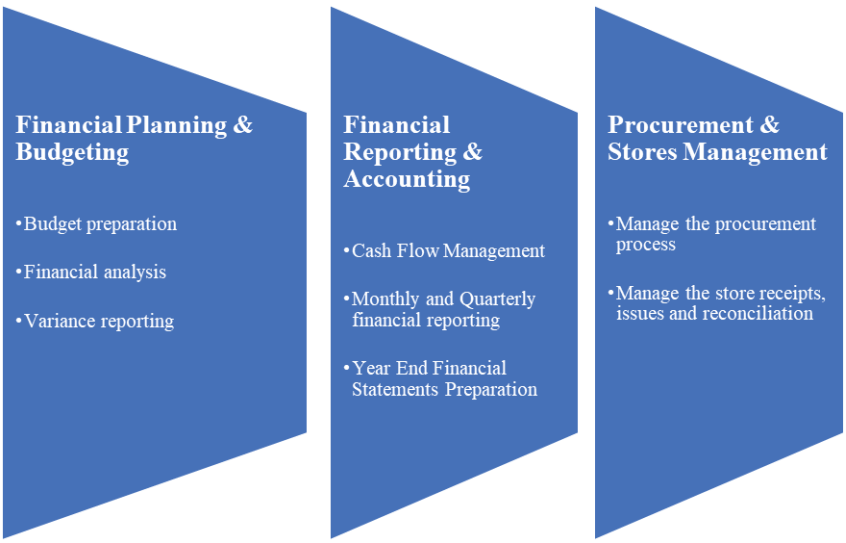
The report is organised under the following headings:

- The Finance Division
- 2023 Accomplishments
- Activities identified for improvement
- Summary of financials for 2023
- Conclusion

8.2 THE FINANCE DIVISION

The Finance Division is responsible for financial planning and budgeting, procurement and stores management, financial reporting and accounting. The division maintains the financial integrity of the Institute under the relevant laws, policies and standards. Management is assisted with the provision of relevant financial information for day-to-day governance of the Institute.

The prime roles of the division are:



In addition to the above outlined functions, the Finance Division ensures compliance and adherence to internal controls and financial and regulatory guidelines.

8.3 2023 ACCOMPLISHMENTS

- The Finance Division assisted the external auditors to conclude the audit of the financial statements for 2022. The statements have been published. The Division also responded to audit observations and recommendations, coupled with status of implementation for the 2022 financial statements. Appropriate responses were given by the Division on audit recommendations and status of implementation for post audit exercises conducted from April, 2022 – March, 2023.
- The quarterly reports for the Controller and Accountant General's attention were submitted to and validated by the National Accounts Unit of the Controller and Accountant's Department.

2023 Financial Facts

Personnel Emoluments
GH¢16,970,633

Internally Generated Fund
GH¢5,261,618

Goods and Services Expenditure
GH¢14,082,286

Capital Expenditure
GH¢1,003,101

Donor Grants
GH¢11,107,814

- Reports for donor funds such as FIP, MAG, GIZ Fire Management and others were submitted to respective donors / sponsors.
- Two officers of the Division attended a two-day GoG Stores Management and Procurement Training Workshop in Accra.
- One staff of the Division attended a five-day GIFMIS trainer of trainee workshop in Accra.
- One staff of the Division attended a two-day GOG Fixed Assets Register training workshop in Accra.
- One staff of the Division attended a two-day Procurement Management workshop in Accra.
- There was also a three-day refresher training for staff of the Division on GIFMIS implementation in June, 2023.
- The cordial relationship between the cashiers and the staff of GRA resulted in prompt collection of cheques for withholding taxes and associated certificates for suppliers.
- Several requests for financial information were received from CSIR-Head Office and were adequately and timely attended to.

8.4 ACTIVITIES IDENTIFIED FOR IMPROVEMENT

For the ensuing year, the following tasks will be prioritised:

- GIFMIS implementation: All CSIR Institutes have been ordered to start the implementation of GIFMIS in the processing of financial activites in 2024. There is therefore the need for preparation to meet the challenges that the implementation shall present. Finanace Divisison are currently awaiting the final implementation training scheduled for 17th – 21st June, 2024 to kick-start the implementation of the programme.

- Continue to review and reconcile all accounts receivables and payables and collect all debts owed by our customers. The target is to maintain accounts receivable to sales ratio of less or equal to ten percent. Such an exercise will enable the Division or Institute ascertain the true status of such accounts to determine actions to be taken on very long-standing account balances.
- Ensure meeting all timelines for statutory reports.
- Ensure the update of all financial records for the preparation of the draft financial statements for 2023.

8.5 SUMMARY OF FINANCIALS

REVENUE NOTES	ANNUAL BUDGET GH¢	YTD ACTUAL GH¢	YTD BUDGET VARIANCE GH¢
GoG Subvention (A)	11,082,311	16,970,633	5,888,322
Internally Generated Funds (B)	3,663,937	5,261,618	1, 597,681
Donor (C)	644,768	11,107,814	10,463,369
TOTAL REVENUE	**15,390,693**	**33,340,065**	**17,949,372**
EXPENDITURE			
Compensation of Employees (D)	11,054,484	18,067,655	7,013,171
Goods and Services (E)	3,497,947	14,082,286	10,584,339
Capital Expenses (F)	838,262	1,003,101	164,839
	-	-	
TOTAL EXPENDITURE	**15,390,693**	**33,153,042**	**17,762,349**

NET SURPLUS / (DEFICIT) - 187,023 187,023

8.6 EXPLANATORY NOTES

(A) GoG Subvention under Annual Budget is the amount appropriated for payment of emoluments of staff, goods and services as captured in the 2023 budget. The YTD Actual is the total personnel emoluments actually received during year 2022.

(B) The budget allocation for IGF is captured under the Annual Budget. The collection for the year under the historical accounting is captured under the YTD Actual.

(C) Donor funds approved in the budget is under the Annual Budget and the actual grants received in cedi terms for the year is under the YTD Actual.

(D) This is the Compensation expenditure budget and actual amount paid as employees' compensation during the year. It also includes casual labour cost paid for IGF activities and allowances paid to project staff.

(E) Goods and Services were financed from both IGF and Donor Projects funds as follows:

	GH¢
IGF	4,442,995
Donor Projects 9,639,291	9,639,291
Total	**14,082,286**

(F) The capital expenses were financed from both IGF and Donor Projects funds as follows:

	GH¢
IGF	281,931
Donor Projects	721,170
Total	**1,003,101**

(G) The low surplus of GH¢187,023 was largely as a result of increased activities of both IGF and donor projects such as the completion and commissioning of the Solar Penels installation, the CSIR Wildlife Musuem and the purchase of a vehicle (pick-up) to augment the Instiutte's aged vehicles. The composition of the surplus was:

	GH¢
IGF	92,612
Donor Projects	94,411
Total	**187,023**

8.7 CONCLUSION

In summary, the Finance Division's 2023 Annual Report highlights specific accomplishment. It also touches on areas that need to be given priority attention in order to ensure update of records, smooth execution of duties and timely financial reporting. The Division is satisfied with the successes chalked in 2023 and intends to do even more in the ensuing years, aspecially when the Institute is being ushered into the GIFMIS implementation in 2024. The Accounts Division is grateful to Management and the entire staff of CSIR-FORIG for the unwavering support and understanding that enabled the Division to live up to expectations.

9.0 STAFF PUBLICATIONS

9.1 JOURNAL PAPERS

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4. Adu-Poku, A., Obeng, G. Y., Mensah, E., Kwaku, M., Acheampong, E. N., Duah-Gyamfi, A., **Adu-Bredu, S.** (2023). Assessment of aboveground, belowground, and total biomass carbon storage potential of Bambusa vulgaris in a tropical moist forest in Ghana, West Africa. *Renewable Energy and Environmental Sustainability*, 8(3), 1 – 12. https://doi.org/10.1051/rees/2023001

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8. **Amponsah, J. O.,** Kwarteng, A. D., Eshun, B. and Arhin, A. A. (2023). Phenology and early growth performance assessment of the endangered Afromosia (Pericopsis elata) of the high forest zones in Ghana. *International Journal of Biodiversity and Conservation*, 1 – 9. https://doi:10.5897/IJBC

9. Ansah, B. P., **Addo-Danso, S. D.,** Belford, E., **Asomaning, J. M.**, Asare-Ansah, A. B., Fosu, N. A. and Ankobia, R. A. (2023). Temperature and soil nutrients drive seed traits variation in Pterocarpus erinaceus (African rosewood) in Ghana. *Plant-Environment Interactions*. 00, 1–13. https://doi.org/10.1002/pei3.10120

10. Appiah-Kubi, E., **Awotwe-Mensah, M.,** Mitchual, S. J. (2023). Assessment of physical and mechanical properties of juvenile and matured *Bambusa vulgaris* glue-laminated bamboo for structural applications in Ghana. *Sustainable Structures*, 3(2), 000026-14 https://doi.org/10.54113/j.sust.2023.000026

11. **Awotwe-Mensah, M.,** Mitchual, S. J., Appiah-Kubi, E., Dadzie, P. K., **Mensah, P.,** Donkor M. B. (2023). Assessment of the drying behaviour of young and mature *Bambusa vulgaris* from Ghana. *Advances in Bamboo Science*, 5, 100044. https://doi.org/10.1016/j.bamboo.2023.100044

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9.2 BOOKS AND HANDBOOKS/BOOK CHAPTERS/MANUALS

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9.3 POLICY BRIEFS

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2. **Opoku-Kwarteng, C., Adu-Bredu, S., Obiri Danso, K., Djagbletey, G.D.,** Frimpong-Anin, K., **Duah-Gyamfi, A., Addo-Danso, S.D.** and Malhi, Y. (2023). Determiners of wood decomposition rates in a Tropical Moist Forest in Ghana.

9.5 TECHNICAL REPORTS

1. **Obeng, E. A., Oduro, K. A., Guuroh, R. T., Acquah, S. B., Andoh, J., and Asamoah, A-G** (2023). Assessment of the Youth in plantation establishment as an occupation project of Forest Plantation Development Fund: Concept, implementation, and lessons. A consultancy report submitted to the Forest Plantation Development Fund Board, CSIR-FORIG, Kumasi, Ghana. 55p.

2. **Acquah, S.B., Oduro, K. A., Obiri, B. D., Obeng, E. A., Guuroh, R. T., Opuni-Frimpong, E., Andoh, J., Akpalu, S. E., Agyekum, C. K., Ofori, D. A.** (2023). Assessment of Deforestation and Forest Degradation in Community Resource Management Areas in the Northern Savanna Zone. Project. FC/FORIG GSLERP. Technical report submitted to Forestry Commission of Ghana.

3. **Obeng, E. A., Andoh, J., Oduro, K. A., Obiri, B. D., Duah-Gyamfi, A., Guuroh, R. T., Adu-Gyamfi, A.,** Aloysius, N. and Clark, K. (2023). Impacts of Illegal Small-Scale Artisanal Gold Mining and Land Clearing Activities on Cocoa Cultivation: Farmers' Perception on the Multiple Threats Facing the Cocoa Industry, and Rural Livelihoods. Technical Report. CSIR-FORIG, Kumasi, Ghana.

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9. **Obiri, D.B., Andoh, J., Guuroh, R.T.,** and Carson, S. (2023). Community mangrove restoration calendar planning for Densu Basin, Ghana. A consultancy report submitted to the World Agroforestry Center (ICRAF), CSIR-FORIG, Kumasi, Ghana.

10. **Obiri, D.B., Asamoah, A-G., Guuroh, R.T**., **Andoh, J., Oduro, K.A.,** Carson, S., McMullin, S. and Muthee, K. (2023). Community action plan for Narkwa Lagoon, Ghana. A consultancy report submitted to the World Agroforestry Center (ICRAF), CSIR-FORIG, Kumasi, Ghana.

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12. **Akpalu, S. and Adeyiga, G.K.** (2023). Effects of tap water pre-sowing treatment on emergence, and early growth response of Pterocarpus erinaceus (African Rosewood) to bottle drip irrigation and mulching. Report submitted to CSIR-FORIG, Kumasi, Ghana.

13. **Obiri, D. B., Andoh, J., Oduro, K.A., Guuroh, R.T., Adu-Gyamfi, A., Gapketor, P. M**. & Carsan, S. 2023. A Review of Stakeholder Engagement in Mangrove Management and Restoration in Ghana. Consultancy Report. ICRAF, Nairobi, Kenya

14. **Ofori, D., Amponsah, J., Obiri, D. B., Asomaning, J. M., Guuroh, R. T.** & **Amissah, L.** (2023). Characterization of priority tree species for agrosilvopastoral systems in target regions of Northern Ghana. Technical Report. Bioversity International, Italy.

15. **Obiri, D.B., Guuroh, R.T.,** Agyekumhene, A., **Oduro, K.A., Asamoah, A-G.,** and Carsan, S. (2023). Best practices in mangrove restoration training workshop report. Densu estuary,

Ghana. Women shellfishers and food security project. Consultancy report, World Agroforestry Center (ICRAF),

16. **Obiri, D.B.,** Guuroh, R.T., Asamoah, A-G., McMullin, S. and Carsan, S. (2023). Installation of Food and Non-Food Portfolio Demonstrations in Coastal Farming systems. Ekumfi Narkwa, Ghana. Consultancy Report. Women shellfishers and food security project. World Agroforestry Center (ICRAF).

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18. **Obiri, D.B.,** Oduro, K.A., Asamoah, A-G., Guuroh, R.T., Andoh, J., Carsan, S., (2023). Forestry and Mangrove Co-Management in Ghana. Women shellfishers and food security project. Consultancy Report. World Agroforestry Center (ICRAF).

19. **Ofori- Boateng, C.,** Segniagbeto G. H., & Osei-Gyan, F. (2023). Range wide conservation action plan for the critically endangered Togo slippery frog (Conraua derooi) 2024-2034. Available via: https://www.iucn-amphibians.org/resources/publications/action-plans/action-plans-by-regions/

9.6 POSTERS PRESENTATION

1. McMullin, S., **Obiri, D.B.,** Muthee, K., Alagie Bah, A. & Carsan, S. (2023). Landscape food system approaches for resilience in women shellfishing communities in Ghana and The Gambia. Poster presented at the Conference on Fisheries and Coastal Environment. 6th – 9th November 2023, Accra, Ghana

2. **Obiri, D.B.,** Guuroh, R.T., Andoh, J., Okyere-Agyapong, E, K.A., Asamoah, A-G., Carsan, S., McMullin, S. and Muthee, K. 2023. Intercropping food trees and food crops in coastal farming systems. Poster for training workshop on demonstration and adoption of food portfolios, Ekumfi Narkwa, March 2023.

3. **Obiri, D.B.,** Guuroh, R.T., Andoh, J., Okyere-Agyapong, E, K.A., Asamoah, A-G., Carsan, S., McMullin, S. and Muthee, K. 2023. Techniques for woodlot establishment in coastal farming systems. Poster for training workshop on demonstration and adoption of non-food portfolios, Ekumfi Narkwa, March 2023.

4. **Obiri, D.B.,** Guuroh, R.T., Andoh, J., Okyere-Agyapong, E, K.A., Asamoah, A-G., Carsan, S., McMullin, S. and Muthee, K. 2023. Poster for training workshop on best practices in mangrove restoration in coastal ecosystems. ICRAF women shellfishers and food security project. Densu Estuary, Accra, 9-10 May 2023

9.7 PART-TIME TEACHING

- Mr. Francis Wilson Owusu: Department Forest Resources Technology, KNUST, Kumasi
- Mr. Prosper Mensah: Department of Construction and Wood Technology Education, AAMUSTED, Kumasi Campus.
- Prof. Joseph R. Cobbinah: Department of Natural Resources Management, CCST, Kumasi
- Dr. (Mrs.) Margret Sraku-Lartey: Department of Natural Resources Management, CCST, Kumasi
- Prof. Daniel A. Ofori: Department of Natural Resources Management, CCST, Kumasi.
- Dr. Ernest G. Foli: Department of Natural Resources Management, CCST, Kumasi.
- Dr. Stephen Adu-Bredu: Department of Natural Resources Management, CCST, Kumasi.
- Dr. Lawrence Damnyag: Department of Natural Resources Management, CCST, Kumasi.
- Dr. Luke C.N. Anglaaere: Department of Natural Resources Management, CCST, Kumasi.
- Dr. (Mrs.) Beatrice Darko Obiri: Department of Natural Resources Management, CCST, Kumasi.
- Dr. (Mrs.) Margaret Sraku-Lartey: Department of Natural Resources Management, CCST, Kumasi.
- Dr. Kwame Antwi Oduro: Department of Natural Resources Management, CCST, Kumasi.
- Dr. (Mrs.) Lucy Amissah: Department of Natural Resources Management, CCST, Kumasi.
- Dr. James Korang: Department of Natural Resources Management, CCST, Kumasi.
- Dr. Emmanuel Ebanyenle: Department of Natural Resources Management, CCST, Kumasi.
- Dr. Reginald Guuroh: Department of Natural Resources Management, CCST, Kumasi.
- Dr. (Mrs.) Stella Britwum Acquah: Department of Natural Resources Management, CCST, Kumasi.

9.8 SUPERVISION OF STUDENTS

a. Mr. Francis Wilson Owusu: Thirteen (13) undergraduate students, Department of Forest Resources Technology, KNUST- Kumasi.

b. Prof. Stephen Adu-Bredu: Ten (10) postgraduate students, Department of Natural Resources Management, CCST, Kumasi.

c. Dr. Lawrence Damnyag: Six (6) postgraduate students, Department of Natural Resources Management, CCST, Kumasi.

d. Dr. Luke C.N. Anglaaere: One (1) postgraduate student, Department of Natural Resources Management, CCST, Kumasi.

e. Dr. (Mrs.) Beatrice Darko Obiri: One (1) postgraduate student, Department of Natural Resources Management, CCST, Kumasi.

f. Dr. Kwame Antwi Oduro: Six (6) postgraduate students, Department of Natural Resources Management, CCST, Kumasi.

g. Dr. (Mrs.) Lucy Amissah: Two (2) postgraduate students, Department of Natural Resources Management, CCST, Kumasi.

h. Dr. Emmanuel Ebanyenle: One (1) postgraduate student, Department of Natural Resources Management, CCST, Kumasi.

i. Dr. Reginald Guuroh: Six (6) postgraduate students, Department of Natural Resources Management, CCST, Kumasi.

j. Dr. (Mrs) Elizabeth Asantewaa Obeng: Three (3) postgraduate students, Department of Natural Resources Management, CCST, Kumasi.

k. Dr. Akwasi Duah Gyamfi: Four (4) postgraduate students, Department of Natural Resources Management, CCST, Kumasi.

10.0 APPENDICES

10.1 Appendix I: List of Senior Members

ADMINISTRATION DIVISION	
Daniel A. Ofori	BSc. Agric., MPhil. Tree Improvement, PhD. Forest Genetics (Molecular Biology) *Chief Research Scientist*, **DIRECTOR**
Comfort D. Kontoh (Ms.)	B.A. (Hons) Economics, Dip. Education, MBA Strat. & Consultancy Mgt. ChPA, *Senior Administrative Officer.* ***HEAD OF DIVISION***
Osei-Tutu Boateng	B.A. Sociology and Social Work, CEMBA, Public Administration, CIHRM, MCIHRM, *Administrative Officer*
FOREST POLICY, GOVERNANCE AND LIVELIHOODS DIVISION	
Kwame Antwi Oduro	BSc. Nat. Res. Mgt., MSc. Forestry and Land Use, PhD. Forest Management and Forest Governance. *Principal Research Scientist* ***HEAD OF DIVISION***
Elizabeth A. Obeng (Mrs.)	BSc. Agric., MSc. Sustainable Res. Mgt., PhD Forest Resource Economics. *Senior Research Scientist*
William K. Dumenu◕◕	BSc. Nat. Res. Mgt., MSc. Forest Ecol. & Mgt., *Research Scientist*
Emmanuel Marfo °	BSc. Nat. Res. Mgt., MSc. Tropical Forestry, PhD. Environmental Science, *Principal Research Scientist,*
Marshall Alhassan Adams	MSc. Interdisciplinary Environmental Studies, PhD. Environmental Studies, Research Scientist
Jewel Andoh	BSc Agriculture, MSc. Forest Resources and Ecological Restoration, PhD. Public Administration in Regional Development and Real Estate. Research Scientist
BIODIVERSITY CONSERVATION & ECOSYSTEM SERVICES DIVISION	
Akwasi Duah Gyamfi	BSc. Nat. Res. Mgt., MPhil. Ecology & Mgt., PhD. Forest Science. *Senior Research Scientist,* ***HEAD OF DIVISION***
Stephen Adu-Bredu**	BSc. Nat. Res. Mgt., MSc. Silv. Mgt., PhD. Silv. Mgt./ Ecophysiology, Chief *Research Scientist,*
Luke Cyprian N. Anglaaere**	BSc. Nat. Res. Mgt., MSc. Silv. & Forest Biology, PhD. Agroforestry, *Principal Research Scientist,*
Lucy Amissah (Mrs.)	BSc. Nat. Res. Mgt., MPhil. Silv. & For. Mgt., PhD. Forest Ecology & Forest Mgt. (Functional Ecology), *Principal Research Scientist*

Bright O. Kankam	BSc. Nat. Res. Mgt., MPhil. Wildlife and Range Mgt. PhD. Primatology, *Senior Research Scientist*
Caleb Ofori Boateng	B.Sc. Nat. Res. Mgt., PhD. Wildlife & Range Management, *Senior Research Scientist*
Hamdia M. Wumbeidow (Mrs.)°°	BSc. Agricultural Technology, MPhil Zoology. *Research Scientist*
Kwadwo Kyenkyehene Kusi	PhD. Environmental Science, *Research Scientist*.
William Hagan Brown°°	BSc. Natural Resources Mgt. MPhil. Geographic Information Systems. *Principal Technologist*.
Douglas Siaw-Baah°°	BSc. Natural Resource Management, MPhil Environmental Resources Management
Fozia Ibrahim°°	BSc. Natural Resource Mgt. MPhil. Climate Change and Integrated. Natural Resources Mgt. *Principal Technologist*.
WOOD INDUSTRY & UTILISATION DIVISION	
Francis W. Owusu°°	BSc. Agric. Engineering, MPhil. Wood Technology, *Principal Research Scientist/* ***HEAD OF DIVISION***
Emmanuel Ebanyenle	BSc. Nat. Res. Mgt., MPhil. Wood Science, PhD. Forest Science *Senior Research Scientist*
James K. Korang	BSc. MSc. PhD. Chemistry, *Senior Research Scientist*
Prosper Mensah	B.Ed. Education Technology, MPhil Wood Science & Technology, PhD in wood Science and Technology *Research Scientist.*
Charles Essien°	BSc. Nat. Res. Mgt., MPhil. Wood Technology, PhD, Forestry *Research Scientist*
Michael Awotwe-Mensah	B.Ed. Education Technology, MPhil Wood Science & Technology, PhD in Wood Science and Technology *Research Scientist.*
Bridgette Brentuo°°	BSc. Physical Sci., MPhil. Wood Technology, *Research Scientist*
James Kudjo Govina°°	BSc. Nat. Res. Mgt., MSc. Forestry Science *Principal Technologist*
Haruna Seidu°°	HND. Agric. Engineering, MSc. Information Technology *Principal Technologist*
Judith Odei Owusu-Asante°°	BSc. Chemistry, MPhil. Analytical Chemistry, *Principal Technologist*
FOREST PRODUCTS & MARKETING DIVISION	
Lawrence Damnyag	BA., MPhil. Economics, PhD. Forest Economics *Principal Research Scientist/****HEAD OF DIVISION***

Beatrice Darko-Obiri (Mrs.)	BSc. Agric., MSc., PhD Agroforestry, *Principal Research Scientist/* ***DEPUTY DIRECTOR***
Crentsil Kofi Agyekum	Master in Business Administration, PhD in Applied Economics. *Research Scientist.*
Samar B. Sparkler°°	BA. (Econs. & Geog.), MA. Geog. & Rural Dev. *Research Scientist*
Jacqueline Joyce Twintoh (Ms.)°°	BA. Business Administration, MSc. Bio-Economy and Nat. Res. Mgt, *Principal Technologist*
Safia Ibrahim	HND Statistics, BSc. Economics and Statistics, MPhil in Economics, *Principal Technologist*
David Fosu-Asante	BSc. Environmental Science. MSc. Environmental Science. *Principal Technologist.*
FORESTS CLIMATE CHANGE DIVISION	
Gloria D. Djagbletey (Mrs.)	BSc. Nat. Res. Mgt., MPhil., PhD. Silv. & Forest Mgt., *Senior Research Scientist /* ***HEAD OF DIVISION***
Ernest G. Foli**	BSc. Nat. Res. Mgt., MPhil Forest Men./Inventory PhD Silv. & Mgt., *Principal Research Scientist*
Stella Britwum Acquah	BSc. Computer Science, MSc Advance ICT Studies, PhD, Forestry, Senior *Research Scientist,*
Daniel Shalom Addo-Danso	BSc. Nat. Res. Mgt., MSc Forest Ecol. And Mgt., PhD, Forestry *Senior Research Scientist*
Reginald T. Guuroh	BSc. Nat Res. Mgt, MSc. Env. Forestry, PhD. Plant Ecology, Senior *Research Scientist.*
George K. Ametsitsi	BSc. Nat. Res. Mgt., MSc. Env. Res. Mgt., PhD in Plant and Fire Ecology, *Research Scientist.*
Stephen E. Akpalu	BSc. Agric., MPhil. Env. Sci., PhD. Agroforestry., *Research Scientist*
Gloria Kukurije Adeyiga°°	BSc. Nat. Res. Mgt., M.Sc. Sust. Env. Mgt., M.Sc. Agric Dev't., *Research Scientist*
Dorothy Asare Akoto (Ms.) °°	BSc. Nat. Res. Mgt., MSc. Tropical Forestry *Principal Technologist*
Daniel Kwame Debrah	Dip. Nat. Res. Mgt., BSc For. Res. Tech., MSc. Forestry Science *Principal Technologist*
Christian Opoku Kwarteng°°	BSc. Nat. Re. Mgt., MSc. Environmental Science *Principal Technologist*
Eunice Okyere-Agyapong	BSc. Natural Resources Mgt. MPhil. Climate Change and Integrated Natural Resource Mgt. *Principal Technologist*
Adu-Gyamfi Asamoah°°	BSc. Natural Resource Mgt. Masters Degree in Climate Change *Principal Technologist*

Francis Kofi Tease	BA Geography and History. MSc. Bio-economy and Natural Resources Mgt. *Principal Technologist*.
FOREST IMPROVEMENT & PRODUCTIVITY DIVISION	
Emmanuel Opuni-Frimpong	BSc. Nat. Res. Mgt., MPhil. Silv. Mgt. PhD. Forest Entomology *Principal Research Scientist/* ***HEAD OF DIVISION***
Joseph Mireku Asomaning	BSc. Agric., MSc. Seed Technology, PhD. Seed Science and Technology, *Principal Research Scientist*
John K. Mensah	BSc. Botany, MSc. Plant Pathology, PhD. Forest Science and Biology. Senior *Research Scientist*
Mawuli Edzei Wisdom	MSc. In Agriculture, Crop genetics and Breeding. PhD. Crop genetics and Breeding. *Research Scientist*
William K. Nuako Bandoh	BSc. Biochemistry, MPhil. Environmental Science. *Research Scientist*
Anthony Antwi-Wiredu °°	BSc. Agriculture, Mphil. Nuclear Agriculture. *Principal Technologist*
James Oppong Amponsah	BSc. Environmental Science, MSc. Seed Science and Technology, MSc. Tropical Forestry. *Principal Technologist*
Patience Mansa Gakpetor	BSc. Agriculture, MSc. Plant Science. *Principal Technologist*
Sandra Owusu	BSc. Agriculture, MSc. Seed Science and Technology. *Principal Technologist*
COMMERCIALISATION DIVISION	
Naomi Owusu Appiah (Mrs)	B.A. Publishing, MBA Marketing, Senior *Marketing Officer.* ***HEAD OF DIVISION***
Alexander Ansong Obeng	BSc. Nat. Res. Mgt., MBA Marketing. *Marketing Officer*
FINANCE DIVISION	
Isaac Donkor	BSc. In Administration, Accounting, Master of Business Administration in Accounting. Senior Accountant. ***HEAD OF DIVISION***
Isaac Boahen	BEd. MBA Accounting, CA, CIPFA (AFIL). Senior *Accountant*
Samuel Atusong	B.A. Business Administration, CEMBA. *Accountant*
Gifty Wiafe Mensah-Tenkorang (Mrs)	BBA. Accounting, CEMBA. *Accountant*
Vincent Boakye	BCOM, CA, CIT. *Accountant*
INFORMATION & COMMUNICATION SECTION	
Martina Elizabeth Nikoi (Ms.)	B.A. Information Studies, M.A. Information Studies. *Principal Technologist/****HEAD OF SECTION***
Emmanuel Minkah	BSc. Agriculture, MSc Food & Postharvest Engineering. *Scientific Secretary*

Emmanuel M. K. Sosu	BSc. Computer Science, MSc Advance ICT Studies. *Research Scientist,*
Margret Sraku –Lartey (Mrs.)**	BSc Soc Sc, PGDip Lib Studs, MA Indus Mgt, PhD. Geography and Rural Development

°° Study leave

° Leave without pay

** Post retirement contract

10.2 Appendix II: List of Senior Staff

No	Name	Grade
1	Paul Kankam	Chief Technical Officer
2	Peter Loving Arthur	Chief Technical Officer
3	Eric K. Frimpong	Chief Technical Officer
4	Emmanuel Asiedu-Opoku	Chief Technical Officer
5	Markfred Mensah	Chief Technical Officer
6	Ernest Osei Boakye	Chief Technical Officer
7	Frank Assuming Baffour	Chief Technical Officer
8	Sarfo Kwame Bonsu	Chief Technical Officer
9	Kwasi Baah Acheamfour	Chief Technical Officer
10	Richard Kwadwo Adjei	Chief Technical Officer
11	Anastasia Duah-Gyamfi	Chief Administrative Assistant
12	Sandra Owusu	Chief Technical Officer
13	Kwaku Asumadu	Chief Marketing Assistant
14	Jemima Owusu	Chief Technical Officer
15	Michael Ampah	Chief Administrative Assistant
16	Ebenezer Frans Mensah	Chief Technical Officer
17	Georgina Boateng Yeboah	Chief Accounting Assistant
18	Wendy O. Amankwah	Chief Accounting Assistant
19	Felix Boakye	Chief Technical Officer
20	Margaret Adubigire	Chief Administrative Assistant
21	Jonathan Dabo	Chief Technical Officer
22	Daniel Peprah	Chief Technical Officer
23	Emmanuel Amponsah Manu	Chief Technical Officer

No	Name	Grade
24	Mark Debrah Marfo	Chief Technical Officer
25	Ebenezer Ofori	Chief Technical Officer
26	Mavis Agyekumwaah Bamfo	Chief Technical Officer
27	Hamdia B. Hudu	Principal Technical Officer
28	Constant Ezuame	Principal Technical Officer
29	Kwabena Achina Owusu	Principal Accounting Assistant
30	Emmanuel Sarpong	Principal Library Assistant
31	Hilda Dokey	Principal Administrative Assistant
32	John Bismark Amokwandoh	Principal Technical Officer
33	Patrick Baidoo-Ansah	Senior Technical Officer
34	David A. Dafliso	Senior Assistant Transport Officer
35	Issa Awal Mohammed	Senior Assistant Transport Officer
36	Diana Afua Tanoah	Senior Administrative Assistant
37	Simon Asumadu	Senior Technical Officer
38	Francis Owusu Nuamah	Senior Technical Officer
39	Daniel Ofori Oppong	Senior Technical Officer
40	Richard Acquah	Assistant Transport Officer
41	Michael Amofa	Accounting Assistant
42	Comfort Donkor	Technical Officer
43	Gideon Abban	Accounting Assistant
44	Eugene Asamoah	Administrative Assistant
45	Yaa Agyeiwaa Boateng	Administrative Assistant
46	Afua Twumasiwaa Adjei	Accounting Assistant
47	Eunice Basanio Boadi	Technical Officer (Teacher, CBS)
48	Abigail Amponsah Ofosu-Brako	Technical Officer
49	Tracy Amponsah Akoto-Bamfo	Technical Officer
50	Alex Frimpong Boakye	Technical Officer
51	Afriyie Agyekum Kwabena	Technical Officer
52	Emmanuel Duodu Nyarko	Technical Officer
53	Joseph K. Ansah	Security Officer
54	William Berchie	Assistant Transport Officer
55	Helena Asiedu Oboamah	Technical Officer

No	Name	Grade
56	Ruth E. Amuzu	Farm Manager
57	King K. Hiatorpe	Security Officer
58	Nancy Asor Agyebeng	Administrative Assistant
59	Emmanuel Kyere Nketia	Technical Officer
60	Daniel Owusu Acheampong	Purchasing Officer
61	Joshua Kwasi Adzigodie	Technical Officer
62	Kwadwo Gyamfi	Technical Officer
63	Gifty Kayla Amoshie	Public Relation Assistant

10.3 Appendix III: List of Junior Staff

No.	Name	Grade
1	Samuel Asamoah	Traffic Supervisor
2	Michael Opoku	Senior Technical Officer
3	Stella Asare (G&G)	Overseer
4	Akabayie Sampson	Senior Security Assistant
5	Joseph Ofori Atta	Senior Account Clerks
6	Zac Achab	Chief Caretaker
7	Michael Asaa Akayagre	Security Assistant Gd. I
8	Anthony Appiah	Security Assistant Gd. I
9	Baba Mahama	Senior Security Assistant
10	Job Akougba (SS)	Senior Security Assistant
11	Issa Abdulai	Senior Security Assistant
12	Kofi Abraham (S&S)	Senior Security Assistant
13	Samuel Ayambire	Overseer
14	Kofi Kanjarga	Overseer
15	Samuel Adu Boahen	Senior Security Assistant
16	Christopher Kudze	Junior Foreman
17	Gladys Opoku (G&G)	Overseer
18	Charles Sarpong (G&G)	Overseer
19	Thomas Atendana	Overseer
20	Sulemana Abdulai	Traffic Supervisor

No.	Name	Grade
21	Kwasi Amakye	Overseer
22	Collins Kwasi Ahenkorah	Overseer
23	Sampson Nketiah	Overseer
24	Kofi Amakye	Assistant Overseer Gd.1
25	Wahab Yakubu	Overseer
26	Edward Nsorwaah	Overseer
27	Peter Lumor	Junior Foreman
28	Ebenezer Oware Tweneboah	Overseer
29	Amos Asemonu Biewko	Overseer
30	Kwasi Nyamekye	Supervisor Gd. I
31	Daniel Awatey	Assistant Overseer Gd. I
32	Samuel Boateng	Assistant Overseer Gd. I
33	Pius Yaw Addo	Assistant Overseer Gd. I
34	Margaret Adablah Azumi	Senior Technical Assistant
35	Simon Kumah	Supervisor Gd. I
36	Gifty Adwoa Agyeiwaah (G&G)	Asst. Overseer Gd. I
37	Joseph Ofori	Supervisor Gd. I
38	Cletus Akudbilla Ayabilla	Asst. Overseer Gd. I
39	Charles Adu	Asst. Overseer Gd. I
40	Ali Inousa	Asst. Overseer Gd. I
41	Gifty Tengan (G&G)	Asst. Overseer Gd. I
42	Leticia Laadi Atareyure	Asst. Overseer Gd. I
43	Emmanuel Koduah	Asst. Overseer Gd. I
44	Peter Ayambire Amoah	Asst. Overseer lGd. I
45	Anthony Osei Kwaku	Supervisor Gd. I
46	Comfort Adoma (Basic School)	Supervisor Gd. I
47	Stephen Abaidoo	Supervisor Gd. I
48	Appiah Kubi (G&G)	Supervisor Gd. I
49	Wiafe Kwaku	Asst. Overseer Gd. I
50	John Mensah	Supervisor Gd. I
51	Francis Yeboah	Supervisor Gd. II
52	Appiah Rawlings	Supervisor Gd. I

No.	Name	Grade
53	Salifu Iddi Serekye	Supervisor Gd. I
54	Amos Ania Akanzire	Supervisor Gd. I
55	Michael Fiawatsor	Supervisor Gd. I
56	Salifu Abdul	Supervisor Gd. I
57	Samuel Acheampong	Supervisor Gd. I
58	Jennifer Osei Owusu	Technical Assistant Gd. II
59	Agyenim Boateng	Supervisor Gd. I
60	Bernard Yeboah	Supervisor Gd. I
61	Kwabena Bosompem	Supervisor Gd. I
62	Joyce Fosu	Supervisor Gd. I
63	Kennedy Appiah	Security Assistant Gd. II
64	Alex Aglebe	Driver Gd. II
65	Enoch Asare	Security Assistant Gd. II
66	Sarfo Amoah John	Driver Gd. II
67	Alberta Yuonayel	Literate Helper
68	Joyce Bakur	Labourer
69	Nicodemus Banahene Boateng	Senior Labourer
70	Yaw Afriyie	Labourer
71	Zacharia Aidoo	Literate Helper
72	Sampson Amoateng	Supervisor Watchman
73	Joshua Owusu Afriyie	Tradesman Gd. II
74	Theophilus Amankwah	Labourer
75	Heavens Mawutow	Labourer
76	Samuel Aidoo	Security Man
77	Sumaila Abubakri	Labourer
78	George Atinyele Jnr.	Overseer

For more information, please contact

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