2020
ANNUAL REPORT

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH
INSTITUTE FOR SCIENTIFIC AND TECHNOLOGICAL INFORMATION
(CSIR - INSTI)

www. insti.csir.org.gh

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LIST OF ACRONYMS & ABBREVIATIONS

AGORA	-	Access to Global Online Research in Agriculture
AJOL	-	African Journals Online
ARI	-	Animal Research Institute
BRRI	-	Building and Roads Research Institute
CC	-	Creative Commons
CCST	-	CSIR College of Science and Technology
CLIMACCESS	-	Climate Accessibility
CNN	-	Cable News Network
COCOBOD	-	Ghana Cocoa Board
CSIR	-	Council for Scientific and Industrial Research
CRI	-	Crop Research institute
DD-G	-	Deputy Director-General
D-G	-	Director-General
DMC	-	Director's Management Committee
DOAJ	-	Directory of Open Archive Journals
FAO	-	Food and Agriculture Organisation
FORIG	-	Forestry Research Institute of Ghana
FRI	-	Food Research Institute
GAEC	-	Ghana Atomic Energy Commission
GISS	-	Geographic and Information Systems Section
GJAS	-	Ghana Journal of Agricultural Science
GNMC	-	Ghana Nursing and Midwifery Council
GJS	-	Ghana Journal of Science
GoG	-	Government of Ghana
HHP	-	Highly Hazardous Pesticide
HINARI	-	Health Inter Network Access to Research Initiative
ICT	-	Information and Communication Technology
IIR	-	Institute of Industrial Research

IITA	-	International Institute of Tropical Agriculture
INSTI	-	Institute for Scientific and Technological Information
iSTEAMS	-	International Sciences, Technology, Education, Arts, Management & Social Sciences Conference
ITS	-	Intelligent Transport Systems
JICA	-	Japan International Cooperation Agency
KNUST	-	Kwame Nkrumah University of Science and Technology
MAG	-	Modernising Agriculture in Ghana
MNO	-	Mobile Network Operator
MNS	-	Mobile Network Subscriber
NASLIC	-	National Science and Technology Library & Information Centre
NGO	-	Non-Governmental Organisations
OARE	-	Online Access to Research in the Environment
OPRI	-	Oil Palm Research Institute
PCB	-	Printed Circuit Boards
PGRRI	-	Plant Genetic Resources Research Institute
PNAS	-	Proceedings of the National Academy of Sciences
QR	-	Quick Response
RELC	-	Research-Extension-Farmer Linkages Committee
RESPRO	-	Research Project
S&T	-	Science and Technology
SARI	-	Soil and Agricultural Research Institute
SDI	-	Selective Dissemination of Information
SIMS	-	Scientific Information Management Section
SRI	-	Soil Research Institute
SSEs	-	Small Scale Enterprises
STEPRI	-	Science, Technology and Environmental Policy Research Institute
STI	-	Science, Technology and Innovation
STREC	-	Strengthening the Ethics and Regulatory Capacity

TDTC	-	Technology Development and Transfer Centre
TEEAL	-	The Essential Electronic Agricultural Library
UAT	-	User Acceptance Test
UAV	-	Unmanned Aerial Vehicle
WHO	-	World Health Organisation
WRI	-	Water Research Institute

MEMBERSHIP OF THE MANAGEMENT BOARD

(As at 31st July 2020)

Dr. Paul Effah	-	**(Chairman)** Management Consultant, Radford University College, East Legon, Accra.
Ing. Kweku Asmah	-	**(Member)** Ghana Institute of Engineers, Accra.
Ms. Genevieve Yankey	-	**(Member)** Director of Administration, CSIR Head-Office
Dr. Wilhelmina Quaye	-	**(Member)** Cognate Director, CSIR-STEPRI, Accra
Dr. Seth Awuku Manteaw	-	**(Member)** Director, CSIR-INSTI, Accra
Dr. Mohammed-Sani Abdulai	-	**(Member)** Senior Lecturer and Consultant, African Centre for Development Informatics, Accra
Mr. Kobina Asmah Jr.	-	**(Member)** CEO, Type Company Limited, Accra
In Attendance		
Mrs. Dorothy Awanyo	-	**(Secretary)** Administrative Officer, CSIR-INSTI, Accra

MEMBERSHIP OF THE INTERNAL MANAGEMENT COMMITTEE

(As at 31st July 2020)

Dr. Seth Awuku Manteaw	-	Director/Chairman
Dr. Abert N.M. Allotey	-	Deputy Director/Head, GIS
Mrs. Dorothy Awanyo	-	Head, Administration Division
Mr. Joseph A. Anyen	-	Head, Accounts Division
Dr. Agnes Decardi-Nelson	-	Head, Printing and Science Publishing Division.
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Ing. Michael Wilson	-	Head, Electronics Division
Mr. Mohammed Zainudeen	-	Head, Fluid Science Division
Mrs. Ivy Koranteng	-	Representative, Senior Staff Association
Mr. Eric Acquaye	-	Chairman, Trade Union Congress
Mr. Benjamin Folitse	-	Representative, Research Staff Association
Ms. Cordellia Busumtwi	-	Secretary

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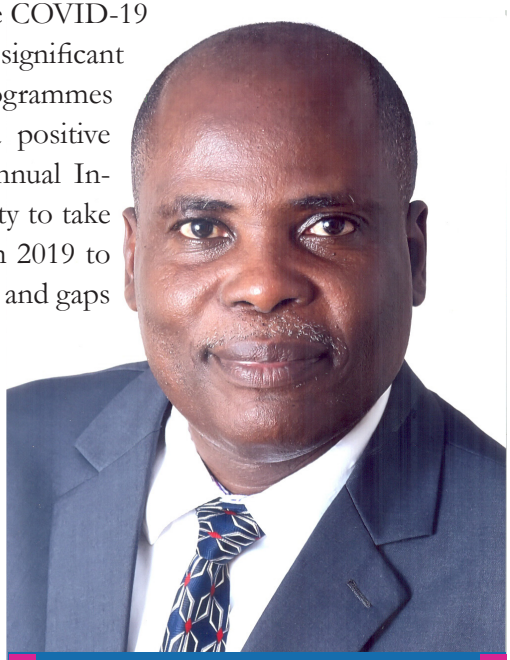
FOREWORD

Despite the challenges brought about by the COVID-19 pandemic, the year recorded some significant achievements in the implementation of programmes and projects. The year commenced on a positive note with the holding of the first-ever Annual In-house Review, which offered the opportunity to take stock and reflect on activities carried out in 2019 to identify shortfalls and gaps. These shortfalls and gaps informed activities into 2020.



Dr. Seth Awuku Manteaw
Director, CSIR-INSTI

Perhaps, the most significant achievement worthy of mention is the inauguration of the first-ever CSIR-INSTI Makerspace, set up to solve electronics and communication problems through learning and sharing of tools, expertise on projects and innovations.The Makerspace, which is currently operational, also provides technical support and assists start-ups and innovators to prototype and test their ideas at a lower cost. As part of efforts at leveraging on the technological accomplishment of the CSIR, the Institute, with the support of the Canadian-funded Modernising Agriculture in Ghana (MAG) Programme, developed four digital solutions to enhance agricultural extension and advisory services. These digital solutions, which are currently online, are *CSIR Technologies*, *CSIR Space*, *Kuafo Market Place* and the *Agritech Mobile Advisor*. These digital solutions represent a significant milestone in the Institute's effort at mainstreaming digital technologies in the various sectors of the Ghanaian economy.

A similar achievement chalked by the Institute on the digital front during the year was the development and implementation of an on-line Promotions Management System for research scientists of the CSIR. The fully operational System represents one of the initiatives to digitise management operations of the Council for the needed efficiency.

The Institute, in a bid to create more awareness about agricultural technologies developed by the CSIR, produced a Manual, which catalogues agricultural and agricultural-related technologies developed by agricultural-based institutes of the CSIR. This publication is expected to be of immense benefit to farmers, processors, input supplies and other actors along with the agricultural commodity value chain as well as agricultural extension agents, scientists, development partners, policymakers and other stakeholders in the agricultural sector.

The various divisions of the Institute deserve commendations for their contribution towards the realisation of the mandate of the Institute. Similarly, the Institute is most grateful to the Government of Ghana, development partners such as Global Affairs Canada, Governing Council of the CSIR and friends of the Institute for the support enjoyed during the year.

It is the pleasure and honour to present the Annual Report of the CSIR-INSTI for the year 2020.

Thank you.

Dr. Seth Awuku Manteaw
Director, CSIR-INSTI

EXECUTIVE SUMMARY

Amidst the COVID-19 Pandemic which took a toll across the board on activities in all sectors, 2020 turned out to be quite a productive year for the Institute with various research and development projects being carried out, software and applications developed and training programmes held both physically and virtually. Divisions worked hand-in-hand with each other to make the year a fairly productive one. A summary of the Institute's undertakings reported on is as follows:

Setup of Digital Agricultural Innovation Hub - Four digital platforms; CSIR Technologies portal, Kuafo Agritech Advisor (Q&A platform), CSIR Space (online repository) and Kuafo Marketplace (online marketplace), were developed and officially launched for use by clients. This programme was implemented and sponsored under the Modernising Agriculture in Ghana (MAG). The four portals which are designed to modernise and introduce efficiency in agricultural extension and advisory services are accessible on https://mag-csir.com.

CSIR-MAG Project on Documentation of CSIR Agricultural Technologies - Inputs (Technologies) from the various MAG Institutes of the CSIR were compiled and validated and have been developed into a manual titled *Manual of Agricultural Technologies Developed by the Council for Scientific and Industrial Research*. The manual has been printed and distributed. In all, two hundred and sixty-three (263) technologies were entered into the manual, which is expected to publicise these technologies and create a lot more awareness among actors of the agricultural commodity value chain and other stakeholders.

Production and Development of Fuel Cell/Biogas - Results from the experiment show that, when cassava peels and yam peels act as co-digestates to cow dung, a higher yield of the flammable gas, methane, is produced. This is about operating the bio-digester with a single feedstock such as cow dung or cassava peels or yam peels alone.

Evaluation of the Impact of Reintroducing the CSIR Newsletter to the Council and Clients - Answers to open-ended questions put to respondents stated that

respondents would be interested in a new CSIR newsletter if it displayed CSIR flagship products, research outputs and services as well as if it had quality packaging.

Impact of COVID-19 on the Printing Industry; Case of INSTI Press – For the study duration which was during the ban on all gatherings by the Government of Ghana as a measure to curb the spread of the COVID-19 virus, three clients expressed interest in CSIR-INSTI PRESS producing activity brochures, event posters, programmes, invitation cards, etc. for their events. However, due to the ban, all three programmes were cancelled. These three social events would have brought in a total of GH₵13,700.00 as revenue to CSIR-INSTI, thus, because of the COVID-19 restrictions, the Institute lost that amount in revenue.

CSIR Online Grants Management Software - An online software was developed for the management of the CSIR Grants System. The staff of CSIR Head Office were trained on its usage and application.

CSIR Promotions Management System Software - A software and an accompanying manual for managing the promotions of Research Scientists of CSIR were developed. The software would eventually replace the manual application system for CSIR Research Scientists with effect from January 2021. Nationwide training was held for all thirteen (13) Institutes of the CSIR as well as the Head Office.

CSIR Profiles Management System - The system, a Senior Members Profile Directory, provides professional and academic details on all Senior Members of the CSIR. Current Designation, Institute of affiliation, Division as well as field of specialisation are some of the information on the System. It is accessible via the link profiles.csirgh.com.

Launch of CSIR-INSTI Makerspace - The CSIR-INSTI Makerspace was launched on 30th October 2020. The Makerspace is a co-innovative space where like-minded persons gather to work on personal projects, share tools and expertise as well as learn from each other. It was meant to establish a solution hub based on applying research into accelerating technologies in electronics and telecommunications and to provide actionable recommendations targeted at creating new businesses from innovations.

Robotics Training Programmes - The training programme which evolved into a club, is a monthly subscription session for students who want to constantly undergo training and also team up as a group to participate in National and International Robotics competitions. Club membership is Gh₵350.00 monthly and includes, tuition, use of equipment and competition subscription fees. Training happens at the CSIR-INSTI on Saturdays from 9:00 am to 12:00 pm with an optional 2-hour slot for practice within the Makerspace facility on Wednesdays between 2:00 pm and 4:00 pm. Additionally, the YouTube video training channel currently has 984 views, 55 subscribers and over 36 hours of watch-time as of 15th December 2020.

Pesticide Verification App for Conservation Alliance - A prototype Pesticide Verification App for the Conservation Alliance is being developed in collaboration with the Conservation Alliance. The App would allow farmers to scan a QR code on a pesticide to know whether it is a Highly Hazardous Pesticide (HHP) or not.

COVID-19 Pandemic Digital Solutions - As part of a working group led by Innovate Ghana and the African Health Innovation Centre, CSIR-INSTI and MiPH Consult deployed a crowd-sourced web app to encourage citizens in Ghana to report suspected cases. The objective was to allow epidemiologists and health service officers to gain access to a larger volume of reports for follow-up, contact tracing and confirmation. The application offers the government the opportunity to leverage citizen reporting to complement existing contact tracing methods. The application is currently a web-based application accessible online at https://covid19gh.miphconsult.ml/views/map.

3D Modeling and Additive Manufacturing - In partnership with CTN Technologies, a 2-day intensive 3D Modeling and Additive manufacturing workshop was organised on 23rd and 24th October 2020 to expose young Ghanaians skills in 3D manufacturing. Participants learnt how to design and produce 3D models for various applications. The participants designed sample phone cases among other items. The Gh₵300.00 training package included; training materials, practical sessions, a certificate and technical support from the tutors beyond the duration of the workshop.

Development of Human Resource Management Software – A software system that digitises day-to-day Human Resource Activities, making them less tedious and simpler for the end-user is being designed. The software has several systems and processes combined to ensure easy management of human resources, business processes and data.

The project seeks to develop a Prototype of Human Resource Management Software that will help the HR department at CSIR-INSTI run its administrative activities.

Spatial Database Development on the Resources in Ghana - Maps for nine (9) regions were designed and composed. A geospatial database for existing Dams and Reservoirs in the country is also being developed. Fifteen (15) maps were produced for WINMAT Publishers to be inserted as illustrations in historical books of Ghana for primary schools.

Printing Services - Call cards, Letterheads, Files, Books and Manuals are some of the items printed out by the Institute for various Institutes of the CSIR, the Head Office and other external organisations.

Ghana Journal of Science & Ghana Journal of Agricultural Science - GJS and GJAS, the two leading science journals in the Country are published by the Institute. During the year, *Ghana Journal of Agricultural Science Vol. 55(1) and (2) (2020)* were published, eight (8) and ten (10) articles were featured respectively. Similarly, *Ghana Journal of Science Vol. 61(1) and (2) (2020)* were published. Eighteen (18) and twenty-two (22) articles were published respectively.

Information Resources - The information resources collected by the Scientific Information Management Section for 2020 stood at six hundred and eleven (611). These included journals, annual reports, and newspapers, which were acquired through exchanges, donations and data collection.

Staff Strength - The staff strength of CSIR-INSTI stood at 68 as at 31st December 2020, comprising twenty-six (26) senior members, twenty-six (26) senior staff and sixteen (16) junior staff. Dr. Albert Nii Moi Allotey was appointed as the Acting Deputy Director of the Institute. Two (2) staff members retired during the year.

Income Generated - Total receipt for the year under review amounted GH₵3,994,209.79 and payments totaled GH₵4,030,515.41 with a negative net receipt of GH₵36,305.62. The receipts are made up of salaries paid by GOG from the Consolidated Fund amounting to GH₵3,442,313.45. Internal Generated Fund (IGF) amounted to GH₵425,429.84 and Donor Funds of GH₵126,466.50. The IGF activities included Printing, Hiring of Facilities and Consultancy.

1.0. INTRODUCTION

The mandate of the Institute for Scientific and Technological Information (CSIR-INSTI) is to develop a national capacity and capability for the efficient and effective provision of scientific and technological information on demand for the benefit of research scientists, policy decision-makers, industrialists, etc. in an appropriately packaged form for national development.
The Institute's operative objectives are to:

- research into the Electronics/Communications and uptake of research findings to end-users.
- utilise and develop ICT tools and communication devices for socio-economic development
- provide sustainable training programmes in the fields of ICT and consultancy services using appropriate technologies and expertise
- adopt, adapt and master known and existing technologies
- conduct research into the following areas:
    - Intelligent Transport Systems (ITS)
    - SMART agriculture for sustainable green cities
    - High-performance data networks and Cybersecurity
    - Computer-aided designs and Robotics
    - Predictive analytics and algorithm development
- distinguish itself in the field of science publishing and ultimately become a leader in the speciality in Ghana.
- collect and analyse data for the design and construction of thematic maps using digital technologies to depict Ghana's resources and development potential to aid planning, policy decision making, research and general education
- collect, process, store and repackage for dissemination science and technology information embodying the results of indigenous science and technology research activities as well as those generated elsewhere for the benefit of planners in government, production and manufacturing concerns
- support the promotion of efficient research and development activities in the country through the provision of science and technology information services using appropriate information processing and communication technologies

- strengthen national science and technology information and infrastructure through effective networking and collaborative activities

In fulfilment of its mandate, CSIR-INSTI continued to collect, organise, coordinate, manage and repackage for dissemination, STI resources on a national scale to facilitate technology transfer between the developers or producers of technologies to enhance and accelerate the adaptation and diffusion of these technologies.
The divisions at the institute under which activities were undertaken were:

- Communications Division
- Electronics Division
- Fluid Science Division
- Geospatial and Information Science Division
    - Geographic and Information Systems Section
    - Scientific Information Management Section
- Printing and Publishing Division
    - Science Publishing Section
    - Printing Section

The supporting divisions were:

- Accounts
- Administration

2.0 RESEARCH & DEVELOPMENT PROJECTS

2.1 Food Security and Poverty Reduction

Completed Projects

2.1.1 Setup of Digital Agriculture Innovation Hub

Research Team: Wilson M., Manteaw S., Folitse B., Danquah P.A, Gordon V., Prikutse F., Twum-Barimah Y., Awotwi J., Ohene-Affih B., Kessey M.B., Mingle N.A., Laryea B., Sackey T.A., Mamah S.A & Boateng A.A.

Start Date:	January 2020
Completion Date:	December 2020
Actual Cost of Project:	GH₵155,000.00
Sponsors:	Modernising Agriculture in Ghana (MAG) Programme
Collaborating Institution:	Coordinating Unit of MAG, CSIR Head Office
Location:	CSIR-INSTI

Objectives

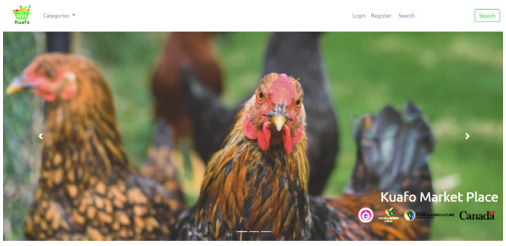
- To establish a standardised science and technology content infrastructure for Integrated Data/Information Exchange and Dissemination among stakeholders in the Agriculture sector.
- To build an agriculture and research data management system and foster a national platform for open crowd-sourcing of data on natural resources and farming activities.
- Provide online access to essential and validated agronomic data (expert newsletters, research outputs, new technologies, market price information, etc.) to the farming community.
- Provide Platforms for efficient Web portals and Mobile Apps that support farmers in improving their operations and getting direct market access to their produce.

Major Findings

1. There is a pressing need for farmers in Ghana to find access to market for their produce.

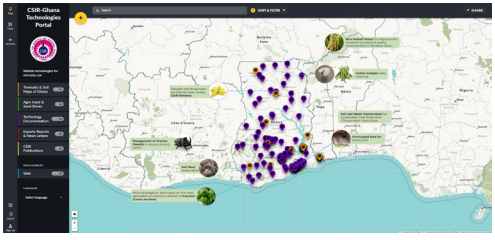
2. There are inadequate platforms in place for CSIR generated technologies and research outputs to reach targeted end-users.
3. There is a need for a unifying communication platform that will address the day-to-day questions of various actors in the agriculture value chain.
4. Four digital platforms; CSIR Technologies portal, Kuafo Agritech Advisor, CSIR Space and Kuafo Marketplace, were developed and made publicly accessible through this project to address challenges 1 – 3. The four portals are accessible from https://mag-csir.com.

Project deliverables were met following a User Acceptance Test (UAT) organised at CSIR-INSTI on the 30th November 2020. The project was closed accordingly as planned in the projects Workplan on the 18th December 2020.

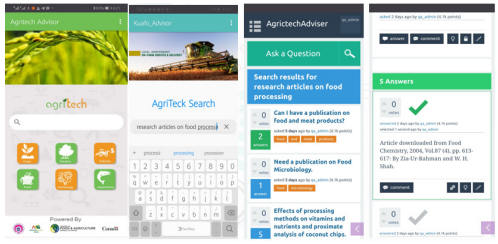


Kuafo Marketplace

CSIR Online Repository



CSIR Technologies Portal



Agritech Mobile Advisor App

Expected Beneficiaries

1. Agric Extension Officers
2. CSIR Institutes and Research Staff
3. Agricultural Input Suppliers
4. Market Women
5. Food Processors

Potential Impact

1. Farmers
2. Food Exporters
3. Development Partners
4. Policy Makers

Publications from Project

Publication on MAG developed platforms as captured on various news platforms:

- https://thevaultznews.com/business/agribusiness/csir-insti-designs-agricultural-digital-apps/
- https://www.csir.org.gh/index.php/publications/multimedia/news/item/505-csir-insti-designs-digital-apps-to-support-agricultural-productivity-dissemination

2.1.2 CSIR-MAG Project on Documentation of CSIR Agricultural Technologies

Research Team:	Manteaw S.A., Folitse B.Y., Mahama S. & Mingle N.A.
Start Date:	July 2019
Completion Date:	December 2020
Actual Cost of Project:	GH₵40,000.00
Sponsors:	MAG
Collaborating Institution:	Coordinating Unit of MAG, CSIR Head Office
Location:	CSIR-INSTI

Objectives

The Coordinating Unit of the MAG at the CSIR Head Office in an attempt to address the problem of lack of awareness about existing CSIR agricultural technologies, in May 2019 commissioned the CSIR-Institute for Scientific and Technological Information (CSIR-INSTI) to document agricultural and agricultural-related technologies developed by institutes of the CSIR for the last 12 years from 2007 to 2019.

The Project was designed to:

- Promote enhanced awareness about current technologies developed by the CSIR
- Make for easy reference by stakeholders attending District and Regional Planning Sessions of the RELCs
- Publicise the work of scientists and inspire confidence for support
- Close the seeming gap that exists between current CSIR agricultural technologies and farmers' awareness about these technologies

Major Findings

Inputs (Technologies) from the various MAG Institutes of the CSIR were compiled and validated and have been developed into a manual; Manual of Agricultural Technologies

Developed by the Council for Scientific and Industrial Research, which has been printed and distributed. In all two hundred and sixty-three (263) technologies were entered into the manual. The breakdown is as follows:

Technology	Number	Technology	Number
Cereals	72	Mushroom	2
Machines and Equipment	11	Non Ruminants	2
Fibres	1	Processed foods	14
Fish	6	Roots/Tubers	60
Forestry	7	Ruminants	9
Fruits	4	Soils	10
Legumes	39	Tree Crops	21
Medicinal Plants	2	Vegetables	3

Expected Beneficiaries/Potential Impact

1) Farmers
2) Processors
3) Input Dealers
4) Agric Extension Agents
5) Agricultural Research Scientists
6) Policy Makers
7) Development Partners

Publications from Project

- Manual of Agricultural Technologies Developed by the Council for Scientific and Industrial Research (CSIR) Manteaw S.A., Folitse B.Y., Mahama S., Mingle N.A. (August 2020).

On-going Projects

2.1.3 The Use of Mobile Phones in Poverty Reduction Among Oil Palm Processors in Ghana: The Case of Small Scale Oil Palm Processors in the Kwaebibirem District, Eastern Region, Ghana

Research Team:	Folitse B.Y., Manteaw S.A. & Ampofo-Addo A.S.
Start Date:	January 2020
Duration:	18 months
Budget:	Gh₵20,000.00
Sponsors:	GoG
Collaborating Institution:	CSIR-OPRI
Location:	CSIR-INSTI

Introduction

The use of mobile phones has introduced significant changes in most sectors of the economy, especially in the informal sector where many Small Scale Enterprises (SSEs) are changing their ways and means of transacting business, and this has impacted greatly on the telecom industry and has made it the fastest-growing sector in the country (Overa, 2006). Mobile phones provide technological services that bring about efficiency in the cost build-up resulting in an increase in incomes and also suppliers' ability to reach out to the people involved (Aker and Mbiti, 2010). They promote social and business networks, and they replace journeys, brokers, traders and other business intermediaries (Donner, 2005, Hughes and Lonie, 2007). Oil palm processors in their routine business engage with numerous service (network) operators to make good use of their mobile phones. Mobile phones have been spreading fast among actors along the value chain and they are exchanging their marketing and business information among themselves. Processors directly contact market brokers and near cities to sell their products. Similarly, farmers focus, search for useful and up-to-date market information from social and business networks (Ilahiane, 2007). Many studies show that access to communication technologies has an impact on the economy, poverty reduction as well as agricultural development. The use of mobile phones could increase the efficiency of processors by affordable access to business information thereby increasing production in rural areas of developing countries. A study conducted in Bangladesh specified that the use of mobile phones increased access to information among men and women and improved their living standards (Abraham, 2006; Aker, 2008; Galperin and Mariscal, 2007; Jensen, 2007, Bhavnani et al. 2008). Equally, Folitse et al. (2019) concluded that

there is a high penetration rate of mobile phones among small-scale poultry farmers and underlined the importance of the mobile phone as a driver of business operations. Therefore, it can be said that mobile phone technologies have provided a good platform for processors to share their knowledge and information among themselves on issues such as market rates and input cost in developing countries (Munyua, 2007, Lehr, 2007).

Objectives

- Find out the socio-demographic backgrounds of oil palm processors in the area of study.
- Ascertain the Importance of Mobile Phone Use to oil palm processors.
- Determine the motivation for oil palm processors uses of mobile phones in the study area.
- Find out the constraints in the use of mobile phones by oil palm processors.
- Establish the relationship between oil palm processors' demographic characteristics and their mobile phone usage.

Materials and Methods

Study Area

This study will be carried out in the Kwaebibirem District in the Eastern region of Ghana. The Kwaebibirem District is located between latitude 6°22'N-latitude 5°75'S and longitude 1°0'W– longitude 0°35'E° (KDAP, 2006). It is bordered by Birim North District to the north-west, Atiwa District to the north-east, on the south-east by Denkyembour District, and on the South-west by Akyemansa District. Kwaebibirem District has a land area of 1230 km^2 with Kade as its capital. The district has a tropical climate characterised by two distinct conditions of wet and dry seasons. The wet seasons ranges from April to July and from September to November with a total annual rainfall of about 1500 m, while the dry season ranges from December to March. Minimum and maximum temperature range between 25°C – 30°C respectively (GSS 2010). The main economic activity carried out in the district is agriculture; that is, crop and livestock production. The following crops are produced: cocoa, citrus, plantain, banana, and cassava, oil palm, rubber, rice, leafy and fruit vegetables, maize, among others. However, oil palm, cocoa, rubber and citrus are the main cash crops produced in the district. It is estimated that about 13,095 households are engaged in the cultivation of oil palm (Ofosu-Budu and Sarpong 2013). About 50% of oil palm farmers produce palm fruits on a contractual agreement with Ghana Oil Palm Development Company (GOPDC), the largest palm oil production company in Ghana (Adjei-Nsiah, Sakyi-Dawson and Kuyper 2012). GOPDC also produces about 30% of oil palm, while 70%

of the production of oil palm is carried out by smallholder farmers. Hence, a total area of 50, 700 ha of oil palm are under cultivation in the district (Adjei-Nsiah, Zu and Nimoh 2912).

Research design

This survey research investigates how small-scale oil palm processors in selected rural communities in the Kwaebibirem District, Eastern Region, Ghana use mobile phones in poverty alleviation. The interview schedules elicit responses about small-scale oil palm processors' demographic characteristics, ascertain the importance of mobile phone use to oil palm processors, determine the motivation for oil palm processors use of mobile phones in the study area, find out the constraints in the use of mobile phones by oil palm processors and establish the relationship between oil palm processors demographic characteristics and their mobile phone usage.

Sampling method

The population for this study is oil palm processors in Asuom, Otumi, Subi, Kade, Kusi, Takorase, Wenchi, Abaam and Abodom, all in the Kwaebibirem District, Eastern Region and numbering about 380. A sample size of 120 oil palm processors from the population will be considered for this study. A random sampling technique will be used to select the 120 oil palm processors for the study from a finite population of registered oil palm processors of the Kwaebibirem Oil Palm Processers Association. All the 120 cases will be analysed, representing 100% of the total sample Table 1). The focus of the field survey will be on small scale Oil Palm Processers. The distribution and location of Oil Palm Processers are shown in Table 1.

Table 1: Number of Oil Palm Processors Surveyed in Each of the Towns in Kwaebibirem District

Town	Oil-Palm processors	Percentage
Asuom	7	5.8
Abodom	8	6.7
Takrowase	9	7.5
Abaam	10	8.3
Wenchi	10	8.3
Kade	14	11.7
Subi	19	15.8
Kusi	20	16.7
Otumi	23	19.2
Total	**120**	**100**

Method of data collection

Interviews were conducted using structured questionnaires to be administered to Oil Palm Processers randomly selected from a database of Oil Palm Processers obtained from the Kwaebibirem Oil Palm Processers Association, Eastern Region, Ghana.

Results Achieved so Far

Data collection has been completed pending analysis.

Way Forward

Results and discussions will start in January 2021, leading to the production of a refereed journal article for publication in a high-impact factor journal.

2.1.4 The Role of Middlemen in Plantain Marketing Channels in Ghana: The Case of Agbogbloshie Market, Accra

Research Team:	Manteaw S.A., Folitse B.Y., Mingle N.A. & Koranteng I.M.
Start Date:	February 2020
Duration:	18 months
Budget:	Gh₵30,000.00
Sponsors:	GOG
Collaborating Institution:	Nil
Location:	CSIR-INSTI

Introduction

According to Latham (2001), plantain (*Musa paradisiaca)* is one of the most important staple food crops for millions of people both in developed and developing countries, a fact reflected in the gross value of its production. It reaches its greatest importance in parts of East Africa, where annual consumption is over 200 kg per capita and in West and Central African where more than 10 million tonnes are produced annually and are traded locally (Lescot and Jacky, 2010). Figures obtained from the FAO (2010) indicate that Ghana is the largest producer of plantain in West Africa and the second in Africa after Uganda and Rwanda.

Plantain belongs to the non-traditional sector of the rural economy, where it is used mainly to shade crops in cocoa farming in Ghana. Plantain is an essential component of the diet of many Ghanaians. More than 90% of the cultivated area in Ghana belongs to

small scale farmers (Dzomeku, Dankyi and Darkey, 2011). In the Ghanaian agricultural sector, plantain is ranked third after yam and cassava (FAO, 2010) and contributes about 13.1% to the Agricultural Gross Domestic Product (AGDP). Plantain is grown across all the humid agro-ecological zones and forms an integral component in most of the complex farming systems (Swennen and Vuylsteke, 1991). Since the last decade, plantain yields in West Africa have experienced slight increases with the largest production of 3.7million metric tonnes in Ghana contributing about 13.1% of the agricultural GDP (Olumba & Onuuka, 2020)

Plantain is a seasonal crop with a relatively short shelf life hence, it is available for a limited period and post-harvest losses are very high. These situations necessitate a scientific survey of its marketing system to promote speedy sales and reduce losses of both quality and quantity. According to Adetunji, and Adesiyan (2008), relative attention given to plantain is focused on its production technology, while little is done on its marketing. It is however understandable that increased production without a consistent increase in marketing may amount to wastage of resources. Also, Njoku and Nweke (1996) later agreed that the marketing condition changed, because the sector was ignored. According to Adetunj and Adesiyan (2008); plantain market is a perfect competitive market and the business is easy to start with moderate initial capital. They further note the profitable nature of the business with high gross margin and marketable margin which are subject to increase as marketers source produce from remote communities.

Akalumbe (1994) had earlier observed the marketing and post-harvest handling systems of plantain in Southern Nigeria and agreed with Njoku and Nweke (1995) that good infrastructure and facilities for storage as well as processing coupled with means of transport are important for an improvement in the plantain marketing system.
Marketing of plantain is very difficult in Ghana because of the diaspora nature of the production areas, absence or poor conditions of roads, poor lines of communication with urban consumption centres and the irregular supplying in the market by wholesalers and middlemen who set the prices. In addition, perishable produce like plantain suffers from continuous deterioration resulting from poor post-harvest management. This aggravates loss of quality and quantity and thus affects the final price. Plantain marketing involves the role of middlemen in passing plantain from the farms to the markets. Therefore, the roles of markets cannot be ruled out because production centres are fragmented and mostly on a small scale. It is faced with a lot of marketing problems and these problems determine whether production can be expanded.

Middlemen are marketing intermediaries who do not add value to the products but receive a fee for expediting the exchange. Bryceson et al. (1993) reported that the middlemen performing the role of marketing are being accused of earning higher profit in the marketing system. Middlemen have various functions in the marketing of products, produce or services. These include maintaining contact with buyers, negotiating prices, delivery, transfer of title, providing credit or collections, servicing of products, providing inventory and storage and arranging transportation. They are also classified differently by scholars into buying brokers. (Gilbert, 1969), finds evidence of brokers in nearly all studied fish markets like in many forms across Nigeria, farmers are not allowed to sell their produce directly to consumers but must deliver the product to middlemen who are mandated to sell the produce to traders and consumers. The role of plantain marketing in developing countries changes with its economic development and as a country develops; the structure of its urban plantain marketing changes.

Plantain marketing assumes greater importance in the Ghanaian economy because the excess production must be disposed of to earn some income. The Middlemen assist the plantain farmers with inputs wherever possible and other monetary needs to run their farming business and in return sells their produce to the consumer (buyer) at an agreed price; any attempt by the outside intermediary is often met with very stiff resistance (Agbebi and Fagbote, 2012). Wholesalers have three sub-groups: The wholesaler agent, the wholesale transporter and the wholesaler retailer. Together they perform important functions such as commodity packing, financing, transportation, sorting, grading and storage; they rarely sell to consumers except where consumer are industrial users.
The retailers also have three sub-groups: They are sedentary or stall retailers, the itinerant retailer (hawker) and the farmer retailer. In this case, the income for the producer and the retailer is very low, while the middlemen have the highest income and consequently, the price of the plantain changes as it passes through these channels such that by the time it reaches the consumer, it becomes too expensive. Hence, this study necessitates how the producers and the retailers will be free and not too dependent on the middlemen.

Objectives

- Identify the socio-economic characteristics of women in plantain marketing
- Examine the roles of middlemen in the plantain industry
- Determine the profitability of plantain marketing
- Find out the constraints of middlemen in plantain marketing

Materials and Methods

Study area

The study was conducted at Agbogbloshie market located in Ghana's capital city Accra. Agbogbloshie lies at the centre of Accra. According to opinion leaders, Agbogbloshie is the name of a river god that controls the area. The place was formerly a burial place for Ga chiefs. In the 1960s, a well-known segment of the Accra Makola market was moved to Agbogbloshie which made the place popular for the sale of fresh foodstuffs to date. Agbogbloshie is known mainly because of the market. Different foodstuffs are sent to the market from every corner of the country for sale. The market serves as the main source of livelihoods for residents of Agbogbloshie and nearby communities. The market is vibrant both at night and during the day. It is busy at night, the time that goods brought to the market are offloaded. Different commodities are traded at the market, the common ones being foodstuffs. The market is, therefore, known to have special sections for different foodstuffs; yam market, onion market, a section for plantain, corn and its by-products, tubers like cassava and cocoyam, dry and fresh fish and much more.

Sampling procedure

The population for this study was members of the plantain sellers association in the Agbogbloshie market in Accra, Ghana. A survey design was adapted for the study. A random sampling technique was used to select 50 plantain sellers in the Agbobloshie market for the study out of the 134 plantain sellers.

Data collection

The source of data for this study would be primary data from plantain sellers who are involved in Plantain Marketing in the Agbobloshie market. In Ghana, plantain is the fourth most important starchy staple after grains, cassava, and yam (Cropley and Morriss, 1993). On a food-value basis, it is the second most expensive starchy staple in urban markets after yam, reflecting a strong consumer preference and an excess demand for the crop (Cropley and Morriss, 1993). Data collection would be through the use of a structured questionnaire administered through face-to-face interviews. Data collected would include the socio-economic characteristics of plantain sellers, the roles of middlemen in the plantain industry, the profitability of plantain marketing and the constraints of middlemen in plantain marketing.

Data analysis

The data collected would be analysed using IBM SPSS Statistics for Windows, Version 24 (IBM Corp., Armonk, NY, USA). Data analysis would be univariate, using descriptive statistics of frequencies and percentages.

Results Achieved so Far

Data collection is on-going.

Way Forward

Data analysis will start in February 2021.

2.2 Climate Change, Environmental Conservation and Green Technology

On-going Projects

2.2.1 Climate Change Resilience in Urban Mobility

Research Team: Kofie R.Y. & Allotey A.N.M.
Start Date: June 2018
Duration: 5 years
Budget: USD289,182.83
Sponsors: Ministry of Foreign Affairs of Denmark
Collaborating Institutions: University of Ghana (Denmark and Department of Geography & Resource Development) & University of Copenhagen (Department of Geoscience), Denmark.
Location: Accra, Ghana

Introduction

The project aims at identifying research-based strategies for increasing climate change resilience within urban mobility, accessibility and transport in Accra, Ghana. It is to establish a comprehensive understanding of the physical and factors that determine resilience to climate change impact on mobility and accessibility in the Accra Metropolitan Assembly (AMA). This would be accomplished by enhancing research capacity in the field, introducing new methods for mobility analysis, new methods for predicting urban floods, and by devising policy and planning measures to advance the sustainable urban development agenda. The research and capacity building are expected to lead to a reduction in inequality in access to mobility and, thereby, the reduced vulnerability of local communities challenged by unsustainable spatial development practices and increased frequency of extreme weather events.

Objectives

- Identify strategies for increasing climate change resilience within urban mobility, accessibility and transport in Accra, and
- Investigate how these strategies may be integrated into the urban planning and decision-making process.

The project aims to:

- Enhance research capacity in the field, introduce new methods for mobility analysis, new methods for predicting urban floods, and
- Devise policy and planning measures to advance the sustainable urban development agenda.

Materials and Methods

This interdisciplinary research effort will draw upon the combined competencies of the involved North and South partner teams within climate change scenarios, flood modelling, urban planning, socio-economic analysis, and GIS-based spatial analysis. The project will apply a combination of quantitative and qualitative methods to address the objectives of the different work packages. The quantitative methods include questionnaire surveys, computerised analysis of local and city-wide elevation models, satellite images as well as GIS-based analysis of the urban transport networks in terms of risk of flooding, connectivity and level of redundancy. A small UAV ("drone") will be applied to collect local elevation data for evaluation purposes. A city-wide elevation model based on satellite images will be obtained for the project. The qualitative methods include focus groups, key informant interviews, field observations, in-depth qualitative interviews and participatory community workshops.

Results Achieved So Far

1. Inception workshop successfully organised on 27th June 2018 at Alisa Swiss Hotel, North Ridge, Accra.
2. A reconnaissance survey was undertaken with all collaborating researchers.
3. Team members travelled to Copenhagen, Denmark for a project meeting (18th – 27th August 2018)
4. Enumeration Areas of Greater Accra Region for 2000 and 2010 population census acquired from statistical Service, Accra. Spatial and statistical data being merged
5. Updating of enumerations areas with population data of 2000 and 2010
6. Scanning newspapers reports on flooding in Accra from the past 15 to 20 years in progress
7. Organised satellite images of the Greater Accra Region which would be interpreted to generate a land use/land cover map.
8. Organised meteorological data (rainfall) from CSIR-WRI
9. Carried out community entry exercise by visiting all the selected study sites thus, Adenta, Pokuase, Santa Maria / Auntie Aku and Gleffe/ Mpoase.

10. Transcribed recorded interviews in Ghanaian languages to English.
11. Had a project meeting in Copenhagen, Denmark from 10th -14th June 2019 with all participating scientists.
12. A Reconnaissance Survey for flying of the drone in selected study sites were carried out.
13. Citywide elevation model created.
14. Flew Drone with LiDAR mounted, at three (3) places namely, University of Ghana, Legon, Santa Maria/ Auntie Aku- Ga Central Municipal Assembly and Adenta in the Adenta Municipal Assembly. This fieldwork was achieved in 10 days (19-30th August 2019)
15. Socio-economic field survey to complete community profiling (settlement narratives) has been accomplished
16. Published article title: Comparison of Satellite-Based Estimates of Urban Agglomeration Size for the Accra Area. ISPRS Int. J. Geo-Inf. 2020, 9, 79; doi:10.3390/ijgi9020079 www.mdpi.com/journal/ijgi https://www.mdpi.com/2220-9964/9/2/79/pdf (2020)
17. Preliminary results for LiDAR images are available. They include merged and aligned points and digital surface models.
18. The design of a questionnaire on livelihood strategies and mobility patterns has been completed.
19. A pilot testing of the designed questionnaire has been accomplished.
20. LiDAR image processing manual completed.
21. Field validation of drone image for three sites carried out.
22. The Four "Settlement Profile Reports" (WP-A) have been completed and published in the IGN working papers series
23. A paper draft on the integration of citywide elevation models with local Drone-based Lidar models for detailed flood modelling with Katerina as the main author is getting ready for submission. Additional field work was carried out in Accra recently to provide more validation data.
24. The final city-wide flood maps and other spatial data have been published on the ClimAccess internet map portals
25. Technical reports on a) the flood modelling methodology (WP-B) and b) GIS analysis of mobility loss due to flooded roads (WP-C) have been completed and published on the website. (check the website: ign.ku.dk/climaccess for more activities and more information)

Way Forward

- Training of research scientists in February 2021 followed by socio-economic data collection using a questionnaire in all the study communities thus, Glefe, Pokuase, Santa Maria and Adenta
- Creation and field validation of digital transport network model.
- Initial spatial analysis and mapping of urban accessibility levels.
- Dissemination of project status and preliminary results on the website.
- Work or the remaining work packages

2.3 Material Science and Manufacturing

Completed Projects

2.3.1 Production and Development of Fuel Cell/ Biogas

Research Team: Zainudeen M.N., Kwarteng M.
Start Date: July 2019
Completion Date: August 2020
Actual Cost of Project: GH₵2,500.00
Sponsors: Fluid Science Division and Geographic and Information System Section
Collaborating Institution: GAEC-SNAS, CSIR-IIR
Location: CSIR-INSTI

Objectives

- To compare the daily volume of biogas produced from three different kinds of organic substrates under ambient or mesophilic temperatures.
- To study the pH and temperature of the anaerobic digestion process.

Major Findings

The results from the experiment show that when cassava peels and yam peels act as co-digestates to cow dung, a higher yield of the flammable gas, methane, is produced. This is about operating the bio-digester with a single feedstock like cow dung or cassava peels or yam peels alone.

Expected Beneficiaries/ Potential Impact

1) Accessible to people in the remote and rural communities of the West-African sub-region.
2) To promote green energy production and its utilisation.

Publications from Project

- Technical report
- Scientific article

On-going Projects

2.3.2 Poultry Incubator

Research Team: Twum-Barimah Y., Wilson M., Gordon V.
Start Date: May 2017
Duration: 4 years
Budget: GH₵45,000
Sponsors: Not yet found
Collaborating Institution: Nil
Location: CSIR-INSTI

Introduction

Research on the possibility of using direct Sun Power as the main heating element for Bird Egg incubation with Solar Panel as the main power supply. The cost of egg production is highly reduced when free direct Sun is scavenged to produce the heat needed for the hatchery. In addition, the integrated Solar Power paves way for egg hatchery production to be established even in rural areas where there is no electricity.

Objectives

To provide efficient, high hatch rate, solar-driven and affordable Incubator for Poultry Farmers leading to an increasing bird production in support of food security and sustainability.

Materials and Methods

The previous top lid method has been modified such that a close contain setting is used. Styrofoam type container is used as the container. The power interface is designed to have Solar Power as the main Power Input. To arrive at the right parameter settings for excellent hatchery, a data logger results simulation is employed. For early warning and quick response action, a channel is developed for real-time communication.

Results Achieved so Far

An incubating box, Systems Control Unit, sensor network and the tray control motor have been assembled. The temperature setting seemed fairly good. Yet, a different approach was experimented with to arrive at much better values. The setup used to control the internal humidity was not able to produce adequate values. Different setups are being tested to arrive at the most appropriate values [50-60 % Relative Humidity]

of humidity generation and control. A humidifier Control Set has been identified and should help solve any instability in this parameter control. An arrangement has been made to purchase the set for the humidifier control. Meanwhile, the experiment continues in trying to achieve a more stable value with the current local setting.

Way Forward

Various design test models for the experiment have been carried out previously. Attention is still on the humidity control and reshaping of the incubating box. A humidifier control system has been identified and the necessary arrangements are being made to order the item. The search for sponsors to support the project continues as the project suffers serious financial constraints. Necessary writings and documentations on the project are also being worked on alongside the main development.

2.4 Electronics and ICT

On-going Projects

2.4.1 Cell Phone Signal Booster

Research Team: Danquah P.A, Prikutse F., Gordon V., Wilson M., Twum-Barimah Y.
Start Date: June 2020
Duration: 24 months
Budget: GH₵20,000.00
Sponsors: In search
Collaborating Institution: None
Location: CSIR-INSTI

Introduction

Cellular signal is broadcast from towers that are installed by the Mobile Network Operator (MNO)s. The closer you are to a tower, the stronger the cell signal is going to be. As you move further away from the tower, the signal becomes weaker, which we call attenuation, until at some point it is too weak to hold a call or transfer data. Being too far away from a cell tower is the most common reason for weak cell signals and the one you will often experience if you live or travel in very rural areas, in the basement of buildings and the corners of some rooms.

The presence of obstacles also causes poor or erratic cell signal. Obstacles such as a mountain, hill or building between the cell tower and the cellular device will result in a weak signal. One may also experience this cell signal problem if the cellular device is at the bottom of a valley or underground. The signal is not usually able to penetrate through large obstacles. The cell signal may bounce off other hills or buildings and reach the cellular device through reflection, in which case the received signal will be weaker and may fluctuate up and down, or may go off completely.

One could also experience weak or poor signals as a result of the construction materials that make up the building or vehicle in which the cellular device is. Brick, block, concrete, sheet metal and wire mesh are some of the construction materials that are known to block cell phone signals. In certain areas, the cell signal outside the building may be usable but drops significantly once the cellular device gets into the room.

This project seeks to design and construct a cellular booster or amplifier that will enhance mobile phone signal reception in areas where the cellular signal from the MNOs is very weak. The cell phone signal booster will improve weak signals from any of the MNOs in Ghana and will be useful in rooms, basements, compounds and any other location where MNOs signals are weak.

Objectives

- To design a cell phone signal booster for subscribers of Mobile Network Subscribers (MNSs) in Ghana.
- To build a cell phone signal booster for subscribers of Mobile Network Operators (MNOs) in Ghana.

Materials and Methods

This project is broken down into the following: The design stage, the drawing and simulation stage, the construction stage and the testing stage.

The design stage will help in determining the values of each component to be used in the circuit. Softwares such as TinyCAD, OrCAD, EAGLE among others will be used in designing Printed Circuit Boards (PCB). For this project, Dip Trace software will be used to design the PCB. It has four modules which include schematic capture, component, pattern editor, 3D modelling and PCB Layout editor. It also supports Windows, Mac, and Linux

The cell phone signal booster circuit will be drawn using Advanced Design System (ADS) Radio Frequency (RF) software. The simulation will be done with this same software.

After obtaining desired results, the circuit will be constructed on a printed circuit board with the components that will be determined during the design stage. An input antenna will be built from scratch and used alongside an existing output antenna.

The cellular signal in decibels (dB) before boosting will be measured and compared to the cellular signal after boosting. This will form part of the testing stage and will be done repeatedly to arrive at conclusive results.

Results Achieved So Far

A Conference paper titled "An Optimal Low Noise Amplifier (LNA) design for Signal Boosting" was successfully presented and accepted for publication in conference

proceedings at the International Conference on Mechatronics, Remote Sensing, Information Systems and Industrial Information Technologies organised virtually by the Institute of Electrical and Electronic Engineers (IEEE) from 20th to 22nd December 2020.

Similarly, a paper has been published: Danquah, P. (2020), Security Operations Centre: A Framework for Automated Triage, Containment and Escalation, *Journal of Information Security* Vol.11 No.4, DOI: 10.4236/jis.2020.114015

The cell phone signal booster project is still in progress. It is intended that the design of the low noise amplifier will be improved and a prototype subsequently built subject to availability of funds.

Way Forward

Further designs and simulations will be carried out with the help of the Advanced Design System (ADS) and Multisim software. Beyond this phase will then be the determination of a more optimal component combination/configuration and the physical construction of the circuit (prototype) and testing.

2.4.2 Towards an Automated Moderation of Abusive Comments: The Case of Ghanaian News Sites

Research Team:	Laryea B., Danquah P.A, Gordon V., Prikutse F.
Start Date:	November 2020
Duration:	24 months
Budget:	GH₵20,000.00
Sponsors:	In search
Collaborating Institution:	None
Location:	CSIR-INSTI

Introduction

Traditional news delivery is a one-way transmission, which is from the producer to the consumer and not vice versa. The advent internet and the birth of web 2.0 have made news delivery a two-way information transmission. The online commenting feature on news articles on websites is a must-have feature. This seeks the views of the audience on the subject matter. However, allowing user-generated content such as comments

creates uncertainty on the quality control of the content on the site as the users who are free to give their opinions on articles are not in a controlled environment with checks and balances. Online abuse and trolling are on the rise and news sites have set up techniques to control their space. In Ghana, news sites have their means of checking their audience's content; however, they find it hard to control content in local languages. The news sites only focus on content in the English language and also third party services. Whiles others provide filters for only content in the English language.

Objectives:

- Automate the Moderation of Abusive Comments On Ghanaian News Sites
- To build a machine learning engine that automatically learns about abusive language on Ghanaian news sites.

Materials and Methods

The source data will be collected from Ghanaian news websites. It is projected that a minimum of 12000 and a maximum of 25000 comments will be collected. Scrapping of the data will be done using Jsoup, which is a Java library for working with real-world HTML. It provides a very convenient API for fetching URLs and extracting and manipulating data, using the best of HTML5 DOM methods and CSS selectors. A java program will be written to scrap the comments from the comments links stored in the database (MySQL).

The comments will then be manually annotated by two possible categories namely abusive and non-abusive in addition to cataloguing specific abusive words. The annotator will be built using Java Springboot with the Thymeleaf template engine.
Upon successful annotation, the machine learning process will be used to train and learn the abusive language for testing.

Results Achieved so Far

The project focuses on tackling abusive comments on Ghanaian websites and blogs. We sourced our training data from comments from GhanaWeb and used the language model machine learning technique to train and evaluate the result trained model. Our trained model recorded 78% accuracy with a 2.498% margin of error. It also showed a confusion matrix of 78% True Positives, 22% False Negatives, 22% False Positives and 78% True Negatives.

Way Forward:

A system that automatically filters out abusive comments and also automatically learns about abusive in the Ghanaian context would be developed. The system is to be hosted as an Application Programming Interface (API) for subscription by Ghanaian News sites.

2.4.3 Design of a Paperless Memo System for Corporate Communication in CSIR, Ghana

Research Team: Adjah J., Wilson M., Sawyerr A., Kalognia J.
Start Date: October 2019
Duration: 18 months
Budget: GH₵10,000.00
Sponsors: Nil
Collaborating Institution: Nil
Location: CSIR-INSTI

Introduction

In this technological age, great strides are continuously made at cutting down timelines in the corporate world. In the area of communication today, many media are incorporated to allow the sending and decoding of messages at a fast rate.

Memos or Memoranda are the main forms of communication within an organisation. Even though paper systems are still relevant, it has its demerits of paper wastage and long channels of information sharing from sender to receiver. To create a working ecosystem in which management reduces the use of papers and time spent printing and sending memos to every department, this project seeks to design and test an Electronic Memo System for the CSIR-INSTI.

Objectives

- To develop, test and deploy a paperless memo system for the CSIR-INSTI
- To commercialise a successfully tested and deployed electronic memo system for other institutes in CSIR and others.

Materials and Methods

The following steps will be adopted for the implementation:

- An evaluation and appraisal of the current printed memo system and CSIR email system through data collection
- Identification and testing of email features for designing, sending, receiving and archiving memos
- Testing for efficiency and effectiveness
- Recommendation to administration for user training to be carried out to prepare respective staff.

Results Achieved so Far

Researchers have halted the development of a new interface following discussions on using an existing framework.

Way Forward

The project team after careful deliberation realised it was necessary to review the current memo system through interviews with administrative staff. The aim is to understand the different types of memos and how they are circulated.

2.5 Science and People

Completed Projects

2.5.1 Evaluation of the Impact of Reintroducing the CSIR Newsletter to the Council and Clients

Research Team: Sawyerr A., Decardi-Nelson A., Adjah J., Kalognia J., Zainudeen M.N., Adotevi E.J.
Start Date: August 2018
Completion Date: July 2020
Actual Cost of Project: GH₵5,000.00
Sponsors: None
Collaborating Institution: University of Ghana
Location: CSIR Institutes and Donor Organisations in the Greater Accra Region

Objectives

To determine what accounted for the demise of the CSIR newsletter and to conduct a needs assessment of the newsletter's purpose to the information and education needs of CSIR's target audience.

Major Findings

A purposive sampling targeting the Research Staff Association (RSA) of CSIR was used. Questionnaires were distributed to them and their responses were collected and analysed. This study determined that respondents were satisfied with the contents of the defunct newsletter and were willing to patronise a new newsletter, provided it suited their expectations.

The complete analysis and write-up of the project would be published in a technical report submitted to CSIR-INSTI.

Beneficiaries/Potential Impact

- CSIR Research Staff Association
- All CSIR staff
- NGOs
- Policy Makers
- Academic researchers
- Printing and Publishing Division of CSIR-INSTI

Publications from Project

A technical report titled "Evaluation of the impact of reintroducing the CSIR newsletter to the council and clients" will be submitted to CSIR-INSTI.

2.5.2 Impact of COVID-19 on the Printing Industry; Case of INSTI Press

Research Team:	Decardi-Nelson A., Adjah J., Sawyerr A., Kalognia J.
Start Date:	February 2020
Completion Date:	April 2020
Actual Cost of Project:	GH₵6,000.00
Sponsors:	CSIR-INSTI/Self
Collaborating Institution:	Nil
Location:	CSIR-INSTI

Objectives

To understand the extent to which the COVID-19 has impacted the activities and revenue generation of the CSIR-INSTI Press.

Major Findings

With the advent of the COVID-19 pandemic, public health experts advocated for strict adherence to several safety measures/protocols as the only way to stay safe from the pandemic. These safety measures/protocols included: wearing of face mask, washing of hands with soap under running water, using alcohol-based hand sanitiser and social distancing. The most challenging of these protocols was the observance of social distancing. To ensure adherence to this safety protocol, the Government of Ghana placed a ban on all gatherings such as funerals, weddings, church activities, etc. The Government placed a limit of not more than twenty-five (25) persons for any social gathering. Social gatherings such as funerals and weddings are key to the success of several industries such as printing and event organising. Establishments within these industries were negatively affected. The CSIR-INSTI Press being a printing institution/establishment whose business is based on these social events which involve a lot of printing activities such as activity brochures, event posters, programmes, invitation cards, etc, was not spared. Thus, the government's ban resulted in a loss of some of the revenue to the printing industry including the CSIR-INSTI Press. The objective of this study was to understand the extent to which COVID-19 has impacted negatively

on the activities and revenue generation of the CSIR-INSTI Press and to document all the potential revenue losses.

Data for this study were sought from two main sources namely; Primary sources and Secondary sources. Secondary data were obtained from the review of relevant literature that relates to the issues under investigation. Primary data for this study were obtained from estimates for jobs for clients who had contacted the design Division of CSIR-INSTI to print brochures, funeral posters, invitation cards, receipt books, pull-up banners, etc. before the ban on social gatherings by the government. CSIR-INSTI Press was purposively chosen for this study. This was due to time constraint and financial capacity of the researchers.

The study revealed that three clients had contacted the CSIR-INSTI press to produce some printing jobs such as brochures, event posters, programmes, invitation cards, etc. for their events. All three programmes were cancelled with the ban on gatherings by the government as a result of the COVID-19 pandemic. These three social events would have brought in a total of Gh₵13,700.00 as revenue to CSIR-INSTI Press, thus because of the COVID 19 restrictions, the Institute lost Gh₵13,700.00 in revenue.

Name of Client	Expected Event	Expected Date of Event	Document to be Produced by CSIR INSTI	Estimate from CSIR INSTI
Mr. Alex Nkrumah	Funeral	March	Funeral brochure	4,500.00
Madam Belinda Addo	Wedding	March	Wedding Program	1,200.00
Dr. Tuffour	Lectures	April	Books	8,000.00
Total				**13,700.00**

Expected Beneficiaries/Potential Impact:

CSIR-INSTI stands to benefit from this research with the potential impact being to enhance the visibility of the Printing Press.

Publications from Project:

Nil

On-going Projects

2.5.3 Colour Preferences Among Selected Adults in Ghana

Research Team: Adjah J., Bekoe S., Decardi-Nelson A., Ry-Kottoh L., Kalognia J.
Start Date: October 2019
Duration: 18 months
Budget: GH₵10,000.00
Sponsors: Nil
Collaborating Institution: Nil
Location: CSIR-INSTI

Introduction

The changing world of technology has diversified the use and application of colour in printing publishing, product design, and architecture. Colour makes a significant impact on a final product as it is employed in designing, printing, and production of various artefacts. Many people express how they feel through the colours they choose as colour carries meanings that go beyond mere valuation. Globally, colour is used in all areas of endeavours, because they communicate emotions and philosophy. In Ghanaian traditional functions, for example, colours regarding the rites of passage like black and red are used for mourning. The use of colour in emblems represents the philosophies of a group or society. The Ghanaian national flag is made of two hues and one achromatic colour viz; red, yellow, green, and black – red symbolising the blood of the forefathers who fought for political freedom (Akansina, 2011); gold symbolizing the rich mineral resource (Bowell, 1992), green for her rich forests and natural wealth (Alastair et al., 2016); and black for the African race/heritage. Colours are used in all production or manufacturing processes. In advertising and marketing, consumers can develop preferred colour associations for a particular product category (Amsteus et al., 2015). The goal of this research is to explore colour preferences from a cross-section of Ghanaians by employing two theories (Ecological Valence and Hunter-Gatherer theories) as reference points. This study employs a set of variables (sex, hobbies, change of colour over time) that gives a different dimension about subjects in Ghana.

Research Questions

- Is colour just a mere expression of emotions or is it influenced by other factors?
- Is a favourite colour likely to change over time?

- What are the common colour preferences among adults in Ghana, as compared to results from other studies?

Materials and Methods

In all literature, one basic model that exists for getting information about colour preferences is the presentation of colour; either on calibrated screens or printed colour cards. The data collection instrument designed for this study is a questionnaire that follows a similar pattern to the one used by Bakker et al. (2013). Bakker et al. studied favourite colours to human characteristics. Participants had an addition of a colour palette (figure 2) in the questionnaire to guide them.

Sample size

To answer the research questions, the researchers purposively sampled 159 adults consisting of males and females from close sources. The researchers believed that the adult population will serve the purpose of this study. These participants were workers with different professional backgrounds eg., engineers, administrators, accountants to mention but a few. Ages were group into three categories namely: 25-35, 36-45, and 46-60 to represent young, middle, and old. Age restriction to 60 years was due to visual deficits in old age (Ishiharea et al., 2001).

Results Achieved so Far

This study found colour as a driving force and expression of people's emotions; whether it changes over time or not. The results are both congruent and incongruent with previous studies that postulate colour preference as being an effective response to objects in the environment viz Ecological Valence Theory (EVT); Palmer and Schloss (2010) and Hunter-Gatherer Theory (Crozier, 2008).

Preference for hues like blue was found to be the most preferred by participants in this study. Categorically, the majority of female respondents preferred blue and pink hues. The preference for blue seems to be a global phenomenon that relates to the natural environment; as such, most of the participants (both males and females) selected it.

Way Forward

After an initial submission to the *Personality and Individual Differences Journal*, Elsevier recommended another journal. The article was therefore submitted to the *International Journal of Cognition* awaiting a response.

2.5.4 Evaluation of Science Journals in Ghana

Research Team: Kalognia J., Bekoe S., Decardi-Nelson A., Adjah J.
Start Date: July 2020
Duration: 18 months
Budget: GH₵15,000.00
Sponsors: Nil
Collaborating Institution: Nil
Location: CSIR-INSTI

Introduction

Scientific journals represent the most vital means for disseminating research findings. Journals in developing countries such as Ghana face challenges in becoming known and respected in the international research landscape. There are also concerns raised about the quality and transparency of publication processes for the journals. This limits the credibility of the research published within these journals. (JPPS, 2017)

In choosing a journal for publication, researchers nowadays look for the extent to which a particular journal meets publishing standards, its accessibility to other researchers and its impact on the academic community in the world (Msuya & Muneja, 2011). Most authors would prefer to publish in the best-ranked journals in their fields.

An Investigation of the International Visibility, Quality, and Impact of Journals Published in Tanzania was done by Msuya and Muneja (2011) where results showed that most of the journals were not visible, but the journals met the standards required in journal publishing. This study seeks to examine the quality of the publishing practices and standards of scientific journals in Ghana, assess their impact and visibility in the global community.

Objectives

This study's objective is to evaluate science journals in Ghana by:

- Comparison of science journals to other recognized science journals on Taylor and Francis. Elsevier and in the nature journal.
- Assess against the Journal Publishing Practices and Standards (JPPS) criteria.
- Determine the best publishing practices.
- Determine the best publishing standards.

Materials and Methods

This study is focused on science journals with online databases in Ghana. Data will be

collected using questionnaires, interviews and observational methods. Results will be computed and analysed using Microsoft Excel and SPSS.

Results Achieved so Far

Questionnaires have been sent to authors of some journals, waiting for their feedback.

Way Forward

The researchers would continue to gather data from the authors. Questionnaires will be sent to Technical Editors and interviews will be conducted with Editors-in-Chief.

2.5.5 Population Dynamics and Land Use/Land Cover Change in the Lake Bosomtwe Basin

Research Team:	Annor J. & Allotey A.N.M.
Start Date:	January 2019
Duration:	1 years
Budget:	GH₵5,000.00
Sponsors:	CSIR-INSTI
Collaborating Institutions:	Environmental Protection Agency (Man and Biosphere Reserve -MAB)
Location:	CSIR-INSTI, Accra

Introduction

Land use and land cover are closely related terms that are often used interchangeably (Anderson et al., 1976), but are not the same. Land cover relates to the physical nature or form of the land surface (Mather, 1985). In its broadest sense, it encompasses vegetation, water, desert, ice and other physical features of the land including those created by man (Skole et al., 1994; Rawat & Kumar, 2015). Land use, on the other hand, describes the way and the purposes for which human beings employ the land and its resources (Lambian et al., 2003).

Together, land use and land cover have important implication for the global environment. Land-use changes result in land cover changes that affect biodiversity, ecosystems, water, radiation budgets, trace gas emission and other processes that come together to affect climate and the biosphere (Townshend et al., 1993; Riebsame et al., 1994 cited in Rawat & Kumar 2015; Lambin, 2003). Ghana, like many other developing countries, has been experiencing major land cover changes.

The lake Bosomtwe which lies 33.8km (21miles) south-east of Kumasi, the capital of the Ashanti region has not been left out of this menace. This study attempted to quantify the effects of population dynamics on the observed land use and land cover changes in the Lake's basin.

Objectives

- To identify the types of land use and land cover in the Bosomtwe Basin
- To investigate the extent and trend of land use and land cover change in the basin
- To examine population trends and their association with land use and land cover changes.

Materials and Methods

The study will use multi-temporal satellite images of 1986, 2007, and 2018 from the USGS for land use/cover analysis. Census data of the same period from the Ghana Statistical Service will be used to analyse population dynamics.

The study area is contained within the Landsat path 195, row 55. The selection of the satellite images would greatly influence the quality of the image especially for those with limited or low cloud cover.

On-screen digitisation would be used to capture the boundary of the lake from the 1986 image using ArcGIS 10.5 software. The digitised boundary of the lake would then be used to create a 5 km buffer zone around the lake. The 5km buffer layer would be used to subset the study area from the Landsat scenes of 1986, 2007 and 2018.

The subset images would then be classified using the supervised classification technique. Before this, a classification scheme would be developed.

Census data would be acquired from Ghana Statistical Service and analyse by observing trends over the years. A relationship would be drawn from the population data and the changes in land use/land cover observed.

Results Achieved So Far

1) Satellite images downloaded, processed and analysed.
2) Change analysis within the classified images has been accomplished.
3) A brief write-up on land use and land cover changes in the study area has been done from the land use and land cover statistics that have been generated from the three classified images.

4) Population data from Statistical Service has been acquired and analysed.
5) Field validation of the classified land use and land cover images completed in December 2020.

Way Forward

1) Classified images being updated after the ground-truthing in December 2020.
2) Accuracy assessment being conducted.
3) Write up is in progress.

3.0 PROGRAMMES AND ACTIVITIES

3.1 Communications

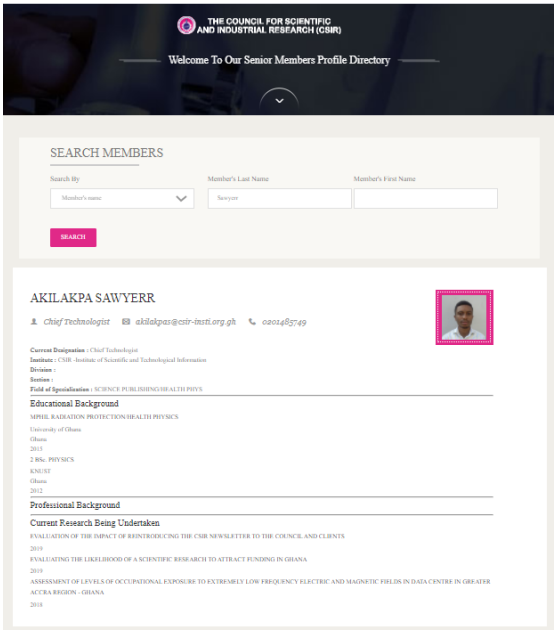
The Communications Division has the mandate to research and develop tools, equipment and communication systems aimed at solving electronics and communication problems for national development.

CSIR Online Grants Management Software

An online software was developed for the management of the CSIR Grants System. The staff of CSIR Head Office were trained on the usage and application of the software.

CSIR Profiles Management System

The system, a Senior Members Profile Directory, provides professional and academic details on all Senior Members of the CSIR. Current Designation, Institute of affiliation, Division as well as field of specialisation are some of the information on the system. It is accessible via the link profiles.csirgh.com.



Profile Page of a CSIR-INSTI Chief Technologist as captured on the online system

CSIR Promotions Management System Software

The Communications Division developed software and an accompanying manual for managing the promotions of Research Scientists of CSIR. Nationwide training was held for all thirteen (13) Institutes of the CSIR as well as the Head Office. The training addressed two different user categories, future applicants who will use the software in filing for promotion when due, and reviewers of the applications which includes the office of the DD-G and external reviewers. The software will eventually replace the manual application system for CSIR Research Scientists from the year 2021.

Participants of Head Office, WRI and STEPRI

Participants of SARI, WRI and ARI (outstations)

Participants of CRI and SRI

Participants of FORIG and BRRI

Participants of INSTI, IIR, FRI and ARI

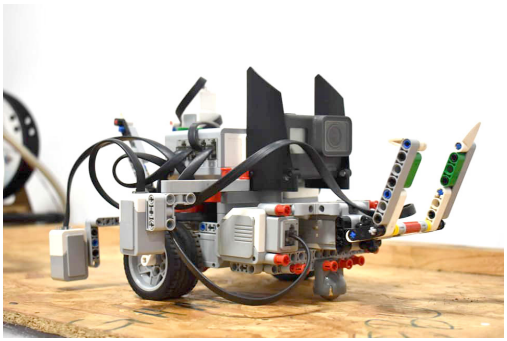
Participants of PGRRI and OPRI

3.2 Electronics

The mandate of the Division is to research into the development of next-generation electronics tools aimed at solving electronics and communication problems for national and social-economic development.

Launch of CSIR-INSTI Makerspace

The Division launched its Makerspace dubbed "The CSIR-INSTI Makerspace" on 30th October 2020. The Makerspace is a co-innovative space where like-minded persons gather to work on personal projects, share tools and expertise as well as learn from each other. At the launch, Ing. Michael Wilson, Head of the Electronics Division, explained the CSIR-INSTI Makerspace was to establish a solution hub based on applying research into accelerating technologies in electronics and telecommunications and to provide actionable recommendations targeted at creating new businesses from innovations. Dr. Seth Awuku Manteaw, Director of CSIR-INSTI, added that being the first-ever Makerspace of the institution, was one of the steps towards operationalising and charting a pathway to respond to the changing dynamics of the generation of knowledge, processing and mainstreaming of digital technologies in the activities of the Institute. Dr. Wilhemina Quaye, Director of the CSIR- Science and Technology Policy Research Institute, who represented Professor Victor Kwame Agyeman, Director-General of CSIR, agreed strongly that technological improvements played a key role in today's global economy, which required an increased knowledge base for industrial innovation. She commended INSTI for coming out with such innovation, which would help boost the technological advancement of Ghana. There were demonstrations on Artificial Intelligence, Machine Learning, Precision farming, Robotics, etc.



Exhibits at the Launch of the CSIR-INSTI Makerspace

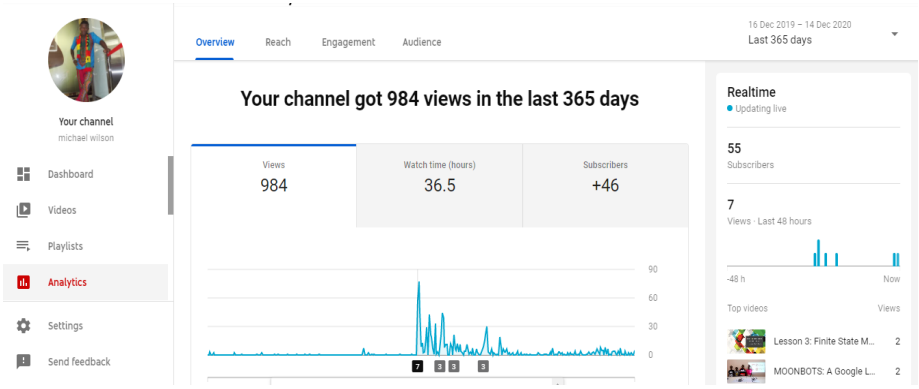
Sod-cutting and tour of the Makerspace facility

Robotics Training Programme

The Robotics Training Programme resumed in the year 2020 with seventeen (17) permanent club members. The programme which has evolved into a club is a monthly subscription session for students who want to constantly undergo training and also team up as a group to participate in National and International Robotics competitions. Club membership is GH₵350.00 monthly and includes, tuition, use of equipment and competition subscription fees. Training happens at CSIR-INSTI on Saturdays from 9:00 am to 12:00 pm with an optional 2-hour slot for practice within the Makerspace facility on Wednesdays between 2:00 pm and 4:00 pm. The programme however had to be put on hold due to the Covid-19 pandemic. The Training Programme with all COVID-19 protocol observation was reinstituted in November following the easing of restrictions by the Government. Numbers dropped to four (4) participants in November and six (6) participants in December.

Some students during a robotics training session

YouTube video training channel on robotics developed by Ing. Michael Wilson of the Electronics Division had 464 more views totalling 984 views as of 15th December 2020. The channel now has 55 subscribers and over 36 hours of watch time. Viewers were mostly from Ghana, Canada and the United States.



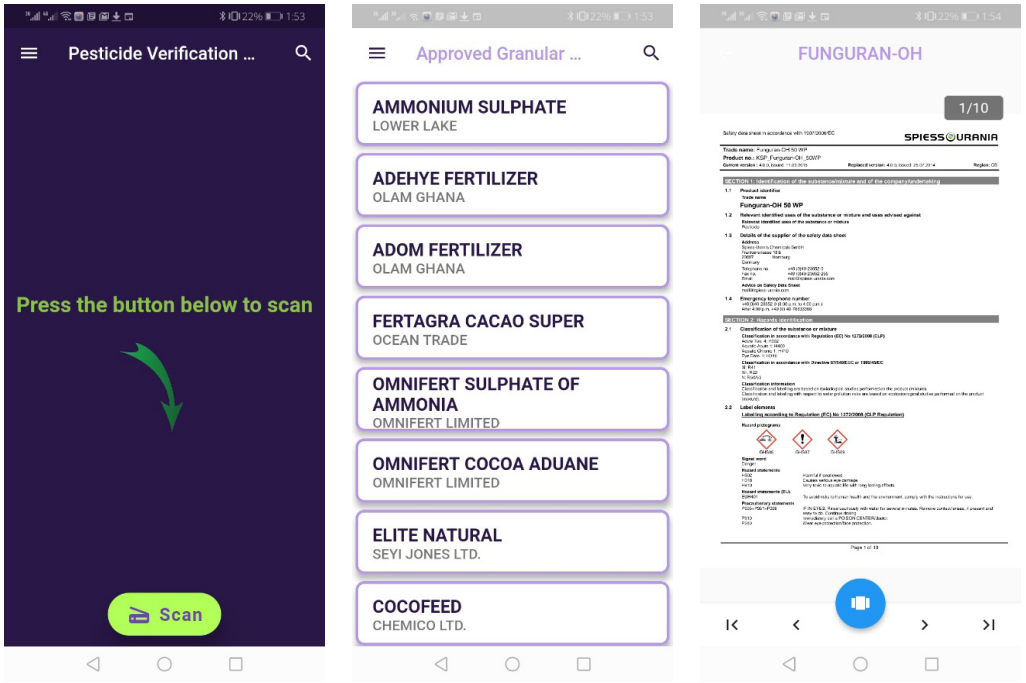
Snapshot of statistics of people who received training through video tutorials

Online Marketplace Mobile App

The Electronics Division is playing a key role in the development of a mobile app, Kuafo Marketplace, that will serve as a market platform for agricultural stakeholders. The app will be a place where agricultural products and services can be bought or sold. The Division is working on the complete documentation about the web and mobile applications being developed. The App is being implemented as part of the ongoing Modernising Agriculture in Ghana (MAG) programme by the CSIR. The MAG programme is agricultural technology dissemination led intervention funded by the Government of Canada.

Pesticide Verification App for Conservation Alliance

A prototype Pesticide Verification App for the Conservation Alliance is being developed in collaboration with the Conservation Alliance. The Pesticide Verification App was demonstrated at the Sector Partnership Programme organised by Conservation Alliance at the Erata Hotel on 24th November 2020, to partner Institutions including Conservation Alliance, COCOBOD and IITA. The App allows farmers to scan a QR code on a pesticide to know whether it's a Highly Hazardous Pesticide (HHP) or not.



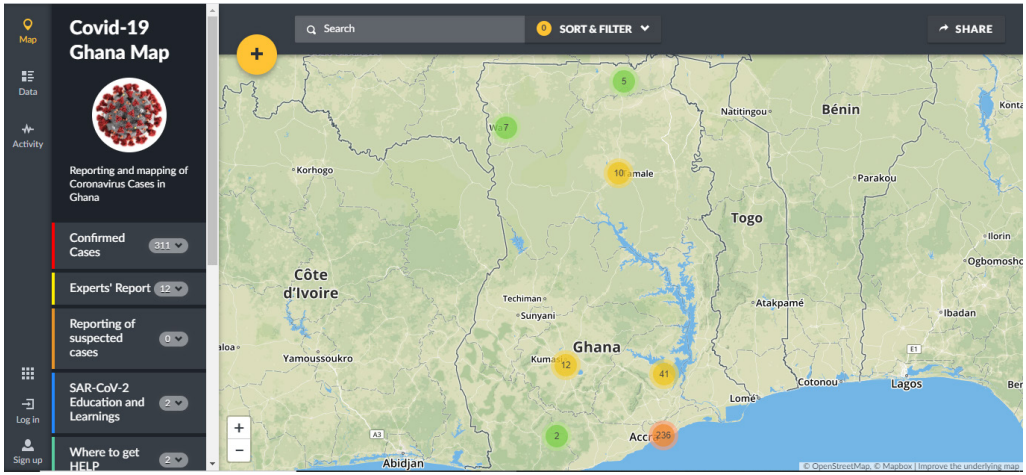
Homepage, search page and details of the Pesticide Verification App

COVID-19 Pandemic Digital Solutions

In January 2020, a new strain of the coronavirus, SARS-CoV-2 popularly called COVID-19, shocked China and the world with its spread. Declared a global pandemic by the World Health Organisation (WHO), the virus reached the African continent and caused irreparable harm for many countries. With communal structures and large populations living in close quarters, the traditional method of contact tracing, while effective, is not fast enough to track the spread.

As part of a working group led by Innovate Ghana and the African Health Innovation Center, Ing. Michael Wilson of CSIR-INSTI and Mr. Philip Asumah of MiPH Consult deployed a crowd-sourced web app to encourage citizens in Ghana to report suspected cases. The objective was to allow epidemiologists and health service officers to gain access to a larger volume of reports for follow-up, contact tracing and confirmation. The application offers the Government the opportunity to leverage citizen reporting to complement existing contact tracing methods.

The application is currently a web-based application accessible online at https://covid19gh.miphconsult.ml/views/map. It provides a user-friendly interface that helps the user visualise cases reported through a map, graphs and detailed activities. It also provides health care workers and local authorities with back-end functionality that provides user contact information for follow-up.



Ghana Covid-19 Map

Development of Human Resource Management Software

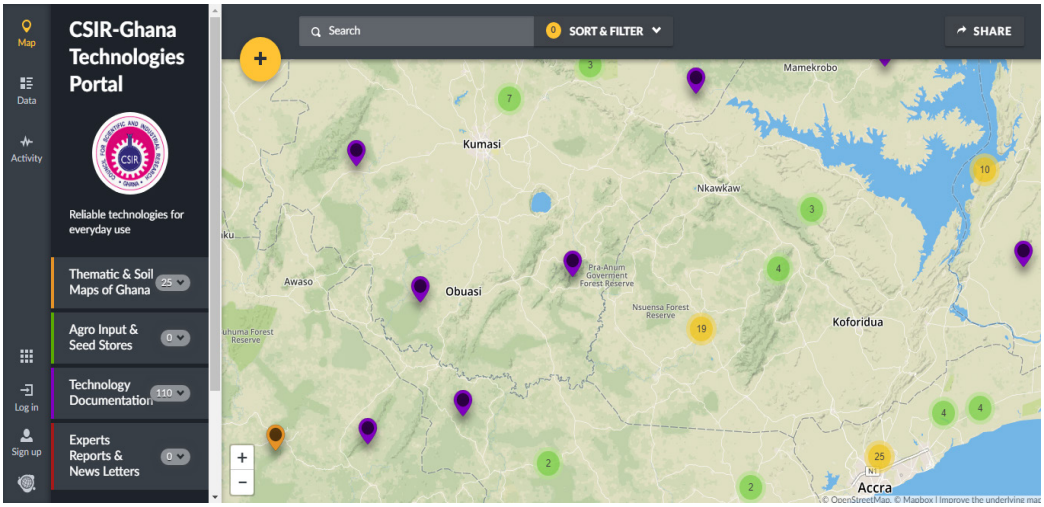
The Division is working on a software system that digitizes day-to-day Human Resource Activities, making them less tedious and simpler for the end-user. The software has several systems and processes combined to ensure easy management of human resources, business processes and data. The project seeks to develop a Prototype of Human Resource Management Software that will help the HR department at CSIR-INSTI run its administrative activities.

CNN Documentary

The CNN Documentary on Robotics activities in Ghana through the Ghana Robotics Academy Foundation featuring the Electronics Division's Makerspace pilot program was aired from 1st to 4th February 2020. The video can be found via the link: https://www.cnn.com/videos/business2020/01/29/innovate-africa-ghana-roboticsacademy.cnn.

Online Repository for Hosting of CSIR Technologies

A database for the hosting of information being gathered on CSIR technologies is being developed. All gathered data has been uploaded onto the database in addition to a user-friendly interface of a frontend visualization dashboard.



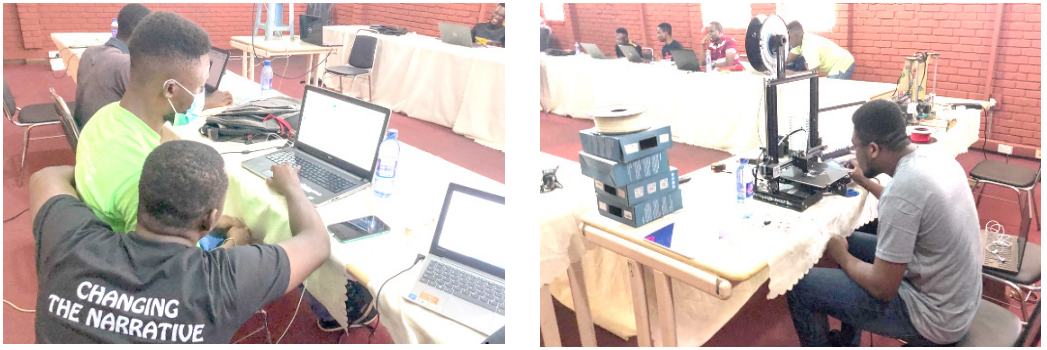
Frontend of Online Repository Portal

3D Modeling and Additive Manufacturing

In partnership with CTN Technologies, the Electronics Division hosted a 3D Modeling and Additive Manufacturing Workshop. The intensive 2-day workshop organised by CTN Technologies and CSIR-INSTI to teach young Ghanaians skills in 3D manufacturing was a huge success. The event which came off on Friday 23rd October to Saturday 24th October 2020 was attended by several eager youth. Participants learnt how to design 3D models for various applications on the first day and by the next, they were ready to produce physical models of their designs using 3D printers. The sessions were facilitated by Mr. Sulemana Kasuadana Adams, an aerospace engineering graduate

from the Kwame Nkrumah University of Science and Technology (KNUST) and other seasoned tutors from CTN Technologies.

The GH₵300.00 training package included; training materials, practical sessions, certificate and technical support from the tutors beyond the workshop. The participants designed sample phone cases among other items as part of their training in 3D Modeling. At the end of the two-day training, all who attended the workshop were ready to head back to the world, produce creative 3D designs, and print out their masterpiece. GHC 740.00 was generated from the partnership. Below are pictures from the event.



Practical session during the 3D Modelling workshop

Facilitator giving an explanation during the programme

3.3 Fluid Science

The Fluid Science Division has the mandate to design and produce fuel cell for the production of Brown's gas for energy generation, to introduce water in the Ghanaian fuel mix through the use of fuel cell and to design and conduct experiments on fluids, as well as to analyze and interpret data.

3.4 Geospatial and Information Science

This Division consists of two sections; the Scientific Information Management Section and the Geographic and Information Systems Section.

3.4.1 Scientific Information Management Section

This Section provides scientific and technological information services for the CSIR and analogous institutions, learned and professional associations and societies, the industrial sector, students and the general public under the collection development, cataloguing and classification and user services technical sub-sections.

3.4.1.1 Collection Development Sub-section

The collection development sub-section is responsible for acquiring books, collecting data, both print and electronic resources of science and technology information and other science materials for the Library. It is also in charge of providing specific and general guidelines for the selection and acquisition of new materials through purchases, exchanges, soliciting or donations, legal deposit or through subscription and collaboration. It is also responsible for data collection to feed all databases created by the Scientific Information Management Section.

3.4.1.2 Cataloguing and Classification Sub-section

Cataloguing and Classification sub-section processes all materials acquired from the Collection Development section by cataloguing, classifying, labelling and entering data on all documents received into databases. Statistics of materials received during the year are captured in Table 3.1.

Table 3.1: Summary of statistics of materials received in 2020

Type of Material		№ of Copies Received	Percentage
Theses		50	8.2
Journals		8	1.3
Newspapers	Daily Graphic	234	38.3
	Ghanaian Times	234	38.3
	Weekly Spectator	39	6.4
	Weekly Mirror	39	6.4
Annual Reports		7	1.1
Total		**611**	**100**

3.4.1.3 User Services Sub-section

The user services sub-section is a public service counter where users are provided direction to library materials, expertise on multiple kinds of information from multiple sources and advice on library collections and services. The section assists clients in the identification and retrieval of information to satisfy user needs. These services are provided through both digital and manual information retrieval of books, periodicals, abstracts, theses, newspapers and reference materials for scientists, consultants and students. Manual searches are done, while search engines such as Google, Dogpile, Yahoo and Yandex are used for digital searches.

The section uses foreign databases to retrieve information for clients. The foreign databases used by the reference section to search information users are; Access to Global Online Research in Agriculture (AGORA), Health Inter-Network Access to Research Initiative (HINARI), Online Access to Research in the Environment (OARE), Journal Storage, African Journals Online (AJOL), PubMed, Directory of Open Archive Journals (DOAJ), Proceedings of the National Academy of Sciences (PNAS), Bioline International, Open Directory - Science: Agriculture: Publications: Journals. The section has also benefited from the free The Essential Electronic Agricultural Library (TEEAL) distributed by the TEEAL Project at Mann Library, Cornell University.

The User-service also offers services in Referrals, Research Advisory, Selective Dissemination of Information (SDI), Current Awareness and Question and Answer. WiFi hotspots are also provided to users.

3.4.2 Geographic Information System Section

The mandate of this section is to collect data for the design and construction of Thematic Maps on Ghana at the national, regional and district levels. The Section is also to answer to the need of clients for special or customised maps and to use existing capacities to train individuals and institutions on techniques of spatial data documentation using Geographic Information.

Spatial Database Development on the Resources in Ghana
Mapping Activities

1. Composition of Regional Maps:

Nine (9) Regional map databases have so far been designed and composed for the following regions;

i. Ahafo region
ii. Bono East region
iii. Bono region
iv. Savannah region
v. North East region
vi. Oti region
vii. Western North region
viii. Northern Region
ix. Western Region

Each database is made up of regional boundaries, settlements, road networks, river and streams, contours and districts themes.

2. Regional land use/ Cover mapping:

Landsat scene, Path 195 and Row 54 covering parts of Bono, Bono East and Savannah Regions were classified.

3. **Designed and composed a customized map of Wenchi Municipal and adjourning Kintampo South District (**at the request of a client)**:**

Each map is made up of the following themes:

- *Study areas*
- *Towns*
- *Roads*
- *Rivers and streams*

4. **Contract Mapping:**

Eleven (11) maps were produced for Winmat Publishers Limited to be inserted as illustrations in historical books of Ghana for primary schools. They include;

1) Desert landforms in the world
2) Ghana Major rivers
3) Ghana Climatic regions
4) Ghana Tourism map
5) World Major Oceans
6) Cadastral map
7) River Systems of Amazon, Amur, Brahmaputra, Chang Jiang (Yangtze), Indus rivers
8) River systems of Africa
9) Maps of major towns like Navrongo, Wa and Tamale which falls within the climate Zone
10) Koppen world climate classification
11) Population Pyramid of Ghana

Dams and Reservoirs

Ongoing development of a geospatial database for existing Dams and Reservoirs in the country is being accomplished through capturing dams and reservoirs through on-screen digitizing. More recent (2017-2020) Landsat images covering the country have been downloaded and are being used to update the vector layer of the dams and reservoirs created from an existing map constructed in the 1990s.

3.5 Printing and Publishing

The Printing and Publishing Division is mandated to provide printing and reprographic services for the production of scientific, technical literature and other printing services and products to support the socio-economic development of the country. Activities of the Division include;

- Designing, receiving and generating quotations for clients.
- Printing, collating, folding/ binding and delivering jobs to clients.
- Editing, typesetting and proofreading of manuscripts submitted by researchers for publication.
- Writing reports, technical correspondence and distribution of print journals.

3.5.1 Printing Section

The section executed to perfection the following internal and external designing, editing, typesetting and printing jobs:

Table 3.2: List of main projects implemented by Printing Division

№	Client	Description of Job
1	CSIR – ARI	Call Cards (Dr. Ebenezer D. O. Ansa)
		Letterheads
2	CSIR – CRI	Call Cards (Director)
3	CSIR – DDG	Call Cards
4	CSIR – DG	Book – Certificate of Proposal for Election to Fellowship
5	CSIR – FORIG	Call Cards (Accountant)
6	CSIR – Head Office	Flat Files
		60th Anniversary Magazine
		Polo Shirts, Caps and Pull up banners
		Citations for Best Workers
7	CSIR – IIR	Call Cards (Director, Deputy Director)
		Book - Solid Waste Management in Ghana
		Annual Thanksgiving Service Programme

8	CSIR – INSTI	Manual of Agricultural Technologies (MAG)
		Citations for Retirees
		2019 Annual Report
9	CSIR – SARI	2018 Annual Report
		Call Cards (Eric Appiah)
		Call Cards (Dr. Roger A. L. Kanton)
10	CSIR – STEPRI	Call Cards (Dr. Essegbey)
		Book Design (Deputy Director)
11	CSIR – TDTC	Desktop Flag
12	CSIR – WRI	Call Cards (Director)
		Pull Up Banners, Banners, Name Tags (STREC-Ghana Project)
13	GNMC	Book-A History of Nursing and Midwifery in Ghana, 1900s to 2019

Samples of products from the Printing Section

3.5.2 Science Publishing Section

This Section is mandated to publish the *Ghana Journal of Agricultural Science* (GJAS) and *Ghana Journal of Science* (GJS) as well as other S&T literature emanating from the national and international scientific community. It is also mandated to conduct R&D projects aimed at aiding policy decision-makers, the scientific publishing industry, planners, researchers and the general public. GJS and GJAS are Open Access Journals, distributed under the terms of the Creative Commons (CC) License [CC BY 4.0]. Guidelines for Authors and templates for the Ghana Journal of Agricultural Science and Ghana Journal of Science can be downloaded from the CSIR-INSTI website via the respective links: http://insti.csir.org.gh/gjas.php and http://insti.csir.org.gh/gjs.php

Ghana Journal of Agricultural Science (GJAS established in 1961)

The Ghana Journal of Agricultural Science Vol. 55 (1) and (2) (2020) were published on the AJOL website. Details of published articles are given below:

Table 3.3: Articles published in Vol 55 (1) (2020) of the GJAS

№	Title	Authors
1	Aspects of the Biology of *Ephestia cautella* and *Tribolium castaneum* on Fermented Stored Cocoa Beans	E. Oyewo B.O. Amo
2	Gender Analysis of Agricultural Financing in Cocoa-Based Farming System in South Western Nigeria	T.B. Alao A.S Bamire, A. D.Kehinde
3	Identification of Seed-borne Fungi of Farmer-Saved Seeds of Pepper and Their Control with some Selected Botanicals	E. Gyasi C. Kwoseh E. Moses
4	Determinants of Farmers' Willingness to Export Yam in Ibarapa East and Ibarapa Central Local Government Areas of Oyo State, Nigeria	O. F. Adesiyan A.T. Adesiyan, L. Abisoye
5	Spatial Distribution of Agro-Input Centers and Their Accessibility to Farmers in Oyo State, Nigeria	A. Oyegbami A.M. Omotayo, S.O. Apantaku K.O Adubi, E. Fabusoro

6	Black Soldier Fly (*Hermitia. illucens*) Larvae Meal as Alternative Protein in Broiler Production in Ghana	S. Affedzie-Obresi G. Adu-Boagye E.K. Bkegbe N. Asuming-Bediako K.O. Ansah A. Mensah-Bonsu D.B. Sarpong D.P.K. Amegashie G.T.M. Kwadso P.A. Wallace V.A. Clottey
7	Changing Agricultural Practices and Indigenous Food Crops in the Upper Afram Basin of Ghana	F. Baa-Poku J.S. Ayivor B.D. Ofori
8	Nitrogen Fertilizer Management Strategy for Oil Palm-Maize Intercropping System in the Semi-Deciduous Forest Zone of Ghana	I.Danso E. Larbi E. Andoh-Mensah P.F. Fibeiro I.K. Adjarko E.Agyarko-Mintah

Table 3.4: Articles published in Vol 55 (2) (2020) of the GJAS

№	Title	Authors
1	Plant-parasitic Nematodes Associated with Sweet Potato Rhizosphere Soil in the Semi-Deciduous Forest and Coastal Savannah Zones of Ghana	J. Adomako Y. Danso B. Sakyiamah F. Kankan K.Osei
2	Time of Introducing Component Crop Influences Productivity of Intercropping System	M.A. Iwuagwu D.A. Okpara C.O. Muoneke
3	Compatibility of Mancozeb 75 WP with Some Plant Extracts in the Integrated Management of Cercospora Leaf Spot Disease of Okra (*Abelmoschus esculentus (L.) Moench*)	V.O. Dania N.E. Sam
4	Awareness and Adoption Levels of Improved Smoking Oven Among Fish Processors in Lagos Lagoon, Nigeria	O.T. Alabi O.J. Olaoye F.O.A. George A.A. Adeola J.O. Alabi W.G. Ojebiyi

5	Assessment of Agro-ecological Influence on the Seed Quality of Groundnut (*Arachis Hypogaea*) in The Gambia	J.A. Adetumbi M.Manga D. Jallow N.A. Akintoye T. Omodele
6	The Dynamics of Agricultural Extension Delivery Along the Value Chain: Assessment of Agricultural Extension Activities of MMDAs in Ghana	S.A. Manteaw B.Y. Folitse J.N. Anaglo S. Mahama N.A. Mingle
7	Dry Matter Accumulation, Distribution and Fresh Tuber Yield of Grafted Accessions of Hausa Potato	K.K. Nanbol O.A.T. Namo
8	Carcass Yield and Intestinal Morphology of Male Rabbits Fed Diets Supplemented with Turmeric (*Curcuma Longa*) Powder	E.O. Okanlawon K.O. Bello O.S.Akinola O.O Oluwatosin O.T. Irekhore R.O. Ademolue
9	Effects f Ensiling Cassava Peels on Some Fermentation Characteristics and Growth Performance of Sheep On-farm	R. Niyale W. Addah A.A. Ayantunde
10	Evaluating the Utilisation of Climate-Smart Agriculture (CSA) Technologies and Practices Among Smallholder Farmers in The Lawra, Jirapa and Nandom Districts of Ghana	K.O. Sam V.A. Botchway N. Karbo G.O. Essegbey D.K. Nutsukpo R.B. Zougmore

Ghana Journal of Science (GJS established in 1968)

The Ghana Journal of Science published GJS Vol. 61(1) and (2) (2020) on the AJOL website. Details of published articles are given below:

Table 3.5: Articles published in Vol 61 (1) (2020) of the GJS

№	Title	Authors
1	Quantification and Removal of Trichloromethane in Chlorinated Water Using Coconut Shell Activated Carbon	A.A Okoya O.E. Akinola O.S. Adegbaju A.B. Akinyele O.S Amuda
2	Estimating the Returns to Schooling: A Comparison of Fixed Effects and Selection Effects Models for Twins	A.Agyeman

3	Effects of Single Bout and Short Term Aerobic Exercise on C-Reactive Protein In Type-2 Diabetes Patients: A Pilot Study	C.I. Ezema M.C. Nweke C.N. Amarachukwu C. Obiekwe C.I. Okafor I.E.A. Esom M.K. Ukwuoma
4	Phosphomolybdenum Blue Detection – A Review of Characteristics, Achievements, Challenges and Future Prospects	G.N. Doku W.K. Agbozo S.J. Haswell T. McCreedu
5	PAH Quantification and Estimated Carcinogenic Risks at Selected Fuel Stations in Tamale Metropolis, Ghana	S.A. Ofori S.J. Cobbina A.Z. Imoro
6	An Experimental Assessment of LiFi Data Communication	V. Gordon P. Danquah
7	Road Use Behaviour of Urban primary School Children in Ghana: Case Study of Ablekuma South Education Circuit of Metropolitan Accra	I.K. Yankson N.K. Nsiah-Achampong A. Yeboah-Sarpong
8	Detection of Human Genotype "B" *Giardia lamblia* in Ghanaian Cattle from Frafraha in Adentan Municipality of Ghana	G.T. Mensah C.A. Narh C.A Brown P.F. Ayeh-Kumi I.O. Frempong
9	The Ghana Highway Code as a Teaching and Learning Material	N.K. Nsiah-Achampong I.K. Yankson W.K. Agyemang N.A. Mingle

Table 3.6: Articles published in Vol 61 (2) (2020) of the GJS

№	Title	Authors
1	Sanitation Practices and Microbial Quality of Drinking Water in Open Defaecation Free and Open Defaecation Communities in the Savelugu Municipality	N. Bakobie A.R. Ibrahim A.B. Duwiejuah
2	An Assessment of Scholarly Contributions and Web Visibility Among Scientists of CSIR-Building and Road Research Institute, Ghana	N.A. Mingle N.K. Achampong D.L. Acheampong

3	Protein Enhancement of Yam (*Dioscorea rotundata)* Peels with Single-or Co-Inoculation *of Aspergillus niger* Van Tieghem and Trichoderma Viride Pers Ex Fr. Under Solid-State Fermentation	L. Yafetto G.T. Odamtten E. Birikorang S.A. Adu
4	Power Generation from Melon Seed Husk Biochar Using Fuel Cell	O.D. Adeniyi B. Ngozichukwu M.I. Adeniyi M.A. Olutoye U. Musa M.A. Ibrahim
5	Pedo-Transfer Functions for Predicting Total Soil Nitrogen in Different Land Use Types Under Some Tropical Environments	S.A. Mesele G.A Ajiboye
6	Impact of Microwave Irradiation Energy Levels on Molecular Rotation, Structural, Physicochemical, Proximate and Functional Properties of Potato (*Ipomoea batatas)* Starch	K.N. Awokoya I.E. Odeleye Y.A Muhammed N.A. Ndukwe A.A. Ibikunle
7	Sugar Content, pH, and Weight of Flour Germpasms of Cashew Apple (*Anacardium occidentale* Linn.) Fruits Grown Under Two Agoro-Ecological Zones in Ghana	E. Odame H. Gonu L. Quansah
8	Effect of Formaldehyde Treatment on Bacteria-Infected Hatching Eggs of *Gallus gallus domesticus* Linnaeus, 1758	H.B. Amoah P. Asiedu C.T. Arthur I.F Aboaygye
9	Processing and Characterisation of Activated Carbon from Coco-nut Shell and Palm Kernel Shell Waste b H_3PO_4 Activation	A.Nyamful E.K. Nyogbe L. Mohammed M.N. Zainudeen S.A. Darkwa I. Phiri M. Mohammed J.M. Ko
10	Differentiation of Two *Pleurotus* Species Based on the Restrictive Direction Profile of the Internal Transcribed Spacer Region	M. Wiafe-Kwagyan G.T. Odamtten M. Obodai
11	Effect of Gamma Irradiation on Chlorophyll Content in the Cowpea (*Vigna unguiculata* (L.) Walp)	C. Azigwe P.A.D. Zoryeku I.K. Asante F. Oppong-Adjei

12	Diversity of Poisonous Plants and Their Antidotes, Affecting Ruminant Livestock Production on Rangelands in Ghana	C.Y.F. Domozoro C.C Wilcock M.D. Swaine A.H. Price
13	Characterisation of the Geophagic Materials and Their Associated Rocks and Soils from Anfoega, Ghana	J.K. Badu P.M. Nude D.E. Dodor E.K. Nartey T.A Adjadeh

3.6 Internal Seminars

CSIR-INSTI organised internal workshops for staff of the Institute and other CSIR Institutes. Topics and Names of the Resource Person(s) are recorded in Table 3.7.

Table 3.7: Internal Training/Workshops 2020

№	Date	Topic	Resource Person(s)
1	20/02/2020	Gender Mainstreaming in the Work Environment (For ladies from CSIR; INSTI, Head Office, STEPRI, WRI)	Ms. Naa Aku Mingle Dr. Agnes Decardi-Nelson Ms. Esther Opoku
2	8-10/09/2020	In-House Review Seminar	Research Scientists & Technologists
3	18/11/2020	Research Seminar	Dr. Richard Kofie & Dr. Paul Danquah
4	22/08/2020	Training for CSIR-Technologies Platform Managers	Ing. Michael Wilson & Mr. John Paapa Awotwi

Chairperson of the Gender Mainstreaming Workshop addressing attendees

Some ladies at the Gender Mainstreaming Workshop attentively listening during a presentation

Resource persons; Dr. Decardi-Nelson, Ms. Naa Aku Mingle and Ms. Esther Opoku (left to right) presenting at the Gender Mainstreaming Workshop

3.7 Visibility

The CSIR-INSTI Documentary on MAG was aired on GBC news on 7th January 2020 at 7 pm and 10 pm. Explanation on the LiFi project spearheaded by Ing. Victor Gordon was given. The research showed that uploads via 0° or 180° positioning between transceivers and illuminating devices tended to produce low transmission speeds. Further research is required to confirm this observation and also identify factors possible for interference and localised transmission speeds.

Ing. Victor Gordon presenting on GBC News

Similarly, a story was done on the CLIMACCESS project on flooding in Accra mainly due to construction in water-ways. Dr. Richard Kofie spoke extensively on the project, the interview was aired on Sunday 3rd May 2020 on GBC News.

Other news articles of activities of the Institute on various platforms include:

- Publications on Makerspace Launch on various news websites:
  - https://newsghana.com.gh/csir-insti-makerspace-launched-in-accra/
  - https://csir-forig.org.gh/forigmedia/news/433-csir-insti-makerspace-launched-in-accra
  - https://ghscientific.com/csir-insti-makerspace-launched-in-accra/

- Publications on MAG developed platforms on various news platforms:
  - https://thevaultznews.com/business/agribusiness/csir-insti-designs-agricultural-digital-apps/
  - https://www.csir.org.gh/index.php/publications/multimedia/news/item/505-csir-insti-designs-digital-apps-to-support-agricultural-productivity-dissemination
  - https://www.csir.org.gh/index.php/research-institutes/item/311-institute-for-scientific-and-technological-information
  - GTV News: 2nd December 2020 and Daily Graphic: 15th December 2020

3.8 Visitors

The year 2020 saw a number of both international and local dignitaries, visiting the Institute. A team from JICA-Tokyo paid a visit to the Institute on 24th February 2020 to find out more about CSIR and where the Council could fit into the proposed mission of JICA-Tokyo regarding using STI to find solutions to identified problems.

The new President for the CCST, Prof. Mark Appiah visited the Institute on 2nd March 2020 and was introduced by the immediate past Deputy Director-General, Prof. Rose Mamaa Enstua-Mensah.

A team from Docutech Ghana Limited, Mr. Jean Louis Feghali and Mr. Joe Alhassan Fuseini visited the Institute on 5th August 2020 to present services they provide in the Printing Industry for a possible partnership.

Prof. Mark Appiah, Prof. Rose Entsua-Mensah with Dr. Seth Awuku Manteaw (front seat right to left) and some CSIR-INSTI staff

4.0 ADMINISTRATION AND FINANCIAL ISSUES

4.1 Administration

The day-to-day running of the Institute was facilitated through the support of the Administration Division. The implementation of directives, policies, rules and regulations of the Council was carried out by the Division.

4.1.1 Management of INSTI

A seven-member Management Board with Dr. Paul Effah as the chair managed the Institute. A virtual meeting was held by the Board on 18th June 2020 to make decisions regarding the re-appointment of Heads of Divisions, renewal of post-retirement contract and appointment of Acting Deputy Director.

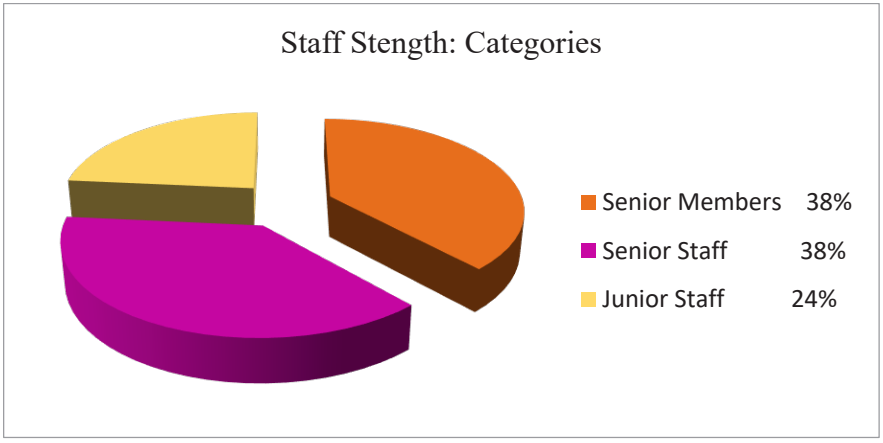
In a similar manner, an eleven-member Internal Management Committee with Dr. Seth Awuku Manteaw as Chairman saw to internal issues of the Institute for the period. Both the Management Board and Internal Management Committee were dissolved in July 2020 after the term of the CSIR Governing Council ended.

4.1.2 Staff Strength

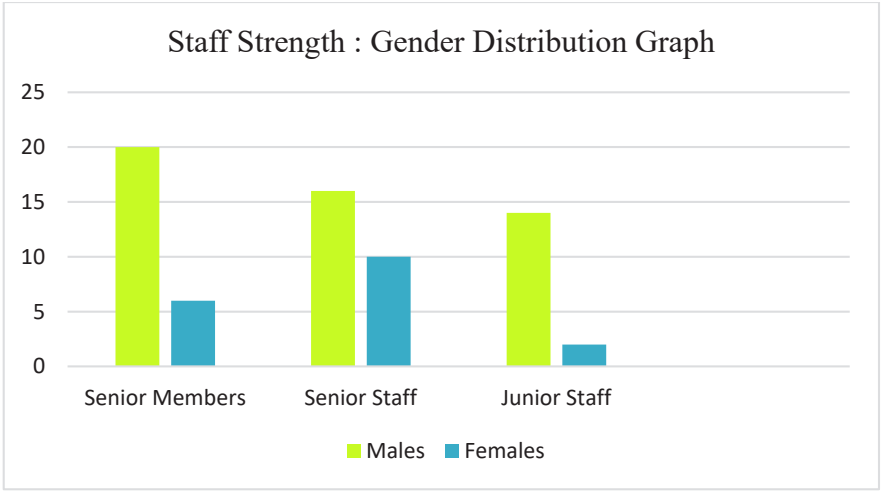
The staff strength of the Institute as of 31st December 2020 stood at sixty-eight (68) consisting of twenty-three (23) Core and three (3) Non-core Senior Members totalling twenty-six (26), twenty-six (26) Senior Staff and fourteen (14) Junior Staff. The staff strength and gender distribution are shown below. A detailed list of staff is recorded in Appendix III.

Table 4.1: Staff Strength: Gender Distribution

Gender	Senior Members	Senior Staff	Junior Staff	Total
Males	20	16	14	50
Females	6	10	2	18
Total	26	26	16	68



Staff Strength: Categories



Staff Strength: Gender Distribution Graph

4.1.3 Appointments

Dr. Albert Nii Moi Allotey, Senior Research Scientist was officially appointed as Acting Deputy Director of the Institute effective 1st August 2020. Before his appointment, he had been serving and still serves as the Head of GISS.

4.1.4 Staff Promotions

The following staff members were promoted to various grades during the year 2020 effective 1st January 2020.

Table 4.2: List of Staff Promotions

№	Name	Division	Previous Grade	Promotion Grade
1	Ms. Sarah Mensah	Accounts	Principal Accounting Assistant	Chief Accounting Assistant
2	Mr. Fuseini Inusah	Administration	Senior Security Assistant	Security Officer
3	Mr. Matthew N. Amoatey	Administration	Driver Grade I	Driver Inspector
4	Mr. Robert Achandi	Administration	Supervisor Grade II	Supervisor Grade I
5	Mr. Francis Ayarik	Administration	Supervisor Grade II	Supervisor Grade I
6	Mr. Wahab Ubsam	Administration	Senior Headman	Supervisor Grade II

4.1.5 Upgrading of Staff

The under listed staff were interviewed for upgrading on 2nd July 2020 via zoom;

Table 4.3: List of Upgraded Staff

№	Name	Old Grade	New Grade
1	Mr. Atta Senior Ampofo-Addo	Chief Library Assistant	Librarian
2	Ms. Esther Opoku	Chief Library Assistant	Administrative Officer
3	Ms. Yvonne Dzifa Azuma	Senior Clerk	Administrative Assistant

4.1.6 Staff Relocation

Ms. Esther Opoku, Administrative Officer, upon being upgraded, was relocated from the Scientific Information Management Section to the Administration Division.

4.1.7 Staff Transfer

- Mr. Bryan Nii Lartey Laryea, Research Scientist, was transferred to the Institute from CSIR-IIR effective 6th January 2020.
- Mr. Jonathan Sotie, Driver Grade I was transferred from the Institute to CSIR-PGRRI effective 1st March 2020.
- Dr. Stephen Bekoe, Senior Scientific Information Officer was transferred from the Institute to CSIR-Head Office effective 1st July 2020.

4.1.8 National Service Persons

In support of training newly graduated students, the Institute accepted, assigned to various divisions and trained the following twenty-seven (27) National Service persons. They assumed duty on Monday, 21st September 2020.

Table 4.4: National Service Persons

№	Name	Institution	Division Attached To
1	Adarkwa Priscilla Osaa	Kwame Nkrumah University of Science and Technology	Science Publishing Section
2	Adiepena Eyra Yao Mensah	Ghana Technology University College, Accra	Communications Division
3	Akorlie Glory Freeman	NIIT Ghana	Communications Division
4	Akpakli Perpetual	Valley View University	Administration
5	Ampofo Ebenezer	University of Cape Coast	Administration
6	Ankamah Stephen Kojo	Ghana Technology University College, Accra	Electronics Division
7	Ankrah Enoch Nii Obeng	University of Ghana, Legon	SIMS
8	Arthur Stephany	Ghana Technology University College, Accra	Marketing Division
9	Attah-Sarfo Harold	Kwame Nkrumah University of Science and Technology	Science Publishing Section
10	Bortey Daniel Borketey	Koforidua Technical University, Koforidua	Printing
11	Boyuke Chakurah Mutari	University of Education, Winneba	Electronics Division
12	Danso Godfred	University of Ghana, Legon	Accounts Division
13	Dzakpasu Yayra Yawa	Ghana Technology University College, Accra	Marketing Division
14	Gordor Ephraim Y.	Ghana Technology University College, Accra	Electronics Division
15	Heflide Vera Bless	Koforidua Technical University, Koforidua	Printing & Publishing Division

16	Kotei Robert Joel Nii Kotei	Accra Technical University	Accounts Division
17	Kumah-Fosuhene Gladys Maame Esi	University College of Management Studies	Administration
18	Kwapong Benjamin Bokoe	Wisconsin International University	Electronics Division
19	Manful Philip Gyan	Accra Technical University	Electronics Division
20	Morkeh Albert	Accra Technical University	Electronics Division
21	Ofosu-Appiah Michael Kwame Addo	Koforidua Technical University, Koforidua	Communication Division
22	Ohene Nyarko Mensah Augustine K.	Kwame Nkrumah University of Science and Technology	Geographic Information System Section
23	Osae Akotuah Ike	Ghana Institute of Management and Public Administration	Administration
24	Owusu Diana Pinto	University of Professional Studies, Accra	Accounts Division
25	Panford Akwasi Antwi B.	Kwame Nkrumah University of Science and Technology	Printing & Publishing Division
26	Spencer Lewis	University of Ghana, Legon	GIS
27	Turkson George Sorho	University of Energy and Natural Resources	Electronics Division

4.1.9 Study Leave

Dr. Felix T. Kabutey, Scientific Information Officer, resumed duty on 17th August 2020 after completing his PhD programme in Environmental Science and Engineering at the Harbin Institute of Technology, China.

As part of the Institute's policy on training, the following members of staff were also granted study leave to continue their education at various local and international Institutions:

Table 4.5: Staff on full-time/ partial study leave with pay

№	Name	Institution	Programme	Duration	Start – End Date
1	Lawal R.	Central University College	MBA (Finance)	2-year partial study leave with pay	Oct 2020-July 2022
2	Wilson M.	Kwame Nkrumah University of Science and Technology	PhD Computer Engineering	4-year partial study leave with pay	Sep 2019-July 2023
3	Zainudeen M.N.	University of Ghana	PhD Nuclear and Environmental Protection	4-year partial study leave with pay	Aug 2018-July 2022
4	Kumiwa D.	University of Cape Coast (Distance Education)	Bachelor of Commerce (Management Studies)	2-year partial study leave with pay	Sep 2018-July 2020

4.1.10 Retirement

Two (2) members of staff gracefully went on pension:

- Mrs. Grace Obeng-Koranteng, Senior Librarian, retired on 7th April 2020. She was employed at NASLIC (now CSIR-INSTI) on 3rd December 1979 as a Typist Grade II where her work schedule involved indexing and records in RESPRO (Research Project) Database, in addition to other secretarial duties.
- Ms. Bernice Acorlor, Chief Administrative Assistant retired on 5th November 2020. Ms. Acorlor was employed as a Typist at the CSIR-Head Office on 30th April 1979.

4.1.11 Obituary

The Institute, unfortunately, lost one member of staff, Mr. Simon A. Angabe on 6th September 2020. He was buried on Saturday 17th October 2020 at Awudome Cemetery. Mr. Angabe was employed as a Security man on 2nd April 2007 and through hard work, rose to the position of Senior Security Assistant, a position he held until his death.

4.2 Accounts Division

The objectives of the Accounts Division for the year 2020 included:

- Capture financial transactions and prepare timely, accurate and transparent financial reports
- Ensure payroll duties are fulfilled
- Ensure adequate internal control procedures are put in place to safeguard the assets of the Institute
- Actively assist, support and guide management in making sound management decisions
- Take an active role in setting the annual budget, monitor the budget and do variance analysis.

4.2.1 Financial Statement for 2020

Total receipt for the year under review amounted GH₵3,994,209.79 and payments totaled GH₵4,030,515.41 with a negative net receipt of GH₵36,305.62. The receipts are made up of salaries paid by GOG from the Consolidated Fund amounting to GH₵3,442,313.45. Internal Generated Fund (IGF) amounted to GH₵425,429.84 and Donor Funds of GH₵126,466.50. The IGF activities included Printing, Hiring of Facilities and Consultancy.

The institute projected to earn GH₵244,140.13 from IGF for 2020. There was a shortfall of GH₵181,289.71 due to shortfall in revenue from the Hire of Facilities.
The Payment of GH₵4,030,515.41 for the period is made up of Compensation for Employees of GH₵3,435,375.60, Goods and Services of GH₵495,512.09. There was no GOG subvention received for Goods and Services during the year 2020. Below is summarized Statement of Receipts and Payment and the Financial Position as at December 31, 2020.

Table 4.6: INSTI Statement of Receipts and Payment for the year ended December 31, 2020

	ACTUAL 2020	**ACTUAL 2019**
	GH₵	GH₵
TOTAL RECEIPTS	3,994,209.79	4,480,777.39
TOTAL PAYMENTS	4,030,515.41	4,493,119.38
EXCESS/DEFICIT	**-36,305.62**	**-12,341.99**

Table 4.7: Summary State of Affairs as at December 31, 2020

	2020	**2019**
CURRENT ASSET	276,449.15	238,000
NON-CURRENT ASSETS	122,137.84	79,000
LIABILITIES	126,563.68	161,000
NET ASSET/(LIABILITIES)	272,023.21	156,000
NET WORTH	**272,023.21**	**156,000**

APPENDIX I
Publications

Refereed Journal Papers

Møller-Jensen, L., **Allotey, A. N., Kofie, R. Y**. & Yankson, P. W. K (2020) Comparison of Satellite-Based Estimates of Urban Agglomeration Size for the Accra Area. *ISPRS Int. J. Geo-Inf.* 2020, 9, 79; doi:10.3390/ijgi9020079 www.mdpi.com/journal/ijgi https://www.mdpi.com/2220-9964/9/2/79/pdf

Danquah, P.A., Bekoe, S. & **Prikutse, F.** (2019). Information Security Practices and IT Disaster Recovery Readiness: An Assessment of Ghanaian Government Ministries. *Information Technologist Journal*

Danquah, P. (2020), Security Operations Center: A Framework for Automated Triage, Containment and Escalation, *Journal of Information Security* Vol.11 No.4, DOI: 10.4236/jis.2020.114015

Danquah, P., Longe, O. B., Lartey, J.D & Tobbin, P.E (2020), Towards a Theory for Explaining Socially-Engineered Cyber Deception and Theft, Modern Theories and Practices for Cyber Ethics and Security Compliance, *IGI Global*, Pages 44-58

Danquah, P.A. (2020), Malware and Anti-Malware Baseline: An Inductive Study of Ghanaian Microfinance Companies, *The Information Technologist*, Volume 17, Issue No. 1, Pages 127-139

Gordon, V. & **Danquah, P.** (2020), An Experimental Assessment of LiFi Data Communication, *Ghana Journal of Science*, Volume 61, Issue 1, Pages 73 - 87. https://dx.doi.org/10.4314/gjs.v61i1.6

Kessey, K, D. & **Abassah-Wesley, M.B.** (2020), Financial Electronic Technology and Innovation for Banking Services Delivery in Ghana: Operations of the Automated Teller Machine Facility from Customer Perspective, *International Journal of Innovative Finance and Economics Research* Volume 8 Issue 2, pp 24-41.

Manteaw, S. A., Folitse, B. Y., Anaglo, J. N., Mahama S. & **Mingle, N. A.** (2020). The dynamics of agricultural extension delivery along the value chain: Assessment of agricultural extension activities of MMDAs in Ghana. *Ghana Journal of Agricultural Science*, Volume 55 Issue No. 2

Mahama, S., **Manteaw, S. A.**, Decker, E. & **Mingle, N.A**. (2020) Gender Dimensions of the Effects of Seasonal Variations in Temperature and Rainfall on Cassava Production: A Study of Smallholder Farmers in Central Region, Ghana. *Agricultural and Food Science Journal of Ghana,* Volume 13, Pages 1312-1326.

Anaglo, N., Antwi, G., **Manteaw, S. A.** & Kwapong, N.A. (2020) Influence of Agricultural Information Sources on the Practices and Livelihood Outcomes of Cassava Farmers in Eastern Region of Ghana. *Journal of Sustainable Development* Volume 17 (1), Pages 2-10.

Mingle, N. A., Achampong, N.K. & Acheampong, D.L. (2020). An Assessment of Scholarly Contributions and Web Visibility Among Scientists of CSIR-Building and Road Research Institute, Ghana. *Ghana Journal of Science*, Volume 61 Issue No. 2

Nyamful, A., Nyogbe, E.K., Mohammed, L., **Zainudeen, M.N.,** Darkwa, S.A., Phiri, I., Mohammed, M. & Ko, J.M. (2020). Processing and Characterization of Activated Carbon from Coconut Shell and Palm Kernel Shell Waste b H3PO4 Activation. *Ghana Journal of Science*, Volume 61 Issue No. 2

Manual

Manual of Agricultural Technologies Developed by the Council for Scientific and Industrial Research (CSIR) **Manteaw S.A.**, **Folitse B.Y.,** Mahama S. & **Mingle N.A**. (August 2020).

Conference Paper

Prikutse, F.L., Twum-Barimah, Y. & **Danquah P.A.** (2020, December 20-22) *An Optimal Low Noise Amplifier (LNA) design for Signal Boosting*. International Conference on Mechatronics, Remote Sensing, Information Systems and Industrial Information Technologies

Book

60 Years of Research For Sustainable Development, compiled and edited by Paul P. Bosu, **Seth A. Manteaw,** Edward H. Decker, David Akowuah and Benedicta Nkrumah-Boateng, CSIR-INSTI Press, Accra, 2020

Newspaper Articles

Ampofo-Addo, A. and **Mingle, N. A.** (2020, November 24) Nurturing Ghanaian Child in the Information Age. *Ghanaian Times*, pp. 7.

Mingle, N. A. and **Ampofo-Addo, A.** (2020, September 30) Why Libraries Will Not Die (1). *Ghanaian Times*, pp. 7.

Mingle, N. A. and **Ampofo-Addo, A.** (2020, October 2) Why Libraries Will Not Die (2). *Ghanaian Times*, pp. 7.

Mingle, N. A. and **Ampofo-Addo, A.** (2020, October 8) Why Libraries Will Not Die (3). *Ghanaian Times*, pp. 7.

APPENDIX II

External Training Workshop/ Conference/ Seminar & Others

Adotevi E. participated in:

- The Kick-Off Meeting for 400 KW Hybrid Waste to Energy Pilot Project on 28th January 2020 at the Ghana Academy for Arts and Sciences.

Adjah J. served as a resource person for the First and Second Editions of the Cosmetics and Soap Production Training Programme on 26th February and 13th August 2020 respectively, at CSIR-IIR.

He also participated in:

- The Kick-Off Meeting for 400 KW Hybrid Waste to Energy Pilot Project on 28th January 2020 at the Ghana Academy for Arts and Sciences.

Agyenim A. B. participated in a CSIR Commercialization and Marketing Officers Workshop from 26th to 27th February 2020 at the CSIR Head Office.

Allotey A.N.M. participated in:

- The Second National Forum on Biosphere Reserves and MAB General Meeting from 17th to 19th November 2020 at Aqua Safari, Ada.

Ankrah S. participated in an Accountants Meeting from 1st to 2nd December 2020 at CSIR-PGRRI, Bunso.

Anyen J. participated in an Accountants Meeting from 1st to 2nd December 2020 at CSIR-PGRRI, Bunso.

Awanyo D. participated in a Training-the-Trainer Workshop on Performance Appraisal for CSIR on 20th October 2020 at CSIR Head Office.

Awotwi J.P. participated in:

- The Kick-Off Meeting for 400 KW Hybrid Waste to Energy Pilot Project on 28th January 2020 at the Ghana Academy for Arts and Sciences.
- A Quality Management System Training Workshop from 6th to 7th October 2020 at CSIR-SRI, Kumasi.
- A Farmer's Day Exhibition on 6th November 2020 at Methodist Park, Techiman.

Danquah P.A participated in:

- A CSO Cyber Security Workshop on 4th February 2020 at Swiss Spirit Alisa Hotel, North Ridge.
- The online 24th iSTEAMS Virtual Platform Enabled International Conference on 2nd June 2020.
- The online International Conference on Mechatronics, Remote Sensing, Information Systems and Industrial Information Technologies from 20th to 22nd December 2020.

Decardi-Nelson A. participated in:

- The Kick-Off Meeting for 400 KW Hybrid Waste to Energy Pilot Project on 28th January 2020 at the Ghana Academy for Arts and Sciences.
- An Agrictech Exchange Workshop on 4th March 2020 at KIC GIMPA campus, Accra.
- An online Organisation for Women in Science for the Developing World (OWSD) workshop on Conducting Excellent and Innovative Research Despite the Pandemic on 13th October 2020.
- The 31st Research Staff Association (RSA) Delegates General Meeting from 9th to 10th November 2020 at CSIR-CRI, Kumasi.
- The Empowering Women in Science: Strategies to Eliminate Challenges Early Career Ghanaian Women in The Chemical Sciences Face: Grantsmanship and Sustaining Research from 10th to 11th November 2020 at CSIR-WRI.

Gordon V.D. participated in:

- An online 5G Beamforming Design Workshop on 3rd July 2020.
- The online Deployment of Smart IT Solutions for Workplace Safety in the Age of COVID-19 workshop on 15th July 2020.
- An online Introduction to FPGA Verification with MATLAB and Simulink Workshop on 4th September 2020.
- The online International Conference on Using Technology & Innovation to Enhance Workplace Wellness and Productivity in the New Normal on 26th September 2020.

Kalognia J. participated in:

- The Kick-Off Meeting for 400 KW Hybrid Waste to Energy Pilot Project on 28th January 2020 at the Ghana Academy for Arts and Sciences.

- The 31st Research Staff Association (RSA) Delegates General Meeting from 9th to 10th November 2020 at CSIR-CRI, Kumasi.

Kessey M. B. participated in:

- An online Workshop on the Role of Science, Technology and Innovation in Accelerating Action and Transformative Pathways Towards Sustainable Development on 8th January 2020.
- The Kick-Off Meeting for 400 KW Hybrid Waste to Energy Pilot Project on 28th January 2020 at the Ghana Academy for Arts and Sciences.
- An online Organisation for Women in Science for the Developing World (OWSD) workshop on Sustaining Research During a Pandemic on 27th October 2020.

Manteaw S.A. participated in:

- A Digital Agricultural Advisory Service Strategic Plan (DAASSP) Development Workshop on behalf of the Deputy Director-General from 25th to 27th November 2020 at Tomreik Hotel, East Legon.
- A Gender Mainstreaming and MAG Stakeholders Policy Dialogue on MAG Activities as the Chair on 21st December 2020 at CSIR-STEPRI.
- Online monthly Agricultural Sector Working Group Meetings on the last Wednesday of every month.

Mingle N. A. participated in:

- A WIKIDATA Workshop titled Finding Glams: WIKIDATA, Librarians and Linked Open Data on 28th February 2020 at the Madina Institute of Science and Technology.
- The online International Conference on Mechatronics, Remote Sensing, Information Systems and Industrial Information Technologies from 20th to 22nd December 2020.

Ohene-Affih B. participated in:

- The Kick-Off Meeting for 400 KW Hybrid Waste to Energy Pilot Project on 28th January 2020 at the Ghana Academy for Arts and Sciences.

Prikutse F.L. participated in:

- The Kick-Off Meeting for 400 KW Hybrid Waste to Energy Pilot Project on 28th January 2020 at the Ghana Academy of Arts and Sciences.

- The 31st Research Staff Association (RSA) Delegates General Meeting from 9th to 10th November 2020 at CSIR-CRI, Kumasi.
- The online International Conference on Mechatronics, Remote Sensing, Information Systems and Industrial Information Technologies from 20th to 22nd December 2020.

Sackey T.A. participated in:

- The Kick-Off Meeting for 400 KW Hybrid Waste to Energy Pilot Project on 28th January 2020 at the Ghana Academy for Arts and Sciences.
- An online Organisation for Women in Science for the Developing World (OWSD) workshop on Sustaining Research During a Pandemic on 27th October 2020.
- The 31st Research Staff Association (RSA) Delegates General Meeting from 9th to 10th November 2020 at CSIR-CRI, Kumasi.

Sawyerr A. participated in:

- The Kick-Off Meeting for 400 KW Hybrid Waste to Energy Pilot Project on 28th January 2020 at the Ghana Academy for Arts and Sciences.

Twum-Barimah Y. participated in in a Solar PV Training Programme from 9th to 13th March 2020 at CSIR-IIR.

Wilson M. participated in:

- An Innovation for Development Seminar on 22nd January, 5th and 12th February at the University of Ghana, Legon.
- A Workshop on Highly Hazardous Pesticide Use in Ghana's Cocoa and Agricultural Landscape: The Way Forward, on behalf of the Institute's Director, on 24th November 2020 at Erata Hotel, East Legon.

Zainudeen M.N. participated in:

- The Kick-Off Meeting for 400 KW Hybrid Waste to Energy Pilot Project on 28th January 2020 at the Ghana Academy for Arts and Sciences.

APPENDIX III

List of Staff as at 31st December 2020

SENIOR MEMBERS

№	NAME	PRESENT DESIGNATION	QUALIFICATION
1	Dr. Seth Awuku Manteaw	Principal Scientific Information Officer/ Director	PhD (Agricultural Extension); MSc (Agronomy); PG Dip.(Communication Studies); MA (Communication Studies)
2	Dr. Albert N. M. Allotey	Senior Research Scientist/ Ag. Deputy Director	PhD (Geography & Resource Development); MPhil (Geography & Resource Development) BA (Hons) Geography & Resource Development
3	Dr. Richard Kofie*	Principal Research Scientist/ Former Deputy Director	PhD (Geography); MPhil (Geography); BA (Hons) Cert (Remote Sensing)
4	Mr. Joseph A. Anyen	Senior Accountant/ Head of Accounts	MBA (Finance); I.CA.; BSc.(Admin) Accounting Option
5	Mrs. Dorothy Awanyo	Administrative Officer/ Head of Administration	MBA (Human Resource Mgt) BA (Public Admin.); Dip. (Librarianship)
6	Mr. Benjamin Yao Folitse	Senior Librarian/ Head of Geospatial & Information Science	MPhil (Agricultural Extension); M.A.(Library Studies); B.Ed. (Agric); Dip (Agric Ed.)
7	Dr. Paul Asante Danquah	Senior Research Scientist/ Head of Communications	PhD (Info. Technology); MSc. (Info. Security); BSc.(Hons) Computing
8	Dr. Agnes Decardi-Nelson	Research Scientist/ Head of Printing & Publishing	PhD (African Art & Culture); BFA (Graphic Design)
9	Dr. Felix Tetteh Kabutey	Scientific Information Officer/ Head of Fluid Science	PhD (Environmental Science & Engineering) MPhil (Botany); BSc. (Applied Biology with Env. Science); Teacher's Cert "A'

10	Mr. Michael Wilson	Chief Technologist/ Head of Electronics	MPhil. (Computer Engineering); PostGrad.(Wireless & Mobile Computing); CDAC; BSc. Computer Eng.;
11	Dr. Mahamuda A. Mahamadu	Scientific Information Officer	PhD (Information & Communication Engineering) MSc. (Electrical & Electronic Engineering); PG Dip. (Management Information Systems and Management Control Systems) BSc.(Hons) Computer Science / Statistics)
12	Ms. Naa Aku Mingle	Librarian	MPhil (Information Studies) BA (Psychology & Linguistics)
13	Mr. Atta Senior Ampofo-Addo	Librarian	MSc (Management Information Systems) CIM-UK (Level 1); BA (Info. Studies & Sociology)
14	Mr. Bryan Nii Lartey Laryea	Research Scientist	MBA (Management Information Systems) BA (Information Studies & Geography)
15	Mr. Yaw Twum-Barimah	Chief Technologist	MSc. (Telecom); BSc. Elec. &Computer Engineering
16	Mr. Victor D. Gordon	Chief Technologist	MSc. (Telecommunications & Internet Technologies) BSc. (Computer Engineering)
17	Mr. Mohammed N. Zainudeen	Chief Technologist	MSc. (Chemical Eng.); BSc.(Hons) Chemical Eng.
18	Mr. Akilakpa Sawyerr	Chief Technologist	MPhil (Radiation Protection); BSc.(Physics)
19	Mr. Christian K. Lettu	Chief Technologist	MPhil (Dev. Geography); BA (Hons) Geography & Resource Development
20	Mr. John Annor	Chief Technologist	MPhil (GIS & Remote Sensing); B.A. (Geography)
21	Mr. Joshua Kalognia	Principal Technologist	MPhil (Radiation Protection); BSc. (Physics)
22	Mr. Frank Lemdi Prikutse	Principal Technologist	MSc. (Telecom Engineering); B.Eng. (Telecom Engineering)

23	Mr. John Adjah	Principal Technologist	MA (Communication Design); BA (Publishing Studies)
24	Ms. Maame Birago Kessey	Principal Technologist	MSc. (Information Technology); BSc. (Computer Engineering)
25	Ms. Tracy Adjeley Sackey	Principal Technologist/ Scientific Secretary	MPhil (Radiation Protection); BSc.(Physics &Computer Science)
26	Ms. Esther Opoku	Administrative Officer	MBA (Human Resource Mgt.) BA (Information Studies and Sociology); Diploma (Librarianship)

On Contract

SENIOR STAFF

№	NAME	PRESENT DESIGNATION	QUALIFICATION
1	Mr. Edwin Adotevi	Senior Technologist	BA (Comm. Studies)
2	Mrs. Janet Otoo-Abedi	Chief Accounting Assistant	Diploma (Public Finance and Accountancy)
3	Ms. Cordellia Akua Busumtwi	Chief Administrative Assistant	Cert. (Private Secretary)
4	Mrs. Faizatu Yakubu	Chief Auditing Assistant	BCom ICA (Gh) Part III (Commerce)
5	Mrs. Margaret Ivy Koranteng	Chief Library Assistant	Diploma (Librarianship)
6	Mrs. Akua Boateng Agyenim	Chief Marketing Assistant	MBA (Marketing) BA (Publishing)
7	Mr. Emmanuel E. Davidson	Chief Technical Officer	Cert. Basic Cartography
8	Ms. Sarah Mensah	Chief Accounting Assistant	Dip.(Public Finance and Accountancy)
9	Ms. Risikatu Lawal	Principal Accounting Assistant	BSc.(Accounting); DBS (Accounting); CIPS Cert. (Purch.&Supply)
10	Mr. Alex K. I. Ocansey	Principal Assistant Printer	Cert. (ITS) Snr. Sup/ Mgt; N.V.T.I. Grade I Cert.
11	Mr. William K. Akpakli	Principal Security Officer	BA (Social Work & Psychology); SSSCE: BECE
12	Mr. Eric Sam	Principal Technical Officer	BFA (Animation) HND (Graphic Designing)
13	Mr. Samuel Ankrah	Senior Accounting Assistant	Bachelor of Commerce; HND (Accountancy); SSSCE; BECE
14	Mr. Robert Abomoi	Senior Security Officer	Security Trg. Module 3; M.S.L.C.
15	Mr. Roland A. Pappoe	Technical Officer	Cert (Linux Network Admin.); City & Guilds Grad. Dip. (Microtech) I & II
16	Mr. Eric K. Acquaye	Technical Officer	Advanced Certificate in Microsoft Certified Systems Eng. (GIMPA); SSSCE
17	Mr. Benjamin Ohene-Affih	Technical Officer	B.Eng.(Computer Science)
18	Mr. John Paapa Awotwi	Technical Officer	BSc. (Information Technology)
19	Ms. Samiratu A. Mamah	Technical Officer	BA (Communication Design)
20	Mr. Yaw Owusu-Ayirebi	Technical Officer	BA (Graphic Design)

21	Ms. Doris Kumiwa	Administrative Assistant	Dip (BCom Management) DBS (Secretariaship); Nat. Banking Coll. (Cert Cashier & Frontline Exec)
22	Ms. Yvonne D. Azuma	Administrative Assistant	Dip (Public Administration) SSSCE
23	Mr. Cephas Awusie	Security Officer	Security Training Module I; G .C. E.'O' Level
24	Mr. Abdul Rahaman Iddrisu	Security Officer	Security Training Module I; M.S.L.C.
25	Mr. Fuseini Inusah	Security Officer	SSSCE
26	Mr. Timothy Kwamena	Assistant Transport Officer	Cert. (Trans Mgt); Intercity STC Coaches Ltd.; MSLC

JUNIOR STAFF

№	NAME	PRESENT DESIGNATION	QUALIFICATION
1	Mrs. Salamatu Abdul Mumuni	Senior Clerk	NACVET Cert.(Stenographer)
2	Ms. Lucy Akyempon	Senior Clerk	"O" level, DBS
3	Mr. Simon Angabe	Senior Security Assistant	Security Training Module I; MSLC
4	Mr. Nathan K. Aborgeh	Senior Security Assistant	Security Training Module I; MSLC
5	Mr. Charles Kulley	Junior Library Assistant	SSSCE
6	Mr. Bancie Habil Hussein	Junior Library Assistant	SSSCE
7	Mr. Enos Awusie	Traffic Supervisor	Intercity STC (Def. Driving Course); MSLC
8	Mr. Joseph Lamptey	Traffic Supervisor	Intercity STC (Def. Driving Course); BECE
9	Mr. Seth Asare	Artisan	Special Junior Tech. Super. Mgt Course, ITS- Accra; MSLC
10	Mr. Matthew Narteh Amoatey	Driver Inspector	Course on Road Safety Mgt. (ATS) City & Guild (Mech. Eng. Craft Practice); BECE; Drive. Lic "C"
11	Mr. Razak Ayidana Akambase	Supervisor Grade I	B.E.C.E.
12	Mr. Kojo Asanaab	Supervisor Grade I	B.E.C.E.
13	Mr. Isaac G. Amponsah	Supervisor Grade I	NVTI GD II
14	Mr. Robert Achandi	Supervisor Grade I	M.S.L.C.
15	Mr. Francis Ayarik	Supervisor Grade I	Nil
16	Mr. Abdul Wahab Usman	Supervisor Grade II	Nil

CSIR-INSTI Office Location Map

1 - CSIR-INSTI/LIBRARY
2 - Geographical Information System Section/Fluid Science lab
3 - Science Publishing Division
4 - Printing Division
5 - ASSIP Block, Research Scientist
6 - CSIR-Canteen
7 - Human Resource Department
8 - CSIR Head Office
9 - Car Park
10 - Kopia Ghana Center
11 - Security Post II
12 - Uncompleted Building
13 - Provident/Superannuation Division
14 - CSIR Stores
15 - Bush Canteen
16 - Maintenance Department
17 - Car Park
18 - WASCAL Car Park I
19 - WASCAL Security Post
20 - WASCAL
21 - WASCAL Car Park II
22 - IITA Annex Building
23 - Car Park
24 - IITA Main Building
25 - AGRA
26 - AGRA Security Post
27 - CAB International/Encyclopedia Africana Project
28 - Car Park
29 - Security Post I
30 - Lawn
31 - IWMI Security Post
32 - IWMI
33 - Biomedical and Public Health Research Unit
34 - Biomedical Building
35 - Covid-19 and Other Infectious Diseases Research and Diagnostics Lab
36 - Bungalow III
37 - Bungalow II
38 - Main Security Post
39 - Lawn
40 - Greenhouse Yard
41 - Farm Yard
42 - Roundabout
43 - Bungalow I
44 - Lawn
45 - Lawn
46 - Drivers Apartment
47 - CSIR Club House
48 - CSIR Guest House
49 - Bungalow IV

Source of data: Google Earth Pro
Credit: GPS Locations

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