



COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH
FOOD RESEARCH INSTITUTE



2015 ANNUAL REPORT



CSIR-FOOD RESEARCH INSTITUTE
2015 ANNUAL REPORT

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LIST OF ACRONYMS

AGORA	-	Access to Global On-line Research on Agriculture
AWARD	-	African Women in Agricultural Research and Development
C: AVA	-	Cassava: Adding Value in Africa
CID	-	Commercialization & Information Division
CRI	-	Crops Research Institute
CSIR	-	Council for Scientific and Industrial Research
CSS	-	Clients Services Section
EU	-	Engineering Unit
FCD	-	Food Chemistry Division
FMD	-	Food Microbiology Division
FNSED	-	Food Nutrition and Socio-Economics Division
FPED	-	Food Processing and Engineering Division
FRI	-	Food Research Institute
GIZ	-	German International Cooperation
GRIB	-	Ghana Rice Inter professional Body
HINARI	-	Health InterNetwork Access to Research Initiative
HQCF	-	High Quality Cassava Flour
IGF	-	Internally Generated Funds
IMS	-	Information Management Section
ISU	-	Industrial Services Unit
KNUST	-	Kwame Nkrumah University of Science and Technology

MOAP	-	Market-Oriented Agriculture Project
MoFA	-	Ministry of Food and Agriculture
MU	-	Mushroom Unit
OARE	-	Online Access to Research in the Environment
PSPU	-	Pilot Scale Production Unit
RTPDU	-	Root and Tuber Products Development Unit
SANAS	-	South African National Accreditation System
SARI	-	Savana Agricultural Research Institute
SMEs	-	Small and Medium Scale Enterprises
STEPRI	-	Science and Technology Policy Research Institute
TBSS	-	Technological Business Services Sections
TEEAL	-	The Essential Electronic Agricultural Library
TRAQUE	-	Trade Related Assistance and Quality Enabling
WAAPP	-	West African Agricultural Productivity Programme

CSIR-FRI MANAGEMENT BOARD MEMBERS

1. Nana Osei Bonsu - CEO, PEF - Chairman
2. Dr. N.T. Dziedzoave - Director, CSIR-FRI - Member
3. Mr. H.A. Obiri - Director, IIR (Cognate) - Member
4. Mr. Timothy A. Osei - Chartered Accountant - Member
5. Prof. Kenneth Danso - BNARI, GAEC - Member
6. Mr. Jacob Tetteh Ayin - Pioneer Food Cannery Ltd. - Member
7. Mr. E. O. Brakoh - Director, Corporate Finance, CSIR - Member
8. Mr. David Hayford Ahiabor - Head/Finance, CSIR-FRI - Member
9. Ms. Janet Aggrey-Yawson - Head/Administration, CSIR-FRI - Secretary

Members of CSIR-FRI Internal Management Committee

1.	Dr. Nanam Dziedzoave	-	Director	-	Chairman
2.	Dr. (Mrs.) Mary Obodai	-	Deputy Director	-	Member
3.	Mrs. Glover-Amengor	-	Head/FNSD	-	“
4.	Dr. Charles Tortoe	-	Head/FPED	-	“
5.	Dr. Lawrence D. Abbey	-	Quality Manager	-	“
6.	Mr. G. Anyebuno	-	Head/FCD	-	“
7.	Dr. Margaret Owusu	-	Head/FMD	-	“
8.	Mr. Stephen Nketia	-	Head/CID	-	“
9.	Ms. Janet Aggrey-Yawson	-	Head/Admin.	-	“
10.	Mr. David Ahiabor	-	Head/Accts	-	“
11.	Mr. Gregory Komlaga	-	Head/RTPDU	-	“
12.	Mr. Hayford Ofori	-	Head/ISU, FCD	-	“
13.	Ms. Matilda Dzomeku	-	Head/Mushroom Unit	-	“
14.	Mr. Elvis A. Baidoo	-	Head/PSPU	-	“
15.	Mr. Jonathan Ampah	-	Ag. Head/EU	-	“
16.	Mrs. Nina Bernice Ackah	-	Head/ISU-FMD	-	“
17.	Mr. Kwabena Asiedu Bugyei	-	President/RSA	-	“
18.	Mr. Michael Amoo-Gyasi	-	Chairman/TUC	-	“
19.	Mr. Theophilus Annan	-	President, SSA	-	“
20.	Mr. Richard Takli	-	Chairman, SWA	-	“
21.	Mr. Eric Ofori	-	Chief Admin. Asst.	-	Recorder

EXECUTIVE SUMMARY

The CSIR-Food Research Institute (FRI) generates technologies that are aimed at meeting the demands of the private sector and socio-economic development of the country. It is tasked to provide consultancy, technical and analytical services as well as contract and collaborative research to governmental agencies, agro-food processing industries and international development agencies. The targeted goal of the Institute has been to assist in poverty alleviation through the creation of opportunities for generating and increasing incomes, contribute to food security, foreign exchange earnings and the application of cost-effective food processing technologies.

During the year, the Institute carried out Research and Development activities which included, baseline studies and collation of data on existing drying systems, capacity training gaps and needs as well as quality audits to monitor performance of processing groups and SMEs. There was the development and transfer of cassava product development technology to thousand five hundred (1500) primary out-processors, the completion of an agribusiness incubation centre for the production of glucose syrup and ethanol. A study on the effect of starch properties and functional uses of traditional and improved varieties of rice was carried out. In the area of Nutrition, mushroom based weaning foods were developed and formulated.

The Institute had a total of twelve (12) research projects running in the year. Through these projects and other collaborative works, twenty-one (21) scientific papers were published in refereed journals and thirteen (13) technical reports churned out as output of scientific research activities. CSIR-FRI continued with the production and sales of eight (8) research by-products for commercial activities and offered production services to clients. Research laboratory sections provided technical, analytical as well as product development services to clients. The Institute also carried out capacity building through socio-economic evaluation and impact assessment of the use of parboiling technology; training on improved rice post-harvest practices (involved 767 farmers and processors); training of matrons and caterers on the use of composite flours, production and use of High Quality Cassava Flour (HQCF) and mushroom technology training to individuals and groups.

The activities of CSIR-FRI generated GH¢ 6,904,204.00 as income and made a surplus of GH¢222,967.00.

1.0 INTRODUCTION

Food Research Institute (FRI) is one of the thirteen affiliate Institutes and Centres of the Council for Scientific and Industrial Research (CSIR). Established by the Government of Ghana on 1st October 1963, Legislative Instrument No. 438 of 19th March 1965, it was later incorporated into the CSIR as one of the Institutes in October 1968. The operations of FRI started in 1965 with assistance from the United Nations Development Programme (UNDP) while the Food and Agriculture Organisation (FAO) acted as the executing agency.

Mandate

The CSIR-FRI is mandated to conduct applied market oriented research into problems of food processing and preservation, food safety, storage, marketing, distribution and utilisation, and national food and nutritional security in support of the food industry and also to advise government on its food policy.

Vision

The vision of the Institute is to be recognised nationally and internationally as an S&T institution that is playing a key role in the transformation of the food processing industry to be internationally competitive with particular reference to product safety, quality and presentation.

In order to achieve the mandate, vision and goals of the Institute, CSIR-FRI's programmes are focused on R&D activities which aid in curbing postharvest losses in Ghana as well as directly contributing to income generation. The main objectives of its activities are:

1. To develop and provide technical information, training and services to the private sector and other stakeholders in the food industry.
2. To provide appropriate technology packages for processing and storage of raw agricultural produce to facilitate curtailment of post-harvest losses and promote value addition for local and export markets.
3. To strengthen the Institute's capability and linkages with industry through human resource and infrastructural development, restructuring and re-organisation for effective commercialization of operations.

Programmes

To accomplish its objectives, the activities of the Institute are classified under the following programmes:

- a. Root and Tuber products programme
- b. Cereal, Grains and Legume products programme
- c. Meat, Fish and Dairy products programme
- d. Fruit, Vegetable and Spice products programme

Areas of Commercialization include:

- Collaborative Research
- Consultancy, Training and throughput Technology Transfer
- Technical and Analytical Services
- Sale of Research By-Products
- Equipment fabrication
- Hiring of Food Processing Facilities

Technical Divisions

- a. Food Processing and Engineering Division
- b. Food Chemistry Division
- c. Microbiology Division

2.0 DIVISIONS

2.1 ADMINISTRATION DIVISION

Introduction

The Administration provides administrative support for the Research and Technological programmes of the Institute; it also assists with the day-to-day running of the Institute. The primary goal of the Division is to ensure the availability and efficiency of skilled staff, uphold the Institute's structures and systems and maintain its properties in the best functional state. CSIR-FRI has a total staff strength of 151, this includes thirty-three (33) Senior members, sixty-five (65) Senior staff and fifty-three (53) Junior staff.

Appointments and Promotions

Six (6) new headship appointments were made in the year. Dr. (Mrs.) Mary Obodai, Principal Research Scientist and Head of Food Microbiology Division was appointed Deputy Director of the Institute. This took effect from 1st February, 2015. With effect from 1st March, 2015, the following appointments were also made:

- Dr. Margaret Owusu, Research Scientist was appointed acting Head of Food Microbiology Division.
- Mr. Hayford Ofori, Research Scientist was appointed the Head of Industrial Services Unit of Food Chemistry Division.
- Mrs. Nina Bernice Ackah, Research Scientist was also appointed Head of Industrial Services Unit of Food Microbiology Division.
- Ms. Matilda Dzomeku, Research Scientist was appointed the Head of the Mushroom Unit of the Food Microbiology Division and
- Mr. Eric Ofori was appointed Acting Head of Administration.

Promotions

Senior Research Scientists, Dr. Mrs. Margaret Ottah-Atikpo; Dr. Mrs. Mary Obodai; Dr. Charles Tortoe and Mrs. Mary Glover Amengor were promoted to the grade of Principal Research Scientists. The promotions of Senior & Junior Staff within the period are shown in appendix II.

Transfers

Ms. Justina Thompson, Senior Marketing Officer was transferred from the Food Nutrition and Socio-Economic Division to the Commercial and Information Division with effect from 1st March, 2015. There were also inter institutional transfers involving Ms. Getty Afukaar, Senior Technical Officer and Ms. Ruth Fosu, Principal Technical Officer of CSIR-Crops Research Institute, transferred to CSIR-FRI with effect from 2nd February and 1st October, 2015 respectively. Ms. Regina Tsotsoo a Senior Accounting Assistant of CSIR-PGRRRI was also transferred to the Institute effective from 1st October, 2015.

Internships/National Service

The Institute continued to provide opportunities for students from Tertiary Institutions to undertake internship programs. During the period, forty (40) students and twenty-three (23) National Service Personnel from Universities and Polytechnics undertook attachments and Service respectively in various Divisions of the Institute. CSIR-FRI furthermore provided its annual six-week internship training for students of the Department of Food Science and Technology from the Kwame Nkrumah University of Science & Technology.

Retirement

The following staff proceeded on leave prior to retirement:

- Dr. (Mrs.) Margaret Ottah Atikpo, Deputy Director and Principal Research Scientist.
- Mr. John Mintah Nakotey, Chief Stores Supt with the Accounts Division.
- Mr. Rhodes Anthonio, Chief Technical Officer of the Food Processing & Engineering Division.
- Ms. Diana Kuwornu, Principal Telephonist

Obituary

Mr. Benjamin Addi Okae, Research Scientist (M & E) and the Acting Head of Administration and Mr. Apollonius Isaac Nyarko a Senior Technologist with the Food Processing & Engineering Division passed on to eternity. The sad events occurred on 23rd and 28th February, 2015 respectively.

2.2 ACCOUNTS DIVISION

Introduction

The role of the Accounts Division is to ensure the effective and efficient management of revenue, expenditure, assets, liabilities and other resources of CSIR-FRI in accordance with the Financial Administration Act 2003 (Act 654). It also ensures that procurement is done in accordance with the Public Procurement Act 2003 (663). The accounts Division sees to it that the Institute complies with the provisions under the Internal Revenue Act 2001 and also makes certain that CSIR policies and regulations which relate to Accounts and Finance are adhered to.

Major Activities

In order to fulfil its roles and responsibilities, the following major activities are carried out in the Division:

1. Preparation of annual budget.
2. Cash receipt and banking transactions.
3. Procurement and store supplies for the Institute.
4. Recording and record keeping of financial transactions of the Institute.
5. Preparation and keeping of assets' register.
6. Preparation of annual financial statements.
7. Provision of reports to government agencies and CSIR Head Office.
8. Overseeing to both internal and external auditing of the Institute's accounting books.
9. Analyzing reports and giving recommendations when appropriate.

During the year under review, the following activities were accomplished:

- Completion of the final accounts of 2015.
- Entries of data of the 2016 financial transactions were matched into the accounting records to June, 2016.
- Management reports were prepared and professional advice was offered to Management in order to assist in decision making.
- Management of funds from donors for research activities and ensuring that the various research activities complied with the financial requirements attached to the activities.
- Reviewed audit comments and ensured that the Institute complied with their recommendations.

Financial Performance for the year ending 31st December, 2015.

Elements	Years	GHC 2015 ACTUAL	GHC 2014 ACTUAL
INCOME:			
	Government Sources	5,814,176.00	6,420,890.00
	Internally Generated Fund	1,090,028.00	620,805.00
	Total	6,904,204.00	7,041,695.00
EXPENDITURE:			
	Normal business	6,302,475.00	7,503,695.00
	Internally Generated Fund	378,762.00	318,597.00
	Total	6,681,237.00	7,822,292.00
	Surplus Income from IGF	711,266.00	302,207.00
	Loss from normal business	(488,299.00)	(1,082,805.00)
	Surplus/Loss	222,967.00	(780,598.00)

Summary

The Institute made a surplus of GH¢222,967.00 which is made up of the following items:

- Loss from normal business. GH¢ 488,299.00
- Surplus from Internally Generated Fund GH¢ 711,266.00
- Total surplus for the year GH¢ 222,967.00

Income

- Total income in 2015 was GH¢ 6,904,204.00 which was 1.6% less than 2014.
- Income from Internally Generated Fund which was 15.79% of the total income was GH¢ 1,090,028 showing a growth of 75% of 2014.
- Income from government sources was GH¢5,814,176.00 and it was 10.44% less than 2014.

Expenditure

Total expenditure in 2015 was GH¢ 6,681,237.00 which was 17% less than 2014. Expenditure on Internally Generated Fund which was GH¢ 378,762.00 constituted 5.67% of the total expenditure. A percentage of 94.33% of the total expenditure was incurred on normal business activities.

2.3 FOOD PROCESSING AND ENGINEERING DIVISION

Introduction

The Food Processing and Engineering Division (FPED) has three (3) operational units, that is, the Engineering Unit (EU) - headed by Mr. Jonathan Ampah; the Pilot Scale Production Unit (PSPU) - headed by Mr. Elvis Baidoo and the Root and Tuber Products Development Unit (RTPDU) - headed by Mr. Gregory Komlaga.

The Division maintained its five (5) Performance-Improvement-Teams, which was created to aid improve the efficiency of the management of the Division. The teams comprise of the Research and Development Management Team, Quality Management Team, Information Management Team, Market Development Team and the Equipment Installation and Maintenance Management Team.

The PSPU consist of the Production and Laboratory sections. The production section processes eight (8) food products for commercial activities and offers production services to clients. These products include groundnut paste, Fermented Maize Meal, yam fufu, cocoyam fufu, plantain fufu, banku mix, oblayo as well as rice and maize weaner mix foods. The laboratory section provides analytical services and product development services to clients.

The Engineering Unit comprises of a mechanical and an electrical section. The sections work together in repairing, modifying and fabricating food processing equipment. The Unit is well versed in fabrication of cassava processing lines as well as mechanized bin dryers and solar dryers.

The RTPDU specializes in the processing of root and tuber crops such as cassava, cocoyam, plantain, sweet potato and yams. The Unit processes kokonte, gari, agbelima, starch and High Quality Cassava Flour (HQCF) as part of its commercial activities and executes contract processing for clients.

Major activities

The major activities undertaken in the Division during the period under review were:

- Research and Development activities
- Production and sale of research by-products
- Technical and analytical Services

- Consultancy and
- Training

Research and Development Activities

The Division was involved in nine (9) projects by direct involvement in R&D activities resulting in capacity building. Under the auspices of the West Africa Agricultural Productivity Programme (WAAPP) Project, composite flour technology and bakery product processing were transferred to flour end-users in the Ashanti and Brong Ahafo regions. Mixers, rollers as well as ovens and their accessories were acquired and distributed to trained bakery groups in the Volta and Eastern regions. The Engineering Unit fabricated and installed equipment for an established Agribusiness Center at Pokuase. Cassava graters and presses also fabricated for processors were distributed to processors in Western, Volta, Brong Ahafo and Eastern regions. Test run of these equipment were carried out.

Modification of bin dryer heat exchanger, test run of bin dryer, installation of fan regulator and thermocouple were carried out under the Cassava Growth Markets (CassavaGMarket) project. Repair and testing of Innotech dryer, installation of hot water pump, fruit drying test with TOBY 2 dryer, gas train installation and the installation of pressure gauge on the solar dryer and TOBY dryer were carried out under GIZ-MOAP.

Client requested trainings and consultancies was conducted on fruit juices, fufu flours, fermented maize meal, groundnut paste etc.

Production and Sale of Research By-Products

Production and Sales

Research by-product production quantities and amounts generated over the period were as presented in Tables 1 to 3.

Table 1: By-Products in the Engineering Unit

No.	Type of Product	No. of Times	Quantity Produced	Total Amount(GH¢)
1	Fabrication of equipment	17	17	31,500.00
2	Installation	-	-	-
3	Repair and maintenance	-	-	-
	TOTAL	17	17	31,500.00

Table 2: Sales of Research By-Products at PSPU

Type of Product	Quantity Produced	Total Sales Amount (GH¢)
Groundnut	1284	9479
Fermented Maize Meal	864	3930
Yam <i>fufu</i>	1442	10976
Cocoyam <i>fufu</i>	1858	14024
Plantain <i>fufu</i>	1350	6620
<i>Banku</i> mix	1994	11678
Maize Grits	1430	7150
<i>Oblayo</i>	2140	12196
TOTAL	12,362	76,053

Table 3: Sales of Research By-Products at RTPDU

Type of Product	Quantity Produced	Total Sales Amount (GH¢)
Kokonte	4552	21500
Gari	560	2090
Agbelima	-	-
Starch	1200	5400
HQCF	-	-
TOTAL	6312	28,990.00

Services to clients

The services provided to clients at the PSPU, EU and RTPDU include roasting of groundnuts and soybeans as well as drying of Hausa Koko as presented in Tables 4 and 5.

Table 4: Services to clients at PSPU

Type of service	Number of times	Total Amount (GH¢)
Drying	10	326
Milling	26	2250
Roasting	116	52994
TOTAL	152	55570

Table 5: Services to clients at RTPDU

Type of service	Number of times	Quantity produced	Total Amount (GH¢)
Drying of Ginger	6	4260	1200
Drying of Fermented maize dough	4	2000	600
Drying of cassava dough	2	800	240
Roasting of <i>gari</i>	2	1200	500
TOTAL	14	8260	2540

Analytical services

Two hundred and eighteen (218) samples were analysed within the period. Analyses are as represented on Table 6.

Table 6: Analytical Services to clients at PSPU Laboratory

No.	Types of Analysis	No. of samples	Total Amount charged (GH¢)
1	Water activity	148	10,208
2	Milling & sieving	4	660
3	Colour determination	56	2824
4	Water binding capacity	42	6820
5	Water absorption	28	3554
6	Water retention	8	1004
	TOTAL	286	25,070
	Total Charges		

Public Private Partnership

- The PSPU was in partnership with Palmer Foods to produce and commercialize plantain, cocoyam and yam *fufu*.
- The RTPDU collaborated with Palmer Foods to renovate and put to use the kenkey factory at RTPDU as an incubation facility.
- The PSPU has completed its plantain *fufu* reformulation. The production of plantain *fufu* for Palmer Foods has just begun. It is envisaged that profits in PSPU will increase.

2.4 FOOD CHEMISTRY DIVISION

Introduction

The Food Chemistry Division plays a key role in support of the commercialization activities of the Institute by offering analytical services to Industry, Local and International students. The Division offers training for students from the Universities and Polytechnics in the country. In addition, the Division conducts applied research into chemical contaminants (mycotoxins and heavy metals) in foods and feeds as well as food aroma analyses. The Division also offers consultancy services and advice to clients. It has two Sections (laboratories), namely the Food Toxicology Section and the Industrial Services Section. The two laboratories are accredited to ISO 17025 by the South Africa National Accreditation System (SANAS). The accredited parameters are protein, moisture, fat, ash and aflatoxins.

Divisional Management Team Members

The Divisional Management Team is made up Mr. George A.A. Anyebuno, Mr. Hayford Ofori, Mr. Nelson Amey, Mr. Vincent Kyei-Baffour and Ms. Vida Awidi.

Analytical Services

The Division carried out analytical services for a total of two hundred and seventy-four (274) samples from clients during the first quarter of the year 2015. The industrial Services laboratory analyzed 232 samples and the Toxicology laboratory analyzed 42 samples. The value of services rendered during the period under review was GH¢ 43,521. Analytical services to clients yielded GH¢ 42,316, whilst total cost of analyzing Food Research products for the quarter was GH¢ 1205. The Actual gross income and expenditure for the Division was GH¢ 38,593.80 and GH¢ 1860 respectively, yielding a profit of GH¢ 36,733.50.

The Division carried out analytical services for a total of three hundred and fifty-six (356) samples from clients during the second quarter of the year. The industrial Services Unit (ISU) analyzed 244 samples (12 samples more than the first quarter) and the Toxicology Unit analyzed 112 samples (70 samples more than the first quarter). The Toxicology analyses included 5 ochratoxin A and 20 histamine analyses. The total revenue realized for these services during the period under review was GH¢ 48,738 as compared to GH¢ 38,593.80 for the first quarter. The cost of analyzing Food Research products for the quarter was GH¢ 1,960 compared to GH¢ 1,205 for the first quarter. Therefore the total cost of analyzing the Institute's products amounted to GH¢ 3,165 for the two quarters of 2015. Actual gross income

and expenditure for the Division was GH¢ 48,738.80 and GH¢ 6,185.95 respectively, yielding a profit of GH¢ 42,532.05. The comparison of profits, expenditures and cost of analyzing Food Research products between the first and second quarters is as shown in figure 1.

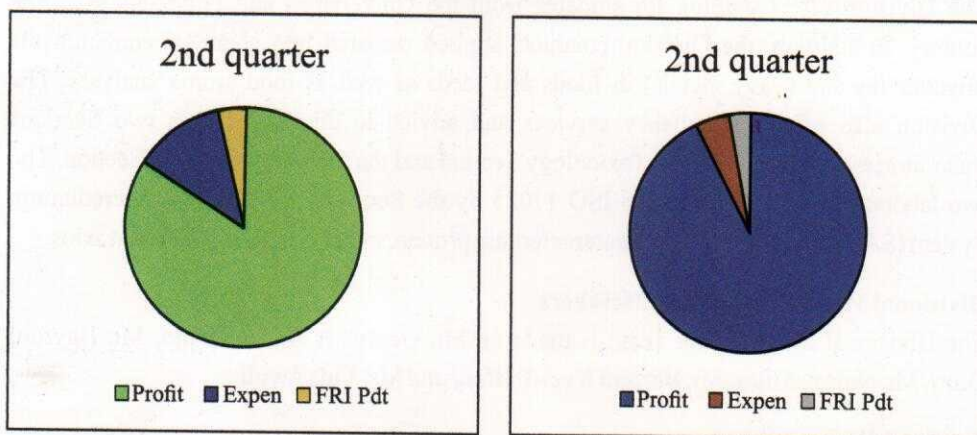


Figure 1: Representation of profit, expenditure and cost of analyses of FRI products

The Food Chemistry Division carried out analytical services for a total of three hundred and thirty-eight (338) samples from clients during the third quarter of the year 2015. The Industrial Services Unit (ISU) analyzed 258 samples (14 samples more than the second quarter) and the Toxicology Unit analyzed 80 samples (32 samples less than the second quarter). The total revenue realized for these services during the period under review was GH¢ 56,568 as against GH¢ 48,738 for the second quarter. The cost of analyzing Food Research products for the quarter was GH¢ 840. Actual gross income and expenditure for the Division was GH¢ 56,568.00 and GH¢ 29,609.94 respectively, yielding a profit of GH¢ 26,961.06.

A total of four hundred and twenty-seven (427) samples were analyzed by the Division for the fourth quarter of the year. The samples analyzed by the Industrial Services laboratory (310 samples) yielded a gross amount of forty-four thousand nine hundred and fifteen Ghana cedis, eighty-three Ghana pesewas (GH¢ 44,915.83) and that analyzed by the Toxicology laboratory (117 samples) yielded a gross of sixteen thousand five hundred and ninety Ghana cedis (GH¢ 16,590).

In summary, during the year under review, the Division analyzed a total of one thousand three hundred and ninety-five (1,395) samples from several companies, establishments and individuals, as shown in figure 2. A total of 1044 samples were analyzed by the Industrial Services laboratory whilst the Toxicology laboratory analyzed 351 samples. These numbers represent a 9.89% increase over the 950 samples for the Industrial Services laboratory and 47% increase over the 186 samples for the Toxicology laboratory received in 2014. The gross revenue for the Industrial Services laboratory amounted to GH¢ 158,837.62 representing a 34% increase over the 2014 amount. The Toxicology laboratory recorded a 59% increase in revenue over that of 2014. The Division clearly made significant gains in 2015 despite the challenges encountered, as shown in figure 2.

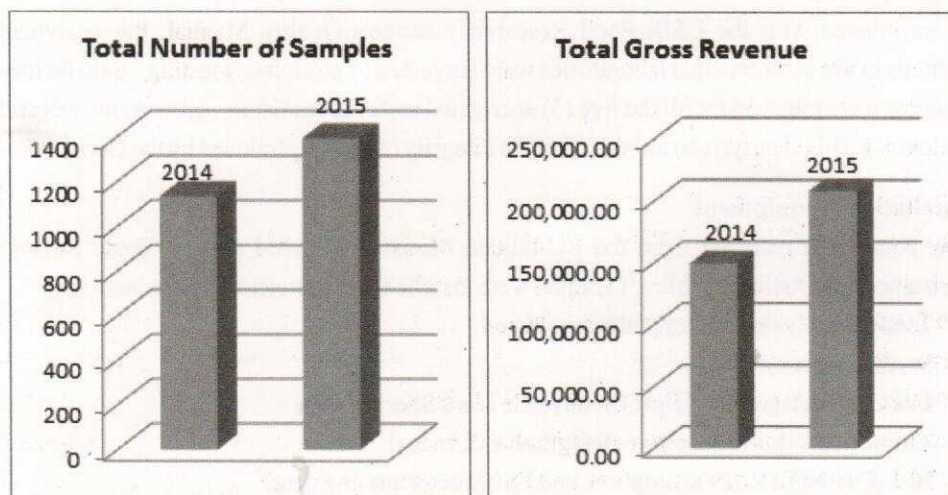


Figure 2: Graphs comparing total number of samples and total gross revenue of 2014 and 2015

For the 3rd and 4th quarters of the year under review, the Chemistry Division carried out analyses for a CSIR-FRI-FAO project. The parameters included fat acidity, moisture, ash, fat, protein, carbohydrate, energy, iron, zinc, copper, manganese, calcium and histamine. A total of fifty-two (52) samples were analyzed at a total cost of GH¢ 10,485.00.

Clients who patronized services of the Division for the year under review with the corresponding number of samples per client is as shown in appendix IV.

Accreditation of Chemistry Laboratories

Internal Audits

In compliance with the CSIR-FRI Accreditation Quality Manual, two internal audits were conducted during the year. These audits were carried out on the 15th of January and the 10th of November 2015.

External Audit (SANAS Audit)

Due to the on-going renovation works at the Microbiology laboratory, SANAS surveillance audit for accredited labs of the Institute originally scheduled for February 2014 was rescheduled for some time in 2016 after completion of works.

Proficiency Tests

In accordance with the CSIR-Food Research Institute's Quality Manual, the analytical methods in use by accredited laboratories were subjected to proficiency testing. Satisfactory Z-scores were returned for all the five (5) accredited methods (moisture, protein, fat, ash and aflatoxins). This clearly, is an indication of the integrity of results produced by the Division.

Installation of equipment

New equipment received from the EU-funded Ministry of Trade project 'Trade Related Assistance and Quality Enabling' (Traque) were installed in the Division. These included;

- Total fat analyzing system, fully automated
- Muffle furnace, > 40L
- Gas Chromatography-Triple Quadrupole Mass Spectrometer
- Atomic Absorption Spectrometer (graphite furnace)
- HPLC with FLD, UV absorption, and ESLD detectors (Agilent)

A Millipore water purification plant and a Kheltec protein analyzer fully automated were however yet to be installed.



Atomic Absorption Spectrophotometer
(Graphite furnace)



Agilent 1260 series HPLC system



Agilent GC/MS (Triple Quadruple)

Activities carried out

Green Growth project

Under the above project, samples of Fura were bought from survey areas (Madina, Old Turaku, Nima and Sukura) and analyses such as protein, ash, fat, moisture, pH, colour and titratable acidity were carried out. Selected SMEs were also visited by a team made up of Mr. Stephen Nketia, Mr. George Anyebuno, Mr. Boadi and Miss Gertrude Afukaar. The CEOs of these SMEs were interviewed. These SMEs are expected to take up the technology that will be developed under the project for commercial purposes. Thus it was necessary to get them on board at the initiation stage. In December the Project Team members (Dr. Margaret Owusu,

George Anyebuno, Stephen Nketia, Amy Atter, Theophilus Annan under the leadership of Dr. Wisdom Amoa-Awua) conducted another survey in the North. The survey areas were Tamale and its environs in the Northern Region, as well as Paga in the Upper East region.

2.5 FOOD MICROBIOLOGY DIVISION

Introduction

The Food Microbiology Division has a mandate to undertake research and commercial activities in the area of food safety and quality assurance for the food and mushroom industries in Ghana. The Division is made up of two units: the Industrial Services Unit (ISU) and the Mushroom Unit (MU).

The ISU carries out services for clients through analyses of samples submitted or sampled directly by staff. The Unit also advises clients as well as inspect food production premises and food products of clients. The analyses carried out include seven accredited methods by South African National Accreditation System (SANAS). ISU is also involved in training entrepreneurs and students from tertiary institutions such as Polytechnics and Universities.

The MU carries out research activities in indigenous and exotic edible and medicinal mushrooms. It disseminates results to stakeholders through training programmes, technical reports and scientific papers. MU also maintains a National Mycelium Bank which contains samples of mushrooms received and researched into. The Unit is also engaged in production and sale of mushroom spawns and compost bags to local farmers and researchers in some countries in sub-Saharan Africa such as Cote d'Ivoire, Benin, Togo and Sierra Leone.

Commercialization activities

Analytical services and products

During the year under review the ISU offered analytical services to several companies, establishments and individuals. The clients included Cadbury Ghana Ltd., Pioneer Food Cannery Ltd., Newrest Catering Ltd, Promasidor Ghana Ltd., Intertek, students from the universities and polytechnics and several other food industries and individuals. The Unit analysed more than 2000 samples constituting about 6000 microbiological tests. This generated an annual gross income of One hundred and eighty-one thousand, six hundred and ninety-two Ghana Cedis, ninety-four Pesewas (181,692.94). Samples analysed included cocoa products, water, swabs, various kinds of cooked and ready-to-eat foods, spices, fish and fish products, meat and meat products, cereals and grains, dairy products, and confectioneries.

The MU produced a total of about 12,000 spawns and 10,000 compost bags for sale to clients. Commercial activities of the Unit yielded an annual gross income of (Forty eight thousand, four hundred and thirteen Ghana Cedis, seventy Pesewas (GHC48,413.70).

Table 7 shows a summary of income generated by the Division during the year under review.

Table 7: Gross income generated by the ISU and MU

Unit	1st quarter	2 nd quarter	3 rd quarter	4 th quarter	Annual total
ISU	55,917.80	44,935.30	80,737.85	101,986.37	181,692.94
MU	11,779	8,775	10,589.00	17,270.70	48,413.70
Total	67,696.8	53,710.30	91,326.85	119,257.07	230,106.64

Trainings and consultancies

The MU organised two training programmes during the year. The first was organised from 20th – 24th April 2015 and the second from 2nd - 6th November 2015. Thirteen participants attended in each instance.

Accreditation activities

The ISU continued its quality system activities under ISO 17025. Although the Unit operated from a make-shift laboratory throughout the year, it ensured the continuous maintenance of the quality system through the use of certified reference cultures, internal audits, calibration and verification of equipment, repeatability and reproducibility test as well as proficiency tests organised by FAPAS, UK. The Laboratory undertook proficiency tests in the following:

- Moulds and yeasts in flour
- Enterococci in beef
- Salmonella in cocoa powder
- Coagulase positive Staphylococci in beef
- Coliforms in milk powder
- Aerobic plate count in beef
- Aerobic plate count in swabs
- Escherichia coli in beef
- Clostridium perfringens in milk powder
- Bacillus cereus in beef
- Enterobacteriaceae in beef.

The Laboratory passed all proficiency tests undertaken with good Z-scores. The Laboratory also undertook two internal audits as part of the quality system during the year.

Under the EU-funded Ministry of Trade project (TRAQUE), the Division started receiving some of the long-awaited equipment, devices and tools.

Donor-funded Projects

Staff of the Division are either principal investigators or members of donor-funded projects and were involved in the activities of these projects. The projects are:

- Development of edible and medicinal mushrooms as functional foods in Ghana funded By Partnerships for Enhanced Engagement in Research (PEER); USAID-funded.
- Characterization, conservation and Domestication of indigenous Edible and Medicinal Mushrooms on agricultural residues (CDEMM) in collaboration with Embrapa (Brazil) (Africa-Brazil Agricultural Innovation Marketplace).
- Cashew - Adding value for food security; Africa-Brazil Agricultural Innovation Marketplace-funded.
- Preserving African food microorganisms for green growth (GreenGrowth); DANIDA-funded.

2.6 FOOD NUTRITION AND SOCIO-ECONOMICS DIVISION

Introduction

The Food Nutrition and Socio-economics Division (FNSED) has two sections, Nutrition and Socio-economics sections. The Division is mandated to conduct nutrition and food utilization studies as well as conduct feasibility studies into the economic viability and socio-economic impact of on-going projects in the Institute. Key activities carried out during the period under review included recipe formulations, sensory evaluation and analyses. Research scientists and technical staff in the Division also collaborated with other Divisions on key projects. Major activities included training on improved technologies and utilisation of cassava, yam, sweet potatoes, millet, sorghum and rice, under WAAPP2A. Other activities included customized training in soymilk and “soy meat” processing, proposal writing, technical reports and publications, as well as presentations at conferences.

Research and Development Activities

- a. Case study on soymilk, tofu and soy-yoghurt production as a micro enterprise – University of Illinois/WISHH/USAID/CSIR-FRI
 - Milk and Tofu production took off on a pilot scale.
 - FDA registration is almost completed.
 - Yoghurt production is being experimented.
- b. Study on tuna processing by-products and burrito (underutilized fish species) (FAO Project) was initiated and completed.
- c. Formulation of *M. oleifera* leaf-fortified meals- as a PhD work was completed.
- d. Mentoring of a Fellow on African Women in Agricultural Research and Development (AWARD) programme from March 2015 by Mrs. Mary Glover-Amengor.
- e. Cashew fruit: adding value for food security- collaborative work with FMD.
- f. In-house sensory tests were carried out on different formulations of composite bakery products using yam, sweet potatoes, cocoyam, rice, millet and sorghum as part of WAAPP2A.
- g. Development of mushroom value added products as part of a USIAD project (PEER project) in collaboration with FMD.

- h. Agricultural innovation MKT Place: A comparative study on the indigenous knowledge of macrofungi in the Eastern and Volta regions of Ghana.
- i. Technology transfer on WAAPP2A was carried out in Volta, Eastern, Ashanti, Northern and Upper East Regions -Trained 40 matrons from Senior High Schools in Ashanti Region on the use of local cereal flours for pastry products.

Other Activities

The Division hosted students from the Department of Food Science and Technology-KNUST, Nutrition and Dietetics students of Allied Health Sciences (UG) and University of Health and Allied Sciences (UHAS) on attachments. The Division also trained students from Cape Coast Polytechnic in sensory evaluation of food products.

2.7 COMMERCIALIZATION AND INFORMATION DIVISION

Introduction

The Commercial and Information Division (CID) coordinates the commercial activities of all the cost centers in other Divisions of the Institute in order to enhance the income generation capacity and ensure effective information management. The activities of the Division are aimed at guiding management decision making and enhancing continual availability of competitive business products and services. The core commercial business areas of the Institute include analytical services, consultancy and training services as well as production and sale of research by-products which has been branded as 'foodsearch'. The Division has three (3) sections namely the Client Services Section (CSS) that is in charge of analytical services, Technological Business Service Section (TBSS) in charge of consultancy and training services, sales of research by-product and other technical services and the Information Management Section (IMS) that is in charge of library, public relation and information technology services.

Client Services Section (CSS)

Figure 3 shows the frequency of visits, number of samples and gross revenue of customers to each of the cost centers' laboratories. This was attached by a portfolio analysis using General Electrical Matrix method to identify regular reliable customers as well as redundant customers. A system to develop follow up format for customers visit were also put in place. Figure 3 also indicates the analytical services provided by the Institute to the Agro-processing Industries in Ghana. It also demonstrates gradual increase in volumes of samples and clients over a three year period.

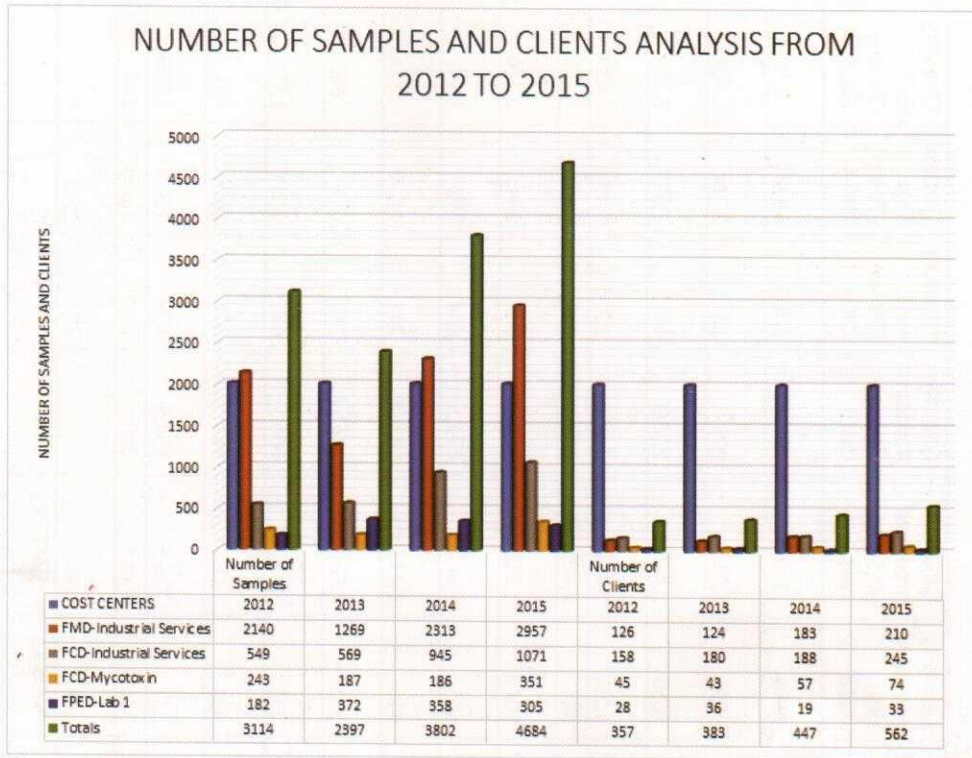


Figure 3: A graph comparing analyses of samples and clients from 2012 to 2015

Table 8: Sales of Research by - Products (foodsearch)

No	Research by- Products	Quantity Produced (Pieces) -2013	Quantity Produced (Pieces) -2014	Quantity Produced (Pieces) -2015	Quantity produced (kg) -2013	Quantity produced (kg) -2014	Quantity produced (kg) -2015	Quantity Sold (Pieces) -2013	Quantity Sold (Pieces) -2014	Quantity Sold (Pieces) -2015
1	Spawns (bottles)	9454	11,557	10,533	9454	11,557	10533	9,403	11,157	10,533
2	Peanut paste (containers)	1858	2,466	1,800	929	1,719	900	1542	2,364	1,800
3	<i>Kokonte</i> (boxes)	1650	2,459	2,750	1650	2,459	2,750	1487	2,027	2,750
4	Compost bags (bags)	5,276	5,454	7,639	5,276	5,454	7,639	5,276	5,454	7,639
5	Plantain <i>fufu</i> (boxes)	838	3,438	1,531	587	2,406.60	1,071.70	662	3,438	1,531
6	<i>Banku</i> mix (boxes)	1017	1,719	1,210	1017	1,719	1,210	768	994	1,210
7	Yam <i>fufu</i> (boxes)	864	392	1163	605	274.4	814.1	684	392	1163
8	<i>Cereal mix</i> maize (boxes)	953	1,622	1,886	476	1,135.40	943.00	745	1,073	1,886
9	Cocoyam <i>fufu</i> (boxes)	479	657	1662	239	459.9	1163.4	371	612	1662
10	<i>Cereal mix</i> rice (boxes)	589	1301	1333	295	910.7	666.5	481	1,200	1333
11	Fermented maize (boxes)	494	717	661	494	717	661	371	680	661
12	Maize grits (boxes)	756	1,473	1,709	378	736.5	854.5	499	1,312	1,709
13	<i>Gari</i> (boxes)	335	1,094	280	335	1,094	280	250	1,006	280
14	<i>Agbelima</i> (sachets)	165	300	0	165	300	0	165	280	0
	Total				5,798 kg	14,842.2kg	12,010 kg			

Sales of Research by- Products

The sales of research by-products during the period under consideration increased in volume from 5,798 kg in 2013 to 14,842 kg in 2014, but reduced to 12,019 kg in 2015. The reduction occurred mainly due to the frequent break down of the dryer. There is therefore the need to replace some of the obsolete equipment; this will go a long way to triple production shown in table 8.

Technical services

The number of technical services provided increased from 21.6 tons in 2013 to 25 tons in 2014 and further to 63 tons in 2015 as shown in Table 9. Some technical services rendered were roasting of groundnuts and soybeans as well as drying of Hausa koko and milling of groundnuts, soybean, and roasted maize. The drying services declined from 21 tons in 2014 to 7 tons in 2015 due to increment in electricity tariff which affected cost and frequent break down of the drying system.

Table 9: Technical Services Provided at PSPU/RTPDU cost center

Type of service	Freq. in 2013	Freq. in 2014	Freq. in 2015	No. of clients 2013	No. of clients 2014	No. of clients 2015	Vol. of products 2013 (kg)	Vol. of products 2014 (kg)	Vol. of products 2015 (kg)
Drying	43	84	20	15	20	15	17,758	21,342	7,386
Milling	14	3	26	4	3	4	2,567	2,132	2,250
Roasting	9	17	118	5	5	8	1,300	1,646	54,194
TOTAL	66	104	154	24	28	26	21,625	25,120	63,830

Technological Business Service Section (TBSS)

The TBSU Services Section is tasked to handle consultations and training activities. Within the year, 290 requests were received out of which 71 were executed. This represented 24.48% which was higher than 6.34% for the previous year for total requests received. The total amount of gross income realized also increased from fifty five thousand and three hundred and two Ghana Cedis, twenty one pesewas (GHC55,302.21) to one hundred and ninety three thousand and two hundred and seventy nine Ghana Cedis thirteen pesewas (GHC 193,279.13) as shown in tables 12 and 10.

The main difficulties underlying the reasons why some requests could not be executed were because, some equipment needed to execute requests broke down. Some of these equipment were, blast freezer, pasteurizer, climatic chamber and texture analyser. Management is working assiduously to acquire more equipment in addition to the existing ones.

Technology Transfer

The technologies transferred were mainly in the area of post-harvest food handling. CSIR-FRI over the years, through its research, has come up with a number of technologies in the areas of food value addition and enhanced food processing among others; using tools such as HACCP (Hazard Analysis and Critical Control Points), QACCP (Quality Analysis and Critical Control Points) and other Quality management tools, most technologies were enhanced for use by individuals and industries. Some of these home-brewed technologies include: Fufu flours (yam, cocoyam, plantain) processing, improved Kokonte, improved Gari, Banku Mix Powder, Fermented Maize Meal Powder, High Quality Cassava Flour, High Quality Cassava Starch, Rice base Weaner, Maize base Weaner, Fruit juice technology, among others. Our technology transfer programme also encompasses the training of interns and other interested persons in basic laboratory practices, quality management and food analyses techniques.

Table 10: Breakdown of requests (received and executed) and revenue

ACTIVITIES OF THE YEAR								
A total amount of		GH¢ 193,279.13		had been received out of an expected				GH¢
								898,099.98
The figures are presented below:								
S E R V I C E S	Services	Requests Received	Requests Brought Forward	Services Executed	Services Ongoing	Clients Served	Expected Income	Income Generated
	Percentages	100.00%	4.48%	24.48%	3.45%	N/A	100.00%	18.04%
	ALL SERVICES	290	13	71	10	414	898,099.98	193,279.13
	TBSU EXCLUSIVES	243	10	53	10	394	802,864.79	161,998.23
	OTHERS	47	3	18	0	20	95,235.19	31,280.90
	TBSU PROJECTS	76	4	6	38	90	333,494.99	62,260.41
	CONTRACT RESEARCH	4	1	1	0	1	5,562.40	3,260.00
	COLLABORATIVE RESEARCH	7	1	2	1	3	20,706.68	20,756.68
	FACILITY SET-UP	7	0	0	0	0	3,656.95	20.00
	BUSINESS INCUBATION	2	0	1	1	2	19,050.03	6,017.92
	RENT OF CONFERENCE FACILITIES	15	0	15	0	112	7,445.00	7,445.00
	TECHNICAL ADVICE	11	0	10	0	11	74.10	54.10

S E R V I C E S	LECTURING	0	0	0	0	0	0.00	0.00
	EXTENSION SERVICES	5	0	0	0	3	2,880.92	100.00
	FEASIBILITY STUDIES	11	0	2	0	3	31,474.51	8,764.00
	EQUIPMENT FABRICATION	28	0	3	2	6	387,756.69	32,270.00
	ENGINEERING SERVICES	0	0	0	0	0	0.00	0.00
	PRODUCT DEVELOPMENT AND UPSCALING	9	0	7	0	9	31,028.48	31,028.48
	PRODUCT DEVELOPMENT AND TRAINING	41	4	2	5	11	51,258.04	19,881.26
	TECHNOLOGY TRANSFER	71	6	7	1	175	191,797.38	78,437.72
	SENSORY EVALUATION	2	0	0	0	2	1,075.75	1,075.75
	LABORATORY ANALYSES*	29	3	12	0	13	42,496.96	33,216.56
	PRIMARY FOOD PROCESSING*	6	1	3	0	3	29,684.19	1,788.21
	SALE OF RESEARCH BY-PRODUCTS*	6	0	2	0	2	30,487.80	10,078.00
	OTHER SERVICES	6	0	1	1	71	2,456.00	406.00

Table 11: Comparison of cost centers

COST CENTRES	Cost Centre	Requests Received	Requests Brought Forward	Services Executed	Services Ongoing	Clients Served	Expected Income	Income Generated
		Percentages	100.00%	4.48%	24.48%	3.45%	N/A	100.00%
	ALL COST CENTRES	290	13	71	10	414	898,099.98	193,279.13
	Non - Technical Cost Centers	0	0	0	0	0	0.00	0.00
	CID-TBSU	37	0	20	1	215	65,264.17	24,283.60
	FMD-MU	8	1	3	1	29	15,418.55	15,104.56
	FMD-ISU	14	1	4	0	5	23,207.09	14,259.66
	FCD-TU	4	0	1	0	1	280.00	0.00
	FCD-ISU	14	0	7	0	8	1,553.49	630.21
	FPED-EU	37	1	4	3	67	421,853.73	54,198.14
	FPED-PSPU	94	6	15	4	28	133,822.41	30,329.67
	FPED-RTPDU	45	2	5	0	45	184,783.28	30,545.41
	FNSD-NU	37	2	12	1	16	51,917.26	23,927.88
	FNSD-SEU	0	0	0	0	0	0.00	0.00

The Library Report

The Food Research Institute library provides and disseminates information in the field of food science and technology, nutrition, food microbiology, aflatoxins and mycotoxins, agricultural economics and food engineering. The library has a total book stock of over four thousand books (4000) and over 250 back issues of food science and technology journals. The library also has over one thousand four hundred (1800) soft copies of books in the area of food science and technology and other related subject areas that can be accessed on the FRI-SERVER.

The library has access to numerous electronic databases and journals such as AGORA, OARE, SCIENCEDIRECT, HINARI, EMERALD, TEEAL and so on. Also the library has an in house database known as AGRIS database that contains about 600 records. The clientele of the library has extended beyond the Institute's research scientists and technical staff to include students from various Polytechnics and Universities in Ghana. The library is also patronized by lecturers, farmers, industrialists, Journalist, Civil Servants and Public Servants, Consultants and many others. A total of one hundred persons (100) used the library during the period under review. During the period under review users noted that the information provided was useful but remarked that there was the need to replenish the stock of the library with more up to date publication and improve access to e-resources available in the library. Users who visited the library personally to source for information had various information materials provided for their perusal. These included soft and hard copies of books and full text journal articles that were acquired from the various Electronic databases like AGORA, SCIENCEDIRECT, CTA/SDI Service and also others made use of the TEEAL Collection and Ghagri database.

Information sought for during the period under review included publications on fermentation of African traditional foods, fish and fish processing, post-harvest losses of fish, Nutritional enhancements of food, food fortification, Gelatinization of starch, Heavy metals in food, Waxing treatments of root and tuber crops, Sweet potato, Nutritional value of Cowpea and Solanum Torvum, Coconut processing, Food product development, Mushroom cultivation, Fruits processing, Determination of fructose in honey, Ginger processing, Pepper processing, Food product development, Aquaculture, Browning reaction on cacao, Food Microorganisms, Shelf life studies on pepper, Lactic acid fermentation on maize, Fish texture analysis, Sour sap and Nmada drink, Physiochemical and functional properties of cereal flour.

3.0 PROJECTS AND PUBLICATIONS

3.1 PROJECTS

A total of twelve (12) projects were run within the year. Two (2) projects, however, came to a successful completion. These projects were the “Improving Food Security by Reducing Post Harvest Losses in the Fisheries Sector (SECUREFISH) project” and the “Characterization, Conservation and Domestication of Indigenous Edible and Medicinal Mushrooms on Agricultural Residues (CDEMM) project”.

A. ROOT AND TUBER PRODUCTS PROGRAMME

1. Upscaling The Nigerian Flash Drying Experience For Sustainable Regional Trade And Income Generation In West Africa (UDESWA)

Sponsors: CORAF/WECARD

Location: Nigeria, Ghana, Benin, Sierra-Leone

Principal Investigator: Mr. Jonathan Ampah

Participating Scientists: Dr. Nanam Tay Dziedzoave, Ms. Helen Ama Annan, Mr. Christian Amegah.

Collaborating Institutions: Fed. Inst. Ind. Res. Nigeria, Nat. Agric. Res. Cent. Sierra-Leone, University d'Abomey-Calavi, Benin.

Objective: To promote efficient and proven drying technologies for sustainable food security and poverty alleviation in West Africa.

Expected Beneficiaries: Framers, Food Processors, Equipment Fabricators, Policy Makers, Scientists, Extension Officers, SMEs, Financers.

Activities/Progress Made:

1. A report was written on “scoping studies and baseline data on existing drying systems capacity training gaps and needs”.
2. A pilot scale testing was conducted on the flash dryer equipment to determine; fuel use efficiency, power options, drying throughput, techno-economic viability in Nigeria, Ghana, Sierra Leone and Republic of Benin.
3. Advertisement was made for flash dryer, graters, pressers procurement.

4. There was the supervision of research students on value chain analysis and product quality using installed drying facility.
5. Capacity building training was attended in Lagos, Nigeria in July.
6. Materials for the construction of supporting equipment; grater, press and hammer mill were purchased.

2. Cassava: Adding Value For Africa (C:AVA) Project-Ghana

Sponsors: Bill and Melinda Gates Foundation

Location: Greater Accra, Brong Ahafo, Volta, Eastern, Central and Ashanti Regions

Principal Investigator: Dr. Nanam Tay Dziedzoave

Participating Scientists: Mrs. Marian T. Wordey

Participating Technologist(s): Mrs. Beullah Sallah

Collaborating Institutions: Associates for Sustainable Rural Development-ASRUD (Ho), Progressive Youth in Community Development (Hohoe), Christ Apostolic Agency for Rural Development (Atebubu), Social Development and Improvement Agency (Bechem), Association of Africa women in Development (Sunyani), Christian Rural Aid Network (CRAN) - Hohoe.

Objective(s): The project aims to significantly boost the incomes of small-scale African farmers by linking them to new markets.

Activities /Progress Made:

1. Promotion of industrial cassava products among industries at an Africa Pharmaceutical Summit held in Accra.
2. Facilitated business support services (feasibility and market information, business plans, branding, quality assurance, advisory services and certification) for 6 SMEs.
3. Supported the establishment of good quality management systems and conducted regular quality audits to monitor performance of processing groups and SMEs trained.
4. Trained Processors in the Volta, Central and Brong Ahafo regions on book keeping of all aspects of cassava processing with emphasis on components of costs of processing.
5. Business discussions were facilitated between 6 enterprises and end- users for the supply of cassava based products.
6. Training of Processors in the Ashanti, Eastern and Greater Accra regions on business and negotiation skills with emphasis on contract sales and purchases.

3. To develop cassava and cereal flour and integrate into bread making and other pastry products for scaling-up of the developed technologies.
4. To develop an agribusiness incubation center for the production of ethanol and glucose syrup.

Activities/progress Made:

1. Technology for processing three (3) intermediate products of cassava transferred and adopted by 1500 primary out-processors; technical backstopping in the Volta, Eastern, Ashanti, Brong Ahafo and Central regions was conducted for 29 groups of farmer processors and processor groups on processing High Quality Cassava Flour (HQCF), grits, chips and gari. A total of 723 processors comprising 459 women and 269 men have been formed in the five regions. A total of 35 graters and presses have been distributed to the processor groups to assist them in their processing activities.
2. Technology for developing and utilizing composite flour from yam, cocoyam and sweet potato successfully transferred and adopted by flour and bakery enterprises. The 17 groups backed stopped included 61 men, 501 women, 249 youth that benefited from the composite flour end-users trainings. Composite products of various percentages (10%, 20%, 30%, 40%, 50%) such as bread, biscuits, queens cake, chips, meat pie, 'chinchin' and doughnuts were developed.
3. Trained groups of cassava processors of High Quality Cassava Flour (HQCF), grits, chips and gari under WAAPP2A within the Western and Brong Ahafo regions were beneficiaries of cassava presses and cassava graters. They were trained on the use of the equipment and processing of the products. In order to ensure the success of their operations a back stopping visits were conducted to the beneficiaries to address their challenges.
4. Composite flours of cassava, sorghum, rice and maize were formulated on 5, 10, 15, 20, 30, 40 and 50% into bread, chips, meat pies, biscuits, cakes and doughnuts. Senior High School Matrons and Home Economics tutors in the Ashanti and Eastern regions were trained on the processing and utilization of cereals and legumes composite flours. The composite flours were developed from cassava, sorghum, millet, rice and maize.
5. The project constructed an Agribusiness Incubation Centre for the production of glucose syrup and ethanol for pharmaceutical and confectionary utilization. The Centre will be used for production and training services for SMEs. The installation of local equipment

7. Discussions were also facilitated between 4 enterprises and 4 end- users for the supply of cassava chips for exports for animal feed production.
8. Worked with 3 fabricators to upscale the bin drying technology to dry cassava.
9. Hosted a team of prospective investors at FRI's processing plant-Pokuase to get firsthand information on cassava processing. (Graduate unemployment Association, Darsfield enterprise).
10. Follow up on funding agencies to ascertain the state of our SME's applications. Export Development and Agricultural Investment fund (EDIAF), USAID and out-grower value chain fund (OVCF).
11. Business plans developed for two (2) potential investors to facilitate the process of securing loans from their funding agencies.
12. Feasibility studies have been carried out for 2 prospective investors and report presented.
13. Market linkage were strengthened between C: AVA and SME's for regular supply of dried cassava chips in Central Region.
14. In country project meeting to decide on method of incorporating technology in data collection.
15. Organized business meetings for existing and potential cassava processing entrepreneurs, end-users and financial institutions on investing in cassava processing.
16. Crunch meetings were held with service providers.

3. West Africa Agricultural Productivity Programme (WAAPP2A.)

Sponsors: World Bank

Location: Greater Accra, Brong Ahafo, Volta, Eastern, Central and Ashanti Regions

Principal Investigator: Dr. Charles Tortoe

Participating Scientists: Mr. Gregory Komlaga and Mr. Peter Addo

Collaborating Institutions: Women in Agriculture Development (WIAD)

Objective(s):

1. To develop technology for processing three intermediate products of cassava, transferred and adopted by 2500 primary out-growers and out-processors.
2. To develop technology for developing composite flour of yam, cocoyam and sweet potato and successfully transferred and adopted by flour and bakery enterprises

was completed. The Centre will be used for production, training services for SME's. Invoices on equipment consisting of fermentation tanks, Hot/Cold tanks, Chillers and accessories systems from China were received and submitted to PCU to facilitate importation of the equipment for the centre.

6. Bakery and pastry groups were formed and trained in the Brong Ahafo and Northern Regions. The training was on composite flour processing and utilization. Composite flours were developed from root and tuber crops consisting of white yam, water yam, yam, cocoyam and sweet potato in combination with wheat. Percentage compositions of 5, 10, 15 and 20% of composite flours were developed and formulated into bread, biscuits, cakes, chips and doughnuts. In the Brong Ahafo, fourteen bakery groups were formed and trained comprising of 457 members of 448 women, 9 men and 232 youth. In the Northern region, ten groups of 361 members were trained comprising of 343 women, 18 men and 189 youth.

4. Gains From Losses Of Root And Tuber Crops (Grattitude)

Sponsors: European Union

Location: Greater Accra, Brong Ahafo and Volta Regions and possibly Northern and Ashanti Regions.

Principal Investigator: Dr. Nanam Tay Dziedzoave

Participating Scientists: Dr. Charles Tortoe, Mr. Gregory Komlaga, Mrs. Marian Tordey, Dr. Mrs. Mary Obodai

Participating Technologist(s): Mr. Richard Takli, Mr. Solomon Dowuna

Collaborating Institutions: Caltech Ventures, St. Baasah Ltd, Social Development and Improvement Agency (SODIA).

Objectives: To improve the postharvest management of cassava and yams leading to reduced physical losses, reduced economic losses through value-added processing and valorization of waste products.

Activities/Progress Made:

1. Completed dissemination of best strategies of post-harvest handling of yam tubers to reduce losses.
2. Completed food safety baseline assessment.

3. Developed methods for scaling up mushroom production as commercial enterprises.
4. Methodologies were also developed to monitor safety and quality attributes of the products at Critical Control Points.
5. Interactive website fully constructed to cover and house all project information. Discussions and interactions are linked FRI website, LinkedIn and Facebook; visit "Root and Tubers" on Facebook.
6. Developed training materials for yam storage and yam flour technologies
7. Documented methods for growing mushrooms from the waste of Yam peels
8. GRATITUDE Newsletter printed and circulated to major stake holders
9. Confirmed project outcomes in newspaper/ Agric journals.

5. Improving Livelihood Of Small Holder Cassava Farmers Through Better Access To Growth Markets (cassavagmarkets)

Sponsors: European Commission (EC)

Location: Greater Accra, Volta and Brong-Ahafo Regions

Principal Investigator: Dr. Nanam Tay Dziedzoave

Participating Scientists: Mrs. Marian Tandoh-Wordey, Mr. Elvis Baidoo, Mr. Paa Toah Akonor

Collaborating Institutions: Natural Resources Institute, UK, University of Agriculture Abeokuta, Nigeria, University of Malawi, Tuber Crops Research Institute, India, Tanzanian Food & Nutrition (TFNC), Africa Innovations Institute (AfII), Uganda.

Objective(s): To provide knowledge and technologies to allow the development of value chains linking small-holder farmers to growth markets for HQCF in the context of climate change & variability.

Activities /Progress Made:

1. Establishment of the Functional properties of HQCF.
2. Examination of New uses of HQCF at laboratory scale.
3. Evaluation and dissemination of market potentials for innovations.

4. Testing of innovative new products with end use industry partners the C:AVA project.
5. Testing of acceptability and end use of products.
6. Publication of impact of climatic change on cassava value chain (post-harvest losses)

B. CEREAL, GRAIN AND LEGUME PRODUCTS PROGRAMME

6. Rice Post-harvest Handling, Marketing And The Development Of New Rice-based Products (AFRICARICE)

Sponsors: Canadian International Development Agency (CIDA)

Location: Afife, Atebubu, Navorongo

Principal Investigator: Elvis Baidoo,

Participating Scientists: Mrs. Ruth Pobee, Ms. Hannah Oduro

Participating Technologist(s): Mr. Ali Sampare, Mr. Isaac Apollonius Nyarko, Mr. F. Mboom

Collaboration Institutions: McGill University, NARS, CSIR-SARI, CSIR-CRI, Ghana Rice Inter-professional body, Sinapa Aba (Micro-finance), Selassie Farms (Secondary Processor), Technoserve, University of Ghana--Departments of (Nutrition & Food Science and Crop Science), MoFA, MoTI- NBSSI, Single Mothers Rice Processors (Primary Processor), GRATIS Foundation (Processing equipment), Institute of Packaging Ghana, Consumer Association of Ghana

Objectives: To introduce improved harvest and post-harvest rice processing practices and technologies to upgrade the quality and marketability of locally produced rice to meet Sub-Saharan African consumers' preferences.

Activities /Progress Made:

1. New rice-based products from broken rice fractions developed: A second product known as the High Energy Snack Bar (HESB) has been developed after the development of rice noodles and Rice-mango weaner. These were all developed from low-grade broken rice fractions.
2. Production of mushrooms from rice by-products tested and disseminated.
3. Effect of starch properties on the functional uses of traditional and improved varieties determined: Still ongoing is the research work on the effects of starch properties on functional uses of indigenous and improved varieties of rice *Oryza glaberrima*. For the period under review the main focus of work has been on the molecular characterization of the isolated starches with respect to unit and internal chain profiles of amylopectins, their α , β -limit dextrins and building block characteristics.

4. Ex-ante and ex-post impact analysis of the adoption of improved practices and technologies: Research work under the title "Impact of an Improved Rice Parboiling Vessel Technology Adoption on Household Income in the Northern Region of Ghana" has been completed. The study described the characteristics of adopters and non-adopters, identified the factors that influenced adoption through logit analysis and measured the effect of adopting the IPBV technology on household income using propensity score matching (PSM) technique. The thesis report is available and has been submitted to the University of Ghana for approval.
5. Partner Scientist trained on policy and value chain analysis.
6. Activities on developing maps of consumer preferences, harvest and post-harvest processing practices continued within the period. So far data has been collected and maps generated for three out of 10 Regions in Ghana.
7. In order to increased efficiency in local rice harvest and post-harvest processes for rice value-chain actors a combine harvester is under fabrication, an engine is yet to be acquired, fixed and tested for training to be conducted for local artisans.
8. For accurate estimate of qualitative and quantitative post-harvest losses data output, activities were completed for the Northern hub, data and reports are available. Due to lack of funds, activities in the Kumasi hub, supposed to have been carried out was suspended.

7. Rice Sector Support Project (RSSP)

Sponsors: Agence Francaise de Development (AFD), MoFA/DCS

Location: Northern, Upper East, Upper West and Volta Regions

Principal Investigator: Mr. Elvis Baidoo

Participating Scientists: Mr. George Anyebuno, Mr. Seidu Ali Sampare

Collaborating Institutions: SARI, CRI, MoFA, GRATIS, GRIB, GRAMEEN, CRAN

Objective(s): To strengthen stakeholders of the rice value chain.

Activities /Progress Made:

1. Survey on impact assessment of parboiling technology was conducted in the Northern regions.
2. Appropriate packaging and labelling of rice introduced to processors.

3. Socio-economic evaluation and impact assessment of the use of parboiling technology was conducted.
4. 245 Farmers and processors in Volta Region were trained on improved rice post-harvest practices.
5. 218 farmers and processors were trained in the Upper West Region on good rice post-harvest practices and improved parboiling.
6. In the Upper East Region 304 farmers and processors received training on rice post-harvest practices.

8. Preserving Africa Food Microorganism For Green Growth (GREENGROWTH)

Sponsors: DANIDA

Location: Greater Accra and Northern Regions

Principal Investigator: Dr. Wisdom Kofi Amoa-Awua

Participating Scientists: Dr. Magaret Owusu, Dr.(Mrs) Mary Obodai, Mr. George Anyebuno, Mr. Stephen Nketia

Participating Technologist(s): Mr. Theophilus Annan

Collaborating Institutions: The University for Development Studies (UDS), Ghana, The National Scientific and Technological Research Centre (CNRST), Burkina Faso. Université d'Abomey-Calavi (UAC), Benin.

Objective(s):

- To identify food value chains with the strongest potential for green growth and development in the three West African countries based on investigations on local and regional trends, ethnic groups, urban and rural preferences, gender issues, consumer acceptability and marketability (Wp1).
- To enable the West African countries to fully utilize and preserve their own microbiological heritage and ensure the sustainable use of this biological diversity for commercialization within the food and biotechnological sectors (Wp2).
- To identify relevant technological properties of microorganisms to be used as starter cultures in the food chain focusing on prevention of loss of raw materials, optimization of

fermentation processes, nutritional value, food safety, consumer needs, food spoilage and prolongation of shelf life (Wp3).

- To identify the requirements and obstacles for implementation of starter cultures at all levels in the West African food sector taking into consideration all identified aspects in the food value chain including technological challenges, packaging, distribution, commercial aspects and consumer preferences (Wp4).
- To implement procedures, quality guidelines and business models for food innovation, green growth including prevention of loss of raw materials, reduced cooking times, sustainable packaging and commercialization of products to increase competitiveness of SMEs (Wp5).
- To train and share scientific knowledge between the West African and Danish scientists within food microbiology, value chain analyses and business models, to ensure research capacity strengthening at the institutional level as well as dissemination and knowledge transfer to relevant stakeholders, in particular the West African food sector (WP6).

Activities /Progress Made:

1. Two open ended questionnaires were administered to SMEs and consumers at Ashiaman, Nima, Madina and Hastoo in the Greater Accra Region to assess the preferences of each stakeholder in value chain analysis and to help develop the business models. Analysis of the questionnaire was completed.
2. The millet value chain analysis have been developed for the Greater Accra Region, after the questionnaire has been administered at Ashiaman, Nima, Madina Socura and Haatso and analyzed.
3. The Micro-organisms involved in the fermentation process have been isolated and developed into starter cultures for the fermentation of millet dough into fura under controlled condition.
4. The -81oC starter culture storage deep freezer for Ghana was installed at the Food Microbiology Division – Industrial Services Unit.
5. Two MSc students and PhD Students are pursuing their Degree programmes at the University of Ghana and KNUST under the project.

C. MEAT, DAIRY AND FISH PRODUCTS PROGRAMME

9. Improving Food Security By Reducing Post Harvest Losses In The Fisheries Sector (SECUREFISH)

Location: CSIR-FRI

Principal Investigator: Dr. Lawrence Abbey

Participating Scientists: Dr. Wisdom Amoa-Awua, Dr. (Mrs) Margaret Ottah - Atikpo

Collaborating Institutions: University Of Surrey

Objective(s): To enhance food security by addressing post-harvest losses comprehensively in the fisheries sector in selected low and medium-income countries.

Activities And Progress Made:

1. The final phase of data logger installation and overhead water tank for heating was completed.
2. Sensory evaluation analysis (acceptability test) was carried out on samples.
3. Statistical analysis of data from sensory evaluation test was carried out.
4. Instrumental texture analysis was conducted.
5. Statistical analysis of texture values was carried out.

Major Findings:

1. Poor environmental, hygiene and handling practices still exist in Ghana's fisheries. A survey of Tema and Kasoa landing beaches showed physical, chemical and biological contaminants of fish.
2. Poor environmental, hygiene and handling of fish reduces it quality, i.e. leads to higher than normal histamine and free fatty acid values.
3. The optimal time for solar drying of fish on a cloudless sunny day, is between the hours of 9:00am and 3:30pm.
4. At optimal operation levels, a solar tunnel dryer generates temperatures between 30°C to 80°C on a cloudless, sunny day.
5. The study established that source variation of fresh anchovies affects the physico-chemical characteristics.

6. Solar tunnel drying produces fish with better shelf life, i.e., lower free fatty acid values, compared to the open sun drying method of fish.
7. The typical whiteness of dried anchovy cannot be achieved using a solar tunnel dryer, since the dryer generates higher internal temperature.
8. Solar tunnel drying bakes anchovies, instead of drying as exist in the traditional opened sun-dried anchovies, due to the higher internal temperatures of the solar tunnel dryer.

D. FRUIT, VEGETABLES AND SPICES PRODUCTS PROGRAMME

10. Development Of Edible And Medicinal Mushrooms As Functional Foods In Ghana

Sponsors: Partnerships for Enhanced Engagement in Research (PEER)-USAID

Location: CSIR-Food Research Institute, Accra, Ghana

Principal Investigator: Dr. (Mrs) Mary Obodai

Participating Scientists: Dr. Steven Schwartz (OSU-USA), Dr Robin Raltson (OSU-USA), Ms. Matilda Dzomeku (CSIR-FRI), Mrs Lynda Hagan, Mrs Deborah Narh Mensah (CSIR-FRI),

Participating Technologist: Mr Richard Takli (CSIR-FRI)

Collaborating Institutions: The Ohio State University-USA

Objectives:

1. To cultivate four different species of edible mushrooms, *P. ostreatus*, *P. tuber-regium*, *Ganoderma* sp. and *Termitomyces* sp.
2. To develop a new mushroom-based food.
3. To assess consumer acceptability of the new mushroom-based products.

Activities/Progress Made:

1. Fruit bodies of cultivated mushrooms were harvested and dried for product development studies on mushroom based infant food which were carried out at Ohio State University, USA.
2. Macrofungi sample collection in three forests: A total of 161 different samples of edible and medicinal fungi were collected from three forest reserves namely the Atiwa forest, Eastern Region (57 samples), Ayum forest, Brong Ahafo Region (59 samples) and Bia conservation biosphere, Western Region (45 samples). Of the identified species two new *Ganoderma* samples were identified; *Ganoderma multipileum* (similar to a species in South Africa) and *Ganoderma carnosum*. Of the edible strains three tissue cultures were inoculated onto Malt Extract Agar and stored in the National Mycelium Bank. These are *Pleurotus tuber-regium*, *Pleurotus* species and *Termitomyces* species. Two technical reports are in progress for submission.

3. Experiments carried out on *Termitomyces* species: A total of 19 soil samples from termitaria mounds which produce *Termitomyces* species in the Eastern, Brong Ahafo and Ashanti regions were collected in May and analysed for microbial and physicochemical components in CSIR- Soil Research Institute to ascertain properties they contain to enhance the seasonal flushes of the *Termitomyces* mushrooms. This will be used to simulate properties for the propagation of this highly sought after mushroom.
4. Development of a new mushroom-based food: Three mushroom based weaning foods have been formulated. These are mushroom blend cereal mix, mushroom soup and mushroom noodles. The mushroom soup and noodles were further constituted in The Ohio State University. Ingredients for the mushroom cereal blend porridge included cereals such as rice, soybeans, groundnut and the mushrooms that were cultivated on the project. These are two strains of oyster (*Pleurotus ostreatus* strain EM1 and *P. sajor-caju* strain PscW, one strain of *P. tuber-regium* and Monkey seat mushroom (*Ganoderma* species).
5. Sensory Testing: Sensory evaluation was conducted on the mushroom cereal blend samples by 30 panelists made up of 15 men and 15 women, comprising of staff, national service personnel or students on internship at the CSIR-Food Research Institute. Judges were asked to indicate their degree of preference for the samples and to give reasons for preference. During the evaluation, samples were kept at a constant temperature by keeping them in food warmers. Evaluations were done in individual sensory booths. Samples were served alongside crackers and a cup of water to be used for rinsing the mouth in-between sample tasting.
6. Two (2) abstracts were written and submitted to the 19th ISMS Congress: International Society of Mushroom Science to be held in Amsterdam from 29th May – 2nd June, 2016.
7. A new project was started with Prof. Robert Blanchette, Depart of Plant Pathology, University of Minnesota as an offshoot of PEER cycle 2. Preliminary work on the molecular characterization of 27 *Ganoderma* samples from three (3) regions of Ghana were carried out to ascertain their variability and phytochemical properties. Two new *Ganoderma* species have been identified.
8. Twenty (20) panelists (made up of eight (8) males and twelve (12) females) were trained twice a week for four (4) hours for a month to taste the mushroom products (Mushroom Orange flesh sweet potato mash and mushroom soup mix) that were developed in Ohio State University in the 3rd quarter.

11. Characterization, Conservation And Domestication Of Indigenous Edible And Medicinal Mushrooms On Agricultural Residues (CDEMM)

Sponsors: Africa-Brazil Agricultural Innovation Marketplace

Location: Embrapa –Brazil

Principal Investigator: Dr. Mary Obodai

Participating Scientists: Dr. Arailde Fontes Urben (EMBRAPA), Dr. Vinicius Reis de Figueirêdo (Brazil), Dr. Edison de Souza (Brazil) Prof. K. Asante (UG), Ms. Matilda Dzomeku (CSIR-FRI), Ms. Deborah Narh (CSIR-FRI), Mr. Richard Takli (Technologist).

Collaborating Institutions: Embrapa Recursos Genéticos e Biotecnologia–Parque Estação Biológica (Embrapa, Brazil), Department of Botany, University of Ghana.

Objectives:

1. To document indigenous knowledge of edible and medicinal mushrooms in four regions of Ghana.
2. To characterize by phenotypic methods mushrooms collected from four forests in these regions.
3. To determine the biochemical composition of these mushrooms in order to ascertain their biochemical components.
4. To ascertain the quantity of β -glucans and antioxidants in the mushrooms
5. To cultivate five selected cultivable species on agricultural residues using the Juncao technology and plastic bag methods.
6. To transfer technology to 100 youths in the communities of the four regions.

Activities /Progress Made:

1. Indigenous knowledge from four regions were documented namely Eastern in 3 villages, Volta in 3 villages, Brong Ahafo in 8 villages and the Western in 9 villages. A total of approximately 1500 questionnaires were administered in these regions. Results showed that most people consume mushrooms for taste, nutritional and medicinal values
2. Four forest were visited within the period. Sixty macrofungi were collected from the four forests visited out of which 51 were identified. Six new species of mushrooms were recorded for the first time in Ghana, namely *Pleurotus sajor caju*, *P. albidus*, *Tremella mesenterica*, *Oudemansiella canarii*, *Pycnosporus sanguineensis* and *Falvolus brasiliensis*. These mushrooms have were photographed in situ, dried and are currently been stored in a refurbished Research Lab.

3. Diversity of mushrooms available for the market: Cultures of *Pleurotus sajor-caju* strain PSCW-1, *Lentinus squarrosullus* strain sqw-10 and *Pleurotus tuber-regium* are now available in the National Mycelium Bank which is kept in CSIR-Food Research Institute. Experiments carried out on *Pleurotus sajor-caju* strain PSCW-1 showed that the yields are comparable to that of *P. ostreatus* strain EM1 which is currently on the market. Shelf-life studies will be conducted and then this variety will be released on the local market.
4. The selected mushrooms from this project when analyzed showed high levels of antioxidants and rich nutritional value.
5. Grass cutting machine has been fabricated and is been used in trainings in the Institute.
6. Juncao technology (use of grass) is now available for extensive technology transfer to the villages.
7. A total of 96 persons have been trained in the Juncao technology at the CSIR-Food Research Institute as part of the training in mushroom cultivation carried out.

Major Findings:

1. Sixty macrofungi were collected from the four forests visited out of which 51 were identified. New species of mushrooms were recorded for the first time in Ghana, namely *Pleurotus sajor-caju*, *P. albidus*, *Tremella mesenterica*, *Oudemansiella canarii*, *Pycnosporus sanguineensis* and *Favolus brasiliensis*. These mushrooms have been photographed in situ, dried and are currently being stored in a refurbished Research Lab.
2. Diversity of mushrooms available for the market: *Pleurotus sajor-caju* strain PSCW-1, *Lentinus squarrosullus* strain sqw-10 and *Pleurotus tuber-regium* are now cultures in the National Mycelium Bank which is kept in CSIR-Food Research Institute. Experiments carried out on *Pleurotus sajor-caju* strain PSCW-1 showed that the yields are comparable to that of *P. ostreatus* strain EM1 which is currently on the market. Shelf-life studies will be conducted and then this variety will be released on the local market.
3. Analysis of selected mushrooms from the project showed high levels of antioxidants and rich nutritional value, these results have been published in a high impact factor journal.
4. Grass cutting machine has been fabricated and is been used in trainings in the Institute.
5. Juncao technology (use of grass) is now available for extensive technology transfer to the villages. Two user friendly hand-outs on this technology have been developed to be used for training.

Potential Impact:

1. The use of the Juncao technology, adapted by Embrapa Genetic Resources and Biotechnology and modified to suit growing conditions in Ghana, in addition to the sawdust plastic bag method will be used as important techniques for the cultivation of mushrooms in Ghana and beyond.
2. The cultivation of three species (Pleurotus sajor-caju strain pscw-1, Lentinus squarrosullus strain sqw-10 and Pleurotus tuber-regium) obtained on this project will be taught during training programmes and then will be cultivated by the youth and the unemployed and this will eventually give them a means of income.
3. The mushroom cultivation using agricultural residues is an important strategy for the biotransformation, where organic waste can be transformed into nutraceuticals and food. As a future perspective, the marketing of these mushrooms and their benefits to human health could be used by the food and pharmaceutical industries due to their rich nutritional and medicinal properties.

12. Cashew Fruit: Adding Value For Food Security.

Sponsors: MKTPlace Agricultural Innovations

Location: Brong Ahafo Region: Kintampo Wenchi, Sampa, Berekum; Embrapa Brazil Brazil/Ghana

Principal Investigator: Mrs. Nina Bernice Ackah

Participating Scientists: Mr. Elvis Baidoo, Mrs. Evelyn Buckman, Mrs. Amy Atter, Mrs. Anthonia Andoh Odoom.

Collaborating Institutions: Embrapa Mid-North

Objectives:

1. Dehydrating the cashew fruit and formulating a cashew fruit powder which can be reconstituted as a fruit drink.
2. Formulating and optimizing an ideal cashew apple fruit-enriched breakfast meal.
3. Getting insight into the effect of frozen storage of the fruit on the sensory and nutritional properties of the cashew fruit powder and the cashew apple fruit-enriched breakfast meal.
4. Evaluate the sensory properties and acceptability of the two products (the cashew fruit powder and the cashew apple fruit-enriched breakfast meal) among consumers.

5. Evaluate the microbial quality and nutritional properties of the two products in lieu of the shelf life of the products.

Activities/Progress Made:

1. A visit to the district office of the Ministry of Food and Agriculture at Dodowa in the Greater Accra region was made to find out cashew farming activities in the area. Currently, the varieties of cashew fruits as known in Ghana are the red cylindrical, red round, yellow cylindrical and yellow round. Information obtained indicates that cashew farmers at Dodowa in the Greater Accra Region have abandoned cashew farming because of the lack of utilization of the cashew apples for economic gains. The Extension officer from the ministry of Food and Agriculture stated that a majority of farmers have cut down their cashew trees and planted mangoes because of the extra economic gains made from mangoes.
2. A field survey was also conducted to get more insight on the utilization of cashew fruits by farmers in the Brong Ahafo Region. 200 cashew farmers were interviewed in four towns; Sampa, Wenchi, Kintampo and Berekum. In the field survey it was discovered that 25.9% of the farmers were female while 74.1% of them were males. 86.1% of the farmers own the farm lands on which they farm. The minimum number of years that a respondent has been farming cashew is 3yrs. However, the majority of cashew farmers have been farming cashew for an average of 10yrs. None of the farmers sell the cashew fruit/apple. 48.2% strongly believe that the cashew apples have no market opportunities and therefore that is not their interest. 48.2% family eat the apple very often and 58.2% strongly agrees with eating cashew fruits even in old age. However, 55.7% will strongly prefer cashew apple juice to fresh apples.
3. The yellow round cashew apple without the skin has been determined to have the highest brix level while the yellow cylindrical with the skin had the lowest brix level.
4. Reduction of tannins has been done on cashew fruits. Four methods were used for the tannin reduction which utilized rice gruel, high quality cassava flour, salt, or gelatin. However, actual tests to check the quantum of reduction of tannins after the treatment was not done due to the delay in supply of chemicals and reagents needed for those tests.
5. The type of cashew fruit with or without its skin which was more acidic and had higher brix levels has also been determined.

6. Ready-to-eat cereals have been formulated using maize, rice, millet or sorghum and peanut or cashew nut and sugar or honey. However because the cashew fruits were not available in the quantities required, these formulated products will be further incorporated with the cashew fruits in the next round of activities.

3.2 PUBLICATIONS

Through research activities, research scientists and technologists produced the under-listed publications within the year.

a) Referred Journal Papers

1. Abbey, L., Glover-A.M., Atikpo, O. M. and Howell, N. (2015). Proximate and Biochemical Characterisation of the Burrito (*Bachydeuterusauritus*) and the flying gurnard (*Dactylopterusvolitans*). Food Science and Nutrition. In Press.
2. Abbey, L., Glover-A.M., Atikpo, O. M., Atter, A. and Toppe, J. (2015). Nutrient content of fish powder from low value fish and fish by-products. Food Science and Nutrition. In Press
3. Akonor, P.T., Dziedzoave, N. T. and Ofori, H. (2015). Degradation of Cyanogenic Glycosides during the Processing of High Quality Cassava Flour (HQCF) Annals. Food Science and Technology. 16(2): 471-478.
4. Akonor, P.T., Dziedzoave, N.T. and Ofori, H. (2015). Degradation of cyanogenic glycosides during the processing of High Quality Cassava Flour (HQCF). Annals of Food Science and Technology, 16 vol 2, 236-24
5. Annan, T., Obodai, M., Anyebuno, G., Tano-Debrah, K and Amoa-Awua, W.K. (2015). Characterization of the dominant microorganisms responsible for the fermentation of dehulled maize grains into nsiho in Ghana. African Journal of Biotechnology 14(19): 1640-1648, ISSN: 1684-5315.
6. Atter, A.; Ofori, H.; Anyebuno, G.; Amoo-Gyasi, M. and Amoa-Awua, W. K. (2015). Safety of a street vended traditional maize beverage, ice-kenkey, in Ghana. Food Control, 55, p. 200-205
7. Buckman, S.E., Plahar, A W., Oduro, N. I. and Carey, T. (2015). Effects of sodium metabisulphite and blanching pretreatments on the quality characteristics of yam bean (*Pachyrhizuserosus*) flour. British Journal of Applied Science and Technology 6(2):138-144
8. Darfour, B., Isaac, K. A., Ofori, H. and Atter, A. (2015). Quality Assessment and Nutraceutical Potential of Traditional Harvested Honey dew Honey from the Wild in Ghana. Journal of applied Life Sciences International, 2(2): 71-82.

9. Glover-A. M., Aryeetey, R., Afari E. and Nyarko, A. (2015). Micronutrient composition and acceptability of Moringaoleifera leaf-fortified dishes by children in Ada-East district, Ghana. Food Science and Nutrition. In press.
10. Hagan, L.L., Johnson, P-N.T., Sargent, S.A., Huber, D.J. and Berry, A. (2015). 1-methylcyclopropene treatment and storage conditions delay the ripening of plantain fruit while maintaining sensory characteristics of ampesi, the boiled food product". International Food Research Journal.
11. Kanton, R. A. L., Asungre, P., Ansoba, E. Y., Baba I.Y. I., Bidzakin, J. K., Abubakari, M., Toah, P., Hagan, L., Tortoe, C. and Akum, F. A. (2015). Evaluation of Pearl millet Varieties for Adaptation to the Semi-Arid Agro-Ecology of Northern Ghana. Journal of Agriculture and Ecology Research International. 3(1):1-11. SCIENCEDOMAIN international.
12. Kortei, N.K., Odamtten, G.T., Obodai, M., Appiah, V., Wiafe-Kwagyan, M and Narh-Mensah, D.L. (2015). Comparative effect of gamma irradiated and steam sterilized sorghum grains (*Sorghum bicolor*) for spawn production of *Pleurotus ostreatus* (Jacq. Ex. Fr) Kummer. Applied Science Reports 10(1): 12-21, ISSN: 2311-0139.
13. Kortei, N.K., Odamtten, G.T., Obodai, M., Appiah, V and Wiafe-Kwagyan, M. (2015). Evaluating the Effect of Gamma Irradiation and Steam Sterilization on the Survival and Growth of Composted Sawdust Fungi in Ghana. British Microbiology Research Journal 7(4): 180-192, ISSN: 2231-0886.
14. Kortei, N.K., Odamtten, G.T., Appiah, V., Obodai, M. Adu-Gyamfi, A. and Wiafe-Kwagyan, M. (2015). Comparative Occurrence of Resident Fungi on Gamma Irradiated and Steam Sterilized Sorghum Grains (*Sorghum bicolor* L.) for Spawn Production in Ghana. British Biotechnology Journal 7(1): 21-32, ISSN: 2231-2927.
15. Kortei, N.K. and Akonor, P.T. (2015). Correlation between hue-angle and color lightness of gamma irradiated mushrooms. Annals of Food Science and Technology, 16 vol 1, 98-103.
16. Narh Mensah, D. L., (2015) "Preliminary Cultural Feasibility Studies of Three Entrepreneurial Economic Activities: A Case-study in Akwapim North District of the Eastern Region of Ghana". In Skill India Global Summit on Entrepreneurship and Skill Development, Noida, India: 380-390.

17. Obeng, O.H., Schwartz, B. and Plahar, A.W. (2015). Can leafy vegetable sauce of Omega-3 fatty acids ameliorate acute intestinal inflammation induced in mice? A case study of Purslane (*Portulaca oleracea*). *European Journal of Medical plants*. 6(2): 70-81.
18. Sonnenberg, A.S.M., Baars, J.P., Obodai, M and Asagbra, A. (2015). Cultivation of Oyster mushrooms on Cassava Waste. *Food Chain* 5 (1-2):105-115 www.practicalactionpublishing.org. <http://dx.doi.org/10.3362/2046-1887.2015.007>, ISSN: 2046-1879 (online).
19. Tortoe, C., Dowuona, S., Dziedzoave, N. T. (2015). Determination of sprout control treatment using seven key yam (*Dioscorea* spp.) varieties of farmers in Ghana. *World Journal of Agricultural Research*. 3(1), 20-23. DOI:10.12691/wjar-3-1-5.
20. Twum, A.L, Kottoh, D. I., Asare, K. I., Torby- T. W., Buckman, S. E. and Adu-Gyamfi. A. (2015). Physicochemical and Elemental Analyses of Banana Composite for infants. *British Journal of Applied Science and Technology* 6(3):276-284
21. Wiafe-Kwagyan, M., Odamtten, G.T and Obodai, M. (2015). Possible Antibiosis Effect of the Metabolites of Three Fungal Species Resident in Rice Straw and Husk Compost on the in vitro Radial and Vegetative Growth by *Pleurotus ostreatus* strain EM-1 and *P. eous* strain P-31. *International Journal of Current Microbiology and Applied Science* 4(8): 525-538, ISSN: 2319-7706.

b) Technical Reports

1. Abbey, L., Glover-A., M, Atter, A., Dowuona, S., Essel, M.E., Peget ,F., Toppe, J. and Kiran, M. (2015). Training manual on dried fish powder and fish powder based products under FAO/FRI project.
2. Abbey, L., Glover-A.M., Atikpo, O. M., Manu, S., Atter, A., Toppe, J. and Kiran, M. (2015). Development of low cost nutrient dense fish products based on low value fish and fish by-products using small and medium scale processing and preservation methods that stabilize the nutritional value and ensure the safety of the product-FAO Report.
3. Atter, A., Owusu,M., Ackah, B.N., Annan,T., Amoo-Gyasi, M., Boham, A. M., Appiah, K.H.A., Yahaya, D. B., Yusuf, F., Baffoe, L., Tetteh, E. (2015). Microbiological safety of the washrooms in the main building of CSIR-Food Research Institute. Small and medium scale processing and preservation methods that stabilize the nutritional value and ensure the safety of the product-FAO Report.

4. Baidoo, M. E. (2015). Technical report on Reformulation of FRI plantain fufu flour.
5. Narh Mensah, D. L., Obodai, M., Dzomeku, M., Takli, R. K. (2015). Report on advisory services for the Mushroom Cultivation Wing of Nutierich Food Products, Accra, Ghana
6. Narh Mensah, D. L., Urben, A. F., Dzomeku, M., Prempeh, J., Takli, R. K., Obodai, M. (2015). Mushroom Cultivation Using the Juncao Technology.
7. Obodai, M., Narh Mensah, D. L., Dzomeku, M, Takli, R., Urben Fontes, A., Figueirêdo, V and de Souza, E. (2015). Characterization, conservation and domestication of indigenous edible and medicinal mushrooms on agricultural residues- Collaborative research report.
8. Obodai, M., Dzomeku, M., Narh Mensah, D., Takli, R and Prempeh, J. (2015). Mushroom training workshop reports (2012-2014).
9. Obodai, M., Dzomeku, M., Narh Mensah, D. L., Prempeh, J, Takli, R. K, Urben, A., Figueiredo, V and de Souza, E. (2015). Domestication of an indigenous Ghanaian edible mushroom-Pleurotus sajor-caju: variations in the proximate and mineral contents of the wild and cultivated species.
10. Tortoe, C., Obodai, M., Owusu, M., Akonor, P.T and Ofori, E. (2015). Report on the Proposal Writing Training Workshop For Research Scientists.
11. Tortoe, C., Obodai, M., Owusu, M., Akonor, P.T and Ofori, E. (2015). Report on the Research Writing Training Workshop for Research Scientists and Technologists.
12. Tortoe, C., Nketia, S., Sampare A. S. (2015). Feasibility studies on plantain processing centre in Abroma of the Ashanti Region, Ghana. CSIR-FRI, Accra, Ghana pp. 30.
13. Tortoe, C., Akonor, P. T., Padi, A., Agezudor, J. (2015). Training of end-users on composite flours for commercialization in the Ashanti Region. CSIR-FRI, Accra, Ghana pp. 36.

c) Conference abstract

1. Ackah, B. N. and Baidoo, A. E. (2015). Development of a HACCP system for Vegetable Shito. Presented at the South African Association for Food Science and Technology 2015 Congress, Durban.
2. Atter, A., Obiri-Danso, K., Amoa-Awua, K. W. (2015). Bottling of burukutu: improving the safety and shelf life of burukutu, a traditional sorghum beer. Presented on 29/10/2015 at the scientific section of the 26th Annual General Meeting of the CSIR-Research Staff Association of Ghana.

3. Atter, A., Abbey, L., Glover-Amengor, M., Dowuona, S., Essel, M. E., Mboom, P.F. (2015). Microbial safety of powdered burrito, tuna trimmings, tuna gills and tuna bones. Presented on 29/10/2015 at the scientific section of the 26th Annual General Meeting of the CSIR-Research Staff Association of Ghana.
4. Dzomeku, M., Narh Mensah, D., Prempeh, J., Takli, R., Obodai, M. (2015). Mushrooms of Ghana: An Over View. Submitted to 19th ISMS Congress: International Society of Mushroom Science.
5. Obodai, M., Blanchette, R.A., Barnes, C.W., Otto, E.C., Narh Mensah, D., Dzomeku, M., Prempeh, J., Takli, R. (2015). Identification of species within the *Ganoderma lucidum* complex in Ghana. Submitted to 19th ISMS Congress: International Society of Mushroom Science.

d) Consultancy Report

Ackah, B. N., Baidoo, A. E. and Appiah, K. H. A. (2015). Validation of a HACCP System for KFC Vegetable Shito, Consultancy Report for Samba Foods, CSIR-Food Research Institute.

e) Media Popularization

1. Ackah, B. N. and Andoh-Odoom, H. A. (2015). Food Safety Management Systems: What does it mean for the Ghanaian Economy? Feature Article – Daily Graphic, September 10th.
2. Andoh-Odoom, H. A., Ackah, B. N. and Abbey, D. L. (2015). Let's adopt and implement the draft National Food Safety Policy: Feature article – The Ghanaian Times, Thursday April 9, 2015.
3. Andoh, H. A., Ackah, B. N. and Abbey, D. L. (2015). Food safety: Theme for this year's world health day, Graphiconline @ <http://graphic.com.gh/features/opinion/41093-food-safety-theme-for-this-year-s-world-health-day.html>

APPENDIX I**Senior Members and Senior Staff List 2015****Directorate**

1. Dr. Nanam Tay Dziedzoave - Prin. Res. Scientist/Director
2. Dr. (Mrs.) Mary Obodai - Deputy Director
3. Dr. Lawrence Abbey - Senior Research Scientist/Quality Manager
4. Mrs. Anthonia Andoh - Deputy Quality Manager
5. Ms. Faustina Somuah - Chief Admin. Assistant
6. Ms. Mariam Yakubu - Technologist
7. Ms. Marmatha Yakubu - Prin. Admin. Asst.

Administration Division

1. Ms. Janet Aggrey-Yawson - Admin. Officer/Ag. Head Admin.
2. Mr. Eric K. Ofori - Chief Admin. Asst.
3. Mr. Patrick Ofori Mintah - Chief Tech. Officer
4. Mrs. Victoria A. Asunka - Prin. Admin. Asst.
5. Mrs. Beullah Sallah - Prin. Admin. Asst.
6. Ms. Anita Adusah - Snr. Admin. Asst.
7. Mr. Moses Ollennu - Snr. Asst. Transport Officer
8. Mr. Samuel Osarfo - Asst. Transport Officer
9. Mr. Reuben Tetteh - Assistant Transport Officer
10. Mr. Anthony Sevor - Assistant Transport Officer
11. Mr. Garriba Alimiyao - Assistant Transport Officer
12. Mr. Samuel Quaye - Security Officer
13. Mr. Philip Agyaye - Security Officer

Accounts Division

1. Mr. David Hayford Ahiabor - Senior Accountant/Head of Finance Division
2. Mr. John Mintah Nakotey - Chief Stores Supt.
3. Ms. Judith Dogbegah - Chief Accounting Asst.
4. Mr. Christian Amegah - Chief Accounting Asst.
5. Mr. Derrick Victor Sallah - Prin. Accounting Asst.
6. Mr. James Cromwell - Prin. Stores Supt.

- 7. Ms. Mabel Aryee - Sen. Accounting Asst
- 8. Ms. Wolase Efodzi - Stores Supt.

Commercialization & Information Division

- 1. Mr. Stephen Nketia - Scientific Sec/Head of CID
- 2. Kwabena A. Bugyei - Scientific Info. Officer
- 3. Mr. Raphael Kavi - Librarian
- 4. Mr. Augustine Andoh - Chief Tech. Officer
- 5. Mr. Philip.O. Baidoo - Prin. Accounting Asst.
- 6. Ms. Joana B. Dzikuonu - Prin. Admin. Assistant
- 7. Mr. Jeremiah Lartey- Brown - Prin. Technical Officer
- 8. Ms. Mary Assimah - Prin. Admin. Assist.
- 9. Ms. Syndy M. Williams - Technical Officer
- 10. Ms. Judith Larweh - Technical Officer
- 11. Mr. Rufai Braimah - Technical Officer

Food Processing & Engineering Division

- 1. Dr. Charles Tortoe - Prin. Res. Scientist/Head. FPED
- 2. Mrs. C. Oduro-Yeboah - Snr. Research Scientist
- 3. Mr. Joseph Gayin - Snr. Research Scientist
- 4. Mr. Gregory A. Komlaga - Snr. Research Scientist
- 5. Mr. Peter Adoquaye Addo - Research Scientist
- 6. Mr. Elvis A. Baidoo - Research Scientist
- 7. Mr. Paa Toah Akonor - Research Scientist
- 8. Mr. Jonathan Ampah - Research Scientist
- 9. Mr. Seidu A. Sampare - Chief Tech. Officer
- 10. Mr. Emmanuel A. Saka - Technologist
- 11. Ms. Edna Mireku - Technologist
- 12. Mr. Solomon Dowuona - Technologist
- 13. Mrs. Helene A. Annan - Technologist
- 14. Mr. Peter Dalabor - Prin. Works Supt.
- 15. Mr. Joseph Akoto - Prin. Works Supt.
- 16. Mr. Desmond Mensah - Prin. Tech. Officer
- 17. Mr. Thomas Najah - Prin. Tech. Officer

- 18. Mrs. Agartha Amuzu - Prin. Tech. Officer
- 19. Mr. Godwin Armah - Snr. Tech. Officer
- 20. Ms. Makafui Torgbui - Technical Officer
- 21. Ms. Jemima Ofori - Senior Technical Officer
- 22. Mr. Ofori Brempong - Senior Technical Officer
- 23. Mr. Emmanuel Tettey Agblo - Works Supt.

Food Microbiology Division

- 1. Dr. Margaret Owusu - Sen. Res. Scientist/Head. FMD
- 2. Ms. Matilda Dzomeku - Research Scientist
- 5. Mrs. Amy Atter - Research Scientist
- 6. Ms. Deborah L. Narh - Research Scientist
- 7. Mrs. Nina Bernice Ackah - Research Scientist/Head ISU-FMD
- 8. Mr. Evans Agbemefle - Asst. Research Scientist
- 9. Mr. David K. Baisel - Prin. Technologist
- 10. Mr. Michael Amoo-Gyasi - Snr. Technologist
- 11. Mr. Theophilus Annan - Snr. Technologist
- 12. Mr. Richard Takli - Technologist
- 13. Mr. Alexander Henry K. Appiah - Technologist
- 14. Ms. May A. Boham-Dako - Technologist

Food Chemistry Division

- 1. Mr. George A. Anyebuno - Research Scientist/Ag. Head/FCD
- 2. Mr. Charles Diako - Research Scientist
- 4. Mr. Hayford Ofori - Research Scientist
- 5. Mr. Nelson Y. Amey - Prin. Technologist
- 6. Mr. Kofi Kwegyir Essel - Snr. Technologist
- 7. Mr. Vincent Kyei-Baffour - Technologist
- 8. Ms. Vida Awidi - Prin. Tech. Officer
- 9. Mrs. Belinda Quaye - Prin. Tech. Officer
- 11. Mrs. Dorothy Narh - Prin. Tech. Officer
- 12. Ms. Emefa Gblende - Technical Officer
- 13. Mr. Ebenezer Tawiah - Snr. Technical Officer
- 14. Mr. Frank Dogbey - Technical Officer

Food Nutrition & Socio-Economics Division

1. Mrs. Mary Glover-Amengor - Prin. Res. Scientist/Head FNSD
2. Mrs. Lynda Hagan - Research Scientist
3. Ms. Hannah Oduro - Research Scientist
4. Mrs. Evelyn S. Buckman - Research Scientist
5. Mr. Frank Peget Mboom - Technologist
6. Mrs. Alice Padi - Snr. Tech. Officer
7. Ms. Constance Boateng - Prin. Tech. Officer
8. Ms. Mary Abena Okai - Snr. Tech. Officer
9. Ms. Justina Thompson - Snr. Marketing Asst.

APPENDIX II

Staff Movements

Table 1.1: CSIR-FRI Staff Promotions 2015

Name	Designation	Promoted To
Mr. Eric K. Ofori	Principal Admin. Asst.	Chief Admin. Asst.
Ms. Faustina Somuah	Principal Admin. Asst.	Chief Admin. Assistant
Ms. Victoria A. Asunka	Senior Admin. Assistant	Principal Admin. Assistant
Mrs. Belinda Quaye	Senior Technical Officer	Principal Technical Officer
Mrs. Dorothy Narh	Senior Technical Officer	Principal Technical Officer
Ms. Jemina Ofori	Technical Officer	Senior Technical Officer
Mr. Ofori Brempong	Technical Officer	Senior Technical Officer
Mr. Samuel Osarfo	Asst. Transport Officer	Senior Asst. Transport Officer
Mr. Ebenezer Tawiah	Technical Officer	Senior Technical Officer
Mr. Philip Agyaye	Senior Security Assistant	Security Officer
Mr. Samuel Quaye	Senior Security Assistant	Security Officer
Mr. Abel K. Sogbe	Technical Assistant Gd. 1	Senior Technical Assistant
Mr. Foster Bosompem	Security Assistant Gd.1	Senior Security Assistant
Mr. Garriba Alimiyao	Traffic Supervisor	Assistant Transport Officer
Ms. Gloria Ghansah	Clerk Gd.1	Senior Clerk
Mr. Godson Agbeley	Technical Assistant Gd.1	Senior Technical Assistant
Mr. Paul Boadi	Technical Assistant Gd. 1	Senior Technical Assistant
Ms. Dinah Kuwornu	Principal Telephonist	Telephonist Superintendent

Table 1.2: CSIR-FRI Staff under Training

NAME	PROGRAMME OF STUDY	INSTITUTION
Mrs. Bernice Karlton - Senaye	PhD, Energy & Environ Systems	North Carolina State Univ. USA
Mrs. Charlotte Oduro-Yeboah	PhD, Food Science	University of Ghana
Mr. Joseph Gayin	PhD, Food Science	University of Guelph, Canada
Mr. Charles Diako	PhD Food Science	Washington State University, USA
Evans Agbemefle	MSC Food Science & Tech.	Chonbok National University, South Korea
Mr. Emmanuel A. Saka	MPhil, Food Science	University of Ghana
Ms. Marian Yakubu	MSc. Sustainable Food Manufacturing Management	Catholic University, Group ISA, Lille, France
Mr. Seidu Ali Sampare	MSc. Mechanical Engineering	Kwame Nkrumah University of Science & Technology (KNUST)

Table 1.3: Staff who resumed from study leave

NAME OF STAFF	PROGRAMME OF STUDY	INSTITUTION
Mrs. Janet Aggrey-Yawson	MBA Human Resource	KNUST
Dr. Joseph Gayin	PhD	University of Guelph, Canada
Mrs. Angela Addy	BSc, Accounting	University of Professional Studies
Ms. Constance Boateng	Bachelor of Technology, Hospitality Management	Ho Polytechnic
Ms. Emefa Gblende	B-Tech, Science Laboratory	Accra Polytechnic

APPENDIX III

Conferences, Courses, Workshops and Seminars Attended

Date of the Conference/Seminar	Type of Conference/Seminar	Organizers	Venue	Participants
25 th - 30 th January, 2015	1 st Annual Review & Planning of C:AVA Phase II	CAVA II Project	Silver Spring Hote, Kampala	Dr. Nanam Dziedzoave Mr. Gregory Komlaga
9 th - 12 th , Feb. 2015	AfricaRice Science Week and GRiSP Africa Forum. Conference	AfricaRice and GRiSP	Cotonou, Benin	Mr. Elvis Baidoo Mrs. Lynda L. Hagan
February 2015	Training programme for Monitoring, Learning and Evaluation Officers	CAVA II project	Dar es Salem, Tanzania	Mr. Gregory Komlaga
2 nd - 6 th , March, 2015	Dissemination workshop of GRATITUDE project	GRATITUDE project	CSIR-FRI	Dr. Charles Tortoe Mr. Gregory Komlaga Mr. Solomon Dowuo na Dr Nanam Dziedzoave Dr Mary Obodai
25 th -27 th March 2015	Training workshop on Laboratory Safety	CSIR	CSIR-STEPRI	Mr. Nelson Amey
10 th April, 2015	Working together to support research	CARLIGH	CSIR-INSTI	Mr. Gregory Komlaga, Mr. Hayford Ofo ri Mr. Kwabena A. Bugyei Mrs. Nina Ackah
20 th -22 nd April, 2015	FRI-AuthorAID Research Writing Workshop	AuthorAID	CSIR-FRI	Dr. Margaret Owusu Mrs. Amy Atter Mrs. Nina Bernice Ackah
27 th - 29 th April 2015	AWARD Sub-Regional Progress Monitoring Forum	AWARD	Dodowa Forest Hotel, Dodowa	Dr. Margaret Owusu Ms. Matilda Dzomeku Mrs. Deborah L. Narh Mensah
27 th -30 th April, 2015	AWARD 2015 Sub-regional Progress mentoring forum	AWARD	Dodowa Forest Hotel	Dr. Mrs. Mary Obodai Dr. Margaret Owusu
3 rd - 9 th May, 2015	AWARD Women's Leadership and Management Course	AWARD	Kampala, Uganda	Mrs. Deborah L. Narh Mensah
12 th - 15 th May, 2016	3 rd Annual Review Meeting for the EU FSTP funded Project	EU FSTP	Blantyre, Malawi	Dr. Nanam Dziedzoave
25 th -30 th , May, 2015	Technical and Planning Meeting of NARS Project Coordinators	NARS	Cotonou, Benin	Mr. Elvis Baidoo
11 th June, 2015	Workshop on business development for domestic and agro-industrial waste reuse enterprises in Ghana	IWMI	M Plaza Hotel	Dr. Margaret Owusu
8 th -12 th June, 2015	AAAS-TWAS Summer Course on Science & Diplomacy	TWAS	Trieste, Italy	Dr. Mrs. Mary Obodai

Date of the Conference/Seminar	Type of Conference/Seminar	Organizers	Venue	Participants
14 - 18 June, 2015	African Women in Agriculture Research and Development (AWARD) and Council for Scientific and Industrial Research (CSIR) Mentoring Orientation Workshop	AWARD	Dodowa Forest Hotel	Dr. Mary Obodai Dr. Margaret Owusu Mrs. Amy Atter Mrs. Nina Bernice Ackah
23 rd June, 2015	One-Day Business Seminar for Research-Exporters Interaction	CSIR-STEPRI	CSIR-STEPRI	Mr. George Anyebuno
7 th -8 th July, 2015	Workshop on mobilizing science for sustainable development in readiness for the post -2015 Development Agenda	MESTI	La Palm Beach Hotel	Dr. Mrs. Mary Obodai
13 th - 17 th July, 2015	Hands on capacity building training for Equipment fabricators	UDESWA	Lagos, Nigeria	Mr. Jonathan Ampah
17 th July - 16 th Sept. 2015	Partnership for Enhanced Engagement in Research (PEER)	Ohio State University	USA	Ms. Matilda Dzomeku Mrs. Lynda Hagan
20 th -24 th July, 2015	Training workshop on laboratory equipment maintenance	PTB, Germany	Ghana Standards Authority	Mr. Vincent Kyei-Baffour Mr. Frank Dogbey
26 th - 27 th July, 2015	Two-day workshop on applying the principles of risk communication in Research Communication	CSIR-STEPRI	CSIR-STEPRI	Mr. George Anyebuno Mr. Gregory Komlaga Mr. Elvis Baidoo Mrs. Nina Bernice Ackah
27 th - 31 st July, 2015	Training workshop on laboratory equipment maintenance	PTB Germany	Ghana Standards Authority	Ms. Vida Awidi Mrs. Belinda Quaye
28 th -29 th July, 2015	INASP/CSIR - FRI-AuthorAID Proposal Writing Training Workshop	AuthorAID	CSIR-INSTI	Margaret Owusu Mr. George Anyebuno Mrs. Amy Atter and Nina Mrs. Bernice Ackah Mrs. Deborah L. Narh Mensah
10 th - 12 th August, 2015	ARIPO National Roving Semina on making better use of IP for business competitiveness and development in Africa	Registrar General's Department	NMIR, Accra	Mrs. Anthonia Andoh Odoom
24 th Aug - 9 th Oct. 2015	Project Management Training and Certification	India	Nodia, India	Mrs. Deborah L. Narh Mensah
25 th -28 th August, 2015	Introductory course on ISO 17025:2005 (General requirements for competence of testing and calibrating laboratories)	Trade Related Assistance and Quality Enabling Programme (TRAQUE)	ERATA hotel, Accra	Mrs. Amy Atter Mrs. Nina Bernice Ackah

Date of the Conference/Seminar	Type of Conference/Seminar	Organizers	Venue	Participants
1 st -2 nd Sept. 2015	CODEX Alimentarius Workshop		Fiesta Royal Hotel, Accra	Dr. Margaret Owusu,
5 th -8 th Sept. 2015	Forum 2015: Agricultural innovation Marketplace	Embrapa	Brasilia, Brazil	Dr. Mrs. Mary Obodai
7 th - 9 th , Sept. 2015	Congress of the South African Association for Food Science and Technology	South African Association for Food Science and Technology	Durban, South Africa	Mrs. Nina Bernice Ackah
14 th - 19 th Sept. 2015	Workshop on project implementation and scaling up, FORUM 2015		Brasilia, Brazil	Mrs. Nina Bernice Ackah
18 th - 19 th September 2015	Skill India Global Summit on Entrepreneurship and Skill Development	National Institute for Entrepreneurship and Small Business Development (NIESBUD)	Noida, India	Mrs. Deborah L. Narh Mensah
22 nd - 23 rd Sept. 2015	CSIR Senior Research Forum	CSIR	CSIR-CRI	Dr. NanamDziedzoave Dr. Mary Obodai Dr. Charles Tortoe Dr. Mrs. Mary Amengor Dr. Lawrence Abbey Dr. Joseph GayinMrs. Charlotte OduroYeboah Mr. David Ahiabor
27 th September - 9 th October 2015	Short course in Local Economy Development (LED)		Guateng South Africa	Evelyn SerwaahBuckman
28 th Sept - 9 th Oct. 2016	Local Economy Development towards Agribusiness cluster development	Center for Development Innovation, Wageningen University	South Africa	Mrs. Evelyn Buckman

Date of the Conference/Seminar	Type of Conference/Seminar	Organizers	Venue	Participants
12 th -14 th October, 2015	Digitization of indigenous knowledge	CSIR-FORIG/Elsevier Foundation	CSIR-FORIG	Mr. Raphael Kavi
19 th -22 nd October 2015	BOSCH/ITC LEAN management Training Program		Marshall University, Accra	Mrs. Evelyn Serwaah Buckman
23 rd October 2015	Food safety awareness Workshop as part of the World Food Day celebration	Food and Drug Authority	Accra	Evelyn Serwaah Buckman
2 nd – 27 th Nov. 2015	Increasing the development impact of Agricultural Research	University of Nairobi	Kenya	Mrs. Deborah L. Narh Mensah
16 th Nov. 2015	23 rd annual meeting of the Global Panel on Agriculture and Food Systems for Nutrition	The John A. Kuffour Foundation	Labadi Beach Hotel	Dr. NanamDziedzoave
20 th - 26 th Nov. 2015	Global Rice Science Partnership (GRiSP) project dissemination workshop; Rice and rice-based products and technologies	Global Rice Science Partnership (GRiSP)	Como, Italy	Mrs. Lynda L. Hagan
23 rd -28 th Nov. 2015	Training workshop on fostering scientific entrepreneurship	Quente/Nuffic	Forest Hotel Dodowa	Mrs. Nina Ackah Mr. Nelson Arney Ms. Vida Awidi Ms. Belinda Quaye
23 rd -28 th Nov. 2015	AuthorAid/ INASP	INASP	Sri Lanka	Dr. Mary Obodai
24 th Nov. 2015	Workshop on agriculture public expenditure review	MoFA	Coconut Groove Regency Hotel	Dr. Charles Tortoe
25 th November 2015	Australia Awards – University Network Summit	Australia Awards	Southern Sun Mayfair Hotel, Nairobi, Kenya	Mrs. Deborah L. Narh Mensah
11 th Dec. 2015	Stakeholder workshop on the development and adoption of solar dryers using local materials in Ghana	Energy Commission	City Escape Hotel, Accra	Dr. Charles Tortoe

APPENDIX IV

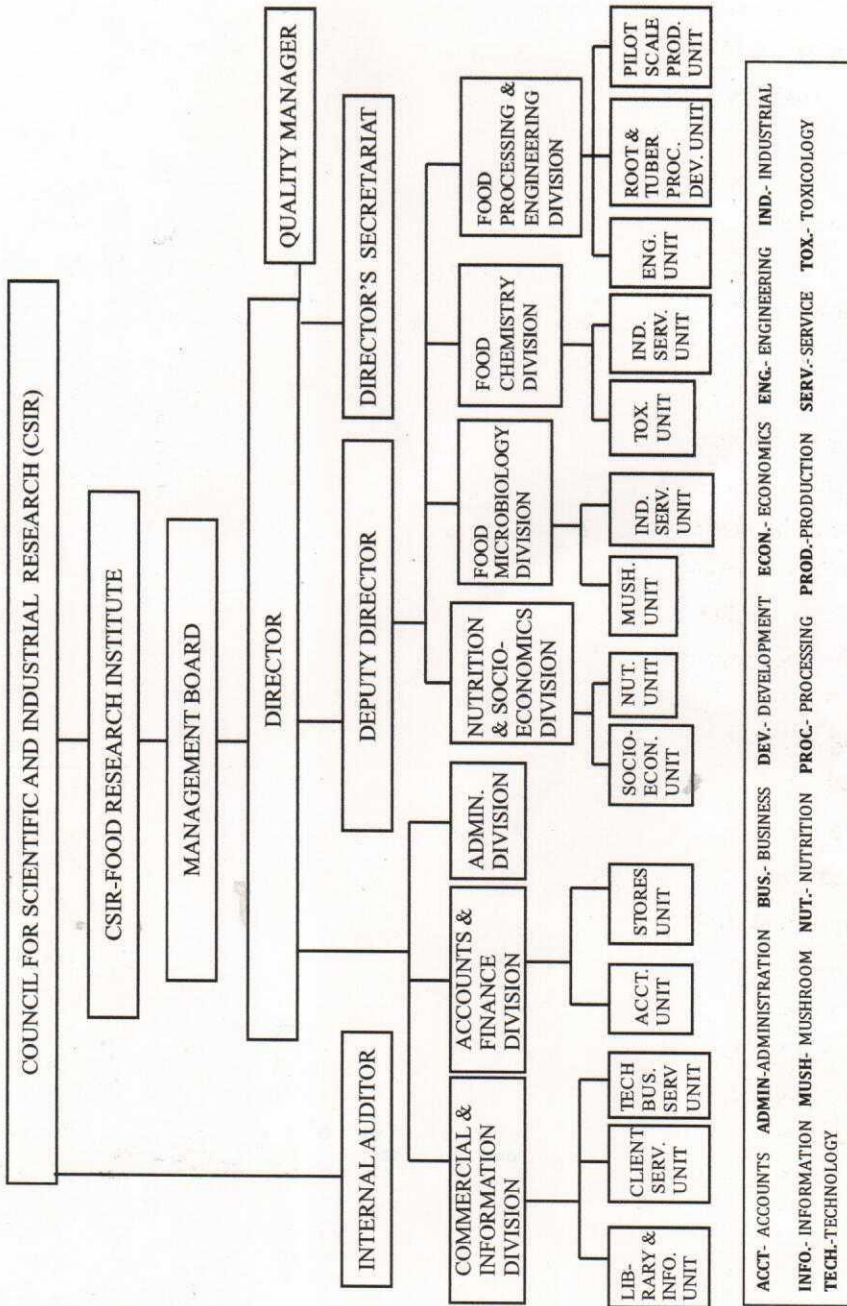
List of customers of Food Chemistry Division

Customer	No. of Samples
Intertek Ghana Ltd	88
Ghana Standards Authority	55
Cosmo seafoods co.ltd	47
Bomarts Farms Ltd	28
WAAPP 2 Project	27
Aquafresh Ltd	24
FTT Project	23
GIZ-MOAP	21
Marvel Hinson Dept of Vocational & Technical Education	19
Cosmo Seafoods 18 Cassava G-Market	17
Dept. of Food Science, KNUST	15
Transmed Gh. Ltd.	15
GCSL/GGBL	14
Cassava G-Market Project	14
Richmon Empire Enterprise Ltd	13
FAO/FRI Project 13 Masco Foods	12
Project Peanut Butter 12 Jebrila Salae Ent.	12
Green Growth 12 Customer No. of Samples Greg Komlaga	12
Equator Foods Ghana Ltd	11
Dry Foods Processing Ltd.	10
Hershey Company	10
Barry- Callebant Gh Ltd.	10
Deysark Company Ltd.	10
Kosher Feedmills Ltd	8
Meicham Ltd	8
Maduforo A.N Dept of Nutr. and Diet	8

Yakubu Tamimu	8
Burger Food Industries	8
Melcom Ltd.	7
Elsa Foods Ltd.	7
Accra Polytechnic	7
Parlays Gh. Ltd.	6
Kasapreko Co. Ltd.	6
Juliana Akraasi	6
Cava - FRI	6
Nkulenu Industries Ltd	6
Cocoa Processing Company	6
Nouveau Foods LTD	6
HONEYCOMB FDs LTD.	6
Linaks Co. Ltd	5
Damian Laryea	5
A.Y. Karikari	5
Healthlife Beverages Ltd	5
Gbekus Vent.	5
Food & Drug Authority	5
T.T Int. Co. Ltd	5
Ultimax Ltd	5
Med Mining Co. Ltd.	5
Denod Ent	5
Grabin Distilleries Ventures	5
Zeno Yoghurt Ent.	5
Premium Foods Co. Ltd	4
Reagvim Ventures Ltd.	4
King Impex	4
Evergreen Super-market Ltd.	4
KNUST	4

AfricaRice Project	4
HPW Fresh and Dry Ltd	4
SNF Faustep ENT	4
NUTRI FOODS GH LTD	4
HomeFoods Processing & Cannery Ltd	4
Royal Sweet Ltd	4
Makefui Borbi Michigan Sate University, Dept of Food Science & Human Nutrition	4
CustomerNo. of SamplesVet Clinic, Nsawam	3
Promasidor Ghana Ltd	3
Theresa G. Frimpong	3
Novan Co. Ltd	3
North-South Local Government Corporation	3
Baboo Foods Limited	3
Tyndale Prime Gh Ltd	3
Peer Science Programme	3
Alpha Ind. Ltd.	3
SlyAddison Ent	3
WAAPP 2A	3
David Mireku	3
Oseboba Ltd	3
Premium Foods Ltd	3
Meagasa Mama	3
Prof. Jonhson	3
MI Fine Ventures	3
A.D Agrispro Co.	3
Caphzan Ent.	3
Idiiban Seafoods Com. Ltd	3

ORGANOGRAM OF CSIR-FRI



ACCT.- ACCOUNTS ADMIN-ADMINISTRATION BUS.- BUSINESS DEV.- DEVELOPMENT ECON.- ECONOMICS ENG.- ENGINEERING IND.- INDUSTRIAL
 INFO.- INFORMATION MUSH- MUSHROOM NUT.- NUTRITION PROC.- PROCESSING PROD.- PRODUCTION SERV.- SERVICE TOX.- TOXICOLOGY
 TECH.- TECHNOLOGY