

# CSIR-FRI

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH  
FOOD RESEARCH INSTITUTE

# 2014 ANNUAL REPORT





CSIR-FOOD RESEARCH INSTITUTE  
**ANNUAL REPORT 2014**

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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
FNSD	-	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
WAAPP	-	West African Agricultural Productivity Programme

## CSIR-FRI MANAGEMENT BOARD MEMBERS

- |    |                                 |   |                                |   |          |
|----|---------------------------------|---|--------------------------------|---|----------|
| 1. | Dr. Osei Boah-Ocansey           | - | Director-General, PEF          | - | Chairman |
| 2. | Dr. Nanam Tay Dziedzoave        | - | Director, CSIR-FRI             | - | Member   |
| 3. | Mr. Herbert A. Obiri            | - | Ag. Director, CSIR-IIR         | - | "        |
| 4. | Dr. (Mrs.) R.E.M. Entsua-Mensah | - | Dep. Director-General,<br>CSIR | - | "        |
| 5. | Mr. Timothy A. Osei             | - | Chartered Accountant           | - | "        |
| 6. | Prof. Josephine Nketsia-Tabiri  | - | Director, BNARI, GAEC          | - | "        |
| 7. | Mr. Charles Debrah Asante       | - | Dep. Managing Director, CPC    | - | "        |



## MEMBERS OF THE CSIR-FRI INTERNAL MANAGEMENT COMMITTEE

1.	Dr. Nanam Tay Dziedzoave	- Director	- Chairman
2.	Dr. (Mrs.) Margaret Ottah Atikpo	- Dep. Director	- Member
3.	Dr. Lawrence Abbey	- Quality Manager	- "
4.	Dr. (Mrs.) Mary Obodai	- Head/Mushroom Unit	- "
5.	Dr. Charles Tortoe	- Head/FPED	- "
6.	Dr. Frederick Teye	- Head/Eng. Unit	- "
7.	Mrs. Mary Glover Amengor	- Head/Nutrition Unit	- "
8.	Mr. Gregory Komlaga	- Ag. Head/PSPU	- "
9.	Mr. Elvis Baidoo	- Ag. Head/RTPDU	- "
10.	Mr. Benjamin Addi-Okae	- Ag. Head/Admin	- "
11.	Mr. Coffie Aikins Tutu	- Ag. Head/Accounts	- "
12.	Dr. Margaret Owusu	- Head/ISU-FCD	- "
13.	Mr. George Anyebuno	- Ag. Head/FCD	- "
14.	Mr. Richard Takli	- Chairman, Staff Welfare	- "
15.	Mr. Theophilus Annan	- Chairman, SSA	- "
16.	Mr. Micheal Amoo-Gyasi	- Chairman, TUC	- "
17.	Stephen Nketia	- Scientific Secretary	- "
18.	Mr. Eric Ofori	- Prin. Admin. Asst.	- Recorder



## EXECUTIVE SUMMARY

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Since its inception, the CSIR-Food Research Institute an affiliate Institute of the Council for Scientific and Industrial Research, generates technologies that immensely contribute to the private sector and socio-economic development of Ghana. The Institute focuses its efforts and resources on solving post-harvest related issues which directly contribute to minimizing food security challenges in the nation.

It is mandated to conduct applied market oriented research into problems of food processing preservation, food safety, food storage, marketing, distribution and food utilisation as well as national food nutritional security in support of the food industry. It is also tasked with the provision of technical and analytical services, contract research, collaborative research and consultancy services to governmental agencies, micro-medium and multinational agro-food processing industries and international development agencies. In order to accomplish its mandate, the activities of CSIR-FRI are purposely aligned with local commodities: Root and Tuber; Cereal, grains and Legume; Meat, fish and dairy as well as Fruit, vegetable and spices.

During the year, the Institute worked on a total of three thousand, eight hundred and two (3802) samples, which is highest compared with that of 2012 and 2013. Research by-products such as plantain, cassava, cocoyam, yam, cowpea flours; mushrooms, fermented flours etc. continued to be produced and sold. A sum of thirty one thousand, nine hundred and eighty nine (31, 989) research by-products were sold within the year. With the sale of its by-products, trainings, technical and consultancy services, the Institute made an income of seven million, forty-one thousand, six hundred and ninety-five Ghana cedis (GHS 7,041,695.00) from its activities in the year 2014.

Impact to society was made through training programmes, workshops and other capacity building activities especially in rural communities. These impacts were realised through the various objectives of twelve (12) projects within the year. Aims of some projects included but not limited to the strengthening of stakeholders of the rice value chain, enhancing food security by addressing post-harvest losses in the fisheries sector, transferring nouvelle mushroom technologies to youths in communities and so on.



Research activities led to the publishing of thirty-one (31) journal articles. Some of the research activities include quality characteristics of pre-treated yam chips produced from irradiated yams, phytochemical and mineral analysis of 12 cultivated oyster mushrooms, Microbiological and chemical processes associated with the production of burukutu a traditional beer in Ghana and Growth and production of aflatoxins by a flavus in aqueous fruit extracts of pepper, okra and tomato.



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## 1.0 ADMINISTRATION DIVISION

### Introduction

The Administration Division provides administrative support for the Research and Technological programs of the Institute. It is also responsible for identifying professional and managerial training needs and opportunities for staff; assessing, maintaining and improving the Institute's infrastructure; maintaining and repairing Institute's vehicles and monitoring their use. The Division consists of the Registry Section, Human Resources Section, Transport Section, Estate Section & Security and Front Desk Section.

### Staff Strength

The staff strength of the Institute as at December, 2014 was 160. The breakdown is as follows:

• Senior Members	-	34
• Senior Members ( <i>On Contract</i> )	-	2
• Senior Staff	-	64
• Junior Staff	-	60

### Appointment

Dr. (Mrs.) Margaret Ottah Atikpo, Principal Research Scientist and Head of Food Microbiology Division was appointed Deputy Director of the Institute. The appointment took effect from 1<sup>st</sup> January, 2014.

### Divisional/Unit Headship

During the period, the following Divisional Headship appointments were made: Dr. (Mrs.) Mary Obodai, Senior Research Scientist was appointed Head of Food Microbiology Division; Mr. George Anyebuno, Research Scientist was appointed Head of Food Chemistry Division; Mr. Benjamin Addi-Okae, Research Scientist (M&E) was appointed Acting Head of Administration; Mr. Stephen Nketia, Scientific Secretary was appointed Head of CID; Mr. Frederick Wayo-Teye, Senior Research Scientist was appointed Head of Engineering Unit; Ms. Anthonia Andoh, Research Scientist was appointed Deputy Quality Manager; Mrs. Nina Bernice Ackah was appointed Head of Industrial Services Unit of Food Microbiology Division. The appointments took effect from 1<sup>st</sup> January, 2014

### Promotions/Upgrading

Eight (8) senior staff and nine (9) junior staff were promoted during the reporting period. Details of this is shown in *Table 1.1 of Appendix II*.



### **Human Resource Development/Training**

The Institute continued to grant training opportunities to staff to enable them acquire new skills and expertise needed to enhance performance. The list of staff on study leave and staff who have resumed duty from study leave within the year under review is shown in *Table 1.2 in Appendix II*.

### **Retirement**

Seven (7) staff members consisting of one (1) Research Scientist; three (3) Senior Staff and three (3) Junior Staff compulsorily retired from the services of the CSIR-Food Research Institute. See *Table 1.4 of Appendix II* for details.

### **Resignations**

Dr. Frederick Wayo-Teye, Senior Research Scientist and Head of Engineering Unit resigned from the Institute on health grounds.

### **Vacation of Post**

Mrs. Ruth Adisetu Pobe, Research Scientist of the FNSD vacated her post and was therefore dismissed from the Institute.

### **Obituary**

Mr. Sylvanus Akanue, Senior Security Assistant with the Administration Division passed on to eternity after a short illness. The sad event occurred in March, 2014.

### **Internships & National Service**

During the year under review, the Institute accepted students from Universities, Polytechnics and other Institutions to undertake internship programs in various Divisions of the Institute. The Institute also hosted ten (10) National Service personnel during the year.

### **Institute Visitors**

The Institute hosted a consultant working on the CSIR Business Plan on 4<sup>th</sup> – 5<sup>th</sup> July, 2014.



## 2.0 ACCOUNTS DIVISION

### Introduction

#### Main Responsibilities of the Accounts Division

- To ensure the effective and efficient management of the Institute's revenue, expenditure, assets, liabilities and other resources in accordance with the Financial Administration Act 203.
- To ensure that procurement for the institute is done in accordance with the Public Procurement Act 2003.
- To ensure that the Institute complies with the provisions under the Internal Revenue Act 2001.
- To ensure that the Institute complies with CSIR policies and regulations which relate to Accounts and Finance.

### Major Activities

In order to fulfil the above 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.

The following activities of the Division were accomplished within the period under review:

1. The completion of the 2013 final accounts was in the second quarter of the year.
2. Entries of data of the 2014 financial transactions were matched into the accounting records to November, 2014.
3. Preparation of management reports and offering of professional advice to management in order to assist in their decision-making.
4. Management of funds from donors for research activities and ensuring that the various research activities complied with the financial requirements attached to the activities.
5. Reviewed audit comments and ensured that the Institute complied with their recommendations.



**Financial Performance for the year ending 31<sup>st</sup> December, 2014.**

Elements	Years	GHC	GHC
		2014	2013
		<u>ACTUAL</u>	<u>ACTUAL</u>
<b>INCOME:</b>			
	Government Sources	6,420,890.00	8,257,061.00
	Internally Generated Fund	620,805.00	410,118.00
	<b>Total</b>	<b><u>7,041,695.00</u></b>	<b><u>8,667,179.00</u></b>
<b>EXPENDITURE:</b>			
	Normal business	7,503,695.00	8,007,886.00
	Internally Generated Fund	318,597.00	280,604.00
	<b>Total</b>	<b><u>7,822,292.00</u></b>	<b><u>8,288,490.00</u></b>
	Surplus Income from IGF	302,207.00	129,514.00
	Loss from normal business	(1,082,805.00)	249,175.00
	<b>Surplus/Loss</b>	<b><u>(780,598.00)</u></b>	<b><u>378,689.00</u></b>

**Summary**

The Institute made a loss of GH¢780,597.00 which is made up of the following:

- Loss from normal business. GH¢ 1,082,805.00
- Surplus from Internally Generated Fund GH¢ 302,207.00
- Total loss for the year GH¢ 780,597.00

The loss made on normal activities was because no funds were released by the Government to cover other expenses apart from Salaries which were paid by the Controller and Accountant General's Department.

**Income**

- Total income in 2014 was GH¢ 7,041,695.00 which was 19% less than 2013.
- Income from Internally Generated Fund which was 9% of the total income was GH¢ 620,804 showing a growth of 52%, 2013.
- Income from government sources was GH¢ 6,420,890.00 and it was 23% less than income received in 2013.



**Expenditure**

Total expenditure in 2014 was GH¢ 7,822,292.00 which was 6% less than expenditure in 2013. Expenditure on Internally Generated Fund which was GH¢ 318,597.00 constituted 4% of the total expenditure, 96% of the total expenditure was incurred on normal business activities.

### 3.0 COMMERCIALISATION AND INFORMATION DIVISION

#### Introduction

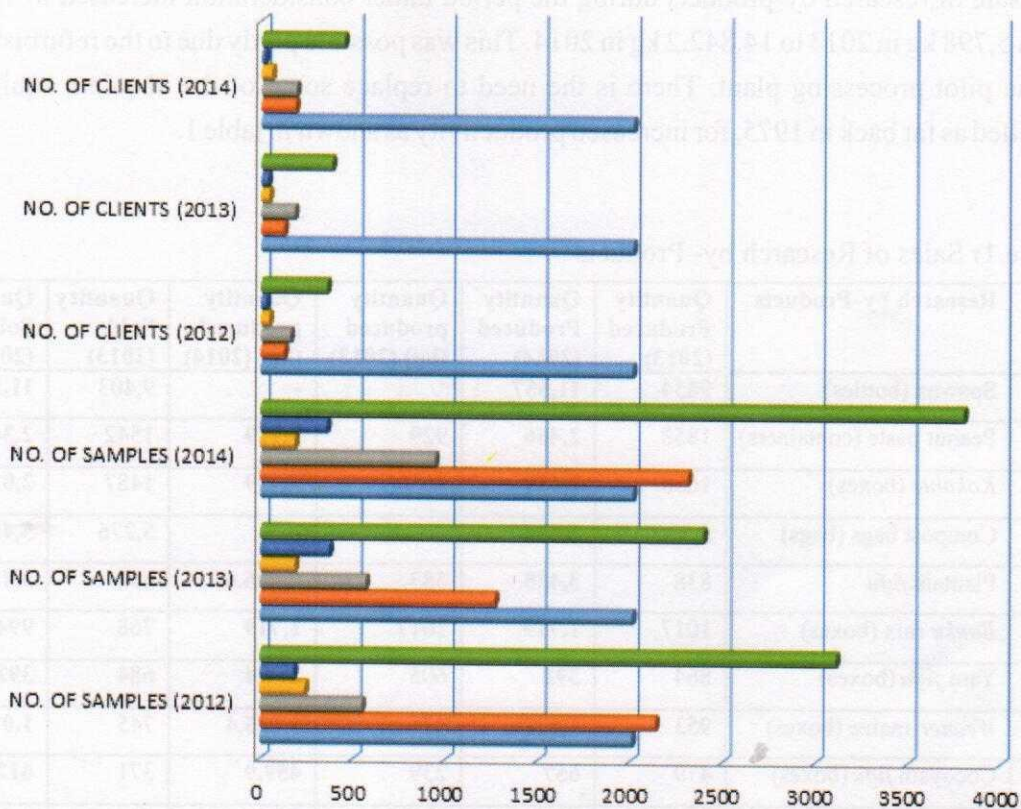
The Commercial and Information Division (CID) coordinates the commercial activities of all other Divisions of the Institute in order to enhance the income generation capacity and ensure effective information management. The activities of the Division are aimed at guiding management decisions and enhancing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

Below are the analytical services carried out during the period under review. A report was prepared on the frequency of visits, number of samples received and gross revenue of customers to each of the cost centers' laboratories as shown in figure 1. This was attached by a portfolio analysis using General Electrical Matrix method to identify our regular reliable customers as well as redundant customers. We also put in place a system to develop follow up format for our customers visit. During the period, three (3) of our major clients who withdrew their engagement of sampling with the Institute due to the suspension of microbiology and chemical laboratory test analyses by SANAS in the previous year, have been won back. *Figure 1* indicates the analytical services provided by the Institute to the Agro-processing Industries in Ghana. It shows gradual increase in volumes of samples and clients over 2012, 2013 and 2014 period.



**SAMPLES AND CLIENTS' ANALYSES FROM 2012 TO 2014**



	NO. OF SAMPLES (2012)	NO. OF SAMPLES (2013)	NO. OF SAMPLES (2014)	NO. OF CLIENTS (2012)	NO. OF CLIENTS (2013)	NO. OF CLIENTS (2014)
<b>TOTAL</b>	3114	2397	3802	357	383	447
<b>FPED - PSPU Laboratory I</b>	182	372	358	28	36	19
<b>FCD- Mycotoxin Unit</b>	243	187	186	45	43	57
<b>FCD- Industrial Services Unit</b>	549	569	945	158	180	188
<b>FMD- Industrial Services Unit</b>	2140	1269	2313	126	124	183
<b>COST CENTER LABORATORY</b>	2012	2013	2014	2012	2013	2014

**Figure 1:** A graph comparing analyses of samples and clients from 2012 to 2014



### Sale of Research by- Products

The sale of research by-products during the period under consideration increased in volume from 5,798 kg in 2013 to 14,842.2 kg in 2014. This was possible partly due to the refurbishment of the pilot processing plant. There is the need to replace some of the obsolete equipment installed as far back in 1975, for increased productivity as shown in table 1.

**Table 1:** Sales of Research by- Products

No	Research by-Products	Quantity Produced (2013)	Quantity Produced (2014)	Quantity produced (kg) (2013)	Quantity produced (kg) (2014)	Quantity Sold (2013)	Quantity Sold (2014)
1	Spawns (bottles)	9454	11,557		-	9,403	11,157
2	Peanut paste (containers)	1858	2,466	929	1,719	1542	2,364
3	<i>Kokonte</i> (boxes)	1650	2,459	1650	2,459	1487	2,027
4	Compost bags (bags)	5,276	5,454	-	-	5,276	5,454
5	Plantain <i>fufu</i>	838	3,438	587	2,406.6	662	3,438
6	<i>Banku</i> mix (boxes)	1017	1,719	1017	1,719	768	994
7	Yam <i>fufu</i> (boxes)	864	392	605	274.4	684	392
8	<i>Weaner</i> maize (boxes)	953	1,622	476	1,135.4	745	1,073
9	Cocoyam <i>fufu</i> (boxes)	479	657	239	459.9	371	612
10	<i>Weaner</i> rice (boxes)	589	1301	295	910.7	481	1,200
11	Fermented maize (boxes)	494	717	494	717	371	680
12	Maize grits (boxes)	756	1,473	378	736.5	499	1,312
13	<i>Gari</i> (boxes)	335	1,094	335	1,094	250	1,006
14	<i>Agbelima</i> (sachets)	165	300	165	300	165	280
	<b>Total</b>			5,798 kg	14,842.2 kg		

### Technical services

The number of technical services provided increased from 21.6 tons in 2013 to 25 tons in 2014 as shown in table 2. Some technical services rendered were roasting of groundnuts and soy beans as well as drying of Hausa koko and milling of ground nuts, soybean, and roasted maize.



**Table 2: Technical Services Provided**

Type of service	Number of times 2013	Number of times 2014	No. of clients 2013	No. of clients 2014	Volume of products 2013 (kg)	Volume of products 2014 (kg)
Drying	43	84	15	20	17,758	21,342
Milling	14	3	4	3	2,567	2,132
Roasting	9	17	5	5	1,300	1,646
<b>TOTAL</b>	<b>66</b>	<b>104</b>	<b>24</b>	<b>28</b>	<b>21,625</b>	<b>25,120</b>

### Technological Business Service Section (TBSS)

The year under review activities of the Unit were mainly focused on consultations and training. Within the year, 214 requests were received out of which 84 were executed. This formed 6.03% of total requests received.

A total of fifty five thousand, three hundred and two Ghana Cedis, twenty-one pesewas (GHC55,302.21) was realized from requests executed as against nine hundred and seventeen thousand, five hundred and eighty-four Ghana Cedis, sixty two Ghana pesewas (GHC917,584.62) expected income that is when all requests had been executed. Income realized was thus 6.02% of expected income as shown in tables 3 and 4.

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



**Table 3:** Breakdown of requests (received and executed) and revenue

		Requests Received	Requests Brought Forward	Services Executed	Clients Served	Expected income	Gross Revenue
Percentages »		100.00%	0.00%	39.25%	N/A	100.00%	6.03%
#	All Services   Numbers »	214	0	84	93	917,584.62	55,302.21
	Exclusive	201	0	76	85	907,383.82	49,830.41
	Others	13	0	8	8	10,200.80	5,471.80
1	TBSU Projects	32	0	7	7	2,101,912.64	5,290.74
2	Contract Research	3	0	1	1	6,226.01	4,840.01
3	Collaborative Research	11	0	4	4	39,471.80	11,239.80
4	Facility Set-up	0	0	0	0	0.00	0.00
5	Business Incubation	2	0	0	0	70.00	0.00
6	Rent of Conference Facilities	2	0	2	2	2,536.73	1,977.50
7	Technical Advice	33	0	29	29	350.00	230.00
8	Lecturing	1	0	1	1	364.00	364.00
9	Extension Services	1	0	0	0	980.12	0.00
10	Feasibility Studies	5	0	1	1	4,024.83	1,117.16
11	Equipment Fabrication	21	0	2	2	158,712.32	20,844.00
12	Engineering Services	0	0	0	0	0.00	0.00
13	Product Development and Upscaling	12	0	3	3	141,686.93	4,435.42

**Table 4:** Comparison of cost centers

		Requests Received	Requests Brought Forward	Services Executed	Clients Served	Expected Income	Gross Revenue
Percentages »		100.00%	0.00%	39.25%	N/A	100.00%	6.03%
#	Cost Centre   Numbers »	214	0	84	93	917,584.62	55,302.21
1	CID-TBSU	22	0	16	16	86,208.97	5,006.50
2	FMD-MU	59	0	34	38	26,954.36	12,530.00
3	FMD-ISU	2	0	1	1	3,076.92	2,116.80
4	FCD-ISU	2	0	2	2	460.00	450.00
5	FPED-EU	22	0	3	3	123,090.16	20,684.00
6	FPED-PSPU	75	0	19	24	56,465.54	11,697.91
7	FPED-RTPDU	17	0	2	2	615,677.55	20.00
8	FNSD-NU	15	0	7	7	5,651.12	2,797.00
9	FNSD-SEU	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 (4000) and over 200 back issues of food science and technology journals. The library also has over one thousand four hundred (1400) 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 etc. 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 and Public Servants, Consultants and many others.

A total of one hundred persons (100) used the library during the period under review. On the whole, the clientele's expectations were met.

The library continued to have a good Internet Connectivity making it possible for the Institute's members of staff to access information needed.

### **Information Request**

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 wheat flour were provided for the library users.



### **Usefulness of information provided**

During the period under review the users noted that the information provided was useful but remarked that there was the need to replenish the stock of the library with current publications 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.

### **Public Relations Report**

Public Relations duties cover communication Research; Compilation of annual/quarterly reports; Preparation of exhibition materials, posters, brochures and fliers, video and photographic exhibitions, etc. PR duties also cover the organization and participation in exhibitions and trade fairs; Secretarial functions e.g. FRI standing exhibition committees, accreditation committees, divisional meetings, etc.; other activities include the preparation of programmes for events (such as staff durbars, visits, end of year parties, etc.; organization of seminars; reception of Institute visitors as well as the preparation of citations for retiring members of staff.



## 4.0 FOOD PROCESSING AND ENGINEERING DIVISION

### Introduction

The Food Processing and Engineering Division (FPED) is headed by Dr. Charles Tortoe. The Division has three operational units; these are the Engineering Unit (EU), Pilot Scale Production Unit (PSPU) and Root and Tuber Products Development Unit (RTPDU). The Unit Heads are Mr. Jonathan Ampah, Mr. Elvis Baidoo and Mr. Gregory Komlaga respectively. The Division had 36 staff members comprising of nine (9) senior members, 14 senior staff and 13 junior staff.

The Division maintained its five Performance Improvement Teams led by other senior members, which was created to support the management of the Division for efficiency. The teams are: Research and Development Management Team, Quality Management Team, Information Management Team, Market Development Team and Equipment Installation and Maintenance Management Team.

The PSPU consist of the Production and Laboratory sections. The production section processes eight food products for commercial activities and offers production services to clients. These products are groundnut paste, fermented maize meal, yam fufu, cocoyam fufu, plantain fufu, bankumix, oblayo, rice and maize weaner mix foods. The laboratory section does analytical services and provides product development services to clients.

The Engineering Unit has a Mechanical and Electrical sections. 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 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, High Quality Cassava Flour (HQCF) as part of its commercial activities and does 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



- Consultancies and
- Trainings

### Research and Development Activities

Senior members and senior staff were involved in nine (9) projects within the Division. Various project activities undertaken during the year were as follows:

#### *West Africa Agricultural Productivity Programme (WAAPP) Project*

- **Agribusiness Incubation Centre at Pokuase.** The project is putting up an agribusiness incubation centre, currently, structural works have been completed and the Engineering Unit is fabricating and installing equipment for the facility.
- **Processing equipment.** Cassava graters and presses fabricated for processors under the WAAPP 2A project were distributed to processors in Western, Volta, Brong Ahafo and Eastern regions. Test running and labelling of equipment distributed to cassava processors on WAAPP project was carried out during the period under review.
- **Bakery equipment.** Mixers, rollers, ovens and their accessories were acquired and distributed to trained bakery groups in the Volta and Eastern regions.
- **Technology transfer.** Composite flour technology and bakery product processing were transferred to flour end-users in the Eastern, Ashanti and Volta regions. Training of cassava processors at various project locations were carried out during the year.

#### *Cassava Growth Markets (CassavaG-Market) project*

- **Technical assessment of bin and solar driers.** The performance for drying such as temperature, air humidity, heat transfer, solar radiation and air velocity as well as solar radiation for the solar drier was continuously evaluated. There was installation of the bin dryer at RTPDU. Bin dryer test was carried out at Caltech industries. Purchases of galvanized pipes for modification of heat exchanger were done during the period. Purchase of fan regulator and thermocouple to control fan speed was also done.

#### *GRATITUDE Project*

- Final reports on Work Package 2, 3, 4 and 5 of the GRATITUDE project were submitted to the project Directorate in the United Kingdom.



***CIDA Africa Rice Project***

- Data collection for generating consumer preference maps in Northern, Upper East and Upper West Regions were conducted during the period. Additionally, loss assessment studies in the Navarongo rice hub were completed.

***GIZ-MOAP***

- The activities conducted during the period were repair and testing of Innotech dryer, Installation of hot water pump, Fruit drying test with TOBY 2 dryer, Servicing of water pump at Incubation drying facility, Gas train installation, Installation of pressure gauge at solar dryer and toby dryer.

***Cassava: Adding Value for Africa (C:AVA II) Project – FRI Technical Services***

- C:AVA II Project activities (data capturing, trainings, quality monitoring, sample analysis etc.) were carried out during the year.

***Rice Sector Support Project***

- Completion of fabrication of up-scaled parboiling vessels, identification of sites for the establishment of best practice centres were completed during the period under review.

Staff of the Division were involved in other projects domiciled in other Divisions such as the AFTER Project. Client-requested trainings and consultancies were conducted on fruit juices, fufu flours, fermented maize meal, groundnut paste etc.



**Figure 2:** Client training on fruit juice at PSPU-Lab 1.

**Production and Sale of Research By-Products**

Research by-product production quantities over the period were as presented in the tables below:



**Table 5:** Productions at PSPU

Product	Quantity of Final Product (Kg/packages)
Groundnut Paste	2,466
Fermented Maize Meal	717
Yam <i>fufu</i>	392
Cocoyam <i>fufu</i>	657
Plantain <i>fufu</i>	3,438
Banku mix	1,719
Maize Grits	1,473
Oblayo	657
<b>TOTAL(packages)</b>	<b>11,519</b>

**Table 6:** Production and Sales of Research by-Products at the RTPDU

Product	Quantity of Raw Material (Kg/NO.)	Quantity of Final Product (Kg/NO.)
Kokonte	8320	1430
Gari	787	1086
Agbelima	600	1150
Starch	2650	261
HQCF	-	-
Contract processing	3026	-
<b>TOTAL</b>	<b>15389</b>	<b>3927</b>



**Table 7:** Activities in the EU

No.	Type of Product	No. of Times	Quantity Produced	Total Amount (GH¢)
1	Equipment design	2	2	0.00
2	Fabrication of equipment	5	5	2100.00
3	Installation	5	6	750.00
4	Repair and maintenance	29	29	7971.50
	<b>TOTAL</b>	<b>41</b>	<b>42</b>	<b>10,821.50</b>

**Table 8:** Sales of Research by-Products at PSPU

Type of Product	Quantity Produced	Total Sales Amount (GH¢)
Groundnut	2,466	15,121
Fermented Maize Meal	717	2,868
Yam <i>fufu</i>	392	7,340
Cocoyam <i>fufu</i>	657	4,024.5
Plantain <i>fufu</i>	3,438	21,985
Banku mix	1,719	4,167
M. Grits	1,473	2,362
Oblayo	657	1,642.5
<b>TOTAL</b>	<b>11,519</b>	<b>59,500.00</b>

**Table 9:** Sales of Research by-Products at RTPDU

Type of Product	Quantity Produced	Total Sales Amount (GH¢)
Kokonte	1430	6,150.00
Gari	1086	3,800.00
Agbelima	1150	1,125.00
Starch	261	1,170.00
HQCF	-	-
<b>TOTAL</b>	<b>3927</b>	<b>12,245.00</b>



### Services to clients

The services provided to clients at the PSPU, EU and RTPDU were roasting of groundnut and soybean and drying of Hausa Koko as presented in Table 6, 7 and 8, respectively.

**Table 10:** Services to clients at EU

Type of service	Total Amount (GH¢)
<b>Fabrication</b>	
Fabrication of cage for lab1 air condition	342
Replacement of fluorescent tubes	264
Installation of grass cutting machine	95
Repair of disc attrition mill	935
FRI dryer and Y cone mixer repairs	720
<b>TOTAL</b>	<b>2,356</b>

**Table 11:** Services to clients at RTPDU

Type of service	Number of times	Quantity produced	Total Amount (GH¢)
Drying of Ginger	4	6400	1,500.00
	<b>TOTAL</b>		<b>1,500.00</b>

### Analytical services

Two hundred and eighteen (218) samples were analysed within the period. Analyses are presented in table 12.



**Table 12:** Analytical Services to clients at PSPU Lab

No.	Types of Analysis	No. of samples	Total Amount charged (GH¢)
1	Water activity	1	55
2	Physical quality	-	-
3	Pasting characteristics	100	4231
4	Milling & sieving	3	200
5	Texture	4	550
6	Colour determination	2	230
7	Particle size	1	186.2
8	Rice dehulling	8	4,950
9	Swelling power	7	2000
10	Solubility	9	200
11	Paste clarity	23	1400
12	Water binding capacity	4	280
13	Water absorption	4	300
14	Water retention	8	400
15	Browning index	9	240
16	Water sorption isotherm	5	118
17	Oil absorption	25	1205
18	Fruit juice training	8	300

**Other Activities**

- One metric ton (1000Kg) of pressed fresh agbelima was processed for FPED-EU for drying trials on the refurbished bin dryer.
- Drying of fermented maize for a client is on-going in the solar tent dryer at RTPDU. Payment is yet to be made.



- The RTPDU facility was used by a ginger processing company as an Incubation Centre. Final documentation is yet to be made for renting the space and facilities.
- The RTPDU facility is being used by Palmer Enterprise as an Incubation Centre for kenkey production. Final documentation is yet to be made for renting the space and facilities.
- Mr. Komlaga and Mr. Peter Dalabor were facilitators in the COTVET training for Manchie Cassava Women Processors. CSIR-FRI was contracted for the training.
- A consultancy service was conducted by Dr. Charles Tortoe and Mr. Jonathan Ampah to Konko Farms Ltd., Koforidua.

**Public Private Partnership (PPP)**

Technical support for the following companies under PPP was provided during the year:

- Home Foods Ghana Limited
- Inland Brewery Limited
- RTPDU is collaborating with a private company, Palmer Foods to renovate and put to use the kenkey factory at RTPDU as an incubation facility. Renovations works are underway.
- PSPU is in partnership with Palmer Foods to produce and commercialized plantain, cocoyam and yam fufu. MOU is yet to be signed.

**Divisional Meetings**

In order to facilitate a bottom-up approach for effective management in the Division, the following meetings were held during the year.

- Five (5) Management Team Meetings were held on 5th January, 8th April, 5th June, 9th July and 21st November, 2014.
- Three (3) Divisional General Meetings were held on 15th February, 3rd May, and 3rd December, 2014.



## 5.0 FOOD CHEMISTRY DIVISION

### Introduction

The Food Chemistry Division is primarily obliged to provide support to the commercialization activities of the Institute by offering analytical services to the local food Industry, local and International students, as well as training for students. The Division also conducts applied research into chemical contaminants (mycotoxins and heavy metals) in foods and feeds as well as food flavour analyses. Additionally, the Division offers consultancy services and advice to clients. The Division has two Units, namely the Food Toxicology Unit and the Industrial Services Unit. The Division has two laboratories namely, the mycotoxin laboratory and the general chemistry laboratory.

### Staff Strength and Movements

The Division currently has 13 members of staff consisting of: 4 Research Scientists; 1 Principal Technologist; 1 Senior Technologist; 1 Technologist; 4 Senior Technical Officers and 2 Technical Officers

### Analytical Services

During the year, the Division offered analytical services to several companies, establishments and individuals. A total of 950 samples were received by the Industrial Services Unit for analyses. This number represents a 66.96% increase over the 569 samples received in 2013.

The samples analyzed included Soft drink cola, Soft drink orange, Dried mango, Yam flour, Smoked fish, Tiger nut flour, "This way" chocolate flavoured milk drink, Samolina, Noni juice, Oyster mushroom, maize, Macbells superior brandy, Nkwande Tomato paste, Fyko lemon flavoured drink, Fyko cola flavoured drink, Vegetable cooking oil, Concord Plus iodated salt, Yumvita wheat infant cereal, Natural cocoa powder, Anchovies, Choco Delight chocolate spread, Yanoga yoghurt, Parle milk and milk biscuits, Local Rich weaner, Adam's brandy, Imperial Eagle red wine, Xtra time ginger liquor, grated cocoyam starch, Rush energy drink, Groundnut butter, Palm oil, Crystal pure sugars, Sesame seeds, margarine, condensed milk, Mahoney garlic wine among others.

The hundred and eighty clients included Intertek Ghana Ltd., Ghana Standards Authority, Premium Foods Ltd, Leander Dede Kubie, Cocoa Processing Ltd, Samartex Timber & Plywood Co. Ltd., Equator Foods Ghana Ltd, Cassava G-Market Project, CSIR-FRI & MirI,



New Age Feed, AfricaRice Project, Evergreen Super-market Ltd., Gratitude Project, Ideal Providence Farms, Rice Sector Support Project, Aisha Senya, WAAPP 2 Project, Bomarts Farms Ltd, Promasidor Ghana Ltd, Acquah Isaac, Olam Wheat Mill, Allied Cocoa Products Ltd, Food Research Institute, The Potters Touch Ventures, Lam Agency Ltd., Isaac Vandapuye, Savannah Agric Research Institute, Reindorf Armah Ashitey, AgranaGh. Ltd., HPW Fresh and Dry Ltd, Bobo Foods & Beverages Ltd., Nii Kortey Kortei, Southern Star Bottling Co., TabamEnt., Dry Foods Processing Ltd., Danblo Enterprise, ApueEnt., EvicEnt., Strongmen Ltd., Super Star Food & Pasteries Ltd., King Solomon Natural Health Center, Irani Brothers & Others Ltd., Agricare Ltd., Mapouka Co. Ltd., among others.

Analyses of the 950 samples generated a gross income of one hundred and eighteen thousand, five hundred and twenty five Ghana Cedis, ninety two pesewas (GHC118,525.92) as against a gross income of eighty-one thousand, three hundred and fifty Ghana cedis, forty-six pesewas (GH¢81,350.46) of 2013. This represents an increase of almost 45.7% over the 2013 gross income.

During the year, the Toxicology Unit received a total of 186 samples from 56 clients for aflatoxin and histamine analyses as against 188 samples for the year 2013. This represents a decrease of 1.06% over the previous year.

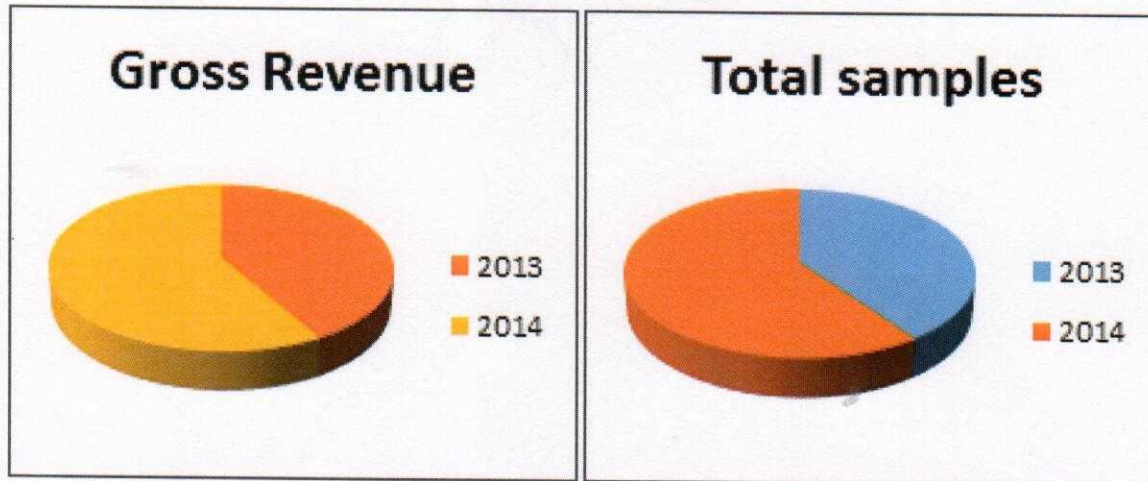
The samples analyzed consisted of peanut and peanut products, maize and maize products, Shea cake, Legume cereal mix, Tom Brown, rice, Neat Yam Fufu, Neat Cocoyam Fufu, Neat Plantain Fufu, Salmon Pillet, White beans, raw cocoa beans, Cassava Flour, Snappy snacks, Soya beans, Agushie powder, Whole agushie, Bambara beans, Yellow maize, Herrings, Groundnut Butter, Corn Flakes, Roasted peanuts, Kokonte Flour, Hausa Koko, Cereal mix, Suya powder, Fish feed, Dried cassava, Shrimp powder, Fish meal, Nkulenu's GaKenkey, and Nkate cake among others.

The clients included: Intertek Ghana Ltd., Ghana Standards Authority, CSIR Food Research Institute, Cassava G-Market Project, Plot Enterprise Ghana Ltd, C & S Foods Ghana Ltd, Neat Foods Company Ltd., Movenpick Ambassador Hotel, Isshad Plus Ent., Melcom Ltd., Premium Foods Ltd., Cynland Enterprise, National Food Buffer Stock Co., Selasie Farms and Groceries, Ghatty Foods, Magida Peregrino Brimah, Africa Global Exports Ltd., Processed Foods and Spices Ltd., Foodtech Ltd., Ghana China Foods, Leehouse and Chemical Ventures, King Peanut, Water Research Institute, #F Ghana Ltd., Nkulenu Industries Ltd., Heritage Fresh Food, Promasidor Ghana Ltd. and Complementary Food project among others.



Total charges for the 186 samples amounted to thirty-one thousand, four hundred and twenty-four Ghana Cedis (GHC31,424) as against twenty-five thousand, one hundred and fifty-seven Ghana Cedis (GH¢25,157). This figure represents an increase of 24.91 % over the 2013 gross income. This significant increase in revenue as compared with the marginal decrease in number of samples was as a result of more express services executed for the period.

The gross total for the two Units of the Chemistry Division was therefore one hundred and forty-nine thousand, nine hundred and forty-nine Ghana cedis, ninety-two pesewas (GH¢149,949.92). This amount represents an increase of GH¢43,442.46 (40.79%) over the gross income of 2013.



**Figure 3:** Graphs of the gross revenue and total samples received; comparisons between 2013 and 2014

**Accreditation of Chemistry Laboratories**

**Internal Audits**

In compliance with the Food Research Institute (FRI) Accreditation Quality Manual, two internal audits were conducted during the year. These audits were carried out on the 12th of March and the 16th of September 2014.

**External Audit (SANAS Audit)**

Due to the on-going renovation works at the Microbiology laboratory, SANAS surveillance audit originally scheduled for February 2014 could not come off. This may be possible towards the end of 2015 after completion of works.



**Proficiency Tests**

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

**Equipment Delivery**

The Food Chemistry Division received four Balances from the Traque project under the Ministry of Trade. The Balances were made up of three Analytical type and one Top loading. All the Balances are currently in use.

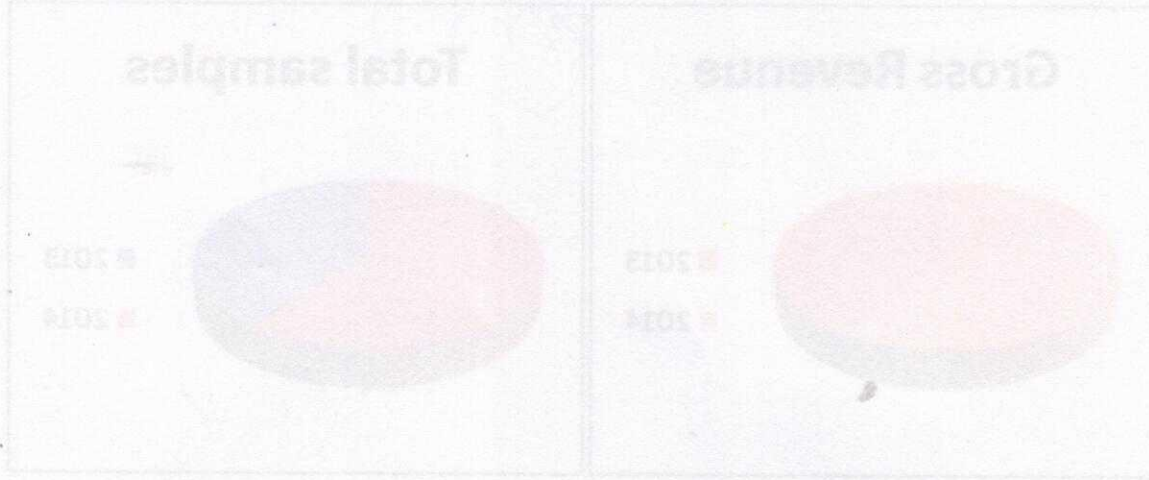


Figure 2: Graphs of the gross revenue and total samples received during the period 2013 and 2014.

Accreditation of Chemistry Laboratories  
 Internal Audit  
 In compliance with the Food Research Institute (FRI) Accreditation Quality Manual, two internal audits were conducted during the year. These audits were carried out on the 15th of March and the 1st of September 2014.  
 External Audit (SANS Audit)  
 Due to the on-going renovation works at the Microbiology laboratory, SANS surveillance audit originally scheduled for February 2014 could not come off. This may be possible towards the end of 2013 after completion of works.



## 6.0 FOOD MICROBIOLOGY DIVISION

### Introduction

The Food Microbiology Division (FMD) has the main task of undertaking research and development activities in food safety and quality assurance for the food industries in Ghana. The division has 18 staff members consisting of 5 senior members, 6 senior staff and 5 junior staff at post with 2 on study leave. There are 2 main Units in the Division, namely 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 and inspects food production premises as well as food products of clients. The methods carried out during analyses include seven accredited methods by South African National Accreditation System (SANAS). The Industrial Services Unit is also involved in training entrepreneurs and students from tertiary institutions such as the Polytechnics and Universities.

The Mushroom Unit (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. The Mushroom Unit also maintains a National Mycelium Bank which contains samples of mushrooms researched into and mushroom species received from different countries. 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.

### Major Activities and Outputs

#### *Activities and output of FMD-ISU*

The main activities carried out were:

- Technical and analytical services to clients as an income generation activity.
- Quality control of analytical methods under the ISO 17025 accreditation system.
- Visit to laboratories of food industries to advice on quality control procedures.
- Advice to clients
- Training of students from tertiary institutions in Ghana.
- Research activities.

The ISU continued with routine technical and analytical services carried out for clients who submitted samples to the laboratory through the CID. A total of 2,311 samples were received for



analyzes. This was double the quantity received in 2013. A monthly distribution of samples received and analyzed in comparison to 2013 is summarized in Table 6.1. Clients that patronized the services of the Unit included Cadbury Ghana Ltd., Pioneer Food Cannery, Cocoa Processing Co. Ltd, Promasidor Ghana Ltd, Olam Ghana, Newrest First Catering, among others.

**Table 13:** Comparison of number of samples and analyses carried out in 2013 and 2014

MONTHS	PERIOD			
	2013	2013	2014	2014
	Number of samples	Number of analyses	Number of samples	Number of analyses
January	144	352	84	341
February	173	345	293	798
March	98	281	211	834
April	187	449	259	685
May	176	392	386	782
June	26	76	184	480
July	0	0	214	603
August	9	31	110	381
September	55	217	107	299
October	131	367	116	322
November	247	669	216	527
December	65	226	131	316
<b>Total</b>	<b>1311</b>	<b>3405</b>	<b>2311</b>	<b>6368</b>

#### Laboratory quality management system: ISO 17025 Accreditation

The quality of analytical services carried out for clients was assured by maintenance of the ISO 17025 for which the Food Microbiology Division has accreditation for 7 analytical methods namely:



- Aerobic microorganisms (NMKL 86: 2013)
- Enumeration of yeasts and moulds (ISO 21527-1: 2008)
- Detection of coliform bacteria (NMKL 44: 2004)
- *Escherichia coli* (NMKL 125: 2005)
- Detection of *Salmonella* (NMKL 71:1999)
- Enumeration of *Staphylococcus aureus*(NMKL 66: 2009)
- Enterobacteriaceae determination (NMKL 144: 2005)

### Proficiency testing

Repeatability and Reproducibility tests were carried out for the accredited test methods. Personnel of the Unit participated in 9 external Proficiency Testing Schemes provided by FAPAS, UK on 5 matrixes and performed satisfactory. The tests were *Escherichia coli* and *Enterobacteriaceae* in Milk and the sum of yeasts and moulds in flour, *Salmonella* in cocoa powder etc.

Two internal audits of the quality system were carried out on the 14th March and 25th September. Also two Management Review Meetings were held on 9th May and 10th November.

### b) Activities and Output of Mushroom Unit

- Production of compost bags and spawn and occasional sale of spawn as an income generation activity
- Consultancy services to clients
- Training of students from tertiary institutions and training workshops organized by CSIR-FRI
- Research projects

The number of spawn and compost bags produced and sold monthly in 2013 and 2014 to mushroom growers are as shown in table 14. In both compost bags and spawn, there were increases of 12% and 40% respectively.



**Table 14:** Production of compost bags and spawns in 2013 and 2014

Months	Period			
	2013		2014	
	Compost bags	Spawns	Compost bags	Spawns
Jan	985	1797	1442	1040
Feb	836	1153	1148	832
Mar	1579	61	1313	339
Apr	966	1189	1286	864
May	1114	572	1375	590
Jun	880	610	737	1383
Jul	886	393	1308	1296
Aug	1233	0	1239	1233
Sep	1106	0	1261	0
Nov	1080	545	914	0
Dec	984	0	1452	950
<b>Total</b>	<b>12804</b>	<b>7040</b>	<b>14419</b>	<b>9887</b>

### Trainings

Two mushroom training programmes were held in the course of the year. The first training was carried out from 27th-30th May, 2014 which attracted 12 participants and the second from 27th-31st October, 2014 which also attracted 17 participants. A total amount of GH¢10,940 was realized. Third year students of the Department of Food Science, KNUST undertook internship programme in the Division from 4th-11th Feb. 2014.

### Research projects

Two donor funded projects are currently on-going in the Division. These are:

- Development of edible and medicinal mushrooms as functional foods in Ghana  
*Estimated duration:* August, 2013-March, 2016  
*Sponsors:* Partnerships for Enhanced Engagement in Research (PEER) USAID
- Characterization, conservation and Domestication of Indigenous Edible and Medicinal Mushrooms on Agricultural Residues (CDEMM)  
*Estimated duration:* Two years (Nov, 2012-Nov, 2014)  
*Sponsors:* Africa-Brazil Agricultural Innovation Marketplace (Mktplace)



## Student projects

- Varietal characterization of two rice species on the biological efficiency and nutrient content of two strains of oyster mushrooms (PhD)
- Utilization of radiations to sterilize compost bags and preserve mushrooms (*Pleurotus ostreatus*) cultivated on sawdust (PhD)
- Production, packaging and preservation of Wagashie - a local cheese (Mphil)
- Development of starter culture for Fura fermentation and preservation of Fura by Gamma radiation (MPhil).



## 7.0 FOOD NUTRITION AND SOCIO ECONOMICS DIVISION

### Introduction

The Food Nutrition and Socio-economics Division (FNSD) has two sections, Nutrition and Socio-economics sections. The mandate of FNSD is 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 Food Research Institute. Key activities carried out during the period under review included Recipe Formulation, Sensory Evaluation and Analysis, Surveys and Nutrient analysis. Research Scientists and Technical Staff in FNSD also collaborated with other Divisions on key projects. Major activities include training on improved technologies and utilisation of cassava, yam, sweet potatoes, millet, sorghum and rice, under WAAPP2A. Other activities were proposal writing, technical reports and publications, as well as presentations at conferences.

### Major Activities

- Collaboration with the mushrooms unit of the Food Microbiology Division on Development of mushroom incorporated food products under USAID-PEER Science project.
- Formulation of snacks with different varieties of sweet potatoes under WAAPP2A.
- A pictorial manual was developed for training of street vendors under the Street foods component of WAAPP2A.
- In-house consumer acceptability tests were carried on different formulations of composite bakery products involving yam, sweet potatoes, cocoyam, rice, millet and sorghum (WAAPP2A).

### Other Activities

- Carried out in-house acceptability tests on hybrid rice varieties for Wienco Ghana.
- Worked with a small scale industry on the production of coated peanuts.
- Assisted graduate students undertaking project works in the Division.
- Conducted organoleptic evaluation of two hybrid rice varieties against two local varieties.
- Organoleptic test on five millet varieties were also conducted.
- In-house acceptability test on fortified rice and rice porridge was carried out.



### Commercialization Activities

Commercialization activities in FNSD involved sale of Research By-products, training of clients and consumer acceptability studies. During the period under review, income was generated from the following activities:

**Table 15:** Description of Income Generation Activities

Item	Quantity	Amount (GH¢)
Cerealmix	466kg	2,048 (profit)
Consumer acceptability	3	387.00
<b>TOTAL</b>		<b>2,435.00</b>

### Student Internship

- Third year students of the Department of Food Science and Technology, KNUST were attached to the Division for three (3) days. They were lectured on the concepts underlying product development and sensory evaluation. They were taken through hands-on practicals in the preparation of composite maize, soybean and peanut meal, “cerealmix” and “dzowe”.
- Students from the Department of Allied Health, University of Ghana were attached to the Division for three (3) days. They were lectured on the concepts underlying product development and sensory evaluation.



## 8.0 PROGRAMMES AND PROJECTS

### Root and Tuber Products Programme

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

**Start date:** March, 2014

**Estimated duration:** 3 years

**Sponsors:** CORAF/WECARD

**Budget:** \$1,400,000.00

**Location:** Nigeria, Ghana, Benin, Sierra-Leone

**Principal investigator:** Dr. Frederick Teye

**Participating scientists:** Dr. Nanam Tay Dziedzoave, Ms. Helene Ama Annan, Mr. Benjamin Addi-Okae, Mr. Christian Amegah

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

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

**Methodology:** Scoping Studies, dissemination of brochures on constraints to drying, Sensitization Workshop, Flash Dryer, Pilot Scale Testing, Capacity Building and National Drying Policy Improvement

#### Activity/progress made since previous report

1. Conducted scoping studies and gathered baseline data on existing drying systems capacity training gaps and needs.
2. Supervised research students on value chain analysis and product quality using installed drying facility.
3. Brochures were developed on constraints of drying systems and profitable investment.
4. Questionnaires were designed for baseline data collection.
5. Conducted recruitment and training of national enumerators.
6. Field data collection was carried out.



## 2. Cassava: Adding Value For Africa (c:ava li) Project-Ghana

**Start date:** January, 2014

**Estimated duration:** 5 years

**Sponsors:** Bill and Melinda Gates Foundation

**Budget:** USD 504,967.00

**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.

**Methodology:** Through training workshops with the use of posters, brochures, Farmer Base Organization (FBO) participation, processing technology transfer.

### Activity/progress made since previous report

1. A Project Launch and business meeting were held in Nigeria.
2. Investment visit was made to Pokuase (CSIR Food research processing plant) by a team of prospective investors to get first-hand information on cassava processing.
3. Follow up on funding agencies was embarked on, to ascertain the state of the project's SME's applications. Export Development and Agricultural Investment fund (EDIAF), skills development fund of COTVET (SDF), and out-grower value chain fund (OVCF).
4. GPS tracking of all farmer groups, farmer processors and processors.
5. Business plans were developed for five (5) potential investors to facilitate the process of securing loans from funding agencies.
6. Feasibility studies was carried out for a prospective investor. A report was presented to this effect.
7. Monitoring visits were made to project partners in the Volta, Ashanti and Brong Ahafo regions during the period under review.



8. Market linkages were established between CAVA and SMEs. An example was the linkage for regular supply of Dried Cassava Chips in the Ashanti Region.
9. Collaborative survey was conducted with Africa Centre for Economic Transformation (ACET) in Ashanti Region on transforming cassava value chain.
10. In country project meeting was held to decide on method of incorporating technology in data collection.

### **3. West Africa Agricultural Productivity Programme (WAAPP2A)**

**Start Date:** 20th January, 2013

**Estimated duration:** 5 years

**Sponsors:** World Bank

**Budget:** US\$500,000.00

**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, Mr. Paa Toah Akonor, Mr. Jonathan Ampah, Mrs. Lynda Hagan, Mrs. Evelyn Buckman

**Collaborating institutions:** Women in Agriculture Development (WIAD), MoFA.

#### **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.
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.

#### **Methodology**

Composition and formulation of three composite flours from cocoyam, yam and sweet potato will be investigated to arrive at the appropriate ratios for recipes. Several compositions and formulations on the composite flour will be tested on recipes. The most appropriate composition and formulations and recipes will then be chosen for the project. Proximate



parameters of formulated flours AOAC (2000) will be determined. The shelf-life characteristics of the developed products of bread, biscuits, cakes and doughnuts would be established. Appropriate packaging material as well as packaging systems would be established. Up-scaling of bakery products using the developed composite flour by selected bakery enterprises is an excellent approach to commercialization.

#### **Activity/progress made since previous report**

1. Dough Kneading Machine was refurbished and installed at the PSPU.
2. The tunnel oven used for bakery products was rehabilitated and tested.
3. The project is constructing an Agribusiness Center at RTPDU, Pokuase, with the assistance of the Engineering Unit of FRI.
4. Processing equipment were distributed to all trained cassava processors. Test running of these equipment was conducted.
5. Technology transfer: Composite flour technology and bakery product processing using the composite flours were transferred to flour end-users in the Eastern and Volta regions.
6. The project organized an Investor's forum in Ho, Volta region.

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

**Start date:** January, 2012

**Estimated duration:** 2 years, 8 months

**Sponsors:** European Union

**Budget:** € 350,850.00

**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)

**Objective(s):** 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.



**Methodology:** Laboratory Research, Field trials, Industrial trials

**Activity/progress made since previous report**

1. Identification and definition of post-harvest characteristics of key yam species/varieties.
2. Research was conducted on levels of losses on farms within target regions.
3. The project identified optimal curing strategies for tuber crops.
4. Identification of appropriate storage structures was also carried out.
5. There were the development of methods for growing mushrooms from the waste of cassava peels.
6. Identification of appropriate sprout control strategies
7. Dissemination of best strategies of post-harvest handling of yam tubers to reduce losses.
8. Reports were written on the:
  - a. development of methods for scaling up mushroom production as commercial enterprises.
  - b. food safety baseline assessment
  - c. identification of Critical Control Points in HACCP systems
9. Methodologies were established to monitor safety and quality attributes of the products at Critical Control Points
10. Information dissemination and distribution of 2,000 GRATITUDE newsletters to stakeholders and target groups like MoFA, Crop Research, NRI UK, Department of Agriculture of the 3 major universities.

**5. Improving Livelihood Of Small Holder Cassava Farmers Through Better Access To Growth Markets (CASSAVAG-MARKETS)**

**Start date:** June, 2012

**Estimated duration:** 4year, 6months

**Sponsors:** European Commission (EC)

**Budget:** EC= £287,883.00; FRI= £31,987.00. Total= £319,870.00

**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.

**Methodology:** Transfer of composite flour baking technology through training workshops with the use of posters, brochures; Bank facility facilitation and search for new markets.

#### **Activity/progress made since previous report**

1. Project review meeting was held.
2. Field survey and data collection were undertaken in the Volta and Brong Ahafo Regions.
3. Functional properties of HQCF were established.
4. Examination of New uses of HQCF in Ghana. Specific innovations and knowledge from associates in India were evaluated, specifically the potential of using HQCF to make bioplastics, snacks and composite foods.
5. Production processes of HQCF has been standardized as follows: sorting, peeling, washing, grating, pressing, sifting, chipping and drying.
6. Evaluation of the market potential for innovations was been carried out.
7. Testing of innovative new products with end use industry partners.
8. Acceptability and end use of products was tested.



## CEREAL GRAIN AND LEGUME PRODUCTS PROGRAMME

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

**Start date:** August, 2011

**Estimated duration:** 5 years

**Sponsors:** Canadian International Development Agency (CIDA)

**Budget:** CAD \$ 423,026

**Location:** Afife, Atebubu, Navorongo

**Principal investigator:** Elvis Baidoo,

**Participating scientists:** Mrs. Ruth Pobee, Ms. Hannah Oduro

**Participating technologist(s):** Mr. Ali Sampare, Mr. Apollonius Isaac Nyarko, Mr. Frank 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.

**Objective(s):** 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.

**Methodology:** By use of questionnaire surveys, and participatory rapid appraisal tools and by conducting product development and sensory evaluation.

#### Activity/progress made since previous report

1. Policy task Force under the baseline surveys embarked on data collection. These included Post-harvest data collection and data on producers.
2. Improved harvest and post-harvest rice processing practices and technologies were introduced.
3. Data collected by the Policy Task Force was analyzed by a student from the Agricultural Economics Department of the University of Ghana as part of her research work.



4. New protein and mineral fortified recipes and products from low grade broken rice fractions have been developed.
5. The technology of production of mushrooms from rice by-products was tested and disseminated.
6. Ex-ante and ex-post impact analysis of the adoption of improved practices and technologies were carried out.
7. Maps of consumer preferences, harvest and post-harvest processing practices were documented.
8. Under Post- harvest activities, data collection for actual loss assessment has been completed in the Volta hub. That of the northern hub had begun.
9. On the introduction of improved technology, fabrication works on a mini combine harvester was completed.
10. Under product Development, Rice-mango weaner has been developed and the development of rice biscuits was initiated.
11. Sensory evaluation and consumer acceptability tests on noodles were conducted in Accra and Kumasi.
12. Edible mushrooms (*Pleurotus ostreatus* and *P. eous* strains) were cultivated using rice by-products under a PhD work embarked on by Mr. Michael Wiafe-Kwagyan, Botany Department of the University of Ghana.
13. The physical and molecular properties of starches were isolated from seven *Oryza glaberrima* accessions (OGAs) under the broader topic 'The effects of starch properties on functional uses of indigenous and improved varieties of rice (*Oryza glaberrima*)' by Mr. Joseph Gayin, PhD student at the Dept. of Food Science, University of Guelph, Canada.
14. An ex-post impact analysis of the adoption of improved parboiling vessels was carried out by Mr. Godfred Antwi (MPhil) of the Agricultural Economics Department of the University of Ghana, under the research entitled "Impact of Improved Rice Parboiling Technology Adoption on Income and Local Rice Quality of Households in Northern Region of Ghana".



## 7. Rice Sector Support Project (RSSP)

**Start date:** August, 2011

**Estimated duration:** 2 years

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

**Budget:** € 120,000.00

**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.

**Methodology:** Materials used include parboilers and rice. Methods used are survey, demonstrations and training sessions.

### Activity/progress made since previous report

1. Survey on impact assessment of parboiling technology was conducted in the Northern region.
2. There was collaboration with GRIB on packaging of improved rice.
3. Appropriate packaging and labelling of rice was introduced to processors.
4. Socio-economic evaluation & impact assessment of the use of parboiling technology was conducted.

## 8. African Food Tradition Revisited By Research (after) Project

**Start date:** June, 2010

**Estimated duration:** 4 years

**Sponsors:** European Union- Seventh Framework Theme

**Budget:** Total=€ 132,800; EU contribution: € 98,000; CSIR-FRI contribution €34,800 (in assets and personnel)

**Location:** Greater Accra, Central and Eastern Regions

**Principal investigator:** Dr. Wisdom Kofi Amoa-Awua

**Participating scientists:** Dr. Mary Obodai, Mrs. Charlotte Oduro-Yeboah, Mr. George Anyebuno, Mr. Charles Diako, Mr. Hayford Ofori



**Participating technologist(s):** Mr. Theophilus Annan

**Collaborating institutions:** Ministry of Food and Agriculture- Women in Agricultural Development, University of Ghana, Legon

**Objective(s)**

- To reach comprehensive scientific knowledge of the existing know-how on technologies, processes and products.
- To propose improved traditional processes by reengineering of the unit operations with the aim of improving the safety and nutritional quality while keeping or improving the organoleptic characteristics of traditional products.
- To reach objective criteria of acceptability of the traditional products by the consumers and to ensure that the products can effectively access the EU markets in view of regulatory and ethical issues while protecting the intellectual rights of the people in Africa.
- To present the results into ready-to-use information for food companies including SMEs via guidelines on quality management, food law and regulation and consumer protection and to transfer the results to the stakeholders from Africa and from the EU.

**Methodology**

Traditional Anum and Atimpoku white kenkey were purchased from hawkers in the Eastern region of Ghana. Three samples of white kenkey were produced using the dehulled maize dough which has been processed using the following processing procedures: 30h steeping time, 25°C temperature and 12h fermentation time, 30h steeping time, 25°C temperature and 0h fermentation time and 45h steeping time, 35°C temperature and 12h fermentation time.

**Consumer acceptance**

Consumer acceptance test was carried out using (n=65) panelist recruited from CSIR-Food Research Institute and students from Kwame Nkrumah University of Science and Technology. The criterion for selection was people who consume kenkey at least twice a week. Each participant evaluated all 4inch slices samples in a randomized order under white light. The samples were coded with 3-digit random numbers. A glass of water and cream crackers (Super cream cracker, Munchee, Sri Lanka) were provided to cleanse the palate between samples. Panelists were asked to provide their liking responses on a 9-point hedonic scale (1 = dislike extremely and 9 = like extremely) for taste, texture, odour and overall acceptability (Meilgaard et al., 2006). Demographic questions including age and gender was included in the questionnaire.



### Statistical analysis

The data were analyzed using Mintab Release 14 statistical software (1972-2004, Mintab Inc.). Analysis of variance (ANOVA,  $\alpha=0.05$ ) and Duncan Multiple range test were performed to determine significant differences between means. Associations between different treatments and the sensory attributes of white kenkey were explored by PCA. Friedman's test was determined using Minitab software.

### Activity/progress made since previous report

1. The following research works was conducted by a PhD student working on the reengineering of dehulled kenkey under the project:
  - Physicochemical (moisture, pH, titratable acidity, particle size, pasting properties and colour) properties of laboratory and traditional white kenkey (nsiho) and its intermediates.
  - Scanning Electron Micrograph (SEM) on maize grain samples and dehulled samples among others.
  - Textural measurement of laboratory white kenkey and traditional white kenkey types.
  - Differential Scanning Calorimetry (DSC) carried out on fermented dehulled dough (12 hours), precooked dough(aflata), white kenkey types- Anum Kenkey, Atimpoku Kenkey and sweet Kenkey), Ga and Fanti kenkey.
  - High Performance Liquid Chromatography (HPLC) determinations for sugar and organic acids.
  
2. Publications submitted to European Commission
  - Laurent Adinsi, Noel Akissoe, Wisdom Amoa-Awua, Sameh Awad, Generose Dalode, Habiba Hassan Wassef, Djidjoho Joseph Hounhouigan, Christian Mestres, Charlotte Oduro-Yeboah, Carole Sacca, Zahra Saleh Ahmed. April (2013). Results of sampling and determination of biochemical and nutritional quality for Group 1: Deliverable number: D1.2.7.1. African Food Tradition revisited by Research FP7 n°245025.
  - Laurent Adinsi, Noel Akissoe, Wisdom Amoa-Awua, Victor Anihouvi, Theophilus Annan, Sameh Awad, Generose Dalode, Djidjoho Joseph Hounhouigan, Christian Mestres, Carole Sacca. April (2013). Improvement of indigenous starter cultures. Deliverable number: D 2.1.1 African Food Tradition revisited by Research FP7 n°245025
  - Laurent Adinsi, Noel Akissoe, Wisdom Amoa-Awua, Sameh Awad, Generose Dalode, Habiba Hassan Wassef, Djidjoho Joseph Hounhouigan, Christian Mestres, Charlotte



Oduro-Yeboah, Carole Sacca, Zahra Saleh Ahmed. April (2013). Results of physical, chemical and textural analysis for Group 1: Deliverable number: D1.2.7.1. African Food Tradition rEvisited by Research FP7 n°245025.

- Manuscript submitted for publication
- Kenkey production, vending and consumption practices in Ghana have been submitted for publication to the Food Chain Journal.

## 9. Preserving Africa Food Microorganism For Green Growth (Greengrowth)

**Start date:** May, 2014

**Estimated duration:** 4 years

**Sponsors:** DANIDA

**Budget:** 1,212,310 DKK

**Location:** Greater Accra and Northern Regions

**Principal investigator:** Dr. Wisdom Kofi Amoa-Awua

**Participating scientists:** Dr. Magaret Owusu, Obodai, 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).

### **Methodology**

- WP1 Value chain analyses and contextual framing.
- WP2 Establishment of bio-banks and methodologies for preservation of microbiological cultures.
- WP3 Optimization of microbial cultures, fermentations and processing parameters.
- WP4 Implementation of starter cultures at SMEs.
- WP5 New business opportunities for production and commercialization of fermented food.

### **Activity/progress made since previous report**

1. Two open ended questionnaires were developed for the SMEs, and consumers to assess the preferences of each stakeholder in value chain analysis and to help develop the business models.
2. The questionnaires have partly been administered at Ashiaman, Nima, Madina Socura and Hachoe in the Greater Accra Region.



## MEAT, DAIRY AND FISH PRODUCTS PROGRAMME

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

**Start date:** January, 2012

**Estimated duration:** 3 years

**Sponsors:** European Commission

**Budget:** € 227,800.00

**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.

**Methodology:** Training of fishermen/women, processors and consumers; with the use of flyers and posters.

#### Activity/progress made since previous report:

1. Solar tunnel drying of anchovies: experimental samples were successfully dried using the solar tunnel dryer.
2. Physico-Chemical analysis was conducted on traditional open sun and solar tunnel dried anchovies;
  - Proximate analysis; moisture, fat, crude protein
  - Toxicological analysis; histamine value
  - Trials on best method for instrumental texture analysis
3. Sensory evaluation analysis: acceptability test was carried out on samples.
4. Data logger and overhead water tank for heating were installed.
5. Statistical analysis of data from sensory evaluation test were carried out.
6. Instrumental texture analysis was conducted and analyzed statistically.



## FRUIT, VEGETABLES AND SPICES PRODUCTS PROGRAMME

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### 11. Development Of Edible And Medicinal Mushrooms As Functional Foods In Ghana (PEER)

**Start Date:** August, 2013

**Estimated duration:** 2years, 7months

**Sponsors:** Partnerships for enhanced engagement in research (PEER) USAID

**Budget:** \$151,394.00

**Location:** CSIR-Food Research Institute

**Principal investigator:** Dr. (Mrs) Mary Obodai

**Participating scientists:** Dr. Steven Schwartz, Dr. Robin Raltson, Ms. Matilda Dzomeku, Mrs Deborah Narh Mensah, Mrs. Linda Hagan

**Collaborating institutions:** The Ohio State University-USA

#### Objective(s)

1. To cultivate four different species of edible mushrooms, *Pleurotusostreatus*, *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.

#### Methodology

**Objective 1:** To cultivate four different species of edible mushrooms, *P. ostreatus*, *P. tuber-regium*, *Ganoderma* sp. and *Termitomyces* sp.

**Objective 1A:** To expand the cultivation of three different species of edible mushrooms, *P. ostreatus*, *P. tuber-regium* and *Ganoderma* sp.

**Objective 1B:** To cultivate *Termitomyces* sp. in vitro using tissue culture methods.

**Objective 1C:** Mushroom analysis will include color, texture, and select nutrient analyses (e.g. vitamin C, vitamin D, B vitamins and amino acid profile).

**Objective 1D:** Extracts of each mushroom will be screened for anti-inflammatory activity at Ohio State University if supplemental funds are received.

**Objective 2:** To develop a new mushroom-based food.



**Objective 2A:** To formulate and develop prototypes of a new mushroom-based infant food.

**Objective 2B:** Samples of the mushroom-based infant food will be analyzed immediately after processing and again after 3, 6 and 12 months at 30°C storage.

**Objective 2C:** The shelf-life of the new food will be assessed by storing samples at three different temperatures (room (30±2°C), reduced (4°C) and elevated temperatures (37±2°C)).

**Objective 3:** To assess consumer acceptability of the new mushroom-based products.

Sensory attributes for assessment will include:

- Physical appearance
- Smell or aroma
- Texture and smoothness
- Taste and feeling on the tongue and
- Overall liking.

#### **Activity/progress made since previous report**

1. Collection of mushroom germplasm from Atiwa forest. Samples collected included the wood ear mushrooms (*Auricularia species*), oyster mushrooms (*Pleurotus species*), *Falvolus brasiliensis*, Oil palm mushroom (*Volvariella volvacea*), Termite mushroom (*Termitomyces species*) and *Pycnosporus sanguinesis* among several polypores. Several of these samples were air dried and proximate, nutrient, and phytochemical analysis were conducted.
2. Four varieties of mushrooms (*Pleurotus ostreatus* strain EM-1, *P. sajor-caju* strain PSCW, *Auricularia auricula* strain AU and *Ganoderma lucidum* strain GLA) have been grown on a mixture of composted sawdust of *Triplochiton scleroxylon* and *Chlorophora excelsa*. Fruit bodies of these mushrooms were harvested and dried for product development studies in Ohio State University, USA.



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

**Start date:** January, 2013

**Estimated duration:** Two (2) years

**Sponsors:** Africa-Brazil Agricultural Innovation Marketplace

**Budget:** \$79,240.00

**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)

**Participating technologist(s):** Mr. Richard Takli

**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  $\beta$ -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.

### Methodology

1. Activity 1: Indigenous knowledge of edible and medicinal mushrooms in four regions documented.
2. Activity 2: Phenotypic characterization of edible and medicinal mushrooms.
3. Activity 3: Biochemical characterization
4. Activity 4: Travelling of staff.
5. Activity 5: Edible and medicinal mushrooms domesticated.



- 6. Activity 6: Technology transfer
- 7. Activity 7: Data analysis and publications

**Activity/progress made since previous report**

1. Nutritional and Antioxidant Activities of Mushrooms. Five cultivated mushrooms (Pleurotus ostreatus strain EM1, P. sajor-caju strain PscW, Lentinus squarrosullus strain LsF, Lentinus squarrosullus strain SqW, Auricularia auricula strain ApA) and two wild mushrooms (Termitomyces robustus strain TrA and Pleurotustuber-regium strain PtA) were sent to Mountain Research Centre (CIMO), ESA, Polytechnic Institute of Bragança, Campus de Santa Apolónia, apartado, Portugal for analysis on their nutritional and antioxidant activities.
2. Data Analysis and Publication of findings. A manuscript titled 'Morphological Characteristics of Mycelia Growth of Two Strains of the Indigenous Medicinal Mushroom, Lentinus squarrosulus Mont. (Singer), on Solid Media' was prepared and sent to African Journal of Agricultural Research.



## APPENDIX I

### Senior Members and Senior Staff List

#### Directorate

1. Dr. Nanam Tay Dzedzoave - Prin. Res. Scientist/Director
2. Dr. Lawrence Abbey - Senior Research Scientist/Quality Manager
4. Mr. Benjamin Addi-Okae - Scientific Secretary (M&E)
5. Ms. Faustina Somuah - Chief Admin. Assistant
6. Ms. Mariam Yakubu - Technologist

#### Administration Division

1. Ms. Janet Aggrey-Yawson - Admin. Officer/Ag. Head Admin.
2. Mr. Eric K. Ofori - Chief Admin. Asst.
3. Mr. Patrick Ofofu 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. Coffie Tutu Aikins - Accountant/Head of Accounts Division
2. Mr. John M. 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 - Snr. Stores Supt.
7. Ms. Mabel Aryee - 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. Dzikunu       | - | Snr. 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.  | Dr. Lawrence D. Abbey       | - | Snr. Research Scientist         |
| 3.  | Dr. Frederick WayoTeye      | - | Snr. Research Scientist         |
| 4.  | Mrs. C. Oduro-Yeboah        | - | Snr. Research Scientist         |
| 5.  | Mr. Joseph Gayin            | - | Snr. Research Scientist         |
| 6.  | Mr. Ebenezer C. Tettey      | - | Research Scientist              |
| 7.  | Mr. Gregory A. Komlaga      | - | Research Scientist              |
| 8.  | Mr. Peter AdoquayeAddo      | - | Research Scientist              |
| 9.  | Mr. Elvis A. Baidoo         | - | Research Scientist              |
| 10. | Mr. Paa Toah Akonor         | - | Research Scientist              |
| 11. | Mr. Jonathan Ampah          | - | Research Scientist              |
| 12. | Mr. Seidu A. Sampare        | - | Chief Tech. Officer             |
| 13. | Mr. Rhodes Y. Anthonio      | - | Chief Tech. Officer             |
| 14. | Mr. Apollonius Isaac Nyarko | - | Senior Technologist             |
| 15. | Mr. Emmanuel A. Saka        | - | Technologist                    |
| 16. | Ms. Edna Mireku             | - | Technologist                    |
| 17. | Mr. Solomon Dowuona         | - | Technologist                    |
| 18. | Mrs. Helene A. Annan        | - | Technologist                    |
| 19. | Mr. Peter Dalabor           | - | Prin. Works Supt.               |
| 20. | Mr. Joseph Akoto            | - | Prin. Works Supt.               |
| 21. | Mr. Desmond Mensah          | - | Prin. Tech. Officer             |
| 22. | Mr. Thomas Najah            | - | Prin. Tech. Officer             |
| 23. | Mrs. Agartha Amuzu          | - | Prin. Tech. Officer             |
| 24. | Mr. Godwin Armah            | - | Snr. Tech. Officer              |
| 25. | Ms. Makafui Torgbui         | - | Technical Officer               |



26. Ms. Jemima Ofori - Senior Technical Officer
27. Mr. Ofori Brempong - Senior Technical Officer
28. Mr. Emmanuel Tettey Agbloo - Works Supt.

#### Food Microbiology Division

1. Dr. (Mrs.) Mary Obodai - Prin. Res. Scientist/Head. FMD
2. Mrs. Bernice D. Kalton-Senaye - Research Scientist
3. Ms. Matilda Dzomeku - Research Scientist
4. Mrs. Anthonia Andoh - Research Scientist/Asst. Quality Manager
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
3. Dr. Margaret Owusu - 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
10. Mr. Derrick Ashley - 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







## APPENDIX II

**Table 1.1: CSIR-FRI Staff Promotions 2014**

<b>Name</b>	<b>Designation</b>	<b>Promoted To</b>
Mr. Eric Ofori	Principal Admin. Assistant	Chief Admin. Assistant
Ms. Faustina Somuah	Principal Admin. Assistant	Chief Admin. Assistant
Mrs. Victoria 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. Jemima Ofori	Technical Officer	Senior Technical Officer
Mr. Ebenezer Tawiah	Technical Officer	Senior Technical Officer
Mr. Ofori Brempong	Technical Officer	Senior Technical Officer
Ms. Gloria Ghansah	Clerk Gd. 1	Senior Clerk
Garriba Alimiyao	Traffic Supervisor	Assistant Transport Officer
Mr. Daniel Nuertey	Driver Inspector	Traffic Supervisor
Mr. Samuel Quaye	Senior Security Assistant	Security Officer
Philip Agyaye	Senior Security Assistant	Security Officer
Foster Bosompem	Security Assistant Gd 1	Senior Security Assistant
Mr. Abel Sogbe	Technical Assistant Gd.1	Junior Foreman
Mr. Godson Agbeley	Technical Assistant Gd. 1	Senior Technical Assistant
Paul Boadi	Technical Assistant Gd. 1	Senior Technical Assistant



## APPENDIX III

## Staff Movement

Table 1.2: CSIR-FRI Staff under Training

NAME	PROGRAMME OF STUDY	INSTITUTION
Mrs. Bernice Karlton - Senaye	PhD, Energy & Environmental 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
Ms. Janet Aggrey-Yawson	MBA Human Resource Management	Kwame Nkrumah University of Science & Technology (KNUST)
Mr. Evans Agbemefle	MSc. Food Science & Tech.	Chonbok National University, South Korea
Mr. Emmanuel A. Saka	MPhil, Food Science	University of Ghana
Ms. Mariam Yakubu	MSc. Sustainable Food Manufacturing Management	ISA- Catholic University 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	PROGRAM OF STUDY	INSTITUTION
Mr. Isaac Apollonius Nyarko	MPhil Food Science	University of Ghana



**Table 1.4:** Retirement 2014

No.	NAME	DESIGNATION	TYPE OF RETIREMENT	YEARS OF SERVICE
1.	Dr. Ebenezer C.T Tettey	Research Scientist	Compulsory	33 years
2.	Mr. Derrick Ashley	Principal Technical Officer	Compulsory	26 years
3.	Mr. Joseph K. Larbi	Senior Accounting Assistant	Compulsory	36 years
4.	Mr. Sampson Tawiah	Works Superintendent	Compulsory	27 years
5.	Mr. Francis Yin	Senior Security Assistant	Compulsory	17 years
6.	Mr. Richard Twum Baah	Senior Security Assistant	Compulsory	22 years
7.	Mr. Adamu Kumblim	Senior Security Assistant	Compulsory	15 years

**Table 1.5:** Resignations 2014

S/N	NAME	DESIGNATION
1	Mrs. Ruth Adisatu Pobee	Research Scientist



## Appendix IV

Conferences, Courses, Workshops and Seminars attended by staff

Date of the Conference/Seminar	Type of Conference/Seminar	Organizers	Venue	Participants
February, 2014.	Workshop on data collection and analysis for developing rice consumer preference maps	Africa Rice Center	Benin, Cotonou	Elvis Baidoo
29 <sup>th</sup> – 30 <sup>th</sup> March, 2014	Workshop on barriers hindering the development and implementation of verification programs at some selected pineapple juice processing companies in Ghana	APCBEEES	Golden River View Hotel, Shanghai, china	Mrs. Nina Bernice Ackah
3 <sup>rd</sup> April & 15 <sup>th</sup> July, 2014	Investors Forum & Exhibition of WAAPP2A Products	CSIR-FRI	Ho and Koforidua	Dr. Charles Tortoe Mr. Gregory Komlaga Mr. Jonathan Ampah
6 <sup>th</sup> - 12 <sup>th</sup> April, 2014	African Women in Agricultural Research and Development (AWARD) Women's Leadership and Management Course (Certificate)	AWARD	Safari Park Hotel, Nairobi, Kenya	Dr. Margaret Owusu
15 <sup>th</sup> - 16 <sup>th</sup> April, 2014	Training Workshop on Application of Multi-Media Environmental Fate Models in Risk Assessment	Environmental Protection Agency Ghana	EPA Training School, Amasaman, Accra	Mr. Hayford Ofori
2 <sup>nd</sup> - 3 <sup>rd</sup> June, 2014	Training Workshop on Technology Transfer for Research Scientists,	CSIR-Technology Development and Transfer Centre	CSIR-Head Office Conference Room, Accra	Mr. Hayford Ofori
2 <sup>nd</sup> – 6 <sup>th</sup> June, 2014	Executive meeting of the EU funded SECUREFISH Project	SECUREFISH project	University of Namibia	Dr. Lawrence Abbey Mr. Apollonius Nyarko
11 <sup>th</sup> June, 2014	Workshop on Business Environment for domestic and Agro -Industrial waste reuse enterprises in Ghana	IWMI	M Plaza Hotel, Accra	Dr. Margaret Owusu
14 <sup>th</sup> - 19 <sup>th</sup> June, 2014	Entrepreneurship Workshop for Scientists and Engineers in West Africa.	African Institute for Mathematical Sciences	AIMS Campus Biriwa, Cape Coast	Mr. Hayford Ofori Mrs. Evelyn Buckman
23 <sup>rd</sup> – 27 <sup>th</sup> June, 2014	Introduction to SPSS Statistical Package, 2014 Winter School.	African Doctoral Academy,	Stellenbosch, South Africa	Dr. Margaret Owusu



30 <sup>th</sup> June – 4 <sup>th</sup> July 2014	Certificate Course in Doctoral Supervision, 2014 Winter School, (Certificate)	African Doctoral Academy,	Stellenbosch University, Stellenbosch, South Africa	Dr. Margaret Owusu
7 <sup>th</sup> July, 2014	Workshop on mobilizing science for sustainable development in readiness for the post-2015 development agenda	MESTI/UNESCO	La Palm Royal Beach Hotel	Dr. Mrs. Mary Obodai
8 <sup>th</sup> July – 7 <sup>th</sup> Oct, 2014	Project Implementation Activities	USAID-PEER	The Ohio State University	Ms. Matilda Dzomeku Mrs. Lynda Hagan Mr. Hayford Ofori
21 <sup>st</sup> - 25 <sup>th</sup> July 2014	6 <sup>th</sup> Africa Nutrition Epidemiology conference, Food and Nutrition Security In Africa: New Challenges and Opportunity for Sustainability	African Nutrition Society	GIMPA	
4 <sup>th</sup> – 7 <sup>th</sup> August, 2014	Proposal Writing Workshop	CAVAIII/FLUNAAB	Abeokuta, Nigeria	Mr. Gregory Komlaga
8 <sup>th</sup> – 10 <sup>th</sup> Oct, 2014	Accreditation forum to create awareness of ISO/IEC 17025:2005 Standard. ADVANCED LEADERSHIP PROGRAMME	BNARI	BNARI	Mr. George Anyebuno
27 <sup>th</sup> October to 3 <sup>rd</sup> November, 2014	After Project Meeting	AFTER project	Natural Resources Institute	Dr. Mrs. Charlotte Oduro-Yeboah
2 <sup>nd</sup> - 8 <sup>th</sup> Nov, 2014	Final meeting of the Project Gratitude	Escolar Superior De Biotecnologia, in Porto	Universida de Carolica Portuguesa	Dr. NanamDziedzoave& Dr. Charles Tortoe
19 <sup>th</sup> – 22 <sup>nd</sup> Nov, 2014	8 <sup>th</sup> International Conference on Mushroom Biology and Mushroom products 2014	Mushroom Society of India, Solan	NASC Complex, New Delhi	Ms. Matilda Dzomeku
1 <sup>st</sup> - 4 <sup>th</sup> Dec, 2014	SECUREFISH Project meeting	SECUREFISH	InstitutoPortugues do Mar e da Atmosfera, Avenida de Brasilia	Dr. Lawrence Abbey Mr. Apollonius Nyarko Mr. Emmanuel Saka



## APPENDIX V

### PUBLICATIONS

#### Journal Papers

1. **Akonor, P. T. and Tortoe, C.** (2014). Effect of blanching and osmotic pre-treatment on drying kinetics, shrinkage and rehydration of chayote (*Sechium edule*) during convective drying. *British Journal of Applied Science & Technology*, 4 (8), p. 1215-1229.
2. **Tortoe, C., Dowuona S., Dziedzoave, N. T., Rees, D.** (2014). Effect of curing treatments on seven key farmers' yams (*Dioscorea spp.*) in Ghana. *Agricultural Sciences*, 5, p. 1119-1128.
3. **Eriksson, E., Koch, K., Tortoe, C., Akonor, P. T., Oduro-Yeboah, C.** (2014). Evaluation of the physical and sensory characteristics of bread produced from three varieties of cassava and wheat composite flours. *Food and Public Health*, 4 (5), p. 214-222.
4. **Obodai, M., Ferreira I.C.F.R., Fernandes, Â., Barros L., Mensah, D. L. N., Dzomeku, M., Urben, A.F., Prempeh, J. and Takli. R. K.** (2014). Evaluation of the chemical and antioxidant properties of wild and cultivated mushrooms of Ghana. **Molecules**, 19, p. 19532-19548.
5. **Oduro-Yeboah, C., Onwulata, C., Tortoe, C. and Thomas-Gahring, A.** (2014). Functional properties of plantain, cowpea flours and oat fiber in extruded products. *Journal of Food Processing and Preservation*, 38, p. 347-355.
6. **Amoa-Awua, W. K., Awusi, B., Owusu, M., Appiah, V. and Ofori, H.** (2014). Reducing the atypical odour of *dawadawa*: Effect of modification of fermentation conditions and post-fermentation treatment on the development of the atypical odour of *dawadawa*. *Food Control*, 42, p. 335-342.
7. **Mensah, J.K., Owusu, E. and Anyebuno, G.** (2014). Growth and production of aflatoxins by a flavus in aqueous fruit extracts of pepper, okra and tomato. *International Journal of Science and Nature*, 5 (1), p. 1-7.
8. **Akonor, P. T., Tortoe, C., Oduro-Yeboah, C.** (2014). Physicochemical characterization of non-alcoholic beverages produced from malted roasted varieties of maize (*Zea mays*). *International Journal of Food Science and Nutrition Engineering*, 4 (1), p. 20-26.
9. **Tortoe, C., Johnson, P-N. T., T. Slaghek, Oduro-Yeboah, C., Addo, P., Nyarko, A., Tamakloe, I.** (2014). Physicochemical, proximate and sensory properties of organic side-



- stream pineapple (*Ananas sp.*) flour. *International Journal of Food Science and Nutrition Engineering*, 4 (1), p. 1-8.
10. **Atter, A., Amewowor, D., Amoa-Awua, W. K.** (2014). The effectiveness of water, salt and vinegar in reducing the bacteria population in fresh green cabbage. *Food Science and Quality Management*, 28, p. 29-34.
  11. **Atter, A., Obiri-Danso, K. and Amoa-Awua, W. K.** (2014). Microbiological and chemical processes associated with the production of burukutu a traditional beer in Ghana. *International Food Research Journal*, 21 (5), p. 1769-1776.
  12. **Tortoe, C., Nketia, S., Owusu, M., Akonor, P.T., Dowuona, S. and Otoo, E.** (2014). Sensory attributes and consumer preference of precooked vacuum-packaged yam from two varieties of Ghanaian yam (*Dioscorea rotundata*) in the Accra Metropolitan Area. *Advances in Research*, 2 (1), p. 40-51.
  13. **Obodai, M., Hayford, O., Matilda, D., Richard, T., Gregory, K., Dziedzoave N. T, Mensah-Narh, D.,** (2014). Prempeh Juanita and Sonnenberg Anton. Heavy metal and proximate composition associated with the composting of cassava (*Manihot esculenta*) peels used in the cultivation of mushrooms in Ghana. *African Journal of Biotechnology*, 13 (22), p. 2208-2214.
  14. **Andoh, A. H., Ackah, B. N, Atter, A., Atikpo O. M., Baisel, D. K., Boham-Dako, M., Appiah A.H. K.** (2014). A survey of the microbial quality of some instant powdered beverages sold in Accra, Ghana. *International Journal of Development and Sustainability*, 3(7), p. 1496-1501.
  15. **Kortei N.K, Odamtten G.T, Appiah V, Obodai M, Adu- Gyamfi A, Annan T.A, Akonor, P.T, Annan S.N.Y, Acquah S.A, Armah J.O and Mills S.W.O.** (2014). Microbiological quality assessment of gamma irradiated fresh and dried mushrooms (*Pleurotus ostreatus*) and determination of D10 values of *Bacillus cereus* in storage packs. *European Journal of Biotechnology and Bioscience*, 2 (1), p. 28-34.
  16. **Tortoe, C., Akonor, P. T., Nketia, S., Owusu, M., Glover-Amengor, M., Hagan, L., Alice Padi.** (2014). Assessing the sensory characteristics and consumer preferences of yam-cowpea-soybean porridge in the Accra Metropolitan Area. *International Journal of Nutrition and Food Sciences*, 3 (2), p. 127-132.
  17. **Tortoe, C., Akonor, P. T., Nketia, S., Owusu, M., Glover-Amengor, M., Hagan, L., Otoo, E.** (2014). Evaluation of the sensory characteristics and consumer acceptability of deep-fried yam (*Dioscorea rotundata*) crisps in the Accra Metropolitan Area. *Journal of Food and Nutrition Sciences*, 2 (1), p. 19-23.



18. **Mensah-Narh L. D. and Mary Obodai.** Morphological characteristics of mycelia growth of two strains of indigenous medicinal mushroom, *Lentinus squarrosulus* Mont. (Singer), on solid media. *African Journal of Agricultural Research*, 9 (23), p. 1753-1760.
19. **Tortoe, C., Amoa-Awua, W.** (2014). Development of business capacity and organization of commercial business of farmer based organizations in the northern intervention zone in Ghana: a case study of nine farmer based organizations. *Agricultural Sciences*, 5 (2), p. 157-164.
20. **Dzomeku, M,** Apetorgbor, A. K, Apetorgbor, M. and **Obodai . M,** Ailments and application of pleurotus tuber-regium (ptr) among indigenes of two regions in Ghana. *Scientia Agriculturae*, 3 (3), p. 129-132.
21. Issaka, R. N., Buri, M. N., Ennin, S. A. and **Glover-Amengor, M.** (2014). Effect of mineral fertilizer on sweet potatoes [*Ipomoea Batatas (L.)*] yield in the Sudan savannah agro-ecological zone of Ghana. *International Journal of Agriculture Innovations and Research*, 2 (5), p. 831-834.
22. Kuijpers, T. F. M., Van Herk T., Vincken, J-P., Janssen, R. H., **Mensah-Narh, D. L.,** Van Berkel, W. J. H. and Gruppen. H. Potato and mushroom polyphenol oxidase activities are differently modulated by natural plant extracts. *Journal of Agricultural and Food Chemistry*, 62, p. 214-221.
23. Kortei, N.K., Odamtten, G. T., **Obodai, M.,** Appiah, V., Annan, S. N.Y., Acquah, S. A., Armah, J. N. O. (2014). Comparative effect of gamma irradiated and steam sterilized composted 'wawa' (*Triplochiton scleroxylon*) sawdust on the growth and yield of *pleurotus ostreatus* (Jacq. Ex Fr) Kummer. *Innovative Romanian Food Biotechnology*, 14, p. 69-78.
24. **Ackah, N. B.** (2014). Developing a verification program for sanitation and pasteurisation activities during pineapple juice production. *Food Science and Quality Management*, 25, p. 1-9.
25. Kortei, N. K., Odamtten, G. T., **Obodai, M.,** Appiah, V., Akuamoah, F., Adu-Bobi, A. K., Annan, S. N.Y., Armah, Jonathan N. O. and Acquah, S. A. (2014). Evaluating the effect of gamma radiation on the total phenolic content, flavonoids, and antioxidant activity of dried *pleurotus ostreatus* (Jacq. ex. Fr) Kummer) stored in packaging materials. *Advances in Pharmaceutics*, 2014, p. 1-8.
26. **Obodai, M.,** Owusu, E., Schiwenger, G. O., Asante, I. K. and **Dzomeku, M.** (2014). Phytochemical and mineral analysis of 12 cultivated oyster mushrooms (*Pleurotus species*). *Advances in Life Science and Technology*, 26, p. 35-42.



27. Kortei, N. K., Dzogbefia, V. P. and **Obodai, M.** (2014). Assessing the effect of composting cassava peel based substrates on the yield, nutritional quality, and physical characteristics of *Pleurotus ostreatus* (Jacq. ex Fr.) Kummer. *Biotechnology Research International*, p. 1-9.
28. **Baidoo, E. A., Akonor, P. T., Tortoe. C.** (2014). Effect of pre-treatment and storage condition on the physicochemical properties of taro (*Colocasia esculenta* [L.] Schott) flour. *International Journal of Food Science and Nutrition Engineering*, 4 (4), p. 91-97.
29. Eriksson, E., Koch, K., **Tortoe, C., Akonor, P. T. and Baidoo, E.** (2014). Physicochemical, functional and pasting characteristics of three varieties of cassava in wheat composite flours. *British Journal of Applied Science and Technology*, 4 (11), p. 1609-1621.
30. Agyei-Amponsah, J., Owureku-Asare, M., Agbemavor, S.K.W., Armah, J., Okyere, A., **Baidoo, E., Dowuona, S. and Tortoe, C.** (2014). Quality characteristics of pre-treated yam chips produced from irradiated yams. *British Journal of Applied Science and Technology*, 4 (36), p. 5045-5057.
31. **Obodai, M., Oduro-Yeboah, C., Amoa-Awua, W., Anyebuno, G., Ofori, H. Annan, T., Mestres, C. and Pallet, D.** (2014). *Kenkey* production, vending and consumption practices in Ghana. *Food Chain*, 4 (3), p. 275-288.

#### EDITED RESEARCH REPORTS

1. **Kwabena A. Bugyei and Raphael K. Kavi.** Design and implementation of a web based human resource information for CSIR-Food Research Institute. 2014, p. 90.
2. **Kwabena Asiedu Bugyei, Raphael Kwame Kavi and Stephen Nketia.** Development and implementation of a CMS-based website for CSIR-Food Research Institute. 2014, p. 45.
3. **Dr. Charles Tortoe, Mr. Emmanuel Alorigiya and Mrs. Alice Padi.** Report on the 2nd International Fair of agribusiness. 2014. p. 22.
4. **Amy Atter, Nina Bernice Ackah, Theophilus Annan, David Baisel, Michael Amoo-Gyasi, May Ama Boham, Alexander Henry Kwadwo Appiah, Badaru Deen Yahaya and Emmanuel Tetteh.** Microbiological quality of water from dispensers situated at CSIR-Food Research Institute. 2014, p. 13.
5. **Komlaga, G. A., Tandoh-Wordey, M. and Nketia, S.** Feasibility studies for Better Foods and Farms. 2014, p. 12.



6. **Komlaga, G. A.**, Tandoh-Wordey, M. and **Nketia, S.** Feasibility studies for Obibini Blackman Company Limited. 2014, p. 12.
7. **Gregory Afra Komlaga** and Solomon Dowuona, Development of methods for making high quality yam flour. 2014, p. 68.
8. **Hayford Ofori, Amy Atter, George A. Anyebuno** and Theophilus Annan. Report on training for ice *kenkey* millers, producers and vendors in and around Ashaiman market. 2014, p. 5.
9. **Dr. Lawrence Abbey, Mrs. Mary Glover-Amengor, Dr. Margaret Ottah Atikpo, Mr. Samuel Manu, Mrs. Amy Atter, Jogeir Toppeand Madhurantakam Kiran.** Report on development of low cost nutrient dense fish products based on low value fish and fish byproducts using small and medium scale processing and preservation methods that stabilize the nutritional value and ensure the safety of the product. 2015, p. 61.

#### MANUAL

1. **Tortoe, C., Akonor, P. T., Padi, A., Boateng, C., Opoku Asiama, M., Addy, P. S.;** Dawson, A. E and Wayo, T. C. A. Root and tuber composite flour processing and recipe manual.
2. **Annan, T., Ofori, H., Amoa-Awua, W. K., Atter, A. and Anyebuno, G.** Training manual on iced kenkey production.
3. **Bugyei, K. A. and Kavi, R. K.** Collection development policy manual for CSIR-Food Research Institute.
4. **Annan, T., Ofori, H., Amoa-Awua, W. K., Atter, A. and Anyebuno, G.** Training manual on iced kenkey production.
5. **Tortoe, C., Dowuona, S. and Dziedzoave, N. T.** Improving yam postharvest: training manual.
6. **Tortoe, C., Akonor, P. T., Padi, A., Hagan, L., Boateng, C., Opoku Asiama, M., Addy, P. S.,** Dawson, A. E. and Wayo, T. C. A. Sweetpotato composite flour, mash and paste processing and recipes preparation manual.
7. **Addo, P. A., Tortoe, C., Hagan, L., Buckman, E. S., Akonor, P. T., Padi, A., Addy, P. S.,** Dawson A. E. and Wayo, T. C. A. Indigenous cereal composite flour processing and recipe training manual.



## MEDIA POPULARIZATION

1. **Andoh, A. H. and Ackah, N. B.** Avoid bacteria in fresh-cut fruits: feature article in Daily Graphic, Monday, November 17, 2014.
2. **Andoh, A. H. and Ackah, N. B.** Avoid bacteria in fresh-cut fruits: feature article in Daily Graphic, Monday, November 17, 2014.
3. **Andoh, A. H. and Ackah, N. B.** The need to avoid bacteria in freshly-cut fruits: Feature article in The Ghanaian Times, Wednesday, December 3, 2014.
4. **Tortoe, C., Dowuona, S. and Dziedzoave, N. T.** Know your yams: a manual on some Ghanaian yams.

## CONSULTANCY REPORT

1. **Ackah, N. B., Baidoo, E. A.; Nketia, S., Appiah, A.H. K. and Lartey-Brown, J.** Development of a HACCP system for KFC vegetable shito.
2. **Narh-Mensah, D. L., Dzomeku, M., Takli, R. K. and Obodai, M.** Report on advisory services for the mushroom cultivation wing of Nutierich Food Products.

## EXTENSION LEAFLET

1. **Tortoe, C., Dowuona, S. and Dziedzoave, N. T.** Reducing postharvest losses in fresh yams: practicing proper storage.
2. **Komlaga, G., Dowuona, S., Wordey, M. T. and Dziedzoave, N. T.** High quality yam flour (HQYF): reducing postharvest losses in fresh yam. Reducing postharvest losses in fresh yams: practicing proper storage.
3. **Obodai, M., Dzomeku, M., Takli, R., Komlaga, G. and Dziedzoave, N. T.** Cultivation of edible and medicinal mushrooms using cassava by-products - extension leaflet.
4. **Tortoe, C., Dowuona, S. and Dziedzoave, N. T.** Yam sprout control: reducing yam postharvest losses.
5. **Tortoe, C., Dowuona, S. and Dziedzoave, N. T.** Yam curing: treating wounded yam tubers to reduce postharvest losses.
6. **Tortoe, C., Dowuona, S. and Dziedzoave, N. T.** Yam storage.



# ORGANOGRAM OF CSIR-FRI

