Council for Scientific and Industrial Research

Food Research Institute

1963 – 2003

40th Anniversary

2003 Annual Report

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Council for Scientific and Industrial Research

Food Research Institute

The Food Research Institute (FRI) of the Council for Scientific and Industrial Research (CSIR) is an internationally recognised centre of expertise in research into problems of food processing and preservation, storage, marketing, distribution and utilisation, in support of the food industry and also to advise the Government of Ghana on its food policy.

This publication is an output of the FRI. The views expressed are solely that of the Institute.

This publication should be cited as follows:

The CSIR-Food Research Institute (2004). 2003 Annual Report CSIR-FRI, Accra, Ghana

Principal Officers

Chairman, Management Board	Prof. A. Ayensu
Director	Dr. Wisdom A. Plahar
Deputy-Director	Dr. Wisdom Amoa-Awua

Heads of Division

Commercialization and Information Division ...	Agnes Osei-Yaw (Mrs.)
Food Processing & Engineering Division	Gladys Nerquaye-Tetteh (Mrs)
Nutrition and Socio-Economics Division	Phoebe Lokko (Mrs.)
Food Microbiology Division	Mary Halm (Ms.)
Food Chemistry Division	Dr. Kafui Kpodo (Mrs.)
Administration Division	Eugenia Atta-Sonno (Mrs.)
Accounts Division	John Mintah

Scientific Secretary ... ... Robert M. Yawson

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EXECUTIVE SUMMARY

The Food Research Institute is forty years old. It was established by the Government of Ghana in 1963, and incorporated into the Council for Scientific and Industrial Research (CSIR) as one of thirteen institutes in 1968. FRI has a mandate to conduct applied research into problems of food processing and preservation, storage, marketing, distribution and utilisation in support of the food industry, and also to advise government on it food policy. The Institute's mission focuses on providing scientific and technological support to the growth of the food and agricultural sectors in the national economy in line with government policy objectives.

The Institute is divided into 7 divisions, 4 of which address technical aspects of food quality and production; food microbiology, food chemistry, food processing & engineering and nutrition & socioeconomics. The remaining 3 divisions deal with business development, administration and finance.

FRI maintained a total of 176 staff during the year under review, of which 39 were scientists and engineers, 51 senior technical and administrative support staff, and 86 junior members of staff in various supporting roles. The Institute maintained its bipartite structure, with the director managing the 3 non-scientific divisions (and with overall responsibility for all divisions and reporting to the management board), whilst the deputy director manages the 4 scientific divisions.

The main programmes of the Institute during the year 2003 were centred on R&D activities for the solution of postharvest problems and also to generate income. The Institute measures and manages its performance using the balanced scorecard approach. The short term goal of the FRI under the current measurement framework is: ***To be a centre of excellence that conducts market-orientated research and provides accredited technical services to the food industry by 2008***. During the year under review the institute accomplished several of its Key Performance Indicators.

To accomplish its objectives, the activities of the Institute for the year 2003 were classified under the following programmes:

- Pilot studies and transfer of processing technologies programme
- Technical and analytical services programme
- Food biotechnology programme
- Food evaluation and product development programme

- Training programme
- Food safety and quality assurance programme
- Community outreach programme
- GOG Institutional Renewal/CSIR Restructuring Programme

Four projects were identified and selected as Flagship Projects for the year, because of their potential socio-economic impact in the near future. These projects include:

- Sustainable uptake of cassava as an industrial commodity: Promoting High Quality Cassava Flour Technology for use in the bakery industry, as paper board adhesive, as extender for plywood, etc. and in the development of glucose syrups for the confectionery, pastry and pharmaceutical industries.
- Industrial development of sorghum malt and its utilization in the food industry
- Dissemination of improved rice post-production and marketing technologies, through a new coalition arrangement, to enhance rural livelihoods in Northern Ghana
- Dissemination of improved bambara processing technologies through a new coalition arrangement, to enhance rural livelihoods in Northern Ghana.

The R&D output for the year was quite good with a high number of refereed journal publications and Edited Research Reports. Sixteen refereed journal papers, twelve edited research reports, fifteen conference papers and three consultancy and training manuals were published within the year by the scientists of the Institute. Key techniques generated and/or transferred to end users during the year include inter alia:

- Under the Salt Iodisation project, simple measurement techniques have been devised to be used by the women processors who can neither read nor write. This has led to quality iodised salt on the market in the study area. The long-term impact of this appropriate technology application will be the curtailment and reduction in Iodine Deficiency Diseases
- Under the DFID-funded project on 'sustainable uptake of cassava as an industrial commodity' the Institute has adapted and fine-tuned a technology for the production of glucose syrup from the HQCF for use in the manufacture of biscuits, confectionery, soft drinks and other food products. Hitherto, no industry in Ghana produced glucose syrup. These technologies were transferred to four companies, which started small-scale production during the year under review. Meanwhile over 100,000 metric tons of glucose syrup is imported annually into the country for use in various industries.

The FRI is therefore in the position to help build the capacity of our local industries to produce glucose syrup and thereby save the country a huge amount of foreign exchange that can be re-channelled to other areas of the economy.

- Under the DFID-funded project on 'Dissemination of improved bambara processing technologies', the technology developed by the Institute for the production of high quality bambara flour (HQBF) was transferred to one commercial entrepreneur as well as to 219 women engaged in micro-scale bambara flour processing in four districts in northern Ghana.
- Under the RTIP several Cassava Flour Pilot Plants were established in various districts. Two of such Pilot Plants were seen to be fully operational throughout the year at Amanase near Suhum and Adidwan near Asante Mampong.
- The Mushroom Unit continued with its extension activities throughout the year. Several people were trained in mushroom cultivation and spawn production

The Institute played host to a number of visitors including local and foreign dignitaries. Notable among them was Hon. (Mrs.) Gladys Asmah, MP and Minister for Women and Children Affairs

PART 1
GENERAL MATTERS
(Non – Scientific Divisions)

Chapter 1
ADMINISTRATION DIVISION

1.1 Introduction

The FRI presently operates under seven divisions – Food Chemistry, Food Microbiology, Food Processing and Engineering, Nutrition and Socio-Economics, Commercialisation and Information, Administration, and Accounts. The detailed existing organisational structure of FRI is given in Appendix IX. The Administration Division caters for the secretarial, personnel, establishment, estate and transport matters of the FRI. The division continued with these support services to the Institute under the constraints of limited staff and lack of some basic office equipment

1.2 Staff Strength

The staff strength of the Institute stood at 176 and the breakdown is as follows:

Category of Staff	Number of Females	Number of Males	Total
Research staff	19	20	39
Senior Staff	8	43	51
Junior Staff	16	70	86
Overall Total	43	133	**176**

1.3 Promotions

Several promotions were announced during the year. Please see Appendix III for further details

1.4 Retirement

The following staff proceeded on retirement on attaining the compulsory age of 60 years:

- Mrs. Gladys Nerquaye-Tetteh, Principal Research Scientist, Head/Proc. & Eng. Of the Processing and Engineering Division
- Mr. Jacob K. Magbo, Chief Technical Officer of the Processing and Engineering Division
- Mr. Ali Bulsa, Security man, of the Administration Division
- Mr. Eklu Azaelakor, Foreman, of the Administration Division

1.5 Appointments

During the year under review five temporal appointments were made including three Assistant research scientists, a Technical officer and a clerk. Please refer to appendix IV for further details

1.6 Leave without Pay

Messrs. David Abusah and Leslie Codjoe proceeded on leave without pay during the year. Mrs. Wilhemina Quaye assumed duty after being away for a year on leave without pay

1.7 Study Leave

The following members of staff are on study leave pursuing various courses in various institutions both in and outside the country: They are: Mr. Charles Tortoe; Mr. E. C. T. Tettey; Mr. Peter Addo; Mr. Aikins Tutu; Mr. Kwame Kavi; Ms. Janet Aggrey-Yawson; Mrs. Alice Padi; Ms. Constance Boateng; Mr. James Cromwell; Mr. Apollonius Nyarko; and Mr. Emmanuel Alorsey. Please refer to Appendix VIII for further information on FRI staff on training.

1.8 Returned to Post After Study leave

Mr. Peter Addo reported for duty on completion of his study leave with pay. Messrs Samuel Tagoe and Samuel Buabeng also returned to post after their study leave at the Weija Institute of Technical Supervision during the year.

1.9 New Heads of Division

Dr. P. N. T. Johnson was appointed the new Head of the Processing and Engineering Division upon the retirement of Mrs. Gladys Nerquaye-Tetteh. Dr. Adu-Amankwa was also appointed as Head of the Pilot Plant Unit of the same Division.

1.10 Visits

The Institute played host to a number of visitors including local and foreign dignitaries. The Institute was honoured with two visits by the Minister for Children and women's Affairs in the person of Mr. Gladys Asmah, the Chief Director and other officials of the Ministry. The visit was with the aim of forging a closer collaboration between the Institute and her Ministry. Other visitors include: The Chief and elders from Bortianor Traditional Council; Mr. Keith Tomlins, Dr Andrew Graffham and Dr. Alistair Sutherland all of the NRI UK; Ms. Vibeke Jeppesen and Mr. Per Nilsson both from Eurofins in Denmark; Dr. Irene Ouaba a visiting scientist from Burkina Faso among others.

Chapter – 2

ACCOUNTS DIVISION

2.1 Introduction

The Accounts Division controls expenditure and caters for all financial transactions of the FRI. The Division prepares the annual estimates, annual accounts and financial statements, and maintains books and documents involved with all these activities. The Division supports all the other divisions to carry out their financial obligations effectively for the smooth running of the Institute. The Accounts Division is made up of two sections, namely, the Main Accounts section and the Stores section.

2.2 Staff Strength and Movement

As at the end of the year, the staff strength of the division stood at ten. The Main Accounts section had seven members of staff and the Stores section had three. Mr Tutu Aikins, Mr James Cromwell and Mrs Lawrencia Botchie were on study leave. Mrs Angela Addy also proceeded on leave without pay effective October 2003.

2.3 Major Activities

The Main Accounts Section of the Division undertook the following activities;

- Prepared Financial Statements for the Institute and for collaborative projects;
- Prepared Quarterly Returns which were forwarded to the CSIR Secretariat,
- Prepared of Quarterly Report on the Institute's Internally Generated Funds (IGF);
- Prepared Annual Budget for the institute;
- Prepared Quarterly Reports for collaborative projects

The Stores section continued with its functions of procurement of chemicals and media for the laboratories, procurement of stationery and other needed items, and their proper storage and documentation for effective running of the Institute.

2.4 Statement of Accounts for the year ending 2003

The balance brought forward was *¢98,515,455.06* and funds received during the year amounted to ***¢5,457,493,870.48***. The total income for the year amounted to ***¢5,556,009,325.54***. The total expenditure for the year was ***¢5,017,191,329***.78 leaving a balance of ***¢538,817,995.76*** carried forward. Please note that this is not an audited statement of accounts. Please see appendix VI for details.

2.5 Constraints

- Funds released to run the Institute in the year 2003 was woefully inadequate.
- Delay in release of Government subventions to meet workers salaries, administrative expenses and research activities.

Chapter - 3

COMMERCIALISATION AND INFORMATION DIVISION

3.1 Introduction

The Commercial and Information Division continued its basic task of coordinating the commercial activities of all the other Divisions of the Institute in order to generate income for the Institute. The Division has three Units namely Client Services Unit, Library and Publications Unit and the Cassava Processing Demonstration Unit. The CPDU was transferred to the Division from Food Processing & Engineering Division during the year under review

3.2 Staff Strength

The staff strength of the division stood at 21 at the end of the year. It is made up of a Head of Division who is a Principal Research Scientist, 8 Processors, 7 Senior Tech Staff, 3 Security men, a labourer, and a driver.

3.3 Commercialisation Activities

During the year under review the Division continued its work of co-ordination of commercialization activities. The main activities carried out include collection of samples for analysis, transfer of technology, hiring of Institute's facilities, organization of training programs and sale of research by-products.

For analytical services, a total of **1430** samples were received by the Client Service Unit, for analysis. Total charges for these samples amounted to ***¢328,839,250.00*** It must be noted that this figure represents charges made and not actual income realized. A total of 7 training programmes were carried out by the Institute.

These were in:

- Mushroom Cultivation
- Laboratory Analyses
- Cassava Processing
- Fruit Juice Processing

3.4 Income Generation

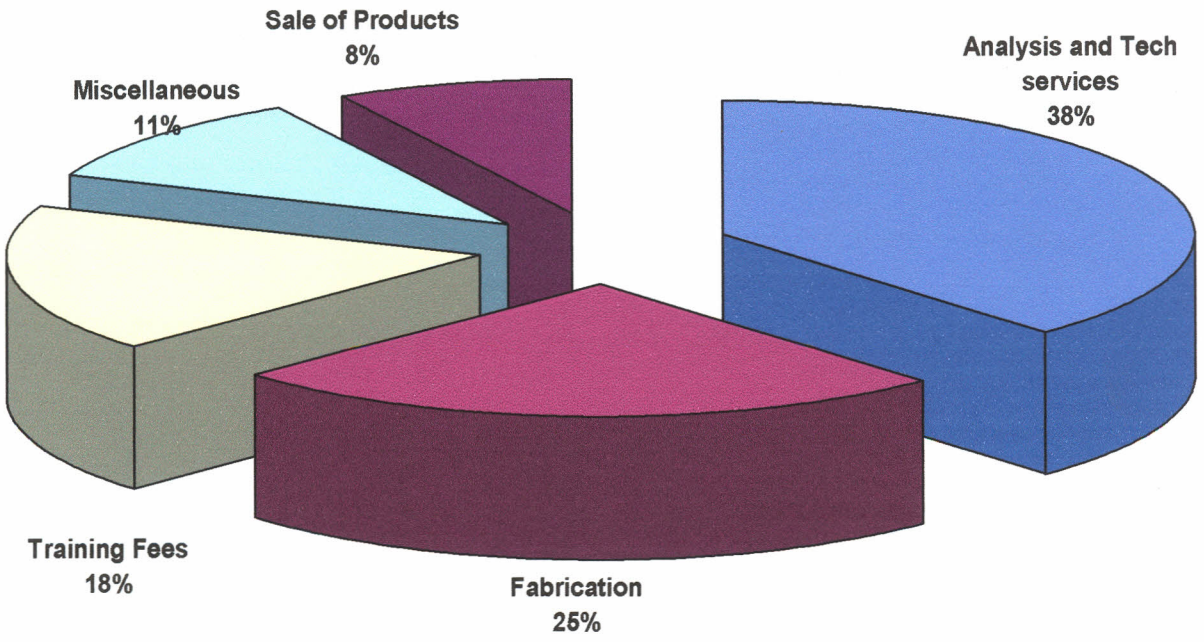
The Internally Generated Income (IGF) of the Institute amounted to one hundred and forty two million, nine hundred and fifty two thousand, one hundred and ninety seven thousand cedis (**¢142,952,197.40).** The Institute received an amount of five billion four hundred and ninety three thousand eight hundred seventy cedis **(¢5,457,493,870.48)** as Government subvention for the year 2003. The IGF as a percentage of total subvention is **2.63%.** However, the institute attracted a lot of donor funding for its research activities, which could not be borne by Government subvention. The total Donor Direct Inflow to the Institute amounted to ***£100,241.00*** approximately ***¢1,653,976,500.00*** at the average interbank exchange rate *of* ***¢16,500.00*** for 2003, which brings the IGF/Subvention ratio to **30.31%** The FRI set **¢485,587,610.00** as target for the year under review. The table below compares the projections with the actual incomes:

ACTIVITY	PROJECTED INCOME (¢)	ACTUAL INCOME (¢)
Sale of Products	78,238,160,00	56,036,500.00
Analysis and Tech. Services	239,748,522.00	268,984,250.00
Training Fees	47,764,600.00	129,374,054.00
Fabrication	26,455,000.00	178,100,000.00
Miscellaneous	93,381,328.00	79,007,000.00
TOTAL INCOME	**485,587,610.00**	**711,501,804.00**

Table Showing Projections as Against Actual Incomes for Year 2003

Although the institute far exceeded its targets, it must be noted that all the projections and the actuals are gross amounts. The total net income amounted to ***¢142,952,197.40*** which means the production cost was exceedingly high. Measures have therefore been put in place to normalise the situation for the coming year. Please see Appendix VII for details of Annual Statement of IGF Account

Relative Contribution to IGF 2003



3.5 FRI Media Exposure in 2003

During the year under review Researchers of the Food Research Institute were involved with several media activities.

- On the nutrition segment of ***TV3** Body Love – health and fitness program*, Mrs. N.T. Annan, a Senior Research Scientist of this Institute was hosted twice to talk on the nutritional value and the health implications of consumption of rice and maize.
- On the 9th of September an interview granted by the Scientific Secretary of the Institute to the *Ghanaian Chronicle* was used as the paper's banner headline ***"Genetically Modified Foods" Ghana in a Fix..... As America and Europe take opposing stands***". The interview attracted a lot of discussion in the media especially on radio and the internet.
- The Scientific Secretary published two full page articles on the July 17 and 24 issues of *The Independent* on "***Ghana and the Controversy over GM Foods***" and "***Emerging Technologies and Ghana's Economic Development"*** respectively. These articles attracted a lot of publicity for the Institute.

- At the closing ceremony of the Training Workshop on Fruits Processing the Chief Director of the Ministry of Environment and Science was invited and he was accompanied by some print Media Personnel.
- As part of the activities marking the World Food Day for 2003, a TELEFOOD Programme was organized and the Scientific Secretary of the Institute was a member of a panel, which included the Minister for Food and Agriculture and this, also gave a good exposure to the Institute.
- During the world Food Safety week celebrations, Dr. P. N. T. Johnson was hosted on several Ghana Television Programmes to talk on Street-vended Foods in Accra.

3.6 Constraints

Delays in reporting analytical services continued to be a problem including *inter alia* shortage of media and shortage of water, all these contributed to delay of report submissions to clients.

PART 11
SCIENTIFIC DIVISIONS

Chapter - 4
NUTRITION AND SOCIOECONOMICS DIVISION

4.1 Introduction

The Nutrition and Socioeconomics Division (NSED) continued with its main responsibility of conducting surveys and feasibility studies into the economic viability and socio-economic impacts of projects of the institute, consumer demand and the utilisation of food. The Division also continued with its community nutrition studies. The NSED has two units: The Nutrition Unit; which is in charge of community and human nutrition studies and runs a Test Kitchen that conducts sensory test on products developed by the FRI and industry; and the Socioeconomics Unit.

4.2 Staff Strength

The Division has a total staff strength of ten made up of 6 Research Grade Staff and 4 Technical grade staff. The staff comprises of one Principal Research Scientist, one Research Scientist, four Assistant Research Scientists, one Chief Technical Officer, two Senior Technical Assistants and one Technical Assistant Grade II

Mrs. Mina Quaye resumed duty after a year's leave of absence. Mrs Patience Larweh is on study leave in Canada. Miss Linda Akuamoah-Boateng, an MPhil student of the University of Ghana is working on her project at the Division. Other Graduate Students of the Nutrition and Food Science Department of the University of Ghana carried out some of their practical lessons (Energy expenditure measurements and Body composition) in the Division during the year.

4.3 Technology Transfer

1) The Ghana Health Service-Nutrition organized a workshop at Adina in the Volta Region, from 2nd to 4th October 2003. Two members of the Division, Mrs. Phoebe Lokko and Mrs. Lynda Hagan were there to train village level salt producers on how to iodise salt.
2) Students form Accra and Kumasi Polytechnics were helped with their project work.
3) A client Mr. Nicolas Opoku was trained in mayonnaise and salad cream production. The total income from the above activities came to two million cedis.

4.4 Support of Research Activities

The Division supported research activities by getting involved in recipe development, sensory and socioeconomic studies.

4.4.1 Sensory Studies and Recipe Development

- A 15 member panel was trained in attributes of rice and groundnuts and in questionnaire response and scoring.
- Acceptability tests were conducted on raw and cooked, parboiled rice, in support of NRI/FRI rice project.
- Recipe development, formulation and documentation were carried out on 5 varieties of groundnuts (AgSSIP project).
- Sensory and consumer studies on some groundnut base recipes and improved fufu flours were also carried out.
- Cassava flour spaghetti was successfully developed and tested.
- Rice tatho, rice and banana fritters, rice queen cakes, rice biscuits, rice sweet pancakes, rice flour moulds, rice wheat bread, rice puffs, rice strips were produced from par boiled rice.

4.5 Participation in workshops and exhibitions.

- Participated in the "Meet the press series", organized by the Hon Minister for Food and Agriculture in March. Various sweet potato dishes were prepared and exhibited at GNAT Hall. As a follow up-several clients came to do business with the FRI.
- Participated in another "Meet the press series", this time for the out going Hon Minister of Environment, Science and Technology in April. Products from Cassava and Soybean were prepared and exhibited on behalf of FRI.
- In May, the Division participated in the "National Economic Dialogue" at the International Conference Centre in Accra. Institute's cassava, soybeans, corn and sorghum products were prepared and exhibited.
- In August the Hon. Minister of women and children's affairs visited the institute, the institute's products and some cassava and soybean based dishes were prepared and exhibited at the Fishery Resource Centre-Okponglo.
- In November, Soy based products were prepared for the Food Crops Development Project (FCDP) workshop and exhibition, in Fumesua, Kumasi (4th-17th Nov.).
- Cassava sweet potato and cocoyam flours were prepared for RTIP during AGRIFEX 2003, (11th – 17th Nov.).

4.6 Attendance at Workshop and Training

- Ivy Johnson-Kanda attended the following training workshops.
  i. Policy Dialogue Forum on Performance Management (NRI/CSIR, 10th Dec. 2003)
  ii. Training workshop on Research Methodology and Report writing (July 17 – 25, 2003).
  iii. Training on Data Management and analysis (July 18 – August 8, 2003) at ISSER.
- Mrs. Lynda Hagan attended a workshop on scientific writing from the 8th to 12th December 2003 at INSTI.
- Mrs Phoebe Lokko attended the following workshops and seminars
  i. Workshop on the PERI programme – CSIR – INSTI in October 2003
  ii. Peanut CRSP workshop in Brazil, University of Vicosa. From November 28-December 5th 2003.
  iii. Workshop on Nutrition on behalf of the Director in Kampala, Uganda from July 25 to August 1st 2003.

4.7 Other Activities

- On going work on compilation of sensory attributes of food and food products.
- On going monitoring visits in support of other projects.
- Data collection, data inputting and data analysis in support of other projects.
- Nutrition Advisory services.

4.8 Needs

The Division is in need of a well equipped kitchen, with a new electric cooker and stainless steel utensils and other accessories as well as space to help the Division improve upon its performance.

4.9 Future Activities

- Together with the CID, the Division will conduct training in sensory evaluation for food industries and individuals.
- Prepare well packaged groundnut products for sale.

Chapter - 5

FOOD CHEMISTRY DIVISION

5.1 Introduction

The Chemistry Division of the Institute comprises two units namely the Toxicology Unit and the Industrial Services Unit.

5.2 Staff Strength

The Division has staff strength of 12 as follows: Two Senior Research Scientists, one Research Scientist, one Assistant Research Scientist, one Chief Technical Officer/Technologist, four Principal Technical Officers/Technologists, one Senior Technical Officer/Technologist, one Senior Technical Assistant and one Technical Assistant

5.3 Analytical Services

During the year under review, the Division offered analytical services to several companies, establishments and individuals. A total of 244 samples were received by the Industrial Services unit for analyses. The samples included biscuit flour, rice, maize, honey, animal feed, alcoholic beverages, fruit drinks, and edible oils, among several others. The clients included Food and Drugs Board, UNHCR, Cadbury Ghana Ltd., Baron Distilleries, Bebox Export Ltd., Ghana Inspectorate, Elsa Foods, and Morgan Farms among others. Analysis of the 244 samples generated a gross income of Forty-one million, four hundred and forty two thousand cedis ***(¢41,442,000).***

During the year, the Toxicology Unit received a total of 142 samples for aflatoxin analysis as against 57 samples for 2002. The samples consisted of groundnut kernels, groundnut paste, maize kernels and grits, Burger peanut snacks, Snappy Peanut snacks, Cocoa cake, and Chocolate Delight. The major clients included Bebox Export Ltd., West African Mills Company (WAMCO), Kokwe Farms, Transpomech International Ltd., Sitos Ghana Ltd., SGS Ghana Ltd., Ghana Standards Board, Transport and Commodity General Ltd. Total charges for the 142 samples amounted to thirty-three million cedis ***(¢33,000,000).*** This works out to a total of seventy-four million, four hundred and forty two thousand cedis ***(¢74,442,000)*** for the two units of the Chemistry Division.

5.4 Practical Training

In support of the Institute's commercialisation efforts, staff of the Division engaged in the training of students from the Country's Polytechnics and Universities:

- Eight students from the Department of Community Nutrition of the University of Development Studies in Tamale were trained in Food Composition Analyses from 10th to 14th March 2003. The training comprised both practical and theoretical courses after which they were assessed and presented with certificates.
- A Practical Training program in Biochemistry was conducted for eighty-seven (87) HND Science Laboratory Technology students of Accra Polytechnic on the 8th, 10th, 15th and 17th of April 2003.

5.5 Practical Attachment

- Two students from Accra Polytechnic (Ms. Vida Awidi and Mr. James Togobo) were on practical attachment with the Division from August to October 2003.
- One student from the University of Cape Coast, and another from the SOS Ghemeiner International College also undertook their project work with the Division. They worked on aflatoxins and fish respectively.
- Mrs. Georgina Fordjour from the Biochemistry Department of the Kwame Nkrumah University of Science and Technology was on Practical Attachment Training with the Division from 7th April to 30th May 2003. This was part of a Technical Supervisory Management Course she was undertaking at the Institute of Technical Supervision at Weija.

5.6 National Service Personnel

- Messrs. Jeremy Lartey Brown and Derrick Annan who started their National Service with the Division in November 2002 completed in August 2003.
- Ms. Mercy Fianu started her National Service with the Division on 1st December 2003

5.7 Temporary Appointment

- Ms. Belinda Ayitey-Adjei was on temporary appointment with the Division from January to November 2003.
- Mr. Jeremy Lartey Brown is currently on temporary appointment with the Division with effect from 1st November 2003.

5.8 Efforts towards Accreditation of Chemistry Laboratories

In preparation towards the Accreditation of five of our chemical methods to ISO 17025 Quality System, three audits were conducted during the year under review. These were:

- An Internal Audit of the Laboratories on 29th April 2003. The Auditors were Ms. Mary Halm and Mr. David Asiedu. A second internal audit was conducted on 4th September 2003. The auditors were Dr. P-N. T Johnson and Mrs. M. Ottah-Atikpo.
- An External Audit was conducted from 3rd to 7th November 2003. The Auditors were Ms. Vibeke Jeppesen and Mr. Per Nilsson both from Eurofins in Denmark.
- Prior to the external audit, Mr. Nilsson (a chemist) assisted staff of the Division in the preparation of forms, methods and other documentation needed to meet some of the accreditation criteria.
- In preparation for the external audit, the Chemistry Laboratories were renovated with funds from the DANIDA Project.

5.9 Training and Attendance at Meetings

- Two-day training on the use of the Atomic Absorption Spectrophotometer and Flame Photometer was organized for staff of the Chemistry Laboratory by Scimed Instruments Service Center. The equipment will be used to analyse for micro elements such as Zinc, Magnesium, Copper, Manganese and Sodium.
- Messrs. Charles Diako, David Ankrah and Emmanuel Allotey participated in a Training Workshop on shelf-life determination of perishable foods organised by UNIDO and the Food Research Institute from 9th – 11th December, 2003.
- Mr. George Anyebuno participated in a CTA/CSIR/INSTI Training Course on Scientific Writing and Oral presentation from 8th to 12th December 2003.
- Dr. Kafui Kpodo participated in the final Project Meeting of the EU funded project "Biological degradation of aflatoxins in fermented maize and sorghum products" from 16th to 20th June in Stellenbosch, South Africa.
- Dr. Kafui Kpodo attended the First African Workshop on Food Safety in Stellenbosch, South Africa from 8th to 13th December 2003. The Workshop was organised by the International Union of Microbiological Societies (IUMS) and the International Committee on Food Microbiology and Hygiene (ICFMH).
- Dr. Kafui Kpodo completed her PhD studies in Food Science registered at the Department of Nutrition and Food Science, University of Ghana, Legon with the successful defence of her thesis on 26th June 2003.

5.10 Other Matters

A water tank was installed during the year at the Broz Tito site of the Institute. The persistent low water pressures and shortages which hindered work in the Chemistry Laboratories have now been alleviated.

Chapter -6

FOOD PROCESSING AND ENGINEERING DIVISION

6.1 Introduction

The Food Processing & Engineering Division in line with its mandate conducted applied research into the processing, preservation, packaging and storage of food as well as the development of new products from available raw materials.

6.2 Staff Situation & Movements

6.2.1 Study Leave: Three officers, Messrs E. C-T. Tettey, Nanam Dziedzoave and J. T Manful continued their PhD programmes at the University of Ghana and the University of Greenwich, UK. Mrs Charlotte Oduro-Yeboah also continued her MPhil course at the Department of Nutrition and Food Science, Legon.

6.2.2 Retirement: The former Head of Division, Mrs Gladys Nerquaye-Tetteh and Mr Magbo went on retirement in November and July, respectively.

6.3 The Units and Consultancy Services of the Division

The three main units of the Division, Pilot-Scale Production, the Cassava Processing and Demonstration and the Engineering Units continued to render normal services to the public and the Institute.

6.3.1 The Pilot-Plant Production Unit (PPU): The PPU continued to provide its normal services; drying, milling, roasting and assisting clients in product development. Commodities dried include pineapple and pawpaw pieces, grated coconut, fermented maize, coffee, cassava dough etc.

6.3.2 The Cassava Processing and Demonstration Unit (CPDU): The CPDU also continued with the production of the three cassava products; kokonte flour, agbelima and gari for the Institute tuck shop and for clients. The Unit was later transferred to the Commercial and Information Division so as to concentrate on its commercial activities.

6.3.3 The Engineering Unit: Most of the activities within the Unit were geared towards completing the construction and installation of machines as part of the Agro-Processing Project. Other activities were concerned with the normal repairs and services for the estate and the divisions.

The Unit also continued to fabricate a number of food processing machines and equipment. The Adventist Relief Agency (ADRA) commissioned the Unit (i.e. the Institute) to fabricate ten sets of cassava processing machines for distribution to their farmers and artisanal processors in the country.

6.4 Visits by Project Collaborators

During the year under review, the division played host to several collaborators on a number of on-going foreign funded projects. Notable among them were Dr Andrew Graffham for the DFID/ NRI/ FRI Expanded Markets for Cassava Project and Mr. Keith Tomlins for the DFID/NRI/FRI Street Food Project.

6.5 Training Workshop

The Division organised a training course on the processing of fruits into juices, drinks and concentrates from the 8th to 12th of September. In all 53 participants took part.

6.6 Use of the Pilot Plant Facilities

A number of organisations including individuals continued to use the facilities in the pilot plant for different food product developments. One of such organization is the Unilever Ghana Ltd.

6.7 Continuation of UNIDO/FRI Sorghum Project

After a very long delay, the Common Funds for Commodities (CFC) gave approval for the continuation of Sorghum Malting Project involving the United Nations Industrial Development Organisation (UNIDO), Accra Office, the Government of Ghana and the Institute. This phase will involve the installation of a brewing and bottling plant to be attached to the malting plants.

Chapter - 7

FOOD MICROBIOLOGY DIVISION

7.1 Introduction

The Food Microbiology Division is made up of the Mycology Unit and the Microbiology Industrial Services Unit; and it is in the process of strengthening its capacity in Food Biotechnology. The Division continued with its task of providing analytical support to both research and industry.

7.2 Microbiology Industrial Services Unit

7.2.1 Analytical services

The Microbiology Services Unit analysed a total number of nine hundred and ninety three (993) samples during the year. This figure is about 18% less than the number analysed in 2002 (1,209). The breakdown of the samples for the year 2003 is shown below:

Client	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Total
Pioneer Foods	118	84	41	151	394 (40%)
Cadbury			40	27	
GAFCO			45	23	
Ghana Airways Catering			4		
Ghana Airways			9	3	
ELSA Foods				5	
UNHCR			24	6	
Others					
Total	***264***	***238***	***235***	***256***	***993***

Table Showing Analytical Services for the year 2003

The samples analysed included pre-cooked Tuna loins, Milk of Magnesia, water samples and swab sites from factories, bottled water, canned foods, fruits and vegetables products, cocoa products, catering products, cereals and grain legumes, confectionary etc.

7.2.2 Laboratory Accreditation

Activities in preparation for the accreditation of 14 Microbiological methods to ISO 17025 Quality System continued during the year. Six samples were received from GK Bio Products Ltd., UK for Proficiency testing in line with the accreditation requirements of 14 Microbiological methods to ISO 17025 Quality System. Two internal audits were conducted during the year and one external audit was conducted in November 2003 by two consultants from Eurofins Denmark. One Management review meeting was also held in January 2003.

7.2.3 Student Attachments

- Four students from the universities and polytechnics were attached to the laboratories of the Division for various periods during the year under review.
- Two HND graduates from Accra Polytechnic were assigned to the Microbiology laboratories for National Service beginning November 2002 to August 2003.
- Four students from the Accra Polytechnic were supervised in the Microbiology laboratories to conduct their project work on the following topics:
  - Microbial load of processed cattle hide '*wele*' from processing sites and marketing centres in the Tema and Accra metropolis
  - Assessment of microbial quality of *dawadawa* from Mallam Atta and Makola markets in Accra
  - Assessment of microbial quality of *wakye* and its condiments from selected vendors in Ashiaman.
  - Microbiological assessment of *fula* from Accra markets.

7.2.4 Temporary employment

Ms Pearl Asigbey completed her temporary employment with the Division in August 2003.

7.3 Mycology Unit

7.3.1 Strain Multiplication

The Mycology Unit produced a total of 3,321 bottles of spawns made up of 3,045 oyster spawn, 42 bottles of wood ear, and 234 bottles of oil palm mushroom spawn for sale to growers throughout the country for the 1st and 2nd quarters of the year.

7.3.2 Bag Production

Two thousand three hundred and sixty mushroom compost bags were produced and sold to growers

7.3.3 Expansion of Compost bag production capacity

Under the MTEF Objective 8 (*Conduct commercial activities through the provision of technical information, training and service to private sector and other stake holders in the Food Industry and Agricultural sectors*), the unit was provided with funds to promote mushroom cultivation in the private sector through training. The specific activity undertaken

was the expansion of compost bag production capacity of the Mycology Unit to enhance the capacity of the institute in promoting commercial cultivation of mushroom by the private sector. Under this project, an additional incubation room of size 5 m^3, which can take over 2000 compost bags, was constructed and an additional composting platform was also constructed. The old incubation room and cropping house were renovated. With these additional facilities and renovations the unit produced more than ten thousand compost bags in 2003. As a result of time spent in constructions and renovations it was not possible to produce the estimated 8000 bags within the stipulated period of three months. Instead 8,360,000 bags were produced over a period of six months.

7.3.4 Extension and Training Activities

- A 12-day training programme on mushroom cultivation was organised for 105 participants at the Mushroom Production and Biodiversity Training Centre- Kumasi in February 2003.
- Two persons from the Kumasi Mushroom production and Biodiversity Training Centre were trained in spawn multiplication from the 11^{th}-13^{th} of June 2003.
- A talk on mushrooms was given to 70 students of the Wild Life Club of Alpha Beta School in Dansoman on the 3^{rd} of June.

7.3.5 Visits to the Mycology Unit

Several individuals and schools visited the unit as follows:

- Students from Kadjebi Asato Secondary School.
- The Chief and elders from Bortianor Council.
- Students of Alpha Beta School Dansoman.

7.4 Problems Encountered during the Year

A few problems were encountered during the year. These were as follows:

- Delays in procurement and supply of media and reagents for microbiological analysis
- Delays in typing of analytical reports

PART III

RESEARCH ACTIVITIES

SECTION I
FOOD EVALUATION AND PRODUCT DEVELOPMENT PROGRAMME

Chapter 7.0

Agricultural Sub-Sector Improvement Project

7.1. Introduction

Scientists in the National Agricultural Research Systems (NARS) are undertaking the Agro-processing Programme under the research component of the 1st phase of the Agricultural Sub-Sector Improvement Project (AgSSIP). This Agro-processing component is being coordinated by the FRI.

7.2 Goal

To contribute to national efforts at reducing the post-harvest losses at the farm-gates and in the fishing industry, improving food security, improving nutritional security as well as improving the socio-economic status of all Ghanaians and also improve export of non-traditional products to help reduce Ghana's balance of payment.

7.3 Purpose

To reduce post-harvest losses of food staples of Ghana as well as improve the socio-economic development through development and diffusion of appropriate technologies, which will add, value to agricultural and fish produce.

7.4 Technical and sensory evaluation of rice varieties from various improvement Programmes in Ghana

- Introduction: For the period under review the physical quality, sensory evaluation and receipt development of twenty (20) local rice samples were carried out. The samples were obtained from the southern part of the country specifically Afife, Dawenya, Akuse/Kpong, Asutuare, Ashaiman and Accra and the control sample used was US No. 5.

- Physical Quality Evaluation: The parameters used for the physical quality evaluation can be found below, moisture content, %whole and broken grains, presence of stones, immature grains, extraneous material, paddy, husk, red rice, moudly grains, chalky grains and discoloured grains. All the samples were generally free from stones most

probably due to the use of tarpaulins and concrete floors in drying and also the type of mills in the southern part of the country where rice is cultivated. Apart from the high percentage brokens, the local samples compared fairly to the control sample in appearance. The sample (AGR 10) from Accra was the one with the least percentage of broken grains while that from Asutuare (GR 3) was the one with the highest percentage of broken. As regards the other parameters there was very little difference between the control and the various samples. It can therefore be said that local samples compare very well with the control in terms of their physical quality. Attached is the result of the evaluation.

- Sensory Evaluation: Sensory evaluation was done on both raw and cooked samples. 18 samples were evaluated and respondents were trained to score on the raw and cooked samples. Attached is the summary of comments made by respondents. The least attractive sample of the raw samples was Kpong 1. Though very attractive physically Asutuare 1 had high level of brokens. Dawenya 3 had the best appearance.

- Recipe Development: 9 recipes were developed. The recipes were rice tatho, rice biscuits, queen cakes, bread, rice puffs, rice moulds, rice strips, rice "agidi", rice and banana fritters and rice pancakes. Apart from the rice bread all the other products were made from 100% rice flour. 9 recipes were developed and photographs taken. Apart from the bread all the other 8 recipes were developed from 100% rice flour. For the bread, wheat flour was added and it constituted 30%, 40% and 50%. The 30% wheat flour and 70% rice flour came closest to normal bread made up of 100% wheat flour.

7.5 Improving the hot-air processing of fish using the Chorkor Smoker

- Project Leader: Daniel Blay
- Other Project Members:
  - L. D. Abbey
  - M. Atikpoe, Mrs.
  - E. C-T. Tettey
- Project Location: Fishery Resource Center, Fri, Accra
- Start And End Date: June, 2002 to May, 2004
- Project Purpose: To improve the efficiency of the chorkor smoker through improvements in the energy and ergonomic characteristics as well as reduction/elimination of the tar usually associated with fish processed by the smoker.
- Project Objectives: To develop an improved smoker which reduces heat loss eliminates the interchanging of tray positions thus making fish smoking less laborious, as well as reduction/elimination of the tar usually associated with fish processed by the original chorkor smoker.
- Summary of Activities Carried Out:
  - Design of FRI Smoking Oven (FRISMO)
  - Construction of FRISMO
  - Testing of FRISMO for leakages
  - Five (5) Test runs of FRISMO
    - Test run with no load
    - Test run with 40% capacity load
    - Test run with 70% capacity load
    - Test run with 85% capacity load
    - Test run with 100% capacity load

7.6 Studies on the characteristics, development and utilization of food products from groundnuts varieties grown in Ghana

- Goal: To contribute to the national effort at reducing the post harvest losses, improving food security and improving export of non traditional products to help reduce Ghana's balance of payments.
- Purpose: To screen available and newly released varieties of groundnut for specific uses and thereby help promote its greater utilisation in Ghana.
- Project members: Phoebe Lokko (FRI), Kafui Kpodo (FRI), Frimpong Adams (SARI) and Margaret Ottah Atikpo (FRI).
- Supporting Staff: Iris Tamakloe (FRI).
- Project Location: Food Research Institute.
- Duration: June 2002 - May 2003.
- Background Information: Groundnuts (*Arachis hypogea*) is a highly acceptable food item in Ghana, being viewed as a nutritious, delicious and a health food, hence improvement in the quality of existing groundnut products and developments of new products need to be addressed. Ghanaians, traditionally, consume groundnuts boiled, roasted, raw, and in processed forms such as groundnuts paste, candies and milk. Groundnuts are also used as ingredients in traditional dishes such as groundnut soup, groundnut and palm soup, groundnut and *nkontomire* soup, *dzowe*, *Oto, saabo* cutlets and in confectionery and bakery products. Research has shown groundnuts to be satiating, help to keep stable body weight in spite of high fat content and also reduce cardiovascular risk factors such as cholesterol and obesity in humans. The oil is used as food in the pharmaceutical industry. The cake is used in animal feed. Not all the varieties produced however are good for every groundnut product. Some varieties are best for oil production while others are best for confectionery. The overall objective of this project therefore is to produce different varieties of groundnuts and use these varieties in preparation of groundnut products. It is hoped that the varieties best suitable for specific products would be identified.
- Objectives
  - To produce and characterize five varieties of groundnuts
  - Investigate the suitability of the use of different varieties in recipes and in product development especially for export.
  - Investigate the effect of processing into paste on the five different varieties i.e. rheological properties and shelf life of products.
  - Document and disseminate the results at workshop.

➢ Results

Table 1. Characterizations of five varieties of groundnuts Chemical Analysis

Variety	Days of maturity	Potential Yield (t/ha)	Seed color	Oil content (%)	100 seed weight (g)
F mix	120	2.5	Tan and white	49	52
Chinese	100	2.2- 2.5	Brown	35	39
Zinkazie	120	2.2	Red	46	62
ManiPinta	120	2.5- 3.0	Red, brown and white	53	53
J.L 24	100	2.2	Light brown	35	40

Table 2 Chemical Profile of the Five Groundnut varieties

Parameter	F-Mix	Chinese	Zinkazie	Manipinta	JL-24
Moisture (%)	4.6	4.2	4.8	4.6	5.0
Fat (%)	51.2	49.3	50.7	47.8	47.1
Ash (%)	2.3	2.4	2.4	2.4	2.6
Protein (%)	26.7	24.8	28.5	28.7	29.3

The moisture content of the samples ranged from 4.2 - 5.0% fat 47.1 – 51.2%, ash, 2.3 – 2.6% and protein 224.8 to 29.5%. The measured values for moisture, fat, ash and protein are all within the expected ranges (FAO, 1968). However, there were differences in the oil content from SARI's analysis and FRI's analysis

➢ Aflatoxin Analysis

Aflatoxin contamination caused by *A. flavus* and *A. parasiticus* in groundnut is one of the most important constraints to groundnut production in many countries in the West African sub- region. Contamination by mould growth is significantly affected by storage conditions of climate and moisture content of the peanuts under both pre and post harvest conditions. All the five samples of peanuts contained aflatoxins at varying levels. F-mix presented with the highest total aflatoxin level of 5,039ug/kg, which is much higher than the FAO recommended maximum permissible limit of 30ug/kg. The other 4 samples contained less than the recommended maximum permissible amount (FAO, 1968).

Table 3 Aflatoxin Levels in the five varieties of groundnut

Parameter	F-Mix	Chinese	Zinkazie	Manipinta	JL-24
Aflatoxin B1 (µg/kg)	4,161.5	8.9	0.9	3.5	1.4
Aflatoxin B2 (µg/kg)	878.2	2.3	ND	ND	ND
Aflatoxin G1 (µg/kg)	ND	ND	ND	ND	ND
Aflatoxin G2 (µug/kg)	ND	ND	ND	ND	ND
Total Aflatoxins (µg/kg)	5039.7	11.2	0.9	3.5	1.4

➢ Microbiological Analysis

The 5 groundnut samples were accessed for their microbiological status. Aerobic plate counts, mould and yeast counts, coliform counts, *E. coli* and pH. Total viable aerobic plate counts at 30 °C of all varieties did not indicate significant variation and ranged between 1.0 x 104and 8.3 x104 cfu/g. The mould and yeast counts ranged between 1.0 x 10^2 and 5.1 x 10^4 cfu/g, predominant moulds were *Aspergillus niger, A. ochraceus* and *Mucor* spp. Coliform counts were less than 10 cfu/g in all the samples except Zinkarzie which had 1.4 x 10^2 indicating possible faecal contamination due possibly to the drying surface dust etc. The pH values ranged from 6.81 – 6.97.

Table 4. Total viable counts, mould and yeast count, coliform count and E. coli count of the groundnut varieties

Groundnut sample	Total viable count at 30°C (cfu/g)	Mould and yeast count (cfu/g)	Coliform count (cfu/g)	*E. coli* count (cfu/g)	pH	Dominant Flora
Manipinta	**1.6 x 10^4**	**5.1 x 10^4**	**< 10**	**<10**	**6.97**	*A. niger*, *A. ochraceus*. Yeasts, *Bacillus* spp
F-mix	**1.0 x 10^4**	**2.5 x 10^2**	**< 10**	**<10**	**6.87**	A. niger, *Bacillus* spp, Micrococci
Chinese	**8.3 x 10^4**	**1.8 x 10^4**	**< 10**	**<10**	**6.89**	*A. niger*, *A. ochraceus*. *Bacillus* spp Micrococci
Zinkazie	**2.3 x 10^4**	**1.0 x 10^2**	**1.4 x 10^2**	**<10**	**6.92**	*A. niger*, Yeasts, Bacillus spp Gram negative rods
JL-24	**3.3 x 10^4**	**1.4 x 10^2**	**< 10**	**<10**	**6.81**	*A. niger*, *Mucor* spp, *Bacillus* spp

➢ Sensory Evaluation

Test Method: Same quantity of the 5 varieties was plain roasted at the same temperature for the same period of time. Fourteen well trained panelists were served whole unpeeled roasted groundnuts. Ordinary water and cream cracker biscuit were given as mouthwash after each sampling. The sensory attributes requested for evaluation were: Appearance; Colour; Taste; Crunchiness; Sweetness; Flavour – nutty; Aroma; Mouth feel; Overall acceptability.

Table 5. Sensory Evaluation on Plain roasted groundnuts

	Manipinta	F-mix	Chinese	Zinkazie	JL-24
Appearance	7.4 ±1.2	6.6 ±0.8	7.9 ± 0.6	7.4 ±0.9	8.3 ±0.5
Colour	7.2 ± 1.1	7.1 ± 0.9	8.1 ± 0.5	7.5 ± 0.9	8.2 ± 0.4
Nutty Flavour	7.2 ± 0.8	6.9 ± 0.8	7.9 ± 0.9	7.4 ± 0.9	7.9 ± 0.8
Taste	6.7 ± 0.82	6.7 ± 0.8	8.0 ± 0.9	7.2 ± 1.1	8.0 ± 0.6
Sweetness	6.5 ± 1.1	6.8 ± 0.9	8.0 ± 0.9	7.2 ± 1.1	7.8 ± 0.7
Crunchiness	7.4 ± 0.7	7.7 ± 0.7	7.7 ± 0.8	7.5 ± 1.1	7.5 ± 0.6
Aroma	6.8 ± 0.6	6.8 ± 0.9	7.9 ± 0.7	7.1 ± 0.8	7.8 ± 0.9
Mouth feel	6.8 ± 0.86	7.0 ± 0.9	7.8 ± 0.9	7.4 ± 1.0	8.0 ± 0.6
Overall acceptability	7.1 ± 0.6	6.7 ± 0.9	7.9 ± 0.6	7.4 ± 0.9	8.1 ± 0.5

➢ Dzowe-Chemical, microbiological and sensory studies.

The 5 peanut varieties were used to prepare Dzowe as a sweet snack. The peanut product was chosen because it has export potential and many people enjoy it.

Table 6. Chemical Profile of Dzowe prepared from the 5 Groundnut Varieties

	Manipinta	Chinese	Zinkazie	F-Mix	JL-24
Moisture (%)	3.0	2.8	3.1	2.9	3.0
Ash (%)	2.2	2.2	2.0	2.0	2.1
Protein (%)	16.6	16.7	14.6	13.4	16.9
Fat (%)	23.5	20.7	21.9	21.3	22.8
Carbohydrate including fibre (%)	54.7	57.6	59.0	60.4	55.2
Energy /100g	496.7	483.5	491.7	486.9	493.6

It is also quite nutritious and very high in energy; Dzowe is prepared from peanuts, roasted maize meal, sugar and other condiments. The samples were prepared under supervision by a professional Dzowe producer. The chemical, microbiological and sensory analyses as well as consumer studies were conducted on the product.

- Microbiological Analysis

Five Dzowe samples were accessed for their microbiological status. The aerobic plate count at 30 oC ranged between 5.6 x 10^5 and 1.2 x 10^7 cfu/g. the mould and yeast count between 3.0 x 10^2 and 5.1 x 10^4 cfu/g. Coliform counts ranged between 2.4 x 10^1 and 1.8 x 10^3 cfu/g, *E. coli* counts ranged between 5.0 x 10^1 and 1.4 x 10^2 cfu/g. *bacillus cereus* and *staphylococcus aureus* counts were less than 1.0 x 10^2 cfu/g while *salmonella* species were not detected in 25.0 g of any of the samples. Dominant flora in the samples include Gram-positive sporing motile and non motile rods, gram- positive cocci, *Aspergillus* species and yeast. The pH of the groundnut paste ranged from 6.2 – 6.7.

Table 7 shows the quantitative and qualitative microbial status of the Dzowe samples.

Table 7 Microbial load of groundnut Dzowe

Dzowe	Aerobic microbes (cfu/g)	Moulds & yeasts (cfu/g)	Coliform organisms (cfu/g)	*E. coli* (cfu/g)	*Salmonella* species (25g)	*Bacillus cereus* (cfu/g)	*Staphylococcus aureus* (cfu/g)	pH	Dominant Flora
Manipinta	6.0 x 10^6	1.4 x 10^4	1.8 x 10^3	1.4 x 10^2	Absent	1.0 x 10^2	1.0 x 10^2	6.2	Gram +ve sporing rods, Gram +ve cocci, yeasts
Chinese	5.6 x 10^5	3.0 x 10^2	6.0 x 10^2	5.0 x 10^1	Absent	1.0 x 10^2	1.0 x 10^2	6.2	Gram +ve sporing rods, Gram +ve cocci, yeasts, *Aspergillus* spp
F-mix	1.3 x 10^6	2.5 x 10^4	1.8 x 10^2	5.0 x 10^1	Absent	1.0 x 10^2	1.0 x 10^2	6.3	Gram +ve sporing motile rods, yeasts
Zinkazie	1.2 x 10^7	4.5 x 10^4	2.4 x 10^1	4.0 x 10^1	Absent	1.0 x 10^2	1.0 x 10^2	6.3	Gram +ve sporing motile rods, Yeasts, *Aspergillus* spp
JL-24	4.0 x 10^6	5.1 x 10^4	1.7 x 10^2	8.0 x 10^1	Absent	1.0 x 10^2	1.0 x 10^2	6.7	Gram +ve sporing rods, yeasts

The recommended limit of aerobic mesophiles GSB (1998) and ICMSF (1982) is < 1.0 x 106cfu/g. thus only Dzowe prepared with Chinese qualified. The mould and yeast count, specified by both Boards is < 1.0 x 104cfu/g. Again Chinese Dzowe product was within limit. The E. coli was also high in product prepared with manipinta. All other tests were within acceptable levels. The product was stored for 4 months and analyses are being conducted on these samples to see if there has been any deterioration

Table 8. Sensory Analysis of 5 Dzowe Samples

	Manipinta	Chinese	Zinkazie	F-mix	JL-24
Appearance	7.67 ± 0.76	7.13 ±1.6	7.66 ± 0.64	7.87 ±1.09	7.13 ±1.99
Taste	7.07 ± 1.09	7.20 ± 1.6	7.07 ± 0.99	7.60 ± 0.77	7.20 ± 1.01
Aroma	7.07 ± 0.79	7.07 ± 1.44	7.07 ± 0.90	7.47 ± 1.59	7.07 ± 0.96
Texture	7.47 ± 0.52	7.07 ± 1.16	7.47 ± 1.42	7.40 ± 1.53	7.33 ± 0.98
Mouth feel	7.33 ± 0.89	7.00 ± 1.41	7.33 ± 0.94	7.40 ± 1.72	7.13 ± 0.99
Hotness	6.93 ± 1.44	7.00 ± 0.85	6.93 ± 1.59	7.13 ± 1.07	7.13 ± 0.92
Overall acceptability	7.20 ± 0.86	6.93 ±1.166	7.20 ± 1.06	7.47 ± 1.06	7.27 ± 0.88

➢ Results from the Consumer Studies

The Dzowe samples were distributed to 60 consumers who were asked to consume the product and make comments and decide whether they would buy the snack if it were for sale. Acceptability tests were also conducted on groundnut soup, groundnut paste and groundnut candy (Nkaticake).

Table 9. Consumer acceptability test for Dzowe from the Five Groundnut varieties

	Manipinta	F-mix	Chinese	Zinkazie	JL-24
Taste	7.43 ± 1.76	7.86 ±1.50	7.61± 1.67	7.79 ±1.44	7.76 ±1.45
Appearance	8.33 ± 0.98	8.04 ± 1.27	8.31± 1.14	8.22 ± 1.23	8.53 ± 0.71
Texture	8.22 ± 1.32	7.27 ± 1.77	7.78± 1.56	7.41 ± 1.69	8.33 ± 1.19
Overall acceptability	7.38 ± 1.42	7.61 ± 1.51	7.71 ± 1.59	7.67 ± 1.46	7.84 ± 1.46
Will you buy it?	Yes = 38, No =10	Yes = 40 No =8	Yes = 38, No =10	Yes = 37, No =11	Yes = 40, No =8

Table 10. Acceptability test for Groundnut Soup

	Manipinta	F-mix	Chinese	Zinkazie	JL-24
Taste	7.43 ± 1.76	7.86 ±1.50	7.61± 1.67	7.79 ±1.44	7.76 ±1.45
Appearance	8.33 ± 0.98	8.04 ± 1.27	8.31± 1.14	8.22 ± 1.23	8.53 ± 0.71
Texture	8.22 ± 1.32	7.27 ± 1.77	7.78± 1.56	7.41 ± 1.69	8.33 ± 1.19
Overall acceptability	7.88 ± 1.42	7.61 ± 1.51	7.71 ± 1.59	7.67 ± 1.46	7.84 ± 1.46
Will you buy it?	Yes = 38, No =10	Yes = 40 No =8	Yes = 38, No =10	Yes = 37, No =11	Yes = 40, No =8

Comments made suggest that although the soups were acceptable, F-mix was too thick, not attractive and had no oil on top. Chinese was good but has no oil on top either. Zinkazie soup tasted good, attractive, would do well with kokonte and fufu Manipinta soup tasted good but left residual spots in the mouth JL-24 has lots of oil on top but tastes good

Table 11. Acceptability test for Groundnut Paste

	JL-24	Chinese	Manipinta	F-mix	Zinkazie
Appearance	6.1 ± 2.1	8.0 ± 0.75	7.06± 1.6	6.6 ± 1.5	6.0 ± 1.8
Taste	7.0 ± 1.8	7.7 ± 0.72	6.5 ± 2.06	6.4 ± 1.6	5.9 ± 2.2
Aroma	7.0 ± 1.5	7.7 ± 0.59	6.9 ± 1.38	6.7 ± 1.3	6.3 ± 1.7
Mouth feel	6.9 ± 1.5	7.7 ± 0.59	6.6 ± 1.2	6.9 ± 1.2	6.2 ± 1.9
Overall acceptability	6.9 ± 1.7	7.7 ± 0.61	6.4± 1.8	6.6 ± 1.2	6.0 ± 1.96

For the paste, Chinese was the one preferred followed by JL-224. The least liked was Zinkazie, which tasted like raw groundnut, no taste and not attractive. JL-24 and Chinese were ranked 1st and 2nd respectively. In conclusion, the JL-24 and Chinese were the two varieties of groundnuts which were preferred by panelists. They also produced the best groundnut products. It is therefore recommended that, J L -24 and Chinese be used in preparation of food products and F-Mix, Manipinta and Zinkazie for oil and cake production and products containing sugar. All the varieties can be used to prepare candies and dzowe.

- Preferred Ranking Test on Nkaticake Made From the Five (5) Varieties of Groundnuts

Ranking: 1= Like best, 5= Like least Panel=20

- Manipinta: mean ± SD = 3.07±1.28
- Chinese: mean ± SD = 3.13±1.50
- Zinkazie: mean ± SD = 2.6±1.64
- F-mix: mean ± SD = 2.67±1.4
- JL-24: mean ± SD = 3.53±1.25
- JL-24 and Chinese came first and second respectively.

In conclusion, JL-24 was the best groundnut variety for food products preparation followed by Chinese

- Future Activities
  - Shelf life studies of groundnut paste
  - Workshop on the inclusion of groundnuts in recipes
  - Write up of Technical Report

7.7 *Improving the post-harvest processing of prawn, shrimps and lobsters to access the export market*

- Project Leader: L. D. Abbey FRI
- Collaborating Institutions: WRI, FISHERIES DEPT. (MOFA)
- Other Project Members: M. Atikpoe FRI, G. Komlaga FRI, Entsua-Mensah WRI, K. A. deGraf Johnson WRI
- Project Location: FRI, Accra
- Introduction: Frozen shellfish, and in particular lobsters, have become a big demand driven export commodity in the fisheries sector of the Ghanaian economy. However, the products do not meet the standards of importing countries and are frequently subjected to confiscation, rejection and in certain cases outright destruction.
- Project Purpose: To improve the income earnings of exporters of shellfish through improvements in the post-harvest handling and quality assurance systems
- Previous Results (or outputs)
  - A progressive decline in the quantities of prawns but increases of lobsters exported annually.
  - More and more smaller sizes caught
  - Habitat pollution is a major cause of contamination of products.
- Fishing Seasons/Major landing sites

  Season: May- August

  Peaks: September- October.

  Low: November- April.
- The major fishing and landing grounds:
  - Keta to Ada,
  - Axim to Cape Three Points
- Further work
  - Quality assessment on the live holding of prawns/ lobsters.
  - Frozen storage of prawns /lobsters.
  - Identification and assessment of critical control points for HACCP applications

7.8 Development of diesel/kerosene operated drying machines for food-grains for small- and medium-scale producers

- Project Leader: C. K. Gyato
- Collaborating Institutions/ Departments
  - Food Research Institute CSIR
  - Industrial Research Institute CSIR
  - Ministry of Agriculture
  - KNUST
- Project Location: Food Research Institute CSIR
- Start and End date: April 2002- Dec 2004
- Project Purpose: To alleviate the problems farmers, traders, and processors face with the drying of food- grains after harvest through the provision of a low cost, yet effective and appropriate on-farm dryer.
- Project Objective
  - To develop low cost, affordable and yet efficient food-grain drying machines (diesel/ kerosene operated) for small & medium scale producers, processors and marketing agencies
  - To allow early harvesting of food-grains (maize, cow-pea, etc.) thus eliminating on farm moulds and pests infestation due to delayed harvesting.
  - To enhance storage (shelf-life) of food-grains
  - To achieve high quality products (maize, cowpea, etc.) to meet the export market requirements.
- Brief Summary of Activities Carried out.

Established the design considerations based on scale of operation and production.

- Surveys were conducted in some of the major maize growing areas and organizations to ascertain types and capacities of existing dryers, and levels of production and handling.
- Surveys covered Ejura Farms Limited in the Ashanti region, Food Distribution Corporation -Sunyani and Wenchi in the Brong-Ahafo region, the Nkwanta-Kpasa district, the Krachi-Dambai district, the Hohoe and Kpandu district in the Volta region.
- Based on the results of the survey, a two- ton per batch drying capacity was considered as the underlying factor for the design of the dryer.

➢ Research Activities carried out

Design and construct prototype atomizer.

- ❖ Design work on the prototype atomizer was completed.
- ❖ Construction of the atomizer nozzles is on going and was about 80% completed. A high- pressure pump has been purchased for the purpose.

Design and construction of heat generator

- ❖ Design work on the heat generator was completed: The construction of the heat generator was completed, i.e. the construction of the heat generator unit parts notably the fan assembly and fan housing, the burning chamber, and the heat generator body have been completed.
- ❖ Assembly of the unit parts is on going currently and is about 70% complete.

Re design of the Power and Driving Systems

- ❖ Upon advice from the World Bank technical team, a re design of the power and driving system is being carried out.
- ❖ This will allow the drying machine to be electrically powered or engine powered.
- ❖ The design is 80% complete, and an 8 h.p. diesel engine as power source has been purchased for that.
- ❖ Materials for construction of the new design have been purchased.
- ❖ Design considerations are also given to the prototype atomizer to be either electrically controlled or driven from the power of the engine.
- ❖ It is expected that early next year the generator will be fired and tested.

➢ Outstanding Achievements

- ❖ Design work on the prototype atomizer is 100% complete.
- ❖ Construction work on the prototype atomizer is 80% complete.
- ❖ Design work on heat generator is 100% complete.
- ❖ Construction work on the unit parts of the heat generator is 100% complete.
- ❖ Re-design of the power and driving system is 80% complete.

7.9 Improvements in the preservation and utilization and promotion of some traditional leafy vegetables to access the urban markets

➢ Project Team

- P. Johnson (FRI) - Food Technologist
- S. Noamesi (FRI) - Post-harvest Physiologist
- G. Timpo (KNUST) - Horticulturist
- M. Yeboah (KNUST) - Pathologist/Breeder
- D. Abusah (FRI) - Chem. Engineer
- W. Quaye (FRI) - Socio-economist
- Technical Staff from FRI, SARI and KNUST

Project Importance

- Traditional leafy vegetables (TLVs) are very good sources of micronutrients; badly needed for good health.
- Post-harvest management of TLVs in Ghana is not developed.
- Appropriate technologies for improving the preservation of selected TLVs could help establish protocols for post-harvest management of most TLVs in Ghana and thereby increase their availability and wider use in the urban towns.

Expected Outputs

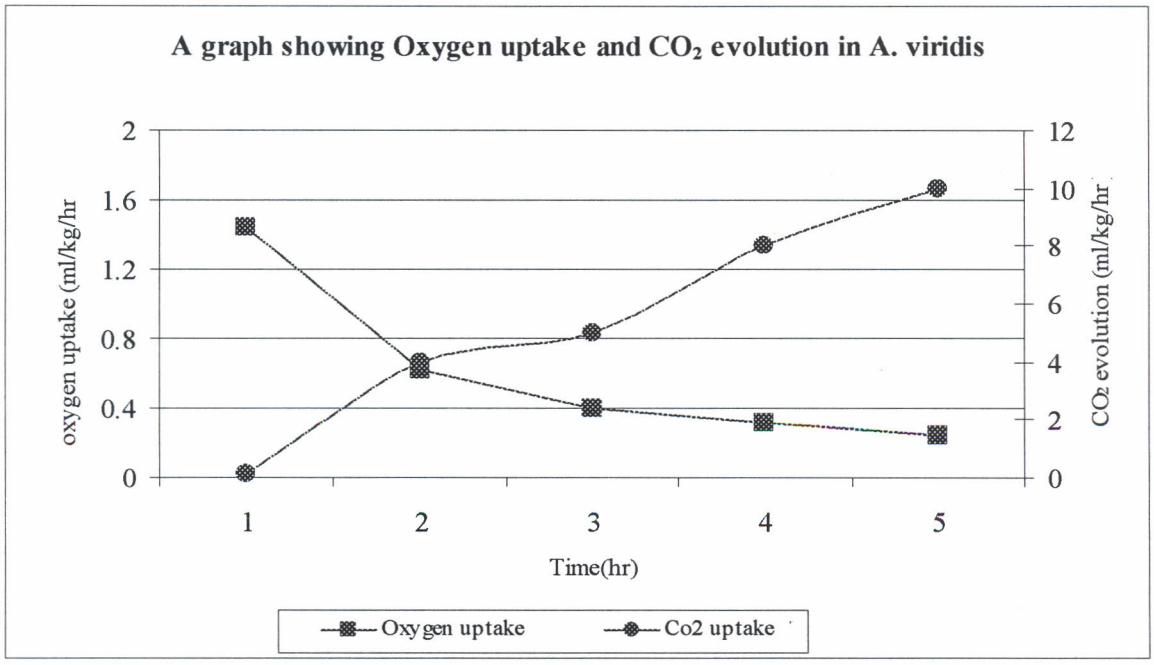
- Appropriate technologies for improving the preservation of selected TLVs developed.
- Market potential of the selected TLVs, using the developed technology, assessed in 4 supermarkets in Accra and Kumasi.

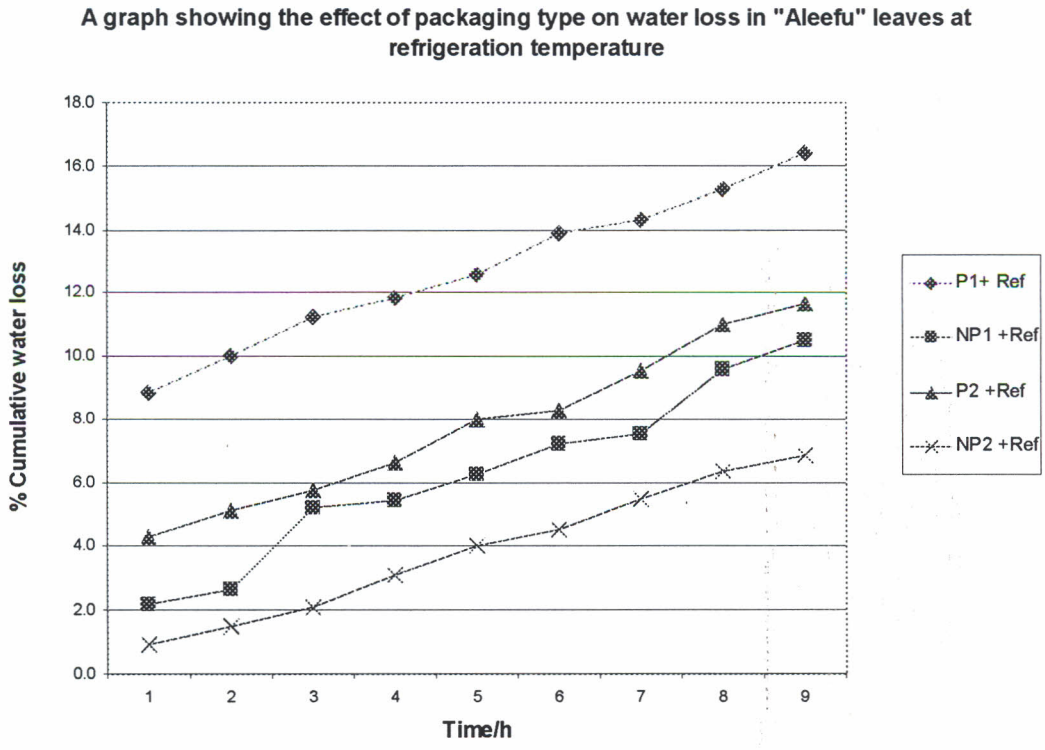
What are we doing?

- Investigate the post-harvest physiology relevant to shelf-life of the selected TLVs.
- Investigate the effect of temperature, humidity and packaging on the shelf-life characteristics.
- Develop appropriate techniques for increasing the shelf-life.
- Market-trials using new technology at selected supermarkets

Milestones by Jan 2004

- Post-harvest physiology relevant to the shelf-life of TLVs.
- Effect of temperature, humidity, pre-treatment and packaging on the shelf-life of TLVs established.

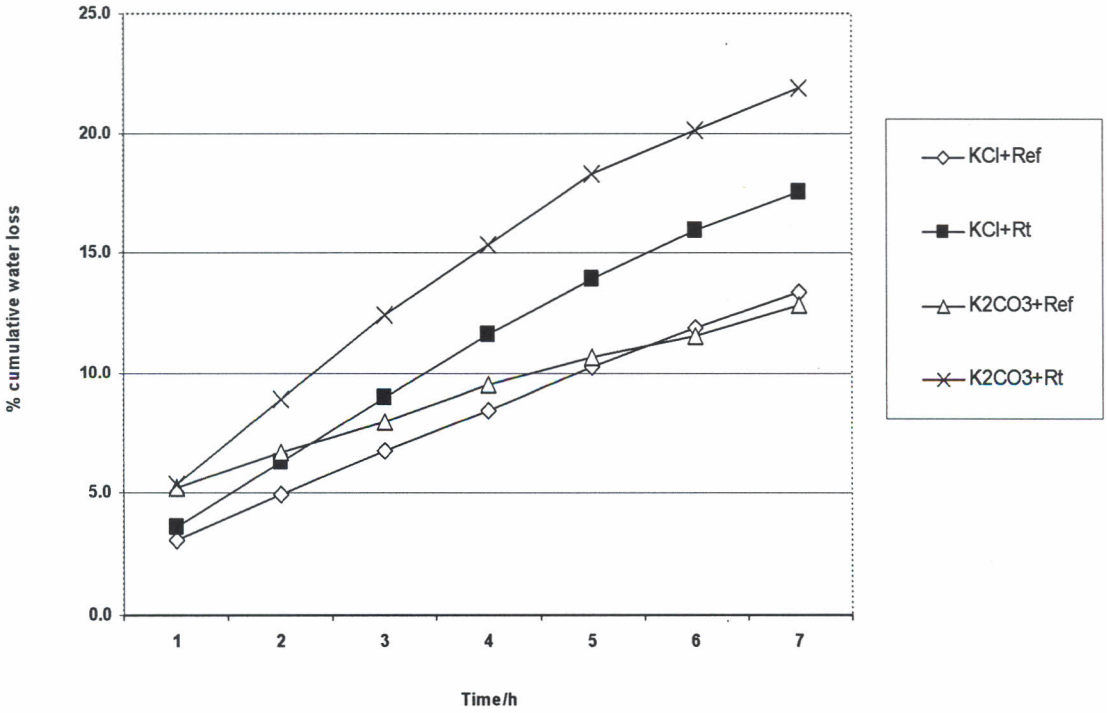




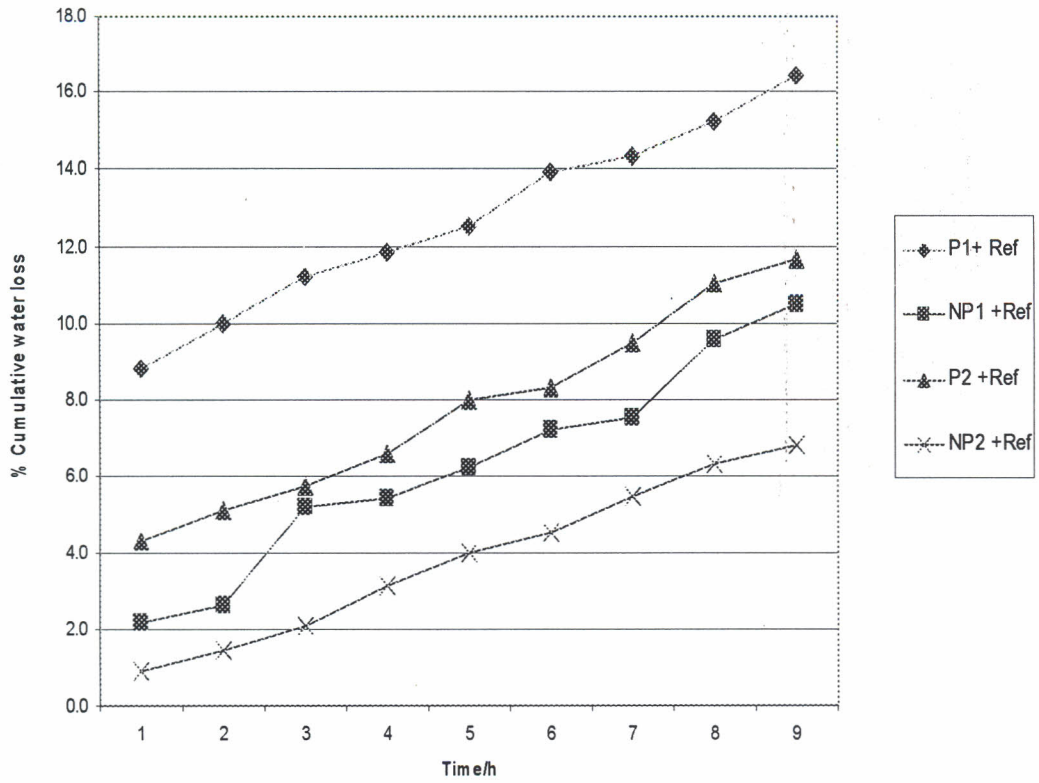
Results (Inferences & Achievements)

- Activities: 2 of the 3 planned activities for Year1 and Year 2 completed.
- Publication: Tech Rep. "Some post-harvest physiological indices of *Amaranthus* spp."
- Present Activity: Sub-activity 1.3. Develop appropriate techniques for increasing shelf life (on-going)

A graph showing the effect of humidity and temperature on water loss in "Aleefu"



A graph showing the effect of packaging type on water loss in "Aleefu" leaves at refrigeration temperature



7.10 *Varietal screening of soybean, bambara and cowpea for anti-nutritional factors and suitability for specific uses*

➢ Project Team

- ❖ W. Plahar (FRI) - Food Technologist
- ❖ H. Adu-Dapaah (CRI) - Breeder
- ❖ N. Denwar (SARI) - Breeder
- ❖ N. Annan (FRI) - Food Chemist
- ❖ A. Osei-Yaw (FRI) - Food Technologist
- ❖ P. Larweh (FRI) - Home Scientist

➢ Project Importance

Chemical, functional, nutritional and anti-nutritional characteristics of newly released varieties of selected legumes evaluated for their processing characteristics and specific food uses.

➢ Expected Output

Compositional, functional and anti-nutritional characteristics and specific food uses of selected bambara, cowpea and soybean established.

➢ Results (Inferences & Achievements)

- ❖ New varieties identified and samples collected.
- ❖ Compositional, functional and anti-nutritional data on released bambara, cowpea and soybean available.
- ❖ Work on 6 new varieties of soybean from SARI: Physical, water absorption, proximate composition, trypsin inhibitor activity and sensory properties of milk from the varieties established.
- ❖ Varieties: TGX-1445, TGX-1445,TGX-1834, TGX-1799, TGX-1448, TGX-1805.
- ❖ TGX-1448-2E was found to have good nutritional quality with protein content 40% and with low levels of trypsin inhibitor activity(TIA).
- ❖ Publication. Tech Report. Quality characteristics of soybean varieties and suitability of TGX-1448-2e for soy milk production.

Chapter 8

EU/FRI/ Cassava/ SMEs Project on development of the small and medium-scale enterprise sector producing cassava based products to meet emerging urban demand in West Africa"

8.1 Collaborating Institutions

- NRI- UK
- FRI- Ghana
- Dept of Agric Extension,
- UAN-Nigeria
- Institute of Advanced Studies, Austria
- Feed & Flour Ghana Ltd and other Cassava-based food manufacturers in Ghana and Nigeria Cassava SMEs (DFID/EC funded)

8.2 Project Duration

Cassava SMES is one of most significant interventions in post-harvest sector for cassava in West Africa. This has brought together two of most important cassava producing countries – Ghana/Nigeria. The timeframe is from 1999-2005. The product originated from two DFID funded and one EC funded project. The DFID projects are from 1999-2003 and the EC project is from 2003-2005

8.3 Background to CASSAVA-SMES

- Cassava - food security and income generation crop
- Research on cassava has been neglected relative to other crops.
- Recent interventions made in crop production s
- Post-harvest and marketing sector innovations required to ensure financial returns to producers and ensure a supply of safe, acceptable foods to the urban centres.

8.4 Overall aim

"Develop selected cassava based foods (fermented fufu, pounded fufu, kokonte, cassava grits and local "starch") to meet the changing and growing urban demand through the production of products that are convenient, of high quality and are safe.

8.5 Approach

Takes into account market demand and consumer preferences, the needs of rural products and processors and the needs of newly emergent or established SMEs. Includes issues of technology development, market economics, business development and social development are addressed in an integrated manner. Aim for approach to be more generally applicable.

8.6 *Objectives of CASSAVA-SMES*

- Develop/promote best practice guidelines for the commercialisation of traditional food products using cassava products as a model.
- Develop/test specific technologies for the commercialisation of cassava based products.
- Understand/optimise impacts of commercialisation specifically that based on SMEs, on the livelihoods of traditional processors.
- Assess potential of traditional processors to produce high quality products that meet urban demand.
- Develop appropriate QA/HACCP systems for SMEs.
- Development more cost-effective and environmentally sensitive processes that will make commercially manufactured cassava products more affordable.
- Establish "best practice" for establishment, support and promotion of SMEs producing traditional food products
- Examine/select marketing strategies and distribution systems which effectively target urban markets.

8.7 *DFID's past/present post-harvest portfolio*

Cassava: two main objectives

- Overcoming physiological deterioration (U. Bath/CIAT)
- Developing new market opportunities (Various incl, NRI)
    - Commercialization of a traditional cassava product (*fufu* in Nigeria): Using sustainable livelihood approach to look at how best to commercialize a traditional product (Continues with CASSAVA-SMEs)
    - Commercialization of cassava according to market demands (Tanzania): Using sustainable livelihoods approach to look at farmer/processor organization to address market opportunities (Continues with innovation systems project)
    - Development of cassava chips as a product for urban market (Ghana): Linkages with small scale processing enterprises to produce high quality products (Continues with CASSAVA-SMEs)
    - Cassava industrial applications (Ghana): Linking small farmers with commercial/industrial industries (Continues with innovation systems project)
    - Cassava/sweet potato commercialisation (Mozambique) : (Innovation systems project)

SECTION II

FOOD BIOTECHNOLOGY PROGRAMME

Chapter 9
Capability Building for Research into Traditional Fermented Food Processing in West Africa

9.1 Collaborating institutions

- Food Research Institute, P.O. Box M20, Accra, Ghana (FRI).
- Department of Biological Sciences, Faculty of Applied Sciences, University for Development Studies (UDS), P. O. Box 1350, Tamale, Ghana,
- Centre National de la Recherche Scientifique et Technologique, BP 7047 Ouagadougou, Burkina Faso (DTA).
- Department of Nutrition and Food Science, Faculty of Agricultural Sciences, National University of Benin, B.P. 526, Cotonou, Benin (FSA/UNB)
- Department of Dairy and Food Science, The Royal Veterinary and Agricultural University, Denmark (KVL).
- Alfred Jørgensen Laboratories Ltd. Denmark.

9.2 Introduction

This collaborative project, which is being funded by DANIDA, was initiated in July 1991. It is currently in Phase 111 and will be completed in July 2004. The project comprise capability building and the establishment of appropriate environments for research into food fermentations to support collaboration between West African countries and provide assistance to local industries at various levels in the production of uniform and safe fermented African foods of defined quality. Four major activities are included for the four African partners.

- Establishment and management of laboratories for analytical work and research.
- Collaborative research activities within the field of food fermentation, food processing and quality management in general.
- Training and exchange of staff between project partners.
- Extension of services to local industries and networking activities in Africa.

9.3 Activities:

9.3.1 PhD programmes

- One PhD thesis: "*Fusarium species* and *fumonisins* in maize and fermented maize products in Ghana" was successfully defended at the University of Ghana Legon in June 2003.

- Two PhD theses were completed and submitted to the University of Ghana in 2003.
  - Aroma Characteristics in Ghanaian Maize Dough Fermentations by Nana Tekyiwa Annan
  - Effect of soybean and cowpea fortification on the microbiological, biochemical and physical characteristics of cassava dough (agbelima) by Margaret Ottah Atikpo.
- One PhD thesis on Microbial interactions in maize fermentation - the role of pH and organic acids was almost completed.

9.3.2 MPhil Programmes

Two MSc projects were completed by two students from the Nutrition and Food Science Department of the University of Ghana. They carried out the projects in our laboratories under the supervision of Dr W. A. K. Amoa- Awua on the following topics:

- Bioconversion of tuna wastes into fish sauce – Ireneous Soyiri (Thesis submitted)
- Production and preservation of starter cultures for maize fermentation – Wisdom Serlom

9.3.3 Laboratory Accreditation

Activities for the accreditation of the Microbiology, Mycotoxin and Chemistry laboratories to ISO 17025 Quality System continued. Two internal audits were conducted in each of the three laboratories preparing for accreditation to ISO 17025 i.e. Microbiology, Chemistry and Mycotoxin.

One external audit of the Quality System of the Food Research was conducted in November 2003 to determine whether the quality system was implemented in the Microbiology, Chemistry and Mycotoxin laboratories and whether the requirements of ISO 17025 are met. Two consultants from Eurofins Denmark conducted the external audit. The microbiology laboratories participated in 6 proficiency tests under GK BIO PRODUCTS of UK, within the year and faired very well in all 6 tests.

9.3.4 Training and exchange of staff

Nana Tekyiwa Annan trained two scientists, one each from University of Development Studies Tamale and Department of Food Technology Ouagadougou Burkina Faso in aroma analysis of fermented products in our laboratories. Each of them was trained for a period of one month in November 2003.

9.3.5 Participation in Conferences and Seminars

One member of the project attended the ICFMH Workshop on Food Safety in Africa Stellenbosch University, South Africa December 2003.

9.3.6 Project Meetings and Visits

The local leader Mary Halm visited FSA/UNB Cotonou, Benin; DTA, Ouagadougou, Burkina Faso and UDS, Tamale, for project meetings with the Project Leader Professor Mogens Jakobsen from KVL and project team members in the partner institutions. One scientist, Dennis Nielsen from KVL Denmark visited the institute to check the functioning of equipment in the molecular biology laboratory from 13th October 2003 to 4th November 2003.

9.3.7 Renovation of laboratories and servicing of equipment

The furniture in Chemistry laboratory was renovated and all three laboratories preparing for accreditation i.e. Chemistry, Mycotoxin and Microbiology were painted. Major equipment in the Kenkey Pilot Plant at Pokuase were renovated e.g. corn mill, mechanical dryer, the electrical system etc. The Astell autoclave in Microbiology laboratory was repaired.

9.3.8 Publications

Thirteen publications were produced during the year including twelve Journal Publications.

Chapter 10
EC INCO Project on Development of biochemical and molecular markers for determining quality assurance in the primary processing of cocoa in West Africa

10.1 WP 2.1 Studies of microbial succession during fermentation

Fermentation of cocoa was evaluated at Tetteh Quarshie farm at Akuapim Mampong using heap fermentation ant at Cocoa Research Institute, Tafo using heap fermentation and the tray method. Sampling was done every 6 hours for the first 3 days of fermentation and every 12 hours for next/last 3 days of fermentation. Sun drying was done for day I, 3,& 6.

10.2 WP 2.1.1 Enumeration and identification of yeasts

Yeasts and moulds were enumerated on Malt Extract Agar and were present in the fermenting beans throughout the six of fermentation and the first three days of sun drying (Table1).

Time	Bacillus species (Nutrient Agar)	Coliforms (VRBA)	Acetic acid bacteria on GYC	Acetic acid bacteria on YPM	Lactococci on M17	Lactic acid bacteria (G+ve, Cat –ve rods and cocci on (MRS)	Yeasts and moulds on MEA
Fermentation time in hours							
0	nt	0.6×10^5	0.3×10^7	8.1×10^6	1.4×10^3	5.0×10^6	1.2×10^7
12	nt	0.3×10^8	3.1×10^7	2.1×10^8	6.9×10^6	10.2×10^5	14.8×10^6
24	nt	6.7×10^3	0.8×10^7	1.7×10^8	1.6×10^6	1.1×10^6	2.5×10^7
36	nt	0.9×10^4	0.6×10^6	1.4×10^6		5.0×10^6	2.3×10^7
48	nt	2.1×10^4	0.9×10^7	1.1×10^7	1.3×10^6	2.2×10^7	2.3×10^6
60	nt	3.7×10^3	1.9×10^7	0.5×10^8	1.6×10^6	1.2×10^7	5.5×10^6
72	nt	4.8×10^4	4.5×10^6	12.0×10^9	1.6×10^6	5.5×10^6	1.2×10^7
84	nt	1.2×10^5	2.4×10^8	0.4×10^9	8.7×10^7	6.7×10^7	nd
96	nt	2.2×10^5	0.2×10^7	1.0×10^7	2.5×10^6	2.4×10^6	1.2×10^7
108	nt	1.1×10^4	2.0×10^7	nt	4.6×10^6	8.7×10^6	2.3×10^7
120	nt	nt	0.5×10^8	5.5×10^8	1.7×10^8	3.1×10^8	4.5×10^6
132	nt	nt	nt	nt	3.4×10^7	25.0×10^6	1.3×10^8
Suntrying time in days							
0	nt	nt	4.3×10^8	1.1×10^9	11.7×10^7	2.2×10^8	3.1×10^7
3	nt	nt	2.2×10^8	nt	1.7×10^8	8.6×10^8	7.6×10^3
6	nt	nt	0.4×10^8	3.4×10^7	1.3×10^7	1.3×10^7	nt

Table 1

10.3 WP2.1.2 Enumeration and identification of lactic acid bacteria

Lactic acid bacteria were enumerated on deMan, Rogosa and Sharpe medium (MRS). They were detected throughout fermentation and sundrying. The population ranged from 1.1 x 10^6 to 3.1 x 10^8 cfu/g during fermentation. Lactococci were enumerated on M17 and were also detected throughout fermentation and sundrying. The population of lactococci were generally ten-fold lower than the counts of the total lactic acid bacteria.

10.4 *WP2.1.3 Enumeration and identification of acetic acid bacteria*

Acetic acid bacteria were enumerated on GYC and YPM and counts will be confirmed after further biochemical tests which are on-going. Counts on YPM ranged from 1.4 x 106 to 1.2 x 1010 cfu/g and on GYC from 6.0 x 10^5 to 2.4 x 108 cfu/g during 120 hours of fermentation (Table 1).

10.5 *WP2.1.4 Enumeration and identification of Bacillus species*

Bacillus species were enumerated on Nutrient Agar but were not isolated in dominating numbers during fermentation and sundrying. Though growth occurred on the Nutrient Agar plates, examination of colonies by Gram reaction, catalase test, and colony and cell morphology did not show the presence of *Bacillus* species on any of the highest or suitable dilution plates.

10.6 *WP3.1 Enumeration and identification of mould species in primary processing and storage of cocoa beans*

Moulds were enumerated together with yeasts on Malt Extract Agar (see WP2.1.1). The actual population of moulds is to be determined.

10.7 *Enumeration and identification of coliforms*

The presence of coliforms in the fermenting cocoa beans were enumerated on VRBA and were detected only during the first 108 hours of fermentation. Counts during this period were generally between 103 and 105 cfu/g except at 12 hours when a population of 3.0 x 10^7 cfu/g was obtained (Table 1).

10.8 Preliminary conclusion from evaluation of cocoa fermentation at the Tetteh Quarshie farm

The results of these initial studies of cocoa fermentation has confirmed that several microbial groups are involved in the fermentation of cocoa beans, including yeasts, lactic acid bacteria, lactococci and acetic acid bacteria though no clear pattern of microbial succession emerged. Coliforms were also found in the fermenting cocoa beans but were no longer detectable in the fermenting mass after four and a half days of fermentation.

SECTION III
PILOT STUDIES AND TRANSFER OF PROCESSING TECHNOLOGIES PROGRAMME

Chapter 11
DFID-funded project on 'sustainable uptake of cassava as an industrial commodity'

11.1 Introduction

'Sustainable Uptake of Cassava as an Industrial Commodity' is a DFID Project Coordinated by FRI between 9 Institutions. The institutions are:

- Afrimart Global Enterprises
- Amasa Agro-Processing Co. Ltd
- Feed and Flour Gh. Ltd.
- Food Research Institute
- Forestry Research Institute of Ghana
- MOFA, Brong Ahafo Directorate
- NBSSI
- NRI, UK
- University of Ghana, Nutrition and Food Science Dept.

11.2 Workshops

Two training workshops were organised during the year under review

- Training Workshop – HQCF and Glucose Syrup Production.
- Conflict Resolution Workshop

11.3 Support to Industry

- Participatory Industrial trials
- Problem Analysis and Solution synthesis
- Product Quality monitoring
- Equipment Fabrication
    - Beneficiary Industries
        i. Afrimart Global Enterprises
        ii. Amasa Agro Processing Company
        iii. Feed and Four Gh. Ltd
        iv. Watro and Kokofu Cassava Processing Units
- Industrial Trials at Fruit and Flavours, Cape Coast

11.4 Strategic Research

- Filtration Properties of Cassava Flour Hydrolysate.
- Development of a mathematical model for the formulation of paperboard adhesive.
- Distribution of Amylolytic Enzymes in Different Parts of the rice seedling

11.5 Promotional Activities

- Five Awareness Seminars in the Atebubu District
- Participation in Video Production Exercise
- Development of Market Linkages
    - Cadbury Gh. Ltd
    - Longlife Confectionery
    - Golden Biscuits
    - Packrite
    - Polykraft

11.6 Project Management

- Four Institutional Quarterly Review Meetings
- Four Coalition Quarterly Review Meetings
- Twelve Monitoring Visits to Coalition Partners

11.7 Principal Achievements

- Linkages with end-users established.
- Linkages with PSI established.
- Afrimart producing and supplying 200kg Glucose Syrup Weekly.
- Rural Income generation from HQCF and GS.
- Biscuit manufacturer – Golden Biscuits - using GS from Afrimart
- Effective Conflict Resolution System Developed.
- Thirty five minutes video documentary on "*Cassava in Industry*" produced.

Chapter 12
CFC/UNIDO project on industrial development of sorghum malt and its utilization in food industries

12.1 Overall Objective

To promote the industrial valorization of sorghum, its utilization in the African brewing industries and market expansion

12.2 Specific Objectives

- Development and upgrading of appropriate technologies for the production of sorghum malt for brewing purpose and establishment of technical and economic viability at industrial level.
- Development of cottage systems for the production of quality malts to be used in the preparation of the traditional beer and upgrading of the technological and managerial levels of the traditional beer producing units which are entirely owned and managed by women.
- Dissemination of project results to other interested African countries

12.3 Previous Sorghum Malt Development Projects

The erstwhile IFAD/ICRISAT Sorghum Project was the First Phase of this project

12.4 Components of the Project

- The 1st Component was the evaluation, at an industrial level, of the economic viability of the varieties of sorghum for brewing purposes introduced by the IFAD/ICRISAT project

- The 2nd Component was the development of quality malts used in the preparation of the traditional beer in Ghana (Pito beer) and Nigeria upgrading the technological and managerial levels of the traditional beer producing units, which are entirely owned and managed by women at the village level

12.5 The Role of the IFAD/ICRISAT Project

The IFAD/ICRISAT parallel project will provide, as part of its outputs, for the introduction, upgrade and dissemination through Ghana and Nigeria technologies for the production of sorghum malt for brewing purposes.

12.5.1 The IFAD/ICRISAT -Output 1 & Activities

- Output 1: New sorghum varieties introduced and evaluated in Ghana & Nigeria
  - Activity 1.1 Develop suitable sorghum varieties.
  - Activity 1.2 Crop tests sorghum varieties that show best malting characteristics.
  - Activity 1.3 Evaluate the harvested sorghum for technical efficacy related to malting characteristics, response to maltability etc

12.5.2 The IFAD/ICRISAT-Output 2 & Activities

- Output 2: Sorghum for malting and brewing pilot tests, produced in Ghana (8 tons)
  - Activity 2.1: Small-scale agricultural production of sorghum to at least 10 ton/year
  - Activity 2.2: Record performances pertaining to the various varieties.

12.6 Output 1.1

Operational pilot brewing facility established at FRI in Ghana (to complete the existing pilot malting plant supplied under the project US/GHA/89/057

12.7 Output 1.2

Malting and brewing technological developments and skills acquired under the phase 1 transferred from Ghana to Nigeria.

12.8 Output 1.3

Ghanaian and Nigerian technical personnel trained on beer production, maintenance, research and quality control methods as well as on the operation of brewing plants

12.9 Output 1.4

Further malting and brewing technologies developed in the form of technological packages and compiled in set of technical reports

12.10 Output 1.5

A technical and economical study of the feasibility of an industrial malting plant in Ghana and in Nigeria to produce malt grains, flour and extracts for beer making and for the production of other food products.

Chapter 13
DFID - project on the dissemination of improved rice post-production and marketing technologies, through coalition arrangement, to enhance rural livelihoods in Northern Ghana

13.1 Purpose

Enhance rural livelihoods in selected communities in Northern Ghana through promotion of improved rice post-production technologies and marketing systems

13.2 Overall Progress

The cooperation among the coalition partners and the enthusiasm of the target beneficiaries continue to be excellent. Training of the beneficiaries progressed in the past year. Suitable means of delivery for target beneficiaries was drafted by Technoserve Ghana, Tamale (TNS) and adopted by coalition after discussion.

Five training manuals covering general quality, farming, parboiling, milling and marketing were produced. A CD copy has been given to the Regional coordinator. Forty agricultural extension agents (AEAs) were trained in improved post production practices by the coalition and they were in turn supposed to be training the farmers, processors and millers that they were in contact with. The exact numbers of beneficiaries trained by the AEAs is yet to be collated. Coalition members further trained 250 parboilers in groups of 12 to 15, 180 farmers and 100 women in the management of the 18,000 tree seedlings supplied to them to grow as woodlots

Engineers at the Food Research Institute (FRI) successfully modified an Engelberg mill and fitted it with an aspirator. The Engelberg mill has proved to be the most appropriate mill for milling parboiled rice in northern Ghana. This type of mill is very robust and does not require frequent replacement of parts. The major draw back for this type of mill has been the fact that often times, the bran comes out together with the milled rice and the Women Parboilers have to spend long periods winnowing out the bran. In this winnowing process also, some milled rice is lost. The idea therefore under this project was to modify some of the existing mills and fit them with aspirators that would separate the bran and husk from the milled rice so as to ensure a better quality product and also to save the women the extra drudgery of winnowing the rice after milling. The first of such modifications was carried out at FRI and installed at a mill house in Navrongo in the Upper East Region of Ghana. The principle has worked and it is being fine-tuned for dissemination. Another draw back of this idea is that it is feasible only

on relatively newer mills and the majority of mills in the project areas are too old for such modification.

A group of rice parboilers in Navrongo led by Amadi Minyila and trained by this project and the earlier project R6688 been consistently producing high quality parboiled rice. Their efforts were recognised and awarded at the last Annual National Farmers Day celebration in December 2003. These women were collectively presented with a donkey christened "Olivia" and a cart as their price. In this part of the country, donkey carts are an important means of transport for agricultural produce and this award will significantly reduce their transportation costs and subsequently increase their profit margins.

Samples of parboiled rice from best practice sites are being analysed on a quarterly basis to confirm consistency of improvement in quality. Socio-economic data from R6688 9 (previous project) has been successfully validated. The necessary information for women using the parboiling vessel and the farmers using the tarpaulin has been collected and is being analysed.

The project distributed 18,000 tree seedlings to various Women Parboilers at the project sites. The seedlings have been planted around their homes and are being nursed by the women. The object here is for the women to cut the trees for fuel when they are matured in order to reduce the already heavy pressure on the fragile ecosystem in these areas. Wood is the main source of fuel for parboiling in Ghana.

Chapter 14

DFID - Project on Dissemination of improved bambara processing technologies through a new coalition arrangement to enhance rural livelihoods in Northern Ghana

14. 1 Introduction

Dissemination of improved bambara processing technologies through a new coalition arrangement to enhance rural livelihoods in Northern Ghana is a two-year project sponsored by the DFID with the Food Research Institute being the managing partner.

14.2 Core Partners/Collaborators

NRI, UK; Univ. of Ghana, Legon; Community Action Programme for Sustainable Agriculture and Rural Development (CAPSARD, NGO, Tamale); Women in Agricultural Development, Min. of Food and Agric., Tamale (WIAD of MoFA); Bambara Food Processors' Association, Tamale and T. Owusu Ent. (Commercial Partner)

14.3 Livelihood constraint addressed

Bambara groundnut is an important source of income and nutrition for peoples in West Africa, especially the rural poor farmers. Production has been on the decline in recent years primarily because of processing constraints. Through a previous CPHP project (R7581), processing technologies have been developed for the production of high-quality bambara flour. The present project will facilitate dissemination of the technologies to enhance bambara utilization and thereby potential increases in production to provide farmers with more crop for sale. Extensive market studies and participatory development of more end-uses for the product will be undertaken to expand the utilization base for improved food and nutrition security.

14.4 Project Objectives

The purpose of the project is to promote bambara production, processing and utilization for improved food security of poor households through the effective dissemination of processing technologies developed under a previous CPHP project (R7581). The main outputs are that high quality bambara flour (HQBF) production technologies are disseminated in northern Ghana and their socio-economic impact assessed. In addition bambara based recipes will be developed and promoted and Institutional linkages strengthened to ensure efficient collaboration between co-operating organizations, leading to sustainable mechanisms for future activities and actions. This will stimulate resurgence in the popularity of bambara and improve food security of households in rural Ghana.

14.5 Research Process

The research process involved the active participation of all members of the coalition from the various partner organizations. All partners took part in planning the research process and in reporting. Milestones were established on a quarterly basis for each coalition partner and reports were submitted and discussed at each of the five quarterly review meetings held so far. Quarterly and annual reports were concluded with members at such meetings and compiled by the Managing partner. Collaboration has been effective during the year, and this greatly facilitated the achievements so far by the project.

14.6 Outstanding Achievements

During the year, 219 women food processors have been trained in four project districts in northern Ghana on the micro-scale production and use of the high quality bambara flour (HQBF). The HQBF technology has been successfully transferred to one commercial entrepreneur who was trained and equipped with mainly locally fabricated machines to produce the flour for sale. To facilitate extensive dissemination of the technology, eighteen extension staff from WIAD and five NGOs operating in four northern districts were trained as trainers. Ten community-based demonstrations have also been conducted in the four districts for 370 participants on household use of the HQBF. Sixteen new bambara recipes have been developed and the quality established. Nineteen market outlets for HQBF have been identified and bambara marketing margins determined along the supply chain.

Chapter 15
IFAD/ CORAF/IITA – Project on Poverty Alleviation and enhanced food availability in W/A through Improved Yam Technologies: Post harvest component

15.1 Aim

The aim of the post-harvest component is to:

- Forge a linkage and integrate scientists and institutions engaged in post-harvest research in Ghana and Togo into the on-going sub-regional yam projects
- EU INCO Yam Project - Yam Post-Harvest and Consumption: Decreases of Losses and Improvement of the Quality of Stored Yam Tubers and Dried Products for African Market.
- Volarization (Value Adding) of Yam Project

15.2 Activity 5.2b. – Field testing of available technologies

- Improved method for the processing of yam into flour and shelf stable couscous, wasawasa, as a convenience food.

This activity was undertaken by the following officers: W. K. Amoa-Awua, B. A. Mensah, Margaret Owusu and Komlaga G. A

- Curing and storage of yam

This activity was undertaken by S. Noamesi

- The technology selected for testing is a combination of a procedure for curing yams developed under the INCO-YAM project and storage in a structure developed by the CSIR-Food Research Institute. The objective is to extend the shelf life of yam beyond the dormancy period.
- Scientists from Institut Togolais de Recherche Alimentaire in Togo visited CSIR-Food Research Institute to demonstrate the curing process.
- The storage structure was rehabilitated for the storage studies

15.3 Transfer of technology to CSIR-FRI

Mme Djake Amouzou from Institut Togolais de Recherche Alimentaire, Togo, visited the CSIR-Food Research Institute in Accra to introduce project personnel to the product wasawasa and give a detailed description of an improved procedure for the production of yam flour, and utilisation of the flour to produce wasawasa, a yam couscous.

15.8 Organoleptic qualities of wasawasa – Focus group

- The traditional processors who were familiar with the traditional product
  - colour of the improved wasawasa better than the traditional product
  - taste of improved wasawasa very close to freshly boiled yam
  - Preferred the traditional product because the improved product did not have the typical aroma and taste associated with wasawasa.
- Panellists who were not familiar with wasawasa
  - showed a great preference for the improved product
  - generally would not eat the traditional product because of its unattractive colour and partially fermented odour
  - Improved wasawasa was acceptable to them because it had the taste and colour of freshly boiled yam.

15.9 Conclusion

- Yam flour of high quality can be produced by dehydrating fresh yam slices at 60 °C.
- The high quality yam flour can be used to prepare wasawasa whose organoleptic quality closely resembles that of freshly boiled yam.
- Because of the closeness of the taste and aroma of the improved wasawasa to boiled yam, there is a great likelihood that it can be successfully promoted to the Ghanaian public as a convenience food which will also offer a means for curtailing postharvest loss of yam.

Table 1. The population of aerobic mesophiles and moulds in cfu/g in sundried yam flour

Sample	Aerobic Mesophiles	Moulds
1a	1.8×10^7	1.6×10^2
2b	8.4×10^7	4.3×10^4
3b	3.1×10^7	1.4×10^3
4b	1.0×10^8	6.0×10^3
5b	1.1×10^8	nd*

1 Peeled, washed, sliced, blanched and dried.
2 Peeled, washed, sliced under water, blanched and dried.
3 Peeled, washed, sliced into limewater, blanched and dried.
4 Peeled, washed, sliced under limewater, blanched and dried.
5 Peeled, washed, sliced and dried.

Table 2. The population of aerobic mesophiles and moulds in cfu/g in mechanically dried yam flour

Sample	Aerobic Mesophiles	Moulds
Fresh yam flour		
1a	4.8×10^3	4.0×10^2
2a	4.7×10^3	1.8×10^2
3a	3.0×10^3	2.1×10^2
4a	2.9×10^4	8.0×10
5a	3.7×10^3	1.2×10^2
After six months storage		
1a	1.6×10	1.7×10
2a	6.6×10^3	9.3×10^3
3a	9.0×10^2	8.0×10^2
4a	5.4×10^4	4.5×10^3
5a	1.5×10	1.7×10

15.7.4 The species of moulds identified in yam flour

- Fresh flour
  - Aspergillu nidulans
  - Fusarium oxysporum
  - Rhizopus ***stolonifer***
- After six months storage
  - *Aspergillu nidulans*
  - *Fusarium oxysporum*
  - *Rhizopus stolonifer*
  - *Sclerotium rolfsii*
  - *Mucor* spp.

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15.4 Brief field study

A brief field study was conducted in Accra involving visits to local markets to investigate the availability of traditionally produced yam flour in Ghana. The study involved informal interviews of traders selling yams and yam flour to find out whether wasawasa is traditionally produced in the country and the method for its production.

15.5 Production of yam flour in the laboratory

- Peeled, washed, sliced, blanched and dried.
- Peeled, washed, sliced under water, blanched and dried.
- Peeled, washed, sliced into limewater, blanched and dried.
- Peeled, washed, sliced under limewater, blanched and dried.
- Peeled, washed, sliced and dried.
    - Mechanically dehydrated at 60 °C in a hot air drier.
    - Sun dried

15.6 Preparation of wasawasa

Wasawasa was prepared from market and laboratory samples of yam flour

- Two kg of yam flour were intermittently sprinkled with water whilst being skilfully kneaded till large granules/small balls were formed
- The granules were steamed to obtain wasawasa.
- Dehydration of wasawasa
- Reconstitution of wasawasa

15.7 Analyses

15.7.1 Yam chips/flour

- Determination of moisture
- Microbiological analysis
    - Aerobic mesophiles
    - Yeasts and moulds
- Colour measurement
    - Minolta Chromameter CR310

15.7.2 Wasawasa

- Sensory analysis
    - Focus group interview

15.7.3 Storage of chips/flour

- Moisture, colour determination and microbiological analysis after six months storage.

Chapter 16
MOFA/FRI Root and Tuber Improvement Project

16.1 Introduction

The RTIP is a national programme under the Ministry of Food and Agriculture. The FRI is coordinating the Post Production and Marketing Component of the programme. The specific objective of RTIP which the Post-Production and Marketing (PPM) component seeks to achieve is to improve access of resource-poor farmers, farmer groups and rural communities, including women to improved post-production technologies. This is being pursued through:

- Research involving sourcing and documentation of information on post-production technologies for root and tuber crops;
- Production of identified technologies by disseminating information through training of staff, potential users and beneficiary groups; and
- Adoption of post-production technologies through production and storage facilities.

16.2 Establishment of Cassava Flour Pilot Plants

Two of the four Cassava Flour Pilot Plants were operational throughout the year. They are the Amanase Pilot Plant near Suhum and Adidwan Pilot Plant near Asante Mampong.

- Amanase Cassava Flour Pilot Plant
  - The beneficiary group is the Amanase Gari Producers Association.
  - Equipment supplied by RTIP (CSIR-FRI) and VIP.
  - The solar tent dryer was rehabilitated.
  - Group given further training in cassava flour production.
  - Group constructed drying platform/table for sundrying.
  - Effluent disposal from screw press was redesigned.
  - Group trained in plant hygiene and Good Manufacturing Practice.
  - Group currently supplies cassava grits to Amasa Agro-processing Co. for milling and grading into flour
- Adidwan Pilot Plant
  - Beneficiary group: Adidwan Food, Farming and Marketing Co-operative Society.
  - Equipment supplied by FRI through RTIP.
  - Equipment installed by REP, Mampong.
  - A new cabinet solar dryer was constructed by KNUST for the group.
  - Group constructed drying platforms/tables for sundrying and gari stoves.
  - Group trained in plant hygiene and GMP.
  - Group has been producing gari and cassava flour.

16.3 Improved gari roasting stoves

- Survey undertaken to assess the status of improved gari stoves built for beneficiary groups. The purpose is to identify constraints to adoption of technology.
- Model designs developed and constructed for LENT group at Krabokesse for evaluation.
- Support mission in February 2004 showed that improved stoves being adopted in various regions and in some cases with modification by gari processors e.g. at Tanyigbe using a dwarf wall instead of chimney

16.4 Research projects

- Research on producing agbelima using unfermented high quality cassava flour was completed. Fermentation of the unfermented cassava flour was carried out by both spontaneous fermentation and through the use of a starter culture. W.K Amoa-Awua, Margaret Owusu, Patrick Feglo
- Research on using cocoyam and cassava peels to grow both oyster and oil palm mushrooms were carried out. The use of cocoyam peels proved more successful and appreciable yields were obtained. Mary Obodai, Matilda Dzomeku, Josephine Cleland-Okine

16.5 Evaluation of starch yield and quality of cassava varieties.

Dry matter and starch content evaluated for 11 cassava accessions and three improved varieties at various stages of growth. (Ph.D studies by Mr Adomako)

16.5 Agrifex, 2003

- Participated in Agrifex in November 2003.
- Exhibited cassava and sweetpotato pastries.
- Improved gari stoves.

SECTION IV
FOOD SAFETY AND QUALITY ASSURANCE PROGRAMMES

Chapter 17

DFID/NRI Developing food safety strategies and procedures through reduction of food hazards in street-vended foods to improve security for consumers, street food vendors and input suppliers

17.1 Project Partnerships

FRI, NRI, FDB, UG, KNUST, NMIMR, AMA, KMA and GTCA

17.2 *Outputs*:

- Extent of hazards from heavy metals and microbiological contamination in selected street foods in Accra evaluated (i.e. Understand how widespread heavy metal and microbiological contamination is).
- Sources of heavy metal and microbiological contaminations identified and economically viable and socially acceptable control measures for reducing the hazards to acceptable levels determined and verified (i.e. Find out where the contamination is coming from & Find ways of improving safety that are not expensive and are acceptable to people)
- Recommendations and consultative documents to improve the safety of foods in the street food sector, delivered to policy, regulatory and enforcement agencies and a strategy for dissemination to the sector developed and implemented. (i.e. make recommendations to help improve the safety of foods in the street food sector; for national and local government, regulatory and enforcement agencies, street food vendors etc. Tell people about what we have found and what we recommend. Training)

17.3 Activities: What are we doing and/or will be doing?

- Work closely with those involved in the street food sector.
- Have regular meetings to consult with the project partners.
- Use an internationally recognised system for improving food safety - (HACCP).
- Analyse street food samples
- Work closely with street vendors and authorities to find ways of improving the safety that are cost-effective and culturally acceptable.
- Review existing food laws and enforcement.
- Train of food inspectors.

- Train of selected street food vendors
- Determine if the findings of the project can be integrated into local and national food policy

17.4 Results & On-going Activities

- Five heavy metals Hg, Cu, Cd, As and Pb have been analyzed in 150 food samples collected from 5 samples sites in Accra.
- Survey of baseline pre-requisites for safe food preparation and delivery by150 food vendors in Accra conducted and analyzed.
- Development of training manual for food inspectors and food vendors
- Development of promotional materials, part being funded by other donors
- Development of appropriate of posters
- Development of consultative documents reviewing existing bye-laws and guidelines on the street food sector in Accra and Kumasi

Chapter 18
Effect of vegetable oil (Peanut, Safflower and olive oil) consumption on blood lipid profile

18.1 Introduction

This project was undertaken at the Laboratories of the Nutrition and Socio-Economics Division by Ms Linda Akuamoah-Boateng, an MPhil student of the Nutrition and Food Science Department of the University of Ghana, under a joint supervision of Dr. (Mrs.) Anna Lartey of the University of Ghana and Mrs. P. Lokko.

18.2 Objectives

- To determine the effect of dietary fatty acids on blood lipid profile
- To document the effect of consumption of peanut oil incorporated in foods on cardiovascular disease risk.

18.2.1 Specific Objectives

- To determine the effect of consumption of diet containing high unsaturated fat on
  - total serum cholesterol
  - HDL cholesterol
  - LDL cholesterol
  - triglyceride,
- To determine whether the fatty acid profile of peanut is responsible for lowering blood lipids

18.3 Rationale

- Nuts consumption is associated with a stable or even lower body weight as well as reduced triglycerides and cholesterol concentration.
- The actual mechanism for this observation has not been examined,
- The fatty acid composition of the nuts has been suggested.
- It would be easier to increase the consumption of peanut oil than the whole peanut

18.4 Hypothesis

- **H_O:** Peanut oil consumption has no significant effect on cardiovascular disease risk.
- **H_1:** Peanut oil consumption has a significant effect on cardiovascular disease risk.

18.5 Methodology

- Sixty- four (64) volunteers were recruited for the study through public announcement.
- Eligibility Criteria

- ❖ Age 18 to 50 years
- ❖ BMI 18 to 30 kg/m^2
- ❖ Stable weight over 6 months ($\pm$3 kg)
- ❖ Non-smoker
- ❖ Serum cholesterol $\leq$220 mg/dl
- ❖ Should not be on medication

➢ Screening

- ❖ BMI
- ❖ Waist to hip ratio
- ❖ Blood cholesterol level (Accu- CHEK Instant Plus- Roche Diagnostics)
- ❖ Blood Pressure (OmRon Blood Pressure Monitor)
- ❖ Load Palatability ratings

➢ Study Design

- ❖ Randomised controlled intervention
- ❖ A nine (9) week study comprised of baseline (1 week) and intervention (8 weeks).
- ❖ Baseline data was collected and subjects were randomized into four treatment groups-
  - i. Olive oil
  - ii. Safflower oil
  - iii. Peanut oil
  - iv. Control
- ❖ Subjects consumed the diet (milk shake) for 8 weeks.

18.6 Conclusions

➢ This study has shown that the blood lipid lowering effect of peanut is due to the fatty acid profile.

➢ It gives further evidence that diets high in unsaturated fatty acid lowers both total and LDL cholesterol levels.

➢ Further more, it shows that the quality and not the quantity of fat affect blood lipid levels.

SECTION V
Community Outreach Programme

Chapter 19

Mushroom Production Project

19.1 Activities

19.1.1 Increased Production of Mushroom Compost Bags.

- The unit constructed an additional incubation room to increase its production of Compost bags from 2000 to 8000 in a quarter to meet the demands of the general public.
- The existing platform for composting was expanded.
- Renovation work was done on the cropping house.
- The unit was able to produce one batch due to delay in the construction of the incubation room.

19.1.2 Strain multiplication

- The unit produced 3,450 bottles of spawns for sale to growers throughout the country.

19.2 Extension and training activities

- Training was organised for the Mushroom Production and Biodiversity Training Centre –(KUM-BIT) Kumasi in February 2003.
- Two persons from KUM-BIT Kumasi were trained in a three-day spawn multiplication course on the 11^{th} –13^{th} June 2003.
- The unit organized a 2-day and a 5-day course from 7^{th} –11^{th} of July 2003.

19.3 Visitors to the Unit

- Students from Kadjebi Asato Secondary School from Kadjebi.
- Chief and Elders from Bontianor Council.
- Alpha Beta School-Dansoman
- Prof. Norman and two students from Legon
- Participants of the Science clinic
- Hon. Mrs. Gladys Asmah, Minister for woman and children affairs
- Students from Adu Gyamfi Secondary Kumasi.

Chapter 20

Small Scale Salt Iodation

20.1 Introduction

- WHO/UNICEF/ICCIDD report estimates that at least 1.5 billion people (29% of the world's population) live in areas of iodine deficiency and will need some form of iodine supplementation.
- The report therefore suggests that all salt consumed by humans and animals be iodised by the year 2001.
- However, field reports from market monitoring indicate that un-iodised salt is available in large quantities in many parts of the country.

20.2 Objectives

- To develop iodisation process suitable for small scale salt producers
- To train small scale salt producers in salt iodisation

20.3 Study Site

- Adina – Volta Region

20.4 Materials Used

- 10 kg margarine bucket
- gloves
- raw salt
- wooden vat or plastic bowl
- potassium iodate (KIO_3)
- spray bottle

20.5 Methodology

Two methods were used: The dry method which involved, Premix; Filler; and Direct Addition, and the wet method which involved Spraying

20.6 Observation

It was observed that the spray method was more efficient and thus it had more uniform distribution of the iodine when samples were taken and analysed. The small scale salt producers found the wet method to be more comfortable.

20.7 Future Trends

The programme will be extended to other areas like Ada and Toflokpo

SECTION VI

GOG Institutional Renewal/CSIR Restructuring Programme

Chapter 21
CSIR/NRI – Performance Management Programme

21.1 Introduction

Under the Performance Management Programme the Council for Scientific and Industrial Research (CSIR)[1] together with the Natural Resources Institute of the United Kingdom and with input from the Ghana Institute of Management and Public Administration convened a one-day Policy Dialogue Forum on "Broadening Monitoring and Evaluation within Reforming National Agricultural Research Systems". The meeting provided a platform for discussing current experiences with monitoring and evaluation by CSIR and for introducing alternative practices (frameworks, methods and tools) that would enable research bodies to manage and demonstrate their performance and contribution to national development targets in a consistent and coherent form. While the pilot project was conducted at institutional level, involving two CSIR institutes (CRI and FRI), the forum was conducted at the corporate level, and including other corporate organisations from the public and private sectors.

21.1.2 The objectives of the forum were

- To disseminate experiences from the first phase of a performance measurement action research project within NARS in Ghana and Uganda
- To raise awareness among Ghana's research management community and allied stakeholders of the importance of measuring institutional performance as an element of demonstrating developmental impact
- To explore with key stakeholders opportunities for strengthening institutional performance measurement and management in the context of ongoing institutional reform in CSIR and other public sector organisations

Participants were made up of Senior Management Personnel from public organisations and training institutions

[1] Specifically the CSIR Directorate, and two of its institutes, the Food Research Institute and the Crops Research Institute, both of which had participated in the first phase of a pilot project on performance management.

21.2 Where FRI started:

The identification of:

- Certain inherent weaknesses within the system at the organisational level: poor communication between staff, appropriate information not always available, burdensome bureaucracy
- Certain strengths within the system at the organisational level: high quality staff and (in-general) equipment, good internal systems for measuring the research process
- A need to have systems that are sufficiently robust to incorporate a better understanding of the external environment (clients and donors) into the internal processes of the institute.

21.3 What FRI has done through this process

- Considered the reconfiguration of existing activities under the framework of the balanced scorecard. Namely, a review of the organisations goal to accurately represent the work + aims of the institute, considered objectives and indicators to achieve this goal, and drafted action plans to achieve some of these objectives.
- Identified, through the use of the balanced scorecard, areas that have not received attention previously- notably methods for enhancing feedback and thus learning across several dimensions, for example, employee satisfaction and its linkages to organisation performance.

21.4 What value the process has added:

- Clarified current capacity and issues, potential opportunities and threats which reflect the existing capacity and utilisation of systems within FRI.
- Utilised a framework for facilitating a broader understanding of organisational performance.
- Development of corporate objectives and indicators that aim to bring together the core work areas of the institute.
- Identified critical success factors for achieving these objectives in view of what is currently being done in these areas. Identifying current M&E activities in these areas, and revealing gaps to be addressed through action plans.

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21.5 The Way Forward

Measurement is not an end in itself, but a tool for more effective management. The results of performance measurement will tell you what happened, not why it happened, or what to do about it. In order for the FRI to make effective use of the results of performance assessment, it must be able to make the transition from assessment to management. It must also be able to anticipate needed changes in the strategic direction of the Institute, and have a methodology in place for effecting strategic change. Successful accomplishment of these two tasks represents the foundation of good performance management. Both of these tasks can be greatly facilitated by use of the BSC. In other words, besides simply assessing performance, the BSC provides a structured framework for performance management. Measurement has provided the basis for the FRI to assess how well it is progressing towards its predetermined objectives, helped it identify areas of strength and weakness, and decided on next steps, with the ultimate goal of improving organizational performance. It has also provided the data necessary for showing how activities support broader goals, and provided the data necessary for supporting requests for additional resources or for supporting new initiatives. But it is the effective use of this data by management at all levels of the Institute to aggressively improve products and services for customers and stakeholders that is the hallmark of leaders in performance management.

The FRI now needs to look at how to manage assessment results to the benefit of the Institute, and how the BSC methodology can be used to guide the Institute towards accomplishment of strategic goals. To effectively move from performance measurement to performance management, two key components need to be in place:

- The right organizational structure; (Which is now in place), and
- The ability to use performance measurement results to actually bring about change in the institute.

Chapter 22
Establishment of Local Area Network/Intranet Connectivity

22.1 Introduction

FRINet Technical Committee was set up to develop proposals for the establishment of a Local Area Network within the Food Research Institute. The membership of the Committee is as follows:

Mr. Nanam Dziedzoave	-	Chairman
Dr. L. D. Abbey	-	Member
Robert M. Yawson	-	Secretary

22.2 Terms of Reference (TOR)

The Committee was given the following Terms of Reference (TOR)

1. Identify a reputable firm to provide the service and award the contract of putting the requisite infrastructure in place
2. Disseminate information on the LAN as much as possible to make staff aware of how important the LAN is to the Institute
3. Put in place a Robust Network system that is easily upgradeable and can stand the test of time
4. Use servers that are up-to-date
5. The LAN that shall be put in place should be able to handle 100 PCs at least
6. identify the relevant operating system that should be used and that Linux OS is highly recommended
7. The committee should constitute an Institute Network Committee which should include a Research Scientist, Hardware Technician, Web Administrator, Librarian and data input clerk and any other person the present committee sees fit.
8. The committee should identify the existing computers and their specification and recommend where there is the need for new computers.
9. The Committee should refer to the CSIR-Net Technical Committee Report as a guide; however, it contents are not binding on the committee.
10. The Committee should submit it report to the Director by 31st January 2004 and the at least the 1st phase of the LAN should be in place by the end of February.

APPENDIX I
2003 FRI MANAGEMENT BOARD

1.	Prof. A. Ayensu Dep. Director-General, INSS/CSIR P. O. Box M.32, Accra	-	Chairman
2.	Dr. W. A. Plahar Director, Food Research Institute (FRI) P. O. Box M.20 Accra	-	Member
3.	Dr. Ransford Lartey Ag. Director, Institute for Industrial Research (IIR) P. O. Box 576, Legon, Accra	-	Member
4.	Professor G. S. Ayernor Head, Dept. of Nutrition & Food Science University of Ghana, Legon	-	Member
5.	Mrs. Rosetta Annan Women In Agricultural Development (WIAD) P. O. Box M.37, Accra	-	Member
6.	Mr. Timothy Osei Oduro, Adiya, Osei & Co. SEDCO House P. O. Box 5712, Accra-North	-	Member
7.	Mr. Nimo Ahenkorah Executive Director, Ghana Standards Board P. O. Box M.245, Accra	-	Member
8.	Mrs. Leticia Osafo-Addo Processing Foods & Spices Ltd P. O. Box 186, Community 2, Tema	-	Member
9.	Mr. Ebenezer Barnor P. O. Box 295 Mamprobi - North	-	Member

In Attendance

10.	Mrs. Eugenia Atta-Sonno Head of Administration, FRI	-	Secretary
11.	Mr. Robert M. Yawson Scientific Secretary, FRI	-	Recorder

APPENDIX II
FRI SENIOR STAFF LIST (2003)

Directorate

1. W. A. Plahar - Director
   BSc (Gen.), BSc (Hons) MSc Fd. Sci. (Ghana) (Chief Research Scientist)
   PhD (Washington)
2. W. K. Amoa-Awua - Deputy Director
   BSc (Ghana) MSc. App. Sci. (New South Wales) (Principal Research Scientist)
   PhD (Ghana)
3. R. M. Yawson - Scientific Secretary
   BSc. (Hons) M. Phil. (Biochem) Ghana (Research Scientist)
   Post Grad. Cert. Fd. Mgt. (Jerusalem)
4. J. Aggrey –Yawson (Ms.) - Snr Admin Assistant.
5. F. Mante (Mrs.) - Admin Assistant

Food Microbiology Division

1. M. Halm (Ms) - Senior Research Scientist
   BSc (Gen.) BSc (Hons), MSc Botany (Ghana) (Head of Division)
   Post Grad. Dip. Rural Fd. Tech (Netherlands)
2. M. Ottah-Atikpo (Mrs.) - Research Scientist
   BSc Microbiology, MSc Fisheries (ABU, Zaria)
3. M. Obodai (Mrs.) - Research Scientist
   BSc (Hons), MPhil. Botany (Ghana)
4. C. Tortoe - Research Scientist
   BSc (Hons), MPhil. Botany (Ghana)
5. P. K. Feglo - Research Scientist
   BSc (Hons), Zoology (Ghana)
   MSc, Clinical Microbiology (UST)
6. M. Owusu (Ms.) - Research Scientist
   BSc (Hons), MPhil. Botany (Ghana)
7. Matilda Dzomeku (Mrs.) - Asst. Res. Scientist
   BSc Biological Sciences (UST)
8. D. K. Asiedu - Snr. Technologist
9. J. Anlobe - Snr. Technologist
10. B. Amoako - Prin. Tech. Officer
11. Peter Addo - Prin. Tech. Officer
12. D .K. Baisel - Technologist
13. R. Takli - Asst. Technologist
14. Theophillus Annan - Technical Officer

Food Chemistry Division

1. Dr. (Mrs.) K. Kpodo - Senior Research Scientist
   BSc (Gen.) BSc (Hons) Ghana
   MPhil (West Indies) PhD (Ghana)
2. N. T. Annan (Mrs.) - Senior Research Scientist
   BSc (Hons) Fd. Sci. (Ghana),
   MSc Fd. Sci. (Nova Scotia)
3. G. A. A. Anyebuno - Research Scientist
   BSc (Hons), MPhil. Botany (Ghana)
4. C. Diako - Asst. Res. Scientist (Temp.)
   BSc (Hons), Fd. Sci & Nut. (Ghana)
5. E. A. Allotey - Chief Tech. Officer
6. S. Antonio - Prin. Tech. Officer
7. W. K. Amevor - Prin. Tech. Officer
8. P. A. Addo - Prin. Tech. Officer
9. Mensah Toku - Senior Tech. Officer
10. D. N. A. Ankrah - Technical Officer
11. N.Y. Amey - Technical Officer

Nutrition & Socio-Economics Division

1. P. Lokko (Mrs.) - Principal Research Scientist (Head of Division)
   B.Sc. (Gen.) BSc (Hons) MSc Biochem (Ghana)
   Dip. Fd. Sci. & Nut. (The Netherlands)
2. W. Quaye (Mrs.) - Research Scientist
   BSc (Hons) MPhil Agric. Econs (Ghana)
3. P. Larweh (Mrs.) - Assistant Research Scientist
   BSc (Hons) Home Sci. (Ghana)
4. L. Larweh (Ms.) - Assistant Research Scientist (Temporary Staff)
   BSc (Hons) Home Sci. (Ghana)
5. B. Kudjawu (Ms.) - Assistant Research Scientist (Temporary Staff)
   BSc (Hons) Home Sci. (Ghana)
6. I. Johnson-Kanda (Ms.) - Asst. Res. Scientist
   BSc (Hons) Fd. Sci & Nut. (Ghana)
7. I. A. Tamakloe (Mrs.) - Chief Tech. Officer

Commercialization & Information Division

1. A. Osei-Yaw (Mrs.) - Principal Research Scientist (Head of Division)
   BSc (Gen.), Ghana,
   MSc. Fd. Sci. & Nut. (Washington)
2. A. Andoh - Chief Tech. Officer
3. B. Awotwi - Prin. Tech. Officer
4. R. Kavi - Prin. Lib. Assistant

5. B. P. Osae - Technical Officer
6. P.O. Baidoo - Technical Officer

Food Processing & Engineering Division

1. G. Nerquaye-Tetteh (Mrs.) - Senior Research Scientist (Head of Division)
   BSc (Gen.) BSc (Hons) Ghana
   MPhil (UST)

2. P. N. T. Johnson - Senior Research Scientist
   BSc (Hons), Biochem. (UST)
   MSc. Agric. Eng. Tech. (Cranfield)
   PhD Food Tech. (Reading)

3. P. Adu-Amankwa (Mrs.) - Senior Research Scientist
   BSc (Hons) Biochem (UST)
   MSc. Fd. & Mgt. Sci.,
   PhD Post-Harvest Physiology (Lond.)

4. N. T. Dziedzoave - Senior Research Scientist
   BSc (Hons), Biochem. (UST)
   Post Grad. Dip. in Fd. Sci. & Nut., (Gent, Belgium)
   MSc Fd. Sci. & Tech. (UST)

5. D. Blay - Research Scientist
   MSc Chem. Eng. (Moscow)

6. E. C. Tettey - Research Scientist
   BSc (Hons) Agric (UST)
   Post-Grad. Dip. Fd. Tech.,
   MPhil, (Humberside, UK)

7. Dr. L. D. Abbey - Research Scientist
   BSc (Hons), Biochem. (UST)
   MSc. App. Sci. (Fd. Tech.) New South Wales
   PhD (Ghana)

8. C. K. Gyato - Research Scientist
   Nat. Dip. in Agric. Mech. (Ghana)
   MSc Agric. Eng. (Bulgaria)

9. J. T. Manful - Research Scientist
   BSc (Agric), Dip. Ed. (Cape Coast)
   MPhil Biochem. (UST)

10. K. A. Vowotor - Research Scientist
    B.Sc. Zoology Dip. Ed. (Cape Coast)
    M. Phil. PhD Crop Science (Ghana)

11. B.A. Mensah - Research Scientist
    MSc. Fd. Press. Tech. (Kransnodar, USSR)

12. S. K. Noamesi - Research Scientist
BSc (Agric) MSc Fd. Sc. (Ghana)

13. J. Gayin - Research Scientist
BSc (Hons) Biochem (UST)
MSc Fd. Tech. (Gent)

14. G. A. Komlaga - Research Scientist
BSc (Hons) Biochem (Ghana)
MSc Fd. Sc. & Tech. (UST)

15. D. Abusah - Research Scientist
BSc (Hons) Chem., MSc Chem. Eng. (UST)

16. C. Oduro-Yeboah (Mrs.) - Assistant Research Scientist
BSc (Hons) Biochem (Ghana)

17. E. A. Baidoo - Asst. Res. Scientist
BSc (Hons) Biochem (UST)

18. J. F. Asigbey - Chief Admin. Asst.
19. S. A. Sampare - Chief Tech. Officer
20. K. Opoku-Acheampong (Mrs.) - Chief. Tech. Off.
21. J. R. Addo - Snr. Tech. Off.
22. E. Ablorh - Snr. Tech. Off.
23. S. A. Tagoe - Snr. Technical Officer
24. J. A. Asafu-Adjei - Prin. Works Supt
25. R. Y. Anthonio - Prin. Works Supt.
26. C. T. Yeboah - Works Supt.
27. G. K. Akleih - Works Supt.
28. R. M. Mawuli - Works Supt.
29. J. L. Lamptey - Works Supt.

Accounts Division

1. J. Mintah - Prin. Accounting Asst. (Head of Accounts)
2. J. Mintah Nakotey - Chief Stores Supt.
3. C. Aikins Tutu - Snr. Accounting Asst.
4. S. O. T. Oddoye - Snr. Stores Supt.
5. G. O. Gyamfi - Stores Supt.

Administration Division

1. E. Atta-Sonno - Snr. Admin. Off. (Head of Division)
BA Hons. (Cape Coast)
Specialist Teachers Cert. in English
Qualifying Cert. in Law
Cert. of Enrolment to the Roll of Lawyers
2. E. A. Larbi - Prin. Works Supt.
3. L. Codjoe - Admin Asst.

APPENDIX III
PROMOTIONS ANNOUNCED IN 2003

The following promotions were announced during the year to take effect from the dates indicated against the names:

Senior Members	From	To	Date
Mrs. Agnes Osei-Yaw	Snr Res. Sci.	Prin. Res. Sci	1/1/2001
Mrs. Phoebe Lokko	Snr. Res. Sci.	Prin. Res. Sci.	1/7/2002
Mrs. G. Nerquaye-Tetteh	Snr. Res. Sci.	Prin. Res. Sci.	1/7/2002

Senior Staff

Mr. David Asiedu		Snr. Technologist	1/1/2002
Mr. Emmanuel Allotey		Snr. Technologist	"
Mr. William Amevor		Snr. Technologist	"
Mr. P.M. Toku		Snr. Technologist	"
Mr. N.K. Amey		Technologist	"
Mr. D.K. Baisel		Technologist	"
Mr. M. Amoo-Gyasi		Asst. Technologist	"
Mr. Richard Takli		Asst. Technologist	"
Mr. J.Y.M. Anlobe	Prin. Tech. Off.	Chief Technical Off.	1/1/2002
Mrs. Iris Tamakloe	Prin. Tech. Off.	Chief Tech. Off.	1/1/2003
Mr. J. Asafu-Adjaye	Prin. Works Supt.	Chief. Works Supt	"
Miss Janet Agree-Yawson	Snr. Admin. Asst.	Prin Admin Asst.	"
Mr. Leslie Codjoe	Admin.Asst.	Snr Admin Asst.	1/1/2003
Mr. E.T. Angmortey	Asst. Transport Off.	Snr Asst Transport Off	"

c. **Junior Staff**

Ms. Christiana Ketsie	Senior Clerk	Admini. Asst	"
Mrs. Faustina Mante	"	Adminis Asst	"
Mr. Peter Delabor	Foreman	Works Supt	"
Mr. Jacob Kuwornu	Foreman	Works Supt	"
Mr. V.C. Tackie	Transport Off.	Asst Transport Off.	"
Mr. M.A. Ollennu	Transport Off.	Asst. Transport. Off	"
Mr Samuel Osarfo	Driver Gd. I	Driver Inspector	2002
Mr. Godwin Armah	Tech. Asst. Gd. I	Snr. Tech. Asst	1/1/2003

APPENDIX IV

APPOINTMENTS

Mr. Ireneous Soyiri	-	Asst. Research Scientist
Ms. Bernice Kudjawu	-	"
Ms. Linda Lamkie Larweh	-	"
Mr. Jeremiah lartey-Brown	-	Technical Officer
Ms. Bernice Antwi	-	Clerk Grade II

APPENDIX V
SCIENTIFIC REPORTS AND PUBLICATIONS

Refereed Journal Publications

1. **Amoa-Awua, W. K. A**., TerLarbie, N. N., Dakwa, S., Sakyi-Dawson, E. 2003. Screening of forty-two Bacillus isolates for ability to ferment soybean into dawadawa. Submitted for publication *International Journal of Food Microbiology.*

2. **Amoa-Awua, W. K. A**., Ngunjiri, P., **Anlobe, J. Kpodo, K., Halm, M., Hayford, A. A.,** and Jakobsen, M. 2003. Experiences in the Application of HACCP to Traditional Food Processing at a Semi-Commercial Kenkey Production Plant in Accra, Ghana.

3. **Amoa-Awua, W. K. A**., Awuku, A. 2003. Importance of *Lactobacillus plantarum* in the fermentation of heavily spiced millet dough. Prepared for submission to *Letters in Microbiology*

4. **Annan, N. T.,** Poll, L., Sefa-Dedeh, S., **Plahar, W. A**., and Jakobsen, M. 2003. Influence of starter culture combinations of *Lactobacillus fermentum, Saccharomyces cereviseae* and *Candida krusei* on aroma in Ghanaian maize dough fermentation. *European Food Research and Technology*. 216, 377-384

5. **Annan, N. T.,** Poll, L., **Plahar, W. A**., and Jakobsen, M. 2003. Aroma characteristics of spontaneously fermented Ghanaian maize dough for "Kenkey" *European Food Research and Technology.* 217, 53-60.

6. **Annan, N. T**., Poll, L., Sefa-Dedeh, S., **Plahar, W. A**. and Jakobsen, M. 2003. Volatile compounds produced by *Lactobacillus fermentum, Saccharomyces cerevisiae* and *Candida krusei* in single starter culture fermentations in Ghanaian maize dough. *Journal of Applied Microbiology*. 94, 462-474.

7. **Annan, N. T., Plahar, W. A**., Poll, L. and Jakobsen, M. (2003). Effect of soybean fortification on Ghanaian fermented maize dough aroma (*International Journal of Food Sciences and Nutrition*, accepted)

8. Dakwa, S., Sakyi-Dawson, E., and **Amoa-Awua, W. K**. Effect of boiling and roasting on the fermentation of soybeans into dawadawa (soy-dawadawa). *International Journal of Food Microbiology* (In press).

9. **Halm, M., Amoa-Awua, W. K.,** and Jakobsen, M. 2003. Kenkey, an African fermented product. In: *Handbook of Food and Beverage Fermentation Technology.* Eds Hui, Y.H., Toldra, F., Nip, W. K. and Goddikl. Marcel Dekker, Inc., New York. (In press).

10. **Halm, M.**, Hornbæk, T., Arneborg, N., Sefa-Dedeh, S. & Jespersen, L. 2003. Individual cells of *Saccharomyces cerevisiae* and *Candida krusei* exhibit different intracellular pH responses to lactic acid. *International Journal of Food Microbiology* (In press)

11. **Johnson, P-N. T.,** Brennan, J. G. & MacDougall, D. B. (2003). The effects of pre-treatments on the reconstitution and physical properties of hot-air dried plantain. *Trop Sc.*, 2003 **43** 156 – 161

12. Mante, E. S., Sakyi-Dawson, E., and **Amoa-Awua, W. K**. 2003. Antimicrobial interactions of microbial species involved in the fermentation of cassava dough into agbelima with particular reference to the inhibitory effect of lactic acid bacteria on enteric pathogens. *International Journal of Food Microbiology* 89 41- 50.

13. Obilie, E. M., Tano-Debrah, K. and **Amoa-Awua, W. K**. 2003. Microbial modification of the texture of grated cassava during fermentation into akyeke. *International Journal of Food Microbiology* 89 : 275 - 280.

14. Obilie, E. M., Tano-Debrah, K. and **Amoa-Awua, W. K**. Souring and reduction of cyanogenic glycosides during the processing of cassava into akyeke in Ghana. *International Journal of Food Microbiology* (In press)

15. **Obodai, M, Cleland-Okine, J & Johnson, P-N. T. 2003**. Use of agricultural wastes in the cultivation of the mushroom *Volvariella volvacea*. *Trop Sci*. 2003, **43** 121 - 124.

16. TerLarbie, N. N., Sakyi-Dawson, E., and **Amoa-Awua, W. K. A**. 2003. Comparative ability of four isolates of *Bacillus subtilis* to ferment soybeans into dawadawa Prepared for submission to *International Journal of Food Microbiology*

Edited Research Reports

17. Ameleke, G., **Abusah, D., Dziedzoave, N.** and Krampah, L. (2003). Baseline Information on the Uptake of Cassava as an Industrial Commodity and the Livelihood Status of Farmers and Small-Scale processors in the Atebubu and Sene Districts of the Brong Ahafo Region, Ghana. DFID Crop Post-Harvest Programme, Final Report on Project Output 3.7, Project R8268, Food Research Institute, Accra, Ghana.

18. **Amoa-Awua, W., Noamesi, S. K., Yawson, R. M**., Smith, D. R., and Ticehurst, D. (2003) "Institutionalising Impact Orientation: Building a Performance Management Approach that Enhances the Impact Orientation of Research Organizations - Food Research Institute Case study summary" Chatham, UK: Natural Resources Institute.

19. **Annan, N. T.** (2003) Aroma Characteristics in Ghanaian Fermented Maize Dough Fermentations. PhD Thesis report. Dept. of Nutrition and Food Science, University of Ghana, Legon and Dept. of Dairy and Food Science, The Royal Veterinary and Agric. University, Copenhagen, Denmark.

20. **Annan, N. T**. and **Plahar, W. A** (2003) Seed quality characteristics and suitability of six soybean cultivars for soymilk production. Report presented to the Food Crops Development Project, (MOFA).

21. **Dziedzoave, N. T**., Graffham, A. J. and Boateng, E. O. (2003). Training Manual for the production of Glucose Syrup. DFID Crop Post-harvest Programme, Training material produced under Project R8268, Food Research Institute, Accra, Ghana.

33. **Johnson, P-N. T**, Gallat, S., Oduro-Yeboah, Osei-Yaw, A. & Westby, A. (2003) Sensory properties of instant fufu flour formulated from cassava starch and cassava flour of four high-yielding Ghanaian varieties. FOOD-AFRICA INTERNATIONAL WORKING MEETING, 5 – 9, MAY, 2003, Yaoundé, Cameroon.

34. Myhara, R, Tomlins, K.I, **Johnson, P-N**. Obeng-Aseidu, Greenhalgh, P. (2003) Sustainable and participatory methods for improving the safety of street-vended foods in Accra, Ghana. FOODAFRICA, INTERNATIONAL WORKING MEETING, 5-9, MAY, 2003, Yaoundé, Cameroon.

35. **Plahar, W. A**. 2003. Dissemination of improved bambara processing technologies through a new coalition arrangement to enhance rural livelihoods in Northern Ghana. CIDA Conference Room, Tamale, Ghana, 14 February 2003. [One-day Inception Workshop for 15 Coalition Partners]

36. **Plahar, W. A., Annan, N. T.** and Nti, C.A. 2003). Training of Trainers Workshop. MoFA WIAD Conference Room, Tamale, Ghana, 23 –25 April 2003. [Three-day Training Workshop for 18 AEAs from WIAD and NGOs operating in northern Ghana]

37. **Plahar, W. A., Annan, N. T**. and Nti, C.A. 2003. Project monitoring evaluation workshop report. Miklin Hotel, Accra, Ghana, 21 May 2003. [One-day Monitoring & Evaluation Workshop for all Coalition Members]

38. **Quaye, W**. and **Johnson-Kanda, I**. 2003. Baseline socio-economic studies on indicators for future performance tracking in four project districts in Northern Ghana. DFID/CPHP/FRI Bambara Project Report. Food Research Institute (FRI), Accra, Ghana.

39. **Quaye, W**. and **Johnson-Kanda, I.** 2003. Bambara marketing margins analysis. DFID/CPHP/FRI Bambara Project Report. Food Research Institute (FRI), Accra, Ghana. 41pp.

40. **Yawson R. M.** (2003) "Management of technology commercialization – Ghana's experience" Paper accepted for presentation at the Conference on "Implementing the theories of R&D management" Manchester 7 – 9 July 2003. http://www.radma.org/Abstracts%20web%2016%20June.PDF

41. **Yawson R. M** (2003) "Emerging Technologies and the Digital Divide – Bridging the Gap, the Case of Ghana" Paper accepted for presentation at the 19th International Conference on CAD/CAM, Robotics and Factories of the Future CARS & FOF 2003 in Kuala Lumpur, Malaysia 22 – 27 July 2003 www.sirim.my/cars&fof2003/day3.htm

42. **Yawson R. M** (2003) "Emerging Technologies and the Digital Divide – Bridging the Gap, the Case of Ghana" In: Proceedings of the World Summit on the Information Society. Geneva, Switzerland, 10 – 12 December 2003 www.irfd.org/events/wf2003/abstracts/africa.html

43. **Yawson R. M.,** (2003) Management of Technology in Ghana – Problems & Prospects. *Refereed Conference Abstract*. IAMOT 2004 Conference. Presented by International Association for Management of Technology, April 3 – 7, 2004. Washington, DC, USA http://www.iamot.org

Other Publications (Consultancy, Training Manuals etc)

44. **Johnson, P-N. T,** Quaye E. T., Essel, K., E. T, & Atupra, F., (2003) Training Manual for Workshop on Good Manufacturing Practice (GMPs) and Good Hygiene Practice (GHPs) for Micro-Small & Medium-Scale Food Manufacturing Companies in Ghana. Consultancy Report for United Nations Industrial Development Organisation, Accra.

45. **Yawson R. M.** (2003) "Ghana and the Controversy Over GM Foods" ***The Independent*** July 10, 2003 Issue No. 078

46. **Yawson R. M,** (2003) "Emerging Technologies and Ghana's Economic Development" ***The Independent*** July 24, 2003 Issues No. 078

Appendix VI

END OF YEAR REPORT ON RECURRENT ACCOUNT

JANUARY TO DECEMBER 2003

	¢	¢
Balance B/f		79,491,325.74
Refund		19,024,129.32
RECEIPTS		
Gov't Grant		5,457,493,870.48
		5,556,009,325.54
LESS :EXPENDITURE		
Salaries		2,846,107,450.26
National Serv.& Attachment		7,067,035.14
ADM. EXPENSES		
Vehicle Running Exp.	62,540,850.00	
R/M- Motor Vehicles	18,729,096.00	
Medical Exp.	61,601,640.00	
R/M - Bungalow Building	26,158,250.00	
R/M - Office Equipments	20,211,500.00	
R/M - Office Building	4,150,000.00	
T & T - Local	3,413,931.01	
Staff Training Exp.	48,453,400.00	
Sitting Allowance	19,726,000.00	
Meetings & Confereces	13,872,678.39	
Telephone Charges	42,049,608.00	
Workshop & Seminars	2,700,000.00	
Sanitation	3,284,000.00	
Stationery	39,796,515.84	
Duty Allowance	3,722,986.60	
Night Allowance	3,900,000.00	
Funeral Exp.	500,000.00	
Postal Charges	816,000.00	
Overtime Exp.	2,650,340.50	
Book Allowance	320,947,782.00	
Entertainment Exp..	9,078,500.00	
Office Gen. Exp.	1,236,930.00	
Insurance Premium	9,464,254.00	
Audit fees	3,969,000.00	
Training allowance	4,786,930.00	
Owner Occupier	1,144,273.00	
		728,904,465.34
STATUTORY DEDUCTIONS		
SSNIT	205,895,091.34	
Income Tax	382,590,834.72	
Welfare Fund	114,635,475.71	
T. U. C	49,057,343.79	
G. S. A	2,310,000.00	
R. S. A	15,262,500.00	
S. S. A	118,018,337.33	
Withholding Tax	1,714,546.66	
		889,484,129.55
CSIR DEDUCTIONS		
SSTL	49,152,637.88	
10% Prov. Fund	169,915,744.14	
Superannuation	118,142,623.60	
Prov. Special Loan	95,696,166.80	
Prov. Housing Loan	30,777,551.12	
CSIR Ladies Club	345,453.40	
Car Recon. Loan	3,952,091.50	
Prov. Car Loan	30,042,618.89	
		498,024,887.33
OTHER DEDUCTIONS		
Consumer Credit	15,898,000.00	15,898,000.00
Salary Advance	8,500,000.00	
Pensions & Gratuities	6,981,362.16	
Honorarim	7,050,000.00	
Direct Research Exp.	9,174,000.00	
		31,705,362.16
		5,017,191,329.78
Balance C/f		538,817,995.76

APPENDIX VII
INTERNALLY GENERATED INCOME

INCOME	1ST QUARTER	2ND QUARTER	3RD QUARTER	4TH QUARTER	TOTAL
Sale of Products	13,002,000.00	10,511,500.00	19,249,000.00	13,274,000.00	56,036,500.00
Analysis and Tech.Services	38,612,850.00	50,287,400.00	107,587,000.00	72,497,000.00	268,984,250.00
Training Fees	3,345,000.00	11,817,895.00	65,140,000.00	49,071,159.00	129,374,054.00
Fabrication	4,000,000.00	95,500,000.00	-	78,600,000.00	178,100,000.00
Miscellaneous	11,161,000.00	15,497,000.00	18,575,000.00	33,774,000.00	79,007,000.00
TOTAL INCOME (a)	**70,120,850.00**	**183,613,795.00**	**210,551,000.00**	**247,216,159.00**	**711,501,804.00**
LESS : DIRECT COST					
Production - Raw Materials	7,982,853.60	17,926,320.00	23,471,000.00	6,771,600.00	56,151,773.60
Fabrication Expenses	-	59,600,000.00	-	75,767,600.00	135,367,600.00
Chemicals	12,570,500.00	49,110,350.00	35,821,000.00	57,448,375.00	154,950,225.00
Operational Expenses	28,784,579.00	33,413,063.00	56,015,324.00	48,047,900.00	166,260,866.00
Training Expenses	445,500.00	10,871,500.00	36,502,142.00	8,000,000.00	55,819,142.00
Technical Expenses				17,400,000.00	
TOTAL DIRECT EXPENSES (b)	**49,783,432.60**	**170,921,233.00**	**151,809,466.00**	**213,435,475.00**	**568,549,606.60**
NET INCOME (a-b)	**20,337,417.40**	**12,692,562.00**	**58,741,534.00**	**33,780,684.00**	**142,952,197.40**

DISTRIBUTION OF NET INCOME

NET INCOME		**142,952,197.40**
15% - CSIR	**21,442,829.61**	
85% - FRI	**121,509,367.79**	
		142,952,197.40

APPENDIX VIII
FRI STAFF TRAINING - 2003

	NAME OF STAFF	DESIGNATION	COURSE	INSTITUTION OF STUDY
1.	M. Ottah-Atikpo (Mrs.)	RS	PhD (Food Microbiology)	University of Ghana
2.	N. T. Annan (Mrs.)	SRS	PhD (Fd. Sc.)	UG / KVL, Denmark
3.	E. C. T. Tettey	RS	PhD (Fd. Sci)	Univ. of Ghana,
4.	N. T. Dziedzoave	SRS	PhD (Fd. Sci. & Tech.)	NRI
5.	C. Tortoe	RS	PhD (Fd. Sci. & Tech.)	NRI, Univ. Of Greenwich
6.	M. Obodai (Mrs.)	RS	PhD (Food Microbiology)	Univ. of Nottingham. UK
7.	C. Oduro-Yeboah (Mrs.)	ARS	MPhil (Fd. Sci)	Univ. of Ghana, Legon
8.	P. M. Larweh (Mrs.)	ARS	MSc (Fd. Sci)	Dalhousie Univ. Hallifax, Canada
9.	E. Allorsey	Snr. Tech. Asst.	HND Biochemical Lab. Tech.	Univ. of Ghana, Legon
10.	R. Kavi	Prin. Lib. Asst.	BSc (Info. Studies)	Univ. of Ghana, Legon
11.	A. Padi (Mrs.)		Dip. in Catering & Hotel Mgt	Graduate School of Management, Accra
12.	C. Boateng (Ms)		Dip. in Catering & Hotel Mgt	Graduate School of Management, Accra
13.	K.K. Essel	Tech. Asst.	HND Biochemical Lab. Tech.	Univ. of Ghana, Legon
14.	A. Andoh	Chief Tech. Officer	Post Grad Dip. In Marketing	GIMPA
15.	A. I..Nyarko.	Tech Asst. Gd. I	HND Biochemical Lab. Tech.	Univ. of Ghana, Legon
16.	L. Botchie (Mrs)	Snr. Accts. Clerk	BSc (Admin) Acct. Option)	Univ. of Ghana, Legon

APPENDIX IX
CONFERENCES, COURSES, WORKSHOPS AND SEMINARS ATTENDED BY FRI STAFF IN 2003

Conferences/ Courses/ Workshops/Seminars	Participants	Designation	Venue	Date/Duration	Organizers
Project Meeting of the EU funded project "Biological degradation of aflatoxins in fermented maize and sorghum products"	Dr. (Mrs.) K. Kpodo	SRS	Stellenbosch, South Africa.	16th - 20th Jun. 2003	EU
Training workshop on Research Methodology and Report writing	I. Johnson-Kanda (Ms.)	ARS	UG, Legon	17 – 25, July 2003	ISSER, Legon
Training Workshop on Data Management and analysis	I. Johnson-Kanda (Ms.)	ARS	UG, Legon	July 18 – Aug. 8, 2003	ISSER, Legon
Workshop on Nutrition	P. Lokko (Mrs.)	PRS	Kampala, Uganda	July 25 to Aug. 1st 2003	
Workshop on the PERI programme	Dr. W. K. Amoa-Awua P. Lokko (Mrs.)	Dep. Director PRS	CSIR – INSTI	October 2003	CSIR – INSTI
First African Workshop on Food Safety	Ms. M. Halm Dr. (Mrs.) K. Kpodo Mrs. M. Ottah-Atikpo	SRS SRS RS	Stellenbosch, South Africa.	8th - 13th Dec. 2003	International Union of Microbiological Societies (IUMS) & Int. Committee on Food Microbiology and Hygiene (ICFMH).
Peanut CRSP workshop	P. Lokko (Mrs.)	PRS	Vicosa, Brazil	Nov. 28 - Dec. 5, 2003.	University of Vicosa
Training Course on Scientific Writing and Oral presentation	Mr. P. Feglo Mr. G. Anyebuno Mr. G. Komlaga Ms. L. Larweh	RS RS RS ARS	CSIR-INSTI, Accra, Ghana	8th – 12th Dec. 2003	CTA/CSIR/INSTI
Training Workshop on shelf-life determination of perishable foods	Mr. C. Diako, Mr. D. Ankrah Mr. E. Allotey	ARS		9th – 11th Dec. 2003	UNIDO/FRI
Policy Dialogue Forum on Performance Management	Dr. W. A. Plahar Dr. W. K. Amoa-Awua Mr. R. M. Yawson Mr. S. K. Noamesi Ms. I. Johnson-Kanda Mr. C. Amegah	Director Dep. Director Sci. Secretary RS ARS Accounts Clerk	Erata Hotel, Accra, Ghana	10th Dec. 2003	CSIR/NRI/DFID
Training Workshop on the use of the Atomic Absorption Spectrophotometer and Flame Photometer	Staff of Chemistry Laboratory	Scientists and Technicians	Accra, Ghana		Scimed Instruments Service Center

APPENDIX X
ORGANOGRAM