COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH
(CSIR)

FOOD RESEARCH INSTITUTE
(FRI)

GHANA

1997 ANNUAL REPORT

Prepared by:
Scientific Information Division
Food Research Institute
P.O. Box M.20
Accra
Tel. 777330 / 761209

TABLE OF CONTENTS

APPENDICES:

FOOD RESEARCH INSTITUTE

1997 ANNUAL REPORT

1.0 EXECUTIVE SUMMARY

The Food Research Institute (FRI), one of the currently 13 affiliate institutes and centres of the Council for Scientific and Industrial Research (CSIR), is mandated to conduct applied research into problems of food processing and preservation, storage, marketing, distribution and utilization, in support of the food industry and also to advise government on its food policy.

In line with this mandate, the main objectives of the institute during the year were centered on R & D activities for the solution of postharvest problems.

The year 1997 saw progress in the installed capacity and capability of the institute. Thanks to the Danish International Development Assistance (DANIDA), a gas chromatogram and mass spectrometer (GCMS) and other pieces of equipment were installed at the institute, increasing the institute capacity to do flavour research and some special chemical analysis. Also a few pieces of equipment, including a Mettler balance, a hot plate magnetic stirrer and a weighing scale, have been acquired for the new chemistry laboratory.

A process was developed for the production of soy-agushie, a stable high-protein residual by-product of soymilk production, for use in Ghanaian dishes. Also, a comprehensive recipe book on soybean utilization was revised and updated for Ghana.

A new malting plant for the FRI/UNIDO Sorghum project and an Insta-Pro extruder, acquired under the FRI/Alabama A & M University Peanut Collaborative Research Support Project CRSP, was installed and tested during the year. These will facilitate development of technologies for the production of high-protein foods.

The FRI, in collaboration with Purdue University, began another project under the Peanut CRSP on "the effect of peanut consumption on hunger, ingestive behaviour, energy expenditure and coronary heart disease risk."

Various other machines, such as the hot-air walk-in dryer, were fabricated for institute projects as well as industry.

Work on the development of a pilot fufu flour production plant is far advanced. The design and final engineering drawings are almost complete. It is estimated that the construction and installation of the pilot fufu flour production plant will be completed by April 1998.

Research studies on food fermentation continued. Studies were initiated on the inactivation of food borne bacterial pathogens, during maize fermentation.

Work progressed in the international collaborative and other research projects. Work also continued on product and recipe development, sensory evaluation of foods, socio-economic baseline and market studies.

Improved pineapple cultivation technologies were developed for small, medium, and large-scale farmers. The number of plants for production per acre has been increased from 50,000 to 61,000, increasing the yield by 20%.

A survey of the postharvest problems of vegetables in all the 10 regions of Ghana was completed.

Another survey was completed in 1997 on Marketing of Cassava and Cassava Products in Southern Ghana. The survey covered the Greater Accra, Central, Western and Eastern Regions.

A survey of Cassava processing in the Ga District was conducted to assess the socio-economic background of traditional cassava processors, the source of cassava used for the processing, the technology employed, the problems and the financial analysis.

Research work continued on edible and medicinal mushrooms, fermentation, cassava, product development using fish flour, etc.

Training programmes were organized for small-scale processors and the general public in fruit and fish processing, in the cultivation of mushroom and soybean and utilization and laboratory technology and salt iodation. More than 150 people benefitted from the training programmes.

There were about 20 research publications, many of which were published in refereed international journals. Research staff took part in more than 10 local and international conferences, seminars and workshops.

Revenue generated from the sale of institute products, hire of institute facilities and services rendered amounted to about ¢50 million.

About 500 samples were submitted to the institute for microbiological and chemical analyses. The samples were made up of cocoa products, milk and egg powders, products from yam, plantain, cassava and spices, etc.

The institute undertook a new project, in collaboration with for Natural Resource Institute (NRI) of the United Kingdom, to test the suitability of using cassava flours as a wheat substitute in the preparation of cookies. Another project began on the Utilization of Fish Flour using Norwegian Herring Meal, for the Norwegian Herring Oil Industry Research Institute (SSF).

2.0 GENERAL MATTERS

2.1. Establishment

The staff strength of the Institute reduced as compared to previous years. Staff strength as at as at December 1997 stood at 171. Please see below.

FRI Staff Profile

	CATEGORY	1995	1996	1997
1.	Scientific Staff	34	35	33
2.	Senior Staff	38	40	40
3.	Junior Staff	103	105	98
	TOTAL	175	180	171

2.2. Appointments

Seven persons were appointed during the year.

1997 Appointments

	NAME	DESIGNATION	DATE
1.	Ms. Charlotte Tete-Marmon	Asst. Scientific Officer (temporary)	1/7/97
2.	Mr. Emmanuel T. Agblo	Technical Apprentice	3/11/97
3.	Ebenezer K. Asare	Watchman	1/8/97
4.	Francis Yin	Watchman	19/8/97
5.	George Ankwa	Labourer	3/11/97
6.	Ababasi Akanzinam	Labourer	3/11/97
7.	John Awiah	Labourer	6/11/97

2.3 Resignations

Five members of staff resigned their appointments with the Institute during the year. They were all honoured at the annual Get-together which served also as a send-off party.

1997 STAFF RESIGNATIONS

	NAME	DESIGNATION	DATE
1.	Liquenda Allotey	Asst. Scientific Officer	August 18, 1997
2.	Ms. Victoria Christian	Snr. Technical Officer	January 1, 1997
3.	Ms. Patience Tetteh	Administrative Assistant	August 1, 1997
4.	Hannah Asafo-Adjei	Snr. Accounts Clerk	October 1, 1997
5.	Ms. Charlotte Arthur	Skilled Labourer	October 1, 1997

2.4. Retirement

Two of the institute's long-serving members of staff, Dr. Joy Kwadwo Berkoh Agubretu Ata, Principal Scientific Officer, and Mr. Alex Kofi Gyamerah Amoah, Chief Technical Officer, were honoured on their retirement from the service of the Food Research Institute with a send-off party organized for them in December.

Dr. J.K.B.A. Ata was first employed at the FRI in August 1967 as a Research Officer. He became Principal Research Officer in 1982. His main specialization was the area of Fats and Oils.

In 1984, he went on a secondment to the Ministry of Industries, Science and Technology as Technical Director. Following his appointment as Chief Director of the Ministry of Environment Science and Technology, he resigned has appointment from the CSIR with effect from August 1993.

Mr. A.K.G. Amoah joined the FRI as Senior Technical Officer (Grade II)in 1969. He became Chief Technical Officer in of the Engineering Division in 1985.

2.5 Vacation of Post

Ms. Elizabeth Koso, Skilled Labourer, vacated her post during the reporting period.

2.6 Promotions

Three promotions were announced during the year:

1997 Promotions

	Name	Promoted from	Promoted to	Date of Promotion
1.	Ms. Patience Tetteh	Senior Clerk	Admin. Asst.	October 1, 1996
2.	Mr. Kenneth Aidoo	Senior Acc. Clerk	Acc. Asst.	"
3.	Mr. Anthony Kwaw Mensah	Snr. Tech. Asst.	Tech. Officer	"

2.7 Study Leave

About 15 members of staff, including six scientific officers, are being sponsored by the Institute to undertake the training programmes. Please refer to Appendix IV for details.

2.8 Resumption of Duty after Completion of Course

Three scientific members of staff and two technical staffs, who were awarded study leave with pay, to undertake various courses have completed their studies and returned to post. See Appendix V for details.

Mrs. Mary Obodai, Scientific Officer, who undertook a short training on mushroom cultivation, in China has returned to post.

2.9 Deaths

Mr. Francis Arthur, a Watchman, passed away during the year under review.

2.10 Workshops /Conferences/ Meetings

There were about 12 local and international conferences, seminars and workshops at which FRI staff participated. Please see Appendix III for details.

2.11 National Service

Mr. Sampson Asante, a graduate of the University of Ghana, began his national service posting at the FRI. He was attached to the Administration Division.

2.12 Institute Visitors

The Institute received many visitors, among whom were Hon. J.E. Afful, Minister for Environment, Science and Technology, Hon. Dr. J. Abu, Minister for Trade and Industry and the CSIR Deputy Director-General for Natural Sciences and Industry.

The Institute also received groups of visitors during the year. They included about 30 Engineering students from the Kwame Nkrumah University of Science and Technology, 35 agricultural students and lecturers from the University of Development Studies, Tamale, 35 students and tutors from De Youngsters JSS International, students from St. Mary's Secondary School, Apowa, Takoradi, and about 20 Higher National Diploma (HND) students from Accra Polytechnic. They were conducted round the Institute facilities by the PRO.

2.13 Commercial Unit

A. *Contract:*

About 51 mt. of groundnut paste was produced for the United Nations High Commission for Refugees (UNHCR), for distribution to refugees at Bududuram, Klikor and Sanzule camps in the Central and Western Regions.

B. *1997 FRI Internally-Generated Funds:*

The FRI Commercial unit generated about ¢50 million cedis in 1997. Please see Appendix VI for details.

2.14 Accounts

A total of about ¢935 million (nine hundred and thirty-five million cedis) was released for the recurrent budget for 1997. Total recurrent expenditure amounted to about ¢940 million (nine hundred and fourty million cedis.) Please see Appendix VII for details.

The total development budget amounted to ¢50 million. Please see Appendix VII for breakdown.

3.0 DIVISIONAL REPORTS

3.1 SCIENTIFIC INFORMATION DIVISION

3.1.1. Introduction

The Scientific Information Division is responsible for the Institute's information processing and handling by way of documentation and public relations services both within the Institute and between the Institute and external organizations.

In 1997, the Division maintained a staff of only four, with one Head of Division.

3.1.2. Scientific Information and Public Relations Section

A. ***Reports:***

Preparation of the 1996 Annual Report was completed within the period. Drafts of the first and second quarterly reports for 1997 were also prepared.

B. ***Institute Clients and Visitors:***

There were about 60 requests for scientific and technical information. These included information on production of cassava chips for export, solar driers and solar heaters, mushroom cultivation, maize storage, tomato preservation, production of dry ice, analysis of gari and bottling of processed foods.

C. ***Exhibitions:***

Mr. A. Andoh, Principal Technical Officer, Public Relations (PTO-PR), attended the meetings of the CSIR Standing Exhibitions Committee and helped to coordinate CSIR/FRI participation in INDUTECH '97, which took place from February 28 - March 10, 1997.

He also represented the Institute in the Day of Scientific Renaissance of Africa, which is celebrated every June 30. The PTO -PR prepared a film script for the CSIR Standing Exhibitions Committee for the video coverage of the activities in commemoration of the Day.

The Institute participated in the first ever DWAPA Trade and Tourism air, which took place at Koforidua in the Eastern Region as well as the 10th National Farmers' Day, at Bechem, in the Brong Ahafo Region.

D. *Conferences and Workshops*:

The PTO, Public Relations served as secretary to the planning committee of the FAO/FRI Regional Workshop on the Design, Construction and Use of Insulated Containers for Artisanal Fishing Canoes scheduled for 14-25 July 1997. He also worked on the adverts, press release and invitations, etc.

E. *Internal Seminars:*

A calendar of the 1997 Institute Internal Seminars was launched in the second quarter. However, only three seminars were held during the year. These were "Development and quality characteristics of fish-fortified weaning foods for fishing communities in Ghana", by Dr. W.A. Plahar, "Development of Food Products from Roots and Tubers", by Mrs. Osei-Yaw, and "Research grade staff promotion procedures and requirements" by the Director, Mrs. Abigail Andah.

F. *Press Relations:*

Thanks to public relations efforts, the Institutes gained coverage of many of its activities in the electronic and print media, both private and public. As in previous years, there were editorial commendations of the work of the Institute.

G. *Training:*

Mr. S. K. Noamesi, Scientific Secretary, began his Ph.D. programme with the University of Ghana. He therefore handed over his duties as Scientific Secretary to Mr. A. Andoh, Principal Technical Officer, Public Relations, in January 1997.

Mr. Kafui Ameh, the Chief Technical Officer, Public Relations, who has been on a secondment to the Ministry of Environment, Science and Technology (MEST), since his diploma course several years back, showed up briefly and proceeded on a one-year study leave for his MA degree in Communication Studies at the University of Ghana.

Mr. A. Andoh under took a week's course in photojournalism organized by the School of Communication Studies of the University of Ghana and sponsored by the Friedreich Erbert Foundation of the Federal Republic of Germany.

3.1.3. LIBRARY AND DOCUMENTATION SERVICE

A. *Stock:*

In all, 79 publications were added to the stock of the library during the year, most of them gifts from CTA, FAO, IDRC and through outright purchase by the Institute.

The library also received journals under the NARP, after a backslide in 1995. Those from the Commonwealth Agricultural Bureau International (CABI) were also received after the counterpart contribution had been paid. The local ones have been received regularly. These include African Review, African Farming and Journal of Biochemical Society.

B. *Input on Computer and Binding of Reports:*

Inputs on the FRILIB Database were 65 documents and that of GHAGRI was seven. A totals of 56 reports were bound for the Institute and staff.

C. *Commercial Activities:*

Photocopying and sales of Food Composition Tables were the main commercial activities during the year. One hundred and sixty documents were copied yielding ¢465,400. Forty-three Food Composition Tables were sold, yielding ¢107,000.

D. *Library Users:*

Apart from the Institute Staff, 88 outsiders used the Library within the period. Over 50% were students from the various Universities and other tertiary institutions. The rest were lecturers, manufacturers, researchers, businessmen, engineers, lawyers, pastors and biochemists.

E. ***Loan System:***

Twenty-five overdue books and Journals are in the possession of twelve staff members.

3.1.2 PROCESSING DIVISION

Research work was conducted on rice, maize, sorghum and millet as well as fruits and vegetables.

3.1.3 ANALYSIS DIVISION

3.1.3.1 Technical Services

A. ***Microbiological Analysis:***

Four hundred and sixteen samples were submitted for microbiological analysis in 1997 as compared to 446 for 1996. The samples were made of cocoa products, milk powder, egg powders, products from yams, plantains, canned fish, dehydrated palm fibre, canned fish, water and poultry feed, etc.

B. ***Chemical Analysis:***

One hundred and twenty-two samples were analyzed for their quality characteristics and nutrient contents during the year. The samples included feeds and feed ingredients, cassava products, spices and condiments, cocoa products, fruits and vegetables, cereals, fats and oils, etc.

C. ***Training:***

Staff of the Department of Food Technology (DTA) the National Centre for Research into Science and Technology (CNRST) of Burkina Faso were provided on-the-job training by FRI scientists and technicians in microbiological techniques and methods for examination of Dawadawa fermentation, including Good Manufacturing Practice (GMP).

Two students from Accra Polytechnic were attached to the Microbiology Section for on-the-job training in microbiological techniques and microbiological examination of foods.

A student from Kwame Nkrumah University of Science and Technology (KNUST) undertook vacation training in proximate and salt analyses.

D. ***Other Activities:***

A review of analytical charges for microbiological and chemical analysis was undertaken

Rehabilitation of the chemistry laboratory, which started during the year, was almost completed. A few pieces of equipment, including a Mettler balance, a hot plate magnetic stirrer and a weighing scale, have been acquired for the chemistry laboratory.

A gas chromatogram and mass spectrometer were received and installed at the FRI. Scientists and technicians were trained on the use of the equipment, including the software and an easy manual for the system has been prepared.

A comprehensive list of equipment needed for the Chemistry laboratory was prepared and submitted to the NARP / World Bank Project for funding.

3.1.4 FOOD ECONOMICS AND UTILIZATION DIVISION

The Division continued to undertake research projects, product development, sensory evaluation of foods, baseline studies, economics and marketing,

A. **Staff Matters**

Three members of staff resigned their posts, but the staff strength increased with the transfer five canteen staff to the division. Currently the division has three scientific officers.

B. ***Salt Iodation:***

The fourth national training programme on the salt iodation was held from October 8-9, 1997. There were 21 participants from eleven salt companies. Topics treated covered Iodine Deficiency Disorders, salt quality, salt iodation, monitoring, costing of iodated salt, laboratory analysis and maintenance of machines. There were field trips and hands-on demonstration of salt iodation.

C. **Catering Services:**

The FRI Test Kitchen serviced about 20 training programmes, workshops and institute visitors.

3.1.5 ENGINEERING DIVISION

A. ***Installation of New Equipment:***

A new malting plant for the FRI/UNIDO Sorghum project and an extrusion plant for the Peanut CRSP project were installed during the year at the Pilot plant.

B. ***Repair and Routine Maintenance of Machines and Equipment:***

The mechanical section carried out routine maintenance of machines and equipment at the Cassava Processing Demonstration Unit (CPDU) at Pokuase, the cowpea processing plant at Ohawu, and the paste filler, hot air cabinet dryer, attrition mill, roasters and burners at the pilot plant complex, Okponglo.

Machines that were rehabilitated include the IITA cassava grater, drum grater and solar dryer at the CPDU, a Y-cone blender, the control panel of the hot-air cabinet dryer and a solar dryer at Okponglo. Repair works were carried out on a pressure gauge for the DANIDA project, the paste filler and the pulping machines at the pilot plant.

Other jobs undertaken include the dismantling and relocation of the FIIRO Gari fryer/dryer and other cassava processing machines to a new location within the CPDU, moulding of dripping trays for the tomato project, etc.

Machines constructed during the year at the workshop include the hot air dryer and a stainless steel grater for Ebenut Ltd., 100 aluminum perforated trays, the conversion of a splitter into a dehuller and the modification of two elevators.

Machines being constructed under the NARP grain legumes project, the Development of Pilot fufu flour production plant and the DANIDA maize processing pilot plant have reached various levels of completion. Work on two 500 kg/hr grain cleaners/graders is 90% complete, a peeling /washing bench

80% complete, a pressure cooker with hoist system 90% complete and a grader/aspirator 90% complete.

The refrigeration section also carried routine maintenance on all air-conditioners as well as some refrigerators and deep freezers both at the Josif Broz Tito campus and the Pilot plant. Electrical wiring faults were repaired in the laboratories and offices as well as staff bungalows. Electrical faults on equipment such as the moisture oven, the pH meter, Magnetic shaker hot plate, ice flakes machine, furnace, de-carbonizer and water bath were repaired.

4.0 RESEARCH ACTIVITIES

4.1 Breakthroughs (and Highlights) in Research and Development and Technology Transfer

4.1.1 Soybean Recipes in Ghanaian Dishes

Under the IDRC/IITA/FRI Soybean Utilization Project, a process was developed for the production of soy-agushie, a stable high-protein residual by-product of soymilk production for use in Ghanaian dishes. Soy-agushie could be used in several traditional foods, bakery products, etc.

About 50 Soybean recipes have so far been developed to improve on the traditional low protein foods commonly consumed in Ghana. A 60-page third edition of the recipe booklet was prepared.

Work was completed on the development of appropriate household/small-scale enterprise level technique for the production of soy-fortified maize products. Please refer to pages 24 - 25 and 31 - 34 for a more detailed reports on FRI Soybean research and recipe development and activities.

The exciting thing about soybean is how easy it is to follow a diet that protects health, prevents diseases, enhances nutrition and has a potential to promote enterprise and industry.

4.1.2 Sorghum Malt Development Project in Ghana

Five cultivars of white sorghum have been identified and found both agronomically and analytically suitable for the substitution of barley in the brewing industry. A malting plant was installed at the FRI and this is to be complemented with a pilot brewing plant in 1998. Please see pages 30 - 31 for a fuller report.

4.1.3 Production of Starter Cultures

The installation of a pilot plant for kenkey, at the FRI at Pokuase, began during the year and was almost complete. The pilot plant was being set up for training and demonstration purposes as well as the production of kenkey for sale.

Production will make use of starter cultures, which be a more time-efficient way of kenkey production and more wholesome production methods.

Work was done on batch starter culture production for commercial fermentation of maize using malted maize substrate. A paper on the subject has been submitted for publication in an international journal. Please refer to page 29 for reports on the fermentation projects.

4.2. National Agricultural Research Programme (NARP) Projects

4.2.1 Rice

The institute received assistance from the Commonwealth Fund for International Development (CFID), through the Natural Resources Institute in the form of equipment for cereal analyses. The equipment have since been installed.

The activities being carried out under this support programme are in the Northern, Upper East and Upper West regions and they include techno-economic analyses of rice processing systems, postharvest practices affecting rice quality of locally milled rice, consumer preference and price-quality studies and loss assessment studies.

Work in all these areas, which began in 1997, are still going on and will reported on in 1998.

A. ***Sensory Evaluation:***

The cooking quality and acceptability of 14 cultivars of rice were investigated. All the samples, except two, were found to have good swelling capacity and good sensory attributes.

4.2.2 Sorghum and Millet

Investigation of the food quality characteristics of Sorghum and millet varieties were carried out to characterize sorghum and millet according to their nutritional and processing properties, to improve the local processing methods and to develop new sorghum and millet-based products.

Although the number of varieties available for this phase of the work was rather limited to facilitate generalizations, the following could be said for the millet varieties evaluated:

* Millet variety, PMB Manga (ICMV IS 92202), had the highest protein content of 15.4% and could therefor be considered for formulation of infant foods.
* The local late millet (SARI) Manga), despite its low protein content of 8.9%, could be considered for malted millet product formulations.

* Kadaga and NSV 1 Sorghum varieties had the highest protein contents of 11.5% and 12.1% respectively, which makes them choices in the search for sorghum types for infant feed formulations

4.2.3 Maize

Eight varieties of maize were received from the Crops Research Institute for food quality evaluation. The pasting characteristics, sensory evaluation and microbiological analyses were carried out on the samples. The physical characteristics of the varieties were also determined. In-depth nutritional analyses would be carried out in the following year.

A. ***Sensory Evaluation:***

Sensory evaluation on the maize cultivars were also evaluated. Fermented dough was used for the preparation of *Kenkey* and *Akasa*. All the samples, except one, were found acceptable.

4.2.4 Processing and Utilization Studies on Cowpea Cultivars

This project seeks to develop through applied research, techniques that would facilitate the effective utilization of locally developed cultivars of cowpea for the improvement of the nutritional status of the average Ghanaian.

During PY2, work continued on the comparative evaluation of cowpea cultivars for anti nutritional factors, methods for their inactivation and suitability for specific food uses. Commercial cowpea cultivars were characterized for specific food uses in terms of colour, functional properties and tannin content, in order to develop appropriate processing techniques for reducing the adverse effects that limit utilization of cowpea and to establish the suitability of cowpea cultivars for specific food uses.

A. *Activities and main findings:*

Four popular West African local cultivars of cowpea *(Vigna unguiculata)*, with distinctly different seed coat colours, were evaluated, for their relative amylograph pasting characteristics, condensed tannin content, *in vitro* protein digestibility and *Tetrahymena* protein efficiency ratio (*t*-PER). The effects of roasting and dehulling on these properties were also determined.

There were wide variations in the hot paste viscosity characteristics of the different cultivars studied. The raw cowpea flour samples exhibited maximum paste viscosities ranging between 260 Brabender Units (BU) for the Mottled cultivar and 460 BU for the cream-coloured Black-eyed cultivar. Cowpea cultivars with the greatest peak viscosities showed low stabilities to extended cooking. Roasting depressed paste viscosity properties of all the cowpea cultivars studied.

Tannin concentrations were 0.3 - 6.9 and 7.2 - 116 mg CE/g flour from whole cowpea seeds and seed coats respectively, increasing with intensity of seed colour. Although dehulling removed 98% of the tannin content of raw cowpeas, improvement in protein quality as a result of dehulling was observed for only the highly-pigmented Maroon-red variety. Roasting significantly improved digestibility and more than doubled the *t*-PER of all cowpea cultivars studied. Roasted cowpeas possess adequate nutritional and functional qualities as protein supplements in cereal-based weaning foods. However, it appears that dehulling is necessary to enhance the nutritional quality of the highly pigmented cultivars of cowpea.

B. *Achievements:*

Commercial cultivars of cowpea were characterized in terms of their relative chemical composition, functionality and content of anti nutritional factors. Appropriate methods for the effective control of the anti nutritional factors in cowpeas for maximum nutritional benefits, especially in weaning food formulations were established. This information is quite vital in the national Weanimix promotional drive for maximum nutritional benefits.

A scientific paper was submitted on the findings and has been recommended by referees for publication in the Journal of Plant Foods for Human Nutrition.

4.2.5 Evaluation of Soybean Cultivars for Processing and Utilization

A. ***Activities and main findings:***

The overall goal of the project is to facilitate diversified food uses of soybeans as a major protein source for improved nutritional status of the average Ghanaian. Planned activities for PY2 were aimed at developing appropriate techniques for household and commercial utilization of soybean for the production of high protein-energy foods.

Studies were therefore undertaken for a comparative evaluation of available methods for household level production of high-protein intermediate soy-based foods in terms of ease and economy of production, product quality and acceptability.

Work was completed on the development of appropriate household/small-scale enterprise level technique for the production of soy-fortified maize products by comparing different treatments, processing methods and fortification levels.

The effects of fortification method of the traditional maize products with raw or processed soybean products at varying replacement levels, on process characteristics and product quality were investigated. Sensory characteristics, trypsin inhibitor activity, amino acid pattern, proximate composition and hot paste viscosity were used as the indices of quality.

Work was also started on the development of appropriate techniques for the production and packaging of full-fat soy flour and grits as stable intermediate soy products for fortification purposes. Comparative evaluation of the different available techniques for the production of full-fat soy flours and grits was undertaken with respect to the effects on the content of anti nutritional factors and sensory characteristics.

Work is still in progress to evaluate the processes in terms of yields, physical, chemical, functional and nutritional characteristics of flours and grits produced by the different techniques. Based on the results, a standard technique will be established and used to evaluate the suitability of the flours and grits in traditional foods, weaning formulations and extruded products.

B. ***Achievements:***

From the results of the study, the most appropriate technique for the preparation of soy-fortified maize-based products were established. The processes developed were aimed at alleviating the drudgery involved in soybean processing for fortification while achieving good nutritional quality.

The study developed a process for promoting enterprise-level production of protein-rich foods to help alleviate protein-energy malnutrition in Ghana. A scientific paper has been prepared and submitted to help add to global knowledge in legume utilization for improved human nutrition.

4.2.6 *Adaptation of winged bean Dehulling Plant for Cowpea, Groundnut and Soybean*

The need to make use of the underutilized winged bean Dehulling Plant at the FRI resulted in the formulation of this project which seeks to modify and adapt the Winged Bean Dehulling Plant (WBDP) to process soybean, groundnut and cowpea.

The project is expected to contribute positively in the introduction of legumes into traditional Ghanaian diets to enhance protein quality. The project involves the test running of the WBDP, selection of suitable units of the plant, modification and adaptation of selected units, establishment of technical data and specifications and the introduction of the designs to local engineering companies and the machine to food processors.

The project, which started in September 1996, continued with the modification and adaptation of the grader/aspirator, the splitter and the elevators. Work done so far include the following:

1. Modification and adaptation of the grader/aspirator to clean and grade cowpea, soybean and roasted groundnut.
2. Modification and adaptation of the splitter to dehull soybean and roasted groundnut.

Modifications made on the grader-aspirator include the introduction of a bigger hopper with a grain feed regulator to control the feed, the change of position and design of the extractor fan system to ensure more air-material contact and the increase in size of fan blade to ensure higher cleaning efficiency.

The grading compartment of the machine has been modified to accommodate a pair of grading sieves at a time slotted into place through the side. Three pairs of grading sieves, with different aperture sizes for the three commodities, have been constructed.

The splitter has been converted into a dehuller by incorporating a separating chamber at the outlet chute and an air blower system across the direction of material flow. The husks and dehulled grains enter the separating chamber where they experience a mass of air perpendicular to their flow. Due to its relatively light weight, the husk is carried by the air across to a husk collecting bin whilst the dehulled grains are collected in a receptacle located at the end of the outlet of the separating chamber. The volume of the lower compartment of the two elevators have been reduced by 20% in order to considerably reduce the quantity of leftover grains after processing. Openings have been created at the rear of the lower compartment to give easier access during repair and maintenance works.

The separate electrical devices such as main switches and starters for the machines have been installed on a common control panel located at a convenient position for the operator from where each of the machines can be operated. Installation of the units mentioned above was 90% complete.

The installation work will be completed in January, 1998 after which the units of the plant will be tested with cowpea, soybean and roasted groundnut where applicable for the establishment of technical operating data and specifications.

4.2.7 Product Development based on Bambara Groundnut and Cereals

Three kinds of Bambara flour were prepared and analyzed for proximate composition, water absorption and fat absorption. The flours include raw Bambara flour, roasted Bambara flour and blanched dehulled Bambara flour.

Formulation trials undertaken within the period were based on bakery products using the Bambara flour at 0, 10, 20, 30 and 40% replacement levels. The objective was to investigate the possibility of adding Bambara to wheat flour and to define the conditions that would produce a loaf of adequate volume and baking quality. While 10% replacement of wheat flour produced bread with acceptable baking quality, greater levels of substitution decreased loaf volume, taste and textural characteristics.

A series of dry blends of wheat flour and Bambara were also used to evaluate the effect of Bambara flour in cookies and doughnuts. Raw Bambara flour was

also tested for its performance in *akla* preparation. The results were quite encouraging. More formulations are in progress.

So far, the experiments carried out indicate that Bambara flour can be used in recipe formulations. The utilization of Bambara can be expanded beyond the traditional prolonged boiling for consumption of the whole-cooked beans.

4.2.8 Design and Construction of Cleaning Machines for Grain Legumes

The planned activities for PY2 included the design and construction of cleaning and grading machines for maize and cowpea, testing of constructed machines and the modification of machines.
During the year, a four ton/day (500 Kg/h) capacity cleaning and grading machine was designed. The design was based on the results of the survey undertaken earlier in the Greater Accra and Volta Regions. Construction and assembly of the machine was started within the year, and, so far, about 80% of the machine has been constructed and assembled. Materials for the completion of the machine has already been procured.

4.2.9 Product Development Using Roots and Tubers

Pre-gelatinized cassava flour and raw unfermented cassava flours can be prepared. Proximate composition, water absorption, fat absorption capacities of the flours were determined. The flours were used for formulation trials. Bakery products and instant fufu formulations tested included cassava bread, cassava cakes, yam fufu flour and cocoyam fufu flours.

For bakery products, replacing wheat flour with raw cassava flour affected the baking quality with replacement level higher than 20%. The bread volume and bread crumb were the bakery qualities adversely. Replacement level of 0-36% did not affect the cookie qualities such as taste, crispness, spread ratios and appearance.

For instant fufu formulations, initially cassava starch was blended with the flours of cocoyam or yam or plantain. However, for cost reduction, raw cassava flour and pre-gelatinized cassava flour were tested as ingredients in formulations. Results indicated that both flours can be used for fufu formulations. However more work on pastry properties and other functional properties of the flour is to be performed.

4.2.10 Development of a Pilot Fufu Flour Production Plant

The project seeks to develop a pilot fufu flour production plant and conduct techno-economic studies which is needed for investment decision be prospective entrepreneurs.

The design of the needed units of the plant was complete and the final engineering drawings were 70% complete.

Two trolleys for the receptacles and the holding tanks were constructed and flour receptacles purchased. The construction of the peeling/washing bench and the pressure cooker with the hoist system were 80% and 90% completed respectively. The control panel of the hot air dryer was repaired and reconditioned and 100 aluminum perforated trays constructed to replace the aluminum wire netting. The Y - cone blender was reconditioned and a metal stand for its control panel was constructed and tested. Work on the construction/acquisition and installation of the pilot fufu flour production plant will be completed before the end of March 1998.

4.2.11 Production and Quality Assessment on Dried Cassava chips

Cassava chips (about 10 mm in thickness) were dried using three different methods, viz.: - mechanical drying, employing a wooden cabinet dryer heated by five 100 watt bulbs, with an incorporated fan for heat distribution within the dryer (maximum temperature attained during drying = 50°C); a natural convection-type solar dryer drying temperature = 51°C) and open-air sun drying (peak temperature = 31°C).

The dried cassava chips were then aerobically packaged in a 7" x 13" (breath by height, high density, translucent polyethylene sheets (gauge = 0.0045 mm) and then stored under room conditions. Samples of the dehydrated cassava chip were then sampled after every two weeks storage analyzed.

Results indicated that mechanically dried cassava chips showed the lowest moisture, water activity and microbiological levels compared with solar or sun-dried after two weeks storage under room conditions.

4.2.12 The Technology and Financial Analysis of Traditional Processing of Cassava into Fermented Chips, *Gari* and *Agbelima* in the Greater Accra Region of Ghana Ga Rural District

A survey was carried out in the Greater Accra Region of Ghana to assess the socio-economic background of traditional cassava processors in the District, the source of cassava used for processing the technology employed and the problem encountered during the traditional processing and the coast and revenue generated by the processing activities. A report entitled "The Technology and Financial Analysis of Traditional Processing of Cassava into Fermented Chips, *Gari* and *Agbelima* in the Greater Accra Region of Ghana Ga Rural District of the Greater Accra Region of Ghana " was prepared.

4.2.13 Pineapples

The main goal of the project is to improve the cultivation and postharvest technologies.

Plant production per acre has been increased from 50,000 to 69,000 per acre, thus increasing the yield by 20%. Technologies have been developed in terms of cultivation practices for small, medium and high technology. Export levels increased from 15,000 metric tonnes in 1995 to - 26,000 metric tonnes in 1996. Field demonstration plots have been established in both the dry and wet zones of the cultivation areas.

4.2.14 Vegetables

The overall goal is to increase the incomes of farmers and other promoters of the tomato industry through the use of low-cost technology for the storage, processing and preservation of fresh tomato, pepper, onions, garden eggs and onions. Survey of postharvest has been completed in all the ten regions of Ghana. There is a blatant misuse of the agrochemical and with the removal of subsidy, the farmers use unorthodox chemicals.

Evaluation of the different varieties of tomato processing was in progress. Dehydration of selected tomato varieties showed the dried powdered sample had higher moisture and water activity levels. Storage work was in progress to assess colour changes, moisture levels, water activity and microbial levels at room temperature and humidity.

Work on the modification of the crates for tomato transportation was also in progress. Work has been completed for the Ada, Akomadan and Techiman areas. The interim analysis showed that partitioning the crates reduced losses by about 80%.

4.3 UNIDO/CDI/GHANA Government Sorghum Malt Development Project in Ghana

4.3.1 Activities

A. ***Agronomic:***

Sorghum varieties, from both local and exotic strains, were put under multi-locational, on-farm adaptive trials in all the three regions of the North to screen, identify and select the most agronomically suitable cultivars for the malting process. So far five cultivars of white sorghum have been identified, selected and found both agronomically and analytically suitable for the malting process.

B. ***Pilot Malting Plant:***

Germinative and related analyses were carried out on sorghum cultivars purchased from selected batch from last year's rainy cropping season and their results matched with results obtained from earlier analyses.

The Pilot Malting Plant of the project was installed at the FRI at Okponglo in April. This is to be used for studies on pilot scale malting.

C. ***New Project Phase:***

A new phase of the project has been planned and arrangements have been put in place for further funding. The intergovernmental Centre for Funding of Commodities (CFC) in Amsterdam is expected to fund this new Sorghum Malt development Project. CFC will supply a pilot brewing plant to complement the pilot malting plant. The project will be implemented by UNIDO and the Food Research Institute.

Successful malting trials require an efficient power supply but the automatic switch to activate the FRI generator at the pilot plant has not yet been supplied, as promised bu UNIDO even though the pro-forma invoice for it has been procured. Regular supply of fuel is also needed to operate the FRI electric power generator.

4.4 IDRC/IITA/FRI Soybean Utilization Project

This is a multi-institutional collaborative project aimed at developing and encouraging the adoption of soybean utilization technologies appropriate for household and small-scale enterprises in order to stimulate soybean production, encourage small enterprise development, make available more utilization technologies, improve economic and social benefits to primary producers, processors and, rural and urban communities in Ghana.

Collaborative institutions in Ghana include the Home Science Department of the University of Ghana, and the Crops Services Department of the Ministry of Agriculture.

The main focus for PY3 (1997) was on product development and recipe formulation as well as production and utilization training. The report provides information on the activities and achievements during PY3.

4.4.1 *Production and Quality Characteristics of Shelf-stable Soy-agushie: a residual by product of Soymilk Production*

A process was developed for the utilization of a stable high-protein residual by-product of soymilk production for use in Ghanaian dishes. The product was called soy-agushie because of its resemblance, in appearance and usage, to the melon seed paste used widely in stews, sauces and soups in Ghana.

Extraction of the 'milk' from blanched and dehulled soybeans was achieved by blending in hot water and sieving through muslin cloth. This yielded the wet residue which was dried at 70°C - 80°C to obtain the relatively shelf-stable dehydrated meal with a moisture content of 3.6%. Depending on the intended use, the dehydrated meal may be milled into grits or flours and used as fortifying material or a protein supplement in a variety of Ghanaian dishes.

A comprehensive quality assessment was undertaken on both the wet and the dehydrated meal products. Product quality factors determined included proximate composition, minerals (sodium, potassium, calcium, magnesium, phosphorus, iron, manganese, zinc and copper), vitamins (total pyridoxamine, riboflavin and biotin), selected disaccharides (fructose, sucrose and maltose), amino acids and trypsin inhibitor activity.

The product was also evaluated in terms of its functional and sensory effects in traditional foods. The milk extraction procedure was able to extract only a small proportion of the protein from the raw seeds, leaving the dried residue soy-agushie with over 42% protein content.

The concentration of individual amino acids in the soy-agushie was similar to (but in some cases greater than) the whole soybean. While lysine was 2.62 g/100g in the raw whole beans, the lysine content of the dried soy-agushie was 3.11g/100g. Tryptophan was also found to be slightly more concentrated in the residue (0.67 g/100g) than in the whole beans (0.59 g/100g).

With the B-vitamins, about 50% of the original content in the beans was extracted with the milk. Contrary to this observation, high proportions of the minerals determined were found to be retained in the residue during soymilk extraction. The heat treatment was found adequate in reducing the trypsin inhibitor levels in the soy-agushie from 25 mg/g to minimal levels of 5 mg/g.

High sensory scores were obtained for its use as agushie substitute in traditional palaver sauce and as agushie stew. For all the sensory attributes, scores for the soy dishes were in the same category of degree of likeness as the traditional dishes.

Protein supplementation in traditional breakfast cereal foods and snacks using the milled soy-agushie also scored highly for taste, aroma, texture and overall acceptability.

The scope of utilization of the soy-agushie developed could be widened to include several traditional foods, bakery products, etc. There is however the need to develop appropriate recipes and large-scale consumer acceptability tests.

4.4.2 *Soybean Recipes in Ghanaian Dishes.*

Recipe formulation and evaluation continued as a major activity under the project during PY3. A total of 50 recipes have so far been developed as improvements on traditional low-protein foods commonly consumed in Ghana. The recipes have been grouped under the following categories:

a. whole soy products (including pastes, flours and drinks)
b. Soybeans in Ghanaian stews and soups
c. Soybeans in Ghanaian staple foods
d. Soybeans in wheat flour products and
e. Soybeans in local snack foods.

A 60-page third edition of the recipe booklet was compiled.

4.4.3 *Training:*

As was the case during PY2, training sessions again focused on soybean production training, small-scale enterprise level product development, and field demonstrations for household utilization of soybean at the two Project sites.

a. Training on Household-level Soy Utilization:

During PY3, the usual training and demonstrations for farmers and housewives in the two project villages on household utilization of soybeans were extended to include training of NGO's as well as demonstrations in other nearby farm villages.

Major demonstrations on soybean utilization were held in four nearby small villages in the Korleman-Manchie area, namely, *Samsam*, *Odumasi*, *Mimpemihoasem* and *Otaomina*. The activity was in response to requests from the villagers themselves.

In addition to major training sessions held for the whole group of people in the project villages, minor training sessions were organized on individual basis for mothers by the extension officers on the project. These informal one-on-one sessions were mainly for mothers who were ready to start weaning their babies.

b. Enterprise level Production Training:

During PY3, enterprise level training on the production of developed soybean products was also extended to include small-scale gari processors in the villages and other individuals in the city interested in setting up a business in soybean processing.

A total of 11 gari processors were trained on the preparation of soy-gari. More processors have expressed the interest in the training.

Soy-gari is prepared for customers on request. Although the customers pay a little more for the soy-gari than the normal gari, the demand is increasing and the beneficial effects on the nutritional status of the people in the cassava processing areas have been favourably acknowledged.

c. Training on Soybean Production:

In the Korleman-Manchie area, the emphasis was on backyard cultivation of soybeans for household use. Twelve farm families took up the production at the backyard level under the supervision of the Project agronomist, the extension officer and the Project coordinator.

The outcome was very impressive as the input was not too much for the farmers to bear and the prospects of a good harvest seem quite good. In addition, however, the Project demonstration farm was used to train more farmers in the area.

At Asutsuare, the other project village, the farmers continued with the commercial production of the crop as a cooperative venture, under the technical assistance of the Project agronomist and the extension officer for the area.

Following persistent requests from interested farmers in the Ashanti Akim North District of the Ashanti Region, the project team extended the production training activities outside the project designated sites. Three farmers in the Ashanti Akim

North district were assisted with technical advice and seeds for trial production of the crop. There has been no previous production trial of the crop in the area, and it is hoped that the present trials being undertaken will pave the way for widespread large-scale production and utilization of soybeans in this Middle Belt zone.

4.5. PEANUT COLLABORATIVE RESEARCH SUPPORT PROGRAMME (CRSP)

A. *FRI/USAID/Alabama A & M University Project on Development of High Development of High Protein-Energy Food products*

The specific goal of the project is to develop a collaborative research and development programme between the Alabama A&M University and the Food Research Institute of Ghana for greater utilization of peanuts, through promoting the role of peanuts as food items in diets, improvement of existing food products and development of new food products.

Work undertaken during the year include the installation and testing of an Insta-Pro extruder supplied under the project. This is to be used in the development of high protein-energy food products.

A training programme was also undertaken for the FRI Engineering technicians and Food Technologists involved in the project, on the operation of the extruder and extrusion cooking technology. This training has provided the necessary expertise for the development of appropriate techniques for the production of extruded foods using local materials.

Raw material sources for the development of high-protein extruded products were established and their quality characteristics determined. Based on the quality characteristics, especially the amino acid composition, theoretical formulations were developed by the project team for production and quality evaluation.

B. ***FRI/Purdue University Project on The Effect of Peanut Consumption on Hunger, Ingestive Behaviour, energy Expenditure and Coronary Heart Disease Risk***

A collaborative project was started, between FRI and Purdue University of the United States of America, on "the Effect of Peanut Consumption on Hunger, Ingestive Behaviour, Energy Expenditure and Coronary Heart Disease Risk."

This is investigating the effects of peanut exposure on salivary response, food intake, hunger and satiety. The study which had previously been carried out in the United States is being repeated in Ghana with the view to making comparison between the two groups of data.

Strong satiety after consumption of peanut has been hypothesized to be attributable to the fatty acid composition, protein content and other micro nutrients of the peanut. In addition, studies have shown that the consumption of almonds and walnuts may reduce Coronary Heart Disease risk factors. Peanuts have been found to have similar fatty acid composition to tree nuts and may also be found to have a favourable effect on serum lipids and other risk factors for coronary heart disease.

4.6 Ghana/Netherlands Artisanal Fish Processing and Applied Research Project

A. ***Research Projects***

Five research projects were completed in the year. A one-day research workshop was organized in December, at the Fishery Resource Centre, on some of the interesting research findings since the inception of the project.

B. ***Project Monitoring***

The International Agricultural Centre, Wagningen, the Netherlands has been charged with the monitoring of the project. Two monitoring visits were made, in January and February and in October, to review progress of work and discuss future prospects and plan the review of the project.

In May, the project was favourably reviewed by Dr. O Sakyi-Dawson of Agricultural Extension Department (AED) of the University of Ghana, Legon and

Mr. P.G.M. Van der Heijden, a fisheries expert from the Netherlands. A report was presented by the team to the Netherlands Embassy.

The project relocated to the new Fishery Resource Centre at the Okponglo in March. The centre was commissioned in April by His Excellency, Mr. Hein Princen, Ambassador of the Royal Netherlands Embassy in Accra.

Twelve Project Management Committee meetings were held in the year. The project Management Board met in November.

B. ***Training:***

The annual fish training programme for key fisheries extension personnel from the Africa Region took place for 19 participants from Ghana, Lesotho, Erithrea, and Uganda. A total of about 200 extension officers from the African region have benefitted from the training programme since its inception in 1988.

4.7 Fish Flour Development using Norwegian Fish Flour

The Institute also began a project in collaboration with the Norwegian Herring Oil and Meal Industry Research Institute (SSF) on the use of pelagic fish flour in local food preparations and products.

Fish flour was used to develop acceptable substitutes for the preparation of the traditional food recipes. These were subjected to sensory evaluation. Two consumer studies involving about 50 respondents were conducted.

After the formulation trials, sensory evaluation of the products was used to determine the suitability of the fish flour in product formulation.

4.8 National Mushroom Development Project

A. ***Germplasm Collection and Maintenance:***

The project received eight new cultures from Hong Kong, Fuzhou, South Korea and the Ivory Coast. This brings to over 100 the total number of cultures in the National Mycelium bank.

B. ***Extension and Training Activities:***

The unit organized five training programmes for interested various groups and persons during the year. About 200 persons benefitted from the training programmes. Please see below.

Extension and Training Activities

DURATION	ORGANIZERS	VENUE	TARGET GROUP	NUMBER OF PARTICIPANTS
March 20 - 21	FRI	FRI, Okponglo	General Public	47
June 18 - 20	Christian Mothers Assoc.	Kaneshie	Christian Mothers Assoc.	20
June 6-27	FRI	FRI, Okponglo	General Public	13
October 2-3	FRI	FRI, Okponglo	General Public	76
December 12	EPA /Wildlife	Bia, Western Region	Rural Farmers	

C. ***Strain Multiplication:***

The Unit produced and distributed over 4,000 bottles spawn of selected mushroom varieties to about 20 growers throughout the country.

D. ***Results of Experiments Carried Out:***

Yield trials of *Volvariella volvacea* var. VV-14 from Hong Kong produced very tiny fruit-bodies on cotton waste, thus it was not multiplied for adoption by farmers.

Two of the three strains of *Ganoderma* spp. received from Hong Kong and south Korea respectively, failed to grow on composted wawa (*Triplochiton scleroxylon*) sawdust.

Drying characteristics of *Plerotus eous* var. EM-1, *P. ostreatus* var. OT-6, *P. cystidiosus* CMA-1 and *Auricularia polytricha* var. APG-1 were determined.

E. ***Major constraints:***

The unit was unable to meet the growing demand for spawn during the year due to inadequate staffing. The unit requires two technical assistants and two labourers in the coming year.

4.9 Capability Building for Research in Traditional Fermented Food Processing in Ghana

A. *Project Activities:*

Starter cultures of *Lactobacillus fermentum* were produced in batch culture fermentation using a cheap growth medium prepared by mashing and malting maize.

Investigations were conducted on the probiotic properties of maize fermented with strains of *Lactobacillus fermentum, Saccharomyces cerevisiae* and *Candida krusei* isolated from the kenkey production process.

Fermenter studies on microbial interactions of dominating yeasts and lactic acid bacteria isolated from maize fermentation for optimal selection of starter cultures were conducted.

A method was developed for typing and identification of *Lactobacillus fermentum* and *Saccharomyces cerevisiae* form fermented maize by molecular techniques.

Studies were initiated on the inactivation of food borne bacterial pathogens, during maize fermentation.

4.10 Capability Building for Research and Development in Quality Assurance and Fermentation and Technology for Traditional African Fermented Foods

Work was done on batch starter culture production for commercial fermentation of maize using malted maize substrate. A paper on the subject has been submitted for publication in an international journal.

4.11 FAO Dawadawa Project

This work which was initiated in 1996 continued in the early part of 1997. The Division and the engineer who fabricated the Parkia seed Dehuller introduced the dehuller to women processors in Northern Ghana.

4.12 Investigation of New Market opportunities for Cassava Flour and Starch

The FRI began a project in collaboration with Natural Resources Institute of the United Kingdom to investigate new market opportunities for cassava flour and starch. The FRI Test Kitchen used cassava flour produced by the Cassava Processing and Demonstration Unit for formulation trials. A standard sugar cookie formula was used for replacement of wheat flour for cassava flour at levels of 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, and 100%. The study found texture and appearance of the cassava cookies were affected by increasing levels of cassava flour and determined accepted levels.

4.13 Agro Enterprises Project

4.13.1 Survey on Marketing of Cassava and Cassava Products in Southern Ghana

A survey was completed in April 1997 on Marketing of Cassava and Cassava Products in Southern Ghana.

Markets visited during the survey included the Agbogblogshie, Mallam Atta and Madina markets in the Greater Accra Region, Kasoa and Mankessim markets in the Central Accra Region, Beposo market in the Western Region, Adeiso and Agogo markets in the Eastern Region as well as the Akatsi and Dabala markets in the Volta Region.

A. ***Summary of Findings:***

The major observations made in the study may be summarized as follows:

a. Marketing of cassava and cassava products is predominantly performed by women who are aged between 31 and 40 years. Sixty-seven percent of the traders had no formal education.

b. Cassava and cassava products markets are organized by District or Metropolitan Assemblies and Market Queens. The former provide market structures and maintain good sanitation conditions at the markets. The latter are appointed by the traders and are charged with responsibility of regulating the number of sellers especially retailers in order to protect traders' interest.

c. Cassava and gari are the most traded commodities but no proper storage was done to take advantage of fluctuations in prices.

d. There are no guaranteed prices for cassava and cassava products. The wholesalers dictate prices they are willing to buy.

e. Lack of market is the most important problem facing the cassava producers and processors. Availability of both local and foreign market will be of much help to processors.

f. Gari was found to be the most preferred cassava product followed by Agbelima and lastly kokonte.

B. ***Recommendations:***

The survey made some recommendations, among which are:

a. Marketing of cassava and cassava products should be greatly strengthened by the provision of the necessary infrastructure, such as good road networks, especially at the village level and the provision of market sheds and most importantly, exploring good local and foreign markets for cassava products.

b. Emphasis must however be laid on the quality of the processed cassava foods in order to meet international standards, proper packaging and handling of cassava products and establishment of guaranteed prices for cassava and cassava products.

C. ***Visits to Processors and Equipment Manufacturers:***

The FRI project team visited two cassava processing communities in the Greater Accra Region, namely Doble Gonno and Mantsi in May 1997 with Dr. J.J. Asiedu, a representative from the Africa Regional Centre for Technology (ARCT) to observe, at first hand, cassava processing activities and to validate equipment needs assessment done in the precious year by the FRI Team. During the same period, the team visited seven equipment manufacturers who had been identified as possible supplies of cassava processing equipment to potential small-scale cassava processing enterprises under the project.

A detailed list of equipment with technical specifications and cost estimates with invoices was prepared and submitted to ARCT for release of funds.

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APPENDIX I

FOOD RESEARCH INSTITUTE MANAGEMENT BOARD - 1997

1.	Rev. Dr. E.K. Marfo Director Ghana Standards Board P.O. Box M.248, Accra	-	Chairman
2.	Mrs. Abigail Andah Director Food Research Institute P.O. Box M.20, Accra	-	Member
3.	Dr. J.B. Wonkyi-Appiah Director Oil Palm Research Institute (OPRI) P.O. Box 74, Kusi Kade	-	Member
4.	Dr. E. Asigbey- Berko Head of Department Department of Nutrition & Food Science University of Ghana Legon	-	Member
5.	Mr. A.K. Gaisie Ministry of Finance & Economic Planning P.O. Box M.40, Accra	-	Member
6.	Ms. Rosetta Tetebo Women In Agricultural Development (WIAD) P.O. Box M.37, Accra	-	Member
7.	Mr. Timothy Osei Oduro, Adiya, Osei & Co. SEDCO House P.O. Box 5712, Accra-North	-	Member
8.	Ms. Sherry Ayitey 31st December Women's Movement P.O. Box 065, Osu-Accra	-	Member

9.	Mrs. Leticia Osafo-Addo Processing Foods & Spices Ltd. P.O. Box 186 Community 2, Tema	-	Member
10.	Mr. Ebenezer Barnor P.O. Box 295 Mamprobi-North	-	Member
11.	Dr. Esther Ocloo Sustainable End of Hunger Campaign	-	Member
12.	Representative of the Director-General CSIR P.O. Box M.32, Accra		

APPENDIX II FRI SENIOR STAFF LIST (1997)

A. Andah (Mrs.) - Director
B.Sc. (Gen.)
B.Sc. (Special - Food Science)
M. Phil. (Leeds University)
Post Grad. Dip. Rural Fd. Tech.
(The Netherlands);
Cert. in Leadership & Strategic Planning,
Univ. of Minnesota, USA;
Cert. in Research Management, GIMPA

W.A. Plahar (Dr.) - Prin. Scientific Officer
B.Sc. (Gen.) (Deputy Director)
B.Sc. (Hons) (Univ. of Ghana)
M.Sc Fd. Sci. (Univ. of Ghana)
Ph.D. (Washington State Univ.)

ANALYSIS DIVISION

M. Halm (Ms) - Senior Scientific Officer
B.Sc. (Gen.) (Univ. of Ghana) (Hd. of Div.)
B.Sc. (Hons) Botany ((Univ. of Ghana))
M.Sc Botany (Univ. of Ghana)
Post Grad. Dip. Rural Fd. Tech (Netherlands)

K.K. Eyeson - Chief Scientific Officer
B.Sc. Bio. Sci.(Lond.) (On contract)
Dip. Nut. (Lond.)
Post Grad. Dip. Fd. Quality Control
(Nat. Coll. of Fd. Tech.) (Lond.)
MRSH; AIRST.

E.K. Ankrah - Prin. Scientific Officer
B.Sc. (Gen.) (Univ. of Ghana)
M.Sc Fd. Quality Control (Reading)

K. Kpodo (Mrs.) B.Sc. (Gen.) (Univ. of Ghana) B.Sc. (Hons). (Univ. of Ghana) M. Phil. (West Indies)	-	Scientific Officer
P.N.T. Johnson B.Sc. (Hons) Biochemistry UST, Ghana) M.Sc. Agric. Eng. Tech. Cranfield Inst. of Tech., U.K. Ph.D. Fd. Tech. (Univ. of Reading)	-	Scientific Officer
L.C.B. Sawyerr B.Sc. (Hons) Biology (UST, Ghana) M.Sc Biological Sci. (UST, Ghana)	-	Scientific Officer
M. Hodari-Okae (Mrs.) B.Sc. Microbiology (ABU, Zaria) M.Sc. Fisheries (ABU, Zaria)	-	Scientific Officer
A.E. Hayford (Ms) B.Sc. (Hons) Biological Sci. (UST, Ghana) M.Sc (Biotech.) Monach Univ. Australia	-	Scientific Officer
N.T. Annan (Mrs.) B.Sc. (Hons) Fd. Sci. (Univ. of Ghana) M.Sc Fd. Sci. (Tech. Univ. of Nova Scotia, Canada)	-	Scientific Officer
M. Obodai (Mrs.) B.Sc. (Hons) Botany (Univ. of Ghana) M. Phil. (Univ. of Ghana)	-	Scientific Officer
K.A. Vowotor B.Sc. Zoology (UCC, Ghana) Dip. Educ. (UCC, Ghana) M.Phil, Crop Science	-	Scientific Officer
J. Tete-Marmon	-	Chief Tech. Officer
N.A. Asare	-	Chief Tech. Officer

E.A. Allotey	-	Prin. Tech. Officer
D.K. Asiedu	-	Prin. Tech. Officer
B. Amoako	-	Snr. Tech. Officer
S. Antonio	-	Senior Tech. Officer
Mensah Toku	-	Senior Tech. Officer
W.K. Amevor	-	Senior Tech. Officer
D.K. Baisel	-	Technical Officer
D.N.A. Ankrah	-	Technical Officer

PROCESSING DIVISION

J. Dei-Tutu - Hd. of Proc.Division
B.Sc. Agric (Univ. of Ghana) (Prin. Sci. Officer)
Dip. Fd. Sci.
M.Sc. New South Wales, Australia
Ph.D. (Mysore, India)

G. Nerquaye-Tetteh (Mrs.) - Snr. Scientific Officer
B.Sc. (Gen) (Univ. of Ghana)
B..Sc. (Hons) (Univ. Of Ghana)

W.K. Amoa-Awua - Snr. Scientific Officer
B.Sc. (Univ. of Ghana)
M.Sc. App. Sci. (New South Wales, Australia); Ph.D Univ. of Ghana

P. Adu-Amankwa (Mrs.) - Scientific Officer
B.Sc. (Hons) Biochemistry
(UST, Ghana)
M.Sc. Fd. & Management Sci. (Lond.)
Ph.D. Post-Harvest Physiology (Lond.)

E.C. Tettey - Scientific Officer
B.Sc. (Hons) Agric. (UST, Gh.)
Post-Grad. Dip. Fd. Tech.
M.Sc. Food Tech.
(Humberside Coll. of Tech., UK)

N.T. Dziedzoave - Scientific Officer
B.Sc. (Hons) Biochemistry
(UST, Gh.)
Post. Grad. Dip. in Fd. Sci. & Nut.

State Univ. of Gent, Belgium

L.D. Abbey B.Sc (Hons) Biochemistry (UST, Gh.) M.Sc. App. Sci. (Fd. Tech.) (New South Wales, Australia)	-	Scientific Officer
J.T. Manful B.Sc (Agric.) (UCC, Ghana) Dip. Educ. (UCC, Ghana)	-	Scientific Officer
B.A. Mensah M.Sc. Fd. Press. Tech. (Krasnodar, USSR	-	Scientific Officer
Mr. J. Gayin B.Sc Biochemistry, UST	-	Asst. Scientific Officer
K. Opoku-Acheampong (Mrs.)	-	Prin.Tech.Off.
J.M.Y. Anlobe	-	Snr. Tech. Officer
S.A. Tagoe	-	Snr. Technical Officer

FOOD ECONOMICS AND UTILIZATION DIVISION

A. Osei-Yaw (Mrs.) B.Sc. (Gen.) (Univ. of Ghana) M.Sc. Fd. Sci. & Nut.	-	Snr. Scientific Officer
P. Lokko (Mrs.) B.Sc. (Gen.) (Univ. of Ghana) B.Sc (Hons) Biochemistry (Univ. of Ghana) M.Sc Biochemistry (Univ. of Ghana.) Dip. Fd. Sci. & Nut. (The Netherlands)	-	Snr. Scientific Officer
W. Quaye (Mrs.) B.A. Agric. Econ. (Univ. of Ghana)	-	Asst. Scientific Officer
S. Nyarko	-	Chief Tech. Officer
F.B. Dake (Mrs.)	-	Chief Tech. Officer
I.A. Tamakloe (Mrs.)	-	Prin. Tech. Officer

B. Awotwi	-	Snr. Tech. Officer
V. Christian	-	Snr. Technical Officer

ENGINEERING DIVISION

D. Blay M.Sc Chem. Eng. (Moscow) Inst. of Chemical Eng.)	-	Scientific Officer (Head of Division)
C.K. Gyato Nat. Dip. in Agric. Mech. (Univ. of Ghana) M.Sc Agric. Eng. (Bulgaria)	-	Scientific Officer
B.A. Mensah M.Sc. Fd. Press. Tech. (Krasnodar, USSR)	-	Scientific Officer
Victor Antwi B.Sc. Chem. Eng. (UST, Gh) M. Phil Chemical Engineering	-	Asst. Scientific Officer
A.K.G. Amoah	-	Chief Tech. Officer
J.K. Magbo	-	Chief Tech. Officer
S.A. Sampare	-	Prin. Tech. Officer
J.R. Addo	-	Snr. Tech. Off.
J.A. Asafu-Adjei	-	Prin. Works Supt.
Charles Takyi Yeboah	-	Works Superintendent
Godwin Kojo Akleih	-	Works Superintendent

SCIENTIFIC INFORMATION DIVISION

W.A. Plahar (Dr.) B.Sc (Gen.) B.Sc (Hons) (Univ. of Ghana) M.Sc. Fd. Sci. (Univ. of Ghana) Ph.D. (Washington State Univ.)	-	Prin. Scientific Officer (Head of Division)
S.K. Noamesi B.Sc (Hons) Agric. (Univ. of Ghana) M.Sc. Fd. Sci. (Univ. of Ghana)	-	Scientific Officer
K. Ameh Dip. Journalism (GIJ, Ghana)	-	Chief Tech. Officer (Public Relations)

Post -Grad. Dip. Communication
Studies (Univ. of Ghana)

A. Andoh Dip. Journalism (GIJ, Ghana) Post -Grad. Dip. Communication Studies (Univ. of Ghana)	-	Prin. Tech. Officer (Public Relations)
M. Streetor (Ms)	-	Chief Lib. Asst.
R. Kavi	-	Library Assistant

ACCOUNTS DIVISION

M.E.K. Amenu Snr. Accting Asst.	-	Ag. Head of Accounts
C. Aikins Tutu	-	Snr. Accounting Asst.
S.Y. Nkansah	-	Prin. Stores Supt.
S.O.T. Oddoye	-	Snr. Stores Supt.
J. Mintah Nakotey	-	Prin. Stores Supt.
G.O. Gyamfi	-	Stores Supt.

ADMINISTRATION DIVISION

E. Atta-Sonno B.A. Hons. (Cape Coast) Specialist Teachers Cert. in English	-	Snr. Admin. Off. (Head of Division)
J.F. Asigbey	-	Chief Admin. Asst.
B.A. Sarbah	-	Chief Admin. Asst.
E.A. Larbi	-	Prin. Works Supt.

APPENDIX III

FOOD RESEARCH INSTITUTE
1997 CONFERENCES, WORKSHOPS AND SEMINARS

	CONFERENCE/WORKSHOP/ SEMINAR ATTENDED	PARTICIPANT/S	DESIGNATION	VENUE	DATE/ DURATION	ORGANIZERS
1.	Project Review Meeting	M. Halm (Ms.)	Senior Research Officer	Zimbabwe	February 7 -18, 1997	EU Project
	"	W.K. Amoa Awua	Senior Research Officer	"	"	"
2	Round Table for the Country Portfolio on IFAD supported projects	A. Andah (Mrs.)	Director	Accra	May 29-31	MOFA
	"	W.K. Amoa Awua	Senior Research Officer	"	"	"
3	Collaborative work on DANIDA Project	M. Halm (Ms.)	Senior Research Officer	Burkina Faso	June 14 - July 6, 1997	DANIDA Project
4	Collaborative work on DANIDA Project	W.K. Amoa Awua	Senior Research Officer	Burkina Faso	July 28 - August 28, 1997	DANIDA Project
5	Conference on Collaborative Work on the DANIDA Project	M. Halm (Ms.)	Snr. Research Officer	Copenhagen, Denmark	July 20 - August 31	DANIDA
6	Collaborative Work on Probiotic Effect of Fermented Maize	M. Halm (Ms.)	Snr.Research Officer	Copenhagen Denmark	August 27-30, 1997	DANIDA Project
7	IITA Project on the Promotion of Cassava in the Semi-Arid Zone in Nigeria	N.T. Dziedzoave.	.Research Officer	Nigeria	September 22-26, 1997	IITA
8	Planning Committee Workshop on FRI/KUL/EU Project on Quality systems for Food Fermentation Africa	W.K. Amoa Awua	Snr. Research Officer	Denmark	October 1-November	FRI/KUL/EU Project
9.	Project Review Meeting	W.A. Plahar	Prin. Research Officer	La Cote d'Ivoire	October 7- 11, 1997	IDRC/IITA/FRI Soybean Utilization Project
10	Fabrication of some Equipment (Seed cleaner and Destoner for IDRC/IITA Soybean Utilization Project	D. Blay	Research Officer	Nigeria	October 12-17	IDRC/IITA Soybean Utilization Project
11.	Collaborative Work on Probiotic Effect of Fermented Maize	M. Halm (Ms.)	Snr.Research Officer	Denmark	November 23 - December 7	FRI/DANIDA Project
12	FRI/EU STD Project Activities	W.K. Amoa Awua	Snr Research Officer	Lagos, Nigeria	December	

APPENDIX IV

Ongoing FRI STAFF TRAINING - 1997

	NAME OF STAFF	DESIGNATION	COURSE	INSTITUTION OF STUDY	DURATION
1.	A.E. Hayford (Ms)	Scientific Officer	Ph.D.	Royal Vet. & Agric. Univ. Copenhagen, Denmark	1995-97
2.	K. Kpodo (Mrs)	Scientific Officer	Ph.D.	Royal Vet. & Agric. Univ. Copenhagen, Denmark	1996-
3.	G., Nerquaye-Tetteh	Scientific Officer	M.Phil. Degree (Biochemistry)	KNUST, Kumasi	1997-
4.	J.T. Manful	Scientific Officer	M.Phil. Degree (Biochemistry)	KNUST, Kumasi	1996-
5.	S.K. Noamesi	Scientific Officer	Ph.D.	University of Ghana	1997-
6.	M. Hodari-Okae	Scientific Officer	Ph.D.	University of Ghana	1997-
7.	L.D. Abbey	Scientific Officer	Ph.D.	University of Ghana	1997-
8.	L.B. Sawyerr	Scientific Officer	Ph.D.	University of Ghana	1997-
9.	S. Antonio	Snr. Technical Officer	H.N.D.- Microbiology	University of Ghana`	1996-97
10.	B. Amoako	Snr. Technical Officer	H.N.D.- Microbiology	University of Ghana	1996-99
11.	K. Aidoo	Acct. Asst.	B. Comm. Degree	University of Cape Coast	
12.	Mr. E. Ankrah	Prin. Tech. Off.	HND Lab. Tech.	Univ. of Ghana, Legon	"
13.	Mr. D. Baisel	Technical Officer	HND Lab. Tech.	Univ. of Ghana, Legon	1994-96
14.	P. Osae	Snr. Technical Asst.	Cert. in Marketing	ATTC	1996
15	Mr. L. Codjoe	Snr. Clerk	ICSA	Mgt. & Financial Tr. Inst.	1996-2000

APPENDIX V

STAFF TRAINING COMPLETED IN 1997

	NAME OF STAFF	DESIGNATION	COURSE	INSTITUTION OF STUDY	DURATION
1.	K.A. Vowotor	Asst. Scientific Officer	Ph.D. Crop Science	Univ. of Ghana/IITA (Cotonou)	1993-96
2.	N.T. Annan	Scientific Officer	Adv. Tr. in Food. Analytical Tech. & Quality Control	Saarbrucken, Germany	1996-1977
3.	V. Antwi	Asst. Scientific Officer	M. Phil Chemical Engineering	KNUST, Kumasi	1993-95
4.	Obodai, Mary	Scientific Officer	Training Programme on Edible Mushroom Cultivation	Fuzhou, China	October 9 to November 3, 1997
5.	Mr. J.Y Anlobe	Prin. Tech. Off.	HND Lab. Tech.	Univ. of Ghana, Legon	"
6.	Mr. R.O. Okine	Foreman	Senior Technical Supervisory Training Course	Weija Technical Institute	1994-96

APPENDIX VI

1997 FRI INTERNALLY-GENERATED FUNDS

	Item	1996	1997
1.	Sale of products	12,801,818.00	34,000,000.00
2.	Hire of Facilities		200,000.00
3.	Services	21,007,907.00	14,000,000.00
4.	Others		300.00
	TOTAL	33,809,725.00	48,500,000.00

APPENDIX VII

STATEMENT OF 1997 RECURRENT EXPENDITURE

NO .	EXPENDITURE ITEM	APPROVED BUDGET 1997 (¢)	AMOUNT RELEASED (¢)	EXPENDITURE (¢)
1.	Personal Emolument	726,003,000.00	848,180,473.30	847,657,320.00
2.	Travelling & Transport	45,000,000.00	21,900,000.00	21,900,000.00
3.	General Expenses	210,000,000.00	50,000,000.00	53,249,528.00
4.	Maintenance Repairs & Renewals	16,000,000.00	8,204,350.00	8,217,552.00
5.	Other Expenditures	6,000,000.00	6,895,650.00	989565.00
	SUB TOTAL ITEMS 2-5	68,000,000.00	87,000,000.00	93,262,730.00
	GRAND TOTAL	814,003,000.00	935,180,473.00	940,920,050.00

DEVELOPMENT BUDGET

1.	Furniture		20,000,000.00	
2.	Pilot Plant Complex		30,000,000.00	
3.	Research Projects (Item 9)	115,000,000.00	Nil	Nil