NUCLEAR TECHNOLOGY CENTRE
THE GAMMA IRRADIATION FACILITY

6.0 INTRODUCTION:

The Gamma Irradiation Facility (GIF) is one of the components of the Nuclear Technology Centre (NTC) of the Sheda Science and Technology Complex. It is a multipurpose facility for both industrial and research applications. Its innovative design has significantly enhanced its versatility, and thus possesses the flexibility to irradiate a wide spectrum of products. Some of the major features are the 340kilocurie Cobalt-60 irradiation source, fully automated operations, laboratories to adequately support comprehensive research and development activities, and above all, the state-of-the-art technology behind the plant. No doubt, it is reputed as one of the most modern facilities in the world and the only one of its kind in Africa.

The core components of the gamma irradiation facility are:

- A building (80m x 28 m single-storey with a mezzanine floor and a 2-storey office on one of the gable walls);
- 340kilocurie Cobalt-60 irradiation sources
- Ventilation and Air conditioning;
- Cranes, Lifting Gears and Transportation Equipment;
- Compressed Air Supply;
- Gas Supply System;
- Power Supply;

It is serviced by a Central Workshop consisting of the following:

- Mechanical workshop;
- Welding (electric, plasma & autogenous welding, soldering, brazing etc.);
- Cutting (plasma & autogenous oxygen) of Material;
- Quality Assurance;
- Heat treatment;
- Glass Blowing Shop;
- Electrical Workshop; and
- Electronics Workshop.

The Gamma Irradiation Facility Building

The Gamma Irradiation Plant will be used in the preservation of food and agricultural products, pest control, healthcare delivery, packaging and improvement of mechanical, thermal and electrical properties of materials such as plastics. It has the capacity to treat over 20 metric tons of products daily. The production section is optimally configured for commercial activities.The facility has numerous potentials, and also possesses the ability to attract both local and foreign entrepreneurs to establish manufacturing industries in pharmaceuticals, cosmetics and packaging as spin-offs.

6.1 Objectives and Scope of Services

6.1.1 Objectives

The objectives of the facility are to:

i Preserve food and agricultural products, thereby reducing post-harvest losses and thus assuring food security and price stability.

ii Boost food production through the production of high yielding and disease resistant varieties of crops and plants;

iii Increase productivity through drastic reduction of food-borne diseases;

iv Improve primary health care delivery through radiosterilisation of medical devices, pharmaceutical and cosmetic products and packages; and

v Add quality to our cable and wire products, plastics, natural rubber, etc through radiation induced cross-linking and improvement of mechanical, electrical and thermal properties of plastics and vulcanization of natural rubber.

6.1.2 Scope of Services

The GIF plant is multipurpose in conceptual design, and has the capacity for an extended scope of services which includes:

i Sprout inhibition of onions, potatoes, yams, etc.;

ii Insect disinfestations of grains (e.g. maize, beans, sorghum, millet, etc.) and cash crops for export (e.g. cocoa, kola nuts, etc.);

iii Reduction of microbial load in spices (e.g. chilli pepper, ginger, etc.) for local consumption and for export;

iv Microbial decontamination of meat, pork, poultry, fish, seafood (e.g. shrimps, lobsters, crabs, etc) for local consumption and for export.

v Delay ripening in fruits (e.g. mangoes, bananas, plantains, tomatoes, etc.) for local consumption and for export.;

vi Plant breeding to boost food production through the production of high yielding and disease resistant crops and plants (e.g. roots and tubers such as yams, low cyanide cassava, etc.);

vii Sterile insect techniques in the eradication of pests that destroy farmland and adversely affects animal production;

viii Radiosterilisation of medical devices, pharmaceutical and cosmetic products and packages (e.g. syringes, catheter, swabs, sterile solutions, hypodermic needles, surgical blades, surgical gloves, etc.);

ix Cross-linking in polymers to improve mechanical, electrical and thermal properties of plastics (e.g. cable & wire products, plastic pipes for hot water in hotels and other household use, etc.) and vulcanization of natural rubber latex;

x Application in the Wood and Furniture Industry particularly in the production of particle-boards from sawdust and waste wood shavings as well as quarantine of wooden tiles for floors and ceilings for export; and

xi The plant also has facilities to perform requisite tests on irradiated food, food products and effect on constituents. Other tests include microbial decontamination level, sterility assurance, material testing and quality control.

6.2 Research Thrust and Facilities

The thrust of the research activities at the Gamma Irradiation Facility is directed at carrying out industry-driven, problem-solving R&D using irradiation technology with the main goal to develop capacity for its massive deployment to improve the socio-economic well being of the citizenry. The research facilities provide the capacity for proper quality control, quality assurance, and to allow for its optimal utilization in the conduct of applied research, and the development of the appropriate manpower and skills required in the irradiation industry in the country.

In this direction, the GIF is fitted with eleven laboratories. These laboratories are available for the training of students from higher institutions, and for the carrying out of graduate research work. They also offer suitable up-to-date research facilities for Scientists and Engineers from within and outside Nigeria.

The eleven laboratories are:

i Physico-chemical laboratory
ii Dosimetry laboratory
iii Two Food laboratories; one for wet products such as fish, seafood, meat and their products and fresh fruits, while the second is for dry products such as spices, vegetable and flour products.
iv Microbiological laboratory and a culture room
v Food identification laboratory
vi Mutation breeding laboratory
vii Sterile insect technique (SIT) laboratory
viii Two plastic laboratories; one for induction moulding machines, while the other is for the measurement of properties of irradiated plastics and quality control
ix Photographic laboratory for fast development of films for desired photos for the purpose of documentation and high quality scientific presentations.

6.3 Research Programmes

These laboratories are designed to adequately support research and development activities in Food irradiation; Food microbiology; Radiation dosimetry; Radiation chemistry; Radiation Protection; and Sterilization of medical devices.

6.3.1 Preservation of Food and Agricultural Products

There are many varieties in various foodstuffs, such as yams, onions, etc. that are unique to Nigeria. Therefore, it is necessary to identify these varieties in each of the common Nigerian foodstuffs, examine them and establish appropriate irradiation conditions for effective preservation. In addition, investigations have to be carried out on the food constituents to ensure that important properties that influence the quality of food are left unchanged. Organoleptic tests are also required to prove that tastes and textures are unaffected by irradiation.

6.3.2 Identification of Irradiated Food

Most consumer organizations opposed to food irradiation premise their opposition on doubts on the safety of irradiated food. The lack of suitable detection methods for irradiated food has been the main argument against the introduction of this technology. The availability of such methods is in the interest of consumers, the government as well as irradiation processors. Physical, chemical and biological methods including biotechnology and genetic engineering have been developed for the identification of irradiated foods. Physical methods being developed include electron spin resonance; luminescence methods such as thermoluminescence, lyoluminescence and photostimulated luminescence; viscosity; electrical conductivity; and differential scanning calorimetry.

6.3.3 Mutation Plant Breeding.

The plant breeding research programme is aimed at boosting food production through the production of high yielding and disease resistant crops and plants. Emphasis has been on roots and tubers, such as yams and production of low cyanide cassava, etc..

6.3.4 Sterile Insect Technique

Tsetse fly transmitted trypanosomiasis in man and domestic animals poses a serious threat to the lives and livelihoods of the entire communities and constitutes the greatest single constraint to livestock and crop production. Sterile insect technique (SIT) is used in the eradication of pests such as tsetse fly that destroy farmland and adversely affects animal production.

Nigeria is part of Pan African Tsetse fly and Trypanosomiasis Eradication Campaign (PATTEC). SHESTCO, in collaboration with the Department of Insects and Pest Control, and the NVRI, Vom, Plateau State as well as other research institutes and universities in related fields aims at participating effectively in

the PATTEC to get rid of tsetse flies in Nigeria in particular, and Africa as a whole. It is expected that the special facilities such as gamma radiation sources, SIT laboratory and sample elevator would provide the nucleus of a national and regional programmes for breeding sterile tsetse fly.

6.3.5 Radiosterilisation of Medical Devices, Pharmaceutical and Cosmetic Products and Packages

The technology of radiation sterilization of biological tissue, e.g. bones and amnion, is being established in Nigeria. The presence of irradiation facility would increase interest in research and development activities of preservation technology of biological tissue. The establishment of this programme for radio- sterilization tissue graft would serve the needs of Nigerian hospitals and eventually that of the subregion.

6.3.6 Radiation Cross- linking in Polymers

Research and development in radiation cross- linking is aimed at producing new materials with improved mechanical, electrical and thermal properties in plastics for example cable & wire products, plastic pipes for hot water, and vulcanization of natural rubber. The R&D is also for development of techniques to improve standardization and quality control services at the GIF to the patronizing industries.

6.3.7 Radiation Dosimetry

The research and development programme in radiation dosimetry is directed at production of high quality, reliable, cost effective, easy to use and cheap local material, fluorspar (CaF^2) for personnel radiation dose monitoring in hospitals, mining industry (including solid mineral exploitation and exploration), petroleum industry, research and tertiary institutions and for export.

In addition to produce locally, commercial quantities of alanine dosimeter materials (palletized and thin film) for radiation processing of food and industrial products for use in Nigeria and for export. Finally to establish an international standard laboratory for selection and calibration of dosimetry system for radiation processing and set up personnel radiation dose monitoring services that will be certified by both International Atomic Energy Agency and the Nigerian Nuclear Regulatory Authority.

1.4 Economic Benefits

The expected economic benefits are many. The presence of Gamma Irradiation Facility at SHESTCO will open up a vista of investment opportunities in many sectors of the economy. Spin-off industries are expected in agriculture and agro-allied sector, food processing, pharmaceutical, plastic, rubber, and wood and furniture sectors respectively with export potentials.

Production Hall of the Gamma Irradiation Facility

Another expected spin-off is the emergence of packaging industries to service the facility. Small and Medium Scale Enterprises (SMEs) in particular can benefit immensely from partnership with the gamma irradiation facility in many ways. Appropriate packaging is expected to reduce post-harvest losses of agricultural products. It is also expected that the sterilization of medical equipment, pharmaceutical and cosmetics products and packages have the potentials to create SMEs.

6.5 Advantages of Food Irradiation

Just as freezing, refrigeration, pasteurization, canning and chemical fumigation, food irradiation is a method for preserving food. For some foods it is obviously a better alternative. Freezing and refrigeration are very expensive and not readily available in most parts of the country. Pasteurization is very good for milk and milk products but has its limitations. Chemical treatment had been the preferred method, however public safety, public health and the environmental concerns over chemical residues have limited its acceptability. Gamma irradiation treatment is therefore the preferred choice.

Food irradiation is the treatment of food by certain type of energy. The process involves exposing the food either packaged or in bulk to carefully controlled amount of ionizing radiation for a specific time to achieve certain desired objectives. The process cannot increase the normal radioactivity level of the food, regardless of how long the food is exposed to the radiation or how much of an energy “dose” is absorbed. Low energy gamma radiation is used and the threshold energy is far below the energy required to cause radioactivity in the products.

Food irradiation is a proven and safe technology for controlling the microbiological contamination, which causes food-borne illness and food losses due to spoilage. It also eliminates insects that infest and destroy food and agricultural products. The World Health Organization (WHO), the UN Food and Agricultural Organization (FAO), International Atomic Energy Agency (IAEA), and the US Food and Drug Administration (FDA) endorse radiation processing of food and agricultural products. It is therefore an internationally acceptable safe and standard procedure for treatment and preservation of food.

Irradiation treatment is competitive in the international market. It is in fact cheaper and more environment-friendly. This is in addition to other advantages, such as savings from use of chemical preservatives, improve wholesomeness of food and food products and safety of consumers.

6.6 International Collaborations:

The facility is being managed in collaboration with our Technical Partners, Framatome ANP, who have acquired vast experience in building of similar facilities. It is expected that this partnership will cover three years post commissioning after which the owners (after privatization) will take over. Currently, discussions are on-going with the International Atomic Energy Agency (IAEA) in Vienna to designate the facility as a Regional Centre of Excellence in Food Irradiation.

A group photograph of GIF staff

Dosimetry Laboratory

6.7 Profile of the Director:

The Gamma Irradiation Facility is headed by Dr. Charles A. Adesanmi, Director of Radiation Application and Safety. He is currently supported by a technical team of seven staff who had had varied degrees of training in Germany and other countries. It is expected that more persons will be engaged once the facility becomes fully operational.

Dr. C. A. Adesanmi had his undergraduate training in Physics (1975), and took his Masters and Doctoral degrees in Nuclear Physics (1979) and Applied Radiation Physics (1983), respectively.He started his academic career at the Centre for Energy Research and Development (CERD), Obafemi Awolowo University, Ile- Ife, Nigeria with research responsibilities in the areas of nuclear instrumentation, radiation application and safety. He moved to SHESTCO in 1997. He has participated in several IAEA projects and programmes in Nigeria and abroad (1985- 2005). He has published many papers in reputable international journals and various conference proceedings.