Inaugural Lecture Series 232

VOYAGE OF GLOBAL DISCOVERY VIA THE FOOD ENGINEERING PATHWAY

By

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Professor of Food Science & Technology

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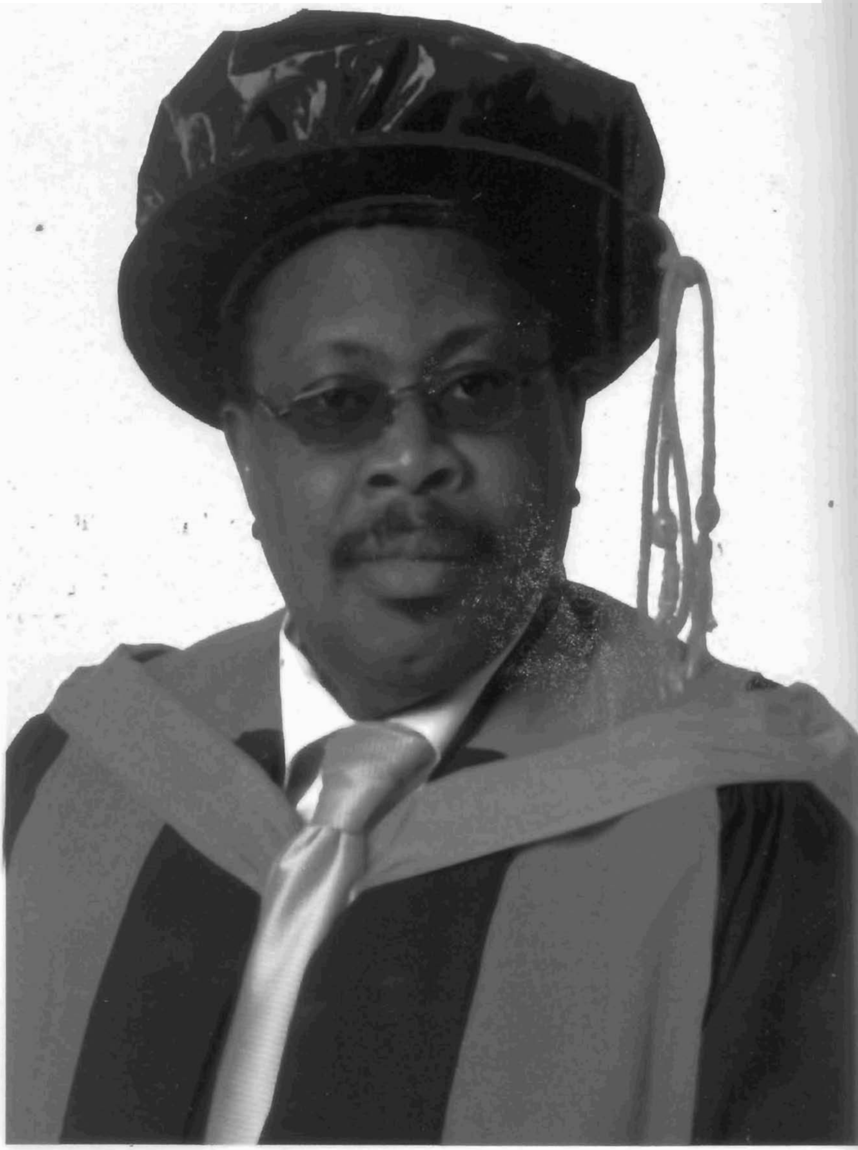

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"The famine was over all the face of the earth and Joseph opened all the **storehouses**, and sold to the Egyptians. And the famine became severe in the land of Egypt. So **all countries came to Joseph in Egypt to buy grain**, because the famine was severe in all lands" Genesis 41:56-57, The Holy Bible, New King James' Version.

PREAMBLE

Mr. Vice Chancellor, Sir, Distinguished Ladies and Gentlemen, every voyage must have a *terminus a quo* and a *terminus ad quem*. I embarked on this journey as a ship-boy in 1977 when I came to Ife as a first-year student. I had taken the Concessional Entrance Examination for admission into the preliminary class at the then University of Ife the previous year. I received all my formal training here in this university leading to the award of the Bachelor of Science degree in Food Science and Technology in 1982 and a Doctorate in Agricultural Engineering in 1997.

Having qualified as an able-bodied seaman in 1982, I continued the sail as a crew member in 1984 when I joined the services of this university as a Graduate Assistant. I rose through the ranks until a Chair was established for me in 2003 in the Department of Food Science and Technology. It is this Chair that I am inaugurating today.

Looking back now, I cannot but give thanks to my creator for sparing my life till the dawn of this day. I am also grateful to the founding fathers of this great university for building an institution such as this that continues to nurture talents even in a highly anti-intellectual environment like ours. I see this occasion as an opportunity to give back to society just a bit of what society has given me.

Mr. Vice Chancellor, Sir, I come from a department with a rich tradition. Late Professor G. R. Howat of the Department of Food Science and Technology delivered the first ever inaugural lecture in this great institution on 30th November, 1971 (Inaugural Lectures Series Number 1). The lecture was titled "Not by Bread Alone" (Howat, 1971). Since then, there have been three other inaugural lectures from the department. This is the fifth time that a Chair has been inaugurated in the department.

In this lecture, I have chosen to talk about the place and contribution of my field of study to national development and human civilization. This will be illustrated with some of my published and unpublished work, and other key publications in my areas of competence and narrow specialization. I will also highlight some of my career milestones with their respective national and international significance. The lecture concludes with my reflections on possible internally-driven strategies, including strategic resource investments required to enhance food and national security, alleviate poverty, and foster accelerated economic development in Nigeria.

THE DIMENSIONS OF FOOD SCIENCE AND TECHNOLOGY

Broadly defined, "Food Science and Technology" is "the scientific study of the intricate nature and properties of biological food materials and the application of the knowledge so derived in their breeding, cultivation (rearing), harvesting (slaughtering), storage, selection, processing, packaging, warehousing, transportation, distribution, merchandising and marketing, in such a way as to preserve or sometimes enhance their *attribute components of quality* so that they get to their eventual consumer in a safe, convenient, and hygienic condition.

Food Science and Technology is thus an interdisciplinary field of study which overlaps generally with several other knowledge areas, but principally with Biology (Microbiology), Chemistry (Biochemistry), Physics, Nutrition, Mathematics (Statistics) and Engineering (Murano, 2003). For this reason, Food Science and Technology is not a traditional scientific discipline, but rather an application or combination of these other disciplines. For instance, Biology is the foundation that is needed to understand the changes that occur during processing, storage and handling of foods. Living organisms such as bacteria, yeasts and molds produce desirable and undesirable effects in food materials. An understanding of Microbiology is therefore needed, to enhance the desirable consequences and eliminate undesirable ones. Genetics, a branch of Biology is the foundation for Food and

Agricultural Biotechnology. That is the aspect of Food Science dealing with genetically modified (GM) foods.

Chemistry is the basis for understanding the molecular structures of biological food materials and the type of (deteriorative) changes to which they are predisposed. Since these are living tissues, an understanding of the chemistry of living systems (Biochemistry) is very important. Several topics in Physics are important to the Food Scientist. For example, physics of the electromagnetic energy spectrum is the basis for understanding not only food color, but how the microwave oven works, and also the use of ionizing radiations for food preservation. Engineering principles in areas of thermodynamics, reaction kinetics, and transport phenomena are applied to food processes and food processing equipment. And since engineering is quantitative in nature, the Food Engineer must have a full grasp of mathematics. Processing and other manipulations carried out impact on the food constituents, and because the science of Nutrition deals with the effects of food when consumed, a working knowledge of nutrition is essential to a successful study of Food Science.

Traditional and Emerging Domains of Food Science and Technology

Arising from the foregoing, it is necessary for me to state, even if only for the sake of formality, the major benefits derivable from the study of Food Science and Technology and the activities of Food Scientists and Technologists. The most obvious role of Food Scientists is to eliminate food wastages by processing perishable agricultural materials into stable intermediate or end products. This activity ensures that large excesses of foods produced at the peak of the harvest season are available all-year round. The second role is to provide for convenience in foods. As more and more homemakers work outside the home as a direct consequence of urbanization and changing lifestyles, the need for these convenience items becomes amplified. Third, the mass production techniques involved in industrial manufacture of foods ensures that only a small fraction of the population is saddled with the daily task of food preparation and or processing, thus freeing a substantial proportion of the population to carry on with the other tasks of nation building. The fourth reason is to ensure variety and novelty in food supply. As the saying goes, "variety is the spice of life". By ensuring variety and novelty in food supply, the food needs of the society are better satisfied. Finally, Food Scientists are involved in the search for food from unconventional sources, such as dried cells of beneficial yeasts for use as single cell protein (SCP) and processing of leaves into edible protein foods.

Mr. Vice Chancellor, Sir, each of the roles enumerated above from the first to the last corresponds roughly with the progressive stages of national development and also human civilization. At one extreme end of the spectrum of development are those underdeveloped nations still struggling with the basic tasks of life sustenance such as providing enough food *for the masses*, while the developed ones have more than enough to eat, and are in fact spoilt for choice from a wide array of manufactured ready-to-eat (RTE) meals. The cumulative progressive advancement of highly developed nations through each of those stages of development represents the entire gamut of change by which entire social systems move away from conditions of life widely perceived as unsatisfactory, towards conditions of life regarded as materially and spiritually satisfying (Goulet, 1971; Todaro, 1985). My brief foray into the area of Development Economics above has implications for Nigeria's economic blueprint otherwise known as Vision 20:2020, which is aimed at placing Nigeria among the biggest 20 world economies by year 2020. I shall talk about this before the end of this lecture.

The domain of Food Science is never static. The attacks on the World Trade Center on September 11, 2001 have raised awareness about the possibility of deliberate contamination of food supplies. Concern about such "food bioterrorism" intensified following the discovery of traces of spores of *Bacillus anthracis* (causative agent of anthrax) in the mail system in the United States shortly after the attacks. The prevention of such acts of food supply terrorism falls under a new area of Food Biosecurity.

Activities of Food Scientists and Food Technologists

It may be quite obvious by now that it will be very nearly impossible to define Food Science and Technology in a way that will be acceptable to all relevant stakeholders. I am acutely aware of this fact. Further, as a teacher, I know that definitions sometimes do not contribute sufficiently to an understanding of a subject matter, and that in situations where definitions are restrictive; more light can be shed on the subject by way of examples. My earlier definition of the term "Food Science and Technology" and the ensuing discussion on the domain of Food Science and Technology will now be illustrated with specific examples.

First, knowledge of Food Science is employed in military feeding (that is, in the manufacture of military rations), thus Food Science is a science of warfare. Second, Food Scientists deploy their expertise for humanitarian missions such as the Oil-for-Food Programme brokered by the United Nations (UN) in the aftermath of the Gulf War in 1991, when Iraq was allowed to sell limited quantities of oil to meet urgent needs like foods and medicines. Thus Food Science is a science of peace. By the way, one of my former teachers in the Department worked with the UN World Food Programme (WFP) as a special consultant on the Oil-for-Food Programme in Iraq. Third, Food science is involved in feeding in times of disaster, as in air-dropping of specially processed and packaged food rations for victims of earthquakes, floods and other natural disasters; so Food Science is a science of mercy. Fourth, Food Science is involved in developing cheap sources of protein which are used to supplement the food of malnourished children, often from humble backgrounds. So Food Science is the science of the poor. Fifth, Food Technologists have played vital roles which were crucial to the success of space programmes starting from John Glenn's mission to orbit the earth in 1962, through the early days of Project Mercury (when space flights lasted from a few minutes to a full day) and the Gemini and Apollo missions (of 1965 and the 1970s respectively) and to the present day International Space Station. Thus, Food science is not only an exotic science; it is also a science of the affluent.

On this note, I want to highlight some of the problems faced by astronauts in space, and how the application of the knowledge of Food science has been and could be helpful. These problems have to do with the unique microgravity environment (or weightlessness), feeding under extremely difficult and adverse conditions, limited space, limited weight (especially of refrigeration and cooking equipment), and special dietary requirements dictated by the stress and physical inactivity of the mission (NASA, 1999). A microgravity environment is one in which gravity effects are greatly reduced such that the spacecraft and all its contents including the human cargo are in a state of free-fall. Microgravity occurs when a spacecraft orbits the earth. Thus any food that is not properly handled floats in the spacecraft and does not drop to the floor because the floor is falling too. Such floating objects constitute hazards to crew and equipment. Thus due to microgravity, the first astronauts in space during the mercury era had to feed on dehydrated foods packed in special pouches, which had to be rehydrated with water at the right temperature from a water gun. Not only that, the food had to be thoroughly mixed inside the container prior to consumption via a tube. Weightlessness was the reason for the feeding tube because any piece of food that gets loose in the craft would float and constitute a hazard. Microgravity also causes eating utensils to float away unless they are secured to magnets on the food tray when not in use. Microgravity and it attendant effects thus have an enormous impact on the development of space foods, their packages and other food system requirements.

Weight constraint with respect to food carried into space during the Gemini and Apollo missions was the main reason why several Food researchers and companies developed highly compressed food bars having structural strengths comparable with any of the composite materials used for the construction of spacecrafts. Some of these materials include compressed freeze-dried peas. The idea was that these edible materials could be used as material of construction for the spacecraft, and could also double as food rations such that astronauts could feed on parts of the craft after landing. A leading aircraft manufacturing company held a patent on this in the early 1970s (Potter, 1978).

With advances in the coating of bite-sized foods with gelatin (to control crumbling), development of shelf-stable semi-moist or intermediate moisture foods (IMF), and special food packages or packaging materials, the feeding tubes were jettisoned in subsequent missions. The status of research in this area is such that the types of foods consumed by astronauts are no longer mysterious concoctions but foods prepared here on earth with many of them commercially available in grocery store shelves. Any interested person can order or purchase these modern day astronaut's or space foods on the web at http://www.aerospaceguide.net/spaceshop/spacefood.html and several other websites.

Mr. Vice Chancellor, Sir, I believe I have up till now been discussing some of the possibilities within my field of study. I now turn to the interface between food and engineering, which is my area of specialization. In this regard, I want to align myself with a famous American colleague (Murano, 2003) who defined Food Engineering as "the application of engineering principles to the manufacture of foods". Thus while a Food Chemist focuses on food components from a molecular point of view, a Food Engineer is pre-occupied with the physical makeup of foods and the evaluation of the effect of processing on the physical properties of the food. However, she or he does this with a full appreciation of the Chemist's molecular viewpoint. Food Engineering also encompasses the design and operation of food processing, **storage**, and analytical equipment.

With the foregoing, I believe this distinguished audience will be able to appreciate my fascination with the quotation on the first page relating to the famine in Egypt, which may well be one of the earliest accounts of Food Engineering achievement in recorded history, and one that at the same time involved some sort of transnational journey. It seems a perfect imagery with which to illustrate the theme of this lecture. Or how else does one construct ***storehouses*** or specially designed structures to store food for upwards of seven years without any knowledge of Food Science or Food Engineering? We should reflect for a moment on the dimensioning, air circulation and other important design considerations for the storehouses. Distinguished Ladies and Gentlemen, I leave the rest to your imagination.

BEVERAGE RESEARCH IN THE DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY (OBAFEMI AWOLOWO UNIVERSITY)

Mr. Vice Chancellor, Sir, it is important for me to describe the situation in the ship in the years leading to my qualification as an able seaman in 1982. This is very important to an understanding of my voyage around the world of food prior to the detour via the pathway of Engineering. Research in the Department was vibrant at that time in all specializations. However, no area of research held as much interest for me as Beverage research. This was due in part to the fact that almost every researcher in the Department had an ongoing research interest on beverages irrespective of their area of primary focus. My teacher in Cereal Chemistry for instance, was interested in "Kunun-zaki", a cereal-based beverage popular in Northern Nigeria. Another of my teacher, though basically interested in Food Microbiology and Biotechnology, had more than a passing interest in "wines" from tomato and some locally fermented beverages such as "agadagidi" from overripe plantain.

The busiest of them all was my late teacher whose specialization was Dairy Technology with primary focus on local unripened cheese otherwise known as "warankasi". This great teacher of mine set up an ambitious sorghum malting plant in the Department and went on to produce lager beer from the grains malted in the plant. And for good measure, he held a number of foreign patents in this area. So confident was he about his innovation, that he sent the malted sorghum grains to Germany (a European country with a great brewing tradition) for brewing trials. As a result of his exploits in this area, a Nigerian businessman and a foreign technical partner (from Germany) entered into an agreement to start a brewery in Ilesha. This project was at an advanced stage when it was aborted by the sudden demise of the Nigerian businessman.

That said, most of the credit for my interest in beverage research must go to where it rightly belongs, that is to my teacher in Food Chemistry. Of course his teaching and research were squarely and firmly located within the domain of Food Chemistry. His lectures were thoroughly captivating.

I was particularly interested to learn from him that the colour of cola-based carbonated soft drinks is due to a colour reaction following the mixture of the two cola concentrates. Further, phosphoric acid is vital for the colour reaction. That is the simple reason that phosphoric acid is always present in all cola-based soft drinks. He supervised the production in the Department, of a wide range of fruit drinks notably papaya nectar (pawpaw raw juice and pulp), orange and pineapple cordials (strained orange and pineapple juices) and mango squash (mango juice with suspended solids) which were exhibited at several trade fairs, notably the Kaduna International Trade Fair in 1979, and also at the Joint Ondo, Oyo, and Ogun Trade Fair in Akure in 1980.

This, in a nutshell, was the situation in the ship around 1984, when I joined the services of the University. So quite naturally, I started my research career on beverages, but with a focus on soft drinks and more specifically cola-based beverages. My major concern at that time was to redress the heavy dependence of the Nigerian beverage industry on foreign-held patents and technology. This dependence meant that the bulk of the profit in the Food and Beverage sub-sector of the Nigerian economy was "offshored". This capital flight, which continues till the present day, is due to the franchise agreement between foreign companies which own rights to formulae and trademarks and the indigenous companies which merely install the plant, produce according to specifications and market the products. I therefore set out to demonstrate that acceptable soft drink concentrates can be developed from locally available raw materials.

My first work in this area was on the development and evaluation of a cola-based carbonated soft drink. (Ogundiwin and Omobuwajo, 1990). The highlight of this work was the novel concentrate formulated from a flavor base containing varying proportions of extracts of kola nut, ginger rhizomes and essential oils obtained from lemon grass and leaves of a flowering culinary herb (*Ocimum gratissium*) know locally as "effirin". The quality indices of the experimental product compared favourably with those of two competitive brands, namely Coca-Cola^{R} and Pepsi-Cola^{R}. The data from this and other related studies, including extensive comparative evaluation of consumer response, indicated that an acceptable cola-based carbonated soft drink beverage can be formulated from raw materials, which are commonly available in Nigeria. Later, this new product development drive was extended to another class of popular soft drinks, that is, lemon-based beverages.

A lemon-based soft drink concentrate was thus developed. On reconstitution, the acidity was observed to be much higher than what obtained in the market equivalents. Thus the formula was modified by partial deacidification of the lemon juice used in the formulation with a 3% calcium hydroxide solution. Comparative sensory evaluation of drinks produced from the initial formula and the modified formula alongside Schweppes Bitter Lemon^R, a popular commercial brand of lemon drink, by Scheffe paired comparisons test showed there were no statistically significant preferences ($P \geq 0.05$) between the three drinks. These results along with other studies in this area demonstrated the technical feasibility for the local production of lemon-based soft drink concentrates by small- and medium-scale enterprises (SMEs) in Nigeria. The outcome of these development efforts were reported in reputable local and international journals (Omobuwajo, 1993; Omobuwajo, 1998). In the meantime, the research and development efforts of all researchers in the Department in the area of Beverage Technology, including my own efforts, were captured in an overview paper which I presented at the 17th Annual Conference of the Nigerian Institute of Food Science and Technology in 1993 (Omobuwajo et.al., 1993). This presentation sensitized local entrepreneurs to the bright prospects for sustainable growth in the beverage industry in Nigeria based on locally available raw materials and expertise.

Before, I leave the subject matter of beverage research, I should like to put on record my involvement with the development of a sugar-based hypotonic energy / sports drink which was developed (formulated) for a company in Lagos. The product was successfully launched into the market as Dextra^R in 1994 and was a market leader in its segment at that time and subsequently. At the prime of its product life cycle, the product was marketed overseas. I trust we all understand that I cannot talk at length or at liberty on proprietary works of this nature.

THE PATHWAY OF ENGINEERING AND ACCOUNTS OF FOOD ENGINEERINGACHIEVEMENTS

My interests in the area of beverage technology were put on hold shortly after I completed my Masters degree in Food Science and Technology in 1986. The Department decided to upgrade the Food Engineering Option of the Bachelors' Degree Programme to a full degree status leading to the award of a B.Sc degree in Food Engineering. This was in addition to the fully-fledged degree of B. Sc. in Food Science and Technology. Of course, the prime mover for these interesting developments was no other than the German trained Chemical Engineer who taught me Food Engineering. In the process, the Department decided that my other colleague and I who were occupying training positions, had to be trained in Engineering to strengthen manpower in that area. The initial idea was to send us abroad, but eventually it was decided that we should be trained locally. The most serious initial problem faced at that time was the non-availability of a conversion programme. As some of us here might know, anybody moving into Engineering from an allied discipline has to undergo a conversion programme, possibly through a diploma of some sort. Therefore arrangements were made with the Department of Agricultural Engineering to work out a programme involving several undergraduate courses to cover our areas of deficiency.

Audition of these courses took the better part of two years before I was able to migrate to the postgraduate courses required to fortify me for the rigors of research towards the doctorate degree in Engineering. This was particularly painful for me because I had successfully completed the coursework requirements for me to commence my doctoral research in the Department of Food Science and Technology before this change of course. Eventually, all the make-up courses were sorted out and I commenced my doctoral research in the area of modeling. This is one of the most demanding areas of engineering research, because if your model does not work, then it means your philosophy is not working. The topic of the dissertation which was successfully defended in 1996 was *Modelling of Screw Press Operation for the Expression of Oil from Palm Kernel* (Omobuwajo, 1997)

The work which was undertaken to elucidate the mechanism of oil expression entailed a rigorous theoretical analysis of the fundamental principles of screw pressing. The work culminated in the proposition of a new theory of the physics of oil expression, which has been used to predict the performance of screw press expellers. The theory thus contributed to a better understanding of the physics of oil expression and has been useful in the computer-aided design (CAD) of screw presses and other food engineering systems employing rotating screws, such as extruders and screw conveyors

In the theoretical development, transport of the oilseed material was modeled as axi-symmetric flow of a semi-solid material in the annular space between two finite horizontal co-axial cylinders to obtain simplified versions of the equations of motion. The stream function Ψ (psi), was introduced as the main dependent variable in place of the pressure and velocity terms in the combined momentum equation for ease of solution by numerical computation. The finite difference form of the partial differential equation was linearized using the Newton-Raphson method to generate a tri-diagonal matrix of Jacobian elements for the system of linear equations.

The equations were solved by a combination of Thomas algorithm and Gauss-Seidel (Leibmann) iteration to generate the radial and axial pressure gradients. The values of predicted axial pressure were recovered from the values of predicted axial pressure gradients by numerical integration using the trapezoidal rule. Approximate values of the predicted radial pressure at selected locations on the press barrel were obtained from values of the predicted axial pressure and validated experimentally. The mean relative percentage deviation moduli between the predicted and experimental values were 30.7% and 23.7% at the operational speeds of 65 rpm and 85 rpm respectively.

The predicted radial pressure gradients were used to predict the oil mass flow rates out of the press in the radial direction based on Darcy's equation for fluid flow in the cylindrical polar coordinate system. The predicted oil mass flow rate at 65 rpm was 16% less than the experimentally determined flow rate; while at 85 rpm, the predicted flow rate was 15% less than the experimental value. The observed deviation between the predicted and experimental values indicated that the model equations needed to be improved. The foregoing notwithstanding, the predictive property of the theory enunciated provided an alternative feasible approach to obtaining information about the performance of a conceptual press (that is, a press at the design stage) on the computer prior to construction, as opposed to costly and time consuming empirical studies involving the trial-and-error approach. These major findings were published in the *Journal of Food Engineering* (Omobuwajo, Ige and Ajayi, 1999).

Meanwhile, prior to the final defence of the dissertation, we published an auxiliary discovery on an important heat transfer phenomenon within the press. We observed that a steady non-isothermal temperature profile was essentially established along the press barrel after about 15 minutes of press operation. In the said paper, which was also published in the *Journal of Food Engineering* (Omobuwajo, Ige and Ajayi, 1997), we established the temperature profile as well as the order of heat generation that could be expected in such small-capacity presses. Further, we demonstrated how the neglect of such thermal effects by earlier researchers could have led to significant errors in their reported models. Therefore, in my major work on the model theory, the comprehensive numerical model of the screw expeller operation developed took due cognizance of this thermal phenomenon.

The basic work on improving the process and hardware technology for the indigenous vegetable oil system was extended to the wider indigenous food crop system. This was specifically to address the drudgery of manual processing which appears to be the major post-harvest engineering problem limiting the utilization of promising but presently underutilized indigenous seeds and nuts such as African breadfruit (*Treculia africana*), sorrel (*Hibiscus sabdariffa*), ackee apple (*Blighia sapida*), breadfruit (*Artocarpus altilis*) and African nutmeg (*Monodora myristica)*. One painful discovery was that the physical properties often required for the design of cleaning, dehulling, and other sundry labour-saving food processing machineries have not been determined. Thus, a substantial part of my research effort was devoted to these tasks. Results of our investigations into the physical properties of these crops relevant to the design of cleaning, dehulling and other sundry labour saving devices were reported in several articles in the *Journal of Food Engineering* (Omobuwajo, Akande & Sanni, 1999; Omobuwajo, Sanni & Balami, 2000; Omobuwajo, Sanni, & Olajide, 2000; and Omobuwajo, Omobuwajo & Sanni, 2003).

To further demonstrate the usefulness of the mass of data generated on the engineering properties of the underutilized food crops, a prototype machine for dehulling the African breadfruit seed was developed (Omobuwajo et. al., 1999). The machine, which is shown in Figure 1 comprised a roller which cracks the hull, an oscillating cam follower which removes the cracked hull through repeated shearing against a stationary wall, and an aspiration unit which sifts the hull from the endosperm. On testing, the throughput of the

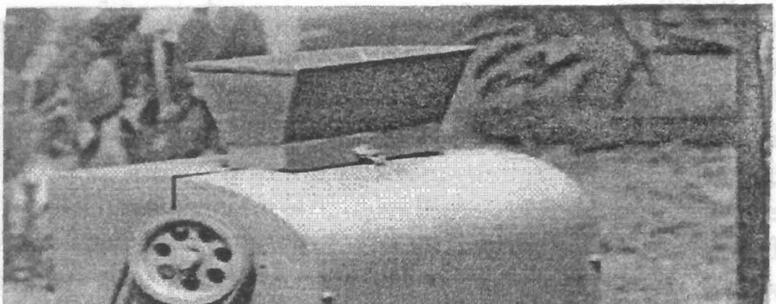

Figure 1: Prototype of the dehuller for African breadfruit seeds

dehuller was 64kg/h; yield, 75%; completely dehulled seeds, 85%; breakage, 1% and sifting efficiency was practically 100%. By removing the drudgery involved in dehulling the breadfruit seed, the machine will promote its optimum utilization and emergence as a veritable staple food.

In order to expand their food uses and further promote their utilization, representative samples of the investigated crops (including the seedless breadfruit variety), were then processed into novel food forms. These included shelf-ready, ready-to-eat products such as butter-like spread from African breadfruit seed (Omobuwajo, 2002), table spices from calabash nutmeg (Omobuwajo, 2003a); and fast moving snack food items like biscuits, prawn crackers and fried chips, from breadfruit (Omobuwajo, 2003b). The data presented in these studies have therefore demonstrated the potential for the industrial exploitation of many of these presently underutilized crops.

Mr. Vice Chancellor, Sir, I want to speak briefly to our work in the development of grain cleaning machinery. By saying our, I mean my Ph.D. supervisor (Prof. M.T. Ige) and I. After the doctoral work, he suggested that we put up a proposal for the development of grain cleaning machinery for funding to the University Research Council. We did and got substantial funding from the University. The starting point for our work was characterization of impurities in a number of locally produced grains namely rice (*Oryzae sativa*), beans (*Vigna unguiculata*), maize (*Zea mays*), and sorghum (*Sorghum bicolor*). Samples of these grains produced under different agricultural practices were collected. For instance, rice samples were collected from Igbimo and Erio-Ekiti (Ekiti State), Erinmo (Osun State), Gboko (Benue State), and Abakaliki (Eboyin State); while for beans, samples collected included those produced under different cultural practices such as Kano or drum beans, Sokoto beans, and Kaduna beans.

The impurities identified included, chaffs, sand, stones, dust, stalk or trash, and untypical seeds. Percentage composition of whole grains, broken grains and all the impurities, were determined for all grain types using a standard set of sieves. Based on the results, three design concepts were experimented at the machine development phase. The first concept was to employ solely differences in the aerodynamic properties of the grains and the impurities to achieve cleaning through aspiration. Consequently, an aspiration grain cleaner comprising a hopper, frame, separating cylindrical sections and a belt and pulley drive system was designed, constructed and tested (Ige, Omobuwajo & Aina, 2002). The aspiration cleaner is shown in Figure 2.

The second concept was to exploit differences in both the specific gravity and aerodynamic properties between the grains and impurities to achieve cleaning. Consequently, a multiple discharge grain cleaner was developed (Figure 3). The machine which subjected the grains to vibratory motion under aspiration comprised basically of a feed hopper, an aspiration unit, a venture unit and a separation unit mounted on the main frame (Ige, Omobuwajo & Ogunfuye, 2003). The separation efficiencies for the various grains ranged from 50 – 85%. The third concept was to exploit combination of

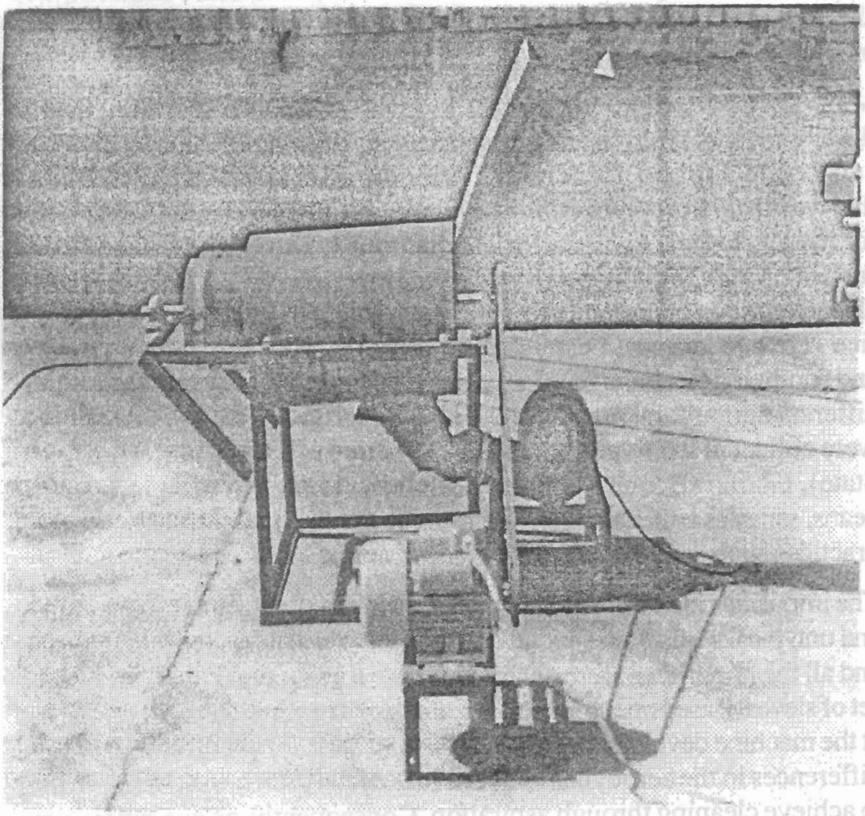

Figure 2: The aspiration grain cleaner

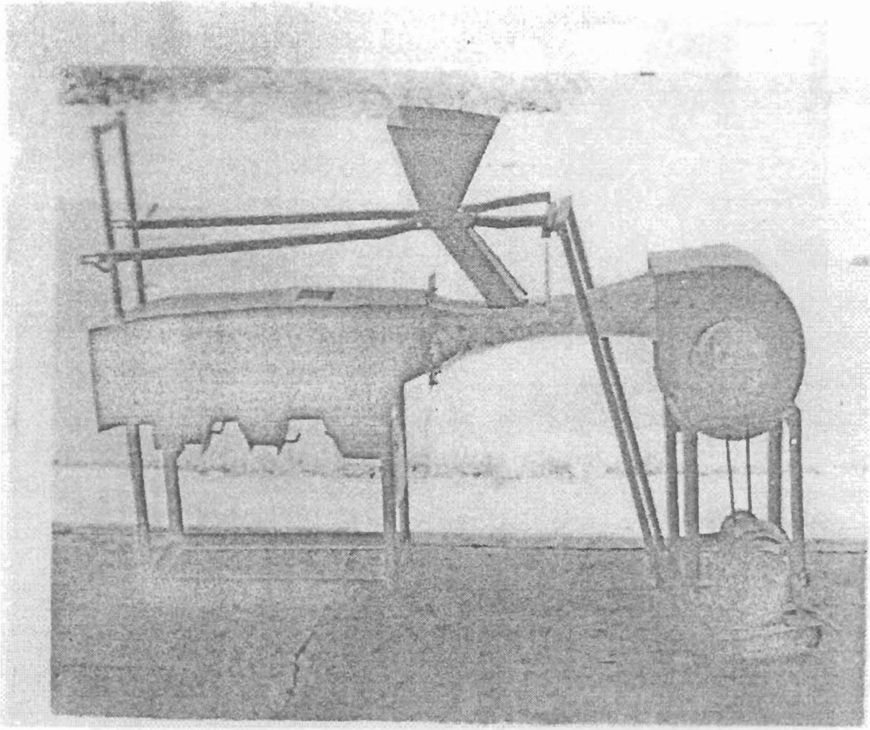

Figure 3: The multiple discharge grain cleaner

differences in characteristics such as size, aerodynamic and frictional properties. Consequently, a concentric drum grain cleaner was developed (Ige, Omobuwajo & Kareem, 2003). The machine shown in Figure 4, was tested at different speeds between 50 and 100 rpm. The machine had cleaning efficiencies of 67 to 97%. The highest cleaning efficiencies were recorded for the smaller seeds, especially at low speeds and in tilted positions of between 15 and 30°.

All the innovations reported on the indigenous food crop system are ready for adoption. The adoption of these technologies will (a) reduce the arduousness associated with the utilization of these crops, (b) increase their patronage and improve the income of local farmers and processors, who are mostly women, and (c) enhance household food security and self-reliance among African families.

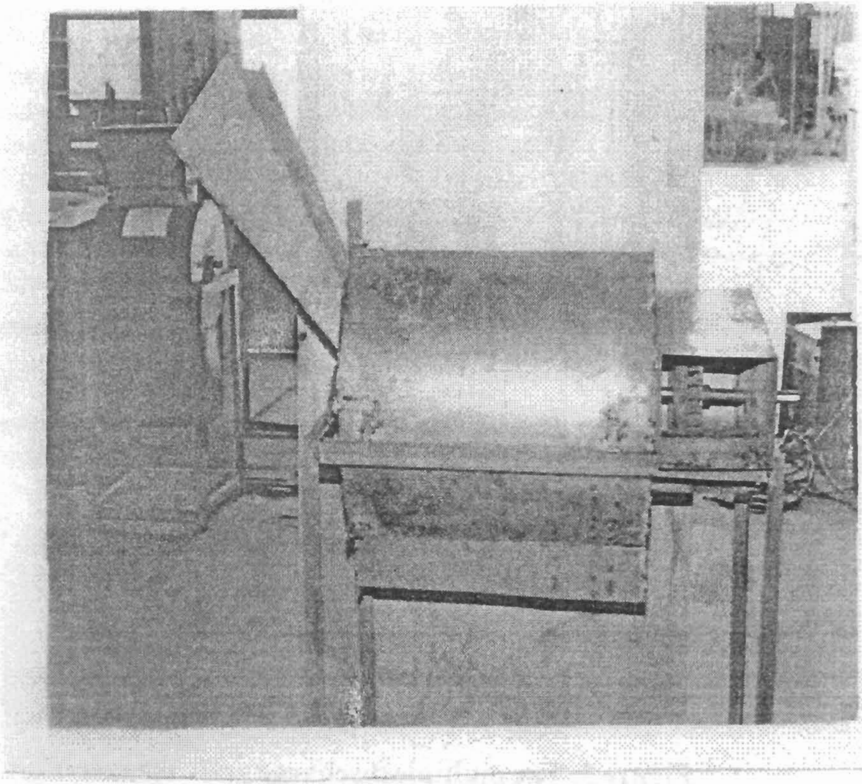

Figure 4: The concentric grain cleaner

Thermal agglomeration of chocolate drink powder

Mr. Vice-Chancellor, Sir, before I draw the curtain on this segment of my discussion, I will like to talk briefly about my work on agglomeration of cocoa powder. Cocoa powder is a by-product of cocoa processing. This is what "Lagosians" popularly refer to as "eruku Oshodi" meaning "Oshodi dust" partly because of its powdery nature and partly because it is commonly hawked in Oshodi, a suburb of Lagos. Agglomeration is the formation of larger and permanent aggregates by sticking together of particulate materials such that the original particles are still identifiable(Coucouglas, 1993). The process has wide applications in the food industry, such as in tumbling of cocoa (chocolate drink) powder to produce chocolate beverage aggregates like Milo^R and Bournvita^R. Benefits accruable from agglomeration include reduction in dusting losses and handling hazards particularly with irritating powders, enhanced flowing and dispensing characteristics, attractive colour and appearance, and better control of solubility, porosity and other functional properties of finely divided solids (Perry and Green, 1984).

At present, agglomeration of chocolate drinks powder to produce granular beverage products is carried out with sophisticated processes requiring expensive additives like binders and surfactants, and also expensive machinery. In our work, a simple low-cost technique of thermal agglomeration for producing chocolate drink powder was developed (Omobuwajo, Busari and Osemwegie, 2000). Essentially, it involved heating the cocoa powder on metal plates, without the need for expensive machinery and additives. Optimal process parameters for the new technique, such as heat flow, operating temperature, and agglomeration time were determined as a prelude to the development of a continuous thermal agglomerator, that is, the equipment required to realize the developed process. Many of the experimental agglomerates compared favourably with the internationally accepted brands of instantized chocolate beverage granules, in terms of objective quality indices, such as ease of reconstitution, density characteristics, flowability, and also sensory attributes. The new technique, comprising of essentially one simple unit operation, promises to be more competitive than the sophisticated multiple unit operation processes, currently in use in the food and beverage industry. The thermal process would make the nutritious chocolate food drinks more affordable by, and therefore available to, the large number of nutritionally disadvantaged people, thereby improving their nutritional status. Enquiries about this process have been received from several interested parties including Cadbury headquarters in the United Kingdom.

DEVELOPMENT OF MILITARY RATIONS

Mr. Vice Chancellor, Sir, the mission of the armed forces is to win battles and wars by means of firepower and maneuvers. To do this successfully, energy is required by the combatants. Thus, the type of food available to meet energy demand is crucially important. The earliest recorded accounts of warfare attest to the fact that the logistical task of providing subsistence to military personnel has been critical throughout history. For instance, the armies of Julius Caesar (100BC-44BC) always marched with wheat wagons on their trail, just as Napoleon Bonaparte, the great French warrior insisted his armies carry wheat and other easily transportable food, during the Napoleonic Wars between 1799 and 1815. And closer home, provisioning for combatants with dry, convenience and easily preserved foods during the famous Yoruba civil wars of the 19th century (e.g Kiriji / Ekitiparapo Wars of 1877 to 1893) is well-documented. Such convenience foods include: dry, roasted and milled maize meal known as "lebute"; and steamed fresh corn mash or "abari" (Akinjogbin, 1998; Adediran, 2010). Due to the logistical nightmares experienced by armies with respect to food transportation, dehydration and packaging of foods for military usage started around the Napoleonic era. The uses of these specially prepared military rations were widespread thereafter and were standard army supply during the Second World War (1939-1945), the Korean War (1950-1953) and American invasion of Vietnam in 1972.

Perhaps the most important lesson of the Second World War was the need to study the multifarious problems of the soldier, his relation to his weapons and his environment and their mutual interplay (Bean, 1948). The need for such studies was easily appreciated in the air where man was the limiting factor in the modern jet fighters of that era; but was not easily appreciated in the mundane area of feeding troops. It soon became apparent that, with mechanized warfare, the days of the kitchen and group mess were numbered. Field rations packaged for use by the individual soldier were conceived. Just as with weapons, machines, clothing and other paraphernalia of war, field tests played an important role in their continual development. Thus the garrison ration which was intended for group feeding was gradually replaced with individually packaged rations. The individually packed rations evolved through several generations such as: (i) the Field Ration D which was basically an emergency ration to sustain life when other sources of supply failed; (ii) the Field Ration C which was designed to provide the soldier with three meals per day; (iii) the K Ration which was an easy-to-carry ration that could be used in assault and combat operations; (iv) the Jungle Ration which was meant for war in the tropical "jungle" (Koehler, 1958).

All canned meals, and Combat Individual rations (C Ration) survived up till the 1980s when they were replaced with the Meal Ready-to-Eat (MRE) which is the current standard individual military operational ration. A typical MRE contains a meal of approximately 1,200 calories made up of an entrée or starch, crackers, a cheese, peanut butter or jelly spread, a dessert or snack, beverages, an accessory packet; a plastic spoon and a flameless ration heater (FRH) (Anon., 2010a). The FRH is a water-activated exothermic chemical heater designed to heat the entrée of an MRE. The special advantage of MREs is that they are packaged in pouches made of several layers of materials and are like a flexible can. Further, they have better storage and distribution qualities than a can, without the weight or need for a can opener. The research behind the MRE is constantly evolving. So versatile and rugged are the modern day MRE that it is now popular saying that "if you cooked a meal, stored it in a stifling hot warehouse, dropped it out of an airplane, dragged it through the mud, left it out with bugs and vermin, and ate it three years later, nothing would happen if it were an MRE" (Anon., 2010a)

Following the peacekeeping missions of the Armed Forces of Nigeria especially the war in Liberia in 1996, especially following the mode of feeding, it dawned on some of us that something needed to be done about the outmoded form of feeding. I did a memo to the Director-General of the Defense Industries Corporation of Nigeria (DICON) based in Kaduna on the need to develop home-made rations for use by the Nigerian military. I got a response that was not entirely satisfactory, but was nevertheless grateful that I got a response. It then occurred to me that I will have to start the project alone. I developed joint proposals on the packaging aspect with some colleagues at the Fraunhofer Institut für Lebensmitteltechnologie und Verpackung in Germany. I started carrying out some basic data collection on this pet project.

This endeavor got a boost in 2005 during my sabbatical at the University of Ibadan. One of the advantages was the location of the Headquarters of the Second Division of the Nigerian Army which facilitated easy interaction and collection of information from serving personnel. I therefore allotted a project to one of my postgraduate students on the development of an individually packaged combat ration. This study entailed the identification of likely combat scenarios for the Nigerian Armed Forces, identification of foods suitable for development into rations, formulation of rations with adequate nutritional requirements, shelf life studies on the packaged rations and finally, an evaluation of consumer preference using serving military personnel.

I will not go into details of our major findings or the status of research in this area, but it suffices to say that the first experimental ration developed and tested consisted of a form of rice and "kilishi", a heavily spiced, sundried meat product popular in West Africa but peculiar to Northern Nigeria (Idowu, 2006). This project requires assistance by military authorities in Nigeria. Imported combat rations are not a substitute for rations developed and produced here in Nigeria because of cultural differences and consumer preferences. Besides, the principle of soldier-acceptance is now a cardinal requirement for Army rations following the experiences of World War II.

BREADFRUIT IN THE PACIFIC – A TRIP TO FIJI ISLAND

Breadfruit is a tropical fruit from the tree of *Artocarpus altilis*. The tree is native to Malaysia and countries of the South Pacific and the Caribbean. It is now cultivated in all tropical regions of the world including Nigeria and Benin Republic. In and around Ile-Ife, the fruit is popularly known as "Gbeere" or "jaloke". When cooked, the taste and aroma is similar to that of freshly baked bread, hence the name breadfruit. The fruit is a key component of sustainable livelihoods throughout the Pacific and Caribbean

Islands chiefly as a staple food, especially on account of the various foods that can be prepared from it. These include several main dishes, casseroles, breads, desserts, appetizers, salads and soups. It is particularly noteworthy that the fruit is eaten at all stages of development, and not only at the mature stage. Aside from the culinary importance, breadfruit is culturally entrenched as part of home gardens and agro-forestry systems. For instance, the luxurious foliage shelters important food crops such as yams, kava (*Piper methysticum*), noni *(Morinda citrifolia)*, bananas; as well as notable cash crops like black pepper and coffee (Ragone, 1997). The tree is also a common feature in erosion control on mountain slopes. In addition to its dietary and cultural significance, the tree is economically important as a source of building materials (timber), medicines, insecticide, fabric, adhesive, and many more articles of trade and commerce. To further underscore its economic importance, breadfruit is fast becoming an export commodity in Samoa and Fiji.

Breadfruit is one of the commodities that have engaged my research attention. It probably would be of interest to the audience to know that my foray into breadfruit research was rather fortuitous. It was during an industrial action by the University Staff Unions in the mid 1980s. The salaries of university staff were withheld for a couple of months and a lot of people had to resort to various "coping strategies". One such strategy was eating breadfruit which was readily available and also very cheap in Ile-Ife and its environs. Breadfruit at this time was like "manna" from heaven as two mature fruits each weighing about 1.5 kg and which can feed four adults, could be obtained at that time for as little as 20 kobo or less. Several colleagues had challenged me on the fruit's nutritional benefits, and it was partly in response to this challenge that I decided to look into the scientific literature on breadfruit.

Around this time I was about rounding off the bench work towards my Master's degree in the area of Food Biotechnology/ Food Microbiology. So, naturally, my academic interest was more on the microbial spoilage than anything else. Eventually, I got some information on the composition and some other aspects, but information was scanty on the microbial spoilage. This further reinforced my interest in the microbial aspects. Thus, after about three years of study, a fellow postgraduate student (in the Food Microbiology Laboratory) and I published our findings on the microbial spoilage of breadfruit in one of the reputed European journal *Lebensmittel Wissenschaft Und- Technologie* (Omobuwajo and Wilcox, 1989). That was the first article on microorganisms implicated in the field spoilage of breadfruit in the Nigerian forest areas. As it turned out, several years later, the paper appeared to be the first reported investigation into field spoilage of breadfruit anywhere in the world. Subsequently, I supervised a number of undergraduate and postgraduate theses on breadfruit both in this university and also at the University of Ibadan where I had been privileged to spend my sabbatical leave, first in 1996 as a Visiting Senior Lecturer, and later in 2005 as a Visiting Professor.

But by far my most widely cited work on breadfruit prior to 2007 was the work undertaken immediately after the turn of the century. In the work published in *Innovative Food Science and Emerging Technologies* (Omobuwajo, 2003b), I successfully demonstrated the potential of breadfruit for industrial exploitation through processing into food forms suitable for production and distribution in fast-food service systems. The rating and visibility of the journal as well as the quality of this work helped in no small way to focus global attention on my other works. This global attention, yielded dividends in form of accolades, invitations and other forms of recognitions all over the world. First, shortly after its publication, I got invitations from three different publishers / authors for book writing projects. After considering the offers, I responded positively to the proposal from Prof. Leo Nollet of the University College Ghent, in Belgium. This collaboration resulted in two contributed chapters to a two-volume reference work on Food Manufacturing (Omobuwajo, 2007a; Omobuwajo, 2007b). Second, I received a special invitation to the First International Symposium on Breadfruit Research held in the Republic of the Fiji Islands in 2007. I would like to dwell a bit on the run-up to the scientific meeting and the role that I played.

The First International Symposium on Breadfruit Research

Though grown in close to 100 countries, breadfruit is still a "backyard" tree. In other words, it is still an underutilized crop in most areas, both with regard to its use for food security and for income generation. This has been attributed to low prioritization both by governments and research institutes, and to a limited knowledge of the genetic diversity available and how best to use that diversity. Therefore in its native land in the Pacific, some attempts were made towards the end of the last century to address these shortcomings. The Pacific Agricultural Plant Genetic Resources Network (PAPGREN) organized a series of workshops and thereby developed a regional approach to genetic resources conservation.

In due course, it dawned on PARPGREN that beyond the regional approach, a more strategic and more global approach was required. This broader approach was with the view to reviewing progress in breadfruit research, analyzing needs and priorities, and developing strategies for the conservation of breadfruit genetic resources. In addition, there was the perceived urgency for prioritizing needed work in breadfruit research and development, particularly post-harvest handling and food product development, and explore new ways to use genetic diversity, and improve breadfruit production and use especially in the food systems of the African, Caribbean and Pacific regions (that is in some of the most food insecure regions of the world).

Thus, the First International Symposium on Breadfruit Research and Development was conceived by the Secretariat of the Pacific Community (SPC), the EU-ACT Technical Centre for Agricultural and Rural Cooperation (CTA) and the Breadfruit Institute of the National Tropical Botanical Garden (NTBG) Hawaii, with financial assistance from the International Centre for Underutilized Crops, Global Facilitation Unit for Underutilized Species (GFU), Global Crop Diversity Trust, and German Agency for Technical Cooperation (GTZ). The meeting eventually held in Fiji Islands from 16th through 19th April 2007. At the meeting, regional overview papers were presented from all regions of the world. I was privileged to present not only the Nigeria country report (Omobuwajo, 2007c) but also, the African Regional paper titled "Overview of the Status of Breadfruit in Africa" (Omobuwajo, 2007d). And with the privilege came a lot of responsibilities. For instance, I Chaired the discussion group on Product Development and also served on the Editorial Board for the conference proceedings.

PRESENT STATUS AND PROMISE OF BREADFRUIT IN NIGERIA

Breadfruit is found in the forest zone in Nigeria, but mainly in the southwest. Occurrence is limited in the southeastern part, where African breadfruit (*Treculia africana*) is more popular. Even in the southwest, the distribution of breadfruit is localized, usually in rural communities. Its main use is for food, in which case it is either boiled, fried, or made into pottage. Its most important food use is by boiling and pounding into a paste akin to pounded yam, and then taken with soup. This is of special livelihood significance in these rural communities in the months of April to June-July, when the preferred yams and cocoyams are out of season, and therefore not readily available.

Breadfruit is highly nutritious on account of its high caloric content (68% starch, 4% protein, and 1% fat on dry weight basis) and significant amounts of certain vitamins (vitamin A, thiamine and ascorbic acid) and minerals like calcium (Graham and de Bravo 1981; Loos et al., 1981). In fact, breadfruit compares favourably with rice in terms of nutrients. Moreover, it is quite cheap in Nigeria as two mature fruits, each weighing about 1.5 kg, can be obtained for the equivalent of US 25 cents, and can provide a meal for four adults.

Although breadfruit is highly nutritious, cheap and readily available in relative abundance where it is grown, especially at the peak of the two fruiting seasons in May and August, it has long been underexploited in Nigeria due to its low social esteem. Removing this social stigma and increasing awareness about its nutritional qualities is one of the major challenges in the quest to transform breadfruit from its present "localized" identity into a crop that can enhance livelihoods in Nigeria.

Despite the apathy towards breadfruit at the household level, it is noteworthy that industrial research and development (R&D) efforts are being made to promote the utilization of the crop. In this regard, there are several reports (Olatunji and Akinrele, 1978; Mbajunwa, 1983; Adegoke, 1988; Ilori and Irefin 1997; Omobuwajo, 2003b) on the production of a variety of products such as composite flour, vinegar, filler (in pharmaceuticals), non-alcoholic beverages, and snacks. New grounds have thus been broken to stimulate the demand for breadfruit as an industrial raw material. These research initiatives need to be progressed to commercialization.

The crop is already offering succor to the rural poor in restricted parts of the country, but these livelihood opportunities need to be expanded. In this context, it is important to highlight some of the reasons for advocating the strategic adoption of breadfruit as a significant component of sustainable livelihoods in Nigeria. Firstly, its food economy is good, in that the fruiting season is spread over many months (including many relatively lean ones), with some fruiting throughout the year. The Breadfruit Research Network is planning to introduce those varieties that can fruit all year round. Second, the crop is highly productive, as it can fruit for 50 years or more. Third, it is easy to propagate through root cuttings and also through suckers, which it puts out freely. Better still, mass propagation techniques have been developed for the trees (Shi et al., 2007). Fourth, the tree matures at about 15 metres or more in height, and the wood has a pleasant yellow colouration and is resistant to termites (Burkill, 1997). It could therefore be useful as construction material (timber) for houses and boats. Fifth, the luxurious foliage is capable of creating a lush overstory that can shelter other economically important crops. Sixth, it has a potential for successful application in forestry development programmes, including environmental forestry, plantation development, and rural forestry. The crop can be promoted both as a food crop and cash crop, and could possibly serve as a foreign exchange earner as an export crop.

Finally, in advocating the strategic adoption of breadfruit, it is pertinent to highlight two government policies which are capable of triggering major changes in the national food landscape. The first is the directive that millers should mandatorily incorporate 10% high quality cassava flour (HQCF) into wheat flour for breadmaking purposes. The second is the bio-fuel initiative aimed at generating ethanol from cassava for use as automotive fuel. These policies could threaten the livelihoods of the people at the greatest nutritional disadvantage, since cassava is not only a subsistence crop, but also the most affordable (cheapest) and also the most popular foodstuff in Nigeria. It is therefore a feasible proposition that presently underutilized crops be developed. In this regard, the starchy breadfruit as partial replacement for the starchy root and tuber staples, like cassava and yam, in Nigerian diets, appears to be an attractive option.

ROADMAP TOWARDS MAKING BREADFRUIT A COMPONENT OF SUSTAINABLE LIVELIHOODS IN NIGERIA

Many African countries, including Nigeria, are presently classified as food-deficit countries (FAO, 2007). There is therefore an urgent need to increase food production. At present, there are vigorous calls that the food base be broadened with indigenous crops, because they still retain much of the hardy, tolerant self-reliance of their wild ancestors, and therefore represent an exceptional cluster of biodiversity, that will provide options for the rest of the world to use (BOSTID, 1996). However, in the face of the current food crisis, it is important to utilize all existing crops.

Breadfruit (*Artocarpus altilis*) is a crop with a huge potential but is greatly underutilized in Nigeria, and other African countries. Its potential is underscored by its impact in the countries of the Pacific and Caribbean Islands, where it is firmly entrenched as a key component of sustainable livelihoods, with special cultural, dietary and economic significance. So, how do we expand and diversify our food supplies in Nigeria, using this valuable natural resource that is now languishing? What are its possibilities for enhancing livelihoods and alleviating poverty? In this era of globalization where goods and services produced in one part of the world are increasingly available in all other parts, are there export possibilities waiting to be tapped? What needs to be done? How? Where lies the responsibility? Given the potentials of breadfruit as highlighted above, and the need for partial replacement of the starchy root and tuber staples in Nigerian diets, how do we proceed in incorporating breadfruit as a significant component of sustainable livelihoods in Nigeria? These are some of the issues that need to be addressed in charting a roadmap. Suffice to say that this adoption needs to be done in an integrated manner.

Firstly, the federal government has to make it a deliberate policy to promote the crop through a multiplicity of actions. This may necessitate tasking the Federal Ministry of Science & Technology and the Federal Ministry of Agriculture to jointly package a Research and Development agenda aimed at translating breadfruit into a national priority crop, or, in the alternative, set up an Advisory Committee to produce a blueprint. This agenda / blueprint must be robust and comprehensive, such that all relevant stakeholders such as Universities of Agriculture and agricultural research institutes will have a role to play. Some of the issues to be addressed by the research will include conservation, as well as germplasm exchange and crop improvement. Although, crop improvement is complex and long-term, these efforts need to be seen as an investment to secure future access to safe food, and the time to start is now.

The second thing that needs to be done to enhance the livelihood potential of breadfruit in Nigeria is the removal of the social stigma attached to the crop. This appears to be a case of an informational cascade. According to Bikhchandani and co- workers (Bikhchandani et al., 1992), "An informational cascade occurs when it is optimal for an individual, having observed the actions of those ahead of him, to follow the behaviour of the proceeding individual without regard to his own information." Culture must be respected, but it is not static, and there are subtle ways of effecting a shift in mass behaviour, especially if it is for societal good.

Third, it is imperative to consolidate the gains of previously mentioned industrial research and development (R&D) efforts by progressing these to full commercialization.

Finally, there is need to find a way to fit breadfruit into both the traditional farming systems and recently introduced ones such as alley farming.

MILLENNIUM DEVELOPMENT GOALS AND GOALS OF NATIONAL PLANNING

Mr. Vice Chancellor, Sir, the Federal Government of Nigeria recently unveiled an economic blueprint popularly called Vision 20:2020. The vision is designed to place Nigeria among the biggest 20 world economies by year 2020. I fully appreciate the thinking behind the vision, but with Nigeria currently ranked as the 165th largest economy in the world by both the International Monetary Fund (IMF) and the Central Intelligence Agency (CIA) (Anon. 2010b), I think the main objectives of the vision needs to be reworked. This is because, unlike the Millennium Development Goals with SMART (**S**mall, **M**easurable, **A**chievable, **R**esult-oriented and **T**ime-targeted) objectives set out in small, incremental and easily achievable steps within a reasonable timeframe, the objectives of Vision 20:2020 represent huge leaps within a comparatively short timeframe and are therefore not feasible given the odds. I will now enumerate the odds.

Firstly, with over 70% of our population involved in Agriculture, the proportion of the population available for the other tasks of nation building, and especially the serious tasks envisioned in Vision 20:2020 is too small. So, there is a manpower deficit. Second, in view of the substantial proportion of our population that are involved in subsistence farming (and so contribute little to our national wealth), and the millions of unemployed Nigerians, it is wishful thinking to expect a phenomenal increase in our national wealth so soon. In this respect, we should take due cognizance of the facts that we cannot do away in a hurry with our subsistence farmers and army of unemployed Nigerians, and that Gross Domestic Product (GDP) per capita is computed in terms of the value of all final goods and services produced in a nation in a given year divided by the average population for the same year. This is the reason why our GDP per capita ranks among the lowest in the world, while some less productive countries that are sparsely populated have higher GDP per capita.

Third, given the parlous state of our infrastructure, we simply do not have the funds to effect the roughly 30 fold increase in our GDP per capita from the present estimated value of \$1,200 to a value of at least \$32,000 which could guarantee us a spot among the biggest 20 world economies by year 2020, other things being equal. Let us for a moment consider the type of capital outlays that are involved in these projections. For instance, Nigeria needs to invest a whopping sum of N42 trillion in the economy in the next four years if she is to attain its vision of being one of the biggest 20 world economies by year 2020 (The Guardian, 19th July 2010), which means more than double of this amount will be required over the next ten years. Even then, this is an underestimation taking into consideration that the country needs a capital injection of over N22.5 trillion ($150 billion) into oil exploration activities in order to gain its market share amid rising global demand (The Guardian, 26th August 2010). Then the power generation capacity (not available power) is currently estimated at roughly 4,500 megawatts, while the energy demand by 2020 is estimated at 50 megawatts at 10% growth rate (Sambo, 2010). Can we for a moment imagine what will happen to our energy demand by the time all the industrial plants which presently lie comatose are brought back to life? Even with the modest projection above, where is the money to effect a ten-fold increase in power generation capacity going to come from? Is it from the private sector? Is Nigeria a preferred destination for investors? I think it will take us quite some time to effect a significant improvement in our economic standing. Therefore, when I think of our economic development blueprint, that is Vision 20:2020, I feel that we need to do a rethink because the figures do not add up. Therefore, in view of the odds listed above and some that time will not permit me to discuss, and given the fact that the other nations are not waiting for us to catch up, I have looked at Visions 30:2030, 40:2040, 50:2050 up to 100:2100 and I think a more realistic target lies somewhere in that series.

Distinguished Ladies and Gentlemen, I am not an apostle of doom. I will now offer some constructive advice on some of the things that we need to do in order to turn our fortunes around. First, Nigeria needs to turn its huge population into a national asset by equipping them with skills which are indispensable for the current and emerging global knowledge economy. This will require massive investment in education and educational reforms, including updating and expansion of academic programmes to include new fields of study and training in entrepreneurship. These reforms will embrace technical and vocational education as well. Second, Nigeria has to embrace scientific and mechanized farming in order to substantially reduce the proportion of her population involved in agriculture, including subsistence farming. Third, we need to develop our infrastructure starting from the power sector and improve our transportation system through diversification into other means of transportation so that heavily loaded articulated trucks do not damage our roads. I think these are some of the things espoused in the Millennium Development Goals by the UN, as quantitative time-bound objectives for poverty reduction and human development.

FUTURE OUTLOOK AND PROSPECTS

Mr. Vice-Chancellor, Sir, I am firmly rooted within the global framework for breadfruit research, amongst others. Also, I get regular invitations from reputable overseas institutions for participation in sundry scientific and academic activities, including book writing projects. But basically I am a Food Engineer, and it is in the area of Food Engineering practice and service that I have contributed and desire to contribute the most. Just as I was brooding on how to do more in my area of narrow specialization, I got a surprise electronic mail sometime in May 2010 informing me of my nomination into the International Scientific Committee (ISC) comprising of prominent world Food Engineers saddled with some responsibilities towards the 11th International Congress on Engineering and Food (ICEF 11) billed for Athens (Greece) in May 2011.

ICEF is a global event where Food Engineers from all over the world meet every 3-4 years. The first meeting was held in Boston in 1976, with subsequent editions in European and North American cities. The meetings are organized by the International Association of Engineering and Food (IAEF). Thus ICEF11 is the 11th of such meetings organized by the IAEF. The main objectives of ICEF 11 are to provide the forum for the discussion of research results and new scientific knowledge, promote personal contact and synergy, advance interaction between academia and industry, and facilitate exchange of information on new processes and equipment.

At ICEF 11, papers will be delivered in the following areas:

(i) Food Materials Science;
(ii) Engineering Properties of Foods;
(iii) Advances in Food Process Technology;
(iv) Novel Food Processes;
(v) Food Product Engineering and Functional Foods;
(vi) Food Waste Engineering;
(vii) Hygienic Design and Operation of Food Plants;
(viii) Food Process Design & Economics;
(ix) Modeling & Control of Food Processes;
(x) Modeling of Food Safety & Quality; and
(xi) Innovation Management.

Although I have demonstrable competence in several of these areas, the area where I have demonstrated considerable depth is on Engineering Properties of Foods. This is the area where I expect to offer the greatest assistance to the work of the ICS.

I am therefore looking forward with enthusiasm to meeting my colleagues from all over the world come May 2011. I see this as another opportunity to put mine and my institution's name on the global map. As we all know, the best recognition is the one that comes from your own people because it is the hardest to earn.

RECOMMENDATIONS

Mr. Vice Chancellor, Sir, experience, they say is the best teacher. I therefore wish to distill my reflections based on my experience in the academic world in form of recommendations.

First, in view of the substantial level of capital flight due to the low Nigerian content in the Food and Beverage sub-sector of the Nigerian economy, the Federal Government of Nigeria (FGN) should take deliberate steps to stimulate the progression of research and development (R&D) results through the national innovation system to commercial exploitation.

Second, the Nigerian Armed Forces should, as a matter of urgency, begin to harness all available resources (including information and personnel) concerned with development of modern meals ready-to eat (MRE) as the foundation for producing locally made combat rations for Nigerian soldiers.

Third, in view of the huge potentials of breadfruit which I have already highlighted, and the need to reduce the severity of food shortages in this era of food-induced biofuels, the Federal Government of Nigeria (FGN) should task the Federal Ministry of Agriculture and the Federal Ministry of Science and Technology to jointly package a national action plan / research agenda aimed at translating breadfruit into a national priority crop.

Finally, considering that Nigeria is currently ranked as the 165th largest economy in the world, in view of the prohibitive resource investments required to upgrade our infrastructure (which are estimated in tens of trillions of Naira), and in view of the fact that we cannot do away in a hurry, with the large number of our subsidence farmers who contribute very little to our GDP per capita, the FGN should direct the Ministry of National Planning to come up with a more realistic economic development blueprint at the next available opportunity to envision another development agenda. A more realistic vision may be somewhere between 30:2030 and 50:2050.

CONCLUSION

Mr. Vice Chancellor, Sir, I have taken the audience through a summary of my journey around the world of food. And what a small world it is. To be sure, this is a voyage that has taken a little over three decades. And still, another part of the voyage is just beginning. Before I continue with my course of passage, I return you all to the harbour of abundant blessings as we all look forward to celebrating Nigeria's 50th Independence Anniversary.

Finally, I thank every individual or body that has supported me on this journey, especially the Commonwealth Scholarship Commission in the United Kingdom (CSC-UK) for sponsoring my study visit to the University of Loughborough in 2004, and the Secretariat of the Pacific Community,

for the special invitation and full sponsorship to the Breadfruit Symposium in 2007. To all of my former teachers, co-researchers, colleagues, friends, present and former students, well wishers, wife, children, dearly beloved parents and family present here tonight, I say thank you for your patience. May God bless you all.

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